I am pleased to present *Understanding Canberra's Wetlands*, a curriculum program for the school community of the ACT. *Understanding Canberra's Wetlands* aims to raise students' understanding of the built environment and the management of urban stormwater.

Water is one of Australia's most precious resources. In this highly urbanised country we need to implement water conservation strategies to ensure safe, clean, plentiful water supplies for current and future generations. The creation of constructed urban wetlands replicates naturally occurring wetlands by improving the quality of urban stormwater before it is returned to creeks and river systems. Significantly, the constructed wetlands increase the biodiversity of an area by providing a sanctuary for plants and animals, improving visual amenity and creating a leisure area for the community.

The ACT Government is committed to sustainable water management. *Think water, act water*, the ACT strategy for sustainable water resource management, provides long-term guidance for the management of ACT water resources. The strategy aims to improve water use efficiency, reduce water quality impacts, enhance ecological values in urban waterways, improve recreational and amenity value, and reduce water supply and management costs.

This curriculum program supports the ACT Curriculum Framework, *Every Chance to Learn*, and provides students with the opportunity to develop an understanding of the construction of urban wetlands as an effective way of managing urban stormwater in a changing climate and of enhancing the quality of life for urban communities.

I commend the ACT Department of the Environment, Climate Change, Energy and Water for this initiative and trust that *Understanding Canberra's Wetlands* will become a valuable resource in your classrooms.

Simon Corbell MLA
Minister for the Environment, Climate Change and Water

acknowledgements

This resource has been developed by the ACT Department of the Environment, Climate Change, Energy and Water and the ACT Sustainable Schools Initiative in collaboration with the ACT Department of Education and Training.

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The units of work have been written by teachers and people with expertise in curriculum development, sustainability and the environment.

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contents

A Water Bug Identification Chart is included in this book

Constructed urban wetlands

Increasingly, the construction of urban wetlands is being used as a strategy to manage urban stormwater. Constructed wetlands replicate natural systems and are designed to accommodate sudden storm events and drought.

These units of work investigate the purpose, construction, biodiversity and impact of constructed urban wetlands. They build students' knowledge, understanding and the skills to care for existing wetlands. They highlight the importance of developing additional wetlands to meet the needs of increased population and changing climatic conditions.

In order to study constructed urban wetlands successfully, it is important for students to understand natural cycles and the complexity of naturally occurring wetlands.

What is a wetland?

Wetlands are water bodies that range from shallow areas to deeper ponds and support a range of vegetation types. They may be naturally occurring or constructed. Constructed urban wetlands form the focus of these units of work for students.

Inland wetlands, such as those in the ACT, are freshwater and occur in the surrounding mountains and lower-lying areas. They are usually located in the vicinity of major rivers and creeks. Inland wetlands are affected by cycles of drought and flood.

Estuarine wetlands are distinguished by their saltmarsh or mangrove vegetation and form the low-lying ecosystem between the ocean and the land. There are good examples of these types of wetlands at Sydney Olympic Park, Homebush Bay.

Why are constructed wetlands important?

Wetlands are important for many reasons. Constructed wetlands can be seen as a valuable outdoor classroom. They improve urban water quality and increase biodiversity. Wetlands provide habitat for migratory birds and refuge for wildlife in times of drought. They enhance the urban landscape, provide recreation and volunteering opportunities and help develop a sense of identity and place for the community. Constructed wetlands may also be used to harvest stormwater for irrigation of playing fields instead of using drinking-quality water.

Global agreements

The Ramsar Convention is an international agreement between member countries to protect the ecological character of their wetlands. It was signed in Iran in 1971. Objectives of the Convention are to halt the worldwide loss of wetlands and to conserve those that remain. Australia is a signatory to the Ramsar Convention and has 65 sites of international importance. Ginini Flats Wetlands in the ACT is one of these sites.

Wetlands are recognised as important sites for migratory birds and Australia is signatory to international agreements with Japan and China to protect these birds. These global agreements confirm Australia's commitment to the protection of wetlands.

National agreements

In addition to being a signatory to the Ramsar Convention, Australia also has legislation in place to protect important flora and fauna as well as places of ecological and heritage importance. These are defined and protected under the *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act).

ACT wetlands

There are numerous naturally occurring wetlands in the ACT and surrounds, such as Nursery Swamp in Namadgi National Park, Gungahlin's Horse Park Wetland, and Lake George, NSW. In addition, there are many constructed urban wetlands, like the David St, O'Connor wetland built in 2001. This water body was constructed to help improve the urban water quality in the Sullivans Creek Catchment and provide urban habitat. Nearby is the recently constructed wetland at Banksia St, O'Connor.

The ACT Government is committed to building more urban wetlands over 2010–12. This includes the Dickson and Lyneham wetlands in the Sullivans Creek Catchment and The Valley Ponds located on a tributary of the Ginninderra Catchment in Gungahlin.

Information about major wetlands of the ACT and surrounds is included in this document.

unit title: constructed urban wetlands

unit description

This unit builds understanding of what a **wetland** is and the place of wetlands in larger and more complex water systems. It explores the practice of managing urban **stormwater** by **constructing urban wetlands**. It builds understanding that design and management of urban wetlands is evolving and based on scientific best practice.

Students are encouraged to act in an informed and responsible manner through involvement in care for wetlands and water **catchments.** It is intended that by direct involvement and positive action this unit will engender a sense of optimism for the future.

The unit is supported by a Case Study of the David Street Urban Wetland in O'Connor ACT and by resource materials collated by the Department of the Environment, Climate Change, Energy and Water.

band of development: Early Childhood

Year level: 2

Duration: 10 weeks

Host KLA: Science

big understandings

Wetlands are part of a large catchment system.

Wetlands are complex systems involving biological, chemical and physical interactions.

Everyone can be a wetlands steward, as an individual, or in partnership with others.

Wetlands have environmental, social and economic values.

Constructed urban wetlands are an important part of managing our water resources in a changing/drying climate.

focus questions

What do we know about urban wetlands?

Where do wetlands occur?

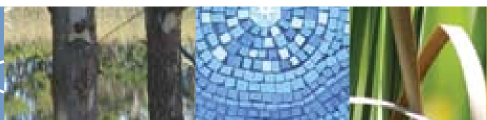
What are the features of wetlands?

Can wetlands be created?

What is the impact of human beings on naturally occurring and constructed urban wetlands?

How can we care for wetlands?

What did I learn from this study?



essential learning achievements

ELA 2 The student understands and applies the inquiry process

Students have opportunities to:

2.EC.2 contribute to planning and conducting simple investigations by asking questions and seeking answers through observing, experimenting, engaging with information in texts and discussing ideas with others

Students have opportunities to:

2.EC.3 ask questions and identify possible sources of information to seek answers

Students have opportunities to:

2.EC.5 make observations about what is happening around them using their senses

Students have opportunities to:

2.EC.12 share and communicate observations, findings, ideas and understandings

ELA 19 The student understands and applies scientific knowledge

Students have opportunities to understand and learn about:

19.EC.1 scientific aspects of their everyday activities and applications of science in their own lives

Students have opportunities to understand and learn about:

19.EC.9 some of the ways in which living things depend on their environment and each other

Students have opportunities to learn to:

19.EC.12 ask questions about and explore phenomena, relationships and ideas

Students have opportunities to learn to:

19.EC.15 talk about their investigations and observations

ELA 20 The student acts for an environmentally sustainable future

Students have opportunities to understand and learn about:

20.EC.1 key concepts used in contemporary information and debates about environmental sustainability (e.g. biodiversity, carrying capacity, ecological footprint, preservation, conservation, wilderness, heritage, sustainable development)

Students have opportunities to understand and learn about:

20.EC.3 how environmental decision making often involves dealing with conflicting values and interests of different individuals or groups (e.g. preservation of wilderness, development of non-renewable and renewable resources)

Students have opportunities to understand and learn about:

20.EC.6 consider and explain their own decisions about lifestyle choices and participation in social actions for environmental sustainability

Students have opportunities to learn to:

20.EC.7 examine examples of individual and global actions to create sustainable futures, assess the strengths and limitations of these, and propose further appropriate actions.

sequence of learning

unit stage: *Tuning In*

focus question: *What do we know about constructed urban wetlands?*

outcomes	assessment
Students will know, understand and be able to: • identify a picture of a wetland from various other water forms, such as a creek or a river • identify a wetland within the ACT.	*Students are able to:* • describe several key features of a wetland.

suggested teaching and learning experiences to achieve outcomes

Determine students' prior knowledge of wetlands and other water based landscape features such as creek, rivers and lakes.

Identify students' knowledge, values and beliefs about **wetlands.**

Examine visual representations of a wetland, identify key features.

Predict what sorts of animals are likely to live in a wetland.

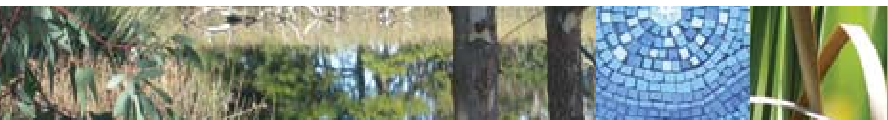
Sort these into groupings such as mammals, birds, reptiles, fish and **macro-invertebrates**.

Visit a wetland.

unit stage: *Finding Out*

focus questions: *Where do wetlands occur?*

outcomes	assessment
Students will know, understand and be able to: • give reasons why naturally occurring wetlands are important • locate wetlands within local region, and significant wetlands within ACT and Australia • identify some plants and animals within an **ecosystem.**	*Students are able to:* • predict a variety of plants and animals you could expect to find in a natural wetland and in a **constructed urban wetland** • explain an example of plant and animal interrelationship • explain the difference between a **habitat** and an **ecosystem** • explain the **life cycle** of a wetland animal that undergoes **metamorphosis.**



suggested teaching and learning experiences to achieve outcomes

Investigate the location of wetlands in the ACT.
www.tams.act.gov.au/play/pcl/parks_reserves_and_open_places/water_catchments/lakesandponds

Investigate the inflows and outflows of a nearby wetland and how it is part of a larger water system.

Compare and contrast the key features of a natural wetland with a constructed urban wetland.
http://education.melbournewater.com.au/content/rivers_and_drainage/wetlands_-_natures_filter/wetlands_-_natures_filter.asp

Use an image sort to differentiate between animals and plants that may live in a wetland or in other environments.

Establish a set of criteria to determine whether things are living or non-living.

Introduce the concept of habitats, varieties and features of habitats.

Establish criteria for determining an example of a habitat.

Introduce the concept of an ecosystem.

Establish criteria for determining an ecosystem.

Predict the plants and animals you would expect to find in a specific natural and a specific constructed urban wetland.

Investigate habitats and ecosystems you predict will be found within the wetland you intend to visit.

Compile a collection of images of plant and animal populations you predict could live in the local wetland.

Introduce the concepts of metamorphosis and life cycles.
www.ginninderralandcare.org.au/res/File/PDFs/Schools%20Resources/Frogwatch%20Education%20Kit%202009.pdf

Investigate wetland animals that undergo metamorphosis, e.g. a frog or dragonfly. Categorise these as insects and amphibians. Speculate on why some animals may go through different stages.

Construct a data collecting tool and record species of plants and animals you expect to find at the wetland.

unit stage: *Sorting Out*

focus question: *What are the features of wetlands?*

outcomes	assessment
Students will know, understand and be able to: • explain some of the geographic features, plants and animals of a permanent wetland • describe how the **water cycle** works • describe the process of **metamorphosis**.	*Students are able to:* • label a diagram of a wetland • sort information as pictures and text and predict what they would and would not find at a wetland • name and give examples of key features of some plants and animals found at the wetland • describe one or more aquatic animals in terms of its habitat • illustrate and label the life cycle of a wetland animal that undergoes metamorphosis • illustrate several habitats within an ecosystem.

suggested teaching and learning experiences to achieve outcomes

Investigate the **water cycle**. Construct a visual representation of the water cycle set in an ACT context.

www.actewagl.com.au/education/water/UrbanWaterCycle/default.aspx

Use maps to show where urban stormwater flows to within the local area. This could be natural creeks or concrete drains as in the case of Sullivan's Creek (refer to Teaching and Learning Resources – Maps/ Aerial Photos/Google Images).

www.molonglocatchment.com.au/catchment_planning.htm

Discuss the importance of scientists using primary sources of information.

Make predictions about the impact of recent weather on the animal and plant species in an urban wetland.

Visit a local wetland.

Invite a guest speaker from Waterwatch and/or ACTEWAGL to conduct water **turbidity** experiments and to illustrate **macro-invertebrates** in water samples.

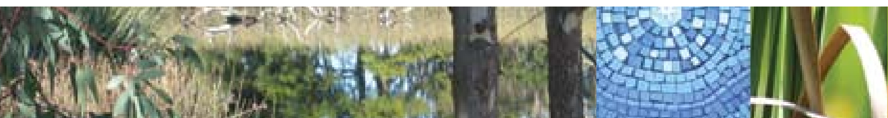
www.act.waterwatch.org.au

Collect and examine water samples to recognise living and non-living things. Collect evidence and record data.

Make observations of a wetland's catchment.

Collect data on how many examples of specific species of plants and animals you observe at the site.

Develop a word wall of appropriate terminology.



unit stage: *Going Further*

focus question: *Can wetlands be created?*

outcomes	assessment
Students will know, understand and be able to: • give a simple explanation as to why constructing urban wetlands is useful in managing urban stormwater • give a simple explanation of how managing urban stormwater is part of managing a bigger water system • explain how individuals, communities and governments are involved in keeping the water supply clean.	*Students are able to:* • annotate a map of the local wetland and catchment using pictures and words • identify the responsibilities of some of the people involved in caring for wetlands.

suggested teaching and learning experiences to achieve outcomes

Draw and label a diagram of the wetland showing some key features including inflows and outflows.
www.environment.act.gov.au/__data/assets/pdf_file/0010/189433/case_study_FOR_WEB.pdf

Construct a model of water running through a concrete drain and contrast it with water flowing through a natural water course which includes plants, rocks etc.
www.ginninderralandcare.org.au/res/File/PDFs/Schools%20Resources/Design%20a%20Wetland_Suggested%20Activity%20Upper%20Primary.pdf

Explain the concept of a water **catchment.**
www.actewagl.com.au/education/water/default.aspx

Construct models to show how **gross pollutant traps** and natural filtration systems work.

Develop a flow chart showing the urban stormwater **runoff** from the school buildings and grounds into the urban stormwater drains.

Develop a role play around the responsibilities of people involved in caring for a wetland.
www.act.waterwatch.org.au

unit stage: *Making Connections*

focus question: *What is the impact of of humans on natural wetlands and constructed urban wetlands?*

outcomes

Students will know, understand and be able to:

- collect evidence from a primary source, act as scientists to make observations and collect and organise data
- distinguish between a habitat and an ecosystem.

assessment

Students are able to:

- record results and organise data into a table of living things found in a wetland
- use an illustration to describe a simple **food chain** which could be found in an ecosystem.

suggested teaching and learning experiences to achieve outcomes

Show photographs, videos or other visual material to enable students to observe and discuss positive and negative human impacts on natural or constructed wetlands.
www.environment.act.gov.au/water/constructed_wetlands

Construct concept maps showing impacts of possible positive and negative human impacts on a local catchment area.

Students sort picture cards of items found in a wetland into useful, non-useful, living and dead, human litter, natural debris.

Use evidence to make inferences from the card sort and predict possible outcomes from future human actions.

Discuss the issues around immediate and long-term planning to improve the quality of water in wetlands.

unit stage: *Taking Action*

focus question: *How can we care for wetlands?*

outcomes

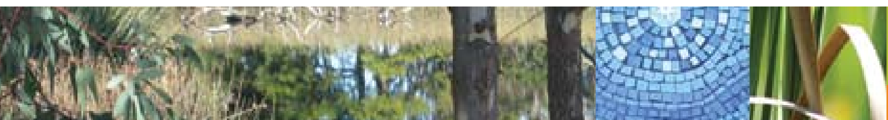
Students will know, understand and be able to:

- explain how planned urban wetlands are a strategy for managing our water resources
- identify a personal and group role for protecting wetlands
- recognise that protecting wetlands requires working together.

assessment

Students are able to:

- design an advertisement promoting the advantages of constructing a wetland for your local community
- articulate some environmental, social and economic reasons for protecting wetlands.



suggested teaching and learning experiences to achieve outcomes

Create a poster showing a cared for and a neglected urban wetland.

Prepare a poster on the advantages of constructed wetlands in urban areas.

Sort the values of wetlands under the headings of environmental, social and economic. Include these in the poster.

Investigate ways individuals and the community can protect local wetlands.

Students develop a personal action plan to protect their local urban water catchment area.

Develop a wetland habitat in your school grounds.
www.ginninderralandcare.org.au/res/File/PDFs/Schools%20Resources/Design%20a%20Wetland_Suggested%20Activity%20Upper%20Primary.pdf
www.lifeinthesuburbs.net.au/res/File/PDFs/GCG%20Frog%20habitat%20guidelines%202007.pdf

unit stage: *Sharing, Discussion and Reflection*

focus question: *What did I learn from this study?*

outcomes	assessment
Students will know, understand and be able to: • develop reflective questions on what they could have done better to improve the quality of their work.	*Students are able to:* • use a reflective question to identify an area for improvement.

suggested teaching and learning experiences to achieve outcomes

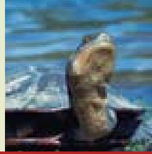
Develop an exhibition of individual and class work.

Consider a range of possibilities and develop a strategy for sharing work with an appropriate audience.

Use reflective questions to explore how their learning has deepened their understanding of their immediate neighbourhood and the world around them.

Use reflective questions to explore how the Constructed Urban Wetlands unit has deepened understanding of the immediate neighbourhood and of the wider world.

Use reflective questions to discuss ways of improving the quality, efficiency and presentation of their work.



unit title: constructed urban wetlands

unit description

This unit builds understanding of what a **wetland** is and the place of wetlands in larger and more complex water systems. It explores the practice of managing urban **stormwater** by **constructing urban wetlands**. It builds understanding that design and management of urban wetlands is evolving and based on scientific best practice.

Students are encouraged to act in an informed and responsible manner through involvement in care for wetlands and water **catchments**. It is intended that by direct involvement and positive action this unit will engender a sense of optimism for the future.

The unit is supported by a Case Study of the David Street Urban Wetland in O'Connor ACT and by resource materials collated by the Department of the Environment, Climate Change, Energy and Water.

band of development: Later Childhood

Year level:	5
Duration:	10 weeks
Host KLA:	Science

big understandings

Wetlands are part of a large catchment system.

Wetlands are complex systems involving biological, chemical and physical interactions.

Everyone can be a wetlands steward, as an individual, or in partnership with others.

Wetlands have environmental, social and economic values.

Constructed urban wetlands are an important part of managing our water resources in a changing/drying climate.

focus questions

What do we know about various types of wetlands, e.g. **swamps, bogs, marshes, fens** and constructed urban?

What is the **water cycle** and what is the place of naturally occurring wetlands within it?

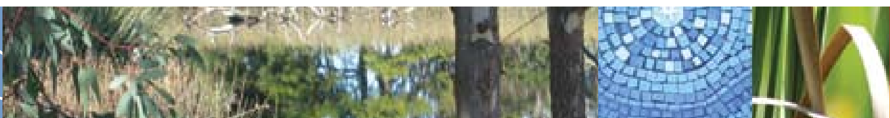
What plant and animal life would you expect to find in a wetland?

How do we determine water quality and what is its impact on animal and plant populations in wetlands?

What is the purpose and what are the features of constructed urban wetlands?

How can individuals, community groups, policymakers and corporations protect and maintain wetlands?

What did I learn from this study?



essential learning achievements

ELA 2 The student understands and applies the inquiry process

Students have opportunities to:

2.LC.1 recognise different contexts for applying the inquiry process

Students have opportunities to:

2.LC.3 create questions and predictions for investigation and testing

Students have opportunities to:

2.LC.13 discuss and compare results with their questions and predictions and draw conclusions

Students have opportunities to:

2.LC.16 reflect on their inquiry experience, identify what went well, difficulties encountered and suggest improvements to the investigation

ELA 19 The student understands and applies scientific knowledge

Students have opportunities to understand and learn about:

19.LC.2 some of the contributions made by different peoples in different times and cultures to the development of scientific knowledge

Students have opportunities to understand and learn about:

19.LC.9 structures of living things and relationships between structure and function

Students have opportunities to learn about:

19.LC.10 some interactions between living things and between living things and their environment

Students have opportunities to learn to:

19.LC.17 observe, explore, investigate, consider, identify, describe, compare and sort natural phenomena and living things and non-living things

ELA 20 The student acts for an environmentally sustainable future

Students have opportunities to understand and learn about:

20.LC.1 natural cycles and systems in the environment

Students have opportunities to understand and learn about:

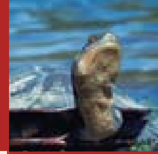
20.LC.2 the concept of **habitat** and living things within a habitat

Students have opportunities to understand and learn about:

20.LC.3 some effects of human action on natural environments

Students have opportunities to learn to:

20.LC.7 observe and gather data about local environments and changes over time due to human or natural events



sequence of learning

unit stage: ***Tuning In***

focus question: ***What do we know about various types of wetlands, e.g. swamps, bogs, marshes, fens and urban constructed?***

outcomes	assessment
Students will know, understand and be able to: • identify some of the living and non-living features of wetlands • identify a wetland within the ACT and several within Australia • give reasons why naturally occurring wetlands are important.	*Students are able to:* • identify several key features of a wetland • locate wetlands on appropriate maps.

suggested teaching and learning experiences to achieve outcomes

Identify student prior knowledge of wetlands and the water cycle.
www.actewagl.com.au/education/water/UrbanWaterCycle/default.aspx

Determine students' beliefs and values about preserving wetlands.
www.environment.gov.au/water/publications/environmental/wetlands/directory.html
www.environment.gov.au/cgi-bin/wetlands/alphablist

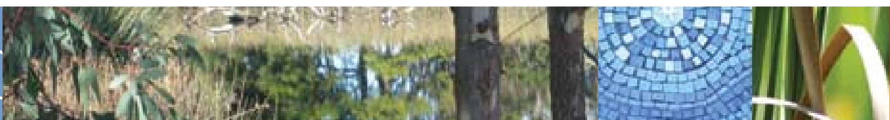
Locate, compare and contrast different types of wetlands – bogs, marshes, fens and urban constructed.

Annotate a map of the local wetland and catchment using pictures and words. Contact your local catchment group for assistance.

unit stage: ***Finding Out***

focus question: ***What is the water cycle and what is the place of naturally occurring wetlands within it?***

outcomes	assessment
Students will know, understand and be able to: • describe the water cycle including the place of natural **aquifers** and underground water storage using text and illustrated diagrams • explain the concepts of permanent and ephemeral wetlands • give some explanation for the place of natural cycles in wetlands	*Students are able to:* • explain why some wetlands are ephemeral and others are permanent • predict a variety of plants and animals you could expect to find in a natural wetland and in a constructed urban wetland • explain an example of plant and animal interrelationship



- describe some of the geographic features of the areas in which wetlands occur
- explain how natural water filtration and purification occur.

- draw a labelled diagram demonstrating the principles of natural filtration and purification
- explain how water flows through and is stored in the landscape as part of the natural water cycle.

suggested teaching and learning experiences to achieve outcomes

Develop a context for looking at rivers and wetlands of the ACT region by examining how the local rivers find their way into the Murray Darling system.
www.mdba.gov.au

Explore the **flood plains** and catchments for these rivers.

Make inferences from research to the probability of natural water storage in the local area.

Investigate natural and constructed wetlands of the region.
www.tams.act.gov.au/play/pcl/parks_reserves_and_open_places/water_catchments/lakesandponds
www.environment.act.gov.au/water/constructed_wetlands

Develop a labelled diagram or model of the natural water cycle and explain how this works.

Develop a class cumulative glossary starting with terms such as cycle, wetland, aquifer, catchment, **riparian zones, swales,** flood plain, etc.

Explore the place of aquifers in the water cycle and in natural wetlands.
www.actewagl.com.au/education/water/UrbanWaterCycle/default.aspx

Examine a wetland either through a field trip, by watching a DVD or film clip or by studying visual images.
www.environment.act.gov.au/__data/assets/pdf_file/0010/189433/case_study_FOR_WEB.pdf

Demonstrate what happens to the water as it flows through a wetland.

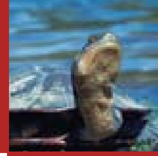
Conduct a water filtration demonstration using charcoal, sand, rocks and filter paper. Investigate the impact of **turbidity.** From this extrapolate how wetlands act as natural water storage and purification centres.

Conduct a wetland site visit.

Make observations of living and non-living elements of the environment, e.g. **flora, fauna,** inflowing creeks, riparian plains, **swales,** rocks, sand and other physical features.
www.act.waterwatch.org.au

Observe, using magnifiers, water samples to recognise living and non-living things.

Compare predictions before the visit with observations during the visit and identify changes in their knowledge, attitudes and beliefs.



unit stage: *Sorting Out*

focus question: *What plant and animal life would you expect to find in a natural wetland?*

outcomes	assessment
Students will know, understand and be able to: • describe some of the habitats and ecosystems you could expect to find in a natural wetland using a local example • explain the principles that determine the balance between reliable water cycles and plants and animals • show some understanding of how frogs are used as **environmental indicators** • use criteria to explain the function of living and non living things in a complex wetlands system.	*Students are able to:* • identify and classify the living and non-living things that you may find in a wetland • describe one or more aquatic animals in terms of its habitat • use primary source evidence to form opinions as to the health and sustainability of a species or an environment • record results and organise data into a table of living things found in a wetland.

suggested teaching and learning experiences to achieve outcomes

Find examples of plants and animals that occur together in wetlands, investigate their interrelationships.
www.lifeinthesuburbs.net.au/res/File/PDFs/GCG%20Frog%20habitat%20guidelines%202007.pdf
Email: frogwatch@ginninderralandcare.org.au

Develop criteria for classification and sort findings appropriately and show this as a graphic organiser.

Use this organiser to show what was seen as direct observation on field trip.

Develop a similar organiser to show plants and animals categories of what is likely to be found in the same area.

Investigate the relationships between several living things found in the wetland.

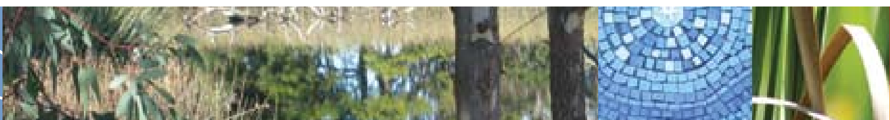
Use text, diagrams and illustrations to describe how **food chains** work and describe a food chain that occurs within the local wetland.

Illustrate the movement of energy from the sun through the food chain. Discuss how it can be stored as **biomass** and can be used to warm animals such as birds or mammals.

Compare and contrast the findings. Give probable reasons for discrepancies and speculate on implications of this for future sustainability of identified species in the future.

Make a model of a habitat where an individual organism lives, describe its place within an **ecosystem**. Include non-living (e.g. temperature, light, water, soil) and living things in the descriptions.

Use an illustrated diagram to show how frogs can be used as environmental indicators for healthy wetland environments.



unit stage: *Going Further*

focus question: *How do we determine water quality and what is its impact on animal and plant populations in wetlands?*

outcomes	assessment
Students will know, understand and be able to: • give reasons for monitoring water quality in terms of impact on health of plant and animal populations • explain the principles of natural filtration • discuss some of the ways the health of water catchments is maintained • use some criteria to discuss the health of a water catchment.	*Students are able to:* • examine water samples using basic equipment such as a microscope and magnifying glass, collect data and record observations • use these observations and data to explain their results and make further predictions.

suggested teaching and learning experiences to achieve outcomes

Form criteria to determine the health of a wetland and from this make some predictions about the health of a nearby or well known wetland.

Invite a guest speaker from Waterwatch and/or ActewAGL to talk about water catchments and managing water quality in the ACT.
www.act.waterwatch.org.au/Files/education/Journaling%20supplement.pdf

Use water samples to observe microscopic flora and fauna populations and check for water temperature, phosphates, oxygen, **pH levels**, conductivity and turbidity.

Discuss and use examples of physical equipment and data collecting tools you could use in conducting primary research.

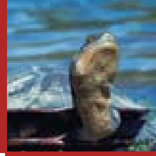
Investigate a local urban creek or concrete channel and make observations about inflows and outflows from constructed urban wetlands.
www.aila.org.au/sustainablecanberra/008-windsor/default.htm

Collect and analyse data about flora and fauna (aquatic and non-aquatic populations).

unit stage: *Making Connections*

focus question: *What are the features and what is the purpose of constructed urban wetlands?*

outcomes	assessment
Students will know, understand and be able to: • explain how constructing urban wetlands is a way of replicating nature and dealing with stormwater • describe the key features of an urban wetland	*Students are able to:* • develop a text and image poster contrasting the advantages and disadvantages to constructing wetlands in urban environments



- explain how a constructed urban wetland, such as the David Street example in O'Connor, can be developed to become part of a natural water system.

- use an illustrated diagram to explain how an urban wetland works
- develop a flow chart to show examples of positive and negative human impact on a specific known wetland.

suggested teaching and learning experiences to achieve outcomes

Compare and contrast the key features of natural wetlands to those of a constructed urban wetland.

Recognise and describe elements of wetlands and their interrelationships, e.g. inflow and outflow points, **gross pollutant traps,** sediment.

Investigate habitats in a wetland - within water, in reeds, in the riparian zone (2–3 metres from water's edge).

Develop an illustrated diagram to show the features of a constructed urban wetland.
www.aila.org.au/canberragarden/casestudies/LAWRENCE/default.htm
www.environment.act.gov.au/__data/assets/pdf_file/0010/189433/case_study_FOR_WEB.pdf

Investigate the site of a constructed urban wetland in terms of whether it is an **online** or **offline wetland**. Also investigate the proximity to an underground aquifer. Examine how aquifers can be used to store stormwater.

unit stage: *Taking Action*

focus question: *How can individuals, community groups, policymakers and corporations protect and maintain wetlands?*

outcomes

Students will know, understand and be able to:

- identify a personal and group role for protecting wetlands
- describe how protecting wetlands requires various interest groups working together.

assessment

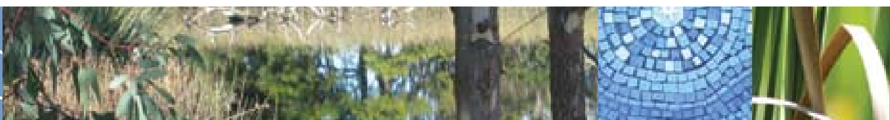
Students are able to:

- demonstrate some environmental, social and economic reasons for protecting wetlands
- create a flow chart showing how individuals, communities, policymakers and corporations can be involved in caring for local wetlands.

suggested teaching and learning experiences to achieve outcomes

Construct an urban wetland in your school grounds.
www.lifeinthesuburbs.net.au/res/File/PDFs/GCG%20Frog%20habitat%20guidelines%202007.pdf
www.ginninderralandcare.org.au/res/File/PDFs/Schools%20Resources/Design%20a%20Wetland_Suggested%20Activity%20Upper%20Primary.pdf

Use photographs, videos or other visual material to enable students to observe and discuss positive and negative human impacts on natural wetlands.



Determine and describe the values of urban wetlands in terms of improved urban water quality, increased **biodiversity**, storage of water for urban use, e.g. irrigation of ovals.

Construct a glossary of wetland terms including **runoff**, stormwater, stormwater drain, water quality, pollutants, gross pollutant trap, wetland, aquifer, biodiversity, irrigation, urban.

Revisit results from filtration demonstration to clarify the advantages of constructed wetlands.

Create a flow chart showing how individuals, communities, corporations can be involved in caring for local wetlands.

Prepare a poster on the advantages of constructed wetlands.

Sort the values of wetlands under the headings of environmental, social and economic. Include these in the poster.

Students develop a personal action plan to protect their local urban water catchment area.

Investigate the role of government, private industry, community organisations, individuals in supporting and developing wetlands project.

Identify three ways in which each level of organisation or individual can demonstrate commitment to caring for urban wetlands.

unit stage: ***Sharing, Discussion and Reflection***

focus question: ***What did I learn from this study?***

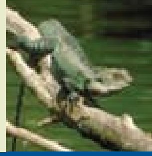
outcomes	assessment
Students will know, understand and be able to: • reflect on a process, identify catalysts for change from original plan and describe and illustrate changes.	*Students are able to:* • analyse and record the changes in their thinking as the response to new information.

suggested teaching and learning experiences to achieve outcomes

Undertake a personal reflection on the unit, what was learnt and describe changes in attitude and behaviours.

Develop a flow chart to show changes/developments in thinking from the beginning to the end of the unit.

Brainstorm how you as an individual and as a member of the school and wider community might go further.



units of work early adolescence

unit title: constructed urban wetlands

unit description

This unit builds understanding of what a **wetland** is and the place of wetlands in larger and more complex water systems. It explores the practice of managing urban **stormwater** by **constructing urban wetlands**. It builds understanding that design and management of urban wetlands is evolving and based on scientific best practice.

Students are encouraged to act in an informed and responsible manner through involvement in care for wetlands and water **catchments**. It is intended that by direct involvement and positive action this unit will engender a sense of optimism for the future.

The unit is supported by a Case Study of the David Street Urban Wetland in O'Connor ACT and by resource materials collated by the Department of the Environment, Climate Change, Energy and Water.

band of development: Early Adolescence

Year level:	8
Duration:	10 weeks
Host KLA:	Science

big understandings

Wetlands are part of a large catchment system.

Wetlands are complex systems involving biological, chemical and physical interactions.

Everyone can be a wetlands steward, as an individual or in partnership with others.

Wetlands have environmental, social and economic values.

Constructed urban wetlands are an important part of managing our water resources in a changing/ drying climate.

focus questions

How are wetlands in the ACT and the rest of Australia part of bigger water catchments?

Is all life within wetlands interconnected and interdependent?

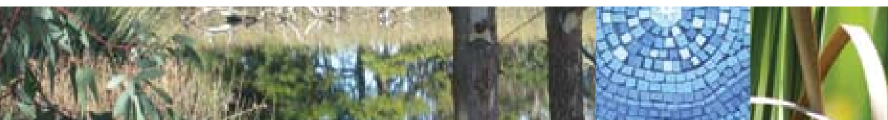
How does a constructed urban wetland differ from a naturally occurring wetland?

How can wetlands be constructed to be a self-sustaining addition to a natural water system and enhance the **biodiversity** of the area?

How can developing scientific concepts and understandings be used to improve social conditions and address priorities?

What social, environmental and economic impacts do constructed urban wetlands have on an area?

What did I learn from this study?



essential learning achievements

ELA 2 The student understands and applies the inquiry process

Students have opportunities to:

2.EA.2 understand variations of the inquiry process used in particular disciplines

Students have opportunities to:

2.EA.3 formulate questions, predictions or propositions suitable for investigation and clarify the inquiry process

Students have opportunities to:

2.EA.8 access a range of primary and/or secondary sources of information

Students have opportunities to:

2.EA.11 organise and analyse data or information, summarise and explain patterns in data, or compare and synthesise information from different sources

ELA 19 The student understands and applies scientific knowledge

Students have opportunities to understand and learn about:

19.EA.1 how science and its applications have changed the way people live

Students have opportunities to understand and learn about:

19.EC.11 why some living things are better suited to their environment than others

Students have opportunities to learn about:

19.EA.12 **food chains** and **food webs** as models of relationships within living communities

Students have opportunities to learn to:

19.EC.15 use their scientific understandings to consider and respond to appropriate ethical and social issues relevant to them

ELA 20 The student acts for an environmentally sustainable future

Students have opportunities to understand and learn about:

20.EA.1 concepts of interdependence of living things, **habitat** and **ecosystem**

Students have opportunities to understand and learn about:

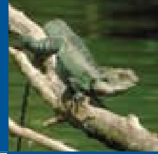
20.EA.2 some of the processes by which human activities change natural environments in positive and negative ways

Students have opportunities to understand and learn to:

20.EA.6 conduct case study investigations into local ecosystems to identify changes and predict their impacts

Students have opportunities to learn to:

20.EC.8 investigate practical ways for individuals, households or communities to conserve resources



sequence of learning

unit stage: *Tuning In*

focus question: *How are wetlands in the ACT and the rest of Australia part of bigger water catchments?*

outcomes

Students will know, understand and be able to:

- explain how all wetlands in the ACT are managed
- explain how wetlands can be located in urban areas, on rural land holdings, or occur in national parks
- describe some of the management strategies of the Parks Conservation and Lands service
- identify their local ACT catchment group and articulate the key roles and responsibilities of the group.

assessment

Students are able to:

- use a map to locate the key water features within the catchment of the ACT
- understand and restate the key reasons why care of the water catchment is important for the overall health of the water catchment
- hypothesize about the factors which affect the water catchment.

suggested teaching and learning experiences to achieve outcomes

Determine students' prior knowledge about wetlands, their types, locations and place in water catchments as part of larger river systems.

Define a catchment, explore types of catchment, i.e. urban, rural, national parks.

Using maps, photographs, charts and DVDs locate major river systems and catchments throughout the ACT and Australia (refer Teaching and Learning Resources).

Describe the catchments of the rivers of the ACT. Compare and contrast the catchments of the Cotter and the Molonglo in terms of proximity to human waste and possible **contaminants.**

Consider the management responsibilities for the categories of wetlands, national parks, farmlands, urban areas. Examine a sign denoting a water catchment 'Do not litter – Water catchment area'. Develop a list of messages inferred by the sign. Generalise about the audience and purpose of the sign.

Locate a map of the water catchment for your local area. Identify which of the ACT water catchment groups has responsibility for it. Use brochures and internet searches to investigate who is involved in the local catchment group and how it works. Be clear about audience and purpose of message.

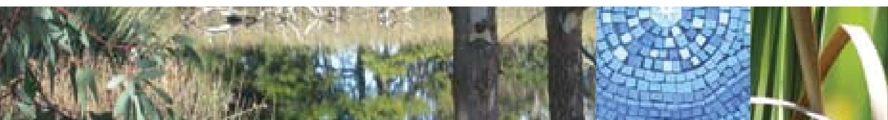
Use informed debate to differentiate between arguments as to whether littering or not littering in wetlands and water catchments matters? Record responses to arguments to use at the end of the lesson as a measure of what students have learnt.

Research and prioritise key issues to speculate on the question – "How does dropping rubbish on the street affect the yabby in the local wetland?" Develop these speculations into some form of interactive game.

Show photos of pristine rivers and of a degraded river, polluted wetland or newspaper article about an initiative with an environmental impact. Students formulate investigative questions on the implications of this problem and explore the similarities of issues within their local catchment area.

Use the identified issues to develop a research plan for a specific area of investigation.

Engage students in the Catchment Detox Game on the ABC website to deepen this understanding of the complexity of the issues and investigate strategies for making short and long-term improvements to the situation www.catchmentdetox.net.au



unit stage:	***Finding Out***
focus question:	***Is all life within wetlands interconnected and interdependent?***

outcomes	assessment
Students will know, understand and be able to: • explain how living things in a wetland ecosystem interact with each other and their chemical and physical environment • generalise about natural filtration and its effectiveness in water purification • demonstrate how scientists use models to help understand the relationships and predict change in a wetland ecosystem.	*Students are able to:* • develop a hypothesis to predict the impact of removing or adding a feature to the ecosystem.

suggested teaching and learning experiences to achieve outcomes

Use the David Street O'Connor Case Study and other resources provided with this unit of work.

Explore the concept of a wetland. Identify and develop a set of distinguishing features of a variety of types of wetlands. Include **bogs, marshes** and **fens**, constructed urban wetlands.

Develop an identification matrix showing the characteristics of the various types of wetlands.

Use maps to locate the wetland/s within local catchment areas. Explain the high interdependency between catchment land uses, flows and water quality.

Hypothesise from a list the variety of species you would expect to find in identified major groups of **flora** and **fauna.** Describe the habitats of several of these species.

Visit your local wetland and conduct some primary research.

Create a graphic organiser including labelled diagrams, data tables and information as text to show the results of your predictions and actual research finding based on your site visit.

Collect data, organise it and compare and contrast the primary source data to the hypotheses you have developed.

Assess the impact of **abiotic factors** (temperature, light, water, nutrients, sediment type, **pH**), and **biotic factors** (plants, animals and micro-organisms) on a specific wetland within the ACT.

Identify two animal species and construct a food chain and web of life describing their place within the ecosystem.

Research examples of a **food web** and/or **food pyramid** and develop hypothesis about what you would expect to find in your local catchment.

Explore the Nitrogen/Carbon Cycles. Construct an illustrated diagram in the context of your local catchment. Investigate the relationship between situations where all natural systems are working well and where systems are out of balance.

Brainstorm a prediction – visit a **stormwater** drain for first-hand observation and data collection. Organise this into a data table. Collect water samples and test to determine the presence of macro-invertebrates, dissolved **nutrients** and sediments.

Create a model of a constructed wetland as a water purifying system within the **water cycle**.

unit stage: *Sorting Out*

focus question: *How does a constructed urban wetland differ from a naturally occurring wetland?*

outcomes	assessment
Students will know, understand and be able to: • act as scientists to make observations and take measurements and collect data to identify trends • present persuasive diagrammatic information illustrating reasons for the care and protection of natural and constructed urban wetlands.	*Students are able to:* • use primary observations, data and measurements, analyse results to identify and make informed decisions • construct a model showing water and sediment flow or nutrient absorption and the importance of these to maintaining healthy water catchments.

suggested teaching and learning experiences to achieve outcomes

Create a graphic organiser including labelled diagrams, data tables, and information as text to show the results of your predictions and actual research finding based on your site visit.

Make observations and record populations of fauna and flora in the wetland environment. Use these to speculate on the health of the wetland.

Demonstrate how urban stormwater drains, based on natural waterways with reed beds, rocks, and swales can slow water down, help with sediment settling, and increase absorption of nutrients by organisms (e.g. **biofilm**, algae and **sedges**) and clean water entering the **aquifer** or entering the drain.

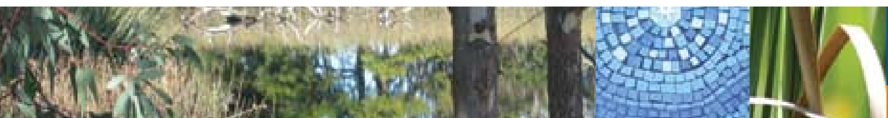
Discuss the importance of accurate data collection in measuring temperature of water, phosphates, oxygen, pH, conductivity and turbidity in the wetland.

Conduct a bug count of water samples to determine water quality, micro and macro flora and fauna of the wetland and of the stormwater overflow.

Use Waterwatch-Campfire/AusRivas (data sheets) to inform your research. www.waterwatch.org.au

Develop an illustrated diagram of the urban wetland to display your findings.

Formulate an argument for additional wetlands in your area. Include a diagram or model of a constructed urban wetland showing the structured components such as **gross pollutant trap**, embankment, overflow pipe or drain.



unit stage: *Going Further*

focus question: *How can wetlands be constructed to be a self sustaining addition to a natural water system and enhance the biodiversity of the area?*

outcomes

Students will know, understand and be able to:

- describe the main components of a constructed urban wetland and the purpose for each
- explain the thinking behind the construction of natural waterways and **swales** as urban stormwater management
- explain how the scientific body of knowledge is constantly evolving and how planning and management practices change in response.

assessment

Students are able to:

- compare and contrast past and present practices in stormwater management and discuss some reasons for the change
- predict the effect of water flows through a constructed wetland and discuss the impact it will have within the catchment.

suggested teaching and learning experiences to achieve outcomes

Analyse how the use of inflow and outflow drains, gross pollutant traps, plantings of reeds and other plants replicates nature.

Use maps to locate the wetland/s within local catchment areas. Explain the high interdependency between catchment land uses, flows and water quality.

Use data collected earlier on flora and fauna to hypothesise about their importance in maintaining healthy wetlands.

Develop a case study on the importance to wetlands of a specific macro and micro wetland fauna.

Formulate theories on the effectiveness of gross pollutant traps in trapping big pollutants, e.g. plastic bags.

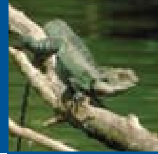
Hypothesise about the management and impact of identified pollutants on the biodiversity within the wetland?

Conduct research to determine who monitors the wetlands and what actions arise from the findings.

Discuss the impact of urban growth on an adjacent area and the implications for loss of local habitat and biodiversity.

Investigate and present conclusions on research into increase risk of flooding and erosion downstream resulting from an increase in hard surfaces such as roads and roofs in areas of development.

Develop a graphic organiser to show populations of flora and fauna prior to and after urban development (at regular intervals). Predict some of the findings and extrapolate possible implications if management strategies aren't put in place.



unit stage: *Making Connections*

focus question: *What social, environmental and economic impacts do constructed urban wetlands have on an area?*

outcomes	assessment
Students will know, understand and be able to: • justify the values of wetlands based on environmental, social and economic criteria • demonstrate human activity impacts on the wetlands ecosystem • make informed conclusions based on analysis of data and information.	*Students are able to:* • design a flow chart and explain how the social, environmental and economic aspects of the changing use of land affect the catchment and the wetland • develop an information pamphlet for the local residents outlining the environmental, social and economic values for a proposal to replace the concrete stormwater drains with an urban wetland.

suggested teaching and learning experiences to achieve outcomes

Students prepare questions to ask an expert guest speaker (ACT Department of the Environment, Climate Change, Energy and Water or from the Australian National University) focusing on social, economic and environmental implications of constructed urban wetlands. Follow through by formulating a visual record of points made.

Construct a survey of school community on benefits and disadvantages of a specific wetland nearby, either natural or constructed, and the social, economic and environmental implications.

Investigate the disadvantages of previous stormwater management through concrete drainage: fast deep flow, turbidity, safety issues, impacts on biodiversity downstream.

Provide examples of past issues, e.g. drowning, drain damage in storm events. Speculate on how this may have informed changes in governmental practices and policy.

Theorise about possible social benefits of community involvement (stewardship, connectedness/sense of place, civic action, health/fitness/mental wellbeing, safety).

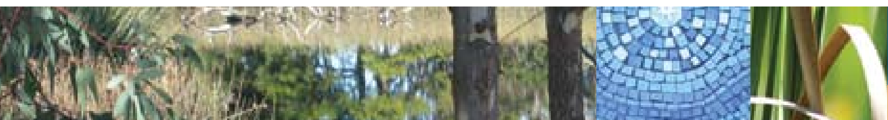
Conduct primary research by interviewing a sample group of residents and discussing the significance of the local urban wetland with them. Present findings in an organised format.

Explore the economic aspects, real estate value, cost effectiveness of water treatment and on site storage for local irrigation, reduced maintenance cost of drain upkeep. Conduct surveys and use current research, including governmental and community information, upon which to base your conclusions.

Examine the effect of water flowing through the catchment to either the ocean or the Murray Darling Basin and stormwater runoff from hard surfaces or surfaces that can absorb water easily. Make hypotheses about future policy and practices in urban stormwater management.

Formulate an opinion on the issue of the changing drying climate and water management strategies. Use data and evidence to support your opinion.

Conduct a debate on stakeholder perspectives of ACT water management decisions and their impacts for downstream users, e.g. irrigators, local industry, downstream water consumers, etc.



unit stage: *Taking Action*

focus question: *How can developing scientific concepts and understandings be used to improve social conditions and address priorities?*

outcomes	assessment
Students will know, understand and be able to: • communicate their responsibility as a steward of the environment to promote sustainability, from the individual through to governments • give evidence of understanding of perspectives of several stakeholders.	*Students are able to:* • design and explain a flow chart that shows how individuals, groups and corporations can take responsibility through involvement with local Waterwatch or Landcare groups.

suggested teaching and learning experiences to achieve outcomes

Speculate on the role of government, private industry, community organisations and individuals in supporting and developing wetlands project.

Consider how social, environmental and economic aspects of the changing use of land affect the catchment and the wetland (e.g. flooding risks, erosion, recreational pressures, loss of wetland vegetation, effect of introduced species on waterways such as carp, cats).

Construct some form of graphic organiser to show the perspective of the various stakeholders.

Develop a game to mix and match roles and responsibilities.

Design a concept map which explains the different management options for constructed wetlands in a local area, e.g. **online** or **offline wetlands** or **median strip wetlands**. Include the roles and links between each stakeholder.

Use one or more of the tools you have developed above to support a public campaign for the development of more urban catchment areas within your local area.

unit stage: *Sharing, Discussion and Reflection*

focus question: *What did I learn from this study?*

outcomes	assessment
Students will know, understand and be able to: • develop reflective questions on what they could have done better to improve the quality of their work.	*Students are able to:* • use a reflective question to identify an area for improvement.

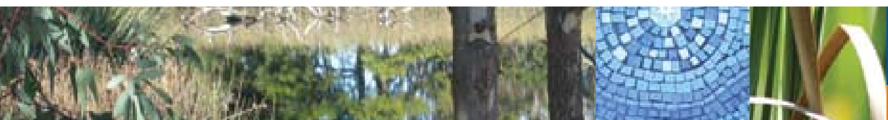
suggested teaching and learning experiences to achieve outcomes

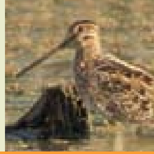
Develop an exhibition of individual and class work.

Consider a range of possibilities and develop a strategy for sharing work with an appropriate audience.

Use reflective questions to explore how the Constructed Urban Wetlands unit has deepened understanding of the immediate neighbourhood and of the wider world.

Use reflective questions to discuss ways of improving the quality, efficiency and presentation of work.





units of work | later adolescence

unit title: constructed urban wetlands

unit description

This unit builds understanding of what a **wetland** is and the place of wetlands in larger and more complex water systems. It explores the practice of managing urban **stormwater** by **constructing urban wetlands**. It builds understanding that design and management of urban wetlands is evolving and based on scientific best practice.

Students are encouraged to act in an informed and responsible manner through involvement in care for wetlands and water **catchments**. It is intended that by direct involvement and positive action this unit will engender a sense of optimism for the future.

The unit is supported by a Case Study of the David Street Urban Wetland in O'Connor ACT and by resource materials collated by the Department of the Environment, Climate Change, Energy and Water.

band of development: Later Adolescence

Year level:	10
Duration:	10 weeks
Host KLA:	Science

big understandings

Wetlands are part of a large catchment system.

Wetlands are complex systems involving biological, chemical and physical interactions.

Everyone can be a wetlands steward, as an individual or in partnership with others.

Wetlands have environmental, social and economic values.

Constructed urban wetlands are an important part of managing our water resources in a changing/ drying climate.

focus questions

Why are wetlands important in the major water systems and catchment areas in Australia and the ACT?

What is the impact on natural water systems of building additional wetlands?

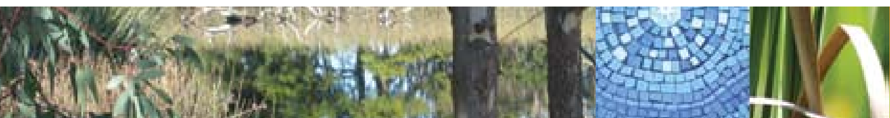
How do you manage water health, monitor trends and anticipate change in wetlands?

How are social needs and environmental trends influencing scientific research in the area of urban stormwater management?

What is the impact of changing land use on wetlands, water quality, catchments and storage?

How can the use of ongoing audits of wetlands impact on water quality, catchments and storage?

What did I learn from this study?



essential learning achievements

ELA 2 The student understands and applies the inquiry process

Students have opportunities to:

2.LA.7 identify sources and collect data and information in systematic ways to improve reliability (e.g. use refined searches to locate a range of relevant sources, control variables, use repeat trials and replication of experiments with appropriate sample sizes, seek counter-examples or explore proofs to verify the truth of propositions)

Students have opportunities to:

2.LA.8 manage and organise data and information in ways that assist in their interpretation, analysis and synthesis

Students have opportunities to:

2.LA.10 explain trends, patterns, relationships and discrepancies in data and information

Students have opportunities to:

2.LA.11 draw conclusions that are consistent with the data or information and provide evidence or supporting details

ELA 19 The student understands and applies scientific knowledge

Students have opportunities to understand and learn about:

19.LA.2 instances in which progress in science can be affected by and influence social issues and priorities (e.g. water purification, alternative energy sources, space exploration, ethics of biotechnology)

Students have opportunities to understand and learn about:

19.LA.13 scientific concepts and models to explain the interdependence of populations of organisms and the environment, and to predict the consequences of changes to an **ecosystem**

Students have opportunities to learn to:

19.LA.16 understand causes and consequences of global atmospheric changes resulting from natural and human activity (e.g. climate change)

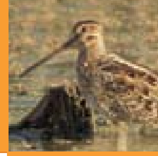
Students have opportunities to learn to:

19.LA.18 analyse and synthesise information, and use scientific models and terms to explain properties and interrelationships and to predict change in phenomena and systems

ELA 20 The student acts for an environmentally sustainable future

Students have opportunities to understand and learn about:

20.LA.1 key concepts used in contemporary information and debates about environmental sustainability (e.g. **biodiversity**, carrying capacity, ecological footprint, preservation, **conservation**, wilderness, heritage, sustainable development)



Students have opportunities to understand and learn about:

20.LA.3 how environmental decision making often involves dealing with conflicting values and interests of different individuals or groups (e.g. preservation of wilderness, development of non-renewable and renewable resources)

Students have opportunities to understand and learn to:

20.LA.6 consider and explain their own decisions about lifestyle choices and participation in social actions for environmental sustainability

Students have opportunities to learn to:

20.LA.7 examine examples of individual and global actions to create sustainable futures, assess the strengths and limitations of these, and propose further appropriate actions.

unit stage: ***Tuning In***

focus question: ***Why are wetlands important in the major water systems and catchment areas in Australia and the ACT?***

outcomes	assessment
Students will know, understand and be able to: • identify different types of wetlands within the ACT region • explain the importance of water and wetlands for organism survival.	*Students are able to:* • map the flow of water through different wetlands in the ACT region • construct a model water cycle • compile a list of international agreements Australia is signatory to that protect wetland **flora** and **fauna**.

suggested teaching and learning experiences to achieve outcomes

Determine student's prior knowledge of: wetlands, catchments and the water cycle.

Identify student's knowledge, values and beliefs about wetlands.

Compare and contrast different types of wetlands – **bogs, marshes** and **fens**, constructed urban.

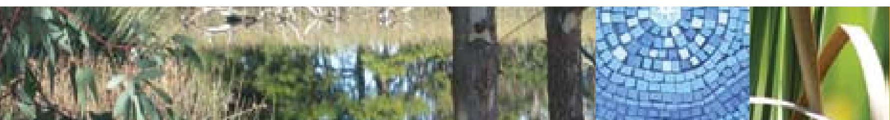
Recognise and describe elements of wetlands and their interrelationships.

Explore Catchment Detox Game and catchment information http://www.catchmentdetox.net.au/

Identify major Australian and ACT water systems, **aquifers** and storages using maps, charts, photographs and film images (refer to Teaching and Learning Resources).

Establish prior knowledge of flora, fauna, water quality and pollutants in wetlands.

Research Australia's commitment and obligations to international agreements related to wetlands, e.g. China Migratory Bird Agreement, Japan Migratory Bird Agreement, **Ramsar Convention.**



unit stage: *Finding Out*

focus question: *What is the impact on natural, animal, plant and water systems of building additional wetlands?*

outcomes	assessment
Students will know, understand and be able to: • describe the interrelationships of the life forms you would expect to find in a wetland • identify reasons for and against the construction of urban wetlands • explain key concepts of **environmental sustainability** • apply models to predict changes in populations and ecosystem.	*Students are able to:* • develop a web of life illustration of various animal and plant species you would find • develop a visual organiser of predicted impact of constructing an urban wetland on an existing waterway.

suggested teaching and learning experiences to achieve outcomes

Develop a model of a constructed urban wetland. Generalise about **biotic** and **abiotic** elements of a wetland.

Give an example of a relevant **food chain**.

Develop a matrix to show possible pollutants and their impact on a constructed urban wetland after a sudden storm event.

Investigate and analyse the reasons for and against constructing urban wetlands.

Use water/carbon/nitrogen cycle models to hypothesize about the impact of constructing an urban wetland on an existing **ephemeral** creek or stream.

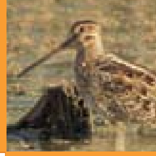
Complete Birrigai's Web of Life game. Relate interactions between food web and the abiotic factors in wetlands.
www.birrigai.act.edu.au

Research and prioritise positive and negative impacts of wetlands on water systems.

Construct water filters: compare wetlands as water filters with drinking water filters (refer to the **Engineers without Borders** program).
www.ewb.org.au

Calculate carrying capacity of ecosystems before and after constructing wetlands.

Draw graphs and/or use computer population models to identify and predict changes caused by constructing wetlands.



unit stage: *Sorting Out*

focus question: *How do you manage water health, monitor trends and anticipate change in wetlands?*

outcomes

Students will know, understand and be able to:

- measure water quality parameters accurately
- analyse collected data for water quality, biodiversity and/or population survey
- draw conclusions on wetland ecosystem health
- explain interrelationships between water quality, biodiversity and ecosystem health
- predict changes to the ecosystem.

assessment

Students are able to:

- measure accurately and record observations and data in tables
- identify trends, draw conclusions and predict changes in wetland populations based on research
- construct graphs for growth rates of frog populations based on previous years' surveys.

suggested teaching and learning experiences to achieve outcomes

Use keys and identification techniques for plants and animals.

Investigate and define water quality parameters within a wetland, e.g. temperature, phosphates, oxygen, **pH**, conductivity, **turbidity**, nitrates etc.

Visit a wetland. Make observations, collect data and water samples for later testing. Identify cause and effect to support your observations.

Collect data to evaluate wetland ecosystem health. Activities could include:

1. introduction: observe and predict wetland health
2. complete biodiversity survey of fauna and/or flora in the wetland environment
3. complete the Waterwatch assessment of physical, chemical and biological survey http://www.act.waterwatch.org.au/secondary.html
4. complete a **macro-invertebrate** survey
5. conduct population estimates for Frogwatch http://www.ginninderralandcare.org.au/content.php?id=19
6. complete RAPID – **Riparian** assessment http://www.act.waterwatch.org.au/secondary.html

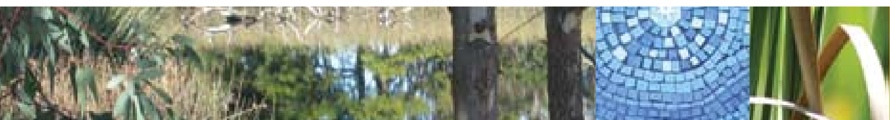
Evaluate water quality.

Compare observations and measurements with historical data from Waterwatch and Frogwatch reports.

Identify trends or changes.

Make conclusions on the health of the wetland.

Predict changes in the populations of flora and fauna within the wetland.



unit stage: *Going Further*

focus question: *How are social needs and environmental trends influencing scientific research in the area of urban stormwater management?*

outcomes	assessment
Students will know, understand and be able to: • demonstrate how environmental decision making is affected by social, economic & scientific interests • make an informed decision based on scientific evidence • give reasons/evidence for the development of an additional wetland in the local area.	*Students are able to:* • collate and evaluate information to make decisions as to why wetlands are a better solution to stormwater management than concrete drains • compile a list of criteria creating demand for urban wetlands • sort and classify into social, economic and environmental categories • prioritise the criteria for each category.

suggested teaching and learning experiences to achieve outcomes

Speculate, discuss and debate the social benefits from urban wetlands – recreation area, aesthetics, health, social interaction, etc.

Survey local community to determine their opinion of constructed wetlands. Prioritise their opinions.

Discuss how social needs can direct scientific research.

Investigate the economic benefits and cost of wetlands – real estate value, water treatment savings and storage for local irrigation, reduced maintenance, cost of drain upkeep.

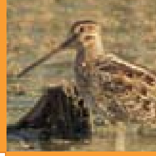
Compare and order disadvantages of previous urban stormwater concrete drainage – causes fast deep flow, turbidity, safety issues, loss of local **habitat** and biodiversity, increase risk of flooding and erosion downstream, maintenance costs.

Presentation from expert guest speaker – (ACT Department of the Environment, Climate Change, Energy and Water or from the Australian National University) to discuss the science behind the constructed wetlands, how it addresses social, environmental and economic needs. SWOT of the wetland from scientist's perspective.

Investigate the impacts of a proposal for a new constructed wetland on affected stakeholders.

Research, survey or interview stakeholders to evaluate the impacts of a proposed wetland for different stakeholder views: PMI or SWOT.

Conduct a debate/role play of a discussion between these stakeholders in order to make a decision on the proposed constructed wetland.



unit stage: *Making Connections*

focus question: *What is the impact of changing land use on wetlands, water quality, catchments and storage?*

outcomes

Students will know, understand and be able to:

- illustrate how different industries pollute and contribute to global warming
- identify community and industrial impacts and propose more sustainable behaviours and actions
- discuss the impact of a change in health of wetlands on local social, recreation and economic situations.

assessment

Students are able to:

- hypothesise about the impact of climate change using the example of a specific wetland
- give reasons for choices of some industrial materials over others in terms of their impact on water catchments, storage and water supplies.

suggested teaching and learning experiences to achieve outcomes

Explain the effects of environmental change on wetlands over the last 20 years. Use specific examples.

Investigate industrial resource (water, energy) usage e.g. mining, energy generation and agriculture. Examine the use of resources, e.g. oil and by-products (plastics, fertilisers etc), coal and metals. Consider the impact of these on wetlands, water catchments and water supply.

Make predictions about more sustainable ways of using the resource and minimising the impact on wetlands or water catchments. Use specific examples and evidence to support your position. Establish relevance by relating to use of these products in our local economy.

Use a tool such as SWOT or PMI to examine a specific controversial industry's environmental impacts. Develop a personal action plan to show individual behavioural changes which can reduce our use of these resources and impact on wetlands.

Evaluate consumer goods and purchasing choices in light of industrial resources that are used and their long term environmental impacts. See

www.waterrating.gov.au/consumers/index.html

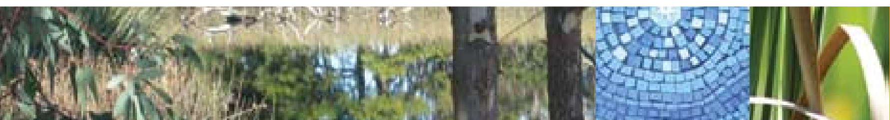
www.energyrating.gov.au/index.html

Complete a personal household water consumption diary.
www.water.anu.edu.au/events

www.water.anu.edu.au/pdf/2009/householdinvite09.pdf

www.water.anu.edu.au/pdf/2009/final_report_waterdiary.pdf

Discuss the emergence of jobs in the area of environmental sustainability. Investigate jobs in environment and sustainability on www.myfuture.edu.au and other jobs sites.



unit stage: *Taking Action*

focus question: *How can the use of ongoing audits of wetlands impact on water quality, catchments and storage?*

outcomes	assessment
Students will know, understand and be able to: • choose, explain and participate in actions to educate and promote sustainability • use evidence to debate the issues related to wetlands, catchments and water quality • evaluate personal behaviours and actions to identify areas for more sustainable living • compare environmental activists and leaders contributions to environmental sustainability.	*Students are able to:* • evaluate tools for conducting water audits in specific situations • use an example of community involvement in a local action to evaluate changes in attitude to water conservation and wetlands conservation • form some criteria for discussing the impacts of environmental activists.

suggested teaching and learning experiences to achieve outcomes

Plan, organise and carry out sustainability audits.

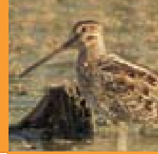
1. Complete a School Water Audit – water usage and stormwater management assessment – ACT Sustainable Schools Water Curriculum Unit.
   www.sustainableschools.act.gov.au
2. Analyse video from Melbourne Water Education Kit – *Drains to the Bay* Video.
   http://education.melbournewater.com.au
3. Complete School Waste Audits and ACT Sustainable Schools Waste Curriculum Unit.
4. Complete School Energy Audits and ACT Sustainable Schools Energy Curriculum Unit.

Research, educate and organise school community environmental events, e.g. World Environment Day, Earth Day, Water Day, Wetlands Day, Biodiversity Day, Tree Day, Clean Up Australia Day, Earth Hour, Walk to School Day, Rubbish Free Day.

Research, design and present Kids Teaching Kids education workshops.
www.onelifeoneworldourfuture.com

Attend and present a workshop at the ACT Murray Darling Basin Commission Riverhealth Conference.
www.onelifeoneworldourfuture.com

Compare, evaluate and rank the impacts of environmental activists and leaders. Examples: Al Gore (watch *An Inconvenient Truth* DVD), Firestarter's River Health Conferences and ANU Water Consumption Diaries.



unit stage: *Sharing, Discussion and Reflection*

focus question: *What did I learn from this study?*

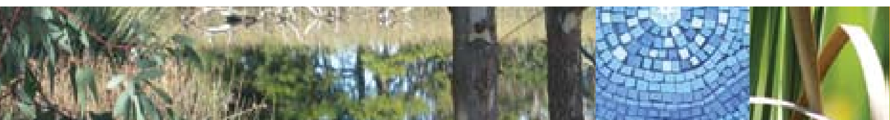
outcomes	assessment
Students will know, understand and be able to: • reflect on a process, identify catalysts for change from original plan and describe and illustrate changes.	*Students are able to:* • analyse and record the changes in their thinking as the response to new information.

suggested teaching and learning experiences to achieve outcomes

Undertake a personal reflection on the unit, what was learnt and describe changes in attitude and behaviours.

Develop a flow chart to show changes/developments in thinking from the beginning to the end of the unit.

Brainstorm how you as an individual and as a member of the school and wider community might go further?



GLOSSARY

Abiotic factors	*the non-living factors in an ecosystem that affect the survival of organisms. They include: water availability, sunlight, temperature range, substrate - rock type or sand, geographical terrain, oxygen availability, exposure etc*
Acidic	*a pH of less than 7*
Aerobic	*(of an organism or tissue) requiring oxygen for life; caused by the presence of oxygen*
Alkaline	*a pH greater than 7*
Anaerobic	*living in the absence of oxygen*
Aquifer	*an underground layer of rock, gravel or sand that contains water*
Biodiversity	*the sum of all species of plants and animals; an ecosystem is considered healthy when it supports the most diverse numbers and types of species it is capable of supporting; the variety of living things in the environment*
Biofilm	*is a collection of micro-organisms that absorb colloids and nutrients. They form on wetland plants and help improve water quality*
Biological indicators	*provide information on biological or ecological changes that may result from changes in water quality and physical habitat (e.g. increased temperature) or biological interactions (e.g. introduction of exotic species or diseases); examples of indicators are algae, macrophytes, macro-invertebrates e.g. stonefly nymphs, mayfly nymphs and yabbies indicate good water quality, whereas an abundance of small red/blood worms indicate poor water quality*
Biomass	*is the mass of living biological organisms in an area or ecosystem*
Biota	*the living and non-living organisms in a habitat; non-biotic e.g. soil, rocks*
Biotic factors	*are the other living things in an ecosystem that affect the survival of an organism in that ecosystem. They include: competition for food and water, competition for shelter, availability of food - plants and animals, number of predators, co-operation to help find food etc*
Bog	*wetlands characterised by a waterlogged, spongy mat of sphagnum moss, ultimately producing a thickness of peat; bogs are highly acid and tend to be nutrient poor; they are typically dominated by sedges*
Catchment	*the area of land drained by a creek or river system; an area for the collection of runoff water from a natural drainage system*
Conservation	*careful preservation and protection of natural resources from loss, harm, or waste; planned management of a natural resource to prevent exploitation, destruction or neglect*
Constructed urban wetland	*wetlands that are built in an urban area and provide a range of benefits including improved water quality, urban habitat and educational and volunteering opportunities*
Contaminant	*a harmful substance deposited in the air or water or land*
Ecosystem	*a community of plants and animals viewed within its physical environment (habitat); the ecosystem results from the interaction between soil, climate, vegetation and animal life*
Emergent plants	*water plants with roots and part of the stem submerged below water level, but the rest of the plant is above water e.g. Cumbungi (Typha)*

GLOSSARY

Engineers Without Borders	*works in partnership with developing communities both within Australia and overseas, assisting them to gain access to the knowledge, resources and appropriate technologies they need to improve their livelihoods*
Environmental indicators	*an indicator is a significant physical, chemical, biological, social or economic variable which can be measured in a defined way for management purposes e.g. frogs are sensitive indictors of declining water quality*
Environmental sustainability	*respect for the natural environment and recognition of the need to reduce any harmful effects on it; ensure it is preserved for future generations*
Ephemeral wetland	*a wetland or part of a wetland that is dry for some times of the year, this type of wetland is common in southern Australia*
Eutrophication	*accumulation of excessively high levels of nutrients, leading to an abundant growth of aquatic plants and bacteria. The accelerated nutrient enrichment may lead to oxygen-deficient conditions in waterways that can be accelerated by human activities. Nutrient increases stimulate algae 'blooms' such as blue-green algae. The algae produces toxins that are harmful to humans and pets if ingested*
Fauna	*the animals of a given region*
Fen	*type of wetland fed by surface and/or groundwater; alpine wetlands dominated by herbs, sedges and grasses; ephemeral; do not include spaghnum moss*
Floating plants	*water plants with floating leaves; may be free-floating or attached to the bottom by a root system as in the case with Water Lilies (Nymphoides)*
Floodplains	*a low area adjacent to a river; made up of river sediment; subject to flooding*
Flora	*the plants of a given region*
Food chain	*interrelations of organisms that feed upon each other, transferring energy and nutrients; typically solar energy is processed by plants that are eaten by herbivores which in turn are eaten by carnivores: e.g. sun -> grass -> mouse -> owl*
Food pyramid	*is similar to a food chain, except a pyramid also shows the number or total biomass of plants and animals. Biomass is the dry mass of the organisms in a food pyramid. It measures how much the plants and animals in a food chain would weigh if they were dried out, leaving only biological material*
Food web	*the combined food chains of a community or ecosystem*
Gross pollutant trap	*a physical structure that traps coarse sediment, leaves and rubbish (like plastic bottles and bags) preventing them from entering a wetland*
Ground water	*water occurring below the ground*
Habitat	*the sum total of all the living and non-living factors that surround and potentially influence an organism; a particular organism's environment*
Life cycle	*a series of stages an organism passes through*

GLOSSARY

Macro-invertebrate	*spineless creatures large enough to be seen by the naked eye, includes insects (Dragon Fly), crustaceans (Yabbies) and molluscs (Snails)*
Macrophyte	*large aquatic plant, either rooted (Typha, Schoenoplectus) or floating, such as Water Lily (Nymphoides)*
Marsh	*semi-permanent wetland, characterised by soft grassy vegetation and often forming a transition zone between water and land; dominated by non-woody vegetation*
Median strip wetland	*planted swales in the road median used for filtering and slowing stormwater*
Metamorphosis	*a process during which an animal undergoes a comparatively rapid change from larval to adult form, for example, from a tadpole to a frog*
Micro-organisms	*soil, air, water microbes such as bacteria, algae, fungi of microscopic size, may be harmful or useful*
Nutrient	*any inorganic or organic compound that provides the nourishment needed for the survival of an organism*
Offline wetland	*water diverted from an existing waterway or concrete channel into a constructed wetland, e.g. David St Wetland, O'Connor, ACT*
Online wetland	*a wetland constructed on an existing water course or concrete channel, e.g. the proposed wetland, Lyneham ACT*
Organic material	*anything that is living or was living; in soil it is usually made up of nuts, leaves, twigs, bark, etc.*
Pedoderm	*a shallow naturally occurring aquifer composed of gravel, typically 5 to 7 metres deep, that contains water*
Perennial wetland	*a wetland that is usually permanent as it is sustained by groundwater flow and surface runoff*
Permeable	*describes a surface that can be penetrated by water*
pH	*a measure of the acidity (less than 7) or alkalinity (greater than 7) of a solution; a pH of 7 is considered neutral*
Phosphorus	*a non-metallic chemical element; essential for the growth of animals; present in many organic and chemical fertilisers, detergents and may, through runoff, contribute to eutrophication, resulting in algal blooms*
Pond	*a relatively small body of standing fresh water; usually shallow enough for sunlight to reach the bottom*
Ramsar	*The Convention on Wetlands (Ramsar, Iran, 1971) is an intergovernmental treaty; its mission is 'the conservation and wise use of wetlands by national action and international co-operation as a means to achieving sustainable development throughout the world'. Over 110 nations, including Australia, have joined the Convention; more than 1,000 wetlands around the world have been designated for inclusion in the Ramsar list of wetlands of international importance; objectives of the Convention are to halt the worldwide loss of wetlands and to conserve those that remain*
Riparian	*a transition area between land and water; the area within or along the banks of a stream adjacent to a watercourse or wetland; relating to a riverbank*

GLOSSARY

Runoff	*rainwater that flows over the land and into streams and lakes; it often picks up soil particles along the way and transports it into streams and lakes*
Rush	*grass-like plant (Juncus, Schoenoplectus), forms dense clumps, mostly in wet areas; needle-like stems are cylindrical or flattened, hollow and green; "rushes are round, sedges have edges"*
Sedge	*grass-like plant (Cyperus), usually with solid triangular stems; "rushes are round, sedges have edges"*
Shrub	*a woody plant generally less than 7 metres in height, having several stems arising from the base and lacking a single trunk*
Silt	*one of three main parts of soil (sand, silt, and clay); silt is small rock particles that are between 0.05 mm and 0.002 mm in diameter*
Stormwater	*rainwater which runs off the land, frequently carrying various forms of pollution such as rubbish, animal droppings and dissolved chemicals. This untreated water is carried in stormwater channels and pipes and discharged directly into creeks, rivers and oceans*
Stormwater system	*the system of pipes, canals and other channels used to carry stormwater to bodies of water such as creeks, rivers or oceans. The system does not usually involve any treatment*
Submerged plant	*a plant that lies entirely beneath the water surface, except for flowering parts in some species*
Surface runoff	*water that flows over the surface of the land as a result of rainfall or snowmelt; surface runoff enters streams and rivers to become channelised stream flow*
Swale	*usually a constructed U shaped drain planted with grass or reeds, used to direct water away from a site (an alternative to concrete drains)*
Swamp	*a wetland where the soil is saturated and often dominated by woody shrubs and water tolerant trees, e.g. (Mangrove swamps, Melaleuca swamps), in contrast a marsh has non-woody plants*
Trees	*woody plants greater than 7 metres tall, and usually with one main trunk*
Turbidity	*the state, condition, or quality of opaqueness or reduced clarity of a fluid due to the presence of suspended matter*
Water cycle	*the process by which water evaporates into water vapor, condenses into liquid form in the clouds, and precipitates as rain or snow back to Earth*
Water table	*the upper level of the portion of the ground (rock) in which all spaces are wholly saturated with water; the water table may be located at or near the land surface or at a depth below the land surface and usually fluctuates from season to season; springs, seepages, marshes or lakes may occur where the water table intersects the land surface*
Wetland	*a place where water forms pools or flows that last long enough for plants and animals to base a significant part of their lifespan around; some wetlands are permanent (perennial), others flow just below the surface, rising and falling with seasonal rainfall, and others last just for a few months at a time (ephemeral); are important as a source of water and habitat, for trapping nutrients and soil and retaining it within a landscape, and for maintaining surface and ground water quality; four main types consist of swamps (include large woody trees); bogs (does not dry out – e.g. sphagnum moss); marshes (e.g. grasses, herbaceous, non-woody plants; fens (low marshy swamp fed by surface and/or groundwater); can be natural (e.g. Ginini Flats) or human made (e.g. David St, O'Connor; Lake Burley Griffin)*

International

Ramsar Convention www.ramsar.org

Wetlands International www.wetlands.org

National

Federal Wetland Resources www.environment.gov.au/water/environmental/wetlands/index.html

WetlandCare Australia www.wetlandcare.com.au

Inland Rivers Network www.irnnew.org.au

Waterwatch – Australia www.waterwatch.org.au

Murray Darling Basin Authority www.mdba.gov.au

Wetlands – Nature's Filters (What is a wetland? How do constructed wetlands work? Diagrams of constructed wetlands)

http://education.melbournewater.com.au/content/rivers_and_drainage/wetlands_-_natures_filter/wetlands_-_natures_filter.asp

Diagram of Melbourne's stormwater system including role of constructed wetlands

www.melbournewater.com.au/content/drainage_and_stormwater/the_drainage_system/the_drainage_system.asp

Catchment Detox Game, ABC, www.catchmentdetox.net.au/play-game

Special Forever - a Murray Darling Water Education Project www.specialforever.org.au/

Australian Institute of Landscape Architects www.aila.org.au/projects/ACT/Enviro-UC/default.htm

Firestarter - River Health 'Kids Teaching Kids' Conference Series www.onelifeoneworldourfuture.com

Australian Capital Territory

AUSSI-ACT Australian Sustainable Schools Initiative www.sustainableschools.act.gov.au

Waterwatch-ACT www.act.waterwatch.org.au

TAMS (Territory and Municipal Services) - Canberra's Urban Lakes and Ponds, Jerrabomberra Wetlands

www.tams.act.gov.au/play/pcl/parks_reserves_and_open_places/water_catchments/lakesandponds

Birragai Education Centre www.birrigai.act.edu.au

Department of the Environment, Climate Change, Energy and Water www.environment.act.gov.au/water/constructed_wetlands

Molonglo Catchment - www.molonglocatchment.com.au/catchment_planning.htm

Southern ACT Catchment www.sactcg.org.au

Ginninderra Catchment www.ginninderralandcare.org.au/content.php?id=55

ActewAGL (Education resources - Urban Water Cycle)

www.actewagl.com.au/education/water/UrbanWaterCycle/default.aspx

Creating wetland habitats www.lifeinthesuburbs.net.au

ACT Frogwatch, frogwatch@ginninderralandcare.org.au

Amphibian Research Centre, Australian Frogs Database and more. www.frogs.org.au

Australian National Botanic Gardens www.anbg.gov.au

Case Studies

David St, O'Connor wetland

www.environment.act.gov.au/__data/assets/pdf_file/0010/189433/case_study_FOR_WEB.pdf

Innovation Centre, University of Canberra (wetlands, bioswales, drycreek beds)

www.aila.org.au/projects/ACT/Enviro-UC/default.htm

Lawrence Garden, Higgins, ACT (cottage garden retrofitted to reduce potable water use, harvest stormwater and incorporates small wetland with a surface area of 160m^2.)

www.aila.org.au/canberragarden/casestudies/LAWRENCE/default.htm

'Ugly concrete drain turned into creek line', Windsor St linear parkland, Adelaide.

www.aila.org.au/sustainablecanberra/008-windsor/default.htm

Windsor St linear parkland, Adelaide - Gardening Australia video (5 minutes)

www.abc.net.au/gardening/video/video_index_July2007.htm

Kits

Nature's Treasures Kit, Centre for Teaching and Learning, 51 Fremantle Drive, Stirling, ACT, 6205 8249

david street wetland

A CONSTRUCTED URBAN WETLAND, O'CONNOR, ACT

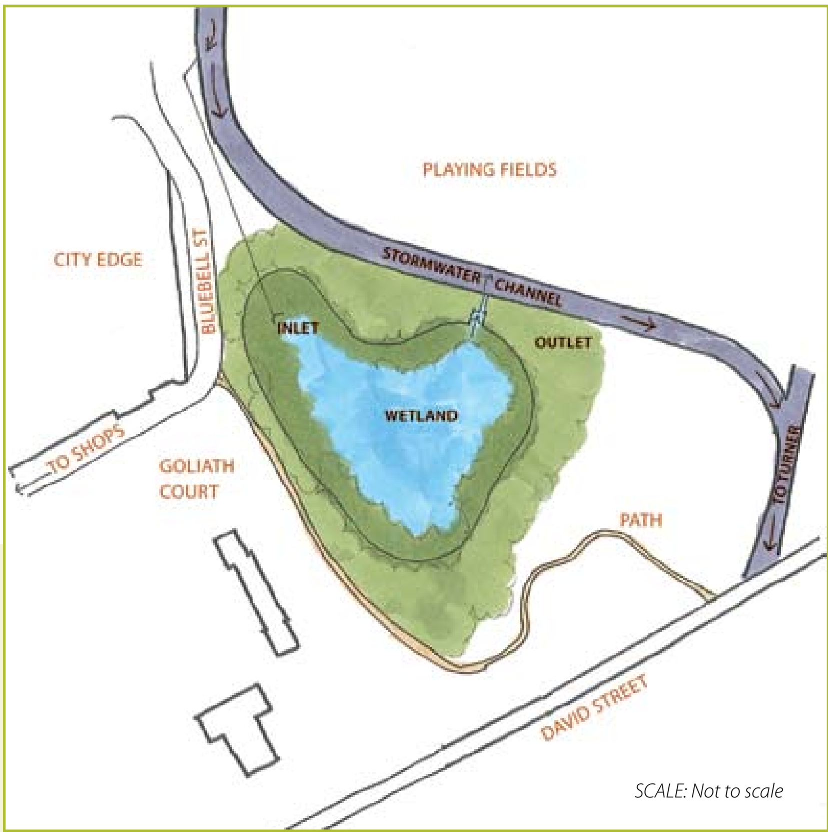
sullivans creek catchment case study

Edwina Robinson and Maureen Bartle 2010

Purpose and audience

This case study has been written to provide background information for teachers implementing the Constructed Urban Wetlands units of work for the Later Childhood and Early Adolescence Bands of Development aligned with the *Every chance to learn* Curriculum Framework for ACT Schools Preschool to Year 10. It has been developed as a series of responses to questions supporting the units. The David St case study provides a framework for schools to construct similar case studies on wetlands near their schools.

The Constructed Urban Wetlands units of work focus explicitly on the David Street constructed urban wetland in the Australian Capital Territory suburb of O'Connor. This wetland is part of the largest river system in Australia, the Murray Darling. Water flows through this broad ranging and complex system from outback Queensland, through New South Wales, the Australian Capital Territory, Victoria and part of South Australia and enters the ocean at Encounter Bay, near the river port of Goolwa.



Sketch plan of the David Street Wetland and dense surrounding vegetation. *Image: Edwina Robinson 2009*

Where is the David Street wetland?

Address: Bluebell St O'Connor, Canberra

Catchment: Sullivans Creek Catchment, Australian Capital Territory

What is the David Street constructed urban wetland?

The David Street Wetland is an offline pond adjacent to Sullivan's Creek located in the inner north Canberra suburb of O'Connor. It was constructed in 2001 as a demonstration urban wetland.

The water body occupies an area of around 800 square metres (equivalent to an average house block size for Canberra's older suburbs).

The wetland was built on a little used block of urban open space, characterised by dryland grass and a mix of native and exotic trees.

The aims of the wetland were multiple:

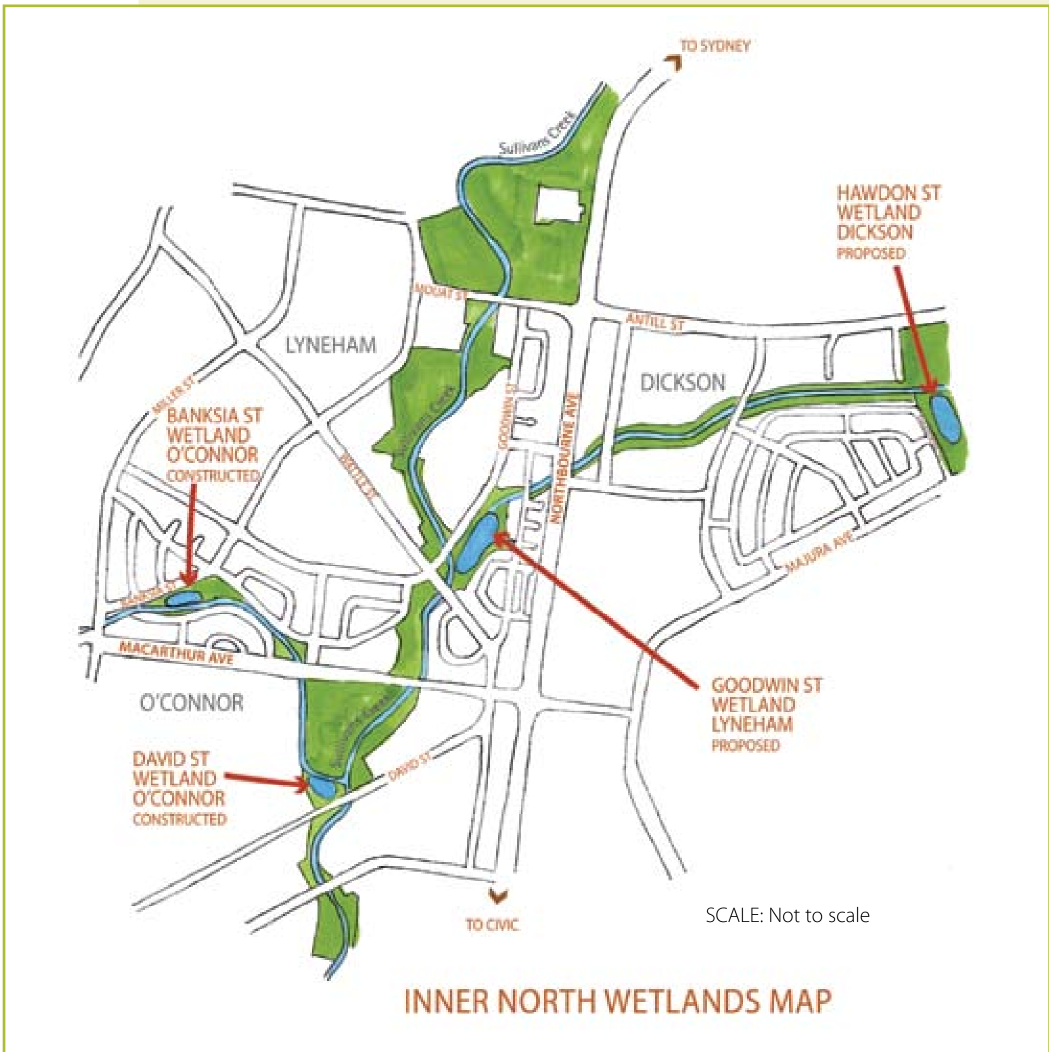
- Improve water quality (particularly remove nitrogen and phosphorous from stormwater)
- Provide aquatic and terrestrial habitat for animals
- To manage stormwater by detaining water during high rainfall events
- Provide an attractive outdoor space with a visible water body

Where is Sullivan's Creek?

Sullivan's Creek is the 'real' name of the large concrete drain that runs from the northern ACT border, through the suburbs of the inner-north (including Mitchell, Dickson, Lyneham, Turner and the Australian National University) into Lake Burley Griffin. The creek was a naturally occurring 11 kilometre tributary of the Molonglo River. The catchment is bounded by the ridges of Black Mountain, O'Connor Ridge, Mount Ainslie and Mount Majura.

Throughout Canberra, creeks were converted to concrete drains in an attempt to protect properties from flooding. Unfortunately this response has had a negative impact on local ecology and adversely affected natural hydraulic systems.

The David St Wetland is designed to receive stormwater from Bluebell St, O'Connor where it is filtered by the wetland. In turn, water empties into the Sullivan's Creek drain via a concrete outlet structure. From there treated stormwater flows through the suburb of Turner and the ANU and eventually reaches Lake Burley Griffin.



Map of a section of the Sullivans Creek Catchment in Canberra's inner north showing the location of the David St and Banksia St Wetlands and the proposed Goodwin St and Hawdon St Wetlands. Together these wetlands will provide around 70% of the water quality improvements in the catchment.

Image: Edwina Robinson 2009

What plants occur at the wetland?

The urban open space, a landscape of dryland grass and an even-aged stand of native and exotic trees was replaced by a diverse landscape of locally occurring plants. In order to mimic natural ecosystems, ground covers, grasses, shrubs, trees and aquatic plants were selected. Creating a landscape with many multiple layers provides niches for a range of animal species.

Plants were sourced locally. Over 50,000 plants in small pot sizes (envirocells and tubes) were planted by volunteers. During hot summer months the plants required watering from the wetland to ensure their establishment. Together the plants and the water body provide a shady enclave on hot summer days.

PLANT SPECIES

Open Water Zone

Baumea rubignosa
Eleocharis sphacelata
Eleocharis acuta

Edge Zone

Bolboschoenus caldwelli
Juncus usitatus
Carex appressa
Carex fascucularis
Crassula helmsii
Cyperus gunnii
Lythrum salicaria
Poa labillardieri

Dryland Zone

Grasses

Dianella
Lomandra longifolia
Poa labillardieri
Themeda australis

Shrubs

Acacia decurrens

Groundcovers

Grevillea juniperina
G. lanigera
Hardenbergia violacea
Melaleuca parvistaminea
Banksia marginata
Callistemon sieberi
Calytrix tetragona
Correa reflexa

Trees

Casuarina cunninghamiana
Eucalyptus aggregate
E. pauciflora
E. stellulata

Perennials

Chrycocephalum semiapossum
Leucochrysum albicans

Many *Eucalyptus* and *Acacia* (Wattle) have grown rapidly since planting, reaching seven to eight metres tall. Species in the wetland edge zone, open water zone plants and grasses are thriving. Interestingly, the shrub layer has become straggly, likely due to shading and root competition from vigorous trees.

There are few weeds due to the success of dense planting, thick mulch layers and the persistence of volunteers maintaining the wetland.

What animals can be found at the wetland?

Some of the animals attracted to the wetlands include waterbirds, frogs, yabbies, native fish, turtles and macro-invertebrates (water bugs). These plants and animals work together to create a diverse and visually attractive habitat.

BIRDS

Waterbirds

Wood Ducks

Black Ducks

Pied Cormorant

Black Cormorant

Crake

Herons

Pelican (occasional visitors)

Black Swan (occasional visitors)

Terrestrial Birds

Reed Warblers

Welcome Swallow (uncommon in other parts of O'Connor but frequently found flying above the water)

The more wetlands that occur in an area, the greater the diversity of water birds. The Sullivan's Creek catchment incorporates the Flemington Ponds, Mitchell; David St Wetland; Banksia St, O'Connor, wetlands within the Australian National University; Lake Burley Griffin and planned wetlands at Goodwin St, Lyneham and Hawdon St, Dickson.

FROGS

Three species have been recorded at the wetland

Crinea parasignifera
Plains Froglet

Limnodynastes peronii
Brown-striped Frog

Limnodynastes tasmaniensis
Spotted Grass Frog

FISH

Mosquito Fish (Gambusia) – this small fish native to North and Central America was introduced as an aquarium specimen then later into waterways as a biological control for mosquitoes. They breed rapidly, and prey upon the eggs and juveniles of native fish and frog species and are generally ineffectual in controlling mosquito larvae.

Who was involved in the development of the David Street wetland?

The community based Sullivans Creek Catchment Group (SCCG) instigated the project. The SCCG worked closely with a technical steering committee and formed a joint venture with Community Housing Canberra and CIC Pendon, developers of the nearby City Edge housing complex. Numerous volunteers helped plant and maintain the site and continue to monitor water quality.

Do constructed wetlands like David Street encourage mosquitos?

Mosquito nuisance is predominantly managed by careful design of the wetland slopes to ensure water circulation and eliminate sheltered pools of stagnant water. The interception of trash and debris by gross pollutant traps works effectively to remove trash and reduce mosquito risk. Correct selection of aquatic plants and water edge plants appropriate to graduated slopes ensure that mosquito larvae become stranded as water levels drop and are unable to breed. The correct selection of aquatic plants reduces the risk of mosquito nuisance by providing a habitat for predators.

A study of the David St Wetland and a neighbouring garden found there was a much higher incidence of mosquito larvae in the garden. This was due to the presence of shallow areas of water, such as saucers under pot plants filled with water that provide an ideal breeding ground for mosquito larvae.

Are wetlands safe for children?

The David Street Wetland was constructed with slopes of gentle gradient rather than with steep sides. In addition, the slopes of the pond, right down into the water, have been planted with emergent plants (macrophytes), to act as a deterrent to children entering the water. A safety fence has been constructed between the pond and the adjacent playing equipment. The pond is not intended for swimming or other aquatic activities.

Young boy at the water's edge at of the David St Wetland. Note how the macrophytes (reeds) create a dense and tall edge making it hard to access the wetland. *Image: E. Robinson 2009*

Will the project be replicated?

The Sullivan's Creek Catchment Group, together with the ACT Government has replicated this project at Banksia Street, O'Connor, upstream from the David Street Wetland. Construction commenced in January 2010 and was completed in March 2010. The ACT government is planning to develop two more wetlands in Canberra's inner north - one at Goodwin St, Lyneham and the other at Hawdon Oval, Dickson.

The ACT and surrounding region is home to a diverse range of wetlands.

Wetland	Natural/Constructed	Description
Ginini Flats, Namadgi National Park, ACT	Naturally occurring	50 hectare sub-alpine peat **bog**, dominated by *Sphagnum* moss. Habitat to endangered Northern Corroboree Frog and Latham's Snipe.
Nursery Swamp, Namadgi National Park, ACT	Naturally occurring	53 hectare **fen**, dominated by a grass-like sedge, *Carex gaudichaudiana*. Habitat for Latham's Snipe.
Horse Park Wetland, Gungahlin	Naturally occurring	Permanent lowland **marsh** dominated by sedges like *Carex appressa* and *Juncus* and *Poa labillardieri and Baumea*. Habitat for Latham's Snipe.
Jerrabomberra Wetlands, Fyshwick	Modified natural wetland	174 hectare wetland made up of deeper ponds, reed beds, marshlands, flooded grasslands and Fyshwick sewerage treatment works. Habitat for Latham's Snipe.
Lake George, NSW	Naturally occurring	15,000 hectare ephemeral lake that attracts a wide variety of fauna.
David St, O'Connor	Constructed urban wetland	A small urban **constructed wetland** built in 2001 to improve water quality and habitat of Sullivan's Creek Catchment.
Banksia St, O'Connor	Constructed urban wetland	A small urban **constructed wetland** built in 2010 to improve water quality and improve habitat of Sullivan's Creek Catchment. Includes an ephemeral section.

Ginini Flats

Ginini Flats, located at 1590 metres within Namadgi National Park is a naturally occurring wetland and regarded as the ACT's most significant sub-alpine bog. It is characterised by extensive hummocks of *Sphagnum* moss *(S. cristatum)* which are sponge-like and can absorb many times their own weight in water. The moss is often covered by snow during winter.

Bogs play a vital role in retaining, filtering and regulating the flow of water in a catchment. They are characterised by a waterlogged, spongy mat of *Sphagnum* moss associated with wet heath and wet grassland. When *Sphagnum* moss decomposes it forms peat.

Bogs are highly acid, nutrient poor and low in oxygen making it hard for many organisms to live in them. They have a complex structure of moss, **sedges**, shrubs and even evergreen trees.

Whilst the *Sphagnum* moss dominates the 50 hectare site, a number of other plants grow in the area, including shrubs like heaths *(Epacris and Richea species)*, Teatree *(Leptospermum lanigerum)*, Alpine Plum Pine *(Podocarpus lawrencei)*, *Grevillea australis* and *Hakea microcarpa* and the twig rushes, *Empodisma* and *Baloskion*. The bog is surrounded by snow tussock and open woodland, dominated by Snow Gums *(Eucalyptus pauciflora)*. Another plant associated with the wetland is the small flowering plant, Alpine Gentian *(Chionogentiana cunninghamii)*.

Ginini is listed as a **Ramsar** site and is considered one of the best preserved and deepest bogs on mainland Australia. The peat within the bog is up to 2 metres deep and has been recorded as older than 3000 years.

Ginini Flats provides habitat for Latham's Snipe *(Gallinago hardwickii)* which use the wetlands as an over-wintering destination and for the endangered Northern Corroboree Frog *(Pseudophryne pengilleyi)*. Two other frogs occur in Eucalypt woodlands adjoining Ginini Flats – the Common Eastern Toadlet *(Crinia signifera)* and Southern Toadlet *(Pseudophryne dendyi)*. The Glossy Bog Skink *(Pseudemoia rawlinsoni)*, which give birth to around six live offspring in summer and the Alpine Water Skink *(Niveoscincus rawlisoni)* are also found in the bog. Invertebrates include the Metallic Bug Cockroach *(Polzostera virridisma)* and the Mountain Galaxias, a small native fish *(Galaxias olidus)* and Yabbies.

Mammals that use the wetland include the Broad-toothed Rat *(Mastacomys fuscus)* and *Antechinus*. Although protected within the National Park, the greatest threat to the bog is feral pigs. Pigs dig up the ground in search of food and wallow in bogs, disrupting the bog ecosystem.

In the past, *Sphagnum* moss was removed from wetlands and used in acetylene tanks and in potting mix. A sustainable substitute for this is coconut fibre or coir. More information on sphagnum moss is available from the Australian National Botanic Gardens.

Nursery Swamp

Nursery Swamp is located within Namadgi National Park and covers an area of 53 hectares making it one of the largest peat deposits in the ACT. It is regarded as one of the best examples of a **fen** on mainland Australia. In areas the peat is up to 2 metres deep and has been dated to12,000 years old. The dominant plant is the sedge *(Carex gaudichaudiana)* which makes a grass-like sward with areas of taller cane grass *(Phragmites australis)*. The peat has blocked old channels and water spreads over the fen after rain, freezing to 15cm in the winter. Post-European disturbance has spread clay through the peat layer. Although it has a simple vegetation system it also contains a number of uncommon or rare plant species like Alpine Teatree *(Lepstospermum micromyrtus)* and the Violet *(Viola caleyana)*.

Jerrabomberra Wetlands

The Jerrabomberra Wetlands are the ACT's largest and probably best known wetlands. They cover an area of 174 hectares including deep open waters, reed beds, marshlands and drowned grasslands. The wetland depressions comprise flooded old Molonglo River channels across the Dairy Flat floodplain. The bed of the wetlands links into an extensive sand **aquifer** across Dairy Flat.

Prior to the flooding of the Molonglo River, a large section of the wetlands would have formed an ephemeral floodplain. The construction of Lake Burley Griffin has elevated water levels in the Dairy Flat aquifer, maintaining permanent water in the wetlands. The wetlands consist of the Jerrabomberra Billabong, Kelly's Swamp, Jerrabomberra Pool, Jerrabomberra Reach and Jerrabomberra Backwaters and the Fyshwick Sewerage Treatment Ponds.

Jerrabomberra is listed on the *Australian Directory of Important Wetlands* for its significant bird habitat. One hundred and seventy different birds have been recorded in the wetlands and in nearby planted woodlands and grasslands. It is regarded as a regionally important bird refuge during prolonged dry periods in Canberra.

The wetlands have a range of aquatic plants *(Myriophyllum, Potamogeton)* and stands of cane grass and bulrush as well as the locally rare reed *(Schoenoplectus mucronatus)*. Latham's Snipe utilises the wetland together with Platypus *(Ornithorhyncus anatinus)*, Eastern Water Rat *(Hydromys chrysogaster)* and Eastern Snake-necked Turtle *(Chelodina longicollis)*. The wetlands are adversely impacted by feral rabbits and weeds including Willow and Blackberry.

Due to its proximity to Canberra, the wetlands are regarded as an excellent education resource. Birrigai Outdoor School runs a number of wetlands related programs for students. The wetlands are widely used by ornithologists and for walking and cycling.

Top: Shallow marsh sections, Jerrabomberra Wetlands
Image: Edwina Robinson 2009

Above: Deeper pond sections, Jerrabomberra Wetlands
Image: Edwina Robinson 2009

Horse Park Wetland

The 40 hectare Horse Park Wetland occurs on the floodplain of Horse Park Creek, Gungahlin. It is a good example of a permanent, lowland freshwater **marsh** that is relatively intact. The site is used for over-wintering by Latham's Snipe.

Horse Park Wetland is dominated by open sedgeland and includes species like *Carex appressa* and *Juncus* species. The wetland zone is located on the face of the alluvial fan created by an extensive upstream **pedoderm**. Drainage from the pedoderm emerges in spring lines across the face of the alluvial fan.

Unusual plants in the wetland include Brownback Wallaby Grass *(Danthonia duttonian)*, the Buttercup *(Ranunculus papulentus)* and the Water Lily *(Nymphoides crenata)*.

The silty clays and permanent moisture provide good cover and attract a range of woodland fauna. Within the area are permanent ponds that include plants such as *Myriophyllum* and *Potomogeton*.

The wetland and surrounds have a number of significant Aboriginal sites associated with food gathering.

NOTE: Horse Park Wetland is located on private leasehold and not open to the public.

Lake George

Although beyond the ACT border, Lake George is a place well-known by those who travel to Sydney. The local indigenous people named the lake Weerewa.

When full, the lake covers 15,000 hectares with a catchment about eight times this extent. Under present warm climates, it is a shallow, naturally occurring lake. Water levels fluctuate dramatically as the lake only fills during years of above average rainfall. Extensive shoreline beaches and wave eroded benches show the lake has had several phases in which it was 10–25 metres deep, probably when temperatures were cooler and evaporation less. The lake has up to 80 metres of silty clays formed over the past 2–3 million years.

The lake is fed by creeks from the south and north and supports a diverse range of fish and waterbirds when full. Even when dry, a line of springs maintain sedge and cane grass wetlands along the western edge.

Researchers have used the site for a range of studies, including indigenous use and the lake's past climate, vegetation and fire history. Pollen records indicate the area was once covered in cool temperate rainforest, including plants like Southern Beech *(Nothofagus)* and tree ferns. During glacial times it was treeless. The modern woodlands appeared only 8500 years ago and are associated with high levels of fire.

Lake George 2010 with wind turbines in the background *Image: Edwina Robinson*

ACT MACRO-INVERTEBRATE FOOD CATEGORIES	compiled by Ian Lawrence		
Phylum	**Class**	**Subclass or Order**	**Trophic status, feeding habit**
Protozoa			
Porifera (sponges)			O, filter, encrusting
Cnidaria (hydras - jellyfish)			C, filter
Platyhelminths (flat worms)	Turbellaria		C, H, sucking, rasping
Nematoda (round worms)	Oligocheata (segmented worms)		D
Annelida (true worms)	Tubificidae (blackworms)		C, D, sucking, rasping
	Hirudinea (leeches)		C, suckers
Aschelminthes	Rotifera (rotifers)		P (plankton), filter
Mollusca	Gastropoda		H, scraper/grazers
	Bivalvia		P, filter
Arthropoda	Arachnida (mites)		C, parasite
	Crustacea	Anostraca (fairy shrimp)	O, filter
		Notostraca (tadpole shrimp)	O, filter
		Cladocera (water flea)	D, H, filter
		Ostracoda (shell shrimp)	O, filter
		Copepoda	H, O, C, filter
		Cyclopoida	H, O, C, filter
		Syncarida	O, D, filter
		Amphipoda (scuds)	O, predator
		Isopoda	D, shredder
		Decopoda (shrimp, yabbie, crab)	O, predator
	Insecta	Ephemeroptera (mayflies)	C, H, D, collectors
		Odonata (dragonflies, damsel flies)	C, predator
		Plecoptera (stoneflies)	C, predator
		Hemiptera (bugs, back swimmers, boatman)	C, piercer
		Coleoptera (beetles)	H, C, O, piercer
		Diptera (trueflies)	C, D, O, piercer, sucker, shredder
		Tricloptera (caddis fly) predator	C, H, O, D, filter, shredder,
		Lepidoptera (moths)	H, shredders

Notes: Trophic status — Carnivores, Herbivores, Omnivores, Detrivores, Particulates

Feeding habit —
'predators' feed on the whole or part of their prey
'shredders' chew plants or dead matter
'scrapers' remove the organic coatings from plants or mineral substrata
'collectors' gather particles from suspension or surface of sediments
'filter' feeders capture small particles by straining from water
'piercer' penetrates tissue by piercing mouthparts
'sucker' abstracts part of organism by sucking

Sources:

Williams, W.D. *Australian Freshwater Life: The Invertebrates of Australian Inland Waters*. 1980

Hawking, John H. & Smith. Felicity J. *Colour Guide to Invertebrates of Australian Inland Waters*. 1997. CRC for Freshwater Ecology & Murray Darling Freshwater Research Centre.

Endangered & vulnerable species

Fish:

Maccullochella macquariensis	Trout Cod
Maccullochella peeli peeli	Murray Cod
Macquaria australasica	Macquarie Perch

Frogs:

Pseudophryne corroboree	Corroboree Frog
Litoria aurea	Green & Golden Bell Frog

Source: Threatened species under the Environment Protection & Biodiversity Conservation Act 1999. Department of the Environment, Water, Heritage and the Arts.

Fish

Carassius auratus	Carp (Goldfish)
Cyprinus carpo	European Carp
Galaxias rostratus	Murray Jollytail
Gambusia affinis	Mosquito Fish
Hypseleotris klunzingeri	Western Carp Gudgeon
Macquaria ambigua	Golden Perch
Macquaria australasica	Macquarie Perch
Misgurnis anguillicaudatus	Water Loach
Perca fluviatilis	Redfin
Retropinna semoni	Australian Smelt

Sources: McDowall, Robert (Ed), *Freshwater Fishes of South-Eastern Australia* 1996

Harris, John & Gehrke, Peter (Eds). *Fish and Rivers in Stress: The NSW Rivers Survey.* 1997. NSW Fisheries, CRC for Freshwater Ecology.

Frogs

Limnodynastes tasmaniensis	Spotted Grass Frog
Limnodynastes dumerilii	Pobblebonk
Limnodynastes peronii	Brown-Striped Frog
Crinia parinsignifera	Plains Froglet
Crinia signifera	Common Eastern Froglet
Uperolia laevigata	Smooth Toadlet
Litoria verreauxii	Whistling Tree Frog

Sources: Robinson, Martyn. *A Field Guide to Frogs of Australia.* 2000

Frogwatch. ACT and Region Census 2008

Reptiles & mammals

Chelodina longicollis	Eastern Long-necked Tortoise
Physignathus leseurii	Eastern Water Dragon
Sphenomorphus tynpanum	Water Skink
Pseudechis porphyriacus	Red-bellied Black Snake
Notechis scutatus	Tiger Snake
Hydromys chrysogaster	Water Rat

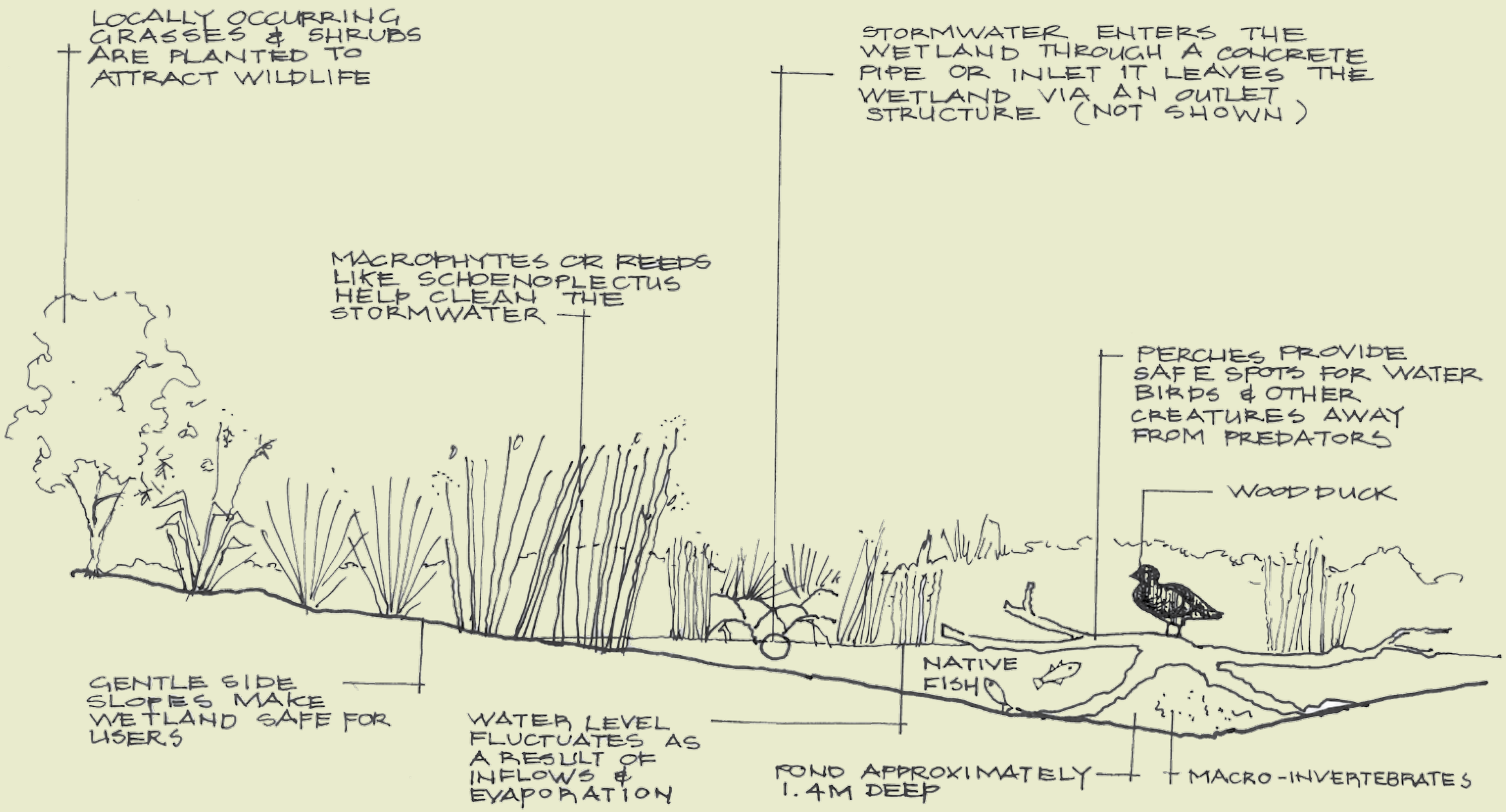
Birds and their diet

Anas superciliosa	Pacific Black Duck	*plants, yabby, dragonfly, beetles, fish, frogs*
Anas gracilis	Grey Teal	*plants, yabby, dragonfly, beetles, fish, frogs*
Anas platyrhynchos	Mallard	*beetles, dragonfly, mayfly, yabby, mussels*
Chenonetta jubata	Australian Wood Duck	*plants*
Fulicia atra	Eurasian Coot	*plants*
Gallinula tenebrosa	Dusky Moorhen	*plants, small invertebrates*
Porphyrio porphyrio	Purple Swamphen	*plants, yabby, dragonfly, beetles, fish, frogs*
Ardea pacifica	White Faced Heron	*yabby, dragonfly, beetles, fish, frogs*

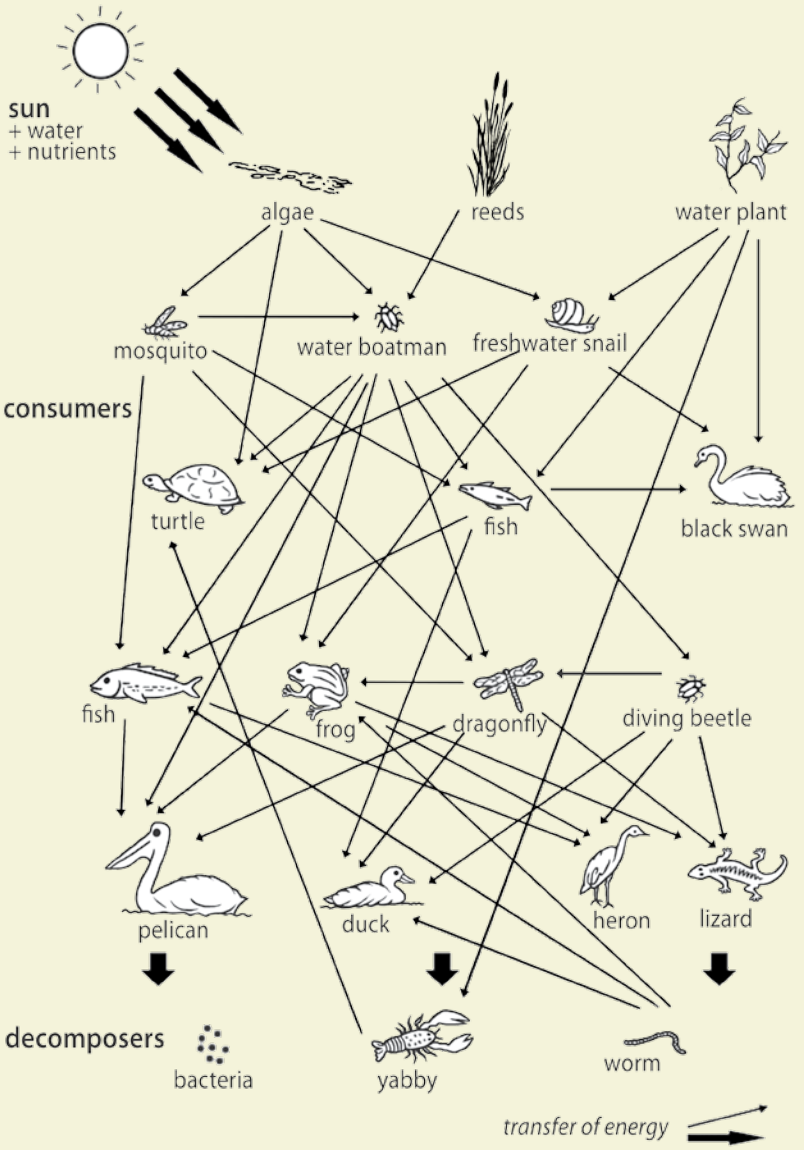
Sources: Morcombe, Michael. *Field Guide to Australian Birds.* 2000. Steve Parish Publishing

Lintermans, Mark & Osborne, William. *Wet & Wild: A Field Guide to the Freshwater Animals of the Southern Tablelands and High Country of the ACT and NSW.* ACT 2002

CROSS SECTION OF TYPICAL CONSTRUCTED WETLAND



WETLAND FOOD WEB 1



WETLAND FOOD WEB 2