

# Creek Rehabilitation Case Studies



Catchments  
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Version 1, 2014

## Creek Rehabilitation Case Studies

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Cover: Hoben Street, Mitchelton, Queensland, 2001

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The commentary presented within this publication, and the results displayed within the case studies, are site specific. The author cannot, and does not, claim that the case study results or the associated commentary can be directly applied to other sites without appropriate consideration of local conditions and site constraints.

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<b>Contents</b>	<b>Page</b>
Purpose of document	4
About the author	4
Introduction	4
Location map	6
<b>Creek Rehabilitation Projects</b>	
Browns Creek, Magellan Street, Lismore, NSW	8
Cubberla Creek tributary, Boblynne Street, Chapel Hill, Queensland	10
Cubberla Creek, Akuna Street, Kenmore, Queensland	13
Kedron Brook tributary, Hoben Street, Mitchelton, Queensland	18
Loder Creek, Queens Road, Southport, Queensland	21
Norman Creek, Lawn St, Holland Park, Queensland	22
Norman Creek, Nicholson St, Greenslopes, Queensland	28
Norman Creek, Willis Street, Tarragindi, Queensland	33
Sheep Station Gully, Laurel Oak Drive, Algester, Queensland	38
<b>Riparian Bush Regeneration Projects</b>	
Cabbage Tree Creek, Bunya Road, Arana Hills, Queensland	48
Fihelly Street, Keperra, Queensland	52
Ithaca Creek, Glenrosa Road, Red Hill, Queensland	53
Kedron Brook, downstream of Ferny Way, Ferny Hills, Queensland	58
Kedron Brook, Lanita Road, Ferny Grove, Queensland	66
Kedron Brook, Lansvale Street, Mitchelton, Queensland	68
Kedron Brook, Osborne Road, Mitchelton, Queensland	70

## **Purpose of document**

This document has been prepared specifically to:

- provide a brief pictorial overview of various creek rehabilitation projects
- provide brief commentary on the projects where such information is available to the author
- provide a location map of creek rehabilitation sites so interested person can visit the sites
- aid in the advancement and promotion of water sensitive, ecologically sustainable, creek rehabilitation and riparian bush regeneration projects

The images presented within this document are intended to represent the current topic being discussed. These images are presented for the purpose of depicting an actual site condition or outcome. In some cases the images may not represent current best practice, but a response to the site conditions or the state of knowledge known at the time of the project's design.

The caption and/or associated discussion should **not** imply that the images necessarily represent either good or bad practice. The actual circumstances, site conditions and history of the site may not be fully known by the author. This means that there may be a valid site-specific reason why the designer chose the layout and channel features depicted in the photo.

## **About the author**

Grant Witheridge is a civil engineer with both Bachelor and Masters degrees from the University of NSW (UNSW). He has over 30 years experience in the fields of hydraulics, stormwater management, creek engineering and erosion & sediment control, during which time he has worked for a variety of federal, state and local governments, and private organisations.

Grant is the principal author of the revised editions of the Queensland Urban Drainage Manual (2007 & 2013), Brisbane City Council's Natural Channel Design (2000) and Creek Erosion (1997) guidelines; the IECA (2008) Best Practice Erosion & Sediment Control documents, and various guidelines on the fish passage requirements at waterway crossings.

## **Introduction**

This document presents only a small sample of the creek rehabilitation work completed in and around Brisbane (plus Gold Coast & Lismore). The inclusion of sites in this document primarily depended on whether the author had access to photos of the site dating back to the 1990s. Many good creek rehabilitation projects have not been included simply because the author did not have early site images that would allow a good comparison with current site conditions.

Creek engineering and Natural Channel Design are not exact sciences. Creek engineering practices are still very much in their infancy. At this point in time our knowledge base still originates from real life case studies such as these, rather than from text books.

Hindsight is a wonderful thing in creek engineering. The approaches taken within many of the following case studies may well be different if they were based on current best practice and the knowledge gained over the past 20 years from each of these case studies.

The designers and practitioners associated with each of these case studies should not be criticised for decisions made in the past, but praised for the part they played in the development of our current knowledge base, and for their leadership in the promotion of ever-improving urban waterway practices.

Natural Channel Design (NCD) may be looked upon as a branch of creek engineering that involves the planning, design, construction and maintenance of waterway channels that are compatible with current and future hydrological, ecological and human requirements of the drainage catchment.

The principles of Natural Channel Design are based on providing the required hydraulic conveyance of a drainage channel and floodway, while maximising its potential environmental values. This holistic approach combines the disciplines of hydraulic engineering, fluvial geomorphology, and in-stream and riparian ecology.

These NCD principle may be applied to the rehabilitation of natural waterways and the construction of new drainage channels in locations where no waterway previously existed.

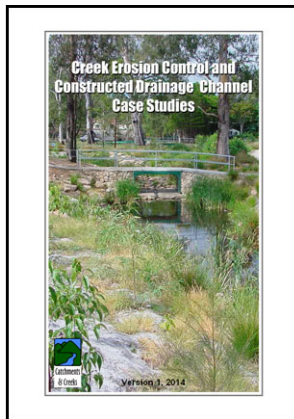
## Introduction



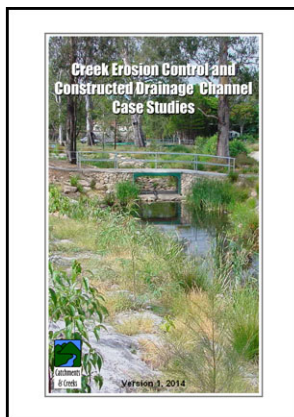
**Major creek rehabilitation project**



**Rehabilitation of riparian zones**



**Creek Erosion & NCD Case Studies (2014)**



**Creek Erosion & NCD Case Studies (2014)**

### Creek rehabilitation projects

- These projects involve the rehabilitation of degraded urban creeks.
- Projects typically involve modifications to the bed and banks, as well as channel and riparian revegetation programs.
- Many of these projects incorporate the principles of *Natural Channel Design*, but the emphasis is often on achieving the best environmental and aesthetic outcomes without the need for major channel reconstruction.

### Riparian bush regeneration projects

- These projects focus on the rehabilitation of riparian areas either side of a waterway without the need for major earthworks.
- Many of the projects within Brisbane are centred around community-based bushcare teams assisted by expert bushcare officers.
- In so many ways the documented projects represent the power and successful outcomes produced through strong community-based participation.

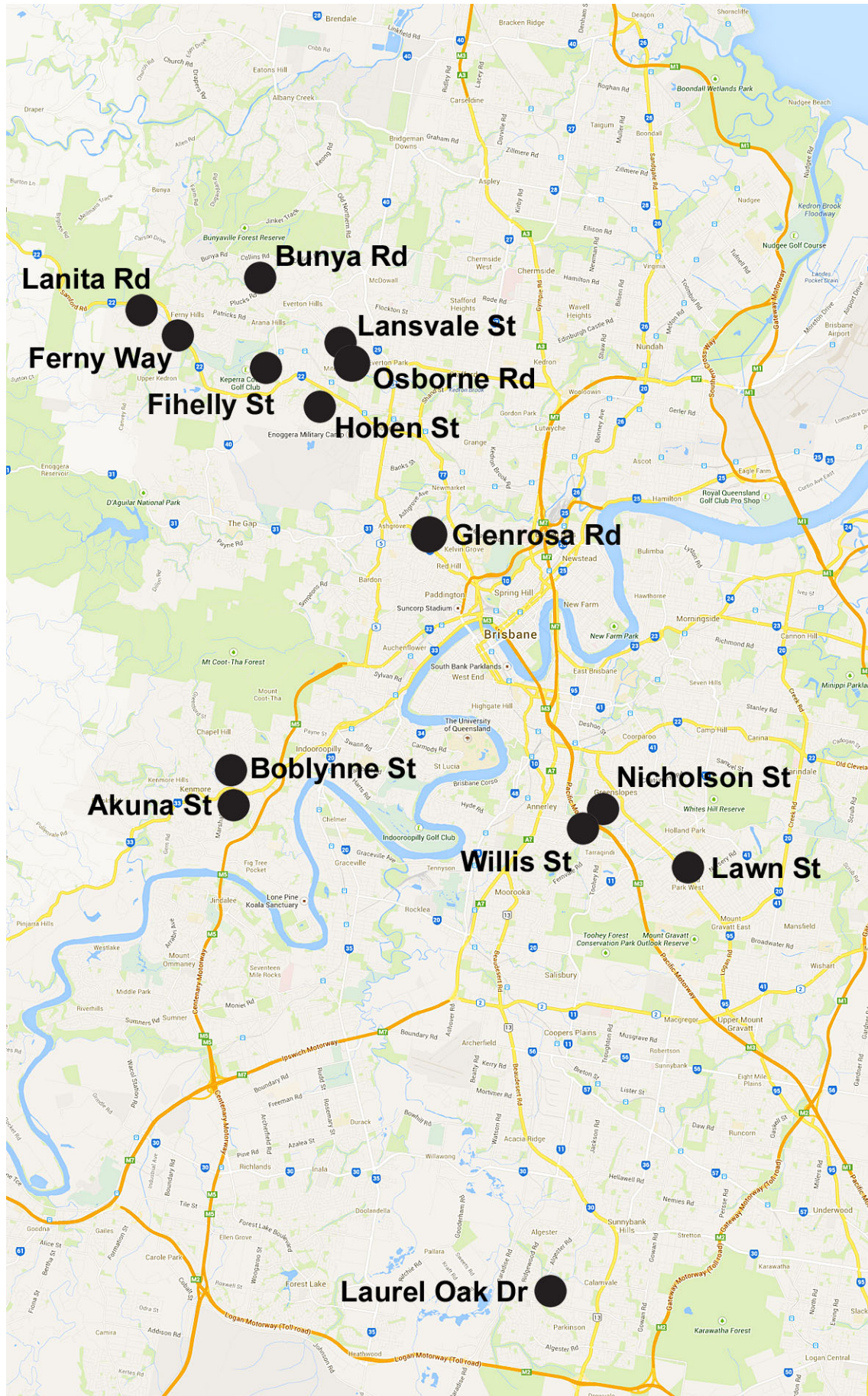
### Creek erosion control projects

- Case studies for creek erosion projects can be found in the *Catchments & Creeks* sister-document '[Creek Erosion Control and Constructed Drainage Channels Case Studies](#)'.
- The focus of these projects is on stabilising bed or bank erosion without the need for major channel reconstruction.
- These projects usually incorporate the regeneration of riparian zones.

### Constructed drainage channels

- Case studies for constructed drainage channels can be found in the *Catchments & Creeks* sister-document '[Creek Erosion Control and Constructed Drainage Channels Case Studies](#)'.
- These projects usually involve either the reconstruction of old drainage channels, or the construction of new drainage channels within new urban developments.
- The principles of *Natural Channel Design* form the basis of many of these projects.

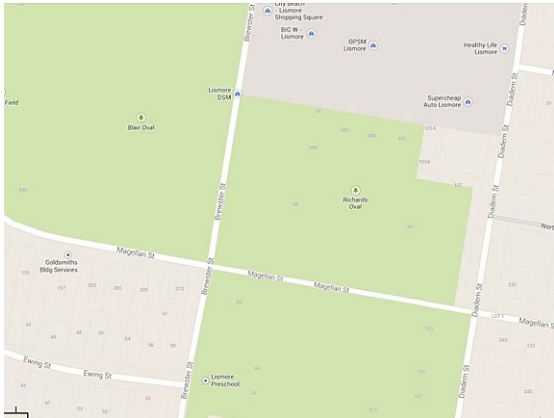
## Location map



Location of Brisbane sites

# **Creek Rehabilitation Projects**

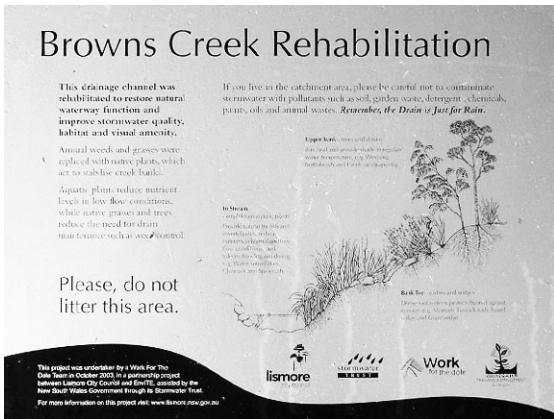
# Browns Creek, Magellan Street, Lismore, NSW



Location map (north to the top of image)



Aerial image of the site



On-site public information sign

## The project

- The project site is located in a Lismore Council park adjacent to Magellan Street.
- The 'stormwater drain' is a tributary to Browns Creek located within the centre of the residential precinct of Lismore, NSW.
- The creek/drain rehabilitation was seen as a demonstration project for both the council and the residents.
- One aim being to improve the resident's appreciation of the value of 'natural' waterways instead of 'stormwater drains'.



Pre-works site conditions (2003)

## Site constraints

- The site was constrained by planned road works south of the drain, and the sports ovals on the northern side of the drain.
- It was also considered desirable to avoid the relocation of the telephone pole.
- The site contains a cracking clay soil that benefits greatly from suitable vegetation cover that can reduce soil drying.
- The visually unattractive, low-value stormwater drain was also subject to urban litter, including shopping trolleys.

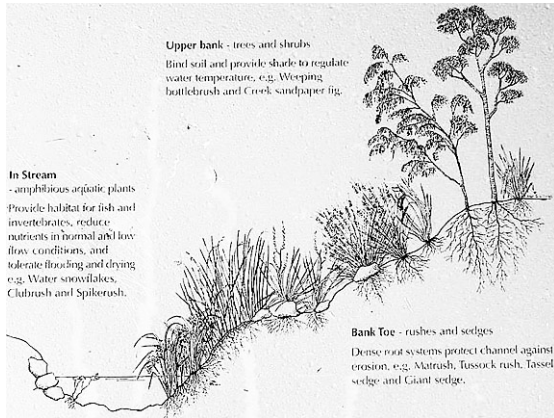


Erodible, cracking black soils



Deposition of rubbish in storm drain

# Browns Creek, Magellan Street, Lismore, NSW



**On-site public information sign**



**Looking downstream (2003)**



**Looking down drainage channel (2005)**



**Looking downstream (2005)**



**Looking down drainage channel (2007)**



**Looking downstream (2007)**

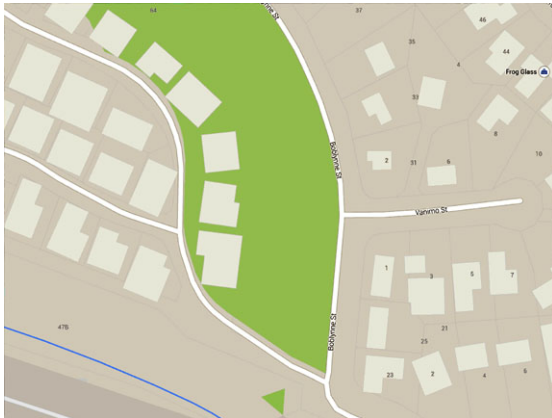


**Looking down drainage channel (2014)**



**Looking downstream (2014)**

## Cubberla Creek tributary, Boblyne Street, Chapel Hill, Qld



Location map (north to the top of image)



Aerial image of the site



Photo supplied by Catchments & Creeks Pty Ltd

Grassed drain (pre-works, 1999)

### The proposal

- The original purpose of the channel works was to reduce the long-term soil saturation problems experienced by the channel bed.
- Soil saturation made mower access to the far bank difficult, and reduce the potential for the planting of native species.
- The original proposal involved forming a well-defined, 300 mm deep, low-flow channel by raising part of the bed at least 300 mm.
- A habitat pool was also constructed.



Photo supplied by Catchments & Creeks Pty Ltd

Constructed habitat pool (2000)

### The lessons

- Unfortunately, cost savings on this low budget project meant that the bed was not raised sufficiently above the low-flow channel—this meant the soil saturation problems continued.
- Also, the upstream reeds and weeds provided a seed source that invaded the habitat pool—this meant that the pool quickly filled with reeds and weeds.
- Ultimately, reed control will only be achieved through the development of a canopy cover.



Photo supplied by Catchments & Creeks Pty Ltd

Reed/weed invasion of pool (2001)



Photo supplied by Catchments & Creeks Pty Ltd

Established canopy cover (2014)

**Cubberla Creek tributary, Boblyne Street**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream along the constructed grassed channel (pre-works, 1999)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from within the newly established riparian zone (2014)**

**Cubberla Creek at junction of the tributary upstream of Moggill Rd**



Photo supplied by Catchments & Creeks Pty Ltd

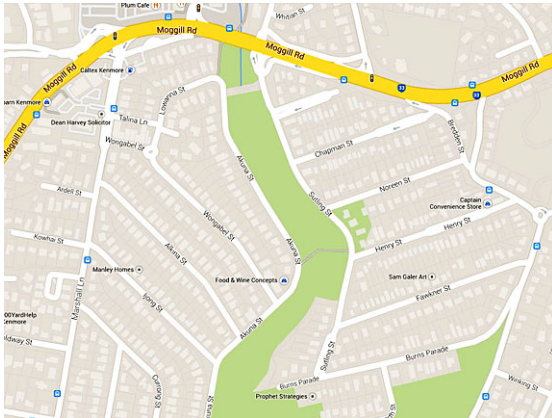
**Looking upstream along Cubberla Creek adjacent to Boblyne Street (2010)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream along Cubberla Creek adjacent to Boblyne Street (2014)**

## Cubberla Creek, Akuna Street, Kenmore, Qld



Location map (north to the top of image)



Aerial image of the site



Photo supplied by Catchments & Creeks Pty Ltd

Looking d/s from Moggill Rd (1991)



Photo supplied by Catchments & Creeks Pty Ltd

Protection of sewer with rubble (1991)



Photo supplied by Catchments & Creeks Pty Ltd

Community tree planting (2004)

### The site

- It is unknown why the creek was originally cleared of riparian vegetation, but it is likely to be a combination of the following reasons:
  - land clearing associated with the area's historical rural activities
  - clearing to allow installation of the trunk sewer line
  - clearing for flood mitigation purposes
  - clearing to allow maintenance access for weed and sediment removal.

### The problem

- In the early 1990s the creek had poor aesthetic appeal due to the exposed, weedy banks.
- Construction waste, in the form of rock, broken concrete and earth, had been used to stabilise and protect the channel banks adjacent the various sewer pipe crossings and sewer inspection chambers (just visible on the right of this image).

### The project

- Around the beginning of this century, Greening Australia coordinated various community re-planting programs along Cubberla Creek.
- During the latter stages of the first decade of the 21st Century a substantial construction of pools and riffles occurred along the channel bed immediately downstream of Moggill Road.

## Cubberla Creek, Akuna Street – plant establishment



**Looking d/s from Moggill Rd (1991)**



**Looking u/s towards Moggill Rd (1991)**



**Looking d/s from Moggill Rd (2004)**



**Looking u/s towards Moggill Rd (2004)**



**Looking d/s from Moggill Rd (2010)**



**Looking u/s towards Moggill Rd (2010)**



**Looking d/s from Moggill Rd (2014)**



**Looking u/s towards Moggill Rd (2014)**

## Cubberla Creek, Akuna Street – ‘then’ and ‘now’



**Looking downstream (1991)**



**Looking downstream (2014)**



**Looking downstream (1991)**



**Looking downstream (2014)**



**Looking u/s towards Moggill Rd (1991)**



**Looking u/s towards Moggill Rd (2014)**



**Downstream of footbridge (2004)**



**Downstream of footbridge (2014)**

**Cubberla Creek, Akuna Street – view from top of Moggill Road**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream from the top of Moggill Road bridge (1991)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream from the top of Moggill Road bridge (2014)**

**Cubberla Creek, Akuna Street – view from culvert outlet**



Photo supplied by Catchments & Creeks Pty Ltd

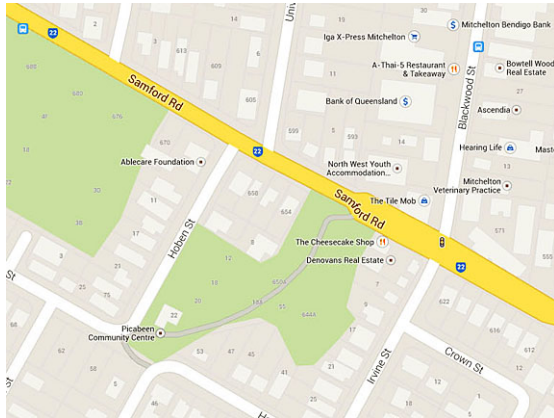
**Looking downstream from the Moggill Road culvert (1991)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream from the Moggill Road culvert (2014)**

## Kedron Brook tributary, Hoben Street, Mitchelton, Qld



Location map (north to the top of image)



Aerial image of the site



Photo supplied by Catchments & Creeks Pty Ltd

Looking upstream from Samford Rd (2005)

### Year 2005

- This project involved the rehabilitation of a park drain back into a waterway.
- Significant quantities of rock stabilisation occurred along the banks of the waterway.
- An existing tree was retained as an 'island' in the middle of the channel.
- Soil was not placed within the rock voids, which delays the establishment of vegetation on the channel banks.



Photo supplied by Catchments & Creeks Pty Ltd

Looking upstream from Samford Rd (2007)

### Year 2007

- Plants are beginning to establish on the channel bed, but with only limited plant establishment on the banks.
- A significant drought between 2005 and 2007 had delayed vegetation establishment along the waterway.



Photo supplied by Catchments & Creeks Pty Ltd

Looking upstream from Samford Rd (2014)

### Year 2014

- Significant weed infestation along the channel bed.
- The north-south alignment of the creek, and the open canopy to the north of the creek produced by the existence of Samford Road, means this section of the creek will always experience a weed problem.
- The shading produced by the growing canopy cover should reduce weeds in the upstream section of the creek.

## Kedron Brook tributary, Hoben Street, Mitchelton, Qld



Upstream end of works (2005)



Upstream end of works (2012)



Riffle (2005)



Riffle (2007)



Looking downstream (2005)



Looking downstream (2014)



Over-bank riparian zone (2005)



Over-bank riparian zone (2007)

**Kedron Brook tributary, Hoben Street, Mitchelton, Qld**



Photo supplied by Catchments & Creeks Pty Ltd

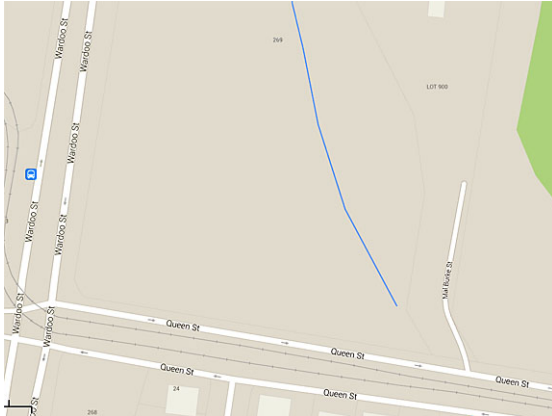
**Looking upstream from Samford Road (2007)**



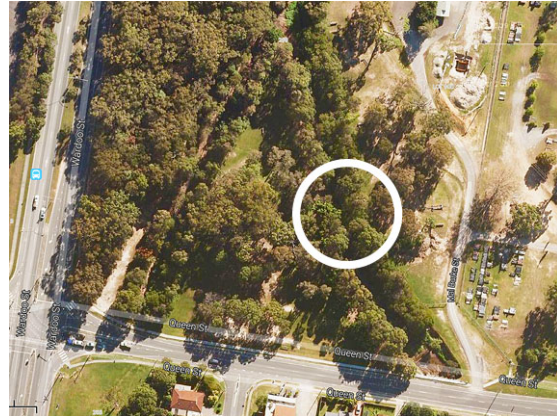
Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from Samford Road (2014)**

## Loder Creek, Queen St, Southport, Qld



Location map (north to the top of image)



Aerial image of the site



Photo supplied by Catchments & Creeks Pty Ltd

Sediment pond upstream of works (1996)

### The proposal

- Originally presented as a demonstration of *Natural Channel Design* concepts.
- A significant sediment collection pond was established upstream of the channel works.
- The establishment of canopy trees and the resulting shading of the channel has unfortunately not controlled the extensive weed infestation.
- The channel works provide significant terrestrial and aquatic instream habitat.



Photo supplied by Catchments & Creeks Pty Ltd

Low-flow meander (1996)



Photo supplied by Catchments & Creeks Pty Ltd

Low-flow meander (2004)



Photo supplied by Catchments & Creeks Pty Ltd

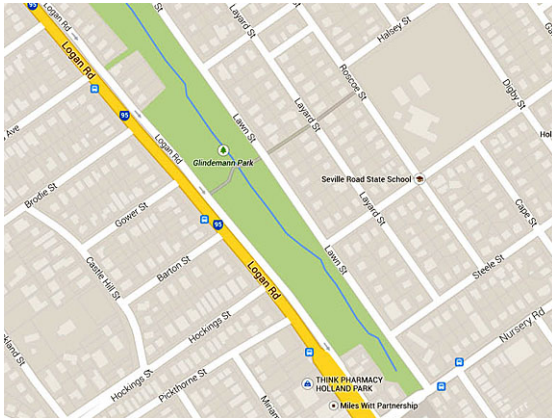
Queens St culvert outlet (2004)



Photo supplied by Catchments & Creeks Pty Ltd

Weed infestation (2006)

## Norman Creek, Lawn St, Holland Park, Qld



Location map (north to the top of image)



Aerial image of the site



Photo supplied by Catchments & Creeks Pty Ltd

1996

### Site history

- As was the case for many council parks, riparian vegetation had in the past been removed from the bank and over-bank areas of the creek to improve safety and the park's visual amenity.
- Parts of the creek had been piped to improve public safety and active recreational usage within the park.



Photo supplied by Catchments & Creeks Pty Ltd

Construction phase, May 2000

### The project

- Lobbying by the Norman Creek Catchment Coordinating Committee (N4C) resulted in the proposal for creek rehabilitation through the park.
- Channel rehabilitation commenced in 2000.
- The project involved significant bank stabilisation with rock and the stabilisation of the creek bed with rock weirs.



Photo supplied by Catchments & Creeks Pty Ltd

Bank erosion adjacent rock riffle (2002)

### The lessons gained from this project

- Significant bank erosion occurred in locations where rock was not placed along the toe of the revegetated banks.
- This toe erosion (left) was primarily caused by the rapid growth of bed vegetation (reeds) which gained strength faster than the newly established bank vegetation.
- The establishment of reeds along the creek bed can cause significant problems in the early stages of creek rehabilitation.

## Norman Creek, Lawn St, Holland Park



Looking downstream from outlet (1996)

### Year 1996

- In the 1990's, the creek presented itself more like a grass-lined drainage channel.



Looking downstream from outlet (2000)

### Year 2000

- The channel was reshaped and revegetated.
- The banks were partly stabilised with rocks (toe stabilisation).
- The channel bed was stabilised with rock weirs plus some lower-gradient rock riffles.



Looking downstream from outlet (2005)

### Year 2005

- As was typical at this time, plants were not initially established within the rock voids.
- The rock weirs placed along the creek bed differ from rock riffles in their shape and hydraulic operation.



Looking downstream from outlet (2014)

### Year 2014

- Riparian vegetation is well advanced along the eastern bank, but the canopy cover is not fully established.
- Some of the rock weirs have been damaged by flood flows.

## Norman Creek, Lawn St, Holland Park



Photo supplied by Catchments & Creeks Pty Ltd  
**Looking downstream from outlet (2005)**



Photo supplied by Catchments & Creeks Pty Ltd  
**Looking downstream from outlet (2014)**



Photo supplied by Catchments & Creeks Pty Ltd  
**Looking d/s just d/s from the outlet (2005)**



Photo supplied by Catchments & Creeks Pty Ltd  
**Looking d/s just d/s from the outlet (2014)**



Photo supplied by Catchments & Creeks Pty Ltd  
**Looking u/s towards the junction (2002)**



Photo supplied by Catchments & Creeks Pty Ltd  
**Looking u/s towards the junction (2014)**



Photo supplied by Catchments & Creeks Pty Ltd  
**Looking d/s from the junction (2005)**



Photo supplied by Catchments & Creeks Pty Ltd  
**Looking d/s from the junction (2014)**

## Norman Creek, Lawn St, Holland Park



**Looking d/s towards end of works (2008)**



**Looking d/s towards end of works (2014)**



**Looking d/s towards end of works (2008)**



**Looking d/s towards end of works (2014)**



**Looking u/s, d/s from junction (2000)**



**Looking u/s, d/s from junction (2014)**



**Looking u/s from d/s end of works (2000)**



**Looking u/s from d/s end of works (2014)**

**Norman Creek, Lawn St, Holland Park**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream from the main stormwater outlet (pre-works, 1996)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream from the main stormwater outlet (2014)**

**Norman Creek, Lawn St, Holland Park**



Photo supplied by Catchments & Creeks Pty Ltd

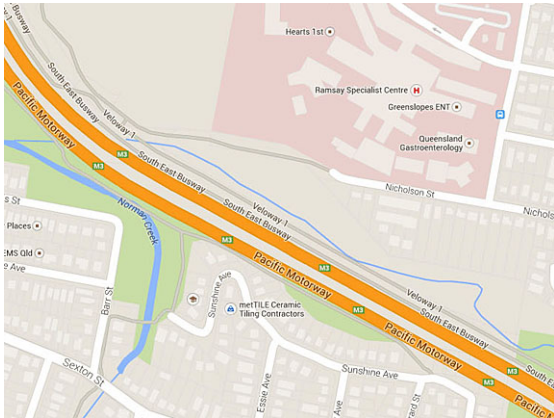
**Looking upstream from the downstream end of the channel works (2008)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from the downstream end of the channel works (2014)**

## Norman Creek, Nicholson St, Greenslopes, Qld



Location map (north to the top of image)



Aerial image of the site



Photo supplied by Catchments & Creeks Pty Ltd

Looking downstream from culvert (2000)

### Site history

- Riparian vegetation was largely cleared along the creek to provide flood mitigation.
- In the 1990s Norman Creek in this area resembled little more than an open storm drain passing through a grassed field.



Photo supplied by Catchments & Creeks Pty Ltd

Upstream reach (2001)

### The project – stage 1

- Construction of the busway adjacent to the South East Freeway resulted in the first stage of creek rehabilitation.



Looking downstream to culvert (2001)

### The project – stage 2

- Lobbying by the Norman Creek Catchment Coordinating Committee (N4C) resulted in the proposal for more substantial creek rehabilitation.
- A series of pools and riffles were formed along the creek based on the past success of a similar creek rehabilitation project adjacent to Willis St, Tarragindi (Ekibin).

**Norman Creek, Nicholson St, Greenslopes**



**Looking downstream to culvert (2000)**



**Looking downstream to culvert (2001)**



**Looking downstream to culvert (2001)**



**Looking downstream to culvert (2014)**

## Norman Creek, Nicholson St, Greenslopes



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from culvert (2001)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from culvert (2014)**

## Norman Creek, Nicholson St, Greenslopes



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream towards the culvert (after flood damage, 2001)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream towards the culvert (2014)**

**Norman Creek, Nicholson St, Greenslopes**



Photo supplied by Catchments & Creeks Pty Ltd

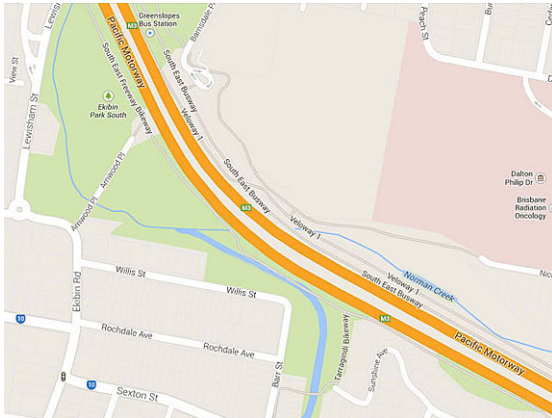
**Looking upstream towards the upper end of the reach (2001)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream towards the upper end of the reach (2014)**

## Norman Creek, Willis St, Tarragindi



Location map (north to the top of image)



Aerial image of the site



Photo supplied by Catchments & Creeks Pty Ltd

Old channel looking to Arnwood St



Photo supplied by Catchments & Creeks Pty Ltd

Pool-riffle system (looking upstream)



Photo supplied by Catchments & Creeks Pty Ltd

Initial weed removal and tree planting

### Catchment history

- The Norman Creek catchment has a very active community group and this project is just one of a number of stream rehabilitation activities.
- The creek is located close to the centre of Brisbane and consequently is one of the most urbanised and modified (channelised) creeks in Brisbane.
- The main focus of the project was a small southern tributary and a short section of Norman Creek downstream of its junction.

### The proposal

- This project centred around the re-naturalisation of the grass-lined, channelised tributary of Norman Creek that passes along Willis Street, Ekibin.
- The project extended from the junction of Barr and Willis streets down to Arnwood Place bridge.
- Key components of the rehabilitation were the establishment of a bed control pool-riffle system, and dense riparian planting.

### Site constraints

- This site benefited from the existence of elevated, flood-free homes on the high southern bank.
- The absence of local flood problems allowed the introduction of dense planting along this tributary to Norman Creek.
- The steep channel banks prevented the meandering of the channel (a cost issue).
- The upper reaches of the tributary consist of a concrete-lined channel (stormwater drain).

## Norman Creek, Willis Street – plant establishment



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from bridge (1999)**

### Year 1999

- Pre-works site conditions.
- Creek channel has significant weed infestation



Photo supplied by Catchments & Creeks Pty Ltd

**Following first stage of works (2001)**

### Year 2001

- Post works condition.
- Pools and riffles established with some planting within over-bank areas.
- Creek is nutrient-rich with heavy algae growth.



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from bridge (2010)**

### Year 2010

- Canopy trees have achieved significant height, but not full maturity.
- Significant weed cover exists within the understorey.
- Tree establishment along the northern bank (visible to the left) is now beginning to shade the waterway.



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from bridge (2014)**

### Year 2014

- Weeding and partial removal of grass cover within the riparian zone by the local community group.
- Shading from the established canopy cover also helps to thin the understorey and groundcover plants.
- The creek had experienced significant flood flows during 2009, 2010 and 2011.

## Norman Creek, Willis Street – plant establishment



**Upper end of tributary (2001)**



**Upper end of tributary (2010)**



**Looking upstream (2001)**



**Looking upstream (2010)**



**Looking down Norman Creek (1998)**



**Looking down Norman Creek (2014)**



**Looking downstream from bridge (1998)**



**Looking downstream from bridge (2014)**

## Norman Creek, Willis Street – pool-riffle system



Photo supplied by Catchments & Creeks Pty Ltd

**Constructed pool-riffle system (2001)**

### Pool-riffle system

- Pool-riffle systems are not natural in all waterways, and thus should not be considered an essential element of all creek rehabilitation projects.
- In this case the riffles help to control channel erosion that would otherwise have occurred once the canopy cover began to shade-out the grass cover.
- The use of 'blue' quarry rock may not be ideal, but the rocks usually develop a more natural brown/green colour over time (see below).



Photo supplied by Catchments & Creeks Pty Ltd

**Nutrient-rich waters (2001)**

### Algae problem

- This image of an algae encrusted turtle was taken within the deep pool that exists upstream of the Arnwood Place bridge in 2001 just after the completion of the channel works.
- This algae problem contributes to a reduction in dissolved oxygen within the water.
- Improved shading of the water body and improved stormwater practices within the catchment should see a reduction in this algae problem.



Photo supplied by Catchments & Creeks Pty Ltd

**Downstream riffle (2010)**

### Stepping stones

- The location of the downstream riffle has been adopted by locals as a stream crossing point.
- The riffle rocks substitute as stepping stones for the stream crossing.



Photo supplied by Catchments & Creeks Pty Ltd

**Upstream riffle (2010)**

### Fish passage

- The riffles have established desirable flow conditions that would encourage fish passage up the waterway.

**Norman Creek, Willis St, Tarragindi**



Photo supplied by Catchments & Creeks Pty Ltd

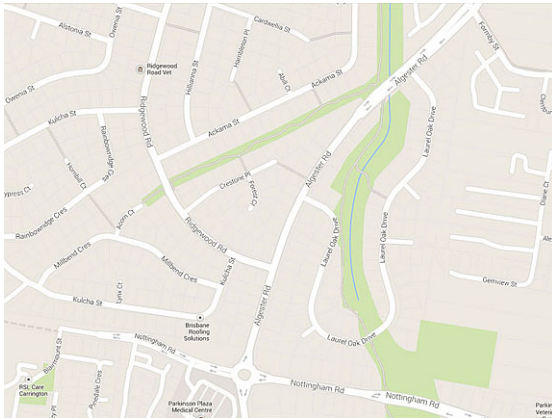
**Looking upstream from Arnwood Place bridge (1999)**



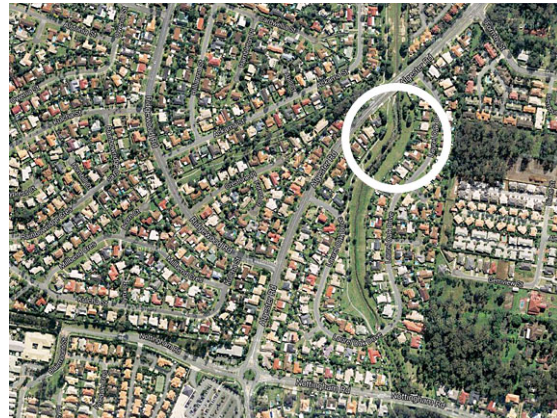
Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from Arnwood Place bridge (2014)**

## Sheep Station Gully, Laurel Oak Drive, Algester, Qld



Location map (north to the top of image)



Aerial image of stage 1 work area



Photo supplied by Catchments & Creeks Pty Ltd

Original grassed trapezoidal channel



Photo supplied by Catchments & Creeks Pty Ltd

Looking downstream to footbridge (2008)



Photo supplied by Catchments & Creeks Pty Ltd

Channel erosion (1998)

### Site history

- The grass-lined trapezoidal waterway was originally constructed during the 1980s urban subdivision of the area.
- The channel was originally developed without a formed low-flow channel, but instead had a sub-surface Ag-pipe drainage system.
- Over time the Ag-pipe blocked with sediment causing a low-flow channel to form (erode) along the channel invert.

### The project

- This was a multi-stage project, commencing with the stabilisation and revegetation of the lower reach between the footbridge and Algester Road.
- This first stage consisted of removing highly erodible slaking soils and the sub-surface Ag-pipe drainage system, and then forming a series of rock-lined pools and riffles.
- The second stage consisted of channel works between Nottingham Road and Laurel Oak Drive.



Photo supplied by Catchments & Creeks Pty Ltd

Exposed Ag-pipe & sewer crossing (1997)

## Sheep Station Gully, Laurel Oak Drive, Algester – Stage 1



Photo supplied by Catchments & Creeks Pty Ltd

Looking d/s to the footbridge (2010)

### Retention of footbridge

- Due to the steep gradient of the creek, and local flood control issues, the decision was made to retain the existing (1998) alignment of the low-flow channel.
- It was also agreed with the council that the footbridge would remain in its current location.



Photo supplied by Catchments & Creeks Pty Ltd

Looking upstream to footbridge (1999)

### Removal of slaking soil

- Significant quantities of rubbish (burnt tree stumps) and highly erodible slaking soils were found in the stream banks adjacent the low-flow channel, which resulted in the need for this material to be removed.
- The channel was then lined with stable soil and a rock-lined pool-riffle system was constructed.



Photo supplied by Catchments & Creeks Pty Ltd

Soil-filled voids ready for planting (1999)

### Pocket planting

- This project was one of the first examples in Brisbane where the voids between the rocks were filled with soil allowing plants to be introduced into the channel upon completion of the channel works.
- Prior to this, the practice of filling the voids with soils was considered unacceptable due to the risk of the soil being washed from the rocks by stream flows.
- Even though some soil is lost, the benefits gained through the earlier establishment of vegetation are significant.



Photo supplied by Catchments & Creeks Pty Ltd

Pool-riffle system (2010)

### Pool-riffle system

- The channel falls in elevation only 400 mm at each riffle system, which is approximately the size of the rocks.
- When initially constructed (see photos over page) the individual pools and riffles were not clearly distinguishable amongst all the other bank stabilisation rock.
- Establishment of a canopy cover, which helps to control weeds, allows the pool-riffle system to be more clearly identifiable.

## Sheep Station Gully, Laurel Oak Drive, Algester – plant establishment



**Looking d/s towards footbridge (1997)**



**Looking d/s from footbridge (1999)**



**Looking d/s from footbridge (2000)**



**Looking d/s from footbridge (2001)**



**Looking d/s from footbridge (2004)**



**Looking d/s from footbridge (2008)**



**Looking d/s from footbridge (2010)**



**Looking d/s from footbridge (2014)**

## Sheep Station Gully, Laurel Oak Drive, Algester – plant establishment



Looking u/s, construction phase (1999)



Sewer pipe crossing (1997)



Looking upstream to footbridge (1999)



Sewer pipe crossing (1999)



Looking upstream to footbridge (2000)



Sewer pipe crossing (2000)



Looking upstream to footbridge (2010)



Sewer pipe crossing (2010)

## Sheep Station Gully, Laurel Oak Drive, Algester – plant establishment



Looking u/s from Algester Road (1998)



Looking u/s from Algester Road (1999)



Looking u/s from Algester Road (2000)



Looking u/s from Algester Road (2001)



Looking u/s from Algester Road (2004)



Looking u/s from Algester Road (2008)



Looking u/s from Algester Road (2010)



Looking u/s from Algester Road (2014)

**Sheep Station Gully, Laurel Oak Drive, Algester**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from Algester Road (1998)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from Algester Road (2014)**

**Sheep Station Gully, Laurel Oak Drive, Algester**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream towards the footbridge (1997)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream from the footbridge (2010)**

## Sheep Station Gully, Laurel Oak Drive, Algester – Stage 2



**Upstream of Laurel Oak Dr (1997)**



**Aerial image of stage 2 work area**



**Upstream of Laurel Oak Dr (2001)**

### Year 2001

- Stage 2 of the project consisted of similar channel works being constructed between Nottingham Road and Laurel Oak Drive.
- The lower channel gradient allowed the use of erosion control mats on the battered banks as opposed to rock stabilisation.
- The Laurel Oak Driver culvert was also modified to reduce sediment and debris blockage problems.



**Upstream of Laurel Oak Dr (2004)**

### Year 2004

- During the early years, plant establishment was dominated by reeds and weeds within the moist low-flow channel.
- At this stage there is the risk of floods causing bank erosion on either side of the reed-infested low-flow channel.



**Upstream of Laurel Oak Dr (Nov, 2014)**

### Year 2014

- Even though a canopy cover has not been successfully achieved, an open low-flow channel is now well defined and the channel banks are partially stabilised with vegetation.
- Ongoing maintenance is required to encourage the establishment of a canopy cover to better control weeds and shade the low-flow channel.
- Loss of rocks is occurring at the riffles.

**Sheep Station Gully, Laurel Oak Drive, Algester – Stage 2**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from Laurel Oak Drive (1997)**



Photo supplied by Catchments & Creeks Pty Ltd

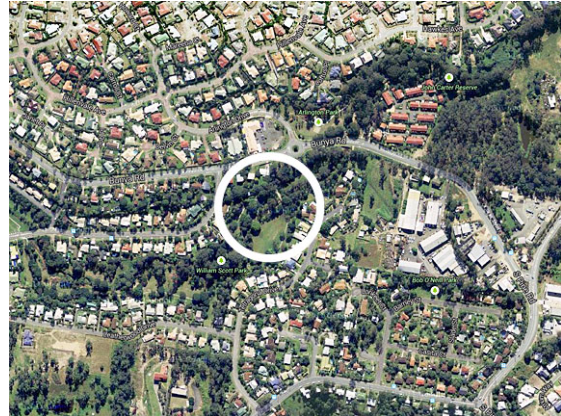
**Looking upstream from Laurel Oak Drive (December, 2014)**

# **Riparian Bush Regeneration Projects**

# Cabbage Tree Creek, Bunya Road, Arana Hills, Qld



Location map (north to the top of image)



Aerial image of the site



Photo supplied by Catchments & Creeks Pty Ltd

Looking upstream (1996)



Photo supplied by Catchments & Creeks Pty Ltd

Looking downstream (1996)



Photo supplied by Catchments & Creeks Pty Ltd

Looking upstream (2014)

## Site history

- Limited information is available on the history of this site.
- Riparian vegetation was cleared from both sides of the creek, presumably to enhance the safety and visual amenity of the council park.
- Removal of the canopy cover from the creek resulted in significant weed infestation of the channel.
- Stream flows then began to erode the northern (shaded) bank.

## Creek rehabilitation

- In the 2000s, riparian regeneration occurred along the banks of the creek.
- Significant flood flows during 2009 to 2011 caused sediment removal and bank erosion along the now-shaded channel.

## The lessons gained from this project

- Along with many other benefits, the retention of shade-producing riparian vegetation is essential for the control of weeds within creeks.
- Weed growth and sediment deposition within urban creeks often causes bank erosion along the more intensely shaded northern banks of creeks.
- The return of riparian plants to a cleared creek can initiate other erosion problems that will need to be managed.

## Cabbage Tree Creek, Bunya Road, Arana Hills



Looking upstream (April, 1996)

### April 1996

- Bank erosion is evident along the northern bank of the creek.
- The bank erosion is worse adjacent the growing shrub due to the increased shading of the bank caused by the presence of the shrub.
- The root system of the shrub cannot control this form of scour erosion.



Looking upstream (November, 1996)

### November 1996

- A new low-flow channel is forming along the base of the northern bank as a result of the following factors:
  - weaker bank vegetation along the northern (shaded) bank
  - weed infestation along the creek bed
  - sediment deposition within the channel.
- This image (left) represents the creek condition after the severe May 1996 storms.



Looking upstream (1999)

### Year 1999

- The bank-side shrub is in poor health due to the severe soil loss around its root system and the resulting root damage.
- The fluvial condition being demonstrated here is the accelerated migration of a creek channel to the north caused by the removal of a canopy cover from the creek.



Looking upstream (2011)

### Year 2011

- Riparian cover returned to both banks of the creek, which has reduced the density and strength of the in-channel weeds.
- Significant channel flows over the period 2009 to 2011 have caused the previously settled sediment to be displaced resulting in the formation of near-vertical creek banks.
- Subsequent bank erosion can in some cases undermine the newly established bank vegetation.

**Cabbage Tree Creek, Bunya Road, Arana Hills**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from footbridge (1996)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from footbridge (2014)**

**Cabbage Tree Creek, Bunya Road, Arana Hills**



Photo supplied by Catchments & Creeks Pty Ltd

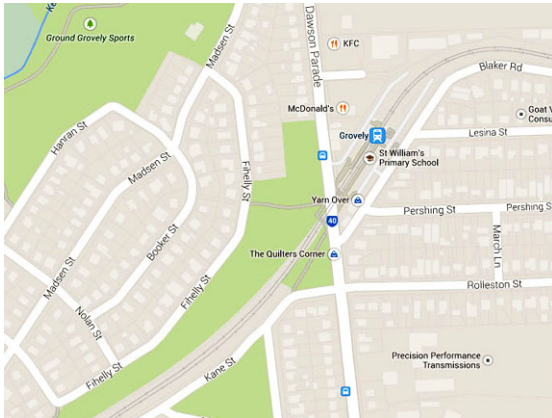
**Looking downstream from footbridge (1996)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream from footbridge (2014)**

## Fihelly Street, Keperra, Qld



Location map (north to the top of image)



Aerial image of the site



Photo supplied by Catchments & Creeks Pty Ltd

Looking u/s towards footbridge (1998)

### Year 1998

- Planted riparian zones were established along both sides of this constructed stormwater drain that passed through the park.
- No works were conducted within the bed of the stormwater drain.



Photo supplied by Catchments & Creeks Pty Ltd

Looking u/s towards footbridge (2003)

### Year 2003

- Establishment of a healthy canopy cover has caused significant shading of the channel banks leading to a reduction in the density of ground covers on the channel banks compared to that on the bed.
- In this condition the channel bed is **less** susceptible to erosion than the channel banks.
- Bank erosion can be seen each side of the well-grassed channel bed.



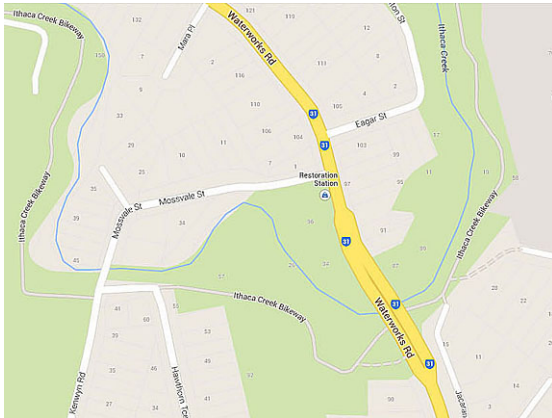
Photo supplied by Catchments & Creeks Pty Ltd

Looking u/s towards footbridge (2014)

### Year 2014

- A partial canopy has established over the creek, but is insufficient in density to fully control weed growth.
- The channel erosion observed in 2003 appears to be under control.

## Ithaca Creek, Glenrosa Road, Red Hill, Qld



Location map (north to the top of image)



Aerial image of the site



Photo supplied by Catchments & Creeks Pty Ltd

Looking d/s from Waterworks Rd (1992)

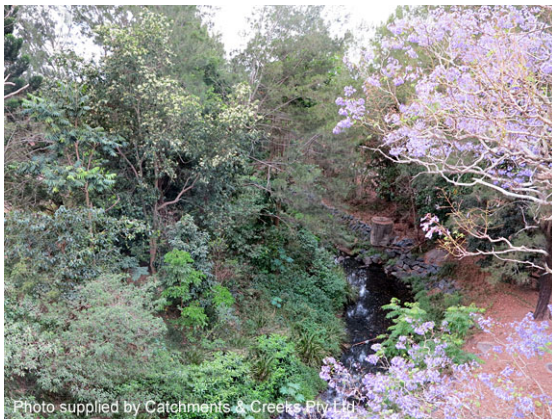


Photo supplied by Catchments & Creeks Pty Ltd

Looking d/s from Waterworks Rd (2013)



Photo supplied by Jenny Leask

Jute bagging planting technique (2005)

### Site history

- In the early 1990s this lower reach of Ithaca Creek was deprived of adequate riparian vegetation cover.
- Significant residential flooding existed upstream of this area and, in the absence of detailed hydraulic modelling, tree planting was considered a flood risk.
- A sewer inspection chamber (manhole) can be seen in the bottom right-hand corner of the photo—this chamber can be used as a reference point in subsequent images.

### The project

- The project consisted of rock stabilisation around the sewer chamber and the re-establishment of riparian vegetation along both banks of the creek.
- The tree planting was conducted by both council funded projects and community planting schemes.

### Jute bagging

- Tried on this site was a new planting technique call 'jute bagging'.
- Small 'bags' were formed from thick jute blankets, filled with soil and a single seedling, then pinned to the exposed creek bank.
- The technique of jute bagging allows plants to be established on steep earth banks that are likely to be subject to occasional stream flows.

## Ithaca Creek, Glenrosa Road, Red Hill – plant establishment



Photo supplied by Catchments & Creeks Pty Ltd

**Western bank looking d/s (1996)**



Photo supplied by Jenny Leask

**Weedy bank (2005)**



Photo supplied by Jenny Leask

**Western bank looking d/s (2005)**



Photo supplied by Jenny Leask

**Weed removal (2005)**



Photo supplied by Jenny Leask

**Western bank looking d/s (2006)**



Photo supplied by Jenny Leask

**Plant establishment (2005)**



Photo supplied by Catchments & Creeks Pty Ltd

**Western bank looking d/s (2010)**



Photo supplied by Jenny Leask

**Planted bank (2006)**

## Ithaca Creek, Glenrosa Road – plant establishment



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream (April 1996)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream to bridge (1996)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream (May 1996)**



Photo supplied by Jenny Leask

**Looking upstream to bridge (2006)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream (2010)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream to bridge (2010)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream (2014)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream to bridge (2014)**

**Ithaca Creek, Glenrosa Road, Red Hill**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream from Waterworks Road (1992)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream from Waterworks Road (2014)**

**Ithaca Creek, Glenrosa Road, Red Hill**



Photo supplied by Catchments & Creeks Pty Ltd

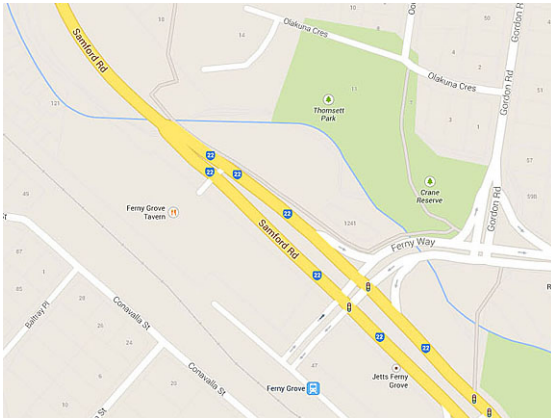
**Looking upstream from Waterworks Road (1992)**



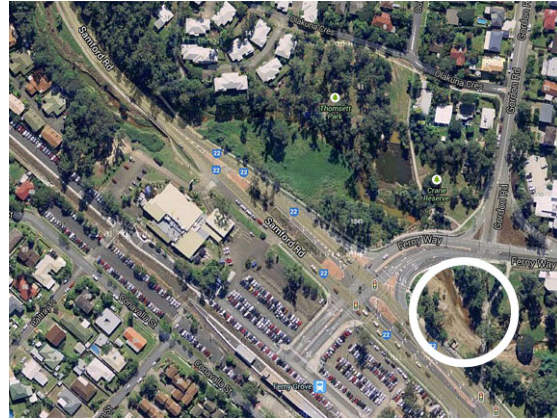
Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from Waterworks Road (2014)**

## Kedron Brook, downstream of Ferry Way, Ferry Hills, Qld



Location map (north to the top of image)



Aerial image of the site



Photo supplied by Catchments & Creeks Pty Ltd

Downstream of Ferry Way (Nov, 2008)

### Site history

- Significant weed and vine infestation had occurred along both banks of the creek downstream of the Ferry Way culvert.



Photo supplied by Catchments & Creeks Pty Ltd

Downstream of Ferry Way (Nov, 2009)

### The project

- A comprehensive weed removal and creek revegetation program commenced during the 'dry season' of 2009.



Photo supplied by Catchments & Creeks Pty Ltd

Downstream of Ferry Way (May, 2009)

### The lessons

- The local council followed appropriate procedures and commenced the channel works during the recognised 'dry' season.
- Unfortunately for the project, an unseasonal storm occurred in May 2009.
- This storm caused significant bank and bed erosion within the work area.

## Kedron Brook, downstream of Ferny Way – plant establishment



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream (2008)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream (April, 2009)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream (May, 2009)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream (Nov, 2009)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream (Jan, 2011)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream (April, 2012)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream (March, 2012)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream (2014)**

## Kedron Brook, downstream of Ferny Way



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream from Ferny Way culvert, Ferny Hills (2008)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream from Ferny Way culvert, Ferny Hills (April, 2009)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream from Ferny Way culvert, Ferny Hills (Nov, 2009)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream from Ferny Way culvert, Ferny Hills (2014)**

## Kedron Brook, downstream of Ferny Way



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from footbridge (2008)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from footbridge (2009)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from footbridge (2010)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from footbridge (2014)**

## Kedron Brook, downstream of Ferny Way



Looking d/s from footbridge (April, 2009)

### Year 2009

- This image presents the creek conditions downstream of the footbridge during the period that the weed removal was occurring.
- Following weed removal, this region was stabilised with plants and erosion control mats, but no enhanced toe protection.

### Year 2010

- The reduced channel roughness caused by the upstream weed removal has increased flow velocities within the creek.



Looking d/s from footbridge (Aug, 2009)



Looking d/s from footbridge (2010)



Looking d/s from footbridge (2013)

### Year 2013

- Significant bank erosion has occurred during the wet years of 2010 to 2013.

### Year 2014

- As of 2014 the bank erosion had not been repaired; instead the area was left to revegetated naturally.



Looking downstream from the Beverley Reserve footbridge (2014)

## Kedron Brook, downstream of Ferny Way



**Downstream of park (April, 2009)**

### April 2009

- Channel conditions downstream of the work area prior to the commencement of week removal.



**Downstream of park (Aug, 2009)**

### August 2009

- Sediment removal from the upstream work area resulted in significant sediment deposition within this downstream reach.



**Downstream of park (Oct, 2010)**

### October 2010

- Significant bankful channel flows occurred throughout 2009 to 2013.



**Downstream of park (2014)**

### Year 2014

- Without a substantial canopy cover, weeds have invaded and stabilised the deposited bed sediment.
- Bank erosion is likely to occur as a result of the growth of bed weeds.

**Kedron Brook, downstream of Ferny Way**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream from Ferny Way culvert, Ferny Hills (2008)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream from Ferny Way culvert, Ferny Hills (2014)**

**Kedron Brook, downstream of Ferny Way**



Photo supplied by Catchments & Creeks Pty Ltd

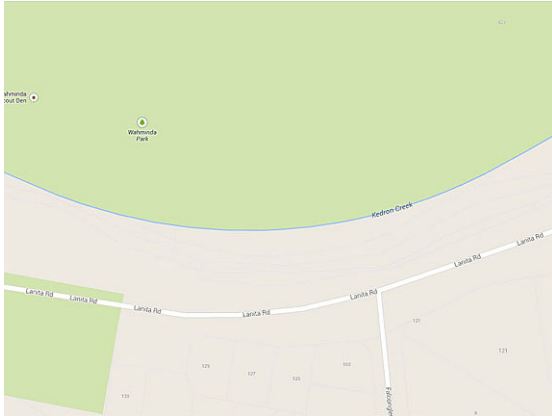
**Looking upstream from the Beverley Reserve footbridge (2008)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from the Beverley Reserve footbridge (2014)**

## Kedron Brook, Lanita Road, Ferny Grove, Qld



Location map (north to the top of image)



Aerial image of the site



Photo supplied by Catchments & Creeks Pty Ltd

Looking u/s into undisturbed creek (1994)

### Site history

- This reach of Kedron Brook represents the upper most extent of urban development within the drainage catchment.
- Upstream of this reach the creek primarily consists of a rocky pool-riffle system.
- In the early 1990s a residential subdivision adjacent to Lanita Avenue resulted in significant sediment deposition within the creek.



Photo supplied by Catchments & Creeks Pty Ltd

Looking d/s at sediment deposit (1994)

### The project

- A community-based bushcare group established in the local area commenced creek rehabilitation activities along the degraded section of Kedron Brook.
- The bushcare group faced the difficult decision of whether to stabilise the sediment 'slug', or to allow it to be displaced downstream by flood flows.
- In most cases, planting (i.e. stabilising) the sediment slug will place increased stress on the adjacent creek banks.



Photo supplied by Jenny Leask

Looking upstream (2012)



Photo supplied by Jenny Leask

Looking downstream (2012)

**Kedron Brook, Lanita Road, Ferny Grove**



Photo supplied by Catchments & Creeks Pty Ltd

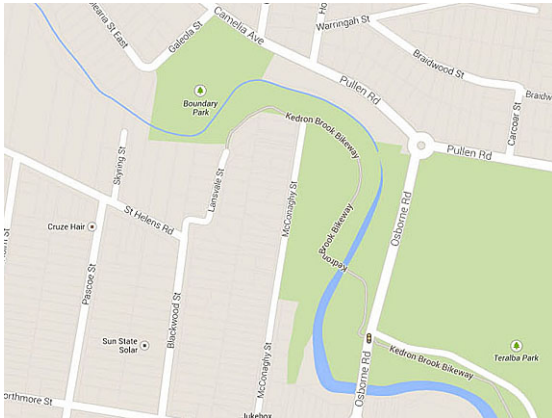
**Looking downstream to sediment deposit adjacent Falconglen Close, Ferny Grove (1994)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream during dry season, Falconglen Close, Ferny Grove (2014)**

## Kedron Brook, Lansvale Street, Mitchelton, Qld



Location map (north to the top of image)



Aerial image of the site



Photo supplied by Catchments & Creeks Pty Ltd

Looking upstream (2010)



Photo supplied by Catchments & Creeks Pty Ltd

Local bushcare group (2013)



Photo supplied by Catchments & Creeks Pty Ltd

Flood damage (2013)

### Site history

- This region of Kedron Brook was substantially cleared during the pre urban phase when the land was used for farming and other rural activities.
- Weed infestation had resulted in the smothering of many of the established riparian trees.
- A community-based bushcare group established and on a history Tuesday, liberated these trees.

### The project

- The local bushcare group, known as the 'Tuesday Tree Liberators', commenced weed removal and native regeneration along the lower bank of Kedron Brook.
- During the floods of 2010 to 2013, significant erosion and tree loss occurred within the work area.

### The lessons

- Significant as the flood damage was, it was not as devastating as had occurred within other creeks during wet years of 2010 to 2013.
- This site proved the benefit of retaining significant weed cover during the establishment phase of the replacement native plants.
- If complete weed removal had occurred on this site, then the flood damage would have likely been more extensive.

**Kedron Brook, Lansvale Street, Mitchelton**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking north-west across lower floodplain, downstream is to the right (2011)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking downstream through the area of greatest flood damage (2013)**



Photo supplied by Catchments & Creeks Pty Ltd

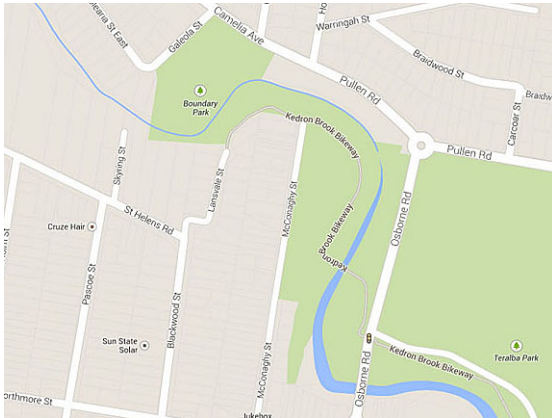
**Looking north-west across lower floodplain, downstream is to the right (Sept, 2014)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking north-west across lower floodplain, downstream is to the right (Oct, 2014)**

## Kedron Brook, Osborne Road, Mitchelton, Qld



Location map (north to the top of image)



Aerial image of the site



Photo supplied by Catchments & Creeks Pty Ltd

Upstream of Osborne Rd (1998)



Photo supplied by Jenny Leask

Long-stem planting in sandy soil



Photo supplied by Catchments & Creeks Pty Ltd

Plants used for floodplain erosion control

### Site history

- Significant weed infestation had occurred along this reach of Kedron brook while the land was held in private ownership.
- Brisbane City Council acquired control of the land in the 1990s and a local bushcare group commenced weed removal from the lower bank bench.

### The project

- Due to the high flow velocities in this area, long-stem planting was trialed.
- This form of tree planting provides the plants with increased resistance to being removed from the sandy soils during flood events.

### The lessons

- Also trialed in this area was the use of *Lomandras* planted in rows transverse to the direction of flood flow.
- The purpose of these plants is to reduce the risk of channel relocation and floodplain erosion during the establishment phase of the native plants.

**Kedron Brook, Osborne Road, Mitchelton**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from Osborne Road bridge (1998)**



Photo supplied by Catchments & Creeks Pty Ltd

**Looking upstream from Osborne Road bridge (2014)**

