Natural Sequence Farming: Catalyst for riparian restoration in semi-arid Australia

Project Planning & Implementation

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Australian Government
Department of Agriculture, Fisheries and Forestry
National Landcare Programme

Lake Cowal Foundation

Acknowledgements

The Natural Sequence Farming (NSF) project was developed by Dr. Donna Johnston, Malcolm Carnegie (Lake Cowal Foundation) and Professor David Goldney (CenWest Environmental Services, Natural Sequence Farming Consortium) with specialist advice from Peter Andrews, Professor David Mitchell, Paul Newell (Natural Sequence Farming Consortium) and David Tongway (Australian National University).

The Spring Creek landholders including G&H West, P & V, Barber, G & A Davies, C. Lee/J. Worner, H & B Mangelsdorf, M. Wilson, Bland Shire Council, Condobolin Rural Lands Protection Board and Barrick Australia Limited were instrumental and have been willing participants in this important landscape restoration project. These landholders have made a significant contribution towards the design, implementation and ongoing management of the project sites.

Project funding was provided by the National Landcare Program Natural Resource Innovation Grants and the Lake Cowal Foundation. Bland Shire Council provided assistance with the installation of the rock weirs. Teachers and students from West Wyalong High School are likely to participate in the planting of the wetland plants when suitable weather conditions prevail in 2008

Research

Australian National University Masters student Kim Marchiori under the supervision of Dr Richard Greene and David Tongway with assistance from Dr Donna Johnston and Malcolm Carnegie undertook her Masters research along Spring Creek. Her project was titled “An assessment of Spring Creek and its catchment, Lake Cowal NSW: Implications for Natural Sequence Farming”. Her research involved assessing the soils and stability and functionality of the Creek to obtain baseline data and making some recommendations in the long-term management of the catchment.

Approvals and licenses

Licenses and approvals were obtained from the Lachlan Catchment Management Authority (c/- Department of Natural Resources), Department of Lands, State Rail Authority, Condobolin Rural Lands Protection Board and NSW Fisheries prior to implementation of the project. The Department of Natural Resources also issued licenses for the installation of the piezometers.

Disclaimer

This project has been developed under the guidance and recommendations of expert landscape ecologists, members of the Natural Sequence Farming Consortium with approvals from participating landholders and relevant Government Regulatory Departments specifically for the purpose of restoring Spring Creek. It has been designed with the best science and intentions at that time and the plan is intended to be adapted as the project evolves. The Lake Cowal Foundation and members of the Natural Sequence Farming Consortium have taken all due care to provide the best advice and support but cannot take any responsibility for mismanagement of the project sites or any unusual or unforeseen circumstances.

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Natural Sequence Farming – catalyst for riparian restoration in semi-arid Australia: Project planning and implementation

1.1 Introduction

Natural Sequence Farming (NSF) is a holistic land management initiative developed by Mr Peter Andrews in the Upper Hunter Valley in the 1970s that seeks to reintegrate stream flow and floodplain processes to sustainably drive production and nature conservation outcomes. A CSIRO expert panel commissioned by the Deputy Prime Minister, Hon John Anderson, reported favourably on the scientific basis and effectiveness of NSF (CSIRO 2002) and recommended that it be trialled in other land systems in Australia. Currently no trials are being conducted in the Australian semi-arid zone. It is now recognised that NSF recreates pre-European chain-of-ponds, swampy-meadow complexes (Andrews *et al*. 2005).

NSF is now an established process for restoring the pre-European hydrological function of streams and their adjacent floodplains by bringing together known ecological and geomorphological principles. In the 1970s Peter Andrews demonstrated that, by understanding the function of pre-European systems and cost-effectively recreating a series of pools and riffles via the construction of inexpensive leaky weirs, it was possible to reconnect the hydrology of floodplain and incised streams. Where needed, the creation of additional channels on the floodplain enabled greater recharges under fresh flows as well as facilitating fish movement. Mr Andrews' application of NSF procedures at "Tarwyn Park" and "Barramul Stud" in the Upper Hunter Valley has had the following results:

- Floodplains are recharged with water via lateral and multi-channeled movement;
- Floodwaters are de-energized;
- Sediment and nutrient build up occurs across the floodplain resulting in lower use of fertilizers, herbicides etc;
- Significant increase in production occurs that can be harvested by traditional means;
- Drought 'proofing' through drought periods is facilitated (in the case of "Tarwyn Park" for at least five years as shown on ABC's 'Australian Story' on June 6 and 13, 2005);
- Positive plant succession occurs that can be manipulated for nature conservation and production outcomes;
- Soil structure improves dramatically and soil production occurs;
- A striking improvement in riparian habitat is initiated; and
- Salinity can be significantly ameliorated; and
- Higher levels of production can be induced.

The activities outlined here are being supported by the progressive development of a significant research base that was initiated by the CSIRO Expert Panel report (2002) that was commissioned by the Deputy Prime Minister. A contemporary analysis of NSF with funding through the Australian Research Council is being undertaken by a team of scientists led by Dr Richard Bush of Southern Cross University and including Professors Wayne Erskine and Ian Lowe.

Thirdly, Andrews, Goldney, Mitchell and Newell (2005) have prepared a scientific paper (soon to be peer reviewed) that identifies the scientific basis of NSF and the linkages between geomorphology, hydrology and ecology (Professors Goldney and Mitchell are two respected scientists in the ecology of Australian landscapes); However, it should be noted that while substantial contemporary efforts in riparian restoration have focused on consolidating stream banks, amenity and habitat plantings,

hitherto, almost no attention has been paid to studies of riparian function and the natural processes reconnecting stream and floodplain ecology. NSF, by contrast is focused on understanding the basic processes required for the repair and restoration of stream and floodplain ecosystems and their ongoing sustainable maintenance.

Similar activities to those now occurring at “Barramul Stud” are being developed near Dubbo, Canowindra and Townsville with a range of other pilot projects being investigated. However, NSF has not yet been trialled in the semi-arid zone of Australia.

1.2 Project objectives

This project aims to:

- Trial the implementation of NSF in a typical incised, ephemeral and degraded stream (Spring Creek) in the semi-arid Lake Cowal catchment, 40 km northeast of West Wyalong, NSW;
- Functionally reconnect Spring Creek and its floodplain by the cost-effective construction of leaky weirs at stable choke points. The weirs will be constructed from rocks, logs, hay and debris. Where necessary one or more additional side channels will be constructed to mimic pre-European multi-channelled floodplain (NB following a fresh flow, leaky weirs help to de-energize water movement, trap nutrients and sediment, facilitate floodplain recharge, create ponds that ameliorate salinity, drive vegetation succession and create an ongoing baseline flow as discharge from the recharged floodplain continues);
- Manipulate plant succession using predominantly native grasses on the floodplain and a range of local provenance rushes, sedges and wetland plants in association with leaky weirs to optimise production and nature conservation outcomes;
- Develop low cost monitoring strategies to assess changes in stream and floodplain health (e.g. carbon, salinity, ground cover, biomass, nutrient cycling, baseline flows and storage);
- Host field days to demonstrate the principles and benefits of NSF and encourage a better understanding of Australian landscape function.

This project will generate an excellent example of a sustainable management practice that improves the productivity, profitability and the condition of our natural resources within a sub-catchment. Specific NRM issues this project addresses include:

- Sub-catchment land degradation;
- Improved water quality and availability;
- Reduced dryland salinity;
- Stabilization of streambeds and streambanks;
- Enhanced riparian and floodplain biodiversity; and
- Increased primary production.

1.3 Summary of the Spring Creek Catchment

Spring Creek (also known as Billy's Lookout Creek) is a typical incised, ephemeral and degraded creek in the semi-arid Lake Cowal catchment. It originates on a skeletal ridge called Billy's Lookout (320 masl, Table 1) and flows approximately 10 km through cleared agricultural land before terminating into Lake Cowal (207 masl), a nationally significant wetland. Lake Cowal is situated approximately 43 km north of West Wyalong in the south-western slopes of NSW. Billy's Lookout once accommodated up to 3000 people during early mining rushes with evidence of the mining activities still remaining.

Spring Creek has a catchment area of approximately 3015 ha managed by eleven landholders/managers. The landholders are made up of six long-term farming families, a mining company, local government, Condobolin Rural Lands Protection Board, Department of Lands and the State Rail Authority.

Rainfall in the Lake Cowal region is "evenly distributed throughout the year" (Bureau Meteorology), however rainfall is often erratic and irregular. The highest recorded rain falling in one day at Lake Cowal was 225 mm (9 inches) on 18th January 1962. Average annual rainfall is 481 mm but the annual average pan evaporation is 2045 mm. With only 1.2% of the rainfall stored in dams in the catchment there is clearly a need improve the water storage capacity within the Spring Creek Catchment.

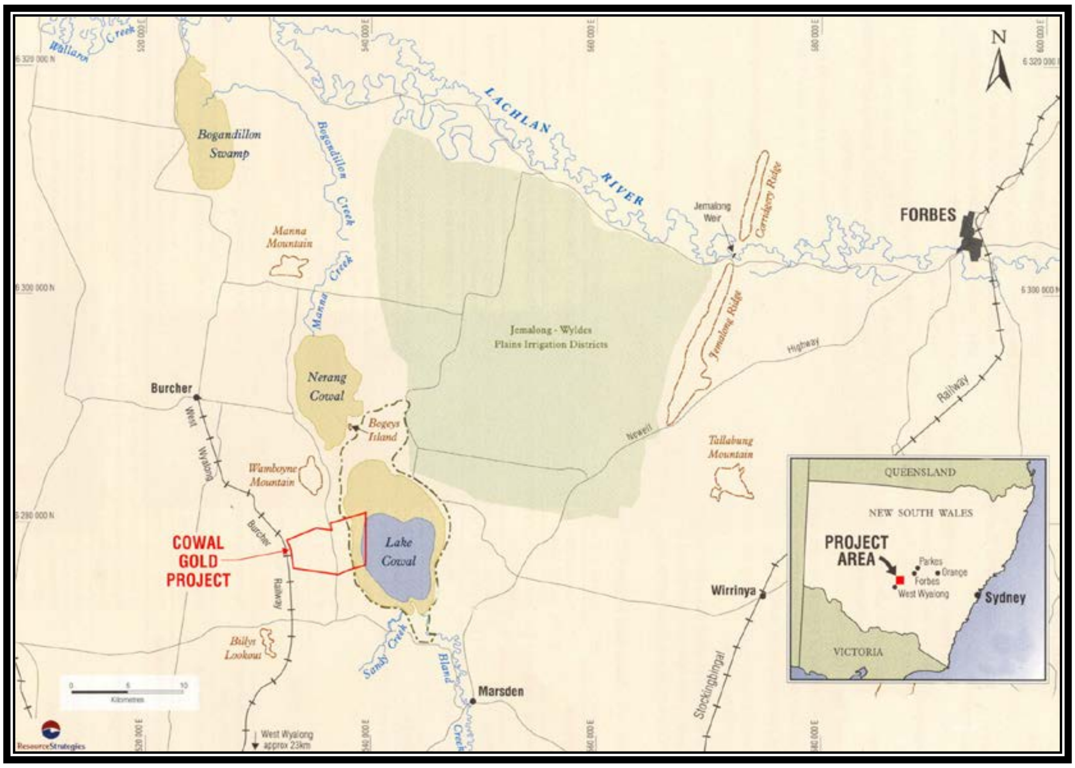

Figure 1: Diagram showing the situation of Spring Creek in relation to Lake Cowal.

Table 1: Spring Creek catchment summary

Landholders / land managers	11
Catchment area	3015 ha
Avg. Annual Rainfall	431 mm
Avg. Annual Pan Evaporation mm	2045 mm
Rainfall/Annum/Hectare	4.31 Megalitres
Average Total Catchment Rainfall	12994 Megalitres
Length of Creek	10 km
Catchment Head Elevation	320 masl
Discharge Elevation	207 masl
Mean annual flow	Ephemeral
Peak flow rate	2-3ML
Remnant Vegetation	440 ha
Area Remnant Vegetation	14.60%
Area Revegetation	20 ha
Area Remnant Native Pasture	128 ha
Percent Remnant Native Pasture	4.20%
TSR	234 ha
Dams in catchment	38
Dam storage as % of rainfall	1.20%
Arable area	2192 ha
Arable area as % of catchment	72.70%

1.3.1 Landuse

The primary land uses within the Spring Creek catchment include cropping (predominantly wheat, barley and oats) and grazing of both sheep and cattle. Common cropping systems incorporate rotational, minimum tillage systems (direct drilling, stubble retention) but some landholders still practice conventional cultivation systems (eg. summer fallow, stubble burning etc). Soils range from silty loam on the higher undulating country to self-mulching grey clays soils on the seasonally inundated floodplains. Gilgai's are also common on the lower floodplains around Lake Cowal.

1.3.2 Pre-European Vegetation

The vegetation within Spring Creek catchment changes according to topography and soil type. The rocky ridges are usually dominated by *Eucalyptus dwyeri* (Dwyer's Red Gum), *E. sideroxylon* (Mugga Ironbark), *Callitris glaucophylla* (White Cypress Pine), *C. endlicheri* (Black Cypress Pine) and *Acacia doratoxylon* (Spearwood). Undulating slopes and loam (red) soils are typically dominated by *E. microcarpa* (Grey Box), *E. populnea* (Bimble Box) and *Brachychiton populneus* (Kurrajong).) The major creeks (Bland and Sandy) and Lake Cowal are dominated by *E. camaldulensis* (River Red Gum), *A. stenophylla* (River Cooba) and *Muehlenbeckia florulenta* (Lignum). The heavier soils of the floodplains are often dominated by *Casuarina cristata* (Belah), *Acacia pendula* (Weeping Myall), *Alectryon oleifolius* (Rosewood) and *Geigera parviflora* (Wilga). Small drainage lines, ephemeral

creeks and small streams in the local area (little evidence of original vegetation can be found along Spring Creek) are often dominated by *Allocasuarina leuhmanii* (Bulloak), *E. melliodora* (Yellow Box), *E. blakelyi* (Blakely's Red Gum) and *E. conica* (Fuzzy Box).

1.3.3 The pre-European condition of Spring Creek

Spring Creek appears to have been a classical swampy meadow-chain of ponds complex terminating in Lake Cowal. The primary base flow, probably of the order of 2-3 Ml/day would have likely continued flowing for 2-5 years in the absence of a significant fresh/flood, resulting from water stored in the landscape. Under fresh –flood conditions the inherent formation of the landscape enabled water to step down through this stable landscape, be de-energised, spread via a multi-channel network across the floodplain, thereby filling the floodplain and raising the water table. The de-energising structures were likely to have been built up over significant time periods through the interaction of sediment deposition and biological formations such as log blockages and/or reed beds that would have been more-or-less continuous. In every valley system there is a baseline sediment load resulting from upland erosion.

Additional de-energising devices within the creek were likely related to the configuration of flow pathways enabling considerable volumes of water to meet from opposite directions. As water flow increased a greater proportion of the floodplain with its de-energising structures would have been brought into play. Depending on the landform and geological constraints, the area of floodplain available for water infiltration at point locations would vary from zero through to a few hectares to many square kilometres.

The dominant vegetation along Spring Creek and the adjacent swampy meadows would have consisted primarily of *Allocasuarina leuhmannii woodland with some* scattered *Eucalyptus microcarpa, E. populnea* and *Callitris glaucophylla*. Pockets of *Casuarina cristata* forests may also have been encountered (Eg, Phillip Barber's property at the head of the old mine diggings). The swampy meadows also contained an understorey dominated by a herb-grassland with some understorey shrubs. Scattered billabongs would also have been present as expressions of the water table. Within the stream channel at base flow regime, the dominant vegetation would be dependant on 'wetness' varying from emergents such as *Thypha orientalis* (Cumbungi) along water-edges to alternating zones of varying degrees of wetness associated with a range of water loving plants such as *Paspalum dischitum* (Water Couch), *Juncus usitatus* (Common Rush), *Cyperus exaltus* (Giant Cyperus), *Carex appressa* (Sword Sedge). It is possible that *Leptospermum* sp. (Tea tree) would have been the dominant understorey shrub along the water edge, except where shade was too intense. There is no evidence that *Phragmites australis* (Common Reed) was ever present in the local area, despite its association with chains-of-ponds and swampy-meadows over a large distribution in more eastern parts of the catchment.

Fresh recharge would have driven productivity within the system. The valley-riparian system was a fully integrated system with sustainability dependent on:

- Basal erosion rates;
- Biological activity including plants, microbes and fauna;
- Relatively closed fundamental ecosystem cycles (water, nutrient and carbon);
- The relatively stable landform in all but episodic flood events; and
- The capacity of native fauna to redistribute nutrients across the valley system.

The pre-European system was relatively stable but not necessarily a permanent land-form. When disturbance occurred the system would invoke self-repair mechanisms – that is the system would have had high ecological resilience. The probability of system failure would have been very low.

1.3.4 Present condition of the Spring Creek catchment

Many thousands of tonnes of topsoil are likely to have been lost with farmers now utilising shallow topsoil underlain by highly dispersive B-horizon soils. The soils are generally very low in organic carbon (0.5 – 1.5%), are highly compacted and often lack ground cover due to overgrazing and cultivation. Soil erosion and soil structure decline are prevalent over extensive areas of the catchment. Annual exotic grasses and weeds have also become prolific and little native perennial vegetation (eg. native grasses) exists.

The native vegetation communities have been modified predominantly by clearing, fire and grazing. Many areas of remnant vegetation, predominantly situated on the rocky hills, are dense regrowth forests, derived as a result of ongoing disturbances. Typically few shrubs are present and the herbaceous understorey has been significantly modified from overgrazing. The *E. microcarpa* woodlands that naturally occupied the more arable areas of the catchment would have contained a diverse shrubby/grassy understorey. These too have been significantly altered by agricultural practices often with only scattered paddock trees remaining. Some partially intact woodland can be found on the Travelling Stock Reserves. There is little evidence of what the original vegetation may have been along the ephemeral creeks, drainage lines and wetlands. Some old growth trees remain on the foreshores of Lake Cowal, but are highly stressed with dieback evident. Lake Cowal is under threat by dryland salinity induced by poor catchment management practices. Overall, the native vegetation exists in a highly modified state and is non-sustainable under present conditions. Many species have been lost from these vegetation communities, weeds have become prevalent, little regeneration is occurring and mature trees are in poor condition. The ongoing drought conditions since 2001, has accelerated the problem.

1.3.5 Present condition of Spring Creek

Spring Creek is now a ‘typical’ degraded Australian Creek with significant broadening and incision having occurred since European settlement, probably due to unlimited stock access with some impact from early mining activities. Significant incision may have occurred in the early 1900’s after periods of extended drought, rabbit plagues, overgrazing, followed by episodic drought breaking rain. Cultivation practices and little ground cover on surrounding areas increase the erosive potential. Clear evidence of ongoing erosion is evident, particularly since the development of the new mine access road which transverses the creek. However, there are sections of the creek that remain partially intact with the chain-of-ponds – swampy meadow complexes, convex shaped drainage systems as well as excellent examples of a meandering sequence of pools that demonstrates the de-energising effects of the stream geomorphology. The lower section of Spring Creek on the “Lake Cowal” property was fenced off and revegetated in October 2003. Already the creek has stabilised with chains of ponds evident (Marchiori 2006). Chains of ponds, rush and reed beds can be found in the least degraded areas along the creek. Some sections of the creek cannot presently sustain vegetation due to active undercutting and steep sided banks. With the heavy rainfall in June 2006 (40mm followed by 25mm within 10days) several areas along the creek were severely eroded, which highlighted the need for intervention.

Generally the creek system has deepened (incised) and broadened resulting in water flowing in the primary flow channel quickly draining and becoming functionally disconnected from the adjacent floodplains. Many of the pre-existing floodplain channel entry points are now significantly higher than the base primary channel flow but probably are able to accept flows greater than 1:50 years. Water retention in the floodplain has been significantly diminished, as have base flow rates. Some runnels from the pre-European floodplains are evident but most are dysfunctional.

Figures 2a & 2b: Severe stream incision on Spring Creek

1.4 *Outcomes of riparian degradation*

The results of riparian degradation appear to be:

- Ongoing soil loss under fresh/flood conditions mainly from bank collapse/erosion;
- Rapid draining of the landscape with the creek acting as a gutter (the fresh hydrographs rise and fall rapidly and there is a very low basal flow rate);
- Hence the water cycle is very open and leaks copiously in linear (down the valley) and transverse mode (across the valley);
- A significant loss of primary production across the floodplain due to limitations of water (induced water stress);
- High nutrient leakage as confirmed by water eutrophication and by deduction (i.e. nutrient cycles are now much more open both from a linear and transverse perspective);
- Increased temperature regimes in-stream and on the floodplain damping both production and microbial activity;
- A very significant loss in biodiversity (species and function);
- Loss of ecological resilience (the capacity for self repair) and the crossing of critical ecological thresholds;
- Plants (native and introduced) are acting as indicator species as measures of degradation and potential recovery processes;
- Floodplain soils are suffering typical degradation such as loss of soil carbon and structure; and
- The significant nutrient and sediment loads coming through this system are available for intervention restoration works.

1.5 *Project conception*

This project first was conceived during 2005 when it was realised that we had an opportunity to improve the Lake Cowal Catchment using Natural Sequence Farming Techniques. Initially we had earmarked Sandy Creek, a larger ephemeral tributary feeding into the southern reaches of Lake Cowal to implement a NSF project. We first identified a section of Sandy Creek and contacted the relevant landholders to attend an information session about NSF and what it aimed to achieve in September 2005. As a result of the discussions held, we felt that restoring this section of Sandy Creek may present an array of difficulties, largely due to the large, erratic volumes of water it receives, particularly when we were inexperienced in the practice of NSF. Rather, it was suggested by the landholders it may be more suitable to implement NSF methods in Billy's Lookout Creek, a much smaller and more manageable creek that was more conducive to our needs and experience. We later discovered that Billy's Lookout Creek was initially called Spring Creek, a name that we have since adopted. Spring Creek as it turns out was a much better choice and with the participation of the landholders, we were able to implement NSF techniques along the entire creek system, something that has not yet been undertaken elsewhere in Australia.

LCF staff proceeded to undertake a reconnaissance of Spring Creek and developed a project application to which they submitted to National Landcare Program – Natural Resource Innovation Grants. On the 8th 2006 February we received confirmation of funding approval from the Minister for Agriculture, Fisheries and Forestry, Peter McGauran funding of $141 880 to trial a NSF project along Spring Creek. The total project was valued at $287 000.

The methodology proposed included the following activities:

- Careful appraisal of stream suitability and potential, catchment area, mean annual flow, landuse, land degradation, geomorphology and soils;
- Negotiation with relevant landholders for project participation;
- Identification of critical choke points along Spring Creek through survey and search procedures;
- Training of two Lake Cowal Foundation staff in NSF practices;
- Negotiations with DNR, CMA, Fisheries and SRA to gain appropriate approvals for stream-related activities;
- Installation of 15 leaky weirs and 41 hay/log weirs at selected choke points;
- Construction of at least one additional floodplain channel to enhance recharge under fresh conditions;
- Erection of approximately 16 km of fencing in sensitive areas to restrict livestock access;
- When a fresh flow occurs that initiates partial or complete recharge, establishment of a seed bank of nursery plants that will enable rapid growth on the floodplain (grasses, shrubs, trees) and at choke-pool areas (reeds and rushes), including planting 12,000 local provenance native trees and shrubs and 19.5km direct seeding concentrated in areas where native vegetation is currently absent and 20,000 wetland plants and native grasses.
- Collect baseline data such as soil carbon, soil formation, ground cover, ground biomass, underground biomass, soil bacterial activity, water retention, water quality, oxygen levels, saline leakage and salinity levels;
- Host field days to engage community in awareness of Australian landscapes and encourage adoption of NSF (and other sustainable land use practices).

In the longer term:

- Record and monitor changes such as soil carbon, soil formation, ground cover, ground biomass, underground biomass, soil bacterial activity, water retention, water quality, oxygen levels, saline leakage and salinity levels;
- Manipulate stock or equivalent to spread fertility over valley floor;
- Implement adaptive management procedures based on scientific evidence to optimise outcomes; and
- Host field days to engage community in awareness of Australian landscapes and encourage adoption of NSF (and other sustainable land use practices).

1.6 Project planning

On the 20 -22nd March 2006, Mr Peter Andrews (NSF Founder), Professor David Mitchell (Specialist Hydrologist), Professor David Goldney (Landscape Ecologist) and Mr Paul Newell (NSF Practitioner) were contracted to undertake a stream appraisal. This process involved careful appraisal of stream suitability and potential, catchment area, mean annual flow, land use, land degradation, geomorphology and soils and identification of critical choke points along the Spring Creek system through survey and search procedures.

Figure 3: Geoff West, Mal Carnegie, Peter Andrews, Paul Newell and David Goldney discussing the restoration of the scalded gully at the headwaters of Spring Creek, March 2006.

Figure 3: Mal Carnegie, Howard Mangelsdorf, Peter Andrews and David Goldney looking at an intact (but somewhat modified) swampy meadow situated along Spring Creek, March 2006.

Lake Cowal Foundation staff refined the proposed plan, indicating the location of weir structures, earthworks, new fencing and areas where tree and shrub planting would be undertaken, as well as areas requiring the planting of wetland vegetation along the creek. In consultation with participating landholders (with exception of the government departments at this point) and Lake Cowal Foundation staff a project plan for implementing NSF methodology was developed. These were then reviewed and adapted as necessary with the participating landholders. The landholders were required to sign a management agreement, which stipulated their commitment to the project and outlined their roles and responsibilities.

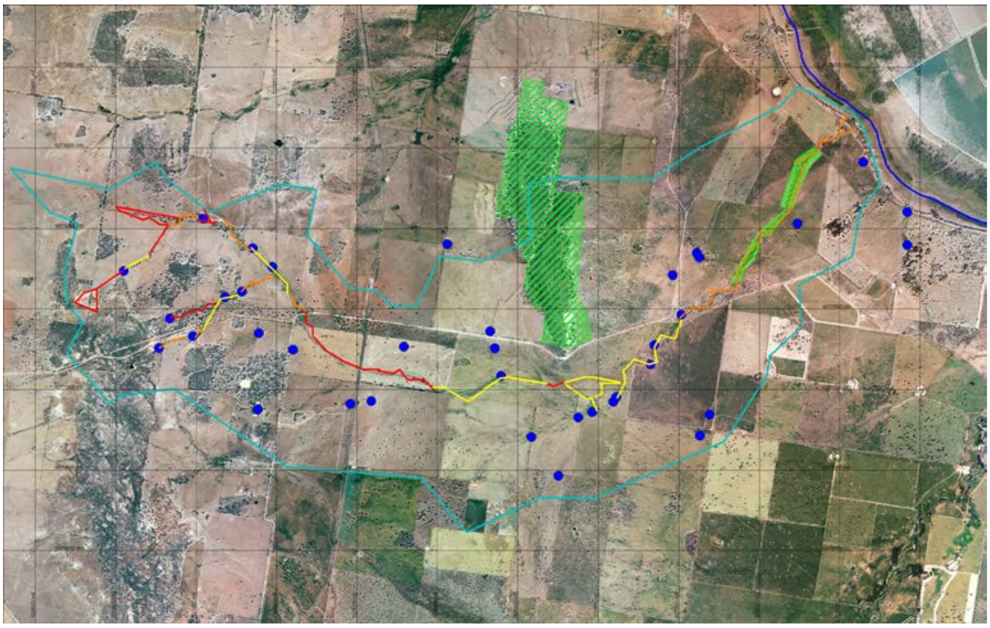

Figure 4: Map of Spring Creek and its catchment boundary, showing the extent of erosion. Red line= severe erosion, Orange= intermediate erosion, and Yellow= stable.

1.6.1 Licences

As part of the project it was necessary to gain a Section 3A approval for stream related rehabilitation works by the Department of Natural Resources (DNR) and Lachlan Catchment Management Authority (LCMA). Once this license was obtained, approval from the State Rail Authority, NSW Fisheries and Department of Lands was also required. The Condobolin Rural Lands Protection Board (CRLPB) were also contacted, firstly as the project adjoined but did not initially include CRLPB land they were informed about the project and secondly, we were required to construct additional fencing along the creek which extended into CRLPB managed land.

1.6.2 Training

This project also intended to involve training of staff and several landholders in NSF principles. LCF staff attended a "Reading the Australian Landscape" field trip/workshop, with NSF specialists and scientists from a range of disciplines, with LCF staff gaining training in NSF techniques over a six-day period. LCF staff also attended a two day workshop "NSF: Defining the science and the practice" held in Bungendore on 31st October – 1st November 2006. Unfortunately, landholders were unable to participate in these training events due to other commitments and some landholders were already participating in a Property Planning course.

Figure 5: Paul Newell demonstrates the principles of NSF at a three-day workshop "Reading Australian Landscapes".

Figure 6: A swampy meadow near Neville remains intact above a road cutting.

Figure 7: The same swampy meadow below the road cutting has been destroyed due to changes in the hydrology

1.7 Project design

The resultant plan for the Natural Sequence Farming project along Spring Creek is given in Figures 8 to 11.

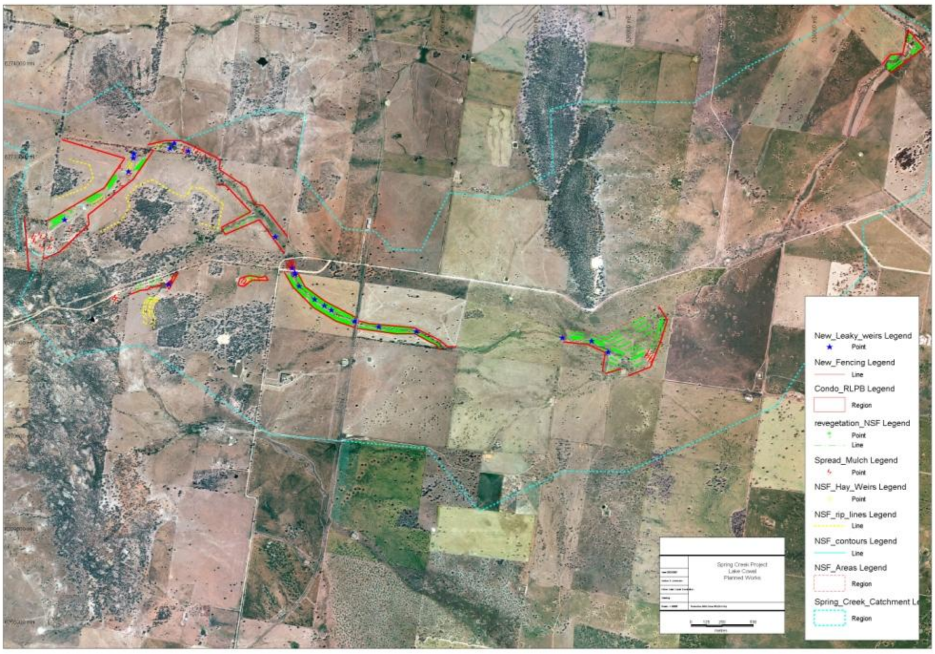

Figure 8: Spring Creek catchment and types and locations of works planned to be undertaken.

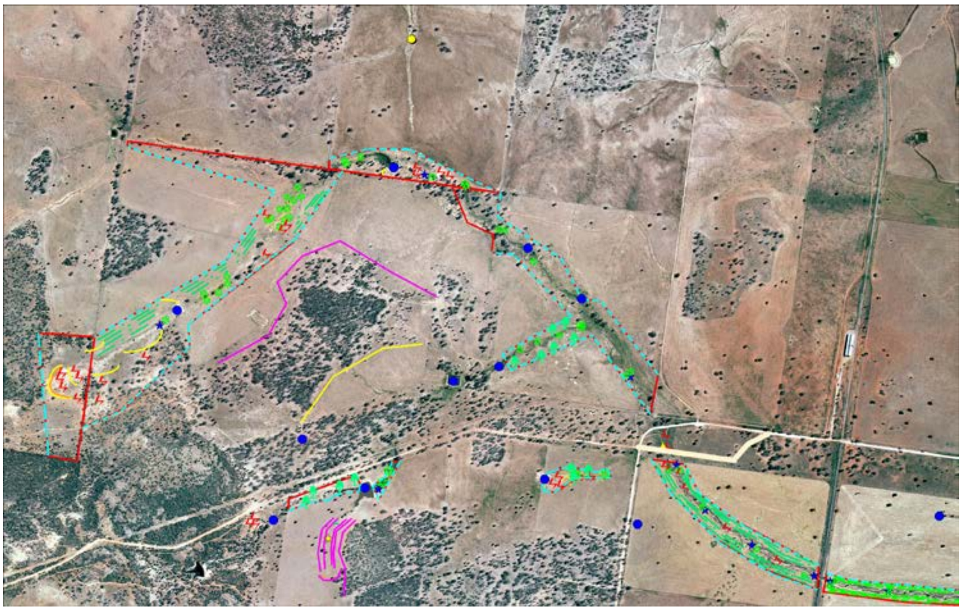

Figure 9: Map of upper third of catchment indicating type and location of project works.

Figure 10: Map of middle of catchment indicating type and location of project works.

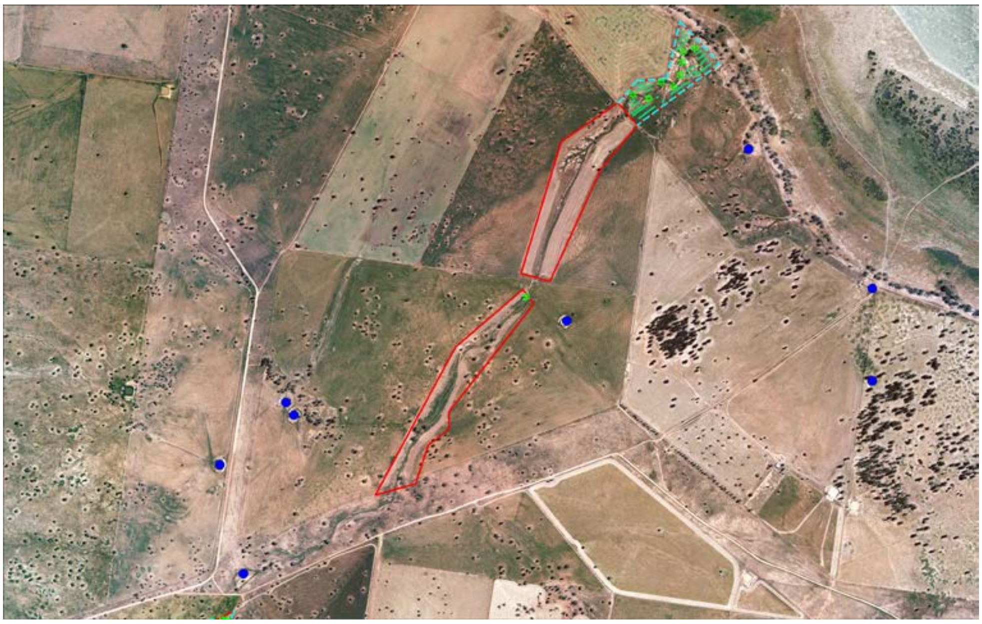

Figure 11: Map of lower catchment indicating type and location of project works.

1.8 Project implementation

1.8.1 Culvert flow augmentation structure

Construction of the access road to the Barrick Cowal Gold Project commenced in September 2004 and completed in March 2006. Works for the road construction included a deviation at the point where the road crossed the Spring Creek. Prior to the construction of the deviation, the creek crossed the old road by means of a 30 metre wide causeway (Figure 12). Water was discharged to a low gradient, grassed area before dropping over an actively eroding gully head 114 metres from the causeway.

Figure 12: Original 30 metre causeway on Spring Creek.

The new mine access road traverses Spring Creek through use of four box culverts placed at the streambed level below the eroding gully head (Figure 8). Box culvert dimensions are 1835mm x 900mm providing a cross-sectional flow area of 6.6 square metres. Upstream from the box culverts earth has been excavated for a distance of 60 metres to create a lead in channel for the Spring Creek (Figure 9). The head of the lead in channel was constructed at a slope of 2% and the channel batters have exposed the unstable and slaking B-horizon soils. As a result of this action advancement of a 1.2 metre gully head has increased markedly and the channel batters are subject significant to fluting erosion. Downstream from the box culverts change of flow direction had a significant effect on bank erosion with emergency placement of large rock in the streambed in conjunction with silt fences by the Bland Shire Council (Figure 10). Following larger flows enhancement of these mitigation measures was required using waste concrete to line the eroding stream bank (Figure 11).

Figure 13: Mine Access Road Culverts.

Figure14: Excavated Lead in Channel.

Figure 15: Large Rock Placed In Stream Bed.

Figure16: Waste Concrete Lining Stream Bank.

Stream instability is also affected by the table drains flowing to the box culvert structure and the resultant erosion is threatening the road structure as site specific flow regimes and soil properties appear not to have been considered when they were constructed (Figure 13).

Figure17: Erosion of the North West Table Drain.

Works will be undertaken through the Spring Creek Natural Sequence Farming Project to address the degradation processes threatening the road culvert system (Figure 14). In order to alleviate the failure of the present road structure it was proposed to install a concrete V-weir upstream from the culverts to increase flow efficiencies through the culverts and create a stilling pond above the V-weir system to encourage aggradation and upstream stability (Figure 14). This structure would also serve to mitigate the erosive potential of the table drains leading back along the road verge. The dimensions of the existing culvert are shown in Figure 15.

The concrete V-weir structure was to comprise 4 x 1835mm wide V-shaped segments arranged in a concertina pattern across the stream-bed, located 3 metres upstream from the box culverts (Figure 16). The depth of the V-shaped segments was to be 850mm with a height of 1000mm and a thickness of 150mm. Within each segment 2 x 250mm low flow diffusers will be positioned at a height to augment aggradation over unstable B-horizon soils in the lead in channel. The eight low flow diffusers provide a cross-sectional flow area of 3.14 square metres, which is equivalent to 48% of the culvert system capacity. Large flows, which drown out the diffusers will flow over the crest of the V-weir structure. The V-weir structure will rest in an apron of concrete topped with a cushion of gabion rock to further diffuse flows and provide support for the structure. Table drain flows will enter the diffusion area via placement of winged irrigation L-stops dropping water onto the rock apron.

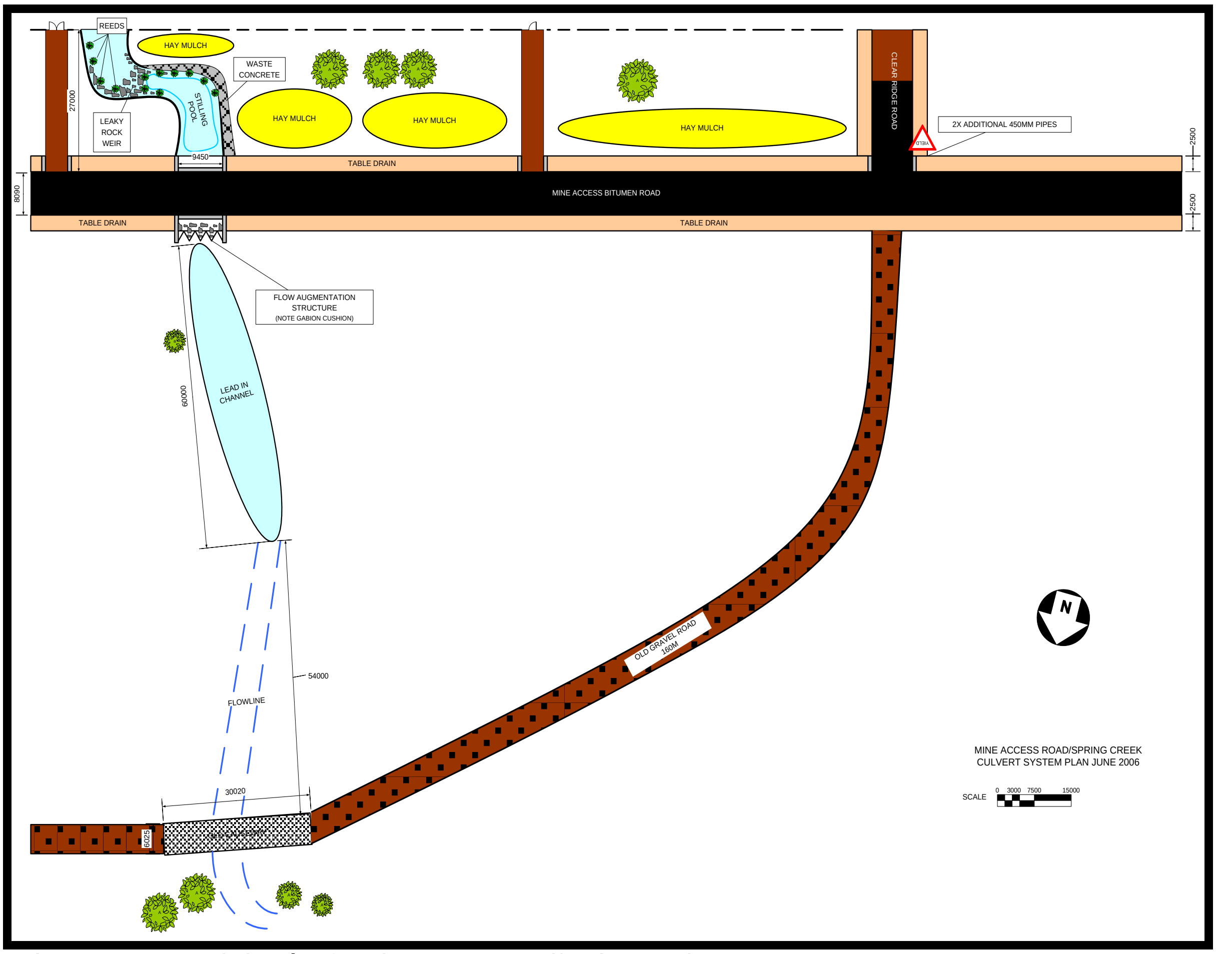

Figure18: Proposed site plan for Mine Access Road/Spring Creek.

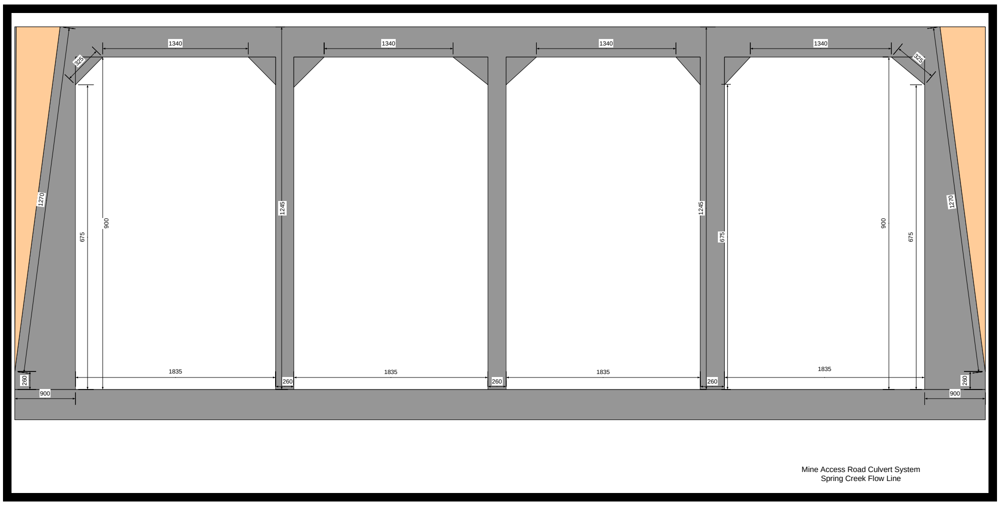

Figure19: Existing concrete culvert dimensions.

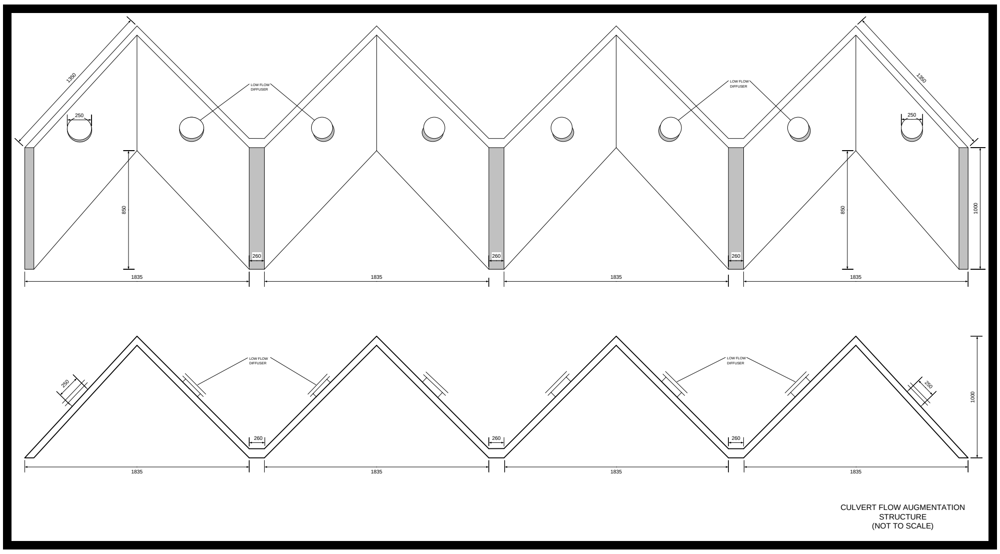

Figure 20: Proposed concrete V-Weir structure plans.

The costs associated with specialised engineering and manufacturing of the V-shaped, concertina concrete structure (Figure 20), were considerably high. After advice from engineering Company a cheaper and equivalent structure was prepared (Figure 21).

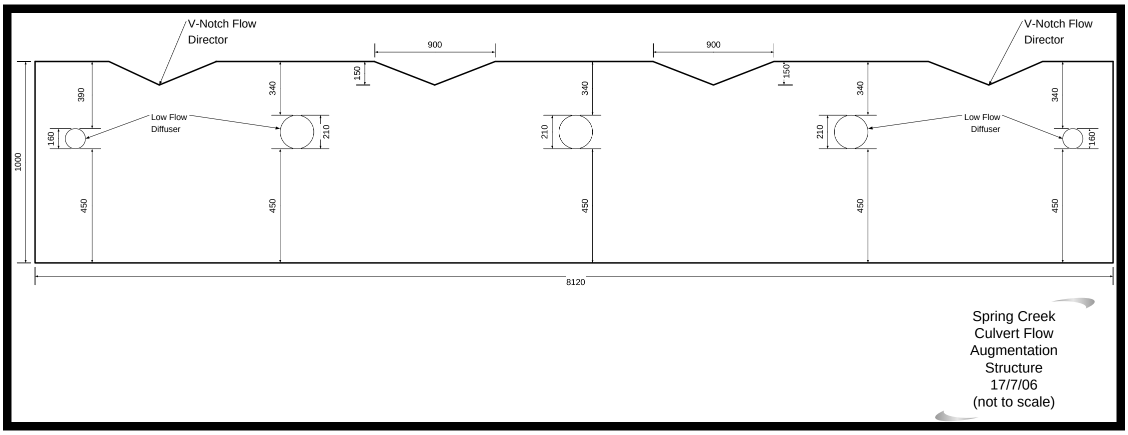

Figure 21 The design of the concrete structure used.

Downstream from the culvert construction of a leaky weir using gabion rock and reed plantings will create a stilling pond to de-energise flows from the culvert system. Resultant change in flow dynamics will diminish stream bank erosion and table drain erosion. The leaky weir will have a V-shaped configuration and a depth of 500mm with rock armouring on both stream banks above and below the weir for a distance of 6 metres. The chute and apron of the leaky weir will be lined with geotextile fabric and gabion rock to ensure further de-energising of flows and maintenance of stream-bed stability.

Mulching of bare soil areas adjacent to the culvert system using waste hay is also necessary to control local runoff and reduce the erosive potential of the exposed soils. This would involve spreading of hay along the lead in channel, table drains on both sides of the road and the area south of the road between Spring Creek and the Clear Ridge Road intersection. This would require round bales of hay and labour to spread mulch over the critical areas.

The intersection of the Mine Access Road and the Clear Ridge Road also requires additional works to reduce damage by flows from the adjoining Lee/Worner property. At present one 455mm concrete pipe under the Clear Ridge Road is insufficient to cope with heavy storm flows and road shoulders will remain under threat without provision of additional flow capacity under the road. This can be achieved through placement of at least two extra 450mm pipes in this location, however these additional works are the responsibility of the Bland Shire Council.

Mal Carnegie and Peter Andrews ready to start!

Mal and Peter checked the levels prior to installing the concrete flow augmentation structure upstream of the culvert.


The stream bed was levelled and a bed of sand was laid down for the structure to be placed on. The Bland Shire Council helped with all of the works.


The first half of the concrete structure was carefully lowered into position.


The second half of the concrete structure was lowered into position and secured together.


The streambanks were also shaped to assist plant establishment


Geotextile fabric was laid down and covered with rock armouring to stabilise the streambed


The table drains also needed addressing and irrigation stops were installed to regulate water flow into the main stream channel.

1.8.1.1 Constructing the stilling ponds at the culvert

The steep-sided and undercut banks were first smoothed over with a bulldozer and a series of meanders were shaped within the creek system. The meandering shape of the creek is a typical geomorphological feature of these small creek systems that de-energise strong flows, particularly under flood conditions. A series of small leaky rock weirs were also positioned in stream to initiate the formation of the stilling ponds. Several headward cutting gullies in adjacent drainage lines also required stabilising with rock armouring.

The steep undercut streambanks were shaped by Ray Cooper using the Soil Conservation's D65EX-12

A series of meanders were created within the stream bed

Small leaky rock weirs were installed to create a series of stilling ponds downstream of the culvert.

A reminder of the creek before we started the project.

1.8.2 Leaky rock weirs

The fall in slope of the creek was first surveyed using a surveyor's theodolite to identify the correct position of the choke points and the location for the leaky rock weirs.

Peter Andrews provided initial supervision of leaky weir construction, mentoring LCF staff in weir construction by strategic placement of appropriate sized rock in the choke points along the creek

system. Each weir was individually engineered to suit the specific characteristics of the site, but typically they were 0.5 – 1 m in height. The larger 900mm shot rock was utilised as the base for weir construction with the 200mmm gabion rock serving as the finer finishing medium, mostly arranged in a mattress-type structure to direct discharge flows. Approximately 32 tonnes of each of the two rock sizes were used for every weir. In future years, the weirs will have to be raised as the aggradation processes begin to operate.

1.8.2.1 Rock

The dolerite rock used for the NSF Project was selected for its high specific gravity (3.2) reducing risk of movement in high velocity flows, availability in a diversity of sizes and proximity to the Spring Creek site with transport from a local quarry near West Wyalong. All rock was pre-ordered and delivered to each site where leaky weirs were to be installed. The rock sizes used ranged from 200mm gabion rock to– 900mm shot rock, as well as a quantity of 40mm product used as a protective layer for the works requiring geotextile. Stockpiles of gabion and shot rock are located in the centre of the project area to allow for easy access should any of the weir and flume structures require maintenance following intense rain events.

Figure 22: Rock of various sizes was pre-ordered and delivered to each of the weir construction sites.

Table 2: Location and photo of each of the leaky rock weirs installed along Spring Creek

Location	Notes	After construction
1	Barber 1A	
2	Barber 1B	
3	Barber 1C	
4	BSC 1B	

5	Barber 3	
6	Barber 3	
7	Barber 3B	
8	Mango 1A	

9	Mango 1B	
10	Wilson 1	

1.8.3 Other rock works

Headward cutting gullies necessitated the construction of two rock flumes and strategic placement of mixed rock sizes in an additional four locations to reduce erosion potential within the stream flow-line. A particularly unstable area in the upper catchment, presenting both gullying and tunnel erosion required intervention with a rock flume (see Barber 1 flume) using 60 tonnes of 200mm gabion rock covering 160m² of geotextile. This area was prepared with the bulldozer using the minimum amount of disturbance possible whilst producing the desired shape for the drop structure. Gabion rock and geotextile were also used for the smaller flume, with a mix of gabion and shot rock without geotextile considered adequate to stabilise the remaining, lesser headward cutting gullies. These areas will all be closely monitored to allow timely intervention should erosion continue to progress following flow events.

Mango 2

BSC1B

Barber 1 Flume

1.8.4 Hay Weirs

100 small bales of barley straw were purchased from a landholder in West Wyalong. The bales were secured into place within the stream channel using 40mm² hardwood stakes.

1.8.5 Mulching and sowing bare areas

In areas where earthworks were extensive, mulch was applied using a hay spreader to reduce the risk of erosion. The mulch used was locally harvested hay, and therefore the risk of introducing new weeds would be negligible. The use of local mulch was particularly important to:

1. satisfy license conditions of the DNR in that erosion risk is controlled by mulching; but
2. prevent the introduction of weeds on RLPB TSR's (generally RLPB's prohibit the feeding of hay to livestock on TSR's).

When seasonal conditions improved, *Secale cereale* (Cereal Rye, Ryecorn), a sterile winter cereal was sown to assist with stabilising the bared areas.

1.8.6 Fencing

Local landholders and in some cases local fencing contractors constructed 15.9 km of 7/90/30 hinge joint, 2 barbed wire fencing (see Figure x). Restricting livestock access is critical to the project, although strategic grazing of the sites will be utilised from time to time as a tool for encouraging increases in biodiversity.

1.8.7 Ground Preparation

Deep ripping of the designated revegetation areas and desired infiltration zones was undertaken during October 2006 using a bulldozer with a three tined ripper operated by Ray Cooper (Soil Conservation, West Wyalong). The soils were ripped to a depth of 450mm with surface disturbance minimised via use of winged attachments on the base of the ripper tines and a tine spacing of 1 metre. Deep ripping is an effective method for breaking compacted layers within soil profiles to increase water infiltration rates and allow for uninhibited root development by desirable deep-rooted perennial plants including forbs, grasses, shrubs and trees. Ripping is best carried out during the drier times of the year as the ripper tynes passing through dry soil profiles cause cracking and shattering of the profile well beyond the immediate path of disturbance. Revegetation areas were cultivated with a small offset disc unit following ripping to reduce soil clod size, allowing for effective soil-root contact when seedlings were planted. The disc machine was matched to the width of rip lines to reduce detrimental effects on existing grasses and forbs, and to reduce the area of opportunity made available to weeds through cultivation.

1.8.8 Revegetation

1.8.8.1 Tubestock

12630 tubestock of local provenance trees and shrubs were ordered in September 2006 to be planted in the autumn – winter 2007, pending suitable rainfall (Table 4) . 2700 native hikos of perennial grasses and 19700 reeds and sedges were also pre-ordered in January 2007 to be planted in spring 2007, pending suitable seasonal conditions. As there has been no evidence of *Phragmites australis* found in the local area, despite extensive surveys, we decided not to use it in this project, despite its appealing colonising attributes. We concluded that we could achieve our objectives with other endemic species and that we did not want to introduce an “environmental weed”, if ever that was to be the case.

Figure 23: Machine planting of tubestock on Barber 3 site

1.8.8.2 Direct seeding

A total of 19.5 km of direct seeding is also proposed to be undertaken during the winter – spring period of 2009, depending on suitable seasonal conditions. Seed was collected by the Lake Cowal Foundation during 2004 – 2005, 2005 – 2006 and 2007 - 2008 seed collecting periods and was processed for storage at the Lake Cowal Conservation Centre. A direct seeding machine has been made available by Greening Australia and is used by towing with a four wheel drive vehicle in desired revegetation areas.

Site	West	Davies	Lee 1	Lee 2	Barber 1	Barber 2	Barber 3	BSC	Mango	Mango 1	Mango 2	Wilson 1	Wilson 2	Barrick 1	Barrick 2	Barrick 3	**Total**
Tubestock																	
Alectryon oleifolius					50		50			25		50	20			50	245
Allocasuarina leuhmannii		20	30	30	200	20	200			150		250					900
Brachychiton populneus			10	10	100	20	100	5		100		100	10				455
Callitris glaucophylla							50	5		25		50					130
Eucalyptus camaldulensis																300	300
Eucalyptus microcarpa		20	40	40	700	50	1000	5		200		1000	30				3085
Eucalyptus populnea			40	40	500	50	1000	5		200		1000					2835
Geigera parviflora					50		50			25		50				50	225
Pittosporum phylliraeoides					25	25	50			50		50					200
Acacia deanei		20	40	40	100	20	100	10		150		100	20			100	700
Acacia decora					100		100			100		100					400
Acacia hakeoides			40	40	100	20	100	10		100		100	10				520
Acacia oswaldii					50	20	100			100		100	10			100	480
Acacia stenophylla																200	200
Apophyllum anomalum										25		50					75
Atriplex nummularia							50			50		100					200
Dodonaea viscosa subsp. cuneata					50		100			100		100					350
Hakea tephrosperma					50		50			50		50					200
Senna artemisioides varieties										50		50					100
Acacia pendula																80	80
Dianella revoluta								300									300
Casuarina cristata					200							250				200	650
TOTAL	0	60	200	200	2275	225	3100	340	0	1500	0	3550	100	0	0	1080	**12630**
Grasses - *hikos*								3000									**3000**
Austrodanthonia eriantha								300									300
Bothriochloa decipiens								350									350
Chloris truncata								300									300
Dicanthium sericeum								350									350
Elymus scaber								300									300
Enteropogon acicularis								300									300
Eulalia aurea								300									300
Themeda australis								500									500
TOTAL								2700									**2700**
Reeds - *hikos*																	
Carex appressa		500	300	150	750	750	750	100		750	750	900	150	500	500	750	7600
Juncus usitatus		500	100	150	750	750	750	100		750	750	750	150	500	500	750	7250
Typha		500	100		250	250	250			250	250	250	150				4850
TOTAL		1500	500	300	1750	1750	1750	200	0	1750	1750	1900	450	1000	1000	1500	**19700**

Table 4: Revegetation species for Spring Creek NSF Project.

1.9 Project expenditure

Table 5: Summary of onground works required
(Note; Expenditure table does not take into account consultancies and staff time)

Project item/activity	Total	Quantity per site	Unit cost	Total Cost
Fencing materials (m)	15700	1	$3.50	$54,950.00
Fencing Labour (m)	15700	1	$1.40	$21,980.00
Ripping (m)	2900	1	$0.18	$522.00
Contours (m)	1750	1	$0.60	$1,050.00
Rock weirs (quantity)	15	1	$1,500.00	$22,500.00
Rock weir installation	15	1	$330.00	$4,950.00
Other rock + placement	5	1	$1,500.00	$7,500.00
Hay/log weirs (quantity)	41	3	$5.00	$615.00
CFAS (quantity) + geotextile	1	1	$6,500.00	$6,500.00
Dam lift (500mm)	2	10	$110.00	$2,200.00
Farm Dam (quantity)	1	1	$3,500.00	$3,500.00
Mulching (sites)	76	1	$25.00	$1,900.00
Fertilising (sites)	1	26	$20.00	$520.00
Fertilising (labour)	1	4	$120.00	$480.00
Reed sites	197	100	$0.25	$4,925.00
Reed planting	197	100	$0.35	$6,895.00
Ground Preparation - ripping (m)	49200	1	$0.18	$8,856.00
Tree mechanical (per tree)	10730	1	$1.75	$18,777.50
Trees - scattered hand planted	1200	1	$1.60	$1,920.00
Tree guards	11930	1	$0.30	$3,579.00
Bamboo Stakes	11930	2	$0.06	$1,431.60
Spray	65100	2	$0.03	$3,906.00
Direct Seeding (m)	19500	1	$0.40	$7,800.00
Area (ha)	179.3			
Total onground project costs				$187,257.10

CFAS: Culvert Flow Augmentation Structure
Rock weir: 40m3 or 64 t/weir @ $19/t gabion rock
Fertiliser: 1 truck load = 26t
Reeds 10m2 @ 10/m@ = 100plants per site
Mulch = 1 round bale/100m2
Hay weir = 3 per weir @ $5

1.10 Budget

LCF staff time	Purchase Order	Cheque No.	Status	Cost	LCF	NLP	inkind	who
Training 3 days Reading Landscape MC	171403	634126	paid	$159.09	$159.09			
Training 3 days Reading Landscape DJ	155733	634128	paid	$159.09	$159.09			
Consultancy PN		634144	paid	$2,726.10	$2,726.10			
Consultancy DG		634145	paid	$3,389.00	$3,389.00			
Consultancy DM		654679	paid	$3,006.77	$3,006.77			
Ag N Vet marker pens	155739	654696	paid	$243.73		$243.73		
Manure (Pace)		654704	paid	$801.00		$801.00		
Consultancy PA		654710	paid	$2,727.27	$2,727.27			
ANU meals & Accom visit 1 (KM, DT)		654711	paid	$751.17		$751.17		
buttweld bends	155744	676761	paid	$348.00		$348.00		
ANU meals & Accom visit 2 (KM, DT)		676765	paid	$741.74		$741.74		
geotextile	155746	676780	paid	$752.00	$752.00			
Culvert Structure	155748	676785	paid	$4,330.36		$4,330.36		
Training 2 days x 2 LCF Fivebough	171401	676794	paid	$545.45	$545.45			
fencing material	155745	676796	paid	$37,675.00		$37,675.00		
load hay WWES	41705	695781	paid	$75.00		$75.00		
Training 2 days x 2 LCF (Bungendore)	171403	695790	paid	$869.09	$869.09			
ANU sept		695803	paid	$114.55		$114.55		
Culvert Structure	41708	695814	paid	$929.00		$929.00		
Accomodation PA		695815	paid	$84.55	$84.55			
Rock	41707	695823	paid	$2,026.76		$2,026.76		
hay spread WWES	41711	716932	paid	$180.00		$180.00		
Rock	417019	716941	paid	$3,433.45		$3,433.45		
Earthworks (Dept Lands)	N/A	716951	paid	$12,444.54		$12,444.54		
Consultancy PA 2nd)		716952	paid	$2,700.00	$2,700.00			
Educational material DVD	171414	716953	paid	$91.67	$91.67			
rock Mango 041714	41714	716954	paid	$326.55		$326.55		
Kim monitoring (Dec)	N/A	716960	paid	$2,730.00		$2,730.00		
Kim accomodation/travel (Dec 2 weeks@$200/wk	N/A	716961	paid	$400.00		$400.00		
Signs (large and small)	171407	716964	paid	$679.80	$679.80			LCF
rock 041717	41717	728950	paid	$2,760.15		$2,760.15		
ag N Vet	N/A	728951	paid	$67.24		$67.24		
fencing materials	41718/41716	728955	paid	$566.80		$566.80		
Kim accomodation/travel (Jan 2 weeks@$200/wk	N/A	728957	paid	$400.00		$400.00		
Kim monitoring (Jan)	N/A	728958	paid	$2,526.00		$2,526.00		
earthworks (Barber)	41719	728959	paid	$660.00	$660.00			
Kim monitoring (Feb)	N/A	728965	paid	$2,048.00		$2,048.00		
Kim accomodation/travel (Feb 2 weeks@$200/wk	N/A	728966	paid	$400.00		$400.00		
10 x Back from the Brink	171408	N/A	inkind	$284.05			$284.05	LCF
other expenses (paint,tags, bolts)	DJ expense claim	N/A	paid	$250.91	$250.91			
Bamboo stakes per unit	N/A	N/A	in kind	$3,031.20			$3,031.20	LCF
Consultancy Col Pardau	N/A	N/A	inkind	$1,500.00			$1,500.00	Col Pardoe
DJ + MC wages	N/A	N/A	in kind	$22,020.42			$22,020.42	LCF
DT supervision 21 days @ 1000/day	N/A	N/A	in kind	$21,000.00			$21,000.00	ANU
Earthworks (West)	N/A	N/A	in kind	$1,500.00			$1,500.00	landholders
fencing labour AF	N/A	N/A	in kind	$4,160.00			$4,160.00	landholders
fencing labour landholders	N/A	N/A	in kind	$14,390.00			$14,390.00	landholders
geotextile	N/A	N/A	in kind	$752.00			$752.00	BSC
JF supervision 21 days @ 1000/day	N/A	N/A	in kind	$3,000.00			$3,000.00	ANU
large hay bales (50@$60)	N/A	N/A	in kind	$3,000.00			$3,000.00	Landholders
NSF support	N/A	N/A	in kind	$12,000.00			$12,000.00	NSF
Reeds planting	N/A	N/A	in kind	$5,910.00			$5,910.00	Community
RG supervision 12 days @ 1000/day	N/A	N/A	in kind	$12,000.00			$12,000.00	ANU
Seed (20km @ 400g/km @ $300/kg)	N/A	N/A	in kind	$2,400.00		$2,400.00	$2,400.00	LCF
Soil analyses 111 samples @ $10/sample	N/A	N/A	in kind	$1,100.00			$1,100.00	ANU
Spray	N/A	N/A	in kind	$1,000.00			$1,000.00	landholders
Weir construction	N/A	N/A	in kind	$10,000.00			$10,000.00	BSC
fencing labour RL	41713			$10,725.00		$10,725.00		
Raingauge	41722			$276.80		$276.80		
Hiko order WWES	171415			$2,632.50		$2,632.50		
Tubestock order WWES	171415			$10,104.00		$10,104.00		
Direct seeding				$500.00	$500.00			
earthworks (Mercia/Mango)				$1,200.00	$1,200.00			
fencing labour BSC/RLPB				$520.00		$520.00		
Field day				$500.00	$500.00	$500.00		
Hikos grasses and reeds (19700@$0.45)				$8,865.00		$8,865.00		
Mechanical plant tubestock (12630@$0.80)				$10,104.00		$10,104.00		
peizometers/data loggers				$22,584.00	$14,487.21	$6,503.66		
small hay bales (150@$3.50)				$525.00		$525.00		
Tree guards (cartons only)				$2,399.70		$2,399.70		
wooden stakes (secure hay)				$1,000.00	$1,000.00			
Total 5/2/07				$286,103.50	$36,488.00	$131,874.70	$119,047.67	
Unexpended funds					-$1,188.00	$10,005.30		
In kind (LCF cash + in kind)					$155,535.67			
excess in kind					$13,655.67			
Cheques 5/3/07				$94,868.92				

1.11 Ponds forming naturally

1.12 Conclusion

This project is an innovative joint initiative between community, industry and government to restore the function of a degraded landscape in a semi arid environment. We expect that the results and experience of undertaking this project will provide valuable information about sustainably managing our natural resources, bring benefits to the farming community and demonstrate how collaborative efforts can achieve significant results.

The planning and implementation process required to successfully complete the Natural Sequence Farming Project was initially underestimated, however as each step was addressed, it became increasingly apparent to the project management team that a longer-term approach and commitment is required to realise the potential benefits this project offers to natural resource management in Australia. The project represents a landscape scale trial of a restorative set of environmental principles which command support from an impressive collection of scientists and ecological practitioners.

Initial timeframes which were allocated to the project proved inadequate due to extended processes involved in satisfying the concerns of participating landholders through education and negotiation, establishment of and compliance with legislative requirements and a variable/irregular climate of drought for the duration of the project implementation phase.

Throughout the implementation of the project works all partners have demonstrated a strong motivation to realise success of this initiative as it presented an opportunity to achieve significant environmental results for an entire catchment through a partnership of co-operation, collaboration, consultation and consideration. The knowledge and understanding of landscape function for all partners has been enhanced and a sense of achievement in difficult circumstances is providing a necessary boost to the social capital of the area. The approach used in the Spring Creek Project demonstrates that restoration of landscape function can be achieved over entire catchments utilising small capital inputs relative to the desired outcomes.

The underlying and inherent resilience of the Australian landscape dictates that many predicted outcomes of this project will occur with greater than anticipated rapidity. However, it must be recognised that climatic and resource limitations associated with the Spring Creek Catchment equally have the capacity to extend the realisation of project objectives and expectations, particularly when comparison is drawn with the landscapes in which the Natural Sequence Farming principles were formulated.

The scale and uniqueness of this project has captured the attention of both the wider local community and the Australia-wide network of people interested in Natural sequence Farming and the work of Peter Andrews.

The Lake Cowal Foundation and Spring Creek project partners are committed to the long-term maintenance and promotion of the project. This will be achieved through active identification of further funding opportunities, continued operation and analysis of the established monitoring protocols and ongoing presentations of findings and experiences. The continued support of researchers, students and related experts will also be sought and encouraged to augment the intellectual values provided by the project.