

**Soft-engineering solutions for
swamp remediation
a “how-to” guide**

Section Three

Case Studies

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Glossary

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Braeside Swamp Blue Mountains LGA

- check dams/water spreaders/infiltration cells

Context

Braeside swamp was being influenced by two water-courses; an intermittently high flow stream which was transporting the majority of the stormwater generated from the upstream urbanised areas around the swamp edges, as well as a smaller low flow accessory (historical drainage?) channel within the swamp itself.

The banks of the high flow stream were being actively eroded and required stabilisation.

The channel was dewatering the swamp resulting in desiccation of the swamp substrates, the die back of swamp vegetation and the subsequent domination of the swamp substrates by exotic weed grasses.

Treatment

The low flow characteristics of the accessory channel and the diversion of the more highly erosive stormwater flows around the site by the stream made the swamp suitable for remediation.

The banks of the high flow stream required bank stabilisation, toe protection and revegetation. Check dams supported by channel packing were placed at several points along the channel to prevent further dewatering subsequently causing the channel to fill up with water. Overflows were then spread over the desiccated swamp substrates with the aid of water spreading structures, and held in a series of infiltration cells. This encouraged the vertical rehydration of the swamp substrates and the recreation of the pre-channel waterlogged swamp conditions.

The water logging resulted in the die-back of the exotic weed grasses and their replacement with native sedges. More elevated areas on the edges of the swamp which were not fully rehydrated were planted out with swamp specialist *Leptospermum spp.* including *L. grandifolium*, *L. polygalifolium* and *L. juniperinum* to create a tea-tree thicket buffer to the swamp.

The structures created a trajectory of change that favoured swamp vegetation over the exotic grasses and resulted in spontaneous natural regeneration of swamp vegetation with very little intensive bush regeneration or planting being required. The soft engineering solution provided a cost effective and long term solution to a previously open ended and labour intensive struggle with exotic weed grasses.



Streambank stabilization on the edge of Braeside Swamp

Swamp remediation snapshot over a 12 month period: Braeside Swamp



- Installation of water spreaders and infiltration cells into degraded swamp substrates dominated by exotic grasses as a result of desiccation.



- Same location 6 months after installation.

Note recolonisation by sedges and the natural die-back of exotic grasses due to the increased water-logging.



- Same location 12 months after installation. Sedge species have re-established and soft engineering structures are barely visible.

Marmion Swamp Blue Mountains LGA

- check dams/sediment fencing infiltration devices/wooden bed control structures

Context

Surface stormwater flows had resulted in the channellisation of Marmion Swamp causing desiccation of swamp substrates and the death of swamp vegetation adjacent to the channelised areas. *Blechnum nudum* ferns had begun to colonise the degraded areas of swamp.

Treatment

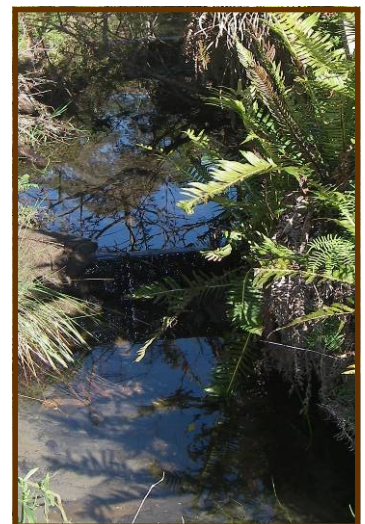
Reinforced sediment fences were installed in the open grassed areas above the swamp to act as detention and infiltration devices to encourage surface water to infiltrate into the groundwater (rather than entering the swamp as high velocity erosive surface flows) pictured below.



Revegetation of the extensive grassed areas above the swamp was also undertaken to increase infiltration rates.

Check dams and channel packing were installed to retain water in the system and encourage the lateral hydration of swamp substrates through the channel walls.

Wooden streambed stabilisation structures were also installed to reduce further deepening of the channel and to gradually raise the streambed of the channel (below).



Wentworth Falls Lake Swamp Blue Mountains LGA

- water spreaders/infiltration cells/landowner incentives

Context

A large sediment plug associated with stormwater discharge was smothering swamp vegetation on the eastern margin of Wentworth Falls Lake through hanging swamp, and supporting an extensive area of exotic grasses.



Treatment

Road verges in the catchment were bollarded to restrict vehicle movement and parking, activities which were denuding them of vegetation making them vulnerable to erosion. Rainwater rebates, driveway sealing and verge revegetation and mulching incentives were offered to landowners in the catchment.

To prevent further inputs of sediment into the swamp, a Baramy Trap was installed upstream of the swamp, below a stormwater discharge pipe adjacent to the road (below).

A series of water spreaders and infiltration cells were installed to help waterlog the sediments to alter the trajectory of change to favour native sedge growth over exotic grasses.

The sediment was further consolidated and held by infiltration cells preventing additional movement into the system. The sediment plug was essentially converted into a giant native sedge sand filter cleansing stormwater inputs into the swamp.



Above: Baramy Trap to catch sediment.

Happy Valley Swamp Lithgow LGA

- water spreaders/infiltration cells/access management

Context

The electricity infrastructure corridor and the associated maintenance trails on either side of Happy Valley Swamp created a desire line across the swamp for 4WD users and trail bikes to link the trails by tracking across the swamp.

Over time the impact zone continued to be widened as crossing points became impassable and new ones were created and as 4WD users tested their machines performance in adjacent areas of swamp. Large amounts of sediment were deposited in the swamp from the heavily eroding access trails.

Treatment

A single track on the least erodible approach was hardened and left open to maintain a thoroughfare along the desire line to reduce the risk of new tracks being created in response to track closures. Extensive soil conservation works were undertaken along all the associated access tracks to reduce sources of sediment and stormwater flow.

Channelised areas of Newnes Plateau Shrub Swamp adjacent the site had check dams installed to divert water out of the channels. The diverted water was then directed over the highly compacted and desiccated areas of swamp substrates damaged by vehicular traffic. Infiltration cells were used to hold the diverted water over the degraded areas to encourage vertical rehydration of the desiccated swamp substrates.

4WD deterrent pits, barrier fencing, brushmatting, jute matting, and planting were installed to close duplicate tracks, prevent erosion and encourage revegetation.

Educational presentations to 4WD clubs and Trail bike clubs were conducted to educate members about their impacts. Workshops with NSW Forest and Integral Energy staff on how to cooperatively address the issues were also held.



Happy Valley Swamp



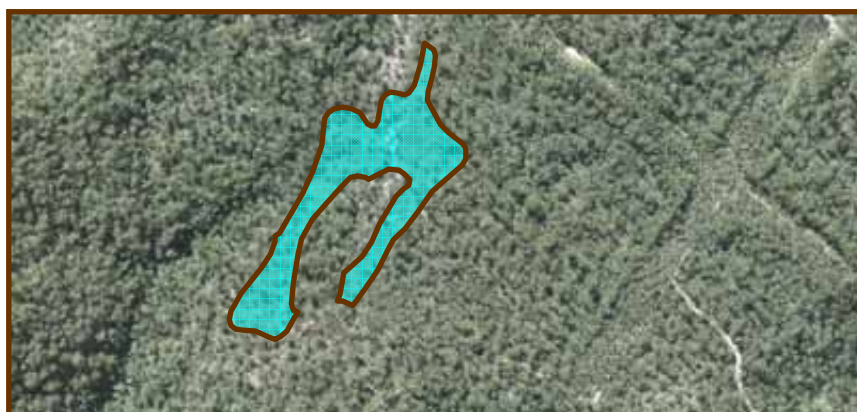
Ellem Gully Hanging Swamp Gosford LGA

- soil conservation and water management

Context

Ellem Gully hanging swamp is a small swamp system within McPherson State Forest west of Wyong NSW, and is classified as a Gosford Sandstone Hanging Swamp. The catchment area is approximately 4ha in size, is comprised entirely of bushland and sits atop a broad plateau. The surrounding catchment to the swamp has few disturbances except for existing formed dirt roads for logging operations, road maintenance activities (i.e. grading etc), and use by recreational vehicles (occasional 4WDs, although predominantly trail bikes).

Approximately half of the upstream catchment draining into the swamp is a revegetation area, initially planted with Blackbutt trees (*E. pilularis*) after an historic airstrip had been in use for some 15 years across the plateau. Initially established nearly 30 years ago these trees are now quite mature, with little diversity in the regenerating understory (below right).



Despite nearly 3 decades since revegetation works were undertaken, the footprint of the airstrip is still very clear from aerial photography (left).

Stakeholder observations had noted that over the last decade the swamp had not been retaining or seeping as much water as historically, and upstream ephemeral flows (including subsurface/subterranean) flows not as evident as had been in previous years.

Vegetation changes were also being observed in the swamp itself (i.e. the increasing dominance of shrubs such as *Callistemon* and *Banksia*), in preference to sedges.



Issues included;

- Upstream erosion and compaction caused by vehicle access above the swamp (predominantly trail-bikes (i.e. tracks))
- Changes to surface water-flows and hydrology
- Road maintenance activities and earth-works/soil conservation.



Investigation through the revegetated airstrip revealed many of the planted Blackbutt trees adjacent to drainage works or trail-bike ruts where water was being detained in pools, had considerably thicker trunks than neighbouring trees across flatter terrain where surface flows sheeted freely. This was consistent across the revegetation area.

Treatment

Works were applied to remove numerous earth barriers and trail bike paths across the upper catchment to help facilitate the free flow of surface water to the downstream swamp.



It was theorised that pooling water being detained in these formed earth basins may be providing additional water to these trees rather than travelling downstream to the swamp itself. The trail bike paths and mitre drains could be creating opportunities for water to be shifted from the road pooling along wheel ruts and end-points of the drains.

Tracks and inroads were reshaped, jute mesh and a number of coir logs were installed to armour the soil and redirect surface flows.

The project is being monitored to assess hydrological changes over time.



Paddy's River Swamp Wingecarribee LGA

- hydrological management and weed control



Intact swamp and wetland systems



Range of weeds within swamp



Treated weeds areas. Structures will rehydrate current dry areas of swamp and encourage desirable swamp species

Context

Paddys River swamp and wetland system has portions of swamp where the natural hydrological cycles have been altered by upstream issues in the catchment resulting in channelling and stream incision .

With this has come sediment deposition in parts of the swamp and the subsequent drying out of sections of swamp.

The fluctuations in water levels has allowed some desirable native swamp species to establish however as the areas subsequently dry out, terrestrial native plants and weeds particularly Japanese Honeysuckle and Blackberry are able to colonise the area out-competing the desirable native swamp vegetation.

Treatment

Hardwood and log structures have been installed in-stream in order to retain water to encourage ‘wet’ native species to permanently occupy the site and effectively out-compete the exotic species.

This will improve the overall hydrological function of the swamp as a system, and the health and vigour of native vegetation will increase as optimum conditions are returned.

In the longer term, the area should require less labour input in regard to weed management in the future as opportunities for weed establishment are reduced.

Glossary

anaerobic	Having little or no oxygen.
anthropogenic	Of or relating to humans; caused by humans.
aquifer	An underground bed or layer of rock, sediment or soil which yields water.
base flows	The usual, reliable, background level of a river or stream maintained generally by seepage from groundwater storage.
basal	Beginning or basic; of primary importance; relating to or forming a base.
biodegradable	Capable of being decomposed by biological agents, especially bacteria, commonly organic materials.
bio-filters	A pollution control technique using living material to capture and biologically degrade nutrients and other pollutants, resulting in improved water quality.
bio-region	An area constituting a natural ecological community with characteristic flora, fauna, and environmental conditions and bounded by natural rather than artificial borders.
channeling	An erosional process by which stormwater incises a drainage channel through swamps, resulting in dewatering of the swamp, lowering of the ground watertable and desiccation of swamp substrates.
check bank	A short level earth bank constructed to slow and spread runoff flows from other structures.
degraded	An area low in functionality and sustainability.
desiccated	Dried out.
dewatered	Has had water removed.
endangered	A species in danger of extinction in the near future throughout all or a significant proportion of a species range.
erosion	The process of eroding or the condition of being eroded: where material is worn away from the earths surface, and in this case from swamps, streambeds, trails, banks, the catchment etc.
eutrophication	The natural and artificial addition of nutrients to lakes, streams, wetlands, swamps and estuaries and the effects of this addition.
extraction	Removal of a substance from it’s constituent body: e.g. of metals or water from the earth.
friable	A soil texture that is loose and crumbly i.e. not strongly coherent and easily eroded by water.

geomorphology	The study of the earth's landforms and the forces and processes which have shaped them.
groundwater extraction	Removal of subsurface water from the soil and rock substrate.
hydrology	Study of water and its relationship with living things, its occurrence, distribution and effects on the earth.
hydrophobic	Water repelling soils.
impeded	Retarded or obstructed process.
impermeable	A surface or material through which water is unable to permeate.
impervious	A surface or material through which water is unable to penetrate.
infiltration	The process of water entering the soil.
Key threatening process	Actions or threats which adversely affect threatened species, their populations and ecological communities, or could cause them to become threatened.
loams	Soil composed of a mixture of sand, clay, silt, and organic
mudstone	Fine grained sedimentary rock, hardened mud, originally consisting of clays and mud. May include shales and/or argillite.
peat	Consolidated organic matter formed by the breakdown of swamp plant species in acidic and anaerobic conditions.
percolate	To drain or seep through a porous material.
permeable	A surface or material through which water can move through.
pipng	An erosional process in which stormwater bores a narrow diameter subsurface tunnel through the swamp substrates which acts like a drainage pipe, dewatering swamp substrates.
rehabilitation	Treatment to an area to restore it as close as possible to its original condition.
remediation	Act or process of correcting a fault or deficiency.
restoration	The act of bringing an area back to its original more resilient and authentic condition. Involves re-instating biodiversity and natural ecological processes or systems, where significance disturbance has occurred and where other regeneration techniques may fail.

retention	Holding back of water or sediment.
rhizomatous	A horizontal, usually underground stem that often sends out roots and shoots from its nodes
sediment	Solid fragments of inorganic or organic material that come from the weathering of rock and soil. Sediments are frequently carried in suspension in stormwater and are deposited when water velocities slow.
sedimentation	Act or process of depositing sediment.
seepage lines	Areas where groundwater is forced to the surface by the outcropping of impermeable rock layers. They frequently occur as horizontal bands or as springs.
shale	A fissile rock composed of layers of claylike, fine-grained sediments.
silviculture	Forestry works and cultivation.
skeletal soils	Soils which are very shallow and are low in nutrients and organic material.
<i>Sphagnum</i>	A moss species, growing in wet conditions on peat soils.
swamp substrates	An underlying layer or substratum, of highly organic peaty medium on which swamps grow.
slumping	Channelling, tunnelling or piping creates voids into which the swamp substrates collapse or ‘slump’.
swale	A vegetated permeable bund which allows infiltration of water along it whilst at the same time providing a erosion resistant conduit for surface stormwater flows.
temperate	An area characterised by moderate temperatures; neither hot nor cold.
threatened	A species at risk of extinction. Categories based on the level of risk include vulnerable, endangered or critically endangered.
tunneling	An erosional process in which stormwater bores a large diameter subsurface tunnel through the swamp substrates which acts like a large drainage pipe, dewatering swamp substrates.

urbanization	An area which is becoming more developed with housing, roads etc resulting in more hardened or impermeable surfaces, in its structure and composition.
velocity	The rate or speed with which water moves.
vulnerable	A species facing a high risk of extinction in the medium term future throughout all or a significant proportion of a species range.
watercourse	A natural or artificial channel through which water flows; ie: stream or a drain.

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