



Pasture Report Marcollat Flat Proposed Drain

Verity Ingham
Rick Jordan
Consultants
Horizon Farming Pty Ltd

Circulation: Rob Kemp *Senior Project Officer*
USE Integrated Catchment Management Program

Background

In April 2004, Rob Kemp Senior Project Officer, USE Integrated Catchment Management Program, approached Rick Jordan, Senior Pasture Systems Consultant, Horizon Farming, to view and assess pasture on three properties on the Marcollat Flat, and provide views on the impact of a proposed drain on the pasture systems on these properties.

Horizon Farming is an independent consulting company with substantial experience in pasture systems across South Australia, Victoria, Western Australia and various other areas in Australia. Pasture and grazing systems establishment and management total approximately eighty percent of Horizon Farming consulting and corporate work.

Whilst Horizon Farming takes every effort to minimise environmental impacts of pasture and grazing management, we are not environmental experts. Nor are we hydrological or engineering experts, and information in relation to these fields of expertise in this report is not an expert opinion, just our opinion through experience. Horizon Farming was employed to write this report solely as experienced consultants on pasture systems.

The proposed drain two (2) metre deep drain discussed in this report is to run north - south along the Marcollat Flat, parallel and in close proximity to, the Marcollat Watercourse. The proposed drain is intended to begin south of Willalooka Pastoral Co and run north to adjoin the already constructed Didicoolum drain (see Map 3).

At least seven properties will be directly affected by the proposed drain, and it will run through six of those properties, extensively through some and on the boundary of others. Further properties may be affected by a deep drain however this paper is based on the properties where the drain is proposed to be constructed, and those directly east.

This paper is written to provide our opinion of the impact of the proposed drain on the pasture base on five of the directly affected properties which include Longeronong (Willalooka Pastoral Co.), P Vercoe, Kyeema (D & S Prosser), Minnamurra (T Truscott) and Amherst (I Johnson).

Property visits were made to three of the directly affected properties (Longeronong, Kyeema and Minnamurra) where pastures and soils were observed and information sought from property owners/managers on the pastures, soils, soil water, grazing management and the proposed drain.

Grazing production capabilities of the properties visited cannot be totally quantified without further research, measurement and on-farm trials. Therefore any production capability information stated in this report is from our past experience in pasture systems in similar country; researched material related to this report; notes and reports provided to us; and anecdotal information.

The areas of focus in this report include the *current pasture status; soil description; current effects of surface water; grazing production and management; and the potential effects of drainage on pasture and soils.*

Some of the phenomenon's stated in this report, such as inundation; movement of local / upstream water (both surface and sub soil flows); rising water table; and decline in pasture species and productivity have not been viewed directly by the authors in this locality, in relation to this report. This is due to the seasonality, or long term nature, of the conditions, and the limitations of a single visit to the properties at the end of April 2004. The conclusions drawn by Horizon Farming in relation to these phenomenons are through experience, research and information collected in compilation of this report.

The information provided in this report should be used in conjunction with relevant environmental, hydro geological and engineering information to ensure that any drainage works carried out do not adversely affect the productive and sustainable, agricultural and environmental systems, already in affect.

The information contained in this report has been collected and collated with due diligence by Horizon Farming. The opinions of landholders, as related to Horizon Farming, have been recorded as accurately as possible. The opinions of Horizon Farming are independent, and unless stated, by no means the opinions of the landholders or any person involved in the project. Horizon Farming has not consulted independently to any of the properties included in this report. The opinions and recommendations of Horizon Farming should not be acted on solely from this report without further collection and analysis of information from either Horizon Farming consultants, or others involved in the project.

Report

Rick Jordan & Verity Ingham (Horizon Farming) met with Rob Kemp on 30th April 2004 to discuss the background of the project, the requirements of this report and to visit three properties to assess the current pasture, pasture management practices and gain information from landholders in relation to the proposed drain on the Marcollat Flat. The detailed information in this report has been collected from these farm visits and enhanced from subsequent discussions with landholders, and from relevant literary research, as detailed in the references at the end of this paper.

The information is reported on a per property basis, without comparison between properties, and indicated below by the property name followed by the contact person/s from the property.

It must be noted that this report does not comment on the suitability, management style or productivity of the current pasture systems on the whole farm, it focuses on the pasture systems on the Marcollat Flat on each property. Each property had varying pasture management practices and this report does not compare pasture types, suitability or management styles between any of the properties. The report is based on the directive of focussing on the impact of potential drainage works on the pasture systems in existence on the Marcollat Flat.

1. Location

The Marcollat Flat is situated west of Padthaway and south west of Willalooka in the Upper South East of South Australia (see Map 1).

The area receives approximately 500mm rainfall per annum with the majority falling from April to October (approximately 380mm) with the wetter months in winter. (Source: Bureau of Meteorology)

Detailed core sample logs were reviewed and due to the varying soil types and depths across the flat, each individual profile is not described here. Generally though, soils on the flat include wet sand over clay; sand over dispersive brown clay; sand over friable brown clay on calcrete; and shallow stony loamy sand over calcrete. Soils on the swamps are wet highly saline grey clay and wet highly saline calcareous loam¹. Soils were generally alkaline and there was some evidence of sodicity.

2. Kyeema, Dean & Susan Prosser

Kyeema is located directly north of the Kingston Keith Road, with the Marcollat Watercourse central on the property, and the Marcollat Flat making up approximately 800 hectares on the eastern side of the property (see Map 3). As stated, the information in this report is directly related to the area on the Marcollat Flat.

2.1. Current Pasture Description

It is evident that pastures on Kyeema are healthy and persistent and there were no visible symptoms of dryland salinity on the area of the property visited (see Appendix A & C for pasture species and descriptions).

On the southern end of the property some pastures contained only Tall Wheat Grass, Puccinellia and some annual grasses and legumes. However, the owner was confident that with renovation, a fescue/strawberry clover based pasture could be established, similar to other areas of the farm. It was the owner's belief that these pastures were showing the effects of previously experienced back flooding and consequently inundation, from the Jip Jip weir (see Appendix D for Jip Jip weir information) and not a rising water table. They were not willing to undertake renovation of these pasture areas until the problem of inundation was rectified, as it was thought this would be a waste of time and money.

Further north a new pasture has been established with Strawberry clover, sub clovers, tall fescue, cocksfoot, phalaris and perennial ryegrass species. This pasture is doing well and has no visual effects of any salinity. Established perennial pastures including fescue, strawberry clover, rye grass and phalaris are currently growing well and have not been renovated for a considerable period, with minimal to no fertiliser application.

2.2. Soil Description

Soil inspected visually on the property was healthy with good root penetration. It has been reported that the soils appear to be non saline or at most mildly saline in relation to pasture species persistence¹. There was some evidence of a hard pan, within the root zone (at an average depth of 150 – 200 mm) perhaps due to cultivation.

The soil type was by appearance a sandy loam over sandy clay to clay subsoil with some areas of stone within the clay layer. The depth of sand varied across the flat, as did the type of clay base. It was deduced that the sandy topsoil layer could be prone to a significant breakdown in structure if plant roots and organic matter components were removed. The clay subsoil could be prone to slaking and dispersion, and without careful management soil structure could be negatively impacted. There was no evidence of these adverse soil structural issues under the current pasture base and management regime. It is our opinion that these adverse soil structural issues are presently being avoided, by use of the current perennial pasture base system. **A switch to annual pasture species on these areas would lead to soil structural issues in the medium to long term, with significant detrimental impacts on the pasture base.** The reasons for this are explained in section 2.5 and in detail in section 7.

It was reported by the owners that soil micro flora and fauna were in abundance in winter. It has been recommended that surface soil tests be carried out on the property and once this has been done, more deductions can be made on the current status of the soils and pastures. This recommendation is also made in the Catchment Agronomist (Combined SE Soil Conservation Boards (USE Project)) property report¹.

2.3. Current effects of surface and ground water

Anecdotal reports indicate that there is little or no leaf scald when there is surface water present. There is very little, if any, area of the property is lost to inundation of water, as the pasture tends to grow out of the water and continues to grow well over winter. The seasonal winter water is constantly moving and does not sit for extended periods, with the exception of the existing Marcollat watercourse and Jip Jip weir backflow.

There are no surface drains on the flat inspected.

Shallow water tests for stock bores have been recommended to determine water quality. This water is currently used for stock water and no detrimental effects on the stock have been, or were noted. No bores on the property are dry at anytime. During summer water is about 5-6 ft, and in winter can be at ground level.

Over one million **trees have been direct seeded on the property in recent years with a high uniformity of excellent germination and growth results.** The establishment of these trees will positively affect pasture and stock growth / maintenance. The successful establishment of direct seeded trees in these areas strongly indicates a lack of salinity issues in this system.

2.4. Production and management

The property is set stocked at approximately 15.8 DSE per hectare¹¹ on the flat and fully feeds stock on the pasture grown on the farm, no supplementary feeding is carried out.

The growing season (see Appendix A & C for pasture species type and description, including growing season) on the flat inspected extends to January or February with reports indicating that good stock feed has been present through to March, allowing carry over stock to be fattened if necessary. The long growing season is also noted by the Catchment Agronomist (Combined SE Soil Conservation Boards (USE Project)) property report¹. Winter growth is high and tends not to slow down or stop in the colder months, even under inundation. **This late finishing country is integral to the Kyeema farming system and without it, there would be significant management changes required, along with probable significant changes and impacts on the total farming system and profitability.**

It is our opinion that the current pasture species selection, cultural practices of fertiliser and grazing management on this flat require modifying to maximise production. Anecdotal information suggests that Lucerne would be a suitable variety for the areas of the Marcollat Flat we viewed, however, we are of the opinion that **Lucerne would either not persist or not grow to its potential on this flat on this property.** Further explanation is in detail in Section 7. It is also our opinion that if pasture species, grazing and fertiliser management practices were modified, the construction of a two (2) metre deep drain would impact negatively on the system negating any potential benefits from pasture management change.

2.5. Potential Effects of Drainage on Pasture and Soils

The following information outlines the *possible* effects to pasture on this property, by constructing the proposed two (2) metre deep drain through this property, along the Marcollat Flat.

It is likely the proposed drain will have a number of negative effects to the pasture and farming systems on this property including:

- Reduction in soil moisture.
- Reduction in soil water holding capacity.
- Reduction in effective growing season of the pasture base
- Reduction in perennial pasture persistence.
- Reduction in soil organic matter.
- Potential change in soil structure and;
- Significant reduction in natural flow of fresh surface water from the east.

These would lead to an inability to finish stock out of season on this property. This was discussed by the owners as a principle trading attribute of the farm business.

It is suggested that the drain will draw surface water and ground water from up to 1.5 kilometres away, thus decreasing the soil moisture in a wide area across this property (the proposed drain is central to the flats on this property – see Map 3). A reduction in soil moisture will cause the soil to dry out more quickly, and subsequently shorten the growing season (see appendix A for pasture species description and related growing season). This would adversely affect the productive pasture species on this area of the farm. The perennial pasture species would then be less persistent, making way for an increased number of annual species. This would then reduce the amount of organic matter in the soil, which would in turn decline the soil structure (the top soil would breakdown rapidly to fine sand particles, and the subsoil structure is prone to slaking and dispersion, therefore structure is easily affected) and could lead to top soil erosion. This would lead to reduced infiltration rates and soil penetration by plant roots, ultimately resulting in a significant reduction in pasture quantity and quality. **This reduction in pasture quality and quantity would significantly reduce stocking rate and animal production potential on the property.** Many of these impacts are noted in the Catchment Agronomist (Combined SE Soil Conservation Boards (USE Project)) property report¹. It is also stated in the afore mentioned property report, that the soils on the Marcollat Flat, with a clay sub soil, once drained have the potential to become sodic.

Sub soil and top soil nutrient reports have been requested, to further determine any issues that could preclude Lucerne from establishing or persisting on these flats. **If Lucerne was to be established, inundation would have to be prevented, requiring a significant draw down and interception of existing soil and surface water flows.** It is our opinion that to achieve this would result in a system that would potentially produce less quality and quantity than the current pasture base. Further explanation of Lucerne is in Section 7.

In our opinion the construction of a two (2) metre deep drain on this property, in the proposed location, would have significant negative impacts on the pasture system and therefore the whole farming system.

3. Longeronong (Willalooka Pastoral Co), Malcolm McDonald

Longeronong is located directly south of the Kingston Keith Road with the Marcollat Watercourse central on the property and the Marcollat Flat making up approximately 1730 hectares on the eastern side of the property (see Map 3). As stated, the information in this report is directly related to the area on this property on the Marcollat Flat.

There are a number of significantly different areas of soil and pasture on the Marcollat Flat area of this property. This is depicted on Map 4 by A - the watercourse; B - saline soak area, heavy clay soils; C - sand over clay type soils.

3.1. Current Pasture Description

A number of pastures were inspected across the Marcollat Flat on Longeronong. Pasture varied across paddocks visited, with some showing strong visual signs of salinity (B), others minimal and some nil (C).

Pasture species and productivity varied considerably from west (A) to east (C). In the lower lying areas and near to the salinity soaks (B), the dominant species were tall wheat grass (TWG) and Puccinellia, and moving eastwards (C) dominant species became phalaris, rye grass, other perennial grass species, native medics and strawberry clover.

It was reported that pasture has been declining in area B for many years, and currently there is only Tall Wheat Grass and Puccinellia growing with some areas of surface scald. A myriad of surface drains have been dug in here in the mid to late 80's and it was said by the owner that this has not improved this area of land. **The surface drains appear to bring surface water to the salinity soak areas, and this may be contributing to the hyper saline environment.** This is due to increased surface water brought to the area with no where to flow on, it then has the potential to pond, evaporate, and leave salts on the surface leading to a hyper saline surface.

It is the view of the manager that the local surface water poses no problem, rather it is the rising ground water table causing these effects on the pasture. From a single visit, Horizon Farming cannot comment on: the progress or rate of the salinity; the pasture decline on these hyper saline areas; or a rising water table. There is certainly the potential for these areas to increase in size, if the issues creating them and contributing to their spread, are not addressed.

On the fringes of the scald areas in area B, pasture decline from stock traffic and exposure of the soil from extended inundation, has also lead to salt accumulation at the soil surface restricting germination and growth of even the annual species. It is interesting to note that the Tall Wheat Grass is still surviving in this environment on the fringes of the saline soak areas.

Some parts of the soak areas have only Puccinellia growing and therefore are classed as saline areas. Puccinellia does not compete successfully with non salt tolerant pasture species or weeds. Tall Wheat Grass once established is a very competitive against non salt tolerant pasture species. The Tall Wheat Grass on the fringes may suggest the soil is not highly saline, however, a soil test is recommended to verify this.¹⁴

3.2. Soil Description

Salinity soak areas (B), in this report, refers to an area that has **historically been a saline sump or depression tending to be hyper saline and a soak or natural collection area for saline water**. Historical maps indicate that this area was dominated by tea tree and cutting grass⁶. Clay over clay soils dominate in the immediate area.

Area C, to the east of area B, the soils is loamy sand (10cm) over medium clay; and loamy sand (20cm) over light-medium clay.

There is only a very slight fall on the property (one inch to the mile) and it was said that water tends to lie longer on this property than other properties on the Marcollat Flat.

Soil inspected in the area of the salinity soaks (B) was of higher clay content, and the areas inspected towards the east (C) were higher in sand and loam as either sand over loam or a sandy clay loam. It was deduced that the **clays in the salinity soak areas (B) are prone to water logging and salinity issues**. The soil structure is adversely affected, inhibiting through-drainage and draw down of the salt load. Where the depth of the sand over the clay increased, more productive pasture species were evident. This trend seems directly correlated. Surface soil tests have been recommended and analysis of these tests, and the effect on pasture, can be carried out once the results are available.

3.3. Production and management

This area of the property is set stocked at an average of 6.95 DSE per hectare¹¹. Pugging can be an issue in winter.

Single Superphosphate is spread on the area every year at 90kg per hectare. Improved pastures on other areas of the property are spread at 120kg per hectare per year.

3.4. Current effects of surface and ground water

Water is said to be of poor quality (shallow water tests have been recommended) and bore water levels are at about two (2) metres in summer and can be overflowing in winter.

The manager stated that in his opinion, the issue on this flat was dryland salinity with a rising water table as the key problem. It was his belief that the pastures were being negatively affected by this phenomenon and that the two (2) metre deep drain would considerably alleviate these issues, leading to increased pasture productivity.

It is our opinion that the evaporation of the soil and surface water in the salinity soak areas (B) is concentrating salts on the surface and creating a hyper saline environment. From the farm visit, subsequent information, and our experience with this issue in like environments, **we do not believe that the pasture in these areas is affected by dryland salinity, rather surface salinity in the salinity soak areas**. We do not dispute the fact that there is a salinity issue present, nor can we comment on the increase or decrease of salinity in the immediate past on these areas.

3.5. Potential Effects of Drainage on Pasture and Soils

The following information outlines the *possible* effects to pasture, by constructing a two (2) metre drain through this property, along the Marcollat Flat.

As stated it is evident that there are salinity soaks in this area (B). This has adversely affected pastures in the immediate surrounding areas. **To have a favourable impact on the soils and pasture in area B, the actual position of a deep drain on the flat is critical.** For maximum benefit on these saline areas (B), the hyper saline environment within the plant root zone needs to have the ability to be flushed by normal winter water flows / rainfall, and removed from this system. This may be achieved by the construction of a two (2) metre deep drain, however, **the currently planned location of the proposed drain may not give this affect at all.** If the positioning of the drain was in the optimal place, and the resultant effect was flushing of the hyper saline root zone, then with combined optimal: stock management; pasture renovation; and soil fertility management; recovery of much of the effected area could result.

Further to the east (area C) it is our opinion that salinity is of a lesser issue and a two (2) metre drain would not significantly improve pasture quality or quantity. **A two (2) metre drain has the potential to reduce soil moisture levels and shorten the length of the growing season, thus decreasing pasture production in this area** (see Appendix A & C for pasture species type and description including growing season). It is our opinion that pasture renovations and grazing management changes would have more of an impact on pastures in this area than a two (2) metre deep drain.

If pasture renovation and grazing management changes were linked to remedial action in the saline soak areas, such as *specifically* draining the saline soak areas or fencing and revegetating the saline soak areas, potentially significant increases in pasture production could be gained. If the surface water flow was restricted across the flat without addressing the saline areas, potentially the salinity issue at present may be controlled, but the end productivity from the flat may well *not* be increased due to diminished growing season, and inability to establish and maintain the potential optimum pasture species and system, for this environment.

It is also suggested that **Lucerne would not be the ideal species to grow in this area due to the soil type and water flow pattern.** In our opinion a fescue, ryegrass, perennial clover and sub clover mix (see Appendix B) would be more suited to the area and produce higher quality and quantity feed, over a longer growing season. Further explanation of this is in Section 7.

On request the Wongawilly drain and flat were inspected. Whilst the Lucerne establishment and production in that area is clearly evident with significant production and grazing benefits, it is our opinion that the soil types and profile, water catchment / flow, and pasture systems in that area, are significantly different from the Marcollat Flat, and therefore cannot be directly compared.

4. Minnamurra, Tim Truscott

Minnamurra is located approximately 8km north of the Kingston Keith Road with the Marcollat Watercourse running central on the property, moving towards and leaving the property in the north western corner (Map 3). The current construction of the Didicoolum drain begins approximately ten (10) metres from the boundary of Minnamurra, in the north eastern corner (Map 3). As stated, the information in this report is directly related to the area on the Marcollat Flat (east / north east of the Marcollat Watercourse).

Minnamurra was visited by Rick Jordan, Verity Ingham and Rob Kemp on 30th April 2004. Tim Truscott was not present, however, he did participate in a phone interview on 11th May 2004 with Verity Ingham, in relation to the areas of investigation for this report.

4.1. Current Pasture Description

On 30th April during the field visit, it was apparent that there were annual pastures species present across the majority of flats along with deep rooted summer weeds (Thistles, Dock and Heliotrope). The presence of these weeds indicate that the root zone moisture and salinity levels are not so saline as to preclude growth of perennial weed species, that do not have saline tolerances above many perennial grass species, such as Phalaris and Fescue. This indicates that **inundation is the principle cause of the decline of the pasture base on the majority of this property**. Tall wheat grass also present in the areas to the north, while phalaris and strawberry clover existed in the pasture towards the south. In the north western corner of the property, there was visual evidence of salinity in the low lying areas. There is very little fall of the land from east to west towards the watercourse.



*Minnamurra (1996) showing inundation.
Photo courtesy of South Eastern Water Conservation & Drainage Board*

We are unable to clearly ascertain the exact species present historically, but the ongoing decline of the pasture base is a typical pattern that occurs as a pasture system comes under stress. As species density declines so does persistence, with the rate of decline escalating as the pasture base switches from perennial to annuals as the dominant species. The annual pasture systems are less able to cope with the saline and inundated environment,

and do not assist in any way with lowering of water table. Eventually these annual systems regress to saline tolerant short lived annual species, as the periods of inundation increase and the growing season decreases.

The owner stated that in previous years (previous to years of inundation from Jip Jip weir development) pastures were extensively renovated, however years of inundation and a significant hold up of water, have seen new (and existing) pastures “drowned” out. Pastures have now not been renovated extensively in this area of the property for many years. Tall Wheat Grass was planted, however, the owner is not satisfied with this pasture species for his grazing enterprise, yet believes it is the only species that will grow well in these areas, under the conditions currently experienced.³

There is a significant area of salinity in the north western corner of Minnamurra where pastures have been adversely affected by what we believe is inundation of water from upstream, with no natural flow route north, and back flow of water from the Jip Jip weir. **It is our opinion that there is a significant issue with loss of production on this property resultant from the construction and management of the Jip Jip weir.**

It is our opinion that water needs to be shifted from this area to stop the decline in pastures, and build up of surface (and maybe groundwater) salinity, through evaporative concentration of salts at the soil surface and in the root zone of plants. Currently, it is evident that renovating and managing high quality pastures in the north western area of this property, is impractical and would not be successful.

4.2. Soil Description

In the north west corner of the property sand (20cm) over sandy clay (20-30cm) dominates with a calcrete pan at 50cm. In the north eastern area, loamy sand is present to 40cm over a light to medium clay. Towards the south loamy sand (0-10cm) sand (10-20cm) over a medium clay (20-30cm) is present with a limestone/calcrete base to 150cm¹⁰.

4.3. Production and management

Pastures across the flat are fertilised with 100 kilograms per hectare of Single Super annually. Other elements are spread at times when advised. The land directly on the Marcollat Watercourse is not fertilised.³

It was mentioned that trees planted on the northern boundary of Minnamurra (but not on Minnamurra) were growing very well on the rises however on the lower lying areas the trees were stunted and fewer in number.³

The owner stated that the stock water quality was not that good. It has been recommended that stock water tests be taken.³

4.4. Current effects of surface and ground water

The owner reported that he believed approximately 420 hectares of the flats on his property were in some way affected by salinity (generally all the flats he owns adjacent east to the Marcollat water course). It was stated that these flats are no where near as productive as they had been in the past and as a result stocking rates have had to drop considerably over the years. In the far north western corner it was reported that the pastures had never been highly productive, possibly due to soil type.³

The water affecting the property is said by the owner to be not just local water, but all the water upstream (south) on the Marcollat Watercourse, which now has no natural flow north, due to the Jip Jip weir. The local water is

not seen as a significant problem, although it exacerbates the amount of total water inundating the property as it collects at this choke point of the Jip Jip weir, and backs up across the farm to significant depth due to topography of the property. **It was reported that the amount of water that comes from the south of the Marcollat Watercourse (upstream) has increased considerably over the years and the current Jip Jip weir is not managed for this increase in water, and the small drain/cutting to the Jip Jip weir cannot handle the increased amount of water.**³

The upstream and local water banks up (due to the limitation on natural flow) onto Minnamurra and is causing considerable damage to pastures, carrying capacity and overall production. **This effect is felt all over the farm as high country has to be stocked at higher rates due to the flats being inundated with water and low in production during the winter.**³

4.5. Potential Effects of Drainage on Pasture and Soils

The owner was of the opinion that the proposed two (2) metre deep drain would be of significant benefit to his property and pastures. He believes that there may not be considerable change in the north western area, however, moving towards the south and east, he believes the water table will be lowered by the proposed two (2) metre deep drain and then he can consider pasture renovation in this area. He believes the removal of the Jip Jip weir will have a significant impact on the removal of water (and a positive influence on the natural water flow) however it will not be enough to cater for the amount of water coming from upstream, unless another route (alternate to the current narrow cutting) is constructed to draw the water away.³

If water is consistently and successfully stopped from standing on the north western area of Minnamurra, at significant depth and for significant periods, pasture types (as suggested in Appendix B), and a suitable fertiliser regime, could be trialled, and should be able to be maintained (see Appendix B for pasture species suggestions). This may take time to achieve and may need to be carried over a staged development program, upgrading species over time, as soil salinity and water table drops. Lucerne would not be the ideal pasture species type for this area (further explanation is in section 2.5 and in detail in section 7).

Whilst we are not experts in drainage and hydrological engineering, we are of the opinion that the **water inundation could be alleviated by localised drainage works assisting the movement of water from this specific area** through to the Jip Jip wetlands, and removal of obstructions at the Jip Jip weir.

Further south and east on the property, it is our opinion that salinity is of a lesser issue, however inundation is still impacting on the pasture base. The potential effects of draining this area, in relation to pasture quality and quantity, are high. Reducing the amount of water inundating the pastures and soils for long periods of time, will allow higher quality perennial pastures to be established and managed. **It is not clear though that the development of the proposed two (2) metre deep drain in its current location will have the desired effect on pastures and without further investigation, trials and information, it is difficult to determine the specific result for Minnamurra.** It is our opinion that high quality perennial pastures (such as describe in Appendix B) could be grown and sustained on this soil type dependant though on good establishment and minimal inundation. We do not believe that Lucerne is a suitable pasture species for this flat.

It is our opinion that the proposed two (2) metre deep drain could assist in alleviating the inundation of water on this property, however, we are not convinced that the currently proposed drains *location* would be the most beneficial solution for the pasture systems on this property. It should also be noted that after the inundation issue was alleviated, some degree of management of soil water levels would be beneficial to the ongoing productivity of the perennial pasture, that could be established in the less detrimental environment.

5. Phil Vercoe

Vercoe's property lies directly east of the proposed drain. The proposed drain runs along part of the western boundary of this property. Part of the property is central to the Marcollat flat and runs eastwards towards the range. Its northern boundary adjoins the Kingston Keith Rd (see Map 3)

This property was not inspected by Horizon Farming, however it is expected that the soils would support a fescue, ryegrass, strawberry clover and sub clover mix of high quality and quantity.

Feedback from the property owner suggests that there is not a salinity problem on his property in the area outlined by this report. He is of the opinion that the pastures have actually improved over recent years due to management factors, and have not declined. **In wetter years the country does become inundated, however, this is not seen as an issue, rather an advantage in that it lengthens the growing season** (see Appendix A & C for pasture species type and description including growing season). It was stated that the area grows strawberry clover well and has a long growing season.²

The property owner indicated that drainage in this area would shorten the growing season and considerably lower the water table. He believes that the water table has already lowered due to the drier years in this area, and a drain would only exacerbate this. He also believes his **shallow bores in the area would be affected by the proposed drain and may lead to bores having to be deepened.**²

It was stated by the owner that historically there are areas south (towards the water course) of the property, that have been saline areas. This was the case before the land was developed². This is supported by historical maps⁶.

As stated, Horizon Farming did not visit this property, however we are of the opinion that the same issues regarding soil types and pastures would occur in the same manner as with the other properties on the Marcollat Flat with similar soil type and winter water flow pattern discussed previously in this report. This was also the opinion of the landholder.

6. Amherst, Ian Johnson

Amherst lies east of the proposed drain on the Kingston Keith Road, with no part of the proposed drain actually entering the property. The property lies directly west of, and shares a boundary with Kyeema. If the proposed drain has a draw of 1.5km, it may have an impact on Amherst's western flats (see Map 3).

This property was not inspected by Horizon Farming, however it is expected that the soils would support a fescue, ryegrass, strawberry clover and sub clover mix of high quality and quantity.

The property owner stated that pastures on the western flats of Amherst where **high in production and quality with no apparent salinity effects**. He did not believe that inundation was an issue and believed that wet winters were of benefit to his production system.⁴

Amherst is stocked at a higher than average rate for the area and the owner reported that he was "pushing" the pasture fairly hard. Pastures on Amherst are stocked at an average of 11.4 DSE per hectare and can get up to 16.8 des per hectare at certain times of the year when opportunity trading¹¹.

The proposed two (2) metre drain was not seen as a construction that would benefit pasture production by the land owner on his property. He was of the opinion that it could **reduce the growing season of the pasture and could lead to a reduction in the range and type of pasture species he could grow, particularly perennial species such as phalaris, which is currently integral to his production system.** He mentioned that there was the potential for salts to leach from the drain, into non saline land, from the drain (should the drain water contain salts).⁴

The local water coming across the flat was not seen as an issue and it was fresh water that was of benefit to his pastures.⁴

The property owner was of the opinion that the salinity issues on the Marcollat Flat were in specific areas. He mentioned that he thought it would be **very difficult to have a generalised solution across the flat for issues that were in specific locations,** not across the entire flat.

Horizon Farming did not visit this property, yet we are of the opinion that the same issues regarding soil types and pastures would occur in the same manner as with the other properties on the Marcollat Flat with similar soil type and winter water flow pattern discussed previously in this report.

7. Horizon Farming Opinions

Generally the focus area examined is potentially a high producing perennial grass, clover, sub clover and perennial clover based pasture area. **This area is capable of sustaining species that persist and produce at higher levels, and maintain quality considerably into the summer, than the surrounding soil types and normal rainfall pattern would sustain in this geographical location.** Currently there are varying levels of these pasture species, resultant from a number of factors, including surface salinity, salinity mounds, inundation, and management practices. Presently all areas, apart for the areas directly around the salinity sumps on Longeronong, and the north western areas of Minnamurra, have the potential to produce high quality perennial pasture of this type. See Appendix B for information on suggested mixes for these areas.

While there may be isolated pockets within the properties that could sustain Lucerne if drainage was to occur, it is our opinion that **this flat is not conducive to good Lucerne production or sustainability.** The inundation events would leave the Lucerne prone to crown and root disease and damage. We are unable to provide data on true production figures from these areas within the scope and timeframe of this report.

It is our opinion that the perennial pasture base evident on a number of sites, if managed well for fertility and grazing, would produce more dry matter of equivalent quality, to that which could be expected from the Lucerne. This is based on the key winter and spring periods where the density of the existing mixed pasture base would deliver significant advantages in total yield.

Lucerne is not as resilient in a grazing situation as a perennial pasture mix. Under grazing (especially set stocking) Lucerne stands decline in density over time, whereas a perennial pasture blend tend to increase in density under correct grazing management. Typically, Lucerne as a single feed source is too high in soluble

protein and too low in Neutral Detergent Fibre (NDF), to optimise animal performance. For optimal production, more fibre and an energy balance is required for the Crude Protein percentage.

A perennial pasture mix has a range of feed values and nutritive base within it. The legume leaves and shoots in a perennial pasture mix are similar to Lucerne, however the legumes in the perennial pasture mix have older leaves and stems at a lower Crude Protein percentage, with good Metabolisable Energy (ME) and NDF. Solubility of Lucerne in the rumen is much greater than a mixed species perennial pasture. This leads to a requirement for acclimatisation of the animals onto the Lucerne. A pure Lucerne stand also has the issue of predisposing animals to bloat. If Lucerne is fed as a sole ration, it is not efficient in utilisation of nutrients. Ruminants (cattle & sheep) evolved on mixed herbage diets, and not on monoculture or single input diets and it is widely recognised that the highest production is gained from mixed herbage diets and / or rations. A suggested blend for clay and loamier soils is listed as Appendix B. The suggested blends offer quality and quantity of pasture forage over a long period, a mix and balance of nutrients and requirements suited to sheep and cattle.

Although we are of the opinion the flats described in this report are not suitable for growing Lucerne, we do agree that there are other areas of the properties visited, that are highly suitable for Lucerne production. The parameters of this report are confined to the flats inspected and therefore this report does not quantify the specific areas and production potential of Lucerne, on other parts of the properties visited. Lucerne managed well as *part of a farming system and ration*, can provide exceptional dryland summer fodder availability and variety in diet for ruminants.

In our opinion, the Jip Jip weir is a major issue in the development of surface salinity across the Marcollat Flats, except in the natural salinity soak areas on Longeronong where it is evident that degrees of salinity have historically occurred (area B Map 4). The Jip Jip weir may have exacerbated surface salinity in these natural salinity soaks, however we do not believe it is the main cause. The Jip Jip weir is certainly impacting on the pastures generally through the Marcollat flat in a negative manner. **The effects of this go beyond single season inundation, as the lack of ability to re-sow and maintain perennial pasture species, in our opinion contributes to the salinity mounds and surface water ponding, and ensuing concentration of salt at the surface through evaporation.** The impact of this is clearly evident on Minnamurra, leading to wastage of considerable grazing area on the north of the property. It is our opinion that this is not a natural phenomenon, and by returning the Marcollat Watercourse to its natural flow pattern, it would certainly have a positive impact on pasture production on the three properties visited.



*Marcollat Watercourse (1990) looking south from Keith Kingston Rd
Photo courtesy of South Eastern Water Conservation & Drainage Board*

Low soil fertility was visually evident on all pastures viewed and it is believed that they are impacting negatively on the pasture species present. However, this cannot be quantified by objective data until soil test results are available. Soil fertility also has potential impact on soil structure though diminished growth and persistence. Grazing management strategies also impact on persistence of these pastures and the effects of this cannot be ascertained from a single visit.

It was agreed by all landholders that the surface water that flowed from east to west towards the Marcollat Watercourse was not a major issue. They claimed that this water was fresh and posed no problem to pasture production, even when pastures were inundated. Horizon Farming cannot validate this claim as we have no objective data to support it, however, the fact that all landholders made the claim, leads us to believe that it is true. This is further supported by the fact the pasture decline does not appear to be occurring due to this period of inundation by the moving surface water.

It was stated that the surface water can cause an issue if it reaches the Marcollat Watercourse and cannot go any further because the Watercourse is full, and the Jip Jip weir is holding back water. Because this water cannot then flow away at a natural rate, and isn't being utilised by pasture or being drained away by another means, it is contributing to saline and hyper saline environments (through evaporation at the soil surface) on Minnamurra and Longeronong. **Water tests and observations in winter when the water is flowing, would need to be carried out to quantify this and should include where the water does become a sheet across the flat.** These measurements should also ascertain the quality and quantity of water flowing across the flat at various stages from east to west and north to south. It is our understanding that this work has not been undertaken at this point in time.

The pasture systems present on the farms, and those systems that aren't present but have the potential to be present, rely on the fresh water coming from east to west across the flat. The pasture species described as the most suitable for this country utilise that water and draw down on it, lowering the water table in summer while contributing significant amounts of high quality feed over a longer period, allowing for good livestock growth rates.

If the deep or shallow drainage system was constructed along the Marcollat Flat, and it acted as an intervention to the surface water flowing from east to west, it would have the potential to stop water laying on the flat, and may have some impact on reducing water lying in the sump areas, however the **negative impacts on the pasture systems and productivity of the whole system would be far greater.**

A deep or shallow drain constructed north south along the Marcollat Flat would substantially reduce the flow of fresh surface water from east to west, capturing a significant amount of the fresh water flow by taking it north and preventing it from flowing westward. If this was the case, **it would most definitely dry the soil profile out and the growing season would be reduced significantly.** This would have a major negative impact on the pasture production and could lead to species and pasture productivity decline, as well as soil structural changes, all of which have been outlined previously in this report. It is also unknown and we could not ascertain what impact this would have on land bordering the Marcollat flat areas. Further objective testing is required in this area.

It must be noted that a two (2) metre deep drain in the centre or eastern side of the Marcollat Flat, whilst having the potential to draw down in the area of the drain, may not draw down from the salinity sump area on Longeronong and the salinity "mounds" on Minnamurra. **It is a real risk that the whole pasture system will be affected by the drain, but the salinity issue in the salinity soak and mound areas may not be affected.**

A two (2) metre deep drain may also draw saline water from salinity sump areas from west to east. This could lead to saline water adversely affecting pastures and soils as it moves towards the drain. It may also have an effect on properties further east by drawing water towards the drain at a quicker rate than normal, therefore affecting the soil moisture and pasture systems on these properties as well. The saline water drawn into the drain will then be flowing from south to north in the drain, with the potential to leach out into non saline areas (the majority of land on the proposed drain flow pattern) that the drain passes through. **The potential for this to occur must be disproved prior to the commencement of drain construction.**

In the salinity soak areas there is evidence of a soil structure issue contributing to the rising salinity levels. In the areas where salinity is not an issue, the surface water percolates through the profile. However, in the soak areas, the soil structure issue impedes infiltration (due to clay or poorly decomposed organic matter) through the soil profile, causing water to lay on soil surface where evaporation further concentrates the salinity level. **In these areas the salinity could be halted through drainage of the soak areas, but not drainage of the whole flat.** It is our opinion that by stopping the surface water laying in the salinity soak or salinity mound areas, and allowing draw down or removal of the salts in the profile, as a result of effective flushing by winter rainfall, these areas could be recoverable to some form of productive pasture. The pasture species currently present in the system (especially on Minnamurra) are not alleviating the problem and are in fact possibly contributing to the problem of salinity. However it is recognised that perennial pasture establishment and management on the effected areas of Minnamurra is very difficult due to inundation. **The protection and enhancement of the perennial pasture base outside of these areas would in our opinion have significant benefits in reducing the saline areas extending in size.**

From historical maps⁶, ground water maps⁷ and anecdotal information, it could be deduced that the hyper saline areas on Longeronong have historically had high salinity levels and are natural saline areas. While we recognise that this does not favour high pasture production areas, it possibly needs to be **managed as a natural saline area** and perhaps fenced off and planted on the surrounds with saline tolerant native species or managed as a separate paddock/s with salt tolerant pasture species. Management of saline pasture could also be adjusted to include applications of Urea, either annually or every two years¹². Research indicates that with Nitrogen application, where 50kg per hectare of Urea is spread, Puccinellia production can increase by 473 – 695kg per hectare annually¹².

It is our opinion that **if nothing is done to change this current situation it will extend the saline areas.** The natural process is of diminishing of existing vegetation, soil structural changes both leading to surface water ponding and evaporating at the soil surface, further concentrating the salinity levels

In our opinion to alleviate the salinity soak areas on Longeronong, a form of deep drainage is required to allow flushing of the soil profile. **We believe this drain needs to be constructed in isolation of the rest of the Marcollat Flat so water is drawn from depth in this area, but has little impact on the rest of the Marcollat Flat system including the other areas on Longeronong itself.**

Horizon Farming believes that in wet years significant amounts of water do need to be moved from Minnamurra. Currently it is at the end of a large flow of water from the Marcollat Watercourse, and local water from east to west. Once water arrives in the northern boundary of this property, it has very limited places it can go, so it lies and / or backflows south. **The result of this is pasture decline due to significant periods of inundation.** Perennial species which could assist with draw down of the water table cannot be established, and productive annual species cannot survive through the winter inundation period. As a result only short lived saline tolerant annuals establish in the spring and these have little productive value or ability to alleviate the problem. This is leading to similar issues with evaporation of water at the soil surface and in the root zones of the plant, leading to further concentration of salt. This salt is then unable to be leached from the profile through normal winter rain

patterns due to sub soil clays and inundation as discussed. **It is imperative for the pasture, production, profitability and sustainability on this property that this water be moved.**

Due to lack of hydro geographical and engineering expertise, Horizon Farming cannot advise the best option for the removal of the water from Minnamurra, whether by opening of the Jip Jip weir; extending the current Didicoolum drain into the property (but not necessarily all the way along the Marcollat Flat into Kyeema and Longeronong); or the construction of another deep drain, however we are of the strong opinion **the water needs to be moved if pasture production is to be increased**, more productive species are to be sown, which can then assist in alleviating the problem, all of which will be required for the operation of a sustainable grazing enterprise on this area.

8. Conclusion

The Marcollat Flat has the potential to produce high quality and quantity of perennial grass, sub clover and clover pasture systems. **The soil types and winter water flow pattern of the majority of the flat leads to a long growing season of productive pastures.** Currently there are varying levels of this potential pasture production due to management, surface salinity and inundation issues.

Whilst it is recognised that Lucerne can be a beneficial pasture species, it would not be the most persistent and productive pasture species selection for the Marcollat Flat.

Surface salinity and / or adverse inundation occur in isolated pockets on the Marcollat Flat at Longeronong and Minnamurra. The causes of these phenomenon are believed to be from changes in the natural Marcollat Watercourse flow pattern by the construction and management of the Jip Jip weir; historical environmental circumstance; and through increased amount of water upstream on the Marcollat Watercourse.

These isolated pockets are low in pasture production and have the potential to encroach adversely on to productive land if remedial action is not taken.

The construction of the proposed two (2) metre deep drain may have detrimental effects on the majority of the grazing land across the Marcollat Flat. It is recognised that deep drainage of the northern part of Minnamurra and salinity soak areas of Longeronong will have many positive benefits, as would the permanent opening of the Jip Jip weir, restoring the Marcollat Watercourse to its natural flow pattern. However, building the proposed drain in the proposed location may not have the direct impact on the north western and salinity soak areas of the two properties affected, yet it may significantly affect pastures on the Marcollat Flat that are currently profitable, productive and sustainable.

Localised solutions need to be investigated for the isolated problem areas. The generalised solution of the proposed two (2) metre deep drain may cause many known and some as yet unknown negative impacts on what are currently productive grazing systems and the underlying soil structure.

It is imperative that the issues on Longeronong and Minnamurra are addressed to facilitate the management of these problem areas and to allow for remedial programs to be undertaken. It is paramount that any of the profitable, productive and sustainable pastures that currently exist on the Marcollat Flat and its surrounds are preserved.

References

1. Strugnell, Tracey, Catchment Agronomist (Combined SE Soil Conservation Boards (USE Project)): Report on the likely impact of drainage on soils, agronomy and carrying capacity on “Kyeema”
2. Vercoe, Phil: telephone conversation with Verity Ingham on 11/05/05
3. Truscott, Tim: telephone conversation with Verity Ingham on 11/05/05
4. Johnson, Ian: telephone conversation with Verity Ingham on 18/05/05
5. Farm maps: various
6. Historical Maps (1887): various
7. Dept. Water Land & Biodiversity (1994): Generalised Water Table, Ground Water Salinity Zones
8. Dept. Water Land & Biodiversity (2004): Diddicoolum Bore Locations
9. Telfer, Andrew; White, Geoff; Santich, Marion (2002): Upper South East Drains – Effectiveness Trials
10. Ground Investigation Field Logs (2004): Various
11. Kemp, Rob (2004): Landholder interview notes on production feedback
12. Morris, Kate (2001): Saltland Agronomy Update for the Upper South East, SA 1. Fertilisers and Puccinellia.
13. Seepage from Jip Jip Wetland Complex (2001): Wetlands Project Officer
14. Strugnell, Tracey, Catchment Agronomist (Combined SE Soil Conservation Boards (USE Project)): General information on saltland agronomy

Maps

1. Locality
2. Soils of Marcollat area
3. Marcollat area showing proposed drain site and properties in report
4. Willalooka Pastoral Co, Longeronong site with different focus areas.

Appendices

- A - Current Pasture Species
- B - Suggested Pasture Species
- C - Pasture Species Notes
- D - Jip Jip weir information

APPENDIX A – Current Pasture Species

		PRODUCTION		
		LOW	MEDIUM	HIGH
SOIL TYPE	Heavier Clay Soils	<ul style="list-style-type: none"> ▪ Bare patches ▪ Puccinellia ▪ TWG ▪ Barley Grass ▪ Samphire ▪ Sea Barley Grass 	<ul style="list-style-type: none"> ▪ Demeter Fescue ▪ Strawberry Clover ▪ Phalaris ▪ Sub clovers ▪ Medic spp. ▪ Barley grass 	Nil viewed
	Loamier Soils	<ul style="list-style-type: none"> ▪ TWG ▪ Demeter Fescue ▪ Strawberry Clover ▪ Barley Grass ▪ Annual rye grass ▪ Kikuyu ▪ Annual Clover spp. ▪ Native Clover and Medic spp. 	<ul style="list-style-type: none"> ▪ Demeter Fescue ▪ Strawberry Clover ▪ Phalaris ▪ Balansa Clover ▪ Sub Clover ▪ Annual grass spp. 	<ul style="list-style-type: none"> ▪ Demeter Fescue ▪ Strawberry Clover ▪ Phalaris ▪ Sub clovers ▪ Cocksfoot ▪ Perennial Ryegrass ▪ Annual grass spp.

** not all locations show all types of species*

APPENDIX B – Suggested Pasture Blends

SOIL TYPE	Heavier Clay Soils	<ul style="list-style-type: none"> ▪ Advance (or similar Continental type) Fescue ▪ Phalaris (eg. Siroso, Uneta, Grazier) ▪ Cocksfoot (Porto) ▪ Sub-clover (cultivar to depend on pH) ▪ Medics (if pH is ≥ 6) ▪ Strawberry Clover
	Loamier Soils	<ul style="list-style-type: none"> ▪ Advance (or similar Continental type) Fescue ▪ Phalaris (eg. Siroso, Uneta, Grazier) ▪ Perennial Ryegrass (Victorian Perennial / Kangaroo Valley cv.) ▪ Sub-clover (cultivar to depend on pH) ▪ Medic (if pH is ≥ 6) ▪ Strawberry Clover

APPENDIX C - Pasture Species Notes

Sources: www.agric.nsw.gov.au/reader/pasture-crops-recovery/dpi269.htm; Seed Distributors Seed Sowing Guide 2004; www3.meu.unimelb.edu.au/grasslands; www.pi.csiro.au/ahpc

LUCERNE	
Description	An important perennial legume, renowned for its drought tolerance and high quality out of season feed production.
Rainfall	250mm
Soils	Requires well-drained, fertile soils, and is best adapted to neutral or alkaline soil conditions. Deep, well drained pH(Ca) > 5.2 (topsoil and subsoil). Soil aluminium less than 5%.
Tolerance	Established plants moderately tolerant to salinity however seedlings very sensitive to salinity.
Growth season	Summer
Nutritive Value	Very high.
Benefits	Responds to summer rain. High potential nitrogen input to soil. Uses soil moisture to depth.
Disadvantages	Increased management needed to reduce livestock health disorders. Seedlings very sensitive to salinity. Inferior to grasses for erosion control. Good grazing management and pest and disease control are critical if stands are to survive for much more than 5 years. Lucerne is not tolerant of continuous grazing, which leads to a rapid decline in plant density. Stem growing points are generally removed during grazing, and the plant must produce new stems for growth to resume. Spelling is required to allow root and crown reserves to build up so they can sustain early growth of replacement stems. Bloat can be a problem when animals are grazing a diet high in Lucerne. Must be rotationally grazed with a grazing duration of not more than 2 - 3 weeks, and a rest period of at least 5 weeks during active growth and 6 weeks when growth is slower.

PHALARIS

Description	Hardy, deep-rooted perennial grass. Valuable on heavier soil types in the medium - high rainfall zones of southern Australia as a persistent, productive species which also provides ground cover all year round. Dormancy mechanisms confer tolerance of dry soil conditions in summer.
Rainfall	> 400mm
Soils	Heavy textured, fertile soils – will grow on a range of sandy soils Sensitive to low pH (<4.2)
Tolerance	Generally tolerant of Water logging Moderately tolerant of salinity
Growth season	Winter active; low summer dormancy Semi-winter dormant types: mainly autumn and spring, moderate winter growth. Winter-active types: autumn/winter/spring.
Nutritive Value	Moderate-high forage quality, provided it is well-managed and fertilised.
Benefits	Water logging tolerance Moderate salinity tolerance Persistence is generally high with rotational grazing Can be highly persistent if well-managed. Survives over summer through dormant buds at the base of reproductive tillers, which are stimulated to grow out into new tillers by moisture and/or cooler temperatures, thus initiating an autumn break. Generally tolerates high grazing pressure, but should be rotationally-grazed for best results, especially the more-erect, winter-active types. Moderate-high forage quality, provided it is well-managed and fertilised.
Disadvantages	Phalaris toxicity / poisoning if not managed well

TALL FESCUE – Dovey & Demeter

Description	Closely related to perennial ryegrass. A productive perennial grass, with superior tolerance of low soil moisture, other soil limitations like waterlogging and salinity, and high temperatures compared to perennial ryegrass. Tolerant of grazing.
Rainfall	Min 450mm (winter active); Min 650mm (summer active)
Soils	Best suited medium and heavy soils types, not well suited to sandy or light soils with low organic matter content unless irrigated and well fertilised Will tolerate low soil fertility & wet soils
Tolerance	Drought tolerant Wet soils Tolerant of moderately saline soils, more so than ryegrass and phalaris. Tolerant of heavy soils, and soils that get wet for short periods. However, prolonged waterlogging (a month or more) will lead to plant death.
Growth season	Vigorous spring through to autumn. Less vigour in winter Responsive to rainfall in summer
Nutritive Value	High, if well utilised. Tends to fall off if allowed to grow longer than 15 - 20cm. Also declines sharply approaching flowering, and should be grazed hard at this time to maintain quality.
Benefits	Suited to high traffic areas Tolerates relatively low summer rainfall Grazing management can be less controlled Insect tolerant Able to cope with hard grazing, provided some form of rotational grazing is used.
Disadvantages	Unlikely to perform or persist in areas where spring and summer is consistently dry

COCKSFOOT

Description	Hardy perennial grass. Useful component of perennial pastures especially on light-textured, acid soils in medium-high rainfall areas, due to it's drought tolerance, and greater tolerance of acidity and soil aluminium compared to other perennials such as phalaris. Relies on summer survival of vegetative tillers for persistence of populations.
Rainfall	>450mm
Soils	Well drained Will tolerate low soil fertility
Tolerance	Low pH Low soil fertility Low - moderate tolerance of waterlogged soils, does not thrive on poorly drained soils as well as phalaris. Moderately tolerant of saline soil conditions.
Growth season	Spring, Summer and autumn
Nutritive Value	Moderate only, and is not preferred by animals if allowed to become long and rank.
Benefits	Easy to establish and combines well with suitable legumes Non toxic Can be extremely persistent
Disadvantages	Not suited to saline areas Not suited to poor draining areas Can form dense, cocksfoot-dominant pastures if not carefully managed

PERENNIAL RYEGRASS

Description	Excellent winter production. A productive, high quality perennial grass suited to a broad range of environmental conditions and managements.
Rainfall	>450mm
Soils	Performs best under fertile conditions (Olsen P 15+). Responsive to nitrogen fertiliser. Tetraploids require good levels of all major nutrients to perform to their potential.
Tolerance	Moderate-slight tolerance of acidity (pH5.5-7.0) Moderately tolerant to water logging
Growth season	Growing season of at least 6 months. Good cool season growth, strong spring production and period of relative inactivity in summer as tiller populations re-establish.
Nutritive Value	High
Benefits	Excellent winter production High feed quality throughout growth period Balanced forage (compared with Lucerne) Well-adapted to grazing, especially the smaller stature, more-prostrate diploid types. Can handle high stocking rates and continuous grazing provided soil moisture and fertility are not seriously limiting. Responds to increased grazing pressure by reducing leaf and tiller size, creating a short, dense pasture structure. Releasing grazing pressure leads to larger, but fewer tillers and a more-open pasture structure. Can be very long-lived (30+ years) depending on management and environmental factors.
Disadvantages	For best results requires good pasture management practices. Not suited to saline areas Ryegrass staggers and heat stress problems may arise due to high endophyte (an internal fungus) levels in some cultivars.

STRAWBERRY CLOVER

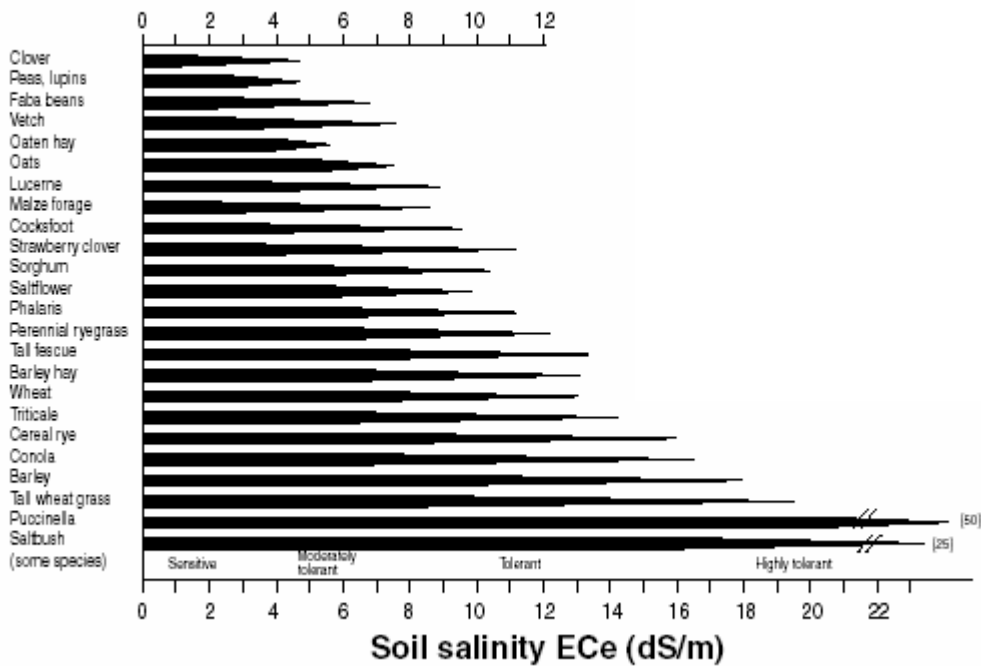
Description	Deep rooted, drought-tolerant perennial, better able to cope with a range of soil limitations like waterlogging, heavy texture and salinity than white clover. Prefers neutral/alkaline soils. Generally used as a minor component in seed mixes.
Rainfall	>525mm but access to sub soil moisture is of greater importance
Soils	Prefers neutral/alkaline soils. Requires moderate fertility (Olsen P 12+) for good growth.
Tolerance	Moderate-slight tolerance of acidity (5.5-7.0) Tolerant of moderate - high soil salinity. Tolerant of waterlogging, and able to withstand long periods of flooding.
Growth season	Spring/summer, poor growth in winter.
Nutritive Value	High
Benefits	There are no recorded ill-effects in animals grazing strawberry clover.
Disadvantages	Can be difficult to establish, but once established is tolerant of most normal management practices.

SUB CLOVER

Description	The 'standard' legume for grazing systems in the medium - high rainfall zones of southern Australia. Sub clover is used almost exclusively in sheep / beef pastures, though large-leaved types such as Leura are often included in seed mixtures for dairy pastures in summer-dry areas. Persistence of populations depends on successful seed set in spring and seedling strike in autumn, which in turn depends on selection of cultivars with the appropriate maturity date for the region, and spring and autumn grazing management. Where these conditions are met, the species is highly persistent.
Rainfall	375-750 mm, depending on maturity date. Early-flowering types are suited to low rainfall / short growing season conditions, and vice-versa.
Soils	Requires moderate fertility (Olsen P 12+), and will respond strongly to phosphorus fertiliser. Adapted to well-drained, moderately acid soils
Tolerance	Moderate-slight acidity tolerance (5.5-7.0). There are specific cultivars for >pH6 Moderately-tolerant of saline soil conditions. Not tolerant of waterlogging
Growth season	Autumn/winter/spring growth. Varies widely between cultivars, depending on maturity date. Growth peaks in the lead up to, and during, flowering.
Nutritive Value	High
Benefits	Hard seed provides a soil seed bank to cover problems with seed production in any one year, and allow the species to persist through the cropping phases of a grazing rotation. High nutrition value Persistent if managed well
Disadvantages	Sheep fertility can be reduced when ewes are grazing pastures based on older cultivars that contain high levels of the phyto-oestrogen formononetin, such as Dwalganup, Yarloop, and Dinninup. This is the 'sub clover infertility' condition, which is now seldom a problem since all new cultivars have been bred for low or zero levels of oestrogen.

PUCCINELLIA	
Description	Ability to tolerate salty conditions. Pioneer plant for the reclamation of badly salt-scalded land.
Rainfall	>400mm
Soils	Copes with low fertility, moderately-responsive to increased fertility.
Tolerance	Moderate-slight tolerance to acidity (5.5-7.0) Highly tolerant of saline soils conditions. Tolerant of waterlogging, and able to withstand winter flooding.
Growth season	Grows in winter, dormant during summer.
Nutritive Value	Low - moderate.
Benefits	There are no recorded ill-effects in animals grazing Puccinellia.
Disadvantages	Slow to establish. Should not be grazed during the first year after sowing, but once established will withstand moderate grazing.

Relative tolerance of crops and pastures to soil salinity



Crops and pastures begin to be affected by soil salinity at narrowing of bar; yield reduced by 50% at end of bar. Salt tolerance is further reduced for seedlings or under waterlogged conditions. (Adapted from T Herrmann, PIRSA, 1995)

APPENDIX D - Jip Jip Weir

The Jip Jip weir was constructed in 1984 with adjustments made in 1992 to reduce the sill level. Reports suggest that this drop in sill level has significantly reduce the back flooding issues of the previous weir however, the management of the weir and the addition and removal of weir boards still has considerable potential to impact on the flow of water.

Reports state that the “the groundwater mound associated with Jip Jip Wetland Complex in 1991 was considerable. It extended 2 km to the east, 500m to the west, and more than 1km to the south of the wetland complex. At its apex, this mound was elevated more than 1m above the regional groundwater level. This extensive mound was caused by ponding water at a level more then 0.5 m above natural surface.”¹³

The following photographs show the significant amounts of water that can be held back by the Jip Jip Weir when all boards are in place.



Jip Jip Weir - all boards in place 1991



Jip Jip Weir – All boards in place with back up of water shown



Jip Jip Weir at current board setting

Photos courtesy of South Eastern Water Conservation & Drainage Board