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Tumut Management Area Fire Salvage

2019–20

Final Report *(for public release)*

Forestry Corporation

Mayday Hill Consulting

Key issues / lessons learnt

Resource planning

- A clear objective is required to guide planning of the salvage program - competing priorities for planning resources include estate damage assessment, salvage operational scheduling and evaluation of medium and long term supply impacts.
- Adopt a standardised approach to damage assessment, and avoid over fragmentation of the resource.
- Incorporate adjustments to log specifications and increased waste into yield forecasts.

Sales / Marketing

- Early and ongoing communication with customers is essential - increased variation in supply (age, density, log size, moisture content) can be managed by processors provided there is ongoing provision of transparent data.
- A reasonable sharing of the risks between growers and processors is required to realise full value of the burnt resource.
- Tolerance for fire damaged material / blue stain is significant, particularly in a buoyant market

Harvesting and haulage

- Early and ongoing engagement with contractors is required, including a transparent management of risks and costs / rebates.
- Steep harvesting capacity must be readily available - older stands are more likely to be located where specialised equipment is required.
- Trucking capacity can be moderated through long and short haul allocations.
- The introduction of significant additional equipment and personnel requires servicing and accommodation issues to be addressed.

Log Storage

- Expectations regarding the salvage window whereby sawlogs can be viably (with some exceptions) retained on the stump post-fire have increased from 9 to at least 18 months. Log storage should therefore be avoided wherever possible due to the costs and risks.
- Purchasing sufficient water to support a wet storage operation in the Murray-Darling Basin can be complex - pre-planning for existing sites should focus on those with existing licences and a secure source of water that can be boosted by on-market purchases.
- Secure water is likely to be very costly and all attempts to capture and recycle applied water on site should be sought. Log storage costs in the Tumut MA are likely to be between \$35 to \$45 per m^3, when undertaken at scale.

Environment - key issues

- An evaluation of drainage crossing intensity and burn severity may assist with assessing environmental risks and assigning priorities.
- Competing priorities may be managed by assigning dedicated planning and resources to managing environmental risks as distinct from facilitating harvesting activities.
- Prioritise use of aerial seeding for reinstating and promoting ground cover on fallow areas, especially on areas of steep slope that have been harvested post fires.

Executive summary

This report includes information that was compiled from numerous sources during the planning and implementation phase of the fire salvage program for the Tumut Management Area of Forestry Corporation of NSW (FCNSW). It provides some background to the approach taken to salvaging the resource, and reports on the outcomes and some of the key lessons learnt.

The salvage period coincided with the onset of the COVID pandemic. Whilst dealing with this, and the immense commercial and social consequences of the fires, FCNSW and the associated processing industry and contractor workforce had salvaged over 2.7 million tonnes by June 2021, 18 months after the fires. This made a significant contribution to sustaining the local industry and providing an opportunity to develop plans for a reduced local supply following the salvage program.

The map below provides some context to the FCNSW Tumut Management Area, plantations and extent of the 2019/2020 fires.

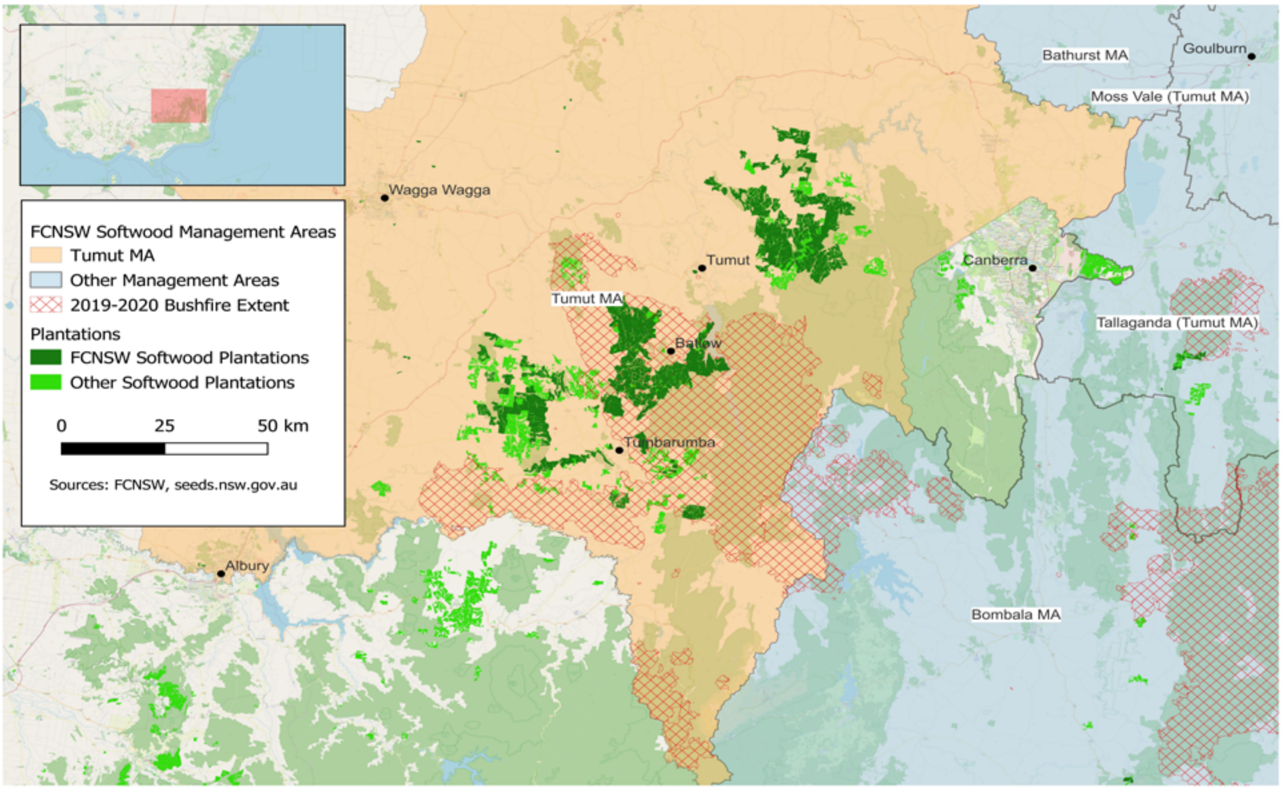

Figure ES1 - Tumut Management Area – Fire extent, plantation location.

Resource / supply planning

The burnt resource overview - previous local experience provided a basis for a rapid assessment of the burnt resource. Initial images were generated from Sentinel, although ongoing smoke issues limited the availability in the immediate days after the fire. The primary use of the assessment was to determine the area, age and potential volume within each burn class. This then supported the development of strategies for the salvage program and formed the basis of modelling the long term woodflows for the estate.

Short- and medium-term supply planning - Initial efforts were directed at identifying priority areas for salvage - more structure was placed around scheduling as resources and time allowed. An objective was established at the outset for the salvage program: To conserve the maximum amount of green wood for the future of the industry at minimum cost, and within cashflow constraints. Factors to consider in scheduling salvage harvesting included – The salvage 'window', burn severity, stand value / age, stand quality, ease of access / suitability of harvest equipment, seasonality and transport distance.

Long-term planning - There was considerable early interest both from FCNSW's core customers and more broadly within government and the community, as to the impact on long term wood supply. The initial plan was based on rolling over the existing Tactical Plan assuming the burnt estate was harvested in the first year, which then left the unburnt portion of the estate to meet the sales and other operational constraints for the remainder of the model.

Sales

Early and effective engagement with existing customers and potential supply outlets, and the management of contractual issues was a critical element to the successful salvage program. Given the enormity of the fire impact, and the obvious implications for long term supply within the region, industry was highly collaborative and keen to maximise the opportunities from the salvage program.

- **Domestic sales** - The primary objective was to meet the immediate and interim supply needs for the existing markets. Other domestic sawlog markets were explored but only limited sales eventuated.
- **Wood swaps with other growers** – did assist with increasing sales opportunities and harvesting and haulage capacity but was a complex arrangement that created a number of issues that were not envisaged.
- **Export sales** - options explored included; trucking logs to railheads at Goulburn, Junee (Harefield) and Ettamogah, direct haulage to Twofold Bay, and trucking directly to Melbourne. Ultimately a transfer yard was set up in Holbrook.

Negotiations with customers included rebates to consider additional costs and the impact on the value of finished goods. The customers generally offered very positive views as to the manner in which the salvage program was handled, with some suggestions about issues that could have been managed better. One key area is the predictability of wood quality, with mills ready to adapt to a change in log quality but not wanting any surprises.

The program was conducted during a very buoyant housing market, which had a positive impact on the volume of wood processed and the tolerance of the market to fire affected material.

Harvesting and haulage

Balancing demand for services and capacity is a real challenge with numerous competing factors to be assessed. The very strong demand from the customers during the salvage program placed significant pressure on logistics generally. Some of the success factors included contractor meetings early in the planning phase, transparent rate adjustments, maximising utilisation of the haulage fleet, tailoring log specifications to minimise impacts on customers, and engaging with the regulators early in the program. Potential areas for improvement include the access to steep harvesting equipment, ensuring adequate planning and supervision is available, dedicating a roading team to remedial works, and a strong focus on revised budgets and forecasting.

Log storage

Initial planning for the salvage program identified that log storage was likely to be a part of the solution to conserving log resources for the use by industry. The initial scoping study identified the key operational requirements but did not find any sites readily suitable. Further modelling of resource estimates indicated that it was likely that the domestic sawmills would be able to process all the available high value logs, and ultimately storage was not required.

Information collated through the planning process will be useful to inform future consideration of log storage options.

- Purchasing sufficient water to support a wet storage operation in the Murray-Darling Basin can be complex, with developing a new site without an existing water access licence likely to take up to six months. Pre-planning for existing sites should focus on those with existing licences and a secure source of water that can be boosted by on-market purchases. Secure water is likely to be very costly (assuming that major fire events coincide with extended drought periods) and all attempts to capture and recycle applied water on site should be sought.
- On that basis a log storage trial was established late in 2020 to test the irrigation of logs in a lined dam to maximise water recovery.

Costs for dam construction, installation of a waterproof membrane and irrigation were significant, however in terms of conserving water proved to be highly effective. Although aided by cool and wet seasons, the system applied an average of 67 millimetres of water each day over a 550-day period with a recovery rate of 96 per cent. Despite logs placed near the top of the stack drying out to some extent, the bulk of the 3200 tonnes stored were processed by one mill in August 2022 with comparable results to logs processed freshly from the salvage operation in mid-2020.

Should it be required, a full operational log storage facility (capable of storing in excess of 125,000 m^3) will need to be located near a secure water source, most likely adjacent to regulated river systems such as the Tumut and Murrumbidgee. The Blowering Nursey site is likely to be the optimal site in the Tumut MA. Total costs based on the log storage trial are likely to be between $35 to $45 per cubic metre.

Environment

A risk assessment comprised an assessment of fire burn severity and road network density – the density of crossings of streams multiplied by fire severity to generate a risk score. The Plantations Assessment Unit (Dept. Primary Industries) were engaged early in the salvage program. Some of the key observations and recommendations included;

- Conduct a landscape risk assessment and follow the principles of minimising the length of water flow to decrease erosive power and trapping sediment at its source across the plantation estate
- Where harvesting is occurring or has recently been completed (post fires) and where sediment and drainage issues are likely to exist due to harvesting, consider these areas as the highest priority
- For plantable areas, use of aerial seeding for reinstating and promoting ground cover on fallow areas, especially on areas of steep slope that have been harvested post fires.

Safety

Contractors identified the following risks during the planning phase; Residual fire activity; carbon and dust; ground conditions – loss of ground cover, impact of dust and charcoal on machines, tree conditions – brittleness, broken tops and windthrow, increase concentration of activity – concentrated harvesting, increase in volume and intensity of trucks; bridges, crossings and drainage structures; new operators and drivers.

Contents

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1. Background

Following the Black Summer bushfires of 2019-20, FCNSW were challenged by the scale of the burnt plantations within the Tumut Management Area, compounded by the complexity of supplying a highly integrated processing industry.

Staff worked with industry, harvest and haul contractors to maximise the opportunities arising from the burnt resource whilst mitigating the medium and long-term consequences of the fire to the greatest extent possible. Balancing harvesting and logistics with local, out of region and export sales, accounting for a variable burnt resource and superimposing seasonality constraints proved to be extremely challenging but in hindsight must be considered highly successful. The key issues and management decisions made during this period are documented here to provide a useful resource for future events of a similar nature either locally or elsewhere.

There were three significant fires in the Tumut region that impacted plantations - Dunns Road, Green Valley and East Ournie. The biggest impact was from the Dunns Road fire which started on 28 December 2019. The fire had several significant runs over multiple weeks. Figure 1-1 illustrates the fire extent and the plantations within the Tumut MA.

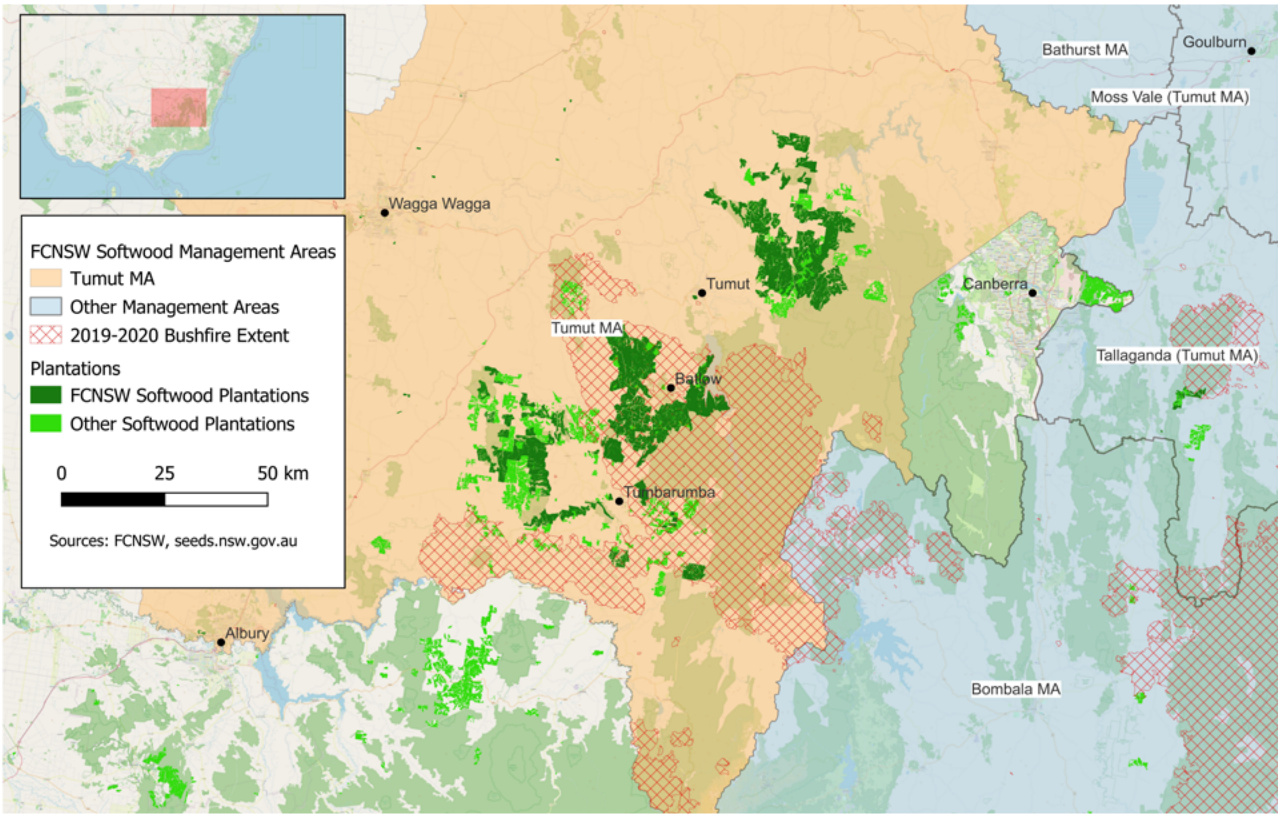

Figure 1-1: Tumut Management Area, fire extent and plantation location

This report aims to capture the key events, considerations and lessons learnt during the primary salvage period from January 2020 to June 2021. It includes information that was compiled from numerous sources during the planning and implementation phase of the fire salvage program for the Tumut Management Area of FCNSW. It provides some background to the approach taken to salvaging the resource, and reports on the outcomes and some of the key lessons learnt.

Acknowledgements

Forest and Wood Products Australia (FWPA) have produced a detailed technical document – 'Technical & Best Practice Recommendations. Guidelines for salvage harvest, storage and processing of plantation-grown logs affected by fire' (Project No: PRB502-1920)[1]. This is referenced throughout this report.

This report has been compiled through discussions with numerous FCNSW staff, and industry representatives. All have made a significant contribution through the provision of data and observations both during and since the fire salvage program was completed.

The log storage trial was completed through the efforts of FCNSW staff, particularly Kerryanne Reiners and Nick Firth with support from field staff and the Department of Primary Industries (DPI) Forest Health team. Phil Clements (PD & AL Clements Consulting P/L) provided invaluable support in the planning stages. AKD processed material from the trial with data supplied by Kim Harris.

1 Guidelines for fire log salvage-Technical Recommendations (FWPA, 2020)

2. Resource / supply planning

The resource planning effort could be classed into three phases. These encompassed:

- Burnt resource overview
- Short and medium term - salvage woodflow – 12 month 'window' assumed
- Long term plan - woodflow for the 'green' estate.

2.1 Overview of burnt resource

The total fire impacted around 35% of the total FCNSW resource in the Tumut Management Area with a spread of ageclasses impacted. This is demonstrated in Figure 2-1 below.

Previous local experience in dealing with the Billo Road Fire (2006) and Jananee Fire (2014) provided a basis for a rapid assessment of the burnt resource. Initial images were generated from Sentinel 2, although ongoing smoke issues limited the availability in the immediate days after the fire. Subsequent images were sourced by FCNSW's Spatial Services team using methodology developed earlier in the fire season for north coast native and plantation forests. This was based on the following descriptors in Table 2-1 below.

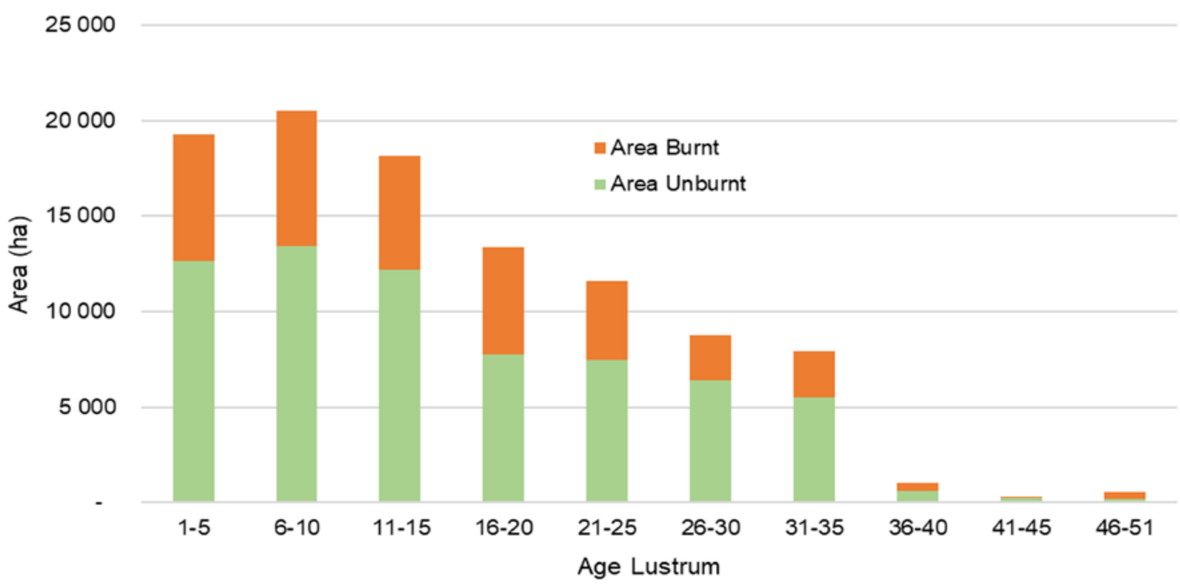

Figure 2-1: Area burnt by age lustrum - Tumut Management Area. Source: FCNSW

Table 2-1: A classification of fire damage in NSW (NBR = normalised burn ratio)[1]

Class	Description	NBR Range
1	No indication of vegetation loss.	NBR < 200
2	Burn, drought or other plant health impacts. Understory present. Crown mostly green with some browning.	200<NBR < 350
3	Crown mostly intact, with green and brown leaves, understorey burnt.	350 <NBR < 500
4	Leaves browned but mostly not crowned, understorey complete burn.	500<NBR < 680
5	Crowned mostly crowned and complete burn.	680<NBR < 1000
6	Active fire.	NBR >1000

1 FWPA (2021) propose a two-way matrix that considers NBR values (crown impacts) and stem impacts (from ground assessment) to provide a deeper understanding of the impacts on tree mortality, merchantable volume and moisture content. In lieu of detailed ground assessment, it would be preferable to use tree age and NBR values to stratify the resource for planning purposes. This is in effect the approach taken by FCNSW in this case.

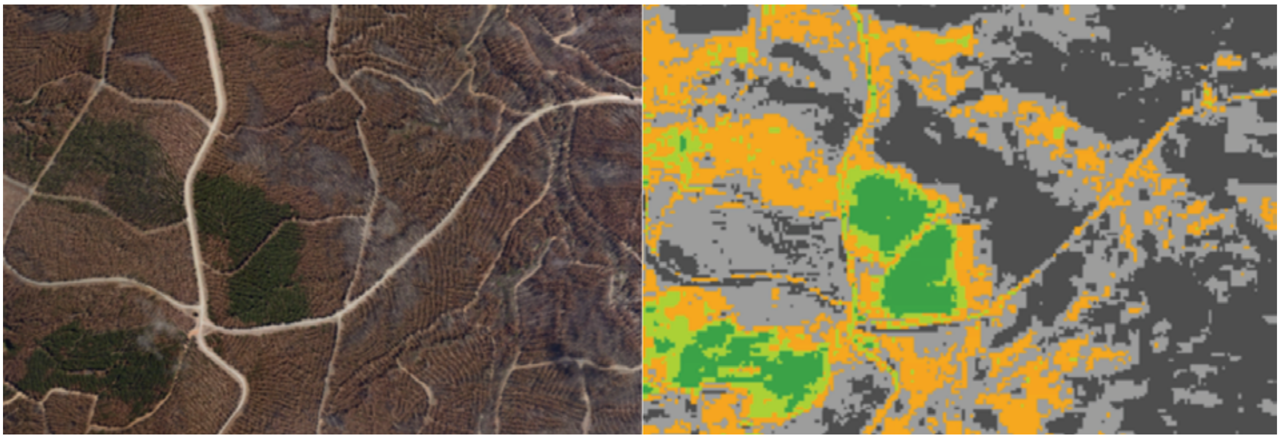

Figure 2-2: Aerial mage and comparable analysis via Sentinel (Source: FCNSW)

Photo 2-1: Green Hills North demonstrating minor areas of green crowns (Photo G. Jeffries 24/1/2020)

Note: The minor green crowns in this image are not apparent in an NBR analysis as the scattering of dead trees and dead lower canopies influence the result.

The primary use of the assessment was to determine the area, age and potential volume within each burn class. This then supported the development of strategies for the salvage program and provided for the basis of modelling the long term woodflows for the estate.

2.2 Short and medium-term supply planning

Initial efforts were directed at identifying priority areas for salvage, that would also assist with building customer yard stocks that had been depleted during and immediately post fire. Stands that had harvest plans and roading in place were obvious target areas. Under normal circumstances, the Operations Schedule would form the basis for allocating and sequence crews to harvest areas that are contained within the tactical plan. Due to staff availability and the urgency to commence salvage harvesting, initial crew placements were largely at the discretion of the harvesting team. More structure was placed around scheduling as resources and time allowed.

2.2.1 Salvage objective and factors to prioritise scheduling

An objective was established at the outset for the salvage program:

To conserve the maximum amount of green wood for the future of the industry at minimum cost, and within cashflow constraints.

This provided guidance for developing salvage plans. Factors considered in assessing and scheduling stands included those described overleaf.

Table 2-2: Factors to consider in scheduling salvage harvesting

Factor	Consideration
Salvage window	Experience from previous fires pointed towards a suitable salvage period of around nine months, with blue stain likely to become a significant issue through the late spring and summer of 2020-21. Determining the salvage window, when there is in excess of 12 months of wood supply available for salvage is a critical element of the sales strategy. *In practice, with changes to industry perceptions regarding burnt material, the 12-month window could potentially be much longer depending upon the quality of the stand, the prevailing weather conditions post-fire, the value of the logs and the strength of the market.*
Burn severity	Green stands were initially avoided if a consolidated area was greater than four hectares. Some evidence had been promoted that severely burnt stands preserved moisture and wood quality more effectively than partially burnt stems and could therefore be retained longer. However sampling and observations concluded this was partially true but not sufficient reason to prioritise brown stands over black. FCNSW formed the view that too much nuancing of burn severity created unwarranted complexity given the benefits and in the context of managing many other constraints.
Stand value / age	As a general rule, older stands in the Tumut MA are more valuable with variances associated with site characteristics, genetics and thinning history also being a factor. Age was the most useful proxy to guide harvesting and sales strategies.
Stand quality	It was observed that stands from poor sites tended to deteriorate faster than high site quality areas. This was most likely due to low density material, severe moisture deficits on poor sites (particularly in the north-western slopes of Green Hills) both at the time of the fire and for some weeks afterwards. High site quality stands retained moisture and maintained sound wood properties regardless of burn severity for a much longer period of time.
Ease of access / suitability of harvest equipment	Areas that had been recently thinned or were adjacent to the main road network facilitated a quick start-up. Flatter terrain enabled quick access, higher productivity and potentially the prioritisation of higher value crops given lower associated harvesting costs.
Seasonality	Retaining stands that offered winter access was critical in maximising the salvage volume. The burnt resource was reasonably well balanced from a seasonality perspective. However the stands available in winter tended to be younger with lower wood quality.
Transport distance	Balancing production, sales and haulage capacity included the ability to move to distant stands as haulage capacity increased.

In consideration of potential markets for stands based on age and burn severity, Figure 2-32-4 illustrates the approach ultimately adopted by FCNSW. It was initially suspected that less severely burnt younger stands may for part of the priority supply for the domestic sawmills. However as the program progressed, it was clear that there was a preference for older, higher quality material regardless of the burn severity. This points to marketing strategies being tailored to known log quality traits, primarily age. Further stratification of the burnt resource is likely to complicate harvesting strategies that are already constrained and dependent on the factors described above.

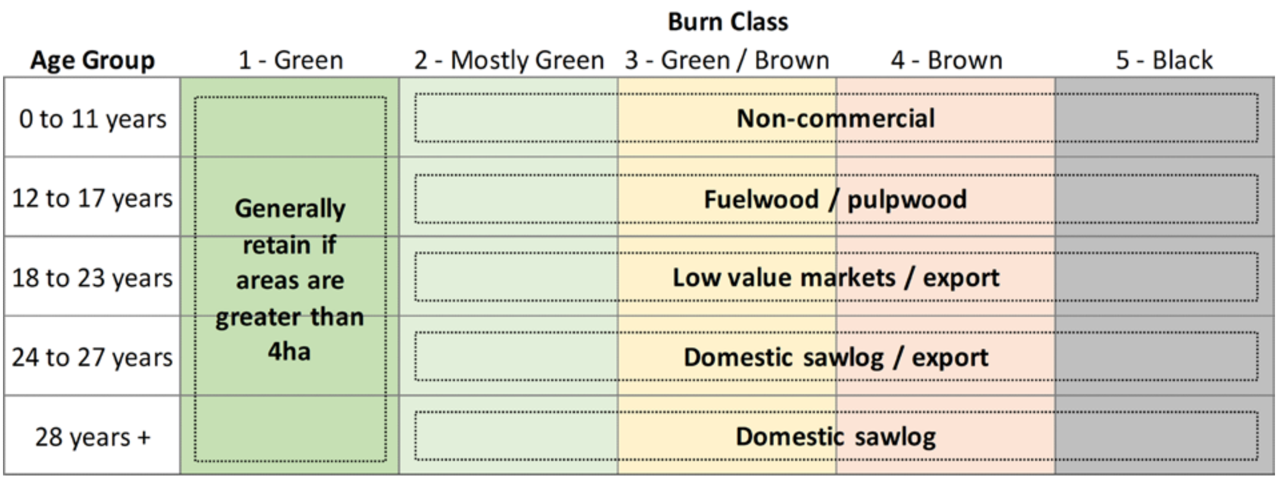

Figure 2-3: Guide to age, burn class and potential markets

2.2.2 Volume estimation

Prior to the fire, FCNSW had routinely applied recovery factors to ensure that yield forecasts accurately accounted for losses and other errors contained in yield tables generated directly from YTGEN. These varied between 0.80 and 1.10 dependent on log size and product type. To further account for losses associated with fire salvage, a further recovery factor was applied as per Table 2-3.

Table 2-3: Recovery factors

Diameter class (cm)	Standard recovery factor	Burnt recovery factor
Sawlog 18-24	0.80	0.90
Sawlog 24-30	0.90	0.90
Sawlog 30-36	0.95	0.95
Sawlog 36-40	0.98	0.98
Sawlog 40-42	0.98	0.98
Sawlog 42-48	0.98	0.98
Sawlog 48-54	0.98	0.98
Sawlog 54-60	0.98	0.98
Pruned	0.98	0.98
Pulp	1.10	0.85

Source FCNSW

2.3 Long-term planning

There was considerable early interest both from FCNSW's core customers and more broadly within government and the community, as to the impact on long-term wood supply. Ensuring planning efforts were directed at both the salvage program and developing an understanding of the long-term impacts was a key challenge. The initial plan was based on treating the burnt area on a pre-blocking basis – i.e. assuming that the burnt area was 'harvested' in period 1 of the tactical plan, which then left the unburnt portion of the estate to meet the sales and other operational constraints for the remainder of the model. This was a quick solution that basically rolled over the existing tactical plan.

Resource planning - key issues

- Establish a clear objective to guide planning of the salvage program
- Manage competing priorities for planning resources include estate damage assessment, salvage operational scheduling and evaluation of medium and long term supply impacts.
- Adopt a standardised approach to damage assessment, and avoid over fragmentation of the resource
- Incorporate adjustments to log specifications and increased waste into yield forecasts

3. Sales

Early and effective engagement with existing customers and potential supply outlets, and management of contractual issues was a critical element to the successful salvage program. Given the enormity of the fire impact, and the obvious implications for long-term supply within the region, the industry was highly collaborative and keen to maximise the opportunities from the salvage program.

3.1 Domestic sales

The primary objective was to meet the immediate and interim supply needs for the existing markets which comprised sawmills, a plymill and a pulpmill. Initial estimates identified the following volume of material available;

Table 3-1: Potential salvage volume

Group	Volume	Equivalent Annual Local Demand
Sawlog >24 years	1 050 000	1.0 years
Sawlog Total > 24cm SED	1 658 000	1.6 years
Pulplog	2 400 000	2.5 years

Source FCNSW

Local sawlog markets –sawmills expressed a desire to prioritise material older than 24 years, which led to a target of all sawlogs greater than 24 years and 24 centimetres allocated to local sawlog customers. Assuming the salvage window would be 12 months, this was a relatively neat match with the available volume in this category.

Other domestic sawlog markets –discussions were held with other domestic sawlog processors outside the management area but limited volume was moved due to a range of factors.

Local pulplog sales –Having experienced the impacts of the Billo Road fire in 2006, the local pulpwood processor was aware of the opportunities and the risks associated with taking burnt wood. Whilst there was considerable nervousness about the salvage program the company was highly motivated to maximise the use of the burnt resource and conserve green wood as much as possible. Additional markets were subsequently identified for use primarily in particleboard, with this operation extending beyond 2 years post-fire.

3.2 Wood swaps with other growers

Following an approach instituted after the 2003 Canberra fires, and the Billo fire in 2006, a grower woodswap was arranged to ensure that utilisation of the burnt resource was maximised. This was implemented in order to;

i. Undertake the salvage harvest

ii. Allow salvage volume to replace green volume to flow to local customers

iii. Preserve green volume for future harvest.

A monthly pre-payment was made to ensure the cashflow impacts were smoothed over time. The concept is demonstrated overleaf.

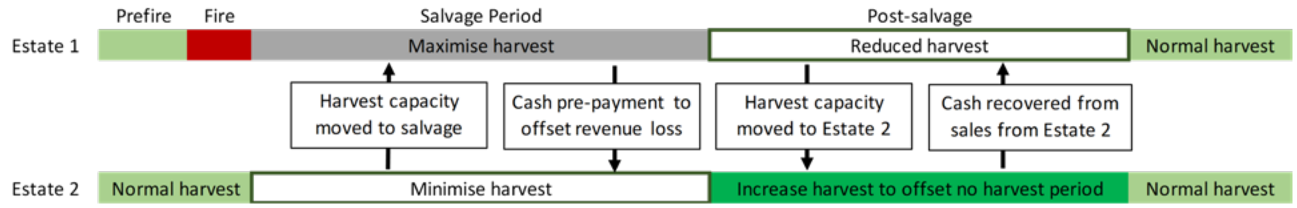

Figure 3-1: Wood swap concept

There were a number of issues arising from the wood swaps that were not envisaged;

- Each agreement with the other forest grower also required an accompanying agreement with the customer accepting the arrangement. This added to the administration of the process.
- What might be a relatively straightforward swap with another grower becomes four or five agreements to cover the customers and another one or two for the associated contract capacity.
- Wood quality from the salvage program was often lower when compared to green supply, therefore the resource is not always harvested and supplied on a 'like for 'like' basis.
- The scale of the fire meant that significant reductions in long-term contracted supply would follow the salvage program. As a result the 'payback' volumes may not be able to be committed at the outset.

In all 75,109 tonnes were swapped under these arrangements over 2020-2021 in the Tumut MA.

3.3 Export sales

Initial enquiries were made with numerous customers - whilst the volume to be considered was not entirely clear, it was felt that up to one million tonnes of pulplog and small sawlog was potentially available for export.

Options explored included:

- trucking logs to railheads at Goulburn, Junee (Harefield) and Ettamogah
- direct haulage to Twofold Bay supplemented by backloading of pulp to local customers
- trucking directly to Melbourne.

Ultimately, a customer established a transfer yard at Bond Street, Holbrook on the site of a former sawmill. This provided for FCNSW to deliver low quality export logs from their own operations with the point of sale at Holbrook, and the customer to set up stumpage operations whereby young low quality stands were allocated south of Tumbarumba. The bulk of the logs were transferred onto A-doubles for transport to Melbourne where they were sorted and containerised.

3.4 Total sales

The following chart depicts how volume was salvaged within the Tumut MA over an 18-month window to June 2021. Of note is the level of sawlog harvested relative to the predicted volume, with basically all sawlog harvested. Less than 60 per cent of the pulpwood had been harvested by the end of the period, primarily due to priority directed to harvesting high value, sawlog rich stands. Domestic pulpwood was maximised through increased sales into a local chip stockpile and to a processor at Oberon, whilst utilisation of pulpwood reduced due to an increase in the specification of pulplogs to reduce charcoal contamination. As a result, average pulpwood yields dropped by 20 per cent due to the increased processing waste.

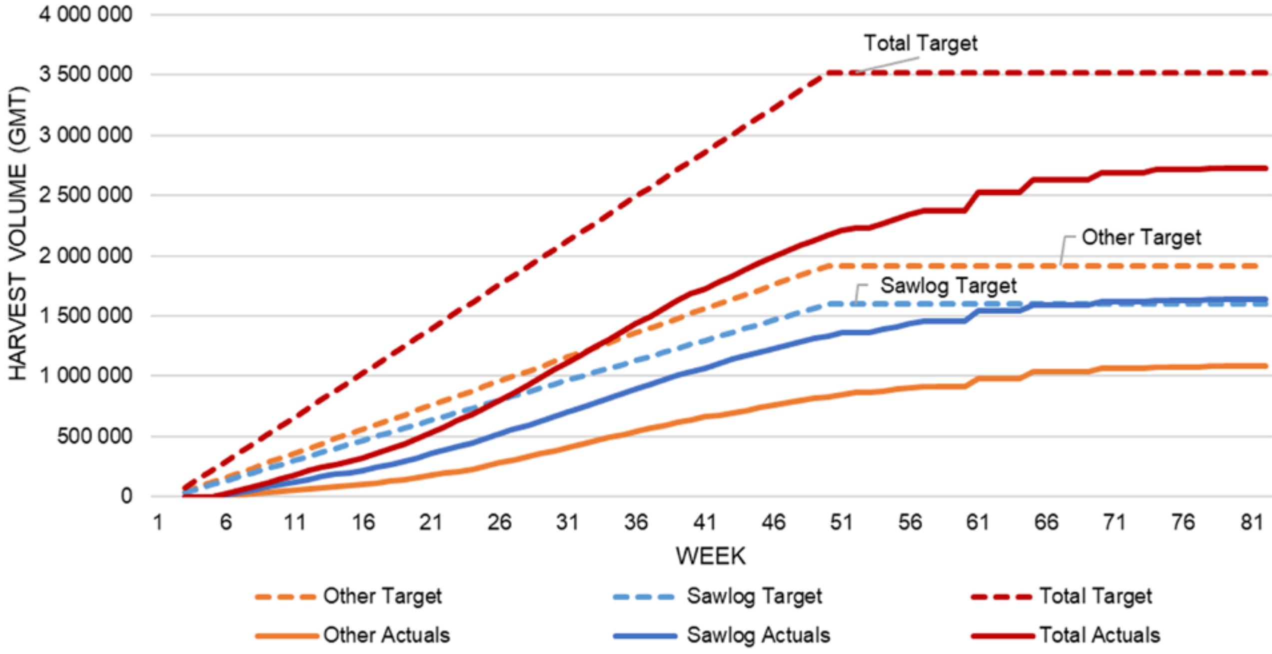

Figure 3-2: Actual salvage production v target January 2020 to June 2021

3.5 Contract / legal customers

Customers were contacted through the course of the actual fire, with force majeure provisions subsequently enacted. All contracts contain clauses regarding the supply of salvage material. It was felt that these provisions adequately addressed this matter from a contractual perspective, however operationally the receival and rebate process may require further development to ensure future events are managed more efficiently.

3.6 Log pricing

Rebates were offered to encourage customers to maximise processing of burnt volume, and in line with current industry expectations. Rebates included:

- Rebate 1 – recognition of additional costs - potentially covered additional treatment costs, mill downtime, worker personal protective equipment (PPE) and allowances, impact on saws, debarking, charcoal, cleaning, and residue downgrade.
- Rebate 2 – recognition of impact on finished goods.
- For stumpage operations an additional rebate was offered to reflect harvesting surcharges.

Customer view of salvage program

3.7.1 Pulpwood

General – The customers consider the program to be very successful, however contingency plans must be further enhanced to understand what is required if a major plantation fire event occurs and how best to respond.

Immediate response – Mills were closed during the fire with a direct threat to infrastructure. A key message is that following any major event all parties need to be conscious of the personal impacts of the fires in operational discussions, and the fact that a level of trauma is possible at both a professional and personal level.

Engagement – information provided to industry by FCNSW was good. Approximately two months post fire FCNSW provided an idea of the scale of the impact, and an idea of what the future might look like. Weekly meetings worked well to ensure that communication was strong. Messaging to the community from industry was mixed – there was probably enough information about, but it wasn't always interpreted well.

Costs and risks – Log rebates were initially based on previous experience. Having a consistent approach to harvesting allowances, and to growers was really important in terms of equity. Sawmill chip quality was a primary focus.

Log quality – customers initially targeted a mix of 70% to 75% burnt chip, ultimately achieving up to 90% to 95%. High grading logs was needed in order to avoid carbon traps. Flush trimming was really important, and the SED[1] was lifted to 10 centimetres, then to 15 centimetres after 13 months. Moisture content was important – wood needed to be quarantined if a problem source was identified.

Processing burnt logs had a big impact on debarker productivity with typical production cut by over 50% in some cases.

Sequencing – initial age of salvage stands for clearfall pulp-only ranged from 12 to 19 years. Generally harvesting started in younger stands and then moved to 20-year-old stands which had a positive impact on maintaining productivity very late in the salvage phase (March-April 2021). Lifting the SED as time went on helped with managing the challenges with difficult stands.

Health and safety – as wood dried out, truck load heights increased, despite operators being compensated for light wood.

3.7.2 Sawlog customers

General – Good communication is essential with mills engaging a liaison between the bush crews and the mill. It was important to manage changes to log mix – at one point there was a significant drop off in log grade as a result of moving out of older stands.

Containing ash and dust issues and increasing the amount of data collected in the mill particularly around the quality of fibre were critical. The Resi[2] tool helped identify issues with younger plantations and the issue of wood quality at specific sites. FCNSW provided good flexibility through the program which allowed the mills to remedy issues as they arose, for example reducing the amount of short logs particularly when there was breakage high up in the tree, and improving the turnaround time from roadside to the mill.

Initial response - the mills responded quickly having learnt lessons from 2007. For example managing water run-off in the mill was important, and not wasting time on looking at log storage or alternative uses.

Costs and risks – all costs were identified, with an effective tracking system - initial estimates turned out to be accurate. Costs were relatively constant through the program – the initial investment in debarking and watering systems were spread across program. Recycling water used in the debarker for dust suppression helped to mitigate raw water costs.

The supply contract clauses in relation to salvage are open to some interpretation - there needs to be a strong partnership to make a salvage program work and both parties need to work collaboratively without any presumptions about what will occur.

Specifications – the focus on longer lengths was important, as well is managing age. The SED fluctuated depending upon age and size of wood. Gamma scan systems helped identify moisture issues. The blending of green, brown and black wood diluted the impact of the burnt material (with an ability to segregate boards within the green mill, mixing burnt and green wood was not a major issue).

Debarker pressure was increased and the feed rate slowed down which would have been an issue from a productivity standpoint if they were processing lots of small logs, but this was offset due to higher average log size.

The increase in SED intended to maximise the sawlog, but this also reduced undersize logs and all but eliminated 3.7s. Average log size was higher than would otherwise have been the case. Blue stain became a non-issue because there was so much of it. There was an increase in treatment costs but this wasn't obvious to customers.

Sequencing –The blending of green wood from unburnt patches helped the mills manage other issues. Moisture content issues were significant but not attributable to any particular area as the mills were getting burnt wood from many suppliers. Chip specifications were generally met through a concerted effort.

Health and safety – No particular issues. Dust was managed in the mills, employees were paid for a dust/dirt allowance, and they had no injuries. Mental health was acknowledged as an issue, but generally appeared to be good.

1 Small-end diamter
2 https://arborage.com.au/resi-forest-industry-assessment-tool/

Grade recovery and markets – structural grade recovery was equivalent to or higher than normal – this was achieved with a lot of work, managing kiln schedules etc. There were initial industry rumours about the quality of burnt timber which required some management, however there were more concerns about not being supplied in what was a buoyant market. With the impact of COVID, imports largely ceased - there were many moving parts to the market during this time, but it was generally very strong. In a tough market it may have been more difficult to manage downgraded material. Blue stain was not a significant issue - some proactive work with sales included the development of a promotional video that considered what the salvage material might be like.

The general view from the sawmills was that this program tended to be more collaborative than previous events, probably due to experience and that the industry recognised that they needed to work together to make the most the resource post-fire.

Sales - key issues

- Early and ongoing communication with customers is essential - increased variation in supply (age, density, log size, moisture content) can be managed by processors provided there is ongoing provision of transparent data
- A reasonable sharing of the risks between growers and processors is required to realise full value of the burnt resource
- Tolerance for fire damaged material / blue stain is significant, particularly in a buoyant market

4. Harvesting and haulage

4.1 Harvesting capacity

Matching harvest and haul capacity to sales for a salvage program can be fraught. Some of the elements to be considered were:

- Some local harvest equipment was burnt in the fire and so local capacity was immediately reduced
- Access to new and existing equipment can be a function of what is happening in both the softwood and hardwood plantation industry at a national level
- Harvesting productivity in salvage is subject to a series of impacts that are both positive and negative influences including:
  - » All operations are clearfall, therefore productivity particularly from forwarders can increase
  - » Piece size may be more, or less than routine operations depending upon the usual placement of equipment relative to the salvage operation
  - » Charcoal and dust can require a higher level of maintenance / downtime
  - » Operators may have to locate some distance from their usual working circle requiring additional travel, or alternatively, operators may be accommodated close to the forest therefore increasing the operating time in the day
  - » Logs may require additional servicing, increasing waste and decreasing productivity
- Other growers – borrowed harvest capacity and markets (refer to Section 3.2)
- Additional capacity through increased local production
- Other regions – access to their harvest capacity and markets.

4.2 Harvesting operational considerations

The harvesting program was undertaken largely within the main period of the coronavirus pandemic. Whilst bush operations were relatively unimpacted, it did present some coordination challenges within the functional groups of FCNSW through 2020. Despite this, the harvesting of 2.7 million tonnes was an achievement of considerable merit.

Keys to success included:

- An initial all-contractor meeting to ensure an open and transparent process was established from the outset, including the agreement of a fixed surcharge to apply to all salvage operations
- An agreed adjustment to compensate contractors for excessive moisture loss – this was based on average weight to volume conversions across all operations tracked via sawmill scanners, and an adjustment for underweight pulp trucks
- A focus on log specifications and how they could be adjusted to maximise the total length and returns from salvage
- The age for sawlog operations was focused on areas over 24 years. This effectively provided the local mills with the better quality stands over a 14-month window.
- The DPI Plantations Regulations Unit were engaged early in the process and were reasonably comfortable with the conditions in place and the management of risks more broadly.

Potential areas for improvement included:

- An increase in steep harvest capacity. This was slow to arrive, initial crews ran into viability and operational problems, and a reasonable area of higher quality logs were unable to be harvested in a suitable timeframe
- Although efforts were made to bring in additional supervisory capacity, these resources were highly stretched at times, particularly for roading works, and further rationalisation of roles across the business may have been warranted to free up extra capacity for the salvage operation
- A specialist remedial roadworks team may have been better focused to ensure this work was carried out more effectively in a timely manner
- Patches of green (unburnt) plantation were skirted around initially, which made it more difficult operationally. In future, patches of unburnt plantation less than five hectares in size may be better off being harvested as part of a salvage operation
- The ability to create or amend harvest plans could be made more efficient - considerable time and effort was required to enable the legal authorisation of harvest operations
- The uncertainty of the future of the industry post-salvage resulted in a reasonable level of anxiety with staff and operators. This was extremely difficult to manage during the COVID period where face to face interaction was not able to be undertaken.

4.3 Haulage operations

High utilisation of the fleet was important in order to offset other potential costs. This required a balancing act between sales and capacity - additional capacity could not be procured without certainty around sales, and it was difficult to lock in sales without being sure of haulage capacity.

Additional capacity included redirecting existing contracted trucks from long to short distance work. Trucks were also inherited via wood swaps. Additional out-of-region trucks were mostly from the Green Triangle. There was a major issue with some haulage contractors not having the ability to have trucks serviced locally, which was generally due to the purchase and service agreements from their home base. Truck parking and accommodation were also an issue locally.

Harvesting and haulage - key issues

- Early and ongoing engagement with contractors required, including a transparent management of risks and costs / rebates
- Steep harvesting capacity must be readily available - older stands are more likely to be located where specialised equipment is required
- Trucking capacity can be moderated through long and short haul allocations
- The introduction of significant additional trucks requires servicing and accommodation issues to be addressed

5. Log storage – operational considerations

5.1 Background

Planning for the salvage program identified that log storage was likely to be a part of the solution to conserving log resources for the use by industry.

An options evaluation project was commissioned. This encompassed a literature review of previous storage facilities and discussions with industry staff with direct operational experience. This review found that:

- In South Australia after the 1983 fires, there was 535,000m^3 stored in Lake Bonney and 400,000m^3 stored under sprinklers (for up to 29 months). Lake storage was difficult operationally, and likely to result in environmental issues. Sprinklers were preferred to ensure good moisture control and efficient log recovery. Ground water was readily accessible and cheap. Logs were generally very large piece size and total storage costs were probably less than $7 per m^3 (in today's dollars).
- After the Beerburrum fires in Queensland in 1994, around 500,000m^3 of sawlogs were stored under sprinklers. A significant investment was required (costs were understood to be in excess of $30 per m^3 stored) to build the infrastructure and maintain a robust watering regime. Cost savings were sought midway through the storage period that curtailed the amount of water applied. This may have contributed to severe fungal and insect attack, rendering much of the stored timber unacceptable for local processing.

Key findings from the initial evaluation:

- Storage of logs underwater is a last resort (if necessary ensure logs fully occupy dam)
- Applied water under sprinklers needs to be in excess of 100mm per day to ensure full saturation
- Recycling water through the system would be preferred to minimise water costs and contain run-off
- Monitoring of wood quality through the storage period is essential
- The higher logs can be stacked, the lower the watering costs – three-metre-high stacks require the same amount of applied water as six-metre stacks.

To this end key parameters were used to evaluate sites and operational constraints as set out in Table 5-1.

Table 5-1: Requirements for log storage site in the Tumut MA

Parameter	Requirement
Effective watering (via sprinklers)	100mm per day
Total water per ha assuming 70% recovery and recirculation	0.70 ML per ha
Target Volume	250,000 m^3 to 500,000 m^3
Target Area	10ha to 20ha
Target Watering requirement	10ML to 20ML per day
Target raw water requirement	3 to 6 ML per day (assuming 70% recovery)
Target log stack height	6 metres
Max operating slope	3%
Log volume per ha	20,000 m^3 to 30,000 m^3
Truck access	Main access road to deliver logs along length of storage area
Unloading	Either conventional wheeled loader or forwarders

Source FCNSW

5.2 Site selection

5.2.1 Review of potential sites

Potential sites and storage options, including submersion, were evaluated in January 2020. Access to a suitable and reliable water supply was the primary factor for identifying suitable sites, as well as road access and terrain. No existing yards were identified of suitable capacity, nor with existing access to water. Submersion was excluded as an option on the basis of likely contamination of water supply and the inability to easily recover logs from any potential water bodies of sufficient size.

The following tables summarise the site evaluation undertaken. This process took in excess of 10 weeks and a number of options were ultimately determined to be unfeasible.

Table 5-2: Log storage sites evaluated and general comments

Site	Area	Comments
Pulpmill in Tumut	Irrigation area	Delivery of water via existing infrastructure from Tumut River was not viable. Concerns related to compromising water availability for the mill, loss of winter storage dam, and a disruption of agribusiness operations.
Mannus Lake	Adjacent land under management of Corrective Services	Insufficient secure water. Cease to pump rules too restrictive. Downstream water use challenges.
Gilmore Creek	Flats behind mills	Pending land availability, high cost of water delivery in excess of $700,000.
In-forest	Adelong, Nacki, Yaven, Oberne Cks	Remote, lack of secure water access
Blowering Nursery	Paddock to east of existing production site	Evaluated in detail – best option but required new off-Highway access to avoid nursery operations.
Readymix Rd Tumut	Private land adjacent to Tumut River	Good option but planning consent was required due to flood overlay, which would be a three to six month process.
Tumut Water Treatment Plant	Treatment Dams	Insufficient water supply.
FCNSW quarries	Coffee Pot, 3-Mile Ck Quarry Sites	Power and water issues, insufficient area (< 1ha).
Sawmill Tumut	Land next to Tumut & Gilmore sites	Limited area.
Sawmill Tumut	Yard	Limited area.
Pulpmill (Ettamogah)	Wood yard & Lake Ettamogah	High transport costs.
Sawmill Tumbarumba	Log yard	Possible surplus land availability, water access issues.
Snowy Mountains Lakes	Blowering, Jounama, Talbingo (submersion)	Impractical in terms of impacts on water quality and log recovery.
Blowering	Western foreshore	Transport costs will be high along Yellowin Rd.
Albury Area	Quarry Site (Rockwood)	Power OK. Water limited. High transport costs.
Albury Area	Quarry Site (Koowong)	Water and power. High transport costs.

Source FCNSW

5.3 Log storage yard operation (full scale)

To assist with the design process, a full appreciation of how an efficient log storage operation might function was necessary. A consultant was engaged to provide advice on log handling. Key elements from the report were:

- Slope should be less than 3.5% if material handlers are to be used (to maximise high stacking). Loaders and excavators could operate on steeper terrain at the expense of stack height.
- Experienced operators would be required to manage high stacking of wet and slippery logs
- Turning circles – estimated a 30m turning radius for the heavy trucks
- Increased risk comes about for trucks operating in the yard in wet conditions
- Bookends would be essential to achieving close to the expected storage volumes on the footprint provided.

5.4 Civil works required (full scale)

Further evaluation concluded that:

- No site was likely to be sufficiently flat with a solid base to use material handlers. A trial with a forwarder proved that stacking height from five to six metres was possible.
- The stacks would have to be constructed and irrigation installed progressively, meaning that containing water on site was going to impact the trafficability of the roads and within the storage rows.
- Investing in a hardstand log storage area would potentially cost $1M - $2M.
- The log storage area needed to be designed to contain run-off to both reduce off-site impacts and ensure water could be recovered and recycled.
- Ideally main access roads would be constructed and surfaced to withstand wet weather and sprinkler impacts. Machinery movements could be supported by using a bed of forest slash or corduroy of low value logs.

5.5 Access to water

The volume of water for log storage was identified as a significant constraint from the outset, and in part resulted in storage not being progressed as a key element to the salvage operation. The following key points from the extensive background work undertaken from this project are worth noting:

- Whilst there are provisions under the NSW Water Act for the Minister to grant water access under emergency provisions, this would be unlikely to apply in these circumstances
- Water Access Licences (WALs) are required, along with an attached water entitlement. The Blowering Nursery site offers FCNSW the advantage of an existing WAL. Water access would need to be boosted through market purchases for a full scale operation, however costs during extended dry periods maybe in excess of $1000 per ML.
- If the pump size is increased at Blowering, FCNSW would require an Amended Water Supply Works Approval from the Natural Resources Access Regulator (NRAR).
- Secure water is unlikely to be available from any other source. Options were explored within Green Hills and Bago, and at Mannus Lake. Most unregulated water sources run the risk of 'cease-to-pump' provisions being applied during dry periods. If logs were unable to be watered for more than a few days, it is likely severe degradation would rapidly occur in warm weather.

An example of the risks in establishing a log storage area adjacent to Mannus Lake is demonstrated below. The red columns indicate the number of days in each calendar year that cease-to-pump orders would apply for the Mannus Creek, based on the water flow at the Glenroy Rd gauge. It shows that from 1983 to 2005, pumping was permissible **all year**, including the drought conditions of 2002-03. An extended cease to pump period applied in 2006, as well as shorter periods in 2010 – 2012. However, during 2018, 2019 and 2020, pumping would not have been permitted for at least three months in each year.

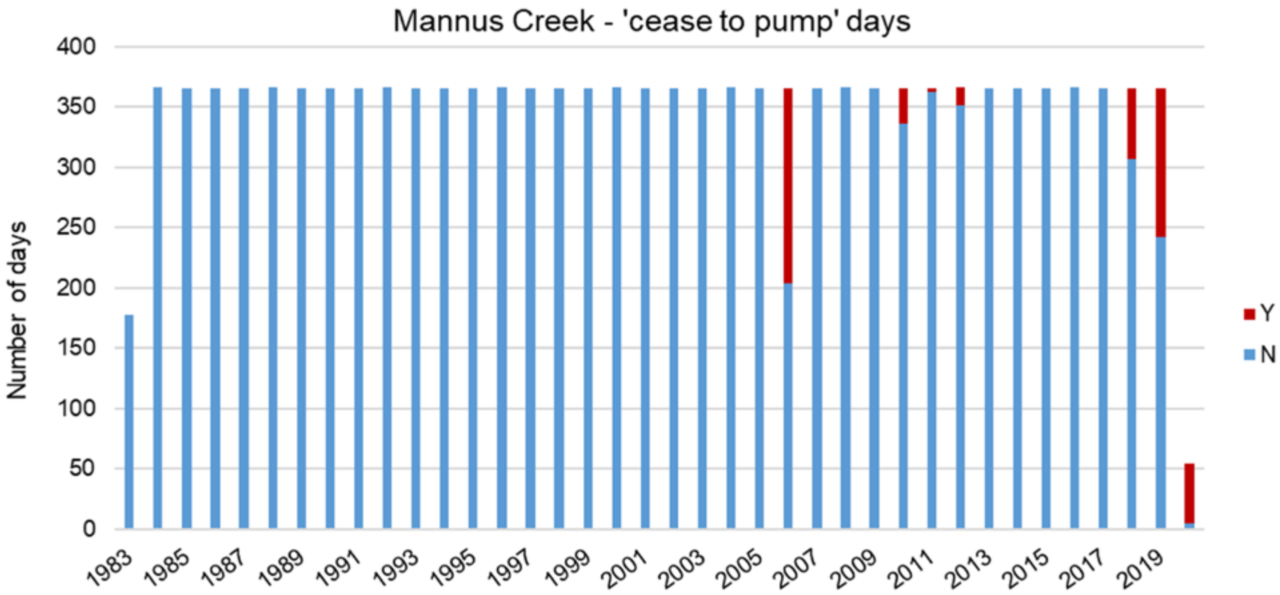

Figure 5-1: Analysis of days where a cease-to-pump order existed on Mannus Creek 1983 - 2020. Source BOM – Mannus Ck (401029)

- Where a new water access license is required, an extensive process is required to be undertaken with Water NSW and the Natural Resource Regulator (NRAR). NRAR are responsible for providing a WAL for government entities such as FCNSW. An application must be made accompanied by a report from a suitable qualified hydrologist, to verify the potential impacts of the WAL.
- This process took in excess of five months for the Zero Share WAL to be approved for the trial at Ardrossan. Following NRAR approval, the Works Approval Number was required in order to register the WAL with the NSW Titles Office. No on-market water purchases could be completed until this had been completed.
- A water broker was engaged to assist with purchasing a water allocation.

Key finding

Purchasing sufficient water to support a sprinkler operation in the Murray-Darling Basin can be complex, with developing a new site without an existing Water Access Licence likely to take around six months. Pre-planning for existing sites should focus on those with existing licences and a secure source of water that can be boosted by on-market purchases.

Secure water is likely to be very costly and all attempts to capture and recycle applied water on site should be sought.

6. Log storage - trial

6.1 Rationale

Whilst a suitable log storage area was being scoped, further modelling of resource estimates and salvage planning indicated that it was likely that the domestic sawmills would be able to process all the quantity of high value logs (see Section 3.1) within a 12-month timeframe. This left the lower value logs that:

- were unlikely to be processed economically by local processors
- due to being lower value would be less likely to withstand additional

handling and storage costs and be profitable.

On that basis, it was decided to not pursue log storage at an operational scale. However it was considered prudent to undertake a trial to ensure that the site evaluation and concepts developed thus far could be tested to enable solutions to be quickly implemented if required in the future. Such an event might arise if a future fire event generated salvage quantities well in excess of local processing capacity and the viability of local processors was strongly dependent upon utilising burnt logs.

6.2 Proposal

The trial presented an opportunity to answer some of the unknowns identified in the scoping process. These primarily related to practicality, costs and efficacy. The results from the trial would assist with making informed decisions regarding log storage for any future fire events across all FCNSW operations.

To develop a sound methodology for storing fire damaged logs it was proposed to implement a trial involving approximately 5,000m3 of burnt logs.

Trial objectives – key unknowns to be tested:

- Assuming highly permeable soils and a flat site, can a dam system with a waterproof liner be constructed to minimise water losses?
- Can logs be placed and stacked in the dam whilst maintaining the integrity of the liner?
- Under this system, what is the water recovery rate likely to be?
- Does the sprinkler design satisfactorily saturate all the logs in the stack?
- How much can the applied water be reduced and still effectively saturate the logs on wet / cool days?
- How much volume can be stored on a per hectare basis?
- Are logs effectively preserved?
- What is the cost of establishing the infrastructure, maintaining adequate water supply and handling the logs over the full trial period?

6.3 Outline of log storage dam

To ensure the trial findings could be applied to a full-scale operation at the Blowering Nursery with flat permeable soils, a 'dam' constructed of earth and waterproofed with a liner was designed. In a full-scale operation, it was envisaged that the cells would be around 0.4ha in size storing up to 10,000m3 each. This volume would roughly equate to a weeks' worth of harvest and ensure stacks could be saturated as early as possible to avoid logs deteriorating.

Outline of dam construction

Earthworks

1. Site surveyed and designed by GeoTrack Engineering and constructed by Brennan's Earthmoving.
2. Construction of a 1.5m bund (wall) around storage cell approx. 0.4ha in size with opening for machines to start stack construction. The trial site required some cut and fill. A Blowering site would be effectively flat.
3. Rock was laid at the dam entrance to ensure stability of the bank.

Log stack construction

4. The bottom of dam lined with log corduroy to ensure firm footing for machine operation and minimise depression of logs onto dam liner
5. Dam liner placed on top of log corduroy – single row width to enable machine to construct row of logs without damaging liner
6. Liner rolled out underneath next row and welded as necessary to seal dam

7. Log stacks built by forwarder or excavator to approx. 4m high on top of liner (stacks at least 6m high would be preferred)
8. Bearers may assist with minimising damage to liner and in recovering logs. Ideally recovery of the liner would be anticipated to enable it to be utilised for other purposes *(however the trial provided that substantial damage to the liner can be expected during decommissioning)*.

Irrigation

9. Installation of pipework and sprinkler system by Randall Irrigation in accordance with a design by Waterwise Consulting
10. Irrigation infrastructure was installed around the perimeter of each cell
11. Raw water introduced into the dam from Germans Greek
12. The dam was be filled to approx. 1.5m to ensure adequate recharge depth was available for pumps to draw on.
13. Irrigating of stored logs with a target application of 100mm per day, with main pump system drawing water from the dam system, which was independently topped up from the creek, as required.

Figure 6-1: Outline of dam construction

6.4 Dam design details

6.4.1 Location and earthworks

The site at Ardrossan was chosen primarily due to being within State forest, adjacent to a FCNSW depot with power, and access to an existing dam on a reasonably sized creek. The water source would not be adequate for a full-scale operation but met the needs for a small trial.

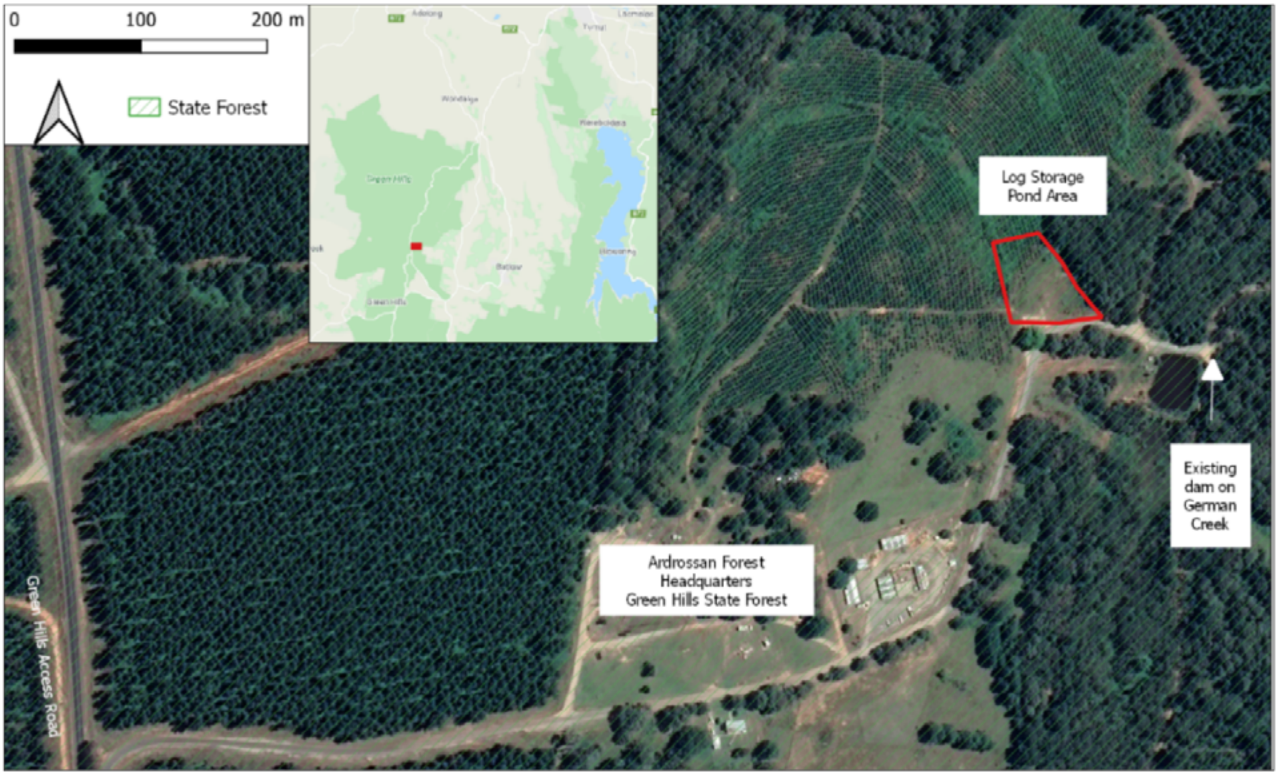

Figure 6-2: Ardrossan log storage dam locality map

Engineers were engaged to design the access and earthworks required to create the bunding for the trial dam area. The prescribed dimensions were 30m x 20m, with suitable access for a loaded forwarder.

6.4.2 Irrigation

A local irrigation service was engaged to consider installation of the watering system and a consultancy service was engaged for the technical design at both full scale and the trial site. Design elements included the access to power (single phase at Ardrossan), the size of the trial area, the requirement to monitor raw water drawn from Germans Creek and the amount of water recycled daily through the system.

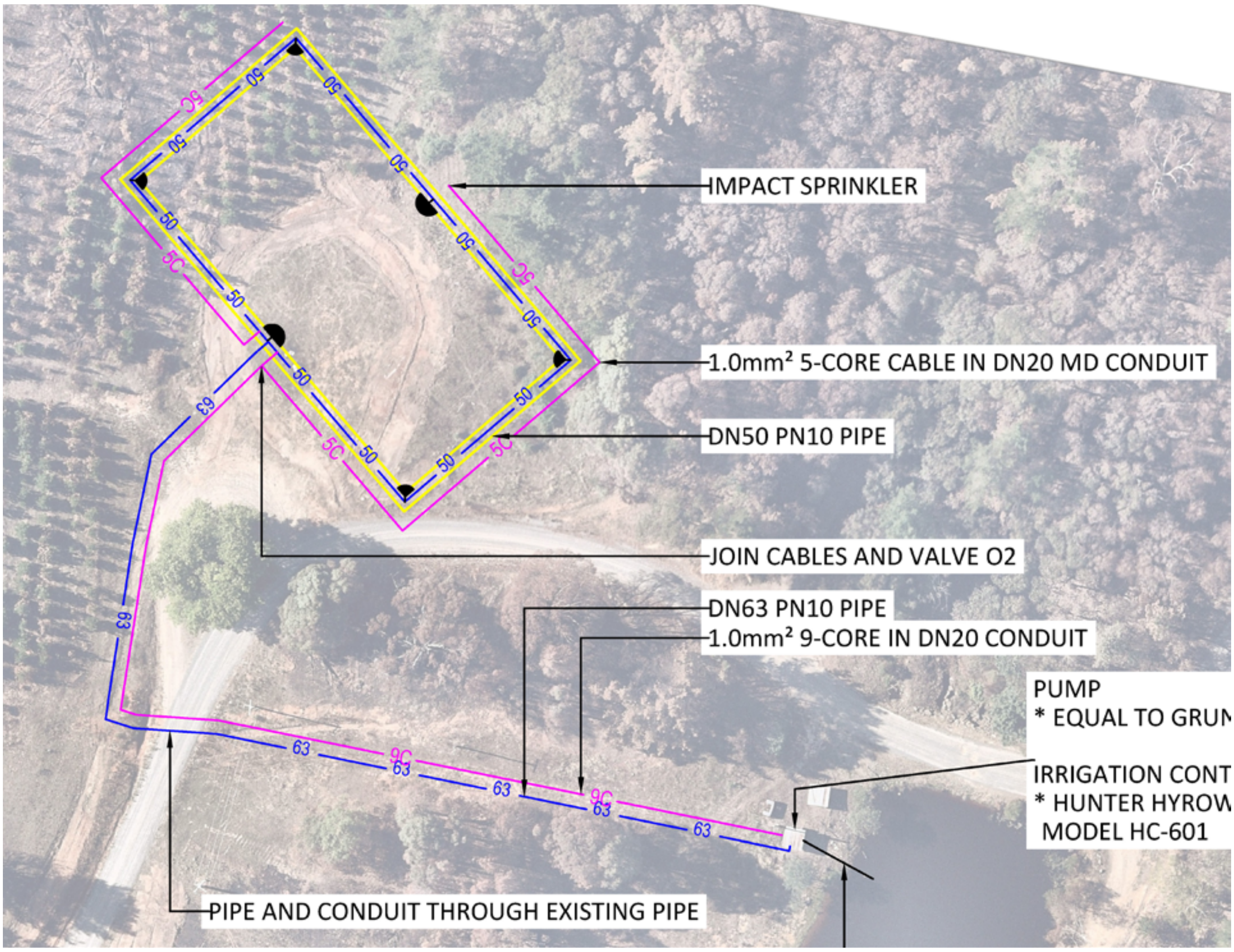

Figure 6-3: Irrigation design. Source: Waterwise Consulting

6.4.3 Provision of waterproof membrane

Dam liners were evaluated by engineers. Cost was a significant consideration with quotes ranging from $2 per m² for basic builders film to $7-00 per m² for HDPE liner. Ultimately HDPE was selected on the basis of durability. The product was Tarpee® M50 Liner, woven 100% polyethylene (PE) fabric with 2 layers of interlocked high-density polyethylene (HDPE) reinforcing mesh built into the liner - 0.59mm thick.

6.4.4 Water access

Refer to Section 6.5 for details regarding the licencing issues for accessing water. Obtaining water approvals was an extensive and protracted process. FCNSW Ardrossan HQ had an existing domestic / stock entitlement, however a new irrigation project required:

- a Water Supply Works Access Approval from NRAR (supported by a hydrologists report)
- a new Zero Share Water Access Licence (WAL). This firstly required a positive Notice of Decision from NRAR. Once approved a WAL number was issued, but only after recording in the Water Access Licence Register and the Land Registry Office registered the WAL on the title.
- A temporary water purchase.

Conditions for the WAL included:

- water could only be taken if the dam was overflowing
- maintenance of a logbook with the recording of date, volume of water, start and end time when water was drawn
- cease-to-pump provisions if the water level in the Adelong Creek at Batlow fell below a threshold level.

The water for the log storage trial was sourced from Germans Creek in Green Hills SF, evident in the photos below.

Photo 6-1: Water source on Germans Creek and overflow of water source

6.5 Operational aspects

6.5.1 Harvesting

Logs were sourced from 38-year-old unthinned stands at Bago. The stand was chosen as there was a reasonable proportion of green logs still available. Given that the trial was delayed until 12 months after the fire, it was desirable to put relatively green logs into storage to truly test the efficacy of the storage system.

6.5.2 Stack construction

There was substantial rainfall preceding construction of the storage log stack. Water had pooled underneath the liner and the corduroy that had been placed onto the dam floor was floating to a degree, making placement of the liner and logs difficult. A team was required to roll the liner out as the stack was constructed, with the liner weighing in excess of 650 kilograms. The liner supplier provided a welder to ensure the two pieces of liner were appropriately sealed. The liner was originally of insufficient width to extend up both sides of the dam, with an additional 10 metres required to be welded to ensure full coverage. Width was lost due to the interaction of the corduroy, the logs and the residual pool of water.

Use of bookends

In order to safely stack logs in a confined space to over four metres, the use of steel bookends was essential. For the trial they were utilised to test how placement of them would impact the liner and other logistics. Whilst driven poles are often utilised in the industry, as a cheaper alternative, it was not practical when a liner would be in use.

Photo 6-2: Bookend placed in dam, first row of stack and corduroy underneath

6.5.3 Irrigation installation and monitoring

The irrigation system had to be installed after stack construction to minimise any damage to the irrigation infrastructure. The dam was filled using the existing electric pump located at the Ardrossan dam on Germans Creek. Due to delays in the liner and irrigation installation, there was a six-week period between the commencement of log harvesting and the activation of the sprinklers. The lack of three phase power to the pump meant that capacity was constrained, such that only one of the six sprinklers operated at any one time. Individual solenoid valves operated each sprinkler. Fine tuning of the sprinkler timing and range was required to minimise water loss and ensure saturation of the full stack. The final pattern determined was 6pm to 5am – 7min / 4mins (centre / corner sprinklers), 5am to 6pm – 14min / 8min.

Photo 6-3: Photos showing the irrigation system and log watering

Walking across the log stack to manually monitor gauges was neither safe nor productive, so to enable monitoring of applied water, an automatic rain gauge was installed. The data logger required manual downloading but provided a useful insight into the amount of applied water (including natural rainfall) during the period it was installed. The results are presented below in -. With the target of 100mm per day specified, there were clearly considerable number of days per month where this was not achieved. This was due to:

- some spray drift
- sprinklers only being able to run sequentially due to power restrictions (single phase pump)
- occasional blockages and water depletion
- occasional failure of power.

These issues became more prevalent towards the latter part of the trial period as equipment aged and water became potentially stagnant with a higher level of contamination. Full time monitoring was not available or practical for the trial. Under a full operational storage system both automatic and on-site monitoring systems would be a fundamental requirement due to the risks associated with sprinkler failure.

The gauge obviously did not differentiate between natural rainfall and applied water. According to the Batlow Post Office weather station, the region received 2135mm of rain during the 550 days of the trial period. On average this was just 3.9mm compared to 67mm measured through the tipping gauge.

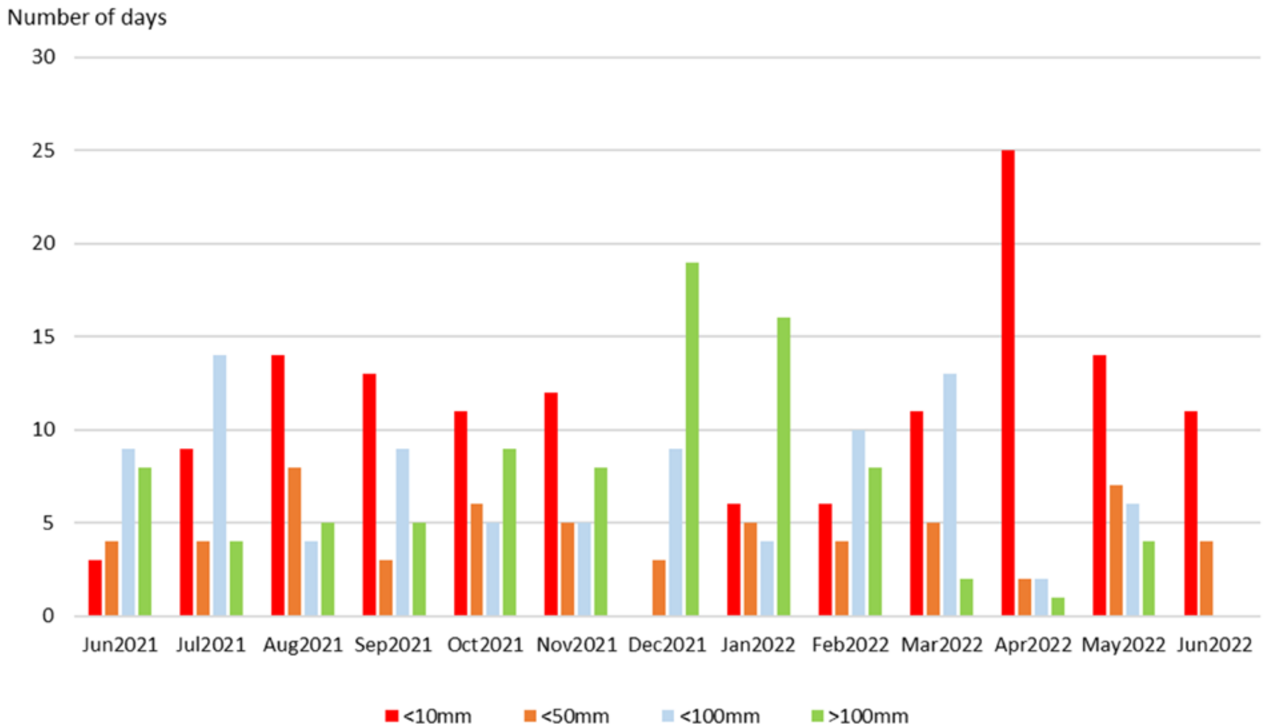

Figure 6-4: Number of days per month (by daily applied water category – mm/day). Source: FCNSW

6.6 Pests and disease management

Two primary forest health parameters were assessed as part of the trial – the presence of Ips bark beetle and the degree to which bluestain was evident in the cross section of the logs. Members of the DPI Forest Health team assessed both parameters at the commencement and periodically through the course of the trial. Surplus logs that had been stockpiled adjacent to the dam and were not watered provided a 'control' sample to compare bluestain levels.

There was no discernible difference between the occurrence of Ips in the watered logs and the control. Although the dataset needs to be treated with caution as the assessment team were not able to sample logs easily from within the watered stockpile, watered logs clearly provided some protection against the ingress of bluestain, from the data available as shown in Figure 6-6.

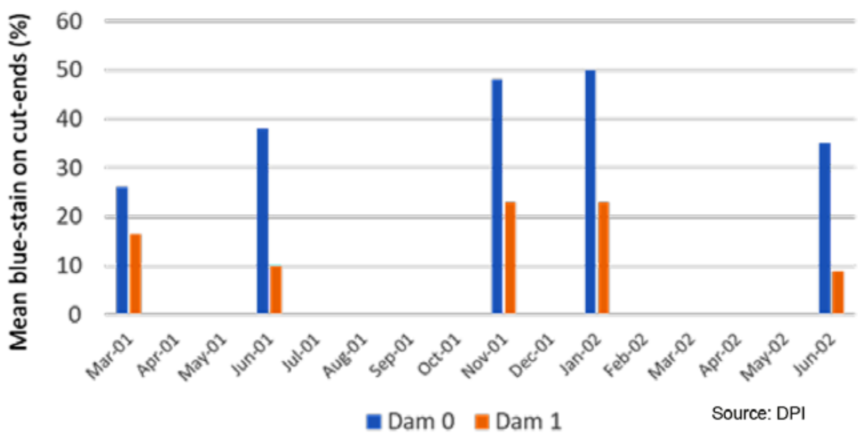

Figure 6-5: Blue stain observed from logs in storage dam (Dam 1) relative to a control sample (Dam 0). Source: DPI

After the logs had been stored for 16 months, the site was inspected, to cut disks and conduct resi sampling. Despite the black outwards appearance of the logs the quality of the internal timber remained largely white and did not have any obvious decay. The logs in the first half metre or so to the surface had started to get blue stain as they were most exposed to the elements and moisture variation. A disk cut from a log one metre down in the middle of the stack had no obvious stain.

The storage dam was decommissioned in late July 2022. Initially all logs near the top of each stack were set aside as they clearly had received less consistent water and contained higher levels of blue stain. The remaining logs were seen to still be very wet, and for the bottom third of each stack were essentially still sitting in water.

Photo 6-4: Logs being removed from the storage dam July 2022

6.7 Log processing

Logs were loaded out from the storage facility to the sawmill in Tumut where they were batch processed. There was reasonable variation in the degree to which the logs had been continually watered, with logs at the top of the stockpile potentially enduring longer periods of drying out. As a consequence, there was reasonable variation in the quality of the logs processed.

Note: Any comparison of log quality data needs to be treated with caution as variation could be ascribed to a range of factors including different sources of logs, with different age, genetics and management history. There was no control available for direct comparison.

Blue stain

Significant blue stain was evident; however it was observed that it was no more severe than logs typically processed from the general salvage operation through 2020 and 2021. Given the logs probably contained high levels of blue stain at the beginning of the trial, the watering process was reasonably effective in mitigating any further deterioration.

Photo 6-5: Photos of trial logs prior to and after breaking down showing level of blue stain July 2022. Source: FCNSW

The trial logs were batch processed and the data captured in relation to green density and MOE[1].

1 One of the key grade-determining properties is the modulus of elasticity (MoE) in bending of sawn boards

Sawmill observations - MoE

The following chart depicts the MoE of sawn boards compared to the routine logs being processed at the same time. Whilst the general observation is a lower MoE was achieved, it was considered very reasonable in terms of structural grade recovery. The data must be treated with caution as other factors are likely to be influencing the results such as genetic stock and site factors.

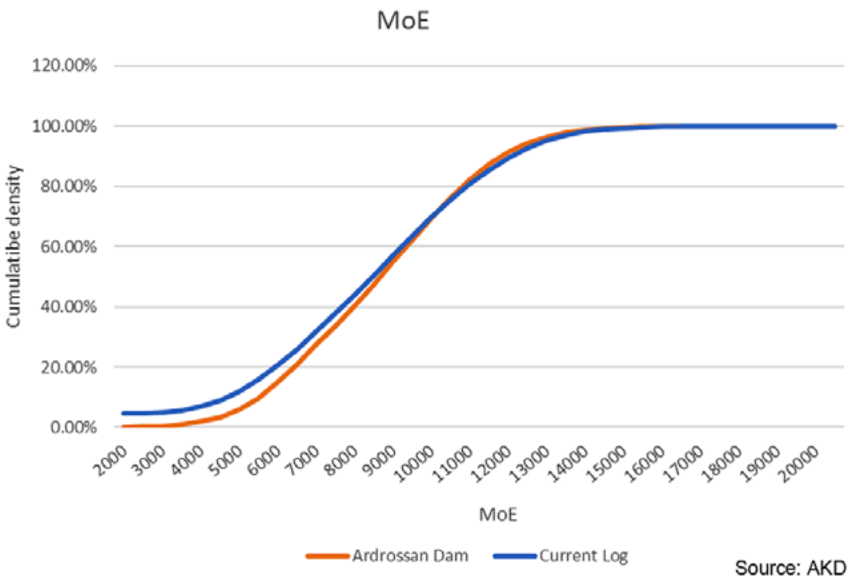

Figure 6-6: Cumulative distribution MoE (GPa) of boards from trial compared to green logs. Source: AKD

The results from the trial were also compared to batches processed in 2020 from 'routine' salvage. This demonstrated that whilst the distribution was clearly lower, it fell within the range considered acceptable for structural grades.

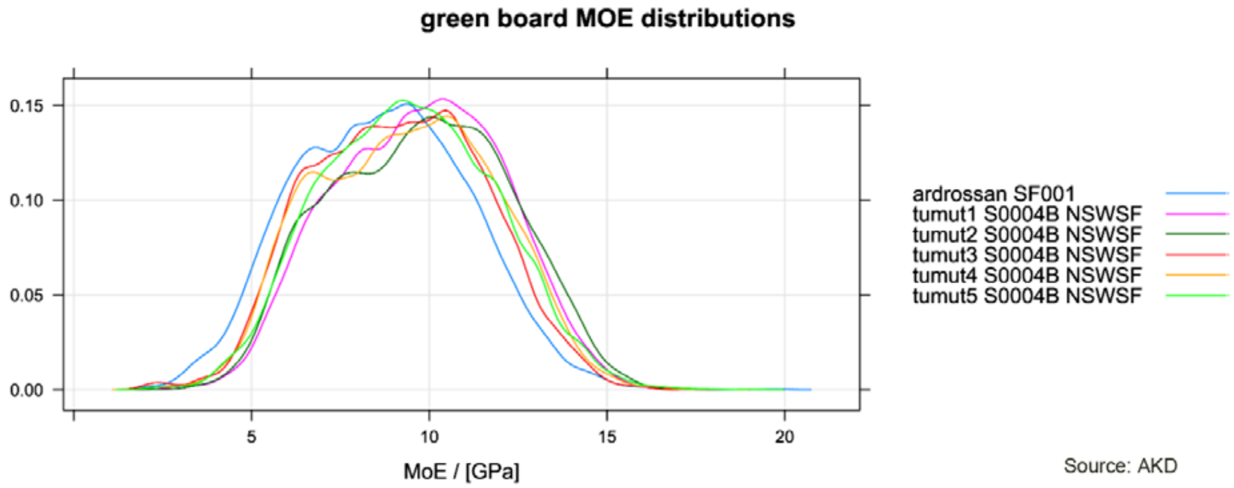

Figure 6-7: MoE distributions of boards from trial compared to 'routine' salvage. Source: AKD

Both density and MOE from the stored logs proved to be very similar to the run-of-bush being processed at the same time.

The mill noted that:

1. The board green density distribution had a sapwood peak that shifted a little to the right. This was unsurprising since the logs have been under water. But otherwise the rest of the distribution was pretty typical of normal production.
2. The Ardrossan trial MOE distribution had a similar spread to the salvage trials, but on the whole a little lower. This could be either due to resource differences, or the effects of storage.

The general conclusion was that there had been no obvious deterioration of logs over the 18 months they were in storage. The main impact was severe bluestain that had in any case been a significant part of the salvage program for the preceding two years. The industry and markets had largely accepted blue stain as part of routine supply, and given the bouyant state of the market and constrained supply blue stain sustained little discounting.

6.8 Financial analysis

The following comparison was completed on the basis of the estimated and actual costs for the trial and assumptions regarding a full-scale operation.

Table 6-2: Log storage dam assumptions - trial and full-scale operation

	Trial (estimate)	Trial (actual)	Full scale (estimate)
Dam dimensions	30x60m	30x60m	250x200m
Area m^2	1 800	1 800	50 000
Area (ha)	0.18	0.18	5.00
Depth (m)	1.5	1.5	1.5
Water Volume (m^3)	2 700	2 700	75 000
Packing Factor	40%	40%	40%
Total Volume (ML)	2.70	2.70	75
Water Volume (ML)	1.62	1.62	45
Log Volume (m^3)	4 500	3 290	125 000
Bookends required	4	4	40
Days in store	525	525	525
Initial Water (ML)	1.62	1.62	45
Daily applied water (mm)	100	67	100
Daily applied water (ML))	0.1800	0.1206	5.0
Water rate recovery	70%	96%	70%
Total supplementary water (ML) over 525 days	28.4	2.60	787.5
Daily supplementary water (ML)	0.054	0.005	1.5

Source: FCNSW

The key differences in the trial in terms of what was estimated and the eventual results were:

- a reduction in log volume primarily due to insufficient width being provided for four full rows (in effect there was an empty row)
- A reduction in actual water applied to an average of 67mm per day
- A recovery rate of 96%, resulting in additional applied water being a fraction of what was expected.
- The resultant financial impacts were significant. Table 6-3 overleaf sets out the trial costs, an estimate of the savings on a unit cost basis by scaling up to a full operation, and the full costs associated with the full operational volume of 125,000m^3.

Table 6-1: Log storage dam costs - trial and full-scale operation

Cost (capital v operational)		Trial Actuals	Trial cost per m³	Scale up savings	Full scale estimate Total $	Full scale estimate $ per m³
Civil works						
Survey and design	C	3 000	0.91	60%	45 593	0.36
Primary Rd (Hwy intersection)	C	NA	NA	NA	500 000	4.00
Wet-weather Loading Bay	C	2 000	0.61	10%	68 389	0.55
Sub-total Roads		5 000	1.52		613 982	4.91
Storage Area						
Storage Area Earthworks						
Catch Drains, bund	C	21 879	6.65	50%	415 634	3.33
Liner	C	34 650	10.53	33%	882 048	7.06
Liner installation	C	10 000	3.04	20%	303 951	2.43
Installation of bookends	C	2 000	0.61	NA	200 000	1.60
Sub-Total Storage Area		68 529	20.83		1 752 242	14.02
Irrigation						
Design	C	3 000	0.91	90%	11 398	0.09
Pumps Pipework / Sprinklers P&E	C	33 000	10.03	20%	1 003 040	8.02
Fuel / Power	O	5 000	1.52	0%	189 970	1.52
Meters	C	1 000	0.30	20%	30 395	0.24
Sub-Total Irrigation		42 000	12.77		1 234 802	9.88
Water						
Hydrology report	O	2 200	0.67	NA	2 200	0.02
Application fee (NRAR)	O	2 560	0.78	NA	2 560	0.02
Water losses		4%			30%	
Water quantity required (ML)		4.2			833	
Water cost ($ per ML)		100			500	
Water Cost (2020/21)	O	879	0.27	NA		
Water Cost (2021/22)	O	599	0.18	NA		
Water Cost (total)	O	-	-	NA	416 250	3.33
Total Water		6 342	1.90		422 343	3.37
Log Costs						
Receival and stack (Forwarders)	O	9 000	2.74	0%	341 945	2.74
Load out	O	9 000	2.74	0%	341 945	2.74
Sub-Total Log Handling						5.47
Summary of Costs						
Management Costs	O	20 000	6.08	30%	531 915	4.26
Development costs (C)	C	106 529	32.38		3 369 263	26.95
Operating costs (O)	O	50 238	15.27		1 857 180	14.59
TOTAL		**156 767**	**47.65**		**5 226 443**	**41.81**
Log Volume		**3 290**			**125 000**	

Source: FCNSW

The costs of completing the log storage trial were similar to those estimated when the project concept was developed. There were some savings in water and log handling costs, whilst earthworks, the liner and the irrigation were all greater than anticipated.

It would be expected that at an operational scale some savings would be achieved. Should the operation be located at Blowering, a major road intersection would need to be fast-tracked to avoid direct interaction with the nursery. The dam liner and the irrigation are the single largest expense items, and presumably could be provided for more efficiently for a large-scale operation. The investment in the liner is essential to ensure total water costs can be held within the assumptions tabled above. With water costs ranging from $100 per ML to over $1000 per ML on the open market. This remains the largest unknown and is entirely dependent upon prevailing seasons at the time of the fire event and the following salvage harvesting and storage period.

6.9 Log storage trial summary

Table 6-4: Answers to unknowns posed prior to the log storage trial

Key unknowns to be tested	Answer
Assuming highly permeable soils and a flat site, can a dam system with a waterproof liner be constructed to minimise water losses?	Yes, at a significant cost but probably more than offset by savings in water required. The 'breakeven' point where the cost of water losses exceeds the cost of a liner would be dependent on prevailing market water process for high security water and the actual recovery rate for a non-lined dam.
Can logs be placed and stacked in the dam whilst maintaining the integrity of the liner?	Still unknown – the liner was shredded during decommissioning. Water retention was high so the liner must have been largely intact for the trial duration, however soils had a relatively high clay content for the trial..
Under this system, what is the water recovery rate likely to be?	96% achieved in the trial. A conservative estimate of 70% could be used on permeable sites and during extended dry periods.
Does the sprinkler design satisfactorily saturate all the logs in the stack?	Yes. The top of the stack did dry out but due to interruption in pumping rather than due to sprinkler design.
How much can the applied water be reduced and still effectively saturate the logs on wet / cool days?	Unknown. The trial averaged 67mm per day including local rainfall (noting that even accounting for an exceptionally wet period, the rainfall was only equivalent to 3.9mm daily of the total precipitation / irrigation measured during the trial period at 67mm per day.
How much volume can be stored on a per hectare basis?	The trial achieved around 18,000m^3 per ha. This could be significantly improved with better stacking and log lengths optimally placed within the dam. 25,000m^3 is very achievable.
Can logs be effectively preserved?	Masked by logs that were not in good condition when placed into storage, the results from the observed and measured data at the mill suggested that the logs were largely preserved and would meet the structural grades required from routine operations.
What is the cost of establishing the infrastructure, maintaining adequate water supply and handling the logs over the full trial period?	Based on the trial and making assumptions about efficiency gains for a larger operation, a cost of between $35 and $45 per m^3 could be expected.

Other lessons learnt (log storage)

1. The broader fire salvage program demonstrated that the industry was highly tolerant to bluestain and generally log quality was retained longer than expected. On this basis, a single dam could be constructed to take say, a month's worth of deliveries – perhaps up to 25,000m^3. The dams could be thus up to a hectare in size, with consequent savings in earthworks.
2. The dam design must consider the expected log lengths to be stored so that log rows fully occupy the dam area.
3. Installing the liner efficiently requires welding pieces into place, demanding a level of manual handling. Sufficient width is required to include extending the liner to the top of the bund, and additional width for any sagging that may occur.
4. Irrigation design, pumping capacity and power sources must account for the ability to run sprinklers simultaneously.
5. The dam liner enabled an estimated 96% average water recovery rate, however this was aided by higher than average local rainfall across the storage period, and potentially soils with a higher clay content than would be expected on alluvial river flats. An assumption of 70% is a reasonably conservative estimate for a large scale operation.

Log Storage – Key findings

- Expectations regarding the salvage window whereby sawlogs can be viably (with some exceptions) retained on the stump post-fire have increased from 9 to at least 18 months. Log storage should therefore be avoided wherever possible due to the costs and risks.
- Purchasing sufficient water to support a wet storage operation in the Murray-Darling Basin can be complex - pre-planning for existing sites should focus on those with existing licences and a secure source of water that can be boosted by on-market purchases.
- Secure water is likely to be very costly and all attempts to capture and recycle applied water on site should be sought. Log storage costs in the Tumut MA are likely to be between $35 to $45 per m^3.

7. Environment

This section is not intended to be an environmental assessment of the impact of fires, it highlights the environmental considerations / constraints for industry during the salvage program

7.1 Assessment

A primary environmental consideration following the fires was erosion and soil stability during plantation operations. Plantations are managed in line with the requirements of the Plantations and Reafforestation Code Regulation, which contains conditions designed to manage environmental impacts of roading and harvesting operations. The scale and severity of the fires necessitated additional environmental assessments, works to restore road and drainage infrastructure damaged in the fires, and extra considerations and measures to minimise any further environmental impact during harvesting and establishment operations.

The approach to managing road repairs is described in Section 8.2. An assessment of fire burn severity and road network density enabled the mapping of areas with a high density of crossings and severe burn. An example is demonstrated below, with the red indicating the highest density of crossings and severity of burn.

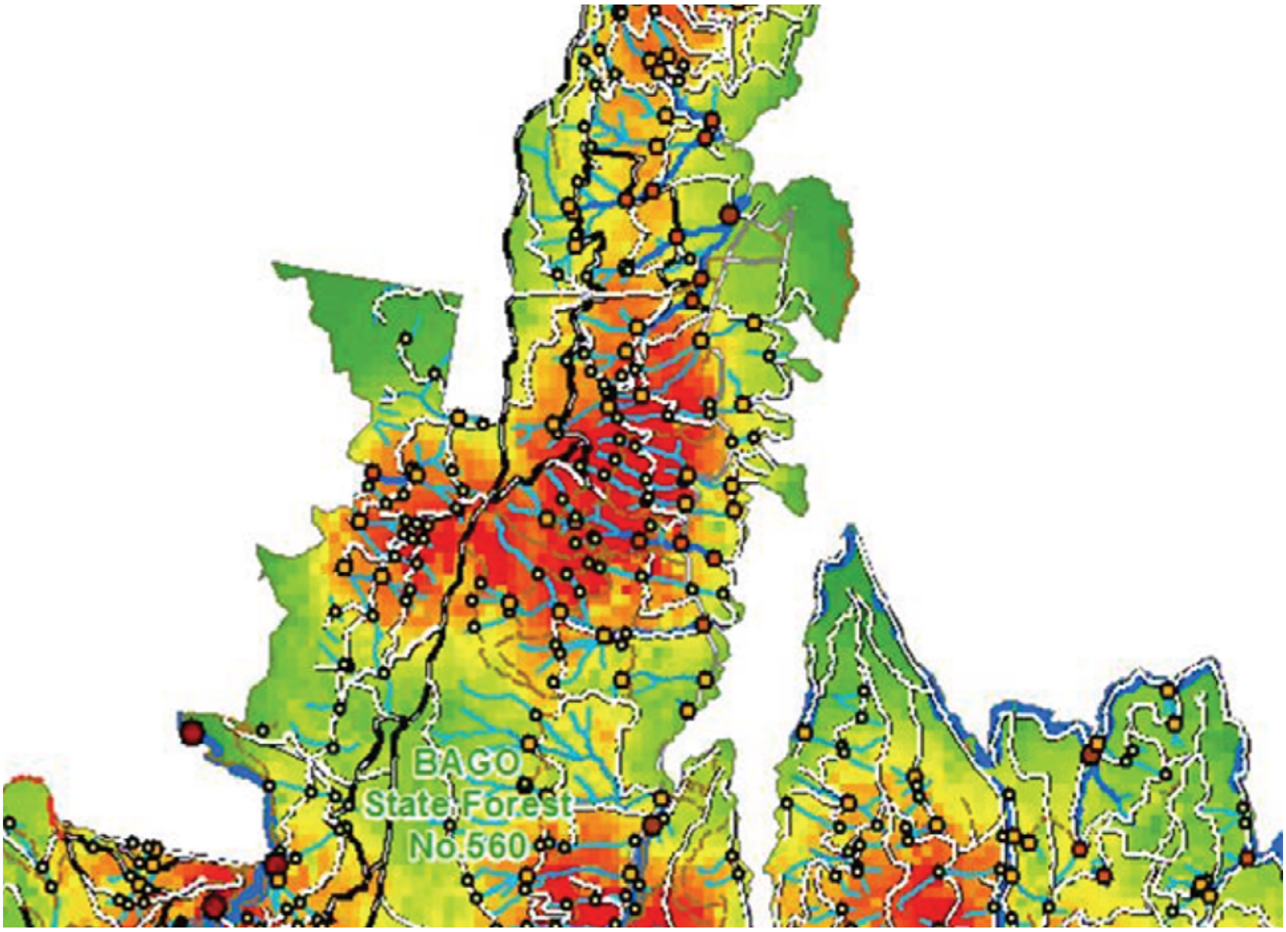

Figure 7-1: Prioritisation of post-fire catchment works – example analysis. Source: FCNSW

Environmental considerations were addressed through early engagement with the DPI Plantations Assessment Unit (PAU), which inspected the burn area in February 2020 and made key observations based on the landscape risk assessment and follows the principles of minimising the length of water flow to decrease erosive power and trapping sediment at its source across the plantation estate. Indicative advice was issued including:

- Where harvesting is occurring or has recently been completed (post fires) and where sediment and drainage issues are likely to exist due to harvesting, consider these areas as the highest priority. Vigilance across all soil risk categories, should be maintained to prevent specific site conditions or weather events leading to point source pollution.
- Where dangerous and/or burnt trees have been cut along roads, avoid pushing these into areas of retained native vegetation, unless damage to native vegetation is minimised and soil disturbance and movement can be kept to a minimum. Where severe gully erosion has been discovered (in plantation areas) as a result of vegetation being burnt away, consideration should be given to revegetating the immediate area surrounding those gullies, including a suitable distance immediately above any head cut and excluding the eroded gully from future production activities.
- Preventing soil movement - Based on categories within the catchment level risk maps those areas identified as Highest Risk and High Risk should be prioritised for works to be completed within three months.
- For plantable areas, use of aerial seeding for reinstating and promoting ground cover on fallow areas, especially on areas of steep slope that have been harvested post fires. As above, harvesting will need to establish a process to transfer to silviculture.
- Consideration should be given to contour ripping to prevent or slow sediment movements post harvesting on highest risk and high risk areas.
- Drainage Feature Crossings - consideration should be given to additional works beyond Code requirements, such as silt traps/sediment fences and strategic grass cover establishment.
- Immediate priority should be given to any crossing over or within 500 metres of a permanent river, stream or other waterways. These works should be completed as soon as possible.
- Reinstate and/or conduct maintenance on all 5 and 30 drains on approaches to 3rd Order drainage features with permanent water flow within three months. Once works on 3rd order with permanent flow features have been completed, prioritise lesser crossings and aim to complete those works within six to twelve months.
- Reinstate and/or maintain harvest road drainage and surface stability to allow continued salvage harvesting. Completion should be within one month or timed to coincide with the relevant harvesting plan schedule.
- Reinstate and/or maintain natural surface road drainage first, then progress to gravelled surface roads. Priority must be given to high use roads or where there is potential for imminent or continued sediment delivery within 500m of a river, stream or other waterways.
- Consideration should be given to closing all roads, tracks or other vehicle access tracks that may be excess to immediate needs, such as harvesting, or where resources and funding may prevent works within the next six months.
- For moderate and low risk areas, confirm the extent of works needed and develop a staged plan across the affected areas drawing upon the principles listed above. These works should be planned for completion over the next two years, subject to resources and funding.

7.2 Subsequent weather events

The post fire period was punctuated by mid-summer storm activity followed by a La Nina period extending over 18 months. This is demonstrated below.

A comparison of the cumulative rainfall totals for the 12 months leading to each of the Billo and Dunns Rd salvage periods and the 18 months following are compared to the average. This provides some context regarding the drought conditions leading into the fire events and the following conditions.

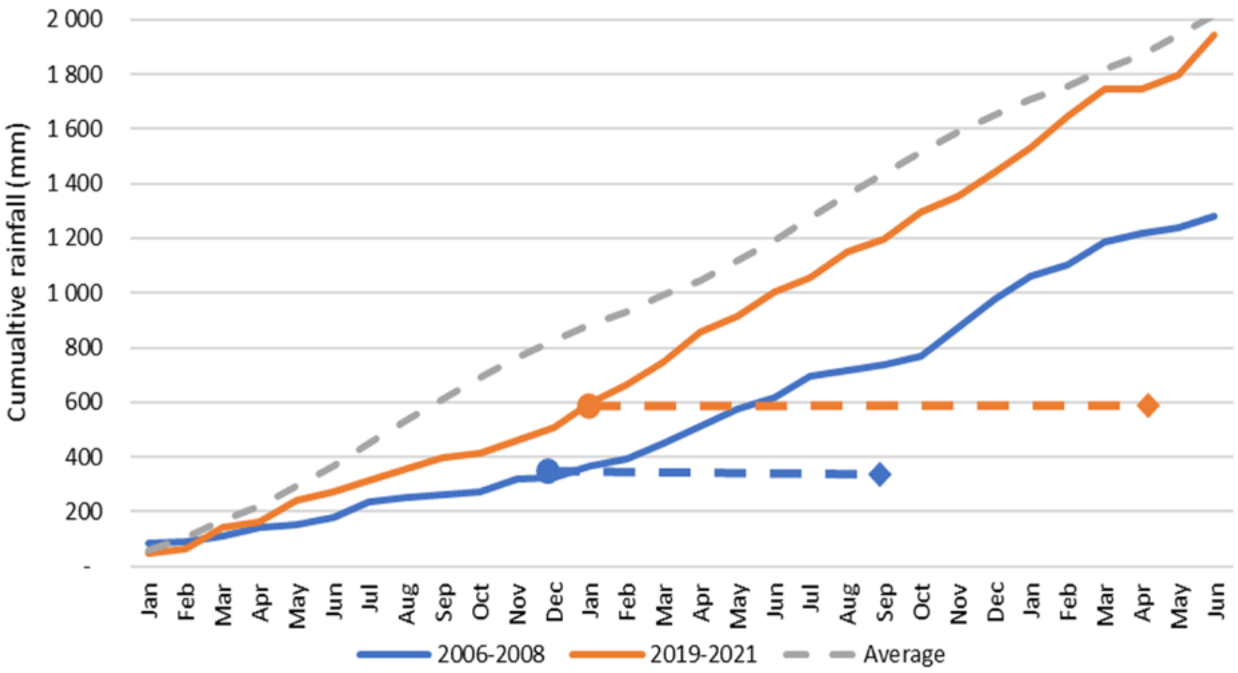

Figure 7-2: 30 month cumulative rainfall totals - Billo / Dunns Rd Salvage periods versus average. Source: BOM (Tumut – Simpson St Weather Station)

This points to the moisture deficits at the time of each of the fire events, but for Dunns Rd, this quickly recovers with continued above average rainfall extending through until late 2021 (2.5 years afterwards). The implications of this were that substantial areas of the road network were not adequately drained during the onset of the wet period. However the cooler and wet conditions presumably assisted with the extended salvage period, by retaining wood moisture across most sites.

Environment - key issues

- An evaluation of drainage crossing intensity and burn severity may assist with assessing environmental risks and assigning priorities
- Competing priorities may be managed by assigning dedicated planning and resources to managing environmental risks as distinct from facilitating harvesting activities
- Prioritise use of aerial seeding for reinstating and promoting ground cover on fallow areas, especially on areas of steep slope that have been harvested post fires
- Wet weather following the fires increased the risks of inadequately drained roads, but may have assisted the extension of the salvage program through conservation of tree moisture

8. Safety

8.1 Harvesting and haulage contractors / workers

Contractors were engaged prior to salvage commencing to address the safety implications of the program and confirming the general approach to harvesting surcharges payable and any compensation for haulage and loading. The main safety issues were:

- **Residual fire activity** – hot stumps, falling trees
- **Health impacts** – carbon and dust
- **Ground conditions** – loss of ground cover, impact of dust and charcoal on machines
- **Tree conditions** – brittleness, broken tops and windthrow
- **Increased concentration of activity** – concentrated harvesting, increase in volume and intensity of trucks and other vehicles
- **Infrastructure** – bridges, crossings and drainage structures
- **Familiarity** – new operators and drivers may not be familiar with local conditions.

8.2 Roading and forest users

Due to the extent of the damage to the plantation assets, it took over six months to access the full network and fully assess the damage to roads in the Tumut MA. A systematic approach was adopted to recording damage and prioritising remediation works, which included:

- Maintaining a spatial record of roads and assets inspected to demonstrate due diligence in assessing risks
- Recording a log of issues with sufficient detail to enable to assign a risk rating and budget
- Isolating immediate hazards using signage and physical barriers
- Developing a works program and incorporating it into existing schedules with appropriate priorities based on risks and available budgets
- Preparing roading plans identifying additional funds required to effectively manage the risks identified
- Regular media releases provided updates to the status of road closures

9. Conclusions

The fires of 2019-20 had a significant impact on the softwood processing industries in the Tumut / Tumbarumba region, however by all measures the salvage program was a success. It assisted in minimising those impacts in the short term and fortunately coincided with an unprecedented demand for timber products associated with COVID stimulus spending and supply zone. It also provided a window of opportunity for the processors to develop plans to adapt to a reduced regional supply post-salvage.

The resource planning process quickly identified the nature of the burnt resource through the application of remote sensing and estate modelling. Although this was subject to significant refinement over time, the original estimates were largely accurate and provided a sound basis for prioritising salvage operations, and informing processors, contractors and the community about the medium and long-term impacts on the resource. There is the potential for a greater focus in the early stages of the salvage planning on operational scheduling to provide clear direction to harvesting teams, however it is recognised that resources are highly constrained immediately following a significant event such as this, with competing priorities.

Although there were inevitable commercial issues that took energy and time to resolve, on the whole there was great willingness to maximise the opportunity the salvage program presented to the various parties. The various rebate mechanisms and log grade adjustments largely compensated the parties to their satisfaction. The willingness from the sawmilling sector to accept logs with blue stain contributed greatly to the amount of domestic wood processed and the associated economic activity the salvage program generated. It has important implications for future events in terms of the viable 'window' a salvage program may be planned around.

A collaborative approach with contractors was a fundamental reason underpinning the success of the program, including the willingness for harvesting contractors to accept the need to undertake salvage work rapidly, and an agreed set of conditions provided a transparent framework from which to operate. Coordinating capacity and sales arrangement with other growers also provides some opportunity to maximise resources and sales in the short term. Maximising the availability of trucks through reducing long haul wherever possible and ensuring out-of-area trucks have suitable infrastructure for servicing and driver accommodation is critical.

Log storage options in the Tumut Management Area are limited without the construction of a dedicated facility adjacent to a secure water source. It is likely to cost $35 to $45 per cubic metre to store logs under water effectively. This should only be done as a last resort, and priority given to storing wood on the stump. The potential window to do so in high quality stands maybe 12 to 18 months, providing a high level of tolerance to blue stain remains in place within the industry, and variation to wood quality is managed, particularly in relation to density and moisture content.