Strategy

EPS-AMS-STR-001

Eraring Power Station
Long Term Ash Management Strategy (LTAMS)

Version:	2.0
Released:	03 October 2020
Document Owner:	Generation Ash Strategy and Management Lead
Review Date:	03 October 2021

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Executive Summary

Origin Energy Eraring (Origin) operates the Eraring Power Station (EPS) as part of its electricity generation portfolio which provides electricity into the National Electricity Market. The EPS is a coal fired power station consisting of four 720 megawatt (MW) units and one 42MW diesel fuelled gas turbine with a total capacity of 2,922MW. Ash produced by the EPS which is not re-used, is stored on site in the Eraring Ash Dam (ERAD).

This Long-Term Ash Management Strategy (LTAMS) summarises the commitment by Origin to improve the efficiency of, and reduce environmental impacts associated with, the operation of the EPS and the ERAD.

Origin remains committed to minimising the quantity of coal ash that is sent to the ERAD consistent with the NSW Department of Planning, Industry and Environment's (DPIE) ash reuse goal of 80% by 31 December 2021. Achievement of this goal is possible with regulatory enhancement and support, and the establishment of new markets given the cap on ash demand in traditional markets.

There are several factors to consider when assessing ash deposition to the ERAD:

1) Ash Reuse

   Origin has a dedicated program in place to maximise ash reuse from run of station ash produced by the EPS. In addition, Origin is exploring future supply of ash from the ERAD.

   As part of the ash reuse program, ash sales can be categorised into three categories:

   a. Contracted Volumes – agreements with customers for use in existing markets;
   b. Expected Volumes – agreements expected to be entered with future customers for use in existing markets; and
   c. Potential Volumes – potential ash sales which currently are limited by regulatory barriers or require development of new markets.

2) Coal Sourcing

   Origin has improved the quality of coal procured for EPS which has seen the average ash content of the collective coal portfolio reduce. These higher grades of coal are priced above high ash coals, and this additional cost is factored into EPS's operating cost.

   Origin estimates it has reduced average annual ash production by ~40ktpa over the last three financial years through procurement of lower ash coal when compared with historical coal types.

3) EPS Generation Management

   Origin reduced EPS's generation levels in FY20 to 13.7TWh which represented a 17% reduction on FY19 generation levels of 16.5TWh. While the reduced generation levels are not reflected in the DPIEs 80% reuse goal, the reduction in the EPS generation has a material impact to reducing the overall ash produced and in turn, ash sent to the ERAD.

In FY20, Origin recycled ~40% of all EPS ash produced, which is an increase on FY19 reuse levels - making Origin the largest recycler of ash in NSW. Through a number of new initiatives, Origin has the potential to reach 80% ash reuse in the short term however this is partially dependent on the removal of regulatory barriers which currently limit the ash market's expansion.

These regulatory limitations include;

1) Misalignment of coal ash quality standards between the Australian Standards and the Roads and Maritime Services (RMS) standards.
2) Limitations set by RMS standards governing the maximum amount of coal ash used in roads.
3) Uncertainty regarding application of resource recovery legislation to coal ash reuse.

In addition to the barriers above, there are also limitations on the demand for EPS ash through traditional markets such as an ingredient in cement and concrete, and as a stabilisation material in land remediation – this effectively creates a cap on the volume of ash EPS can re-use in the absence of regulatory support or establishment of new end use markets.

While Origin continues to seek regulatory support in the areas identified above, it is also investing capital in infrastructure and research & development activities (R&D) in order to expand traditional markets or create new markets for EPS ash. Origin has recently co-invested in an on-site classifier to further refine run of station ash to a quality suitable for the construction industry and is undertaking R&D activities to develop a low cost, light weight aggregate material. Further, despite the limitations of ash use in roads currently imposed by the RMS, Origin is undertaking further trials to validate the use of high quantities of ash in roads.

Origin is also actively participating in and advocating for collaboration between generators, government agencies, regulators and potential customers to achieve optimum recovery of ash as a resource.

1. Introduction

This LTAMS represents a commitment by Origin to improve the efficiency of, and reduce environmental impacts associated with, the operation of EPS and the ERAD. The LTAMS is a tool for both Origin and Government agencies to guide significant reductions in ash storage at EPS through an increase in reuse and development of new technologies in ash management. The LTAMS is used as a management tool to allow for progress in these areas to be measured and monitored on a regular basis and reported back to the relevant stakeholders.

The LTAMS is a dynamic document which undergoes regular review subject to developments in available and preferred ash management practices. The Ash Manager at Origin maintains overall responsibility for the implementation of the actions and strategies contained in the document and for the revision of these actions and strategies where appropriate. Over the past year, Origin has considerably expanded the Ash Management Team to ensure these strategies are implemented in a timely & optimal manner.

1.1 Purpose

The key goal of the LTAMS is to develop and implement strategies that maximise the reuse potential of fly ash (both classified and unclassified) and bottom ash produced at EPS. The objectives of the LTAMS are to:

- Work towards a change in the perception of ash from a waste product to a commodity.
- Establish and develop new markets for ash across a variety of industry sectors.
- Foster partnerships between Origin, local industry, industry associations, the State and local Government, and the local community to work towards the use and recycling of ash.
- Improve the efficiency and reduce the environmental impact of ash management at EPS.
- Set benchmarks for environmental best practice in ash management across Australia.

This document is the October 2020 update of the LTAMS.

1.2 LTAMS Requirements

The Long-Term Ash Management Strategy (LTAMS) for ash was initially prepared in accordance with Condition 3.1 of the Concept Approval for the upgrade of the existing ash storage facility at EPS (Project Number 05_0138). The Department of Planning Industry and Environment (DPIE) subsequently approved the LTAMS on the condition that the LTAMS be updated within one month of the issue of Project Approval and reviewed periodically until 2015. A revised LTAMS was subsequently prepared in accordance with this requirement and submitted to DPIE in June 2008. Typically, the LTAMS has been reviewed and submitted to DPIE on an annual basis.

The DPIE included the following condition 4A in the Project Approval (07_0084) modification (MOD1) when the modification application was approved by the Independent Planning Commission (IPC) on 23 December 2019 under the former Section 75W of the Environmental Planning and Assessment Act 1979 (EP&A Act):

4A LONG-TERM ASH MANAGEMENT STRATEGY

4A.1 The Proponent shall prepare and submit for the approval of the Planning Secretary, a Long- Term Ash Management Strategy for the site. The Strategy shall be developed in consultation with the EPA and Council, and shall include, but not necessarily be limited to:

a) a mandatory goal of 80% reuse or recycling of ash from the Eraring Power Station by 31 December 2021. This goal may only be altered with the prior written agreement of the Planning Secretary, based on a demonstration by the Proponent that market conditions reasonably preclude this goal being achieved;
b) a program for the investigation of alternative ash management measures over time, with a particular focus on the minimisation of ash disposal on site and beneficial reuse of ash;
c) a framework for the identification and assessment of alternative ash management measures from time to time, having regard to the operational needs of the Eraring Power Station, and social, economic and environmental implications of those measures;
d) a staging strategy for the implementation of works the subject of this approval;
e) a strategic management framework for the optimisation of ash disposal capacity on the site, and periodic review of ash management practices to achieve this outcome;
f) an environmental management framework for the on-going management of ash disposal and ash management measures on site, consistent with contemporary best environmental practice;
g) a rehabilitation strategy that outlines proposed rehabilitation, with consideration of the ash reuse potential, including:
  - *a description of techniques to restore the area;*
  - *a timetable for the progressive staging of the rehabilitation program; and*
  - *a monitoring and auditing program; and*
h) a strategy for the reconciliation of the generating life of the Eraring Power Station and the availability and management of ash produced by the Power Station.

In respect to a), if reuse options are slow to emerge, or they are not feasible on economic environmental, or industrial reliability criteria, the timeframe goal be may extended with the agreement of the Planning Secretary, in consultation with the EPA. Extension of the goal shall be subject to the Proponent providing to the satisfaction of the Secretary information on available reuse options, justification of why these cannot be – or have not been - adopted, and a description of what measures will be implemented to facilitate the reuse of all ash generated on the premises for a beneficial purpose. After reviewing this information, the Planning Secretary in consultation with the EPA, may approve a modified timeframe goal(s), and may require the Proponent to carry out further investigations or works into reuse of all ash generated on the premises for a beneficial purpose.

4A.2 By the end of October each year, or other timeframe agreed by the Planning Secretary, a report shall be submitted to the Department to demonstrate annual progress of reuse and recycling of ash, to the satisfaction of the Planning Secretary.

2. Minimisation of ash Disposal On-site and Beneficial Reuse of Ash

2.1 FY20 Ash Reuse Results

In FY20, Origin increased its ash reuse rate from 35% to almost 40%, making Origin the largest recycler of ash in NSW. While absolute recycled volumes declined against FY19 due to the closure of a one-off bottom ash recovery opportunity in the year prior, some of this volume was replaced by an increase in dry ash sales. The overall increase in the reuse rate within the current economic conditions and the challenges associated with the global COVID-19 pandemic reflects Origin's commitment to recycling and reusing our ash by-products. Actual ash reuse data is provided in **Table 1**.

Table 1 Rates of Reuse for ash Produced at EPS

Year	Reuse Amounts (tonnes)	Reuse Rates
FY16	505,622	36.6%
FY17	361,839	27.6%
FY18	477,292	29.8%
FY19	602,580	34.8%
FY20	559,710	39.3%

2.2 Ash Reuse Program

Origin has a three-tiered reuse program in place designed to decrease the quantity of ash impounded in the dam, with a long-term view to harvesting ash from the dam to continue supply to markets. This reuse program also aims to meet the 80% reuse goal.

2.2.1 Contracted Volumes

Origin's ash reuse program has three contracted customers, primarily in the cement and concrete industry, who are responsible for 530kt, or 95%, of the FY20 sales. This market is well established, demand is capped and driven by swings in the construction industry and broader economic drivers. Origin expects these sales to be on-going for the remainder of EPS's life, and intends to increase supply to these customers by undertaking a program to increase the efficiency of the Coal Combustion Products Plant (CCP Optimisation) to enhance our ability to supply ash to this just-in-time industry.

2.2.2 Expected Volumes

Origin has two large projects underway to increase the ash reuse rate which are expected to commence operation in 2021. The first is a partnership with a local ash supply firm to install a large capacity classifier to increase the supply of RMS grade ash to market. This initiative is intended to increase sales by ~200kt over three years, a significant step change in Origin's reuse rate.

Origin also intends to commence a supply deal to a local mine rehabilitation project in Q1 2021 which is expected to utilise ~1Mt+ of ash. This project will be completed over approximately three years, a slower rate than forecast in the LTAMS in FY19. The rate at which these two initiatives deliver an increase in sales in addition to any change to the existing regulatory barriers, will impact Origin's ability to reach the 80% goal by 31 December 2021.

2.2.3 Potential Volumes

Origin is exploring a wide range of potential reuse applications, including, but not limited to, lightweight aggregate, bricks and blocks and fly ash pavements / roads. The extent to which these markets can be pursued, and current sales channels uplifted, are dependent on two key factors; market dynamics and the regulatory environment. A summary of the opportunities investigated are as follows:

1) **Ultra-high-volume fly ash pavement/roads**
Origin has conducted a detailed durability assessment of an ultra-high-volume fly ash pavement constructed on the Coal Haul Road at EPS in 1995. Results indicate that the road has outperformed the standard heavy vehicle pavement design. Origin is seeking to develop the product offering further and is working with the local Lake Macquarie City Council (LMCC) to deliver a second trial in 2021.

   Ultra-high-volume fly ash pavements are not yet feasible in NSW due to regulatory limitations. Meaningful implementation of this opportunity requires engagement with the RMS and local council stakeholders to trial the product and enable the commercial roll out via a change of the relevant RMS Standards for pavements.

2) **Mine void rehabilitation and structural fills**
Origin undertook a trial program to rehabilitate a tailings dam at a local mine. The successful trial used 30,000t of fly ash over a 6-week period. Given the success of this trial, Origin intends to supply ~1Mt+ to the project over a 3-year period from 2021.

   Origin and the mine operator are pursuing a suite of approvals to proceed with this project. This approvals process has delayed the start of the full-scale rehabilitation project, and Origin expects similar approvals timeframes for future initiatives.

3) **Lightweight aggregate manufacturing**
The lightweight aggregate market is a small and underdeveloped market in Australia. Origin undertook market research in the United States and United Kingdom in 2019 to understand how these markets were developed overseas. To be successful in this endeavour, a supply chain needs to be established and the economics need to evolve such that the benefits of a lightweight aggregate are recognised as a premium to the traditional materials in the aggregate market.

   Despite these impediments, Origin is undertaking a research and development project with a local construction firm to develop a lightweight aggregate using ash from the ERAD. The goal of the R&D program is to establish a commercial scale manufacturing process to produce a range of coarse and fine aggregates for use in concrete and other traditional aggregate applications.

4) **Pre-cast building materials**
Origin is currently in various stages of research and negotiation with numerous organisations for the construction and operation of various building material manufacturing plants at EPS that would bind coal ash to produce a range of pre-cast building materials including blocks, bricks, pavers and tiles.

   These pre-cast manufacturing plants require significant capital investment that is difficult to reconcile with the under-developed market for these products and the strong competition from the well-established traditional product offerings.

5) **Cenospheres**
Origin is investigating the supply of cenospheres to a number of potential customers. However, this sale process has been delayed by the recent uncertainty regarding whether the Coal Ash Order and Exemption applies to this material, as cenospheres are sourced from the ERAD. The sale of this product would be a success for the reuse program but more importantly the ash management strategy, as cenospheres are a significant contributor to dusting events.

6) **Proppants**
Origin has reviewed the opportunity to use fly ash as a proppant in CSG exploration and production. However, the volumes are small (~15ktpa) and EPS is located far from current fracking operations, the logistics of which limit the economics of the proposal.

7) **Geopolymers**
Origin is currently investigating the use of fly ash as a geopolymer, which have a wide range of applications, from traditional concrete applications to aggregate and other pre-cast applications as discussed above. The lightweight aggregate as discussed in Item 1 is also a geopolymer product.

8) **Ash amended road base pavements and quarry products**
Origin has undertaken a range of product development trials with a regional quarry to incorporate ash products into sub grade, road base and other quarry materials suitable for utilisation in the Lake Macquarie City region. To date this opportunity has identified six potential products, featuring possible improvements on the Plasticity Index, BCR or workability of the products. Origin intends to expand these applications within the local area, however, we face strong competition from the well-established natural aggregates market.

9) **Agriculture**
Ash can be used as a soil ameliorant to improve lower quality soils provided it complies with regulatory specifications. The resource recovery legislation imposes a frequent testing regime that is not currently practicable given the small market demand for ash as a soil ameliorant, therefore Origin does not supply ash for this purpose, however this may present opportunities in future if markets can be developed.

2.3 Barriers to Ash Reuse and Impact on 80% Goal

Through the implementation of the existing and future ash use initiatives and the innovative new products and technology opportunities, Origin continues to work towards the ash reuse goal of 80% by the end of 2021. However, Origin success in meeting this goal is subject to prevailing economic conditions, which have proven unfavourable for ash reuse since the COVID-19 pandemic.

The construction industry is the largest driver of demand for fly ash, therefore Origin's success in ash reuse is largely defined by the performance of NSW's construction industry and the broader economy as a whole. Origin achieved an ash reuse rate of ~40% in FY20, an increase from the FY19 rate of 35%. This was achieved in spite of the difficult economic and operating conditions created by the pandemic. These poorer economic conditions have impacted Origin's forecasted ash reuse rates by delaying the start of three initiatives and impacting future demand for fly ash.

Additionally, the current regulatory environment limits Origin's ability to increase ash reuse. As part of our submission to the NSW Legislative Council's inquiry into the costs for remediation of sites containing coal ash repositories, Origin outlined three key areas where the current regulatory environment does not support the remediation of coal ash repositories;

1. Misalignment of standards between the Australian Standards and the RMS.

   The current RMS standards require a higher quality for fly ash than the national standards. Aligning the RMS standards with the Australian standard will facilitate the substantial increase of re-use of coal ash in concrete applications.

2. Regulation governing the maximum amount of coal ash used in roads.

   A change to the regulations that limit fly ash in road applications to a performance-based standard would allow a substantial increase in the use of fly ash in pavements and other quarry products. Origin has successfully implemented an ultra-high fly ash pavement on its private haul road which contains 92% ash which has exceeded performance standards over a 25-year test period.

3. Uncertainty regarding application of resource recovery legislation to coal ash reuse.

   Ash recycling projects have also been delayed as a result of uncertainties with regard to the interpretation of resource recovery legislation and the need to assess projects on a case by case basis. Origin continues to work with NSW EPA to identify ways in which ash projects can be progressed in an environmentally safe and timely manner.

2.4 Options for Minimisation of Ash Disposal

In line with the DPIE's intention to reduce the amount of ash impounded on a yearly basis in the ERAD, Origin has options available outside of increasing ash reuse. These options are being actively investigated and implemented where commercially feasible:

1) Coal Sourcing

   Origin has improved the quality of coal procured for EPS which has seen the average ash content of the collective coal portfolio reduce. These higher grades of coal are priced above high ash coals, and this cost is factored into EPS's short run marginal cost.

   Origin estimates it has reduced average annual ash production by ~40ktpa over the last three financial years through procurement of lower ash coal when compared with historical coal types.

2) EPS Generation Management

   Origin has reduced the annual EPS generation levels in FY20 to 13.7TWh, a 17% reduction of the prior year's peak of 16.5TWh. This led to an ~300kt decrease in ash production from previous years.

While the reduced generation levels will not be reflected in the DPIEs 80% reuse goal, the reduction in EPS generation has a material impact on the overall ash produced and in turn, sent to the ERAD.

2.5 Forecast Ash Production

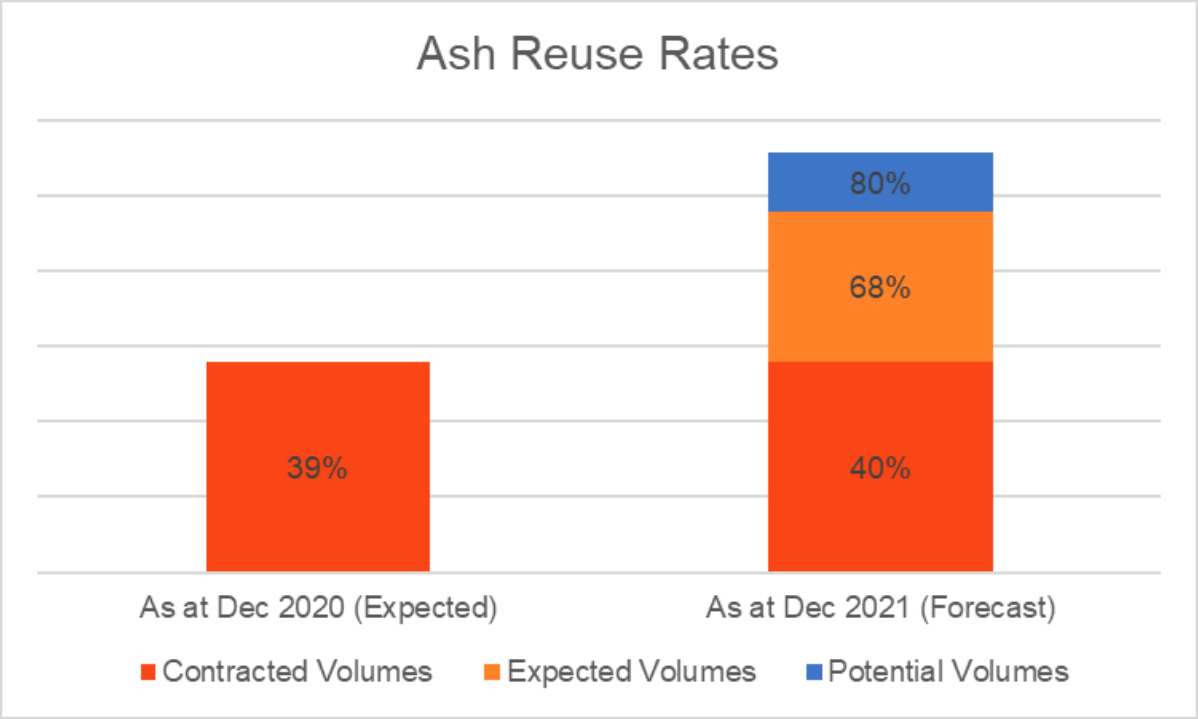
Future ash production is directly related to the energy produced and the quality of coal utilised. If Origin maintains the current the generation rates and coal quality, the annual ash production could be up to ~1.5 million tonnes per annum (Mtpa). That is 18 Mt of additional ash over the 12-year period from 2021 to end 2032. An 80 % ash reuse goal equates to approximately 1.2 Mt of ash use per annum, and if the goal was achieved from 2022 then 13.2 Mt of ash would be recycled of the total 16.5 Mt produced through to the end of 2032.

As outlined above, Origin is continuing our efforts with a view to meeting an 80% reuse goal in the short-term and plan to sustain ash reuse as high as possible out to the end of power station coal operations planned to occur by 2032.

However, ash reuse rates, as a factor of as production, are subject to the generation demands of the National Electricity Market. During periods where generation demand is consistently high, percentage reuse rates may be negatively impacted, despite reuse tonnages remaining comparatively stable or increasing.

2.6 Forecast Ash Reuse

Origin has forecasted a range of ash reuse outcomes, dependent upon the success of the program as subject to the barriers outlined in Section 2.3.



3. Investment in Ash Reuse Infrastructure

Origin is investigating and undertaking a broad range of options to invest in infrastructure to facilitate the 80% reuse goal.

3.1 Additional Reuse Facilities

Origin proposes to construct additional ash reuse facilities and augment existing ones to enable a forecast uplift in reuse as discussed above. This would be achieved by increasing the typical annual throughput of some existing plant elements and construction of additional facilities.

Origin is considering the following options:

- Constructing additional ash storage silos (e.g. 2 x 400t, and/or a variety of other configurations) which provide additional storage capacity and enable export of stored ash product to the just-in-time industry demand.
- Uprating an ash classifier with an additional 450m3 storage capacity.
- Constructing an ash aggregate, brick or other bound manufacturing facility with a nominal
  - capacity of 250,000t per annum, producing a geopolymer cement product.
- Constructing an improved access via Newstan-Eraring Private Coal Road to Awaba Road to provide an additional transport route for ash haulage and manage an increase in ash trucks on Wangi Road that would otherwise result from increased ash reuse rates. The proposed works formalise existing access arrangements.

The final project configuration may adopt some or all of these solutions and may vary slightly from the description provided above.

3.2 CCP Optimisation Program

The above options (as per 3.1) is complimented by the CCP Optimisation Program which is actively investigating opportunities for efficiencies and reliability improvements in Origin's run of station ash supply chain. This program includes an air flow study to understand the capabilities of Origin's ash delivery system for further augmentation, a review of ash quality analysis options and a review of the maintenance program to improve reliability.

3.3 ERAD Harvesting Program

Origin is at the forefront of the Australian market with the adoption of an ERAD harvesting program to further facilitate the increase in ash reuse. Origin has developed a team and process for the harvesting, screening and delivery of ash to the mine remediation program.

Further to this, we are investigating the investment into a range of technologies available to process pond ash for use in established industries such as the cement and concrete industries, with a view to continue supply beyond the planned life of EPS. These include carbon burnout, sonification, drying and washing of ash. These technologies are in various stages of maturity, which Origin will research for development through to potential pilot plant and commercial scale phases.

4. Framework for the Identification and Assessment of Alternative Ash Management Options

4.1 Overview

Origin has designed and implemented detailed program for the investigation and development of ash reuse opportunities as alternatives to the storage of ash at the ERAD.

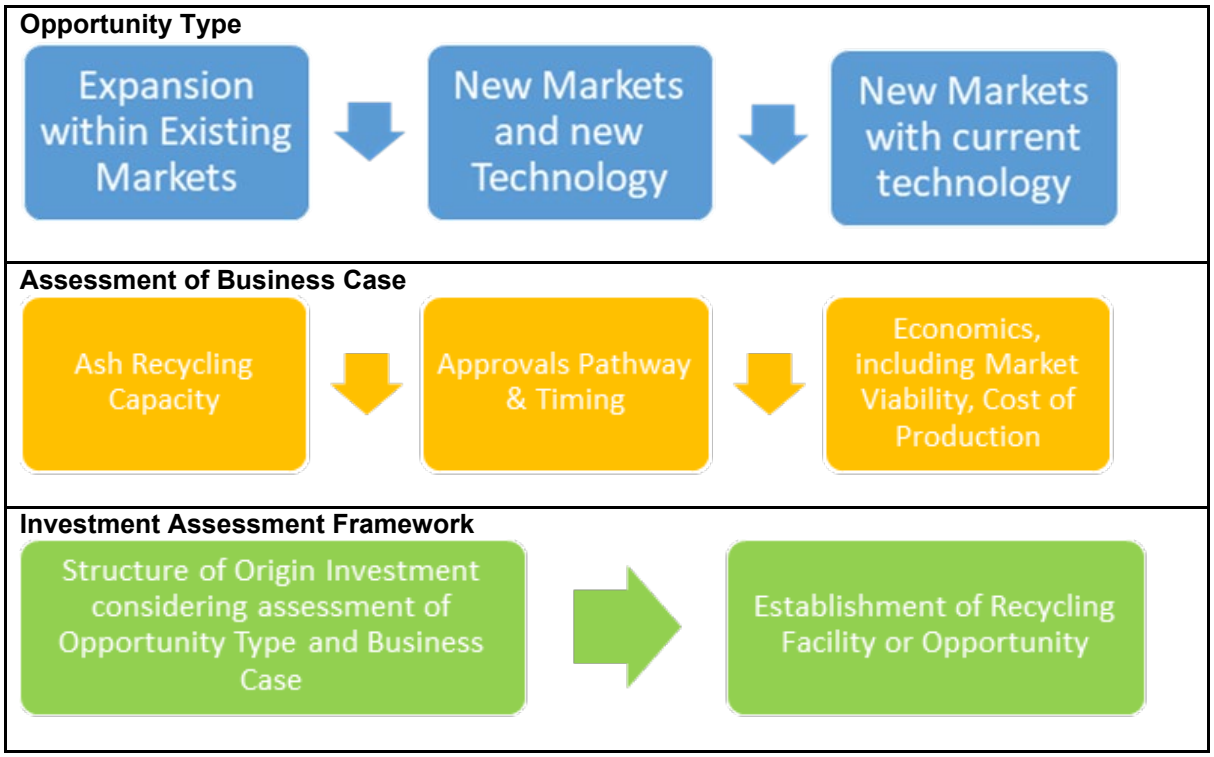
Origin has taken the following steps to further develop the framework, including:

- Origin is an active participant in the Ash Development Association Australia (ADAA), through which Origin monitors developments in ash management and reuse opportunities and assists in changing the image of ash from a waste product to a commodity.
- Origin engages with global fly ash industry bodies, including the UK Quality Coal Ash Association and the American Coal Ash Association, to further investigate and develop new markets and opportunities.
- Origin holds regular meetings with key stakeholders within relevant State and Local Government departments to facilitate access to opportunities for ash use in government projects.
- Origin has and continues to engage with local and international industry research bodies to investigate options to increase ash reuse and investigate how to efficiently and safely harvest ash from the ERAD for reuse.

4.2 Identification and Assessment Framework

Origin has developed a detailed framework for the identification, investigation and development of alternatives to ash storage at the existing ERAD through possible ash recycling and reuse options.

An overview of the framework is set out below.



5. Staging Strategy for Implementation

5.1 Overview

This section of the LTAMS discusses Origin's historic staging of ERAD development and proposed augmentation (MOD1) as per our conditions of approval. This includes planned staging of ash reuse projects.

5.2 ERAD Augmentation

The works required for the progressive augmentation of the existing ERAD at EPS have been staged to reflect the operational needs of EPS in terms of ash management as well as to mitigate and minimise the potential environmental impacts as part of the augmentation projects.

Clearing of land required for the ERAD augmentation commenced prior to the first generating unit being connected to the new dense phase pumping system (August 2009) to allow for commissioning of the dense phase placement process. Details of the staging of proposed and actual clearing works are shown in Table 3. A Habitat Offset Plan (HOP) has been prepared and shows each separate area comprising the total offset area.

Table 2 Schedule of Clearing for ERAD Augmentation

Stage	Actions	Timing
Preliminary	Preparation of Habitat Offset Plan for all stages of compensatory habitat.	January 2008 (Complete)
Stage One	Dedication of all compensatory habitat offset area (total 42 ha) of vegetation to be removed (up to 21 ha).	May 2008 (Complete)
	The first stage of land clearing (3.5ha).	October 2008 (Complete)
Stage Two	The second phase of land clearing (approximately 4.5 ha).	June 2010 (Complete)
Stage Three	The third stage of clearing (3 ha) carried out up to around RL 135.	December 2010 (Complete)
Stage Four	The fourth stage of clearing (3 ha to complete 14 ha clearing in total) carried out up to around RL 140 m.	2017 (Complete)
Stage Five	The fifth stage (8.95 ha) as part of the planned western development of the ERAD (MOD1) which is in the project design phase.	Planned for 2020/21 subject to detailed design.

The following protocol is adopted for each stage of the proposed works:

- Offset areas are offered for the stage requirements before the commencement of any clearing.
- Where possible Origin utilised disturbed areas rather than clear bushland for access to the area of ash placement.

6. Integrated Ash Deposition, Storage and Use

6.1 Overview

This section of the LTAMS outlines forecast ash deposition, storage and use and the potential need for future ERAD projects to meet Life of Facility (LoF) requirements for EPS operations out to 2032 which is the proposed closure date for the power station.

6.2 Forecast Ash Deposition and Storage

6.2.1 Current recycling rate (FY20)

As outlined above, there is estimated to be 18 Mt of additional ash over the 12-year period from 2020 to end 2032. If the ash reuse rate was to stay at 40%, then 7.2 Mt would be recycled, and 10.8 Mt stored in the dam.

This would likely require an increase in capacity of the ERAD including the proposed MOD1 Augmentation Project. This provides adequate storage capacity in the ERAD until approximately 2024 if reuse is maintained at approximately 40%, and the generation demand remains high. At 40% reuse, additional ERAD projects would be required post 2024.

6.2.2 80% recycling goal

As outlined in Section 4.2.1 an 80 % ash reuse goal equates to approximately 1.2 Mt of ash use per annum, and if the goal was achieved from 2024 when the existing capacity including the MOD1 Augmentation project is exhausted then 10.8 Mt of a total 13.5 Mt would be recycled over the remaining 9 year like of the power station.

In this situation the ERAD would be required to store 2.7 Mt of ash storage. This is considered a best-case scenario.

6.3 Future ERAD Projects

Origin is planning future ERAD projects to ensure there is adequate storage in the ERAD out to 2032. The planning of these projects considers both the worst-case scenario, where there is no increase in ash reuse rates, and the best-case, where ash reuse is at or above the 80% goal.

It is prudent that the worst-case scenario is used for the planning of future projects. Where the planned increase in ash reuse ramp rate is realised, the need for future ash storage projects and the scale of these projects will then be revised.

Key ERAD augmentation projects include:

- Ash Dam Augmentation Project – includes western development of the ERAD for up to 5 Mm^3 (6 Mt), and provides additional storage required until 2024 (currently in the design phase).
- Life of Facility (LoF) – in preliminary options assessment and design phase, but planned ERAD capacity increase for ash storage between 2024 and 2032.

The scope of the LoF project will continually be reviewed consistent with Origin's endeavours to increase the rate of ash reuse.

7. Management Framework

7.1 Overview

This section of the LTAMS sets out the approach to ash dam management including environmental management and ash reuse activities.

7.2 EPS Ash Dam Management

The Eraring Power Station Ash Dam Operations and Maintenance Manual has been developed to establish in one primary controlled document (with associated supporting documents) the complete, accurate, current, structure-oriented operating instructions for the ERAD and reservoir/decant pond, and its related structures. The Manual's purpose is to ensure adherence to the approved operating procedures over long periods of time and during changes of operating personnel.

The Manual contains, as a minimum, information and instructions necessary for the operating personnel to perform their duties. It also contains general information, details of operation, inspection and maintenance procedures and an outline of dam safety and surveillance practices.

Operating procedures must not deviate from those stated in the Manual without appropriate authorisation and must be reviewed and updated regularly.

7.3 Environmental Management System (EMS) and Plans (EMPs)

The overall framework for environmental management is governed by the Eraring Power Station Environmental Management Plan (EMP) and subsidiary Land and Biodiversity Management Plan and Water Management Plan. These plans are based on the principals of ISO14001:2015, with a focus on achieving continual improvement in environmental management practices.

Environmental aspects of ash management will be monitored and managed through weekly EPS Ash Management Meetings and the status of action plans resulting from these meetings will be reported to the Ash Steering Committee (held monthly). The meeting agenda shall include:

- Review of progress with regard to ash reused and recycled (both fly ash and bottom ash) and tracking against the 80% reuse goal.
- Tracking the progress of any surface disturbance, revegetation and rehabilitation activities to ensure compliance with the provisions of the EPS Land and Biodiversity Management Plan.
- A review of the implementation of dust and water quality management measures with regard to the Ash Dam Safety and Dust Management Plan and the EPS Water Management Plan.

Environment subject matter experts will also provide input into any Project Specific risk assessments relating to ash management at EPS.

7.4 Reconciliation of EPS Life of Facility and Ash Management

During FY20, EPS produced approximately 1.4 Mt of coal of which more than 0.86 Mt were placed onsite. Market conditions and reuse technology to date have precluded the achievement of the 80% reuse and recycling goal. As per Sections 2 and 3, significant

effort and planning is going into the advancing of opportunities and projects with the aim of achieving the 80% goal in the future.

Future expansions to the ERAD may be required to accommodate the ash management needs of EPS within its current design life. Origin is proposing to augment the ERAD using an alternative placement strategy and landform design to maintain operational flexibility and extend the storage life of the ERAD in the short mid-term whilst continuing to support long term ash placement strategies towards 2032.

8. Rehabilitation Strategy

8.1 Overview

This section of the LTAMS sets out Origin's rehabilitation and offsets strategy for the progressive rehabilitation of the ERAD consistent with existing and future ash reuse projects.

8.2 Revegetation and Rehabilitation Management Plan

As part of the PA07_0084 MOD1 approval, the IPC included a new condition 4.9 as follows:

Rehabilitation Management Plan

4.9 The Proponent must prepare a Rehabilitation Management Plan for all land disturbed by the development to the satisfaction of the Planning Secretary. This plan must:
a) be prepared by a suitably qualified and experienced person/s;
b) be prepared in consultation with the Department and Council;
c) be submitted to the Secretary for approval within 3 years of approval of Modification 1 or other timeframe agreed by the Planning Secretary;
d) be consistent with the Long-Term Ash Management Strategy required under section 4A of this approval;
e) include detailed performance indicators and completion criteria for each rehabilitation domain, and triggers for remedial actions;
f) describe the measures to be implemented on the site to achieve the criteria in paragraph e);
g) include a program to monitor, independently audit and report on progress against the criteria in paragraph e) and the effectiveness of the measures in paragraph f); and
h) describe any further studies, work, research or consultation that will be undertaken to expand the site-specific rehabilitation knowledge base, reduce uncertainty and improve rehabilitation outcomes.

The Proponent must implement the approved Rehabilitation Management Plan.

To date, to the extent necessary to facilitate end use, revegetation and rehabilitation of the ERAD is undertaken in accordance with the provisions within the EPS Biodiversity and Land Management Plan (BLMP, 2017), which details techniques for primary, secondary and maintenance revegetation and rehabilitations works and defines Key Performance Indicators (KPIs). The EPS BLMP consolidates and supersedes a number of previous plans including:

- Threatened Species Management Plan (HLA ENSR, December 2007); and
- Revegetation and Rehabilitation Management Plan (HLA ENSR, November 2007).

The EPS BLMP also details a monitoring and auditing program for revegetation and rehabilitation activities at the site. Progress against this program will be tracked by the Ash Committee and periodic auditing will occur in line with the provisions of the EPS Environmental Management Plan.

The MOD1 Rehabilitation Plan (to be completed by 23 December 2022 or other approved timeframe) once approved will supersede the BLMP with regards to ash dam rehabilitation.

8.3 Provision of Vegetation Offsets and Compensatory Habitat

Condition 2.1 of the Project Approval (07_0084) issued for the 2008 CCP Facility expansion required that a compensatory habitat package be prepared that consisted of no fewer than two hectares of compensatory habitat for each hectare of terrestrial vegetation removed as part of the project. This compensatory habitat package does not apply to clearing undertaken for MOD1 which is currently in the design stage, with additional offset requirements outlined in Condition 2.1A as follows:

2.1A Within 12 months of commencing construction of MOD1 under this consent, or other timeframe agreed by the Planning Secretary, the Proponent shall retire the biodiversity credits specified in Table 1 to offset the biodiversity impacts of MOD1. The retirement of credits shall be carried out in consultation with BCD and in accordance with the Biodiversity Offsets Scheme of the BC Act, to the satisfaction of the BCT.

As detailed in Section 1.2 the initial Concept Approval required the project to be staged. The progressive ERAD augmentation to date has thus been delineated into five separate stages as summarised in Table 2. As per the requirements of the 2:1 replacement ratio, 42 ha of compensatory habitat were provided during the staged storage augmentation up to stage 4.

Origin has prepared a Habitat Offset Plan (HOP) for the compensatory habitat areas which have been approved by the OEH. The HOP includes details of compensatory habitat areas for both the 2008 CCP project and the Origin Cooling Water Attemperation Reservoir project. These areas are contiguous in nature.

Origin will update the 2008 Habitat Offset Plan to include offset measures undertaken in accordance with the requirements of MOD1 following the completion of project construction.

8.4 ERAD Rehabilitation Timetable

Full ash placement in the ERAD will not be completed until towards the end of the life of EPS. This is because a substantial ash storage area would still be required whilst EPS is operational. In addition, future ash reuse and recycling opportunities may necessitate removal of ash from areas of the ERAD. It is therefore likely that the majority of the final rehabilitation works will commence during the last 12 months of EPS's operational life.

Where necessary and feasible, Origin temporarily caps and revegetates areas of the ERAD where ash placement is not currently occurring but may again occur in the longer-term future in order to manage environmental issues such as dust generation. Origin has already undertaken temporary capping and revegetation in several areas of the ERAD in line with the principles of the EPS BLMP. Where temporarily capped areas are reopened for ash placement or reuse, capping materials will be salvaged and stockpiled for future use. To date, Origin has undertaken temporary capping in the South West and South East sections of the dam and is planning to temporarily cap Eastern areas of the dam, which have recently been reopened, once placement in the area is complete. Origin will continue to review opportunities for temporary capping in line with current strategies for ash placement and reuse. Origin may also re-open previously capped areas of the ERAD to recover impounded ash for reuse purposes.

Following decommissioning of EPS it is anticipated that the site will be rehabilitated as required by the Rehabilitation Management Plan (to be completed by 23 December 2022 or other approved timeframe) to a point that will allow further uses, for example: recovery

of impounded ash for reuse; industrial and/or community uses. Origin will rehabilitate the final footprint of the CCP management facility in a manner generally consistent with the surrounding landform and the future land use. Any rehabilitation activities would be undertaken in accordance with the Rehabilitation Management Plan following its completion and approval.

Figure 1 Offset Areas

8.5 Monitoring and Auditing Program

Specific aspects of the LTAMS will be subject to regular monitoring and auditing as described throughout this document, with subsequent updates of the LTAMS in accordance with any approval conditions. The monitoring and auditing procedures adopted by Origin in this respect are summarised in Table 3.

Table 3 Monitoring and Auditing Procedures

Aspect	Forum/Procedure	Timing	Responsibility
Review of 80% reuse goal and evaluation of achievability of reuse goal in current market Conditions	Continual monitoring of national and international market trends in ash reuse and ash sales.	Annual	Ash Committee Leaders Meeting
Review and tracking of existing markets for reuse of ash	Continual tracking and follow up of opportunities with review at ash dam steering committee meetings.	Quarterly	Head of Operation Services
Review and tracking of new opportunities and markets for reuse of ash	Continual tracking and follow up of opportunities with review at ash dam steering committee meetings.	Quarterly	Head of Operation Services
Level of reuse of ash at EPS	Records kept and tracked at monthly ash reuse report.	Monthly	Ash Manager
General ash management at EPS	Records kept and reviewed at each ash dam steering committee meeting. To include: Review reuse rates for the period Confirm reuse goals for following period	Monthly	Ash Committee Leaders Meeting
Review of ash reuse performance	Review of reuse rates for the period Trend analysis vs market performance Consider potential impact on storage capacity and LTAMS reuse goal performance	Quarterly	Ash Committee Leaders Meeting

Aspect	Forum/Procedure	Timing	Responsibility
Ash rehabilitation areas	The Ash Committee will review opportunities for temporary capping and revegetation, and work towards developing a timetable for final rehabilitation activities. Any revegetation or rehabilitation activities currently underway will be monitored in accordance with the Land and Biodiversity Management Plan.	Monthly	Senior Environmental Business Partner
Update and endorsement of LTAMS	LTAMS to be updated based upon findings of above reviews and tracking, development of new opportunities and progress of ash management and compensatory habitat.	Annually until 2032	Head of Operation Services