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Content of submission (you can choose multiple): Latrobe Valley Mine

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Hazelwood Mine Fire Inquiry
PO Box 24
Flinders Lane Vic 8009

24th August, 2015

Dear Members of the Board

Mine Rehabilitation Submission

I am pleased to submit the attached document for consideration by the Board in its review of options for rehabilitating Victoria's brown coal mines.

The purpose of this submission is threefold:

- To highlight the areas where we believe that new knowledge will need to be created in order to deliver a viable rehabilitation outcome for the mines that will achieve the goals of a landscape that is deemed safe, stable and compatible with the surrounding landscape and final land use.
- To demonstrate ways in which the community can be engaged in the processes of rehabilitation and can contribute meaningfully and effectively to the delivery of the desired outcomes for the rehabilitation projects at the mines
- To show that there is a wealth of experience within Victoria's Higher Education Community that can be utilised to meet the needs for new knowledge creation in conjunction with the community, the mine operators and Government.

We would be delighted to explore any of the ideas presented in this document further if required and look forward to seeing the outcomes of the deliberations of the Board and its team in the coming months.

Yours sincerely,

Professor Frank Stagnitti
Deputy Vice-Chancellor (Research and Innovation)

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Hazelwood Mine Fire Inquiry

Federation University Australia Submission

Prepared by:

Prof Rae Mackay & Dr Jessica Reeves

Faculty of Science and Technology

Status: FINAL **Date:** 17/08/2015

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Introduction

As Victoria's only regional, multi-sector university and with a major campus at Churchill, Gippsland, Federation University Australia (FedUni) is well placed to provide expert input to this important inquiry and to the future program of research and development that will be needed to achieve the inquiry's objectives and the outcomes that will have to be delivered by the mine owners.

Our expertise in mine stability assessment, mine site rehabilitation, community engagement and data management is recognised nationally and internationally. FedUni has strong academic units covering Mining engineering and Ecological management, with staff experienced in research and remediation strategies related to severely disturbed ecosystems. We are well suited and well located to engage in the development of holistic large-scale brown coal mine restoration planning, research and delivery.

Our research and partnerships throughout regional Victoria, and in the Gippsland region in particular, mean that we have close access to local community, industry and government agency partners. We recognise the importance that community engagement will play in a successful outcome and the value of long-term student and citizen science projects for ongoing monitoring of sites.

Our research centres have the capacity to develop interoperable databases and spatial representation of the complex information that the mines will generate through the process of rehabilitation for use by stakeholders and the community alike.

Understanding the Inquiry Needs

In addressing and responding to the needs of an inquiry of this breadth, Federation University has drawn together a multi-disciplinary team. In preparing this submission we undertook a thorough capability mapping through expression of interest across all FedUni campuses. From over 30 responses, this application outlines the key aspects of the issues that we feel need to be addressed by the inquiry if it is to achieve sustainable ecological, community and economic outcomes. These issues include:

- Assessing the physical, structural and ecological characteristics of the mine sites and region, in collaboration with local stakeholders
- Ensuring long-term ecological health of terrestrial and aquatic ecosystems, though a staged succession approach to rehabilitation
- Minimising future risk from hazards (fire, climate, ground stability, contamination)
- Building community capacity through citizen science and education programs, knowledge sharing and participatory monitoring programs
- Developing long-term employment prospects for the region
- Returning sites to the community, in a safe and responsible manner that provides benefit to the ecological health and economic prosperity of the region.

Key Points

Development of rehabilitation strategies

It is understood that the mine owners are independently developing plans for rehabilitation and are implementing progressive rehabilitation of overburden dumps and the mine batters based on the outline concepts in their work plans. It is also accepted that there are technical aspects of the rehabilitation plans that are not well understood at the present time and that there is a need for continuing research to fill knowledge gaps and reduce the future potential risks to people, infrastructure and the environment. Further, it is recognised that any planning for rehabilitation of each mine in the Latrobe Valley and the recently closed mine at Anglesea must take account of the rather different situations that exist at each site in terms of depth, proximity to and impact on natural and developed infrastructure and the remaining working life of the mine. This means that a common strategy for rehabilitation encapsulating all mines is unlikely to be appropriate or successful.

The common issues to be resolved are concerned with:

- To what degree can rehabilitation progress while the mines are still operational?
- What range of options are available for rehabilitation that meet a long term goal of productive reuse of the mine sites?
- How stable will the final landform be and what does this mean for future land use?
- What knowledge is still required to permit rehabilitation plans to be finalised?
- What will be the long-term monitoring and management requirements for the rehabilitated mine site?

Risk Assessment for future mining plans related to fire management and rehabilitation

It is critical that plans for the mine sites are developed in acknowledgment of the risks related to fire, drought, flood, urban development and encroachment, ground stability and contamination.

Risk assessments for future rehabilitation of each mine should specifically evaluate the land functional attributes for the proposed reclamation to determine whether the site is fit for purpose. It can be expected that the capability of land areas for different uses will vary over the rehabilitated areas, with different potential uses defined relative to distance from the centre of the mine voids. Land capability assessments require data on the following variables: (i) hydrology; (ii) ground movement; (iii) ground stability and erosion; (iv) soil properties; and, (v) climate.

The overarching objective of rehabilitation is to produce a landscape that is safe, stable and compatible with the surrounding landscape and final land use. There are a number of principles of rehabilitation which are reflected in the literature:

1. Restoration principles should be developed consistent with regional or landscape level ecological objectives.

2. Final reclamation designs should ensure that the proposed land use objectives are compatible with the surrounding landscape.
3. On completion of reclamation, the site should be self-sustaining and/or suitable for an identified or predetermined future land use.
4. Community priorities and needs should be taken into consideration. This can be achieved through the inclusion of community in the planning and design process.
5. Consultation and communication between the community, stakeholders and project coordinators should be meaningful and timely.
6. Public safety is of paramount importance and must be incorporated into the reclamation plan.

Hydrological and Geotechnical factors influencing ground movements that will affect future use.

The geology of the Latrobe Valley is relatively simple but the geotechnical properties of the geological formations present significant challenges for mine rehabilitation. The individual coal seams are very thick, the coal is very light (not much heavier than water), has a relatively low modulus of elasticity, undergoes creep movements, lies on weak sediments and contains vertical joint sets due to historical tectonic stresses. As a consequence, water pressures in the coal joints can relatively easily mobilise lateral movements around a mine void that can lead to cracks and sinkholes in the land surface. These in turn can connect the coal with surface water bodies that again reinforce the ground movements, leading to large displacements at the perimeter of the mine void. During mining, water control is an essential requirement for the control of ground movements and the maintenance of stability. Water control is achieved by aquifer pumping and by the inclusion of horizontal drains in the coal to drain the coal joints and recharge waters entering the coal from the land surface. Management of surface water sources is also undertaken through backfilling of surface cracks, lining of surface drains and prevention of water accumulating on the batters. Unless the mine void is fully backfilled, control of water will continue to be necessary. Fully backfilling all the mines would seem to be impractical given the lack of spoil and other fill materials. This raises a question around whether water control can be achieved without long term intervention. Designing durable surface and subsurface drainage needs a significant investment of effort.

Irrespective of the degree of water control, it can be anticipated that ground movements will continue to occur over the long term due to changes in subsidence rates and the rebound of aquifer pressures, climatic variations, and coal creep. The magnitude and severity of these movements will vary with distance from the mine void; large movements are currently observed close to the mine with significantly smaller to negligible movements at distance. This pattern can be expected to persist under almost all future rehabilitation scenarios. Understanding the environmental changes and the changes to material properties that will influence these movements is an area requiring significant continuing research.

Land uses that are sensitive to such movements will need to be rejected or the uses will need to be engineered to meet the movements. Zoning of land according to predicted movement types and magnitudes, largely related to distance from the mines will need to be considered.

Finally, it is important to address the need for and the approach to reshaping the land surface and the introduction of new soil covers to achieve the final land form in and around the pit void. The current pit walls would not be stable in the long term and would be prone to significant fire risk. Placing appropriate soil cover over the mine walls requires shallower slopes than exist around most of the mine perimeters. Any decision to cut back the mine walls to reduce slope angles will have a strong influence on the possible timing, cost and long term stability. It is particularly important to understand the stability of the slopes as this will to a large extent determine the more regional stability of the land around the mines. The method of slope covering and the selection of cover materials and soils will determine the resilience of the land surface to mass movements due to wetting and drying. As the available materials will largely be obtained locally, detailed investigation of the performance of these materials will be essential to meet the requirements for coal fire resistance and ground stability.

Potential Contaminant Risk

Coal and its after-mining products inclusive of combustion products and overburden materials, are chemically complex, metal enriched and provide a contamination source long after mining ceases. Mobility of metals (Hg, As, Cd amongst others) into surrounding water, soil and atmospheric zones at other sites has resulted in significant and adverse short and long term environmental and human health outcomes (Rowe *et al*., 2002; Lemly *et al*., 2014).

Taking just one of the examples in the literature to illustrate the issue, Belews Lake has been impacted by the disposal, both intentionally and accidentally, of coal combustion residues. Elevated metal values of As, Cd and Se, amongst others are seen in water, soils, sediment and vegetation profiles. Aquatic plants, invertebrates and specifically fish species are impacted by these metals with an adverse array of observable effects including decreased red blood cell ratios and histological anomalies in fish, population decline and large scale aquatic system change (Ruhl *et al*., 2012).

Characterisation of coal from the Latrobe Valley indicates a chemical signature that requires detailed understanding of the mobility pathways. The major requirement will be to provide a detailed chemical evaluation of any in-pit waterbody and any effluent from the pit, whether to surface water or groundwater over the long term to ensure that these water bodies are ecological viable and retain their current function, or in the case of new water bodies, achieve a stable and useable quality. In addition, care should be taken to minimise any airborne dust during the process of in-fill and rehabilitation.

Lemly, AD., 2014. An urgent need for an EPA standard for disposal of coal ash. *Environmental Pollution* 191: 253-255.

Rowe, CL *et al*., 2002. Ecotoxicological implications of aquatic disposal of coal combustion residues in the United States: a review. *Environmental monitoring and assessment* 80(3): 207-276.

Ruhl, L. *et al*., 2012. The impact of coal combustion residue effluent on water resources: a North Carolina example. *Environmental science & technology* 46(21): 12226-12233.

Environmental values in rehabilitation planning

Creating 'ecological value' includes the establishment of those features and processes that support the development of higher plant and animal diversity at the mine sites and in the region as a whole. Priority areas for vegetative restoration should thus be identified by their spatial relationship to existing sites. This will contribute to the enhancement of processes such as the migration of smaller mammals or insects relevant to the restoration process. A site cannot be considered successfully rehabilitated unless the required vegetation is able to regenerate without on-going external input. Essential to these processes are nutrient cycling by herbivores and the necessary soil macro and micro-fauna communities which will need to be incorporated in the rehabilitation and monitoring processes.

As far as possible, restoration of the original biodiversity of the local vegetation communities and the complementary faunal assemblage is considered desirable for any areas that will be returned to a natural state. Areas returned to natural conditions should be encouraged. Historical and contemporary investigation of the sites is required to meet this concept, if not already completed. This includes creating inventories of the indigenous and current flora and fauna, and analysis of soil and groundwater quality. If missing, detailed examination of the current species composition in the seed bank of the site and remnant vegetation in the vicinity needs to be carried out to establish the suite of species most likely to be successful in any future rehabilitation. As is normal for remediating heavily disturbed land, a staged succession plan is recommended to achieve optimal health and biodiversity of the ecosystem.

Specific considerations include:

- Assessment of soil parameters such as surface cover, soil condition, erosivity and other factors to determine the need for soil stabilization and the suitability of the vegetation for reintroduction;
- The quality of water run-off in terms of silt load and chemical composition;
- The condition and composition of present and remnant vegetation to establish appropriate species composition for rehabilitation of different localities, and to assess the availability of local seed. All relevant plants, annuals as well as perennials, should be assessed for their suitability and ability to support a staged restoration project;
- The impact of animals in terms of damage to soil slopes and introduced flora;
- The potential for noxious weed invasion;
- The state and subsequent development of soil macro- and micro-fauna to determine their ability to sustain the on-going regeneration of the soil;
- The visions of the communities and stakeholders in the area. Successful restoration will balance community, economic and ecological concerns.

Development of long-term environmental monitoring plans for the various works

Long-term monitoring is essential to determine the effectiveness of the restoration program. Monitoring needs to include ground movements, air and water quality, soil and vegetation health, floral and faunal biodiversity – both aquatic and terrestrial and coal fires. The monitoring program will rest with the mines prior to release of the land, but can engage a large element of citizen science once the land is released for its final purpose, including local natural resource management groups and school programs. Monitoring data can be collated and managed through interoperable systems, as outlined below, and made available to all stakeholders, including the development of teaching tools. In addition, long-term monitoring projects can be developed to enhance our understanding of the rehabilitation processes.

A modified monitoring program should also be undertaken during the works to detect any effects that the reclamation activities may have on the environment. The monitoring frequency must be adequate to detect any issues, and be sufficiently comprehensive to ensure public safety and environmental integrity.

Efficacy of proposed works under future climate scenarios

Since the mid-twentieth century, rainfall has decreased in Victoria, droughts have become more severe, and the number of extreme hot days has risen. Climate change projections indicate that these conditions are likely to worsen in the future climate scenarios, creating greater hydrological variability (with consequent ground stability issues), fire risks and impacts on the evolving environmental and ecological systems arising through the rehabilitation The short-term and long-term implications of these changes for restoration activities are currently, however, unknown.

The success of future rehabilitation works will only be realised if the planning is undertaken in consideration of future climate scenarios, including, but not limited to, higher mean annual temperature, altered rainfall patterns and increased risks of fire-weather events.

More specifically, adaptive management and management planning of rehabilitation provide the means to address the knowledge-gaps on the potential impacts of climate change on the rehabilitation area covering biodiversity, flood and fire management, forestry, emergency management and insurance.

Enhancing community wellbeing and capacity through mine rehabilitation

Critical to the success of rehabilitation is to include the local community and other stakeholders in the planning and design stages and, ultimately, the ongoing monitoring to ensure that the rehabilitation options chosen produce the best outcomes for the community and the economy. This can only happen with an inclusive participatory community engagement process that acknowledges the long time-scales that will elapse between the inception of the rehabilitation process and the final release of the land for wider community use.

A range of participatory processes could be used to do this, to uncover the community's values and thus, what feasible rehabilitation options the community would benefit the most from in terms of community wellbeing, health and economic development.

To ensure two-way knowledge sharing with the community and an ongoing learning process throughout the rehabilitation process, tools and programs should be developed to help get the community involved in appropriate aspects of the rehabilitation design. This could include the development of education programs at all levels (primary to tertiary level) around the rehabilitation of each mine site. This will create opportunities for local schools and children to have input into the rehabilitation project through learning about waste management, ecosystems, community decision making process, monitoring processes and economic development.

As site access must necessarily be limited while mining persists and even during initial restoration given the hazards inherent near large machinery, there is nevertheless an opportunity for the community to keep abreast of developments and to engage with the evolution of the rehabilitation. A resource and education centre should be setup. This might utilise the Powerworks complex, as one option. This should have a number of important aspects including a data repository, which would include initial site surveys and evaluation and updated monitoring reports as well as visual displays. In addition, dedicated and regularly updated web pages that contain the agreed scope of works must be considered appropriate outlets for the knowledge sharing between the mine operators and the community. There should also be opportunities for the wider community to get involved with citizen science programs at different stages of the rehabilitation, such as third-stage revegetation and ongoing monitoring of the site, in conjunction with the education programs, once the sites are considered very low risk for such activities.

Online transparency for enhanced community engagement and risk management

Knowledge management encapsulating and distributing all aspects of these rehabilitation processes is complex and requires state-of-the-art web-based spatial knowledge management and planning tools. The field of eResearch is based around development of these tools and can be implemented to: 1) improve data capture, data availability and community engagement, 2) be utilised in ongoing risk- management strategies and 3) encourage the generation of new ideas and research investment with other collaborators, locally to globally. eResearch has the ability to provide the community, practitioners, researchers and industry with place-based information on demand, and hence encourage a deeper understanding, consideration and appreciation of the landscape values of the rehabilitated mines.

Web-based knowledge management and e-Research can provide innovative solutions to:

- Search, filter, analyse and interrogate federated data and information to rapidly provide answers to frequently asked questions, make new discoveries, identify research gaps, or report on restoration activity and its impact on the catchment condition,
- Visually present federated research data, information and knowledge in a way that best conveys the relevant information to Latrobe Valley managers and research practitioners. This can extend to the development of tools capable of presenting interactive, animated visualisations to enhance the comprehension of complex subjects, such as soil health, conjunctive water management, wetland ecology, environmental history or indigenous values,
- Continue and enhance citizen science activity to capture past, current and future data in an interoperable way that makes it effortless and intuitive for the stakeholders, yet enriches and extends the value of the data by creating research-ready datasets,
- Crowd-source data and encourage 'citizen science' and 'citizens as sensors' activities to support land managers, citizens and community groups feel connected and supported in their post-mine rehabilitation interests.

Future Use of Coal Pits

Each of the three mine sites in the Latrobe Valley presents a unique set of engineering and ecological characteristics. It is therefore critical that each of the sites is evaluated and rehabilitated independently to ensure an effective long-term outcome. There is a real opportunity here to return the sites to the community by providing recreation and engagement resources and create long-term and diverse job-prospects for the region, whilst ensuring an optimal environmental outcome.

The objective of mine reclamation is to restore land that has been mined to an economically usable and environmentally viable state. Reclaimed mines can become useful landscapes that meet a variety of objectives, ranging from the restoration of ecosystems to the creation of industrial and municipal resources.

Generally, reclamation of large, deep open pits (such as the coal mine pits in the Latrobe Valley region) is limited if they cannot be backfilled (Bohnet & Kunze, 1990). Under these circumstances, reclamation efforts are limited to allowing the pits to be filled with water. If the water quality can be appropriately managed, these areas can then be used for recreational purposes, such as fishing or as a water reservoir.

It is essential that the future prospects of the pits are underpinned by the four pillars for sustainable development, which are (i) economic prosperity, (ii) environmental protection, (iii) social and community well-being, and (iv) governance (Cherry, 2008).

There are several options that could be considered for the future use of the mine voids, particularly in view of the limited amount of current available fill and water within the pits. Some recent examples of how coal mines elsewhere have been reclaimed/redeveloped are described below:

Filling the void

Mined pits/voids are increasingly becoming important resources for the storage of wastes such as municipal wastes, tailings, heap leach residues, and waste rock. Completely backfilling or partially backfilling coal pits with waste rock, mine waste and residues is an option. In mine closure planning, backfilling voids/pits with waste is considered as best practise, especially in ecologically sensitive environments (Puhalovich & Coghill, 2011).

One of the advantages of backfilling it that it provides an opportunity to return the land contours to close to their original state. Secondly, this option would remove the waste which is currently at the surface – this would help meet potential community expectations and minimise risks from dispersal of contaminants in future fire events.

Development of waste storage needs careful consideration during the planning phase. Backfilling may result in environmental contamination. The time required for backfilling could be lengthy and therefore a long-term management plan for controlling the stability of the continuously open void is required, including any exposure to fire risks.

Waste conditioning through chemical treatment or insertion of barriers may be needed. Ongoing monitoring studies would be required to support any in-pit waste deposition strategy, including gas monitoring, leachate collection and analysis, compaction behaviour, hydraulic conditions and ground stability. Pit liners and barriers may be needed where effluents could be generated and enter the external environment (Puhalovich & Coghill, 2011).

The use of abandoned surface mines to dispose of public waste is common practice in the UK and US, and may also include recycling facilities. Innovative waste management including green waste processing, separation of all recyclable items and development of waste to energy programs could see this as a state of the art facility. Creation of such facilities would lead to jobs creation both during and after construction.

The size of these pits is such that total backfilling is probably unrealistic, but nevertheless there are strong arguments for fully backfilling parts of mines where movement risks are greatest. One example would be to fully backfill the north eastern section of Hazelwood to stabilise the Princes freeway and Morwell town to the north.

Developing grassland, forests of native species and ponds

This would include developing slopes with natural vegetation, flat areas for agricultural use, and a drainage network including watercourses, pools and sediment ponds and water quality control ponds (Ibarra & Heras, 2005). Such activities on the existing overburden dumps at two of the mines at least are already underway but could potentially be further enhanced as locations for engagement with the community on aspects of the final land form for the overall rehabilitated mine site. Figure 1 below provides a visual representation of this reclamation option. Examination of the seedbank in the overburden material would provide valuable information for species selection. Revegetation is critical for containment of airborne particles, encourage slope stability and improve the ecological health of the region, as well as aesthetic values.

Fig. 1. Reclaimed waste rock dumps at an open pit coal mine

Construction of lakes for fisheries, recreation and water retention

Creation of pit lakes is an economically feasible reclamation alternative. Lakes are typically preferred by the public due to their recreational potential for fishing, boating, swimming etc., as well as their aesthetic value (Murdoch *et al*., 2002). Cycling and walking tracks may also be incorporated, with interpretative environmental signage. Lakes may also contribute to the overall ecology of the rehabilitated mining area through the provision of wetland habitat for wildlife.

Creation of pit lakes requires careful consideration. They may be characterised by high concentrations of dissolved solids, sulphate and nitrate. Reclamation work typically includes:

- Recontouring and soil placement on the slopes – waste rock may be required to stabilise slopes
- Creation of a littoral zone and habitat construction
- Inlet and Outlet channel construction by diverting existing streams and channels
- Lake refilling to final elevation
- Flushing the newly constructed inlet and outlet channels to remove sediment (Brinker *et al*., 2011).

Fig. 2. Sphinx lake reclamation at the Cardinal River Operations (Alberta)

Construction of a series of lakes has been used to clean up large scale brown coal pits from the Soviet era. The pit walls were stabilised and massive lakes were created in the mine voids. These were linked in with the country's river network, which created environmental and recreational areas. The lakes provide added benefit such as flood mitigation. There is potential also, providing the quality of the water can be managed to within recommended guidelines for stock and ecological health, that the stored water could be used for environmental flow and/or agricultural use. In addition, these large areas would provide a significant water resource for fire-fighting in the fire season. Implementation of a connected lake network is unlikely to be feasible given the hydrometeorology of the area which indicates that bringing the water level in the voids to levels that will outflow to stream will take both a very long time and will be wasteful of water for two of the mines. Nevertheless, options as a water storage reservoir do exist and could prove to be of significant value in the region.

Fig. 3. Reclaimed brown coal pits.

Development of a "tourism precinct"

Plans to develop a major tourism development on a reclaimed open cast coal mining site in Chesterfield are underway. The development includes a large dome under which the resort will lie, 600 holiday apartments, hotel and hostel units, as well as outdoor sport and leisure facilities (including a golf course). This development would increase tourism to the area, as well as create jobs during and after construction. A development such as this may be a desirable endpoint following infill of a pit from mine spoil and landfill.

Fig. 4. Proposed development of an open cast coal field in Chesterfield, UK.

Bohnet, E.L., & Kunze, L.,1990. Waste disposal––Planning and environmental protection aspects. In: B.A. Kennedy (Ed.), Surface Mining, 2nd Edition. Baltimore, Maryland: Port City Press.

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Cherry, J., 2008. Case studies of successful reclamation and sustainable development at Kennecott mining sites. In: A. Berger (Ed.), Designing the Reclaimed Landscape. New York: Taylor and Francis.

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http://www.acg.uwa.edu.au/_data/page/7436/01_Puhalovich_v3_websamplepaper.pdf
accessed 12 August 2015.

Capabilities

Federation University Australia is the nation's newest university, yet it is the country's third oldest tertiary education institution. As a leading regional university with a reputation for relevance and excellence, FedUni has a strong tradition of education and training delivery which spans more than 140 years via our predecessor institutions, the University of Ballarat and Monash University's Gippsland Campus. FedUni is Australia's only regional, multi-sector university and a pivotal provider of post-secondary education for regional Victoria. Five campuses from the west of Victoria to the east, combined with the Nanya Environmental Research Station in Western New South Wales, anchor the range of programs that FedUni delivers throughout Australia and internationally.

The expertise available to this inquiry and going forward from across FedUni include the following capabilities:

Engineering

Funded by the Victorian Government (through the Department of Economic Development, Jobs, Transport and Resources), Federation University Australia's Geotechnical and Hydrogeological Engineering Research Group (GHERG) focuses on the key issues affecting open-cut mines in the Latrobe Valley, including slope stability, groundwater impacts, environmental rehabilitation and the long-term sustainability of mine sites. Bringing together local and international experts, GHERG works closely with government and industry to further improve the safety and sustainability of the open-cut mines that surround the Gippsland campus.

GHERG's key roles are to:

- Provide broad range geotechnical and hydro-geological research and development support to the Latrobe Valley coal mines;
- Foster research and innovation in coal geotechnical and hydro-geological engineering, particularly in the areas of mine stability, mine monitoring systems and interpretation, ground subsidence, effect on rigid structure such as infrastructure, ground and surface water control in mine, and evaluation of models used in practice;
- Review and develop systems modelling approaches to planning involving issues of mine water quality, contamination, ground subsidence, safety risks, and bushfires.

There is a wealth of understanding from the research carried out by the SECV of short term geomechanical and hydrogeological processes governing ground movements in the early stages of mining the coal, but there is a dearth of information on the long term material properties and processes that will govern the future stability of the mines prior to and post closure. GHERG's current research is largely targeted at understanding the long term behaviour of the materials that make up the geological succession in the Latrobe Valley including the brown coal. These investigations cover the strength and deformability of the materials and the environmental factors that govern coal creep and groundwater flow processes.

Energy

There is extensive experience within FedUni staff in alternate uses of brown coal, including applied research into brown coal based fertilisers, liquid fuels and carbons. A new 2.3M$ EIF funded analytical facility primarily focusing on carbon capture research provides a state of the art local laboratory for the analysis of complex samples such as waste waters, leachates, coal derived materials and aerosols.

There is also significant expertise in alternate energy sources, including biodiesel, anaerobic digestion and algae as a fuel. Waste to food and waste to energy are key areas of development, particularly in the Gippsland dairy and horticulture industries.

Physical Environment

FedUni academics have a broad range of expertise in geology, physical geography and hydrology. This includes slope stability, hazard assessment, wetland hydrology and soils and sedimentary processes. In particular, we have a range of expertise of the occurrence of contaminants in the environment. This includes air pollution, historical contaminants in soils and sediments, dust emissions and fly ash characterisation – in particular volatile organic compounds. We have extensive analytical capabilities in engineering and chemistry for both research and commercial purposes, including analysis of soil, air and water.

Ecology

Researchers in the Centre for Environmental Management have extensive local ecological knowledge and specific skills in fire ecology and mine site restoration. We have expertise in habitat assessment, specifically mine site restoration including terrestrial flora and fauna, birds and soil invertebrates. The influence of fire on shaping landscape and habitat for fauna, particularly in temperate forests, is a key interest. In addition, wetland ecology and evolution – in particular the impact of European land practices on wetlands (river regulation, water abstraction, nutrient enrichment) is a research focus of the Water Research Network.

Community Engagement

We have broad expertise in community engagement and participatory and other decision making processes that will ensure the community feels ownership and pride for the rehabilitated spaces produced. This includes water management decision making, tools for effective community engagement, social impacts of natural disasters, such as fire and landslides, stakeholder reputations in the mining sector, and also projects on climate change adaptation and behaviour change strategies.

We envisage the possibility of citizen science projects in the long-term monitoring of the sites after the early rehabilitation phases during the final stages of mining are complete. We have developed many such programs at school and broader community level. Further, our aims are to empower communities to be involved in environmental projects through knowledge sharing, shared decision making, participatory monitoring, citizen science and education programs. This can have a strong positive impact on community resilience and capacity, social wellbeing and sustainability of the region.

Data Management

The Centre for eResearch and Digital Innovation (CeRDI) at FedUni has established national and international recognition in innovative spatial information systems. FedUni Spatial showcases the diverse range of projects that are supported. Projects share common goals to inform 'big picture' understanding and enhance decision making, create greater efficiencies in communication, increase the quality of information and support policy formulation and evaluation. These include development of interoperable web sites for knowledge management and making research ready datasets. Examples of these include Visualising Victoria's Groundwater, Fire and Emergency Management Planning portal, Soil Health Knowledge Base, NRM Planning Portal and SWIFFT. These methods ensure that the community remains informed of ongoing research and activity and other relevant stakeholders are equipped with data management tools to make ongoing informed decisions.

Optimal Decision Making

The Federation Learning Agents Group (FLAG) provide expertise in reinforcement learning, which is a computational method for developing optimal strategies for sequential decision-making tasks. Such tasks arise naturally in environmental rehabilitation and maintenance, and reinforcement learning approaches have previously been successfully applied in areas such as preventing the spread of invasive species, and managing the release of water from reservoirs. FLAG researchers have pioneered the extension of reinforcement learning to problems that involved multiple competing objectives, which facilitates decision support when balancing environmental, economic and social factors. As such FLAG's research has the potential for application to various aspects of the ongoing management of the rehabilitation process, building on the models developed by the other members of FedUni's team.

Mathematical modelling and simulation of climate, power systems, biological processes, movement of people and employment, prediction of environmental factors or transport of pollution can all be undertaken by FedUni researchers and be used to inform the decision-making algorithms.

Sustainability

The National Centre for Sustainability at FedUni has experience in sustainability design and implementation and, in particular, community decision making. The NCS has extensive experience in South West Victoria, the Wimmera and in metropolitan and coastal councils, and a range of catchment management authority projects spanning Soil Health, NRM Planning and Climate Adaption. In addition, FedUni has numerous contacts in the Gippsland region through the Regional Centre for Expertise in Education for Sustainability.

Collaborative Partnerships

FedUni's research partnerships throughout the Gippsland region include:

Energy Industry Research and Development
Brown Coal Innovation Australia
CO_2 Co-operative Research Centre (CO2CRC)
CSIRO Energy Flagship
AGL Energy
GDF Suez
Energy Australia
Australian Paper
Department of Economic Development, Jobs, Transport and Resources

Natural Resource Management Agencies
Department of Environment, Land, Water and Planning
Environmental Protection Authority, Victoria
West Gippsland Catchment Management Authority
Parks Victoria
Gippsland Water
Southern Rural Water
Co-operative Research Centre for Bushfire and Natural Hazards
Co-operative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE)
Arthur Rylan Institute
Office of the Victorian Commissioner for Environmental Sustainability
Regional Universities Network Water Research Flagship
Bureau of Meteorology

Agricultural Research
Gippsland Food Cluster
Regional Universities Network Precision Agriculture Flagship
Research and Innovation Network for Precision Agriculture Systems (RINPAS)

Local Council and Community Groups
Latrobe City Council
Wellington Shire Council
Gunaikurnai Land and Waters Aboriginal Corporation
Field and Game Australia
Valley Field Naturalists
Greening Australia
Water Watch
Birdlife Australia

Final Remarks

Federation University supports the Victorian State Government's approach in deeply understanding and responding to the issues associated with the Mine Fire in relation to the industry, community and long-term environmental health of the region. We trust that the information enclosed in the above document will make it apparent how FedUni can contribute to achieving the Government's desired outcomes.

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