Springsure Creek Agricultural Co-existence Research Committee (ACRC)

Draft Co-existence Research Plan

2013 – 2016

Title	Reviewer	Review Date	Version	Version Controller
ACRC Research Plan	D Hamilton	13 June 2013	11.1	Rachel Gibson

TABLE OF CONTENTS

Appendices

List of Figures

List of Tables

Springsure Creek Agricultural Coexistence Research Committee

The purpose of the Springsure Creek Agricultural Coexistence Research Committee is to guide the Coexistence Research program in the following:

- Setting the research framework, questions and program;
- Developing criteria for selecting research providers;
- Receiving quarterly updates (progress reports/results) from the researchers;
- Providing guidance of research (advice on any research issues);
- Timing of research; and
- Disseminating research findings to relevant stakeholders.

Members of the Committee:

- David Hamilton – Hamilton Agriculture (Current Chairman)
- Professor Steven Raine – Deputy Dean and Associate Dean (Academic) within the Faculty of Engineering and Surveying at University of Southern Queensland;
- Professor Helen Ross (and Associate Professor Jim Cavaye while Helen Ross is on sabbatical leave) – School of Agriculture and Food Science University of Queensland;
- Dr David Freebairn, Soil Scientist, Principal Environmental Scientist, RPS Australia East Pty Ltd
- Professor Robert Darmody, Professor of Soil Science, University of Illinois at Urbana-Champaign
- Representative from Agforce (to be nominated);

EXECUTIVE SUMMARY

This Draft Co-existence Research Plan has been developed by the Springsure Creek Agricultural Co-existence Research Committee (ACRC). The ACRC has been established to guide co-existence research aimed at:

- Maintaining natural resources and agricultural productivity during mining operations and enabling restoration of agricultural productivity on areas affected by mining activities including subsided areas; and
- Understanding community expectations and identifying strategies to minimise adverse impacts and maximise the social and economic benefits of the mining investment.

A characteristic of longwall mining is the associated subsidence of the land surface after coal extraction. The most likely infield impacts of subsidence due to longwall mining will be:

- Tensile cracks and compression areas forming in the surface soils near the pillar zone leading to potential changes in soil-water relations in this zone;
- Steeper microrelief in areas adjacent to the pillars which may affect surface water movement and soil erosion risk;
- Changes to drainage patterns and an increased potential for infield surface water ponding or areas of poor drainage within fields depending on the level of subsidence and natural topography; and
- Changes to drainage water volumes or water quality flowing from subsided land.

One of the most likely responses to mitigating soil erosion risk and surface drainage issues will involve the installation and/or redesign of erosion control measures including contour banks and waterways. However, the installation of erosion control structures in fields where these have not existed previously has the potential to impact on the efficiency of farm operations if not designed to complement the farming system. Similarly, there is a need to ensure effective engagement with landholders and the development of appropriate co-existence strategies that adequately incorporate their landholder and local community needs.

Bandanna Energy is funding a research program with an investment of approximately $2.1 million over the first three years of the program and a further $0.75 million in the following two years. The research investment will occur across four major research areas:

- Benchmarking productivity;
- Assessing and managing biophysical impacts;
- Developing effective farming systems; and
- Understanding community expectations and maximising investment benefits.

Details on the proposed project activities within each research area are provided in the body of the plan report.

Feedback is invited on all aspects of the research plan by Friday 19 July 2013.

1.0 INTRODUCTION

1.1 Background

This Draft Co-existence Research Plan has been developed by the Springsure Creek Agricultural Co-existence Research Committee (ACRC).

The ACRC has been established to guide co-existence research aimed at:

- Maintaining natural resources and agricultural productivity during mining operations and enabling restoration of agricultural productivity on areas affected by mining activities including subsided areas; and
- Understanding community expectations and identifying strategies to minimise adverse impacts and maximise the social and economic benefits of the mining investment.

1.2 Review and feedback on Draft Co-existence Research Plan

The ACRC intends to develop this research plan in full consultation with local stakeholders and will seek community input before research is commissioned.

ACRC will also seek feedback from the following stakeholder groups:

- Adjacent farmers;
- Agforce;
- Department of Natural Resources and Mines;
- Department of Agriculture, Fisheries and Forestry;
- Queensland Farmers Federation;
- Central Highlands Regional Council;
- Central Highlands Development Corporation;
- Central Highlands Regional Resources Use Planning Co-operative Ltd;
- Fitzroy Basin Association; and
- Community members.

1.3 Location

The Co-existence Research Plan is based in the central Queensland and directly relates to the proposed Springsure Creek Coal Mine, refer to Figure 1.

1.4 Commissioning the research

After consultation with the agricultural community and examination of existing experience, the ACRC will seek Expressions of Interests (EOIs) from potential research providers. The ACRC will ensure that the research commissioning process will be open and transparent. Once the Research Plan has been finalised, the research portfolio will be managed on a project basis and overseen by the ACRC.

A review of relevant literature will be required as part of each research project. This is aimed at building on current knowledge. The committee is aware of considerable local research undertaken on soils and farming systems and research on rehabilitation and restoration of productivity elsewhere such as in Illinois USA.

Figure 1: Location of the proposed Springsure Creek Coal Mine

2.0 POTENTIAL IMPACTS OF LONG WALL MINING AND KEY RESEARCH OBJECTIVES

A characteristic of longwall mining is the associated subsidence of the land surface after coal extraction. Extraction in "bays" of subsided land with dimensions of several hundred metres width and up to several kilometres length. The depth of subsidence varies with the depth of the extracted coal seam and the depth of the coal beneath the land surface.

The land directly above the longwall at Springsure Creek is expected to subside between 1.2 to 2.3 metres and the "pillars" are expected to subside between 0.2 to 1 metres (refer Appendix A). The major changes to soils and land surface slope will occur in the zone directly above and adjacent to the pillars. This zone is expected to be approximately 5% of the total area (15 m in 300 m) affected by mining operations. Figure 2 shows a conceptual diagram of the expected change to landform following subsidence.

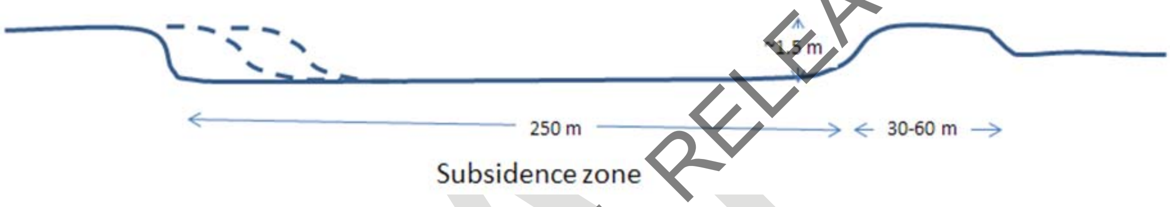


Figure 2: A conceptual diagram of landscape changes associated with longwall mining

2.1 Potential impacts on natural resources and agricultural productivity

The most likely infield impacts of subsidence due to longwall mining will be:

- Tensile cracks and compression areas forming in the surface soils near the pillar zone leading to potential changes in soil-water relations in this zone;
- Steeper microrelief in areas adjacent to the pillars which may affect surface water movement and soil erosion risk;
- Changes to drainage patterns and an increased potential for infield surface water ponding or areas of poor drainage within fields depending on the level of subsidence and natural topography; and
- Changes to drainage water volumes or water quality flowing from subsided land.

Without amelioration and appropriate management, these impacts may affect agricultural productivity through changes in soil functions and water flows (both surface runoff and deep drainage). Hence, this research program will need to achieve the following objectives:

Objective (a)	evaluate the impact of subsidence on productivity,
Objective (b)	evaluate the impact of subsidence on soil physical properties, soil-water relations, erosion and drainage, and
Objective (c)	develop appropriate engineering and agronomic management practices to mitigate the impacts of subsidence and maintain productivity.

2.2 Potential impacts on farming systems and logistics

One of the most likely responses to mitigating soil erosion risk and surface drainage issues will involve the installation and/or redesign of erosion control measures including contour banks and waterways. New soil conservation designs and structures may be required, or at least modification of current soil conservation structures (**Error! Reference source not found.**). However, the nstallation of erosion control structures in fields where these have not existed previously has the potential to impact on the efficiency of farm operations if not designed to complement the farming system.

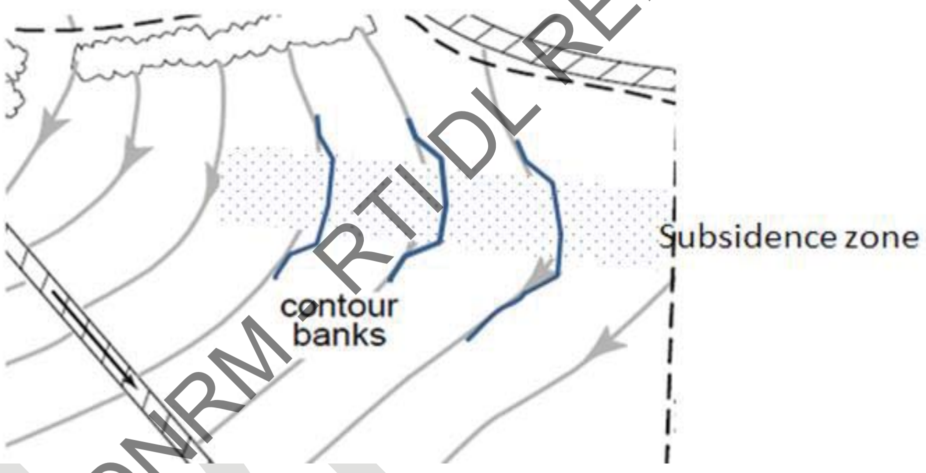


Figure 3: A conceptual diagram of possible changes in contour banks associated with subsidence

The design and installation of erosion control and drainage structures will need to consider the implications for field layouts, cultivation patterns, irrigation design and management, as well as farm machinery (e.g. cultivation, seeding, harvesting etc) constraints. The potential to use agronomic management practices (e.g. controlled traffic, crop stripping and stubble retention) to enhance production and erosion control should also be considered. Hence, this research program will need to achieve the following objectives:

Objective (d)	evaluate the potential impacts of subsidence mitigation structures and management practices on farming logistics; and
Objective (e)	develop erosion control structures and agronomic management practices that enable efficient and sustainable farming operations on subsided land. (links to (c) above)

2.3 Understanding community expectations and maximising the benefits of mining investment

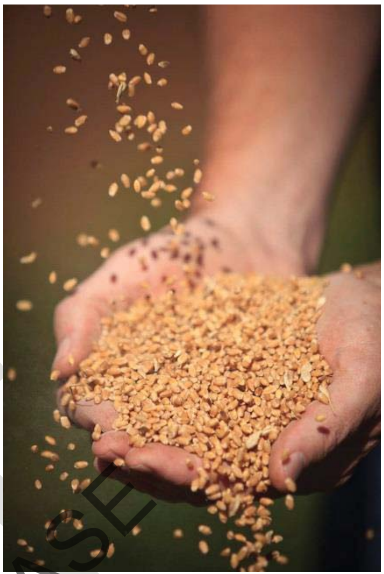
The community most affected by the mining proposal is the local community of landholders. Most socio-economic research focuses on impacts for towns, such as effects on housing, employment, infrastructure and social networks. The effective engagement with landholders and the identification of appropriate co-existence strategies that account for their needs will require an understanding and acknowledgement of:

- How landholders interact with and experience mining operations;
- How landholders want to be engaged by mining companies and how engagement could be improved;
- The additional time, expertise and costs involved for landholders to respond and adjust to co-existence with mining operations; and
- The emotional adjustment involved such as impacts on community identity and feelings of stewardship, heritage and fears for the future. This would include how landholders perceive risks and benefits, interpret information and go through the emotional adjustment of unchosen change.

Hence, this research program will need to achieve the following objectives:

Objective (f)	Assess the nature and extent of the human, social and economic impacts of the Bandanna operations on landholders
Objective (g)	Determine the adjustments required by landholders and by Bandanna for agricultural and mining operations to best co-exist
Objective (h)	Determine how landholders be best engaged by Bandanna and mining companies generally

3.0 RESEARCH FRAMEWORK AND INVESTMENT



Bandanna Energy is funding a research program with an investment of approximately $2.1 million over the first three years of the program and a further $0.75 million in the following two years. This investment may also be used as seed funding to encourage other research funding (e.g. ACARP, GRDC) and provider organisations (e.g. Universities, Government agencies, regional bodies and CSIRO) to co-invest in research outcomes.

To address the research objectives, the research investment will occur across four major research areas:

- Benchmarking productivity,
- Assessing and managing biophysical impacts,
- Developing effective farming systems, and
- Understanding community expectations and maximising investment benefits.

Several project activities will be undertaken within each of the major research areas and the research activities are expected to be undertaken concurrently.

Key research questions within the major research areas include:

3.1 Research Area 1 - Benchmarking productivity

- *What is the impact of longwall mining on farm productivity and sustainability?*
- *Given the difficulties in quantifying long term productivity and resource condition (sustainability), how do we best integrate the various measures above to provide an objective assessment of system changes?*

3.2 Research Area 2 - Assessing and managing biophysical impacts

- *What happens to the soil properties and behaviour with subsidence?*
    - *Is soil structure in top 2 m impacted? Does the nutrient profile change? What impact is there on infiltration of rainfall and irrigation? Is deep drainage or subsurface lateral water flows affected? If changes are detected, how can they be managed?*
- *Is soil erosion risk increased by changes in landform?*
    - *What are the slope and slope length changes? What impact on contour bank design and workability? If changes are likely, how can they be best managed?*
- *Will subsidence impact on ponding and drainage, particularly in low slope areas?*
    - *Is poor drainage likely in low slope conditions such as flood plains?*
    - *How is ponding and poor drainage best managed?*
- *Does longwall mining and associated infrastructure impact on water quality in the local sub-catchment? What are the best methods to detect changes at the local sub-catchment scale?*

3.3 Research Area 3 - Developing effective farming systems

- *Does subsidence affect farm logistics through changes in landform?*
  - *What is the impact of subsidence and redesigned contour banks on tillage, irrigation and harvest logistics?*
  - *What are appropriate contour bank and irrigation designs/layouts for these farming systems?*
  - *If impacts are likely, how can they be effectively managed?*

3.4 Research Area 4 - Understanding community expectations and maximising investment benefits

- *What is the nature and extent of the human, social and economic impacts of the Bandanna operations on landholders?*
  - *How do landholders perceive and experience Bandanna and mining operations generally (including the time, expertise and costs involved for landholders to respond and adjust to mining proposals)?*
  - *What are the social dynamics of landholders that are impacted, or potentially impacted, by mining?*
  - *What are the social risks and benefits of the Bandanna proposal?*
  - *What are the community economic risks and benefits (as opposed to specific economic impacts on farming systems addressed above)?*
  - *What are the broader cumulative impacts of the mine in the region?*
- *What are the adjustments required by landholders and by Bandanna for agricultural and mining operations to best co-exist?*
  - *How do landholders adjust socially and emotionally to mining proposals? What could assist in landholders and other stakeholders feeling more empowered and able to adjust to change?*

- *What is needed to encourage informed negotiation and give all parties full capacity to participate in an informed open process?*

- *How can landholders be best engaged by Bandanna and mining companies generally?*
  - *What is the best way to provide community awareness and information of what is proposed and how landholders and others can interact with Bandanna.*

A summary of the relationship between the research areas, objectives, proposed projects and indicative investment by Bandanna Energy is provided in Table 1.

Table 1: Summary of proposed research investment

RAC Role	Research Area	Research Objectives	Project activities	Indicative budget
Maintaining natural resources and agricultural productivity	1.Benchmarking productivity	*(a) Evaluate the impact of subsidence on productivity*	*1.1 Assessing productivity changes in a variable environment*	*$150,000 /3 years*
	2. Assessing & managing biophysical impacts	*(b) Evaluate the impact of subsidence on soil physical properties, soil-water relations, erosion and drainage* *(c) develop appropriate engineering and agronomic management practices to mitigate the impacts of subsidence and maintain productivity*	*2.1 Assessing the impact of subsidence on soil properties and the soil-water balance* *2.2 Assessing and managing erosion risk* *2.3 Managing drainage and ponding with subsidence* *2.4 Assessing local sub-catchment impacts on water*	*$550,000 /5 years* *$500,000 /3 years* *$150,000 /5 years* *$410,000 / 5 years*
	3. Developing effective farming systems	*(d) Evaluate the impact of subsidence mitigation structures and management practices on farming logistics* *(e) develop erosion control structures and agronomic management practices that enable efficient and sustainable farming operations on subsided land.*	*3.1 Assessing and managing the impact of subsidence on farm logistics*	*$450,000 5 years*
Understanding community expectations and maximising the benefits of mining investment	4. Understanding community expectations and maximising investment benefits	*(f)Assess the nature and extent of the human, social and economic impacts of the Bandanna operations on landholders* *(g)Determine the adjustments required by landholders and by Bandanna for agricultural and mining operations to best co-exist* *(h)Determine how landholders be best engaged by Bandanna and mining companies generally*	*4.1 Understanding community impacts and maximising investment benefits*	*$300,000 /3 years*

4.0 RESEARCH PROJECT ACTIVITY OUTLINES

4.1 Research Area 1 - Benchmarking productivity

Table 2: Project 1 – Benchmarking productivity

Project 1.1 Assessing productivity changes in a variable environment	
Why?	Maintenance of "productivity" underlies the public expectation of longwall mining. While assessing productivity changes is problematic, there is a high expectation that an appropriate measure and benchmarks can be defined. This activity will produce a process that is robust and transparent to a wide range of audiences.
What are the research questions?	What is the impact of longwall mining on farm productivity and sustainability? Given the difficulties in quantifying long term productivity and resource condition (sustainability), how do we best integrate various productivity measures to provide an objective assessment of system changes?
Style of research, time frame, scale (how, where, when)	Given the variable nature of the environment and the multiple components that lead to a level of productivity, it is expected that a "multiple lines of evidence" approach will be required. An initial scoping study will evaluate the availability of local benchmarking data and the potential to use modelled productivity to account for spatial and temporal variations. This initial 3 month scoping study can be progressed immediately with a key outcome being the recommended protocol for assessing productivity changes. This protocol will then need to be implemented, evaluated and refined over at least three seasons
What is already known?	That assessing changes in production, profit and environmental outcomes has been extremely challenging across agriculture in general, even when associated with long term and large investments. Direct measurement of many production indices results in measurement of the ambient conditions, not changes associated with an intervention. Multiple lines of evidence, while not definitive, can deal with both "soft" and "hard" links to performance
Links with other data collection	It is envisaged that the initial scoping activity will be a synthesis of information from all available sources and that ongoing implementation will require access to local benchmarking and other biophysical data.
Research providers and co-investors (who)	Open call for methodology and implementation from Universities, CSIRO, Qld Govt agencies and private providers. Possible co-investment from GRDC, CRDC.

Project 1.1 Assessing productivity changes in a variable environment	
Indicative cost and time frame (when, cost)	Initial scoping study – 3 months ($30,000) Implementation, evaluation and refinement – 3 years ($120,000)

4.2 Research Area 2 - Assessing and managing biophysical impacts

Biophysical impacts are likely to occur infield through changes in soil properties and the soil-water balance, changes in erosion risk and changes in ponding and drainage. Surface hydrology changes may also impact on the quality and quantity of water run-off. Hence, the key project activities in this Research Area will involve:

- Assessing the impact of subsidence on soil properties and the soil-water balance
- Assessing and managing erosion risk
- Managing drainage and ponding with subsidence
- Assessing local sub-catchment impacts on water.

Table 3: Project 2.1 - Assessing the impact of subsidence on soil properties and the soil-water balance

Project 2.1 Assessing the impact of subsidence on soil properties and the soil-water balance	
Why?	Soil is the primary natural resource controlling production. Subsidence will result in some sheer and compression during subsidence. Infield crop productivity is a function of the efficiency of rainfall capture and storage. Subsidence is likely to affect all aspects of the water balance and there is a need to understand the nature and magnitude of these impacts to develop and target appropriate mitigation strategies. Observational studies may well describe whether these impacts are important to soil-water and nutrition.
What are the research questions?	What happens to the soil properties and behaviour with subsidence? • macro-scale changes soil structure (top 2 m) impacted? • nutrient profile changes Does subsidence affect the infiltration of rainfall and irrigation? What is the impact on infiltration and deep drainage, potential for subsoil seepage/scalding, run-off and sediment movement, compaction impacts on soil water storage? If changes are detected, how can they be managed? If so, at what scale (e.g. localised, field level)?
Style of research, time frame, scale (how, where, when)	Preliminary examination of subsided sites suggests that changes to friable cracking clays may be subtle, but this proposition is fundamental to supporting claims one way or the other re LWM operations on in-situ productivity potential. This research will provide the fundamental understanding of subsidence impacts on the soil and crop water balance. It will require soil mapping and site characterisation and involve soil pit transects for detailed pedology description, the measurement of infiltration under both rainfall and irrigation, soil-water storage, crop water uptake, soil nutrient profile assessment, deep drainage and run off.

Project 2.1 Assessing the impact of subsidence on soil properties and the soil-water balance	
	Where possible preliminary measurements could use existing site case studies. However, this work will primarily occur at "DenLo Park" during and after subsidence. This work will be conducted under the pivot (i.e. irrigated cropping) but consideration should also be given to extending the trial to dryland cropping and pasture sites.
What is already known?	Soil responses to surface conditions well understood in general. Few specific published studies, although basic soil description (chemical, physical incl. pedology) will provide enable initial estimates of likely impacts.
Links with other data collection	Detailed soil mapping as baseline, use key reference sites if available. At the field site, irrigation and field operational data collected by CFM.
Research providers and co-investors (who)	Open call for methodology and implementation from Universities, CSIRO, Qld Govt agencies and private providers. Possible co-investment from ACARP.
Indicative cost and time frame (when, cost)	5 years Baseline measurement will be taken on cropped fields prior to subsidence (approximately 2 years) and a further 3 years of measurements on subsided fields. Capital costs – approximately $150,000 Operating costs – approximately $80,000/year ($400,000 over 5 years)

Table 4: Project 2.2 – Assessing and managing erosion risk

Project 2.2 Assessing and managing erosion risk	
Why?	Subsidence is likely to impact on crop productivity and erosion by increasing run-off and sediment movement. This research will develop strategies to reduce run-off and erosion on subsided land. Soil erosion is a recognised threat to the soil resource in Central Queensland. Changes in landform may increase erosion risk due to increased slopes on the 'drop down" zone associated with pillars and other changes in drainage lines. Although not frequent, high intensity storms and rainfall events which can produce over 250mm of rain in a matter of days can be very destructive. Infiltration is also a key aspect of agricultural productivity. Almost all the water a crop uses is stored in the soil at some stage. This applies to both irrigated and rain grown crops. Apart from managing surface water with contour banks (and this will still be a requirement for sloping lands in central Queensland) surface cover (preferably with a standing crop) is the most effective way of preventing runoff and soil loss. Surface cover also greatly increases

Project 2.2 Assessing and managing erosion risk	
	infiltration. Farming practices and crop rotations which maximise surface cover are essential for sustainable production. Surface roughness is helpful to a limited extent, but by maintaining standing stubble and maintaining root channels and by limiting the impacts of raindrops, soil erosion can be minimised. Anecdotal evidence suggests that revised soil conservation layouts can accommodate the new landform after subsidence. This proposition needs to be further tested and documented.
What are the research questions?	Do changes in landform (slope and slope length) and changes in contour design change erosion risk including implementation of conservation tillage systems? What strategies can be used to maintain/maximise crop production and sustainability? If changes are likely, what are the benefits derived from surface cover, surface roughness and contour banks? How can impacts be best managed?
Style of research, time frame, scale (how, where, when)	This project will develop infield mitigation strategies to maximise crop production and minimise environmental impacts on subsided land. It will investigate soil and crop management strategies to reduce run-off and sediment movement and the design . Desktop study using detailed topographic data and established soil conservation design processes, as well as experience from currently subsided land, analyse changes in soil conservation layout and possible changes in soil conservation structures
What is already known?	Existing subsided areas have revised soil conservation layouts which appear to function satisfactorily. These areas are probably well suited to case studies
Links with other data collection	Topographic information from existing subsided areas on other mines. Baseline soil and topographic data on site. Soil conservation experience in the region (mainly Qld Govt) Surface water data (SCC) and field production data (CFM) Link to Project 2.3 for infield evaluation component.
Research providers and co-investors (who)	Open call for methodology and implementation from Universities, CSIRO, Qld Govt agencies and private providers. Possible co-investment from ACARP.
Indicative cost and time frame (when, cost)	Minimum 3 year project including: (a) Initial review of related research in central Queensland (3 months) (b) Case studies of existing subsided areas (6-12 months) (c) Studies to measure the impact of surface cover and

Project 2.2 Assessing and managing erosion risk	
	roughness on runoff in both subsided and natural situations. As well as new farming system options, technology adoption, row spacing, crop mix, rotation, etc (as above) (d) Evaluations of contour bank and detention basin design options Initial review & case studies – approximately $50,000 Surface cover and contour bank risk modelling and evaluation - approximately $450,000 (over 3 years)

Table 5: Project 2.3 – Managing drainage and ponding with subsidence

Project 2.3 Managing drainage and ponding with subsidence	
Why?	Subsidence in low slope areas is likely to impact on water flow and create depressions. Wet areas will hinder normal agricultural operations.
What are the research questions?	Will subsidence impact on water flows and drainage in low slope areas? Is poor drainage and waterlogging likely in flood plains and low slope areas? How should poor drainage and infield ponding be managed? Is there a lower slope limit beyond which restoration of productivity following subsidence is either impractical or too expensive?
Style of research, time frame, scale (how, where, when)	Two step process: (a) Initial study involving both a desktop assessment and evaluation of impacts observed in existing subsided case study sites. Desktop assessment would use detailed topographic data and established soil conservation design processes, as well as experience from currently subsided land, to identify scale of poor drainage, likely impact on production, and propose amelioration options for field evaluation. (b) Implementation of amelioration options and evaluation of wet areas and pondage after rainfall and overland flow at "DenLo Park". This work should be undertaken in conjunction with Project 2.2 and Project 3.1 activities.
What is already known?	Anecdotal evidence from subsided areas at other sites indicates areas of poor drainage do occur depending on final landform. However there is little information on the spatial scale of this issue and temporal impacts on production. The potential for poor drainage and ponding would be expected to be greater on flat and low lying areas affected by subsidence.
Links with other data collection	Topographic analysis Preliminary assessment completed as part of EIS studies

Project 2.3 Managing drainage and ponding with subsidence	
	Soil conservation experience in the region (DNRM) Links to Project 2.2 in relation to water flow paths and infield design of drainage lines and infrastructure.
Research providers and co-investors (who)	May be direct follow on from hydrological studies completed by EIS hydrology consultant. Otherwise open call for methodology and implementation from Universities, CSIRO, Qld Govt agencies and private providers.
Indicative cost and time frame (when, cost)	(a) Analysis of infield drainage and ponding impacts along with assessment of and design options to ameliorate impacts (6 months). ($50,000) (b) Implementation should be conducted along with Project 2.2 activities. (additional investment for monitoring and evaluation $100,000 over 5 years)

Table 6: Project 2.4 – Assessing local sub-catchment impacts on water

Project 2.4 Assessing local sub-catchment impacts on water	
Why?	Subsidence from longwall mining may impact on hydrology, hydraulics, erosion and water quality at the sub-catchment scale. Soil erosion represents degradation of the soil resource. Water quality leaving paddocks impacts on downstream ecology function and water users. Management actions can mitigate impacts.
What are the research questions?	How does subsidence and mining infrastructure impact on hydrology and water quality in the local sub-catchment? What are the best methods to detect changes at the sub-catchment scale? What is the contribution from various land use units within the catchment to any impacts on soil stability, hydrology and water quality? What management strategies are required to mitigate impacts?
Style of research, time frame, scale (how, where, when)	Sub-catchment water flow and quality measurements will be undertaken pre-mining to provide baseline data on sub-catchment attributes. Ongoing measurements will be used to identify changes in sub-catchment run-off and water quality which could be attributed to mining and/or changes in the farming operations activities. These measurements will also provide a basis to better understand the contribution to run-off from different soils/fields/farming system components. Monitoring of hydrology, erosion and water quality and implementation of an adaptive risk assessment process will support a quantitative assessment of the performance of the landscape pre, during and post mining. This data will need to be well managed,

Project 2.4 Assessing local sub-catchment impacts on water	
	archived and analysed (should not be assumed).
What is already known?	Links between soil conditions (cover, slope, soil type) and hydrology and erosion well understood in general terms, some local studies available, models available (see Capella study in www.howleaky.net). Analyses in the EIS have indicated changes (some positive, some negative) in hydrology and water depth during floods. If negative impacts are observed, the monitoring program will be well positioned to pinpoint failure and target amelioration actions. Local and overseas experience needs reviewing.
Links with other data collection	Infield data collected in project 2.2. Surface hydrology data (SSC) Field operations and production data (CFM) Monitoring of hydrology and water quality associated with EIS requirements.
Research providers and co-investors (who)	Maintenance/monitoring at permanent sites – Bandanna or consultants. Additional sites – Bandanna or open call for methodology and implementation from private providers, CSIRO or Universities.
Indicative cost and time frame (when, cost)	Ongoing mine inflow and outflow monitoring required for the lease area by the EA is expected to be for mine life. Baseline sub-catchment measurements by this project will be initiated before mine start-up and continue for a minimum 5 years after the initial subsidence before review. Capital costs for additional sites – approximately $210,000 ($35,000 for five year sites x 6) Operating costs – approximately $200,000 over 5 years (approximately $40,000/year x 5 years)

4.3 Research Area 3 - Developing effective farming systems

Table 7: Project 3.1 – Assessing and managing the impact of subsidence on farm logistics

Project 3.1 Assessing and managing the impact of subsidence on farm logistics	
Why?	Changes in landform associated with subsidence may impact on the farm operations including tillage, spraying, planting, harvest and irrigation. The adoption of appropriate farm design and agronomic management practices are likely to be required to mitigate the impacts of subsidence on farming operations, crop productivity and sustainability. Current commercial machinery in the district is large-scale board acre farming standards. For instance, tillage and harvesting machines are commonly up to 12m wide, planting machines 12 – 24m wide and spraying machines 18 – 36m wide. Farmers can currently cope with this machinery on land where broad-based contour banks are present, but subsidence after underground mining is expected to result in much greater variation in gradient, slope length and direction than currently exists. This is expected to cause increased difficulty in conducting farm operations. While the impacts appear to be manageable in similar situations (experience in CQ), there is a need to quantify changes in farm logistics and management and where appropriate, develop appropriate infrastructure design and management practices to mitigate these impacts. Some modification of farm machinery may be also be required.
What are the research questions?	What will be the impact of subsidence on the conduct of commercial farming operations? For example, does subsidence affect farm logistics through changes in landform? - Contour bank layout and design - Irrigation design and management - Tillage, irrigation and harvest logistics What mitigation strategies will need to be implemented to enable continued commercial farming operations on subsided cropping land?
Style of research, time frame, scale (how, where, when)	This project will investigate how subsidence and changes to soil conservation and farming infrastructure will impact on farm operations. In conjunction with related projects (Projects 2.2 and 2.3) on managing the impact of subsidence on in-field rainfall capture, runoff, erosion and agronomy, this project will investigate solutions that enable practical and commercial farming operations to continue on subsided land. Mitigation measures may include one or more of earthworks, machinery modification and/or design, and change in farming systems and practices. An initial desktop and case study will be undertaken using detailed topographic data, established soil conservation design expertise and

Project 3.1 Assessing and managing the impact of subsidence on farm logistics	
	agricultural engineering expertise, as well as experience from currently subsided land, analyse changes in farm layouts including soil conservation structures. This will produce farm layouts, infrastructure designs or machinery modifications that would be expected to minimise impacts on farming logistics. These mitigation measures will be implemented on the first areas of "Denlo Park" to be subsided. They will subsequently be evaluated and where appropriate, refined over the following three years.
What is already known?	Experience from similar landscapes in the region and overseas
Links with other data collection	Subsidence management plan (SCC) Access to topographic information or collection from existing subsided areas Project 2.2 and 2.3 Field operations and production (CFM)
Research providers and co-investors (who)	Agricultural engineering (private) and soil conservation experience (QG) Farm planning and topographic analysis businesses (QG and private)
Indicative cost and time frame (when, cost)	Total $450,000 over 5 years: (a) Initial desktop and case studies - 12 months ($100,000) (b) Field trials – 5 years ($350,000) - 2 years of baseline data prior to subsidence - 3 years of monitoring data after subsidence

4.4 Research Area 4 - Understanding community expectations and maximising investment benefits

Table 8: Project 4.1 – Understanding community expectations and maximising investment benefits

Project 4.1 Understanding community expectations and maximising investment benefits	
Why?	Effective engagement with landholders and the identification of appropriate co-existence strategies that account for their needs will require an understanding and acknowledgement of: - how landholders interact with and experience mining operations, - how landholders want to be engaged by mining companies and how engagement could be improved, - the additional time, expertise and costs involved for landholders to respond and adjust to co-existence with mining operations, and - the emotional adjustment involved such as impacts on community identity and feelings of stewardship, heritage and fears for the future. This would include how landholders perceive risks and benefits, interpret information and go through the emotional adjustment of unchosen change.
What are the research questions?	What is the nature and extent of the human, social and economic impacts of the Bandanna operations on landholders? What are the adjustments required by landholders and by Bandanna for agricultural and mining operations to best co-exist? How can landholders be best engaged by Bandanna and mining companies generally?
Style of research, time frame, scale (how, where, when)	Some initial scoping of the research will be needed with key people in the community to consider the feasibility, risks and benefits of the work.
What is already known?	The current conflict and protest by landholders is a major risk for the research. This conflict is likely to continue and even if the research was conducted in a year or more, it is likely that considerable emotion will be involved.
Links with other data collection	
Research providers and co-investors (who)	Open call for methodology and implementation from Universities, CSIRO, Qld Govt agencies and private providers. Possible co-investment from ACARP.
Indicative cost and time frame (when, cost)	$300,000 over 3 years

5.0 COMMUNICATION

The value of this research investment will be judged by a wide range of stakeholders based on their perception of quality and validity of the research activities. Hence, an important component of any research program is the engagement of key stakeholders in all stages of the research activities. In the context of this research plan, the key stakeholders include the relevant government agencies (e.g. DEHP, DNRM) and local landholders, as well as the broader regional community including the local regional Council. In all cases, there is a need to ensure that stakeholders are appropriately informed of the design, implementation and results for this research investment. Bandanna will undertake to develop a communication plan to effectively engage and inform stakeholders of the co-existence research project activities.

6.0 CHALLENGES OF CROPPING IN THE CENTRAL HIGHLANDS OF QUEENSLAND

Field crop agriculture in Central Queensland faces many challenges, but in particular, a variable rainfall with evaporative demand exceeding average rainfall by 2-3 times in all months means water management is a crucial part of management. Soil depth is often shallow and variable within a paddock with crop type and management skills all contributing to productivity in any one season. As a result, crop yields are highly variable and to a large degree unpredictable in any one season.

Other challenges include the high erosion risks as a result of intense rainfall and erodible soils and soil fertility decline associated with cropping. These challenges are expanded below to emphasise some features of managing agriculture in the region, whether it be mined and subject to subsidence or left in its current developed state. It should be kept in mind that much of the region was under natural grassland or brigalow forest before development, so significant change in landscape use and processes is not new.

Understanding the research challenge involves knowledge of agricultural systems and process in Central Queensland, including:

- Water supply and temperature;
- Nutrient supply;
- Soil type, depth and capacity to store Plant Available Water;
- Erosion risk associated with rainfall intensity and seasonality and management of soil cover; and
- Economic viability.

6.1 Water supply and temperature

Rainfall in Central Queensland is highly variable as is shown in Figure 4. Annual rainfall can vary from 220 mm to 1500 mm with a mean annual value of 690 mm. The frequency of high intensity rain is demonstrated by the fact there is a 48% chance of daily rainfall exceeding 75mm in any year at "Arcturus Downs", compared to 25% in Dalby or 7% in Wagga Wagga. High intensity rainfall, particularly in the summer months is the norm and often produces significant overland flows and soil erosion.

Overland flow and river flows are also highly erratic with near zero flows in dry years and damaging floods a frequent occurrence.

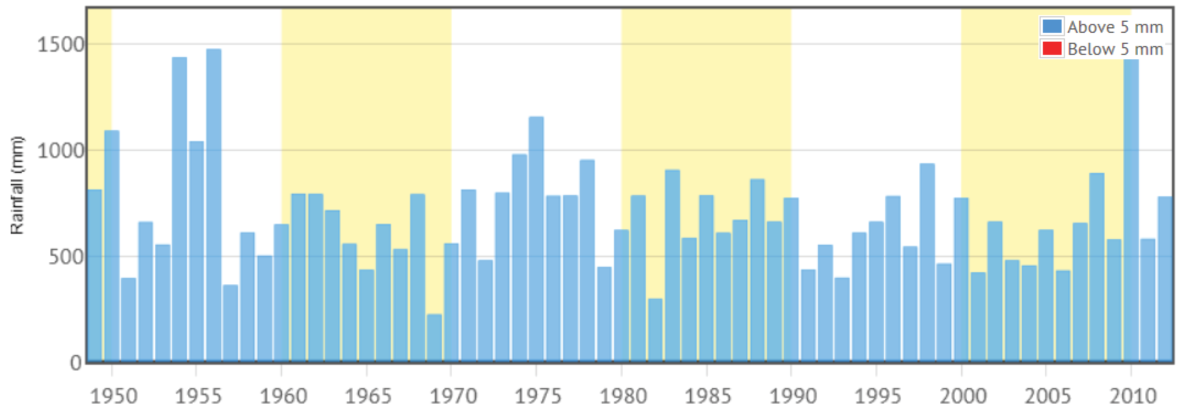


Figure 4: Annual rainfall at "Acturus Downs" Springsure, Qld

(derived from Australian CliMate).

Daily maximum temperatures often exceed 35°C in summer, limiting plant growth and reducing crop yields especially if these conditions occur around crop anthesis (Figure 5).

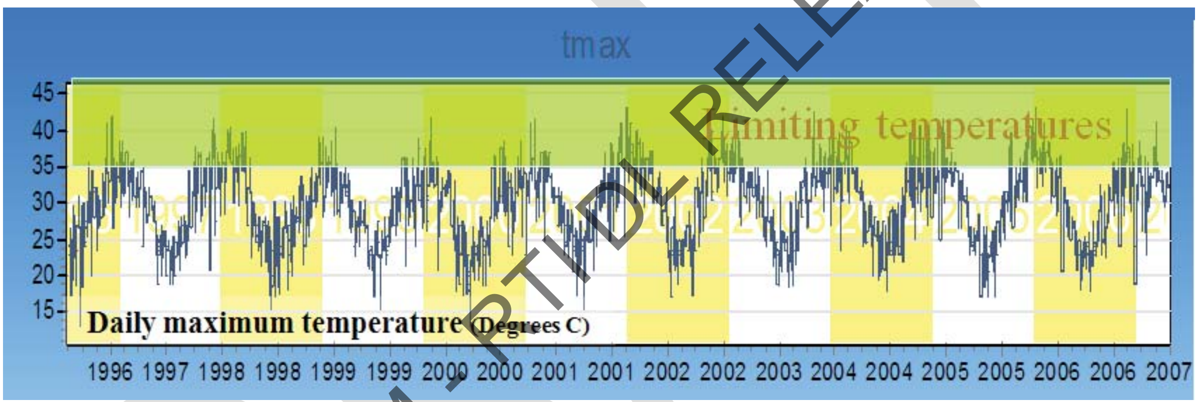


Figure 5: A sample of daily maximum temperature at Emerald, Qld

(derived from Silo database, Queensland Government).

This highly variable rainfall and high temperatures results in highly variable crop yields, and episodic soil erosion events

Evaporation rates in Central Queensland range from 4 to 5 mm per day during winter to in excess of 10 mm per day through summer. This translates into a daily crop water use of up to 5 mm for winter crops and 8 mm for summer crops when full canopy cover is reached. With a PAWC of 150 mm on the better soils, rainfall or irrigation would be required at 20 day intervals in winter and 10 day intervals in summer to sustain crops. This highlights the importance of stored soil water and explains why any subsidence effect on PAWC or infiltration will impact on crop productivity.

Irrigation water supply derived from overland flow can be erratic and stored water is vulnerable to evaporation from storages. Irrigation water requirements range between 4 ML per hectare for winter crops such as wheat to 7 ML per hectare in cotton. These crop water requirements vary from season to season, but an irrigation system with a capacity to provide 10mm per day in summer should be sufficient to produce acceptable crop yields.

6.2 Nutrient supply

Although detailed soils maps for the Springsure Creek area are not currently available, similar soils have been mapped near Emerald (Tucker, Irvine, Godwin and McDonald, 2003). On *DenLo Park*, the soils range from Red Earths (Massive Gradational Soils) formed on tertiary sediments on the upper slopes, to Black Earths (Cracking clays or vertisols) formed as alluvial soils close to Springsure Creek.

These soils are inherently fertile. Similar soils close to Emerald record organic carbon of 0.95%, Total N of 0.05% and Bicarbonate P of 35 mg/kg (Red Earths) and organic carbon of 0.87%, total N of 0.09% and Bicarb P of 14 mg/kg (Black Earths). Although these soils are fertile, their fertility declines rapidly with cultivation, in a pattern similar to Figure 6.

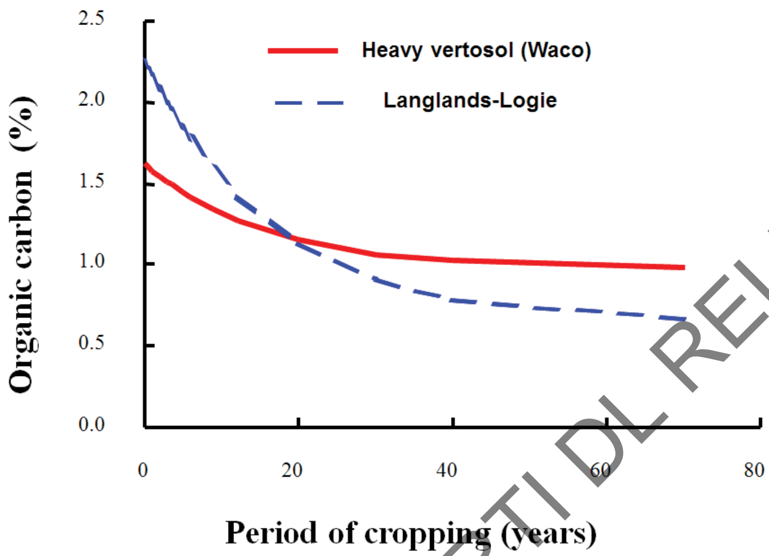


Figure 6: Soil Organic Carbon since cultivation, lower Condamine

(from Dalal and Mayer, 1986).

6.3 Soil type and depth and capacity to store Plant Available Water

With such an erratic supply of water from rainfall, a soils ability to store water to enable viable crop production is highly dependent on Plant Available Water Content (PAWC). PAWC is an important measure of soil physical fertility because crop plants extract all of the water they use from the soil. The higher the PAWC, the more water that is available for plant growth and the greater ability for crops to create grain with intermittent dry periods. Plant Available Water contents of similar soils at Emerald range from 90 mm (Red Earths) to 180 mm (Black Earths). Should the process of subsidence affect PAWC, this will impact on crop productivity.

6.4 Erosion risk associated with rainfall intensity and seasonality and management of soil cover

The combination of high intensity rainfall and long slopes results in an environment with extreme erosion risk. A management option to manage this risk is to maintain soil cover. Either through cover crop or maintaining crop residue and reducing slope lengths using soil conservation structures such as contour banks in association with grassed waterways to safely dispose of excess water. Contour banks have been established on much of the Central Highlands in recognition of the erosion risk while conservation cropping has been adapted widely. The relationship between soil cover and soil erosion in cropping lands is well established and depicted in Figure 7.

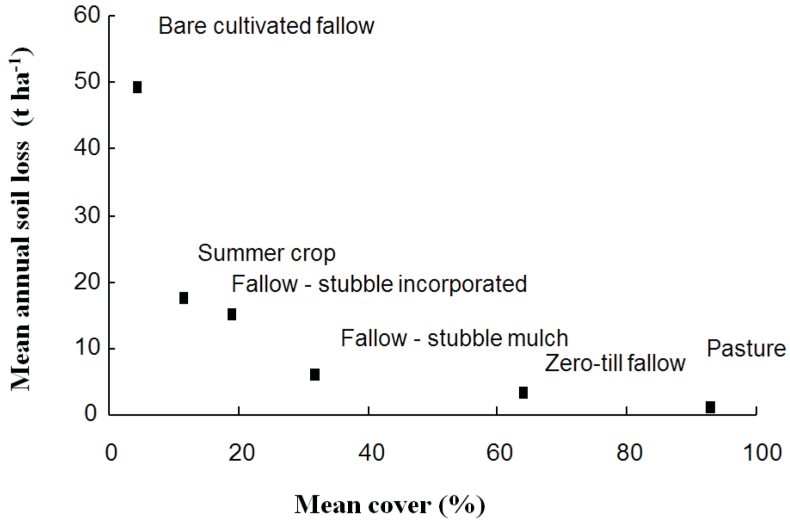


Figure 7: Relationship between soil loss and soil cover for five soil management conditions

(Freebairn et al, 1986).

Maintenance of soil cover of at least 30% particularly over the summer months is essential in Central Queensland cropping areas to reduce soil erosion.

6.5 Economic viability

Viable cropping in the Central Highlands is restricted to the better clay soils. This is a result of the requirement that soils can store sufficient soil water (PAWC) to sustain crops through the frequent dry periods during a crop period.

As well the need for good soils, a range of crop species are grown to manage disease and weeds and respond to market forces.

Thus economic viability is a product of natural resources (soil type, climate and possibly irrigation water availability), agronomic and financial management skills and to some degree luck. Established primary producers generally on the factors at the beginning of this list while a new producer needs all factors in their favour. Because of the complex interactions between these factors and incident weather patterns, it is difficult to define what is likely to lead to a viable agricultural operation. Hooper and Levantis (2011) concluded that at a regional scale, the most successful farmers were those that planted a higher proportion of their land to wheat and sorghum but it was difficult to define any recipe that assured financial viability.

7.0 CHALLENGES IN ASSESSING PRODUCTIVITY

The following features of crop production and environmental performance in central Queensland may impact on a proposed methodology for assessing productivity:

- Crop production is extremely variable due to seasonal variability, soil type, crop sequences, agronomy and management skill.
- The relatively small proportion of soil area directly impacted (the "drop down" zone) will result in dilution of changes observed at the paddock or property scale, even if they are evident at the point scale
- Factors other than soil properties and landscape shape are likely to be important contributors to variability (weather sequence, agronomy, crop type and sequence)
- Environmental performance indicators such as soil quality, hydrology, soil erosion and water quality are more variable than crop production.

As a result, measurement of any indicators of change may not permit easy attribution of cause and effect.

A possible set of pragmatic indicators to monitor system performance is suggested to promote discussion pending a detailed analysis of options:

- A desktop analysis of land shape changes associated with subsidence and agriculture and potential impacts (existing LWM and proposed);
- A desktop assessment of subsidence impacts on machinery operations (machinery width, contour banks, flow lines, wet areas);
- Monitoring of crop yield using a combination of yield mapping and stratified harvest sampling;
- Benchmarking paddock and property scale yield against a combination of ABS data, regional yield predictions (QDAFF) and paddock specific yield estimations (Yield Prophet);
- Record of adoption of what is regarded as Best Management Practice (BMP) for all crop and soil management practices;
- Detailed recording of practice (what is done) and land condition (tillage, cover, and erosion events); and
- Integrate system performance based on all of the above indicators and measures.

8.0 REFERENCES

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APPENDIX A

Longwall Mining at Springsure Creek Coal Mine

Longwall Mining at Springsure Creek Coal Mine

Understanding the research challenge involves knowledge and understanding of the longwall mining system and processes at the proposed Springsure Creek Coal Mine, including (but not limited to):

- Longwall mining technique
- How subsidence occurs after longwall mining
- The expected change to the surface topography

Longwall mining technique

Longwall mining is a method of underground mining where panels of coal are removed from a coal seam in horizontal session. Hydraulic roof supports (or chocks) hold up a section of roof within the longwall operation. A shearer (the piece of machinery that cuts into the coal) moves parallel to the chocks, within the supported roof area, to extract the coal, refer to Figure A.1.

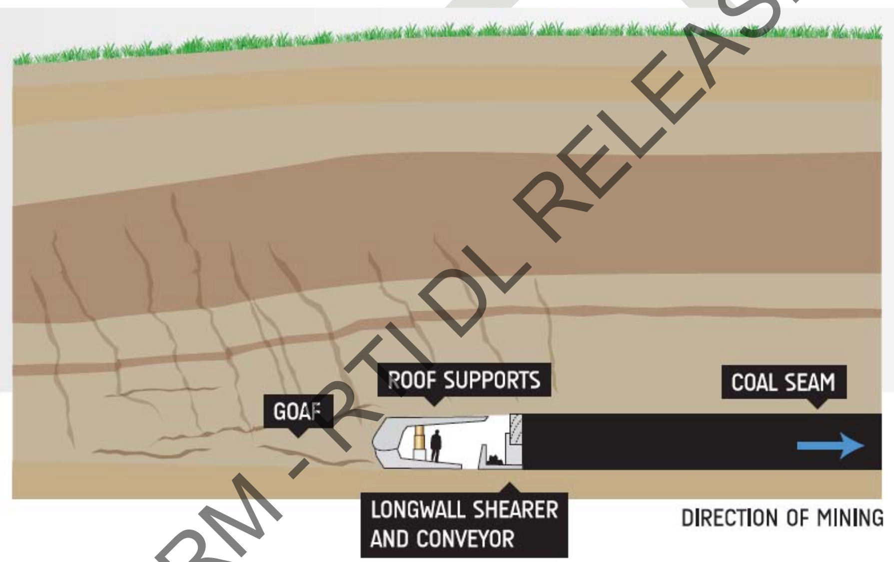

Figure A.1: Conceptual diagram of longwall mining

The shearer travels back and forth along the coal face removing a section of coal with each pass. As the shearer mines the coal it falls onto a conveyor, which transports the coal above ground.

As each section is removed, all the mining equipment moves toward the panel of coal. The checks move forward to support the next section of rock and the earth behind the chocks is allowed to fall into the space left behind (known as the goaf). Figure A.2 shows a conceptual diagram of an underground longwall mine.

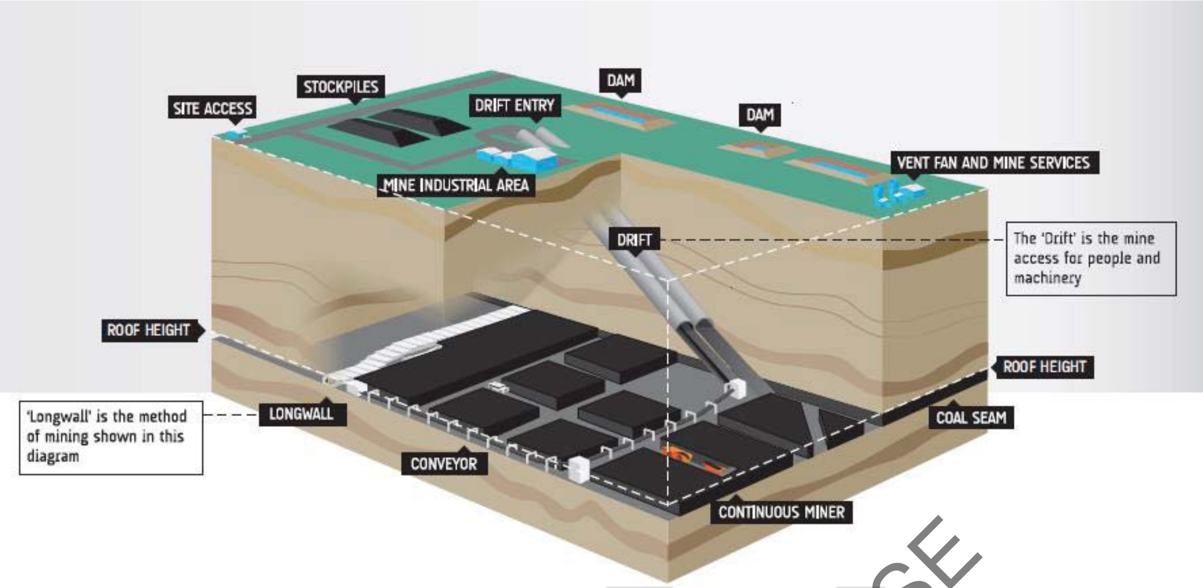

Figure A.2: Conceptual diagram of a longwall mine

How subsidence occurs after longwall mining

Underground longwall mining creates a void in the coal seam. As mining progresses, the rock above (known as overburden) lose support and sag to fill the void beneath (this void is referred to as the goaf). As the rock moves into the void the effect typically transfers to the surface causing subsidence, which is the vertical and horizontal displacement of the surface.

The extent to which subsidence occurs is dependent on the width and height of the coal seam extracted, the coal seam depth from the surface and the strength and nature of the overburden.

Surface subsidence occurs progressively as the coal is extracted from within the longwall panel and the resulting void increases in size. As mining progresses, a point is reached within the panel where a maximum level of subsidence will occur. Despite mining continuing beyond this point along the panel, the level of subsidence will not increase.

The subsidence effect at the surface occurs in the form of a wave, which moves across the ground at approximately the same speed as the longwall face collapses within the longwall panel i.e. at a rate of approximately 120 m per week for the present Project. The extraction of each panel creates its own wave as the panels are mined in sequence.

Subsidence associated with longwall mining generally occurs in two phases:

- Phase 1 - active subsidence – as the coal face advances; and
- Phase 2 - residual subsidence (also known as incremental subsidence) – after the coal face has stopped.

Longwall mining is known for being able to predict both active and residual subsidence, with the majority of active subsidence occurring within a few days or weeks and residual subsidence occurring both concurrently with active subsidence and possibly continuing for up to two years (depending on the rate of mining) (ACARP 2003).

The magnitude of residual subsidence consists of approximately 5-10% of the maximum subsidence, and is often likely less than that amount with very little residual settlement occurring after a year or so. Given the relative immediacy of active subsidence and the limited degree of residual subsidence occurring, surface impacts of subsidence can effectively be planned for by focusing management on the active subsidence phase.

Predicted subsidence

A technical assessment was undertaken by Strata Control Technology (SCT) to predict subsidence within the Project area (refer Appendix A4-2 for the complete report). The predictions were produced by extrapolating two dimensional (2D) subsidence profiles for the proposed underground longwall mining of the Aries 2 Seam. The mine plan the predictions were based on comprised of:

- 81 longwall panels, with 67 of the panels orientated in a northwest direction and 14 panels in a north-northwest direction; and
- 300 m wide longwall panels, 40 m chain pillars and 160 m barrier pillars over the entire mine plan.

It should be noted the mine plan has since been amended and has been reduced in size. Therefore, the subsidence predictions produced by SCT are a conservative estimate.

The process used to determine subsidence included:

- Producing 2D subsidence profiles from empirically based subsidence characteristics in relation to angle of draw, maximum subsidence and pillar subsidence;
- Extrapolating the 2D profiles over the total Project area by creating a 3D surface subsidence prediction using a grid of 10 m x 10 m elements;
- Subsidence was then determined at each grid point and superimposed onto the existing topography; and
- Surfer 10, a contouring and 3D surface mapping software package, was then used to manipulate the grid files and model subsidence surfaces.

SCT created three 2D subsidence profiles to represent the supercritical, critical and subcritical longwall panel geometries. These profiles modelled the minimum overburden depth, the critical subsidence depth and maximum overburden depth of 190 m, 270 m and 580 m, respectively. Furthermore, the profiles were reproduced to cover the maximum and minimum seam thickness as well as the varied subsidence related to the 160 m wide pillars located at approximately every eighth longwall panel in the eastern mine area.

Monitoring subsidence levels in the initial longwall panels will confirm subsidence predictions as they occur during mining operations.

The Project will result in a total of 7,050 ha of land being subsided within the Project area. Subsidence will occur gradually, however, over the life of the mine, with a maximum of 100 ha per year being subsided during single longwall operations and 200 ha of land being subsided per year when both longwalls are in operation. The level of subsidence will primarily depend on overburden depth and coal seam thickness. Modelling predictions indicate the maximum subsidence over the Project area will range from 1.2 m to 2.3 m. Furthermore, pillar subsidence is predicted to range from 0.2 m for areas of shallower overburden depths to 1 m at the greatest overburden depth. As shown in Figure A.3 the greatest level of subsidence is likely to occur within the central section of the Project area.

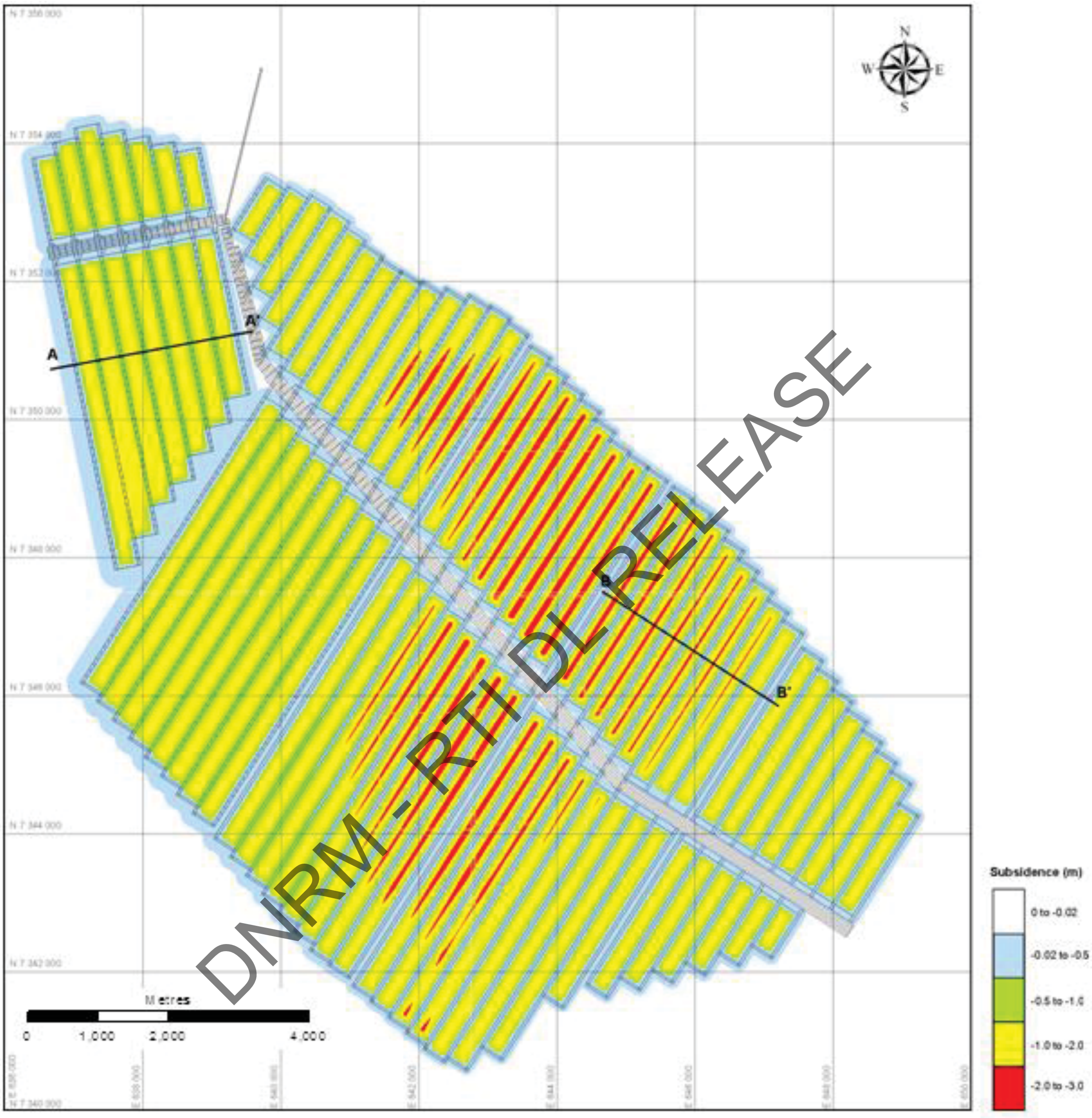

Figure A.3: Predicted subsidence contours across the Project area – no mitigation (SCT 2012)

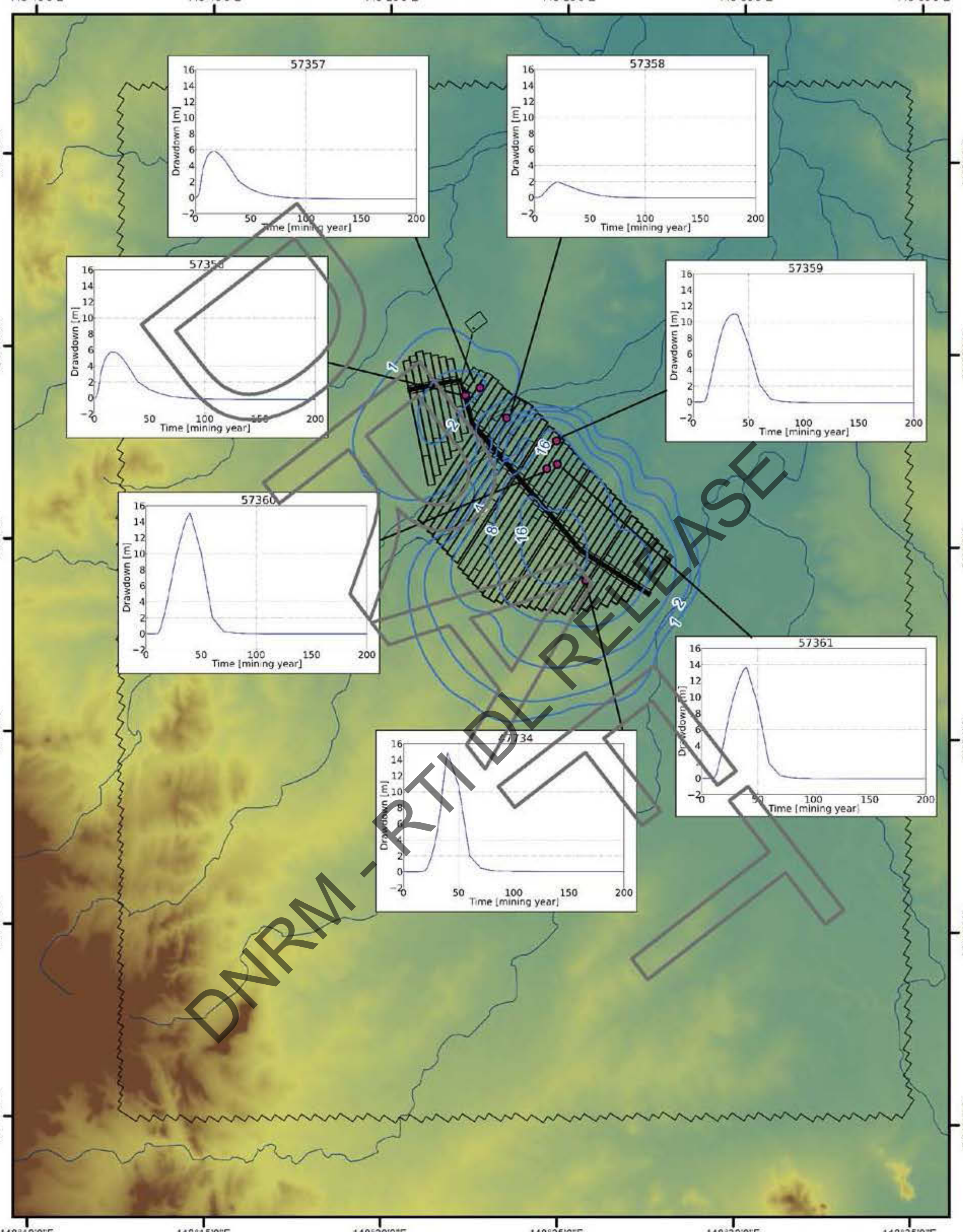

Figure X - XX Drawdown in the Basalt after mining year 40 - revised fracture depth

Key

- Drawdown contour (m)
- Watercourse
- Bore location
- Underground mine
- Model boundary

Topography (m AHD): 630 – 150

Scale 1:250000

Metres 0 2500 5000

Data Source: Topography by SRTM; Watercourse by Geoscience Australia

DISCLAIMER
CDM Smith has endeavoured to ensure accuracy and completeness of the data. CDM Smith assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.

Job: BEA130038_145_R1_ddnL3_RW_P40yrs
Date: 26/07/2013

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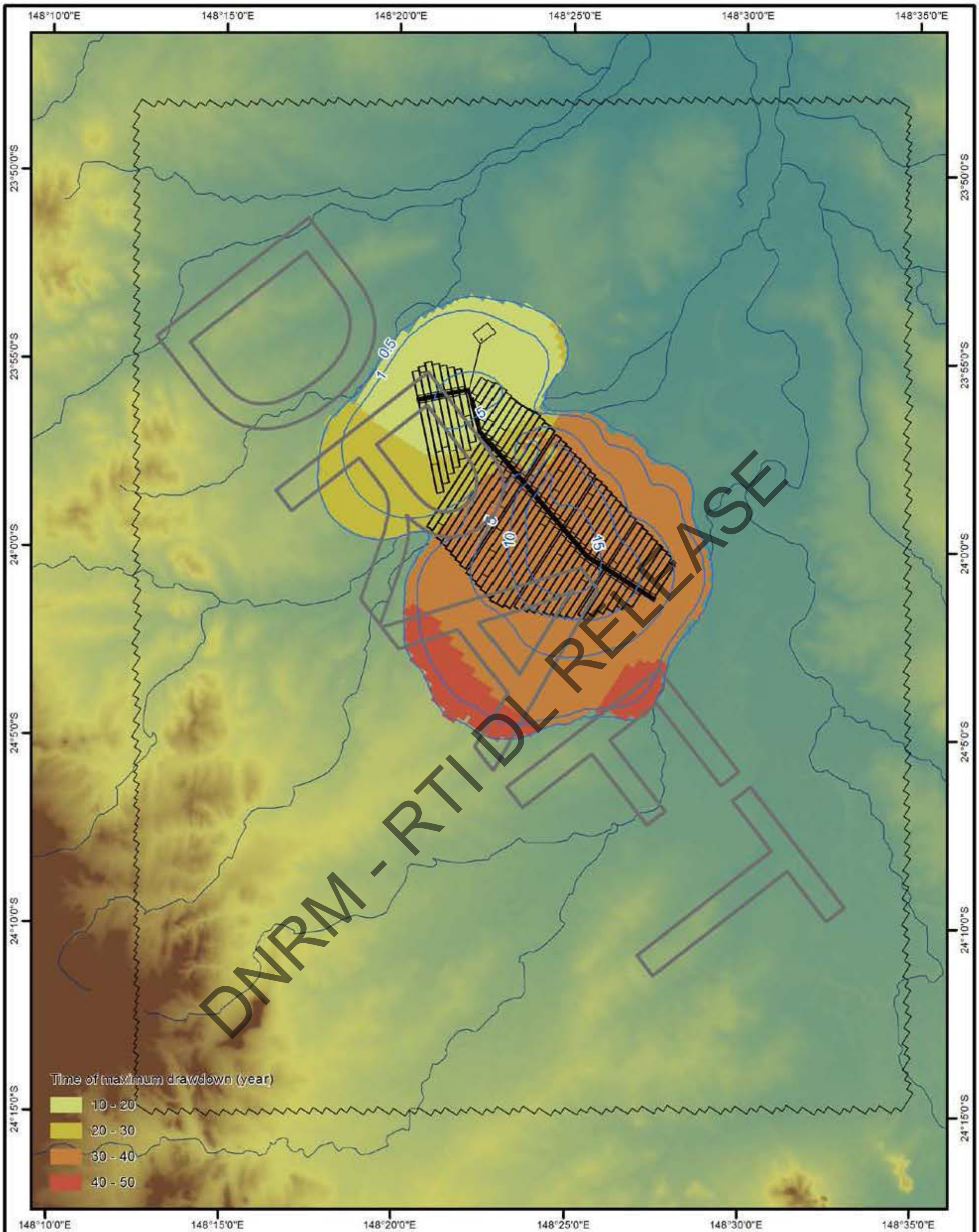

Figure X - XX Maximum drawdown at the water table and the time at which maximum drawdown occurs - revised fracture depth

Key

- Maximum drawdown contour (m)
- Underground mine
- Model boundary
- Watercourse

Topography (m AHD)
630
150

Data Source:
Topography by SRTM; Watercourse by Geoscience Australia

Job: BEA130038_143-R1_MaxddnL3_13_RW_P
Date: 26/07/2013

Scale 1:250000
Metres
0 2500 5000

DISCLAIMER
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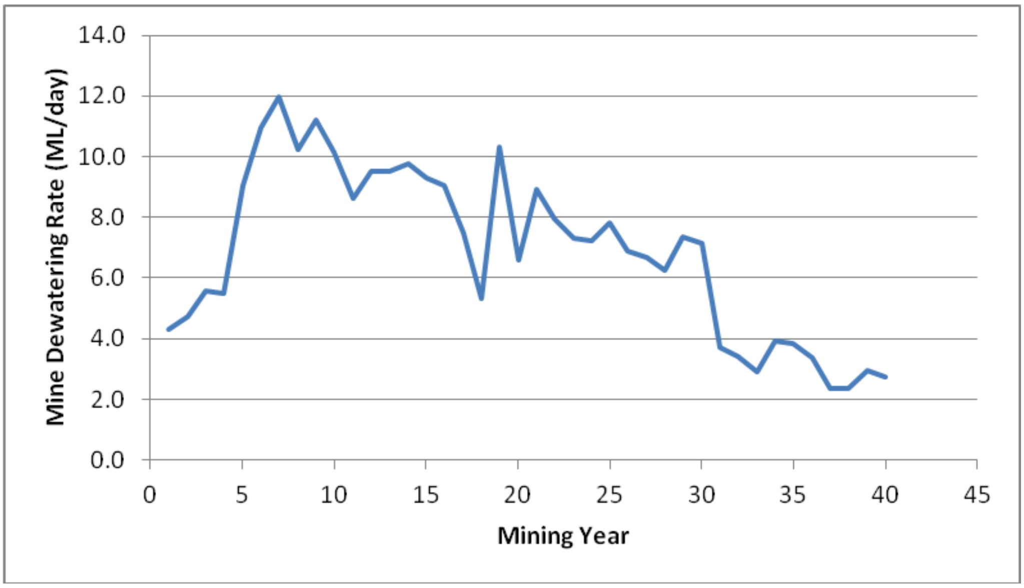
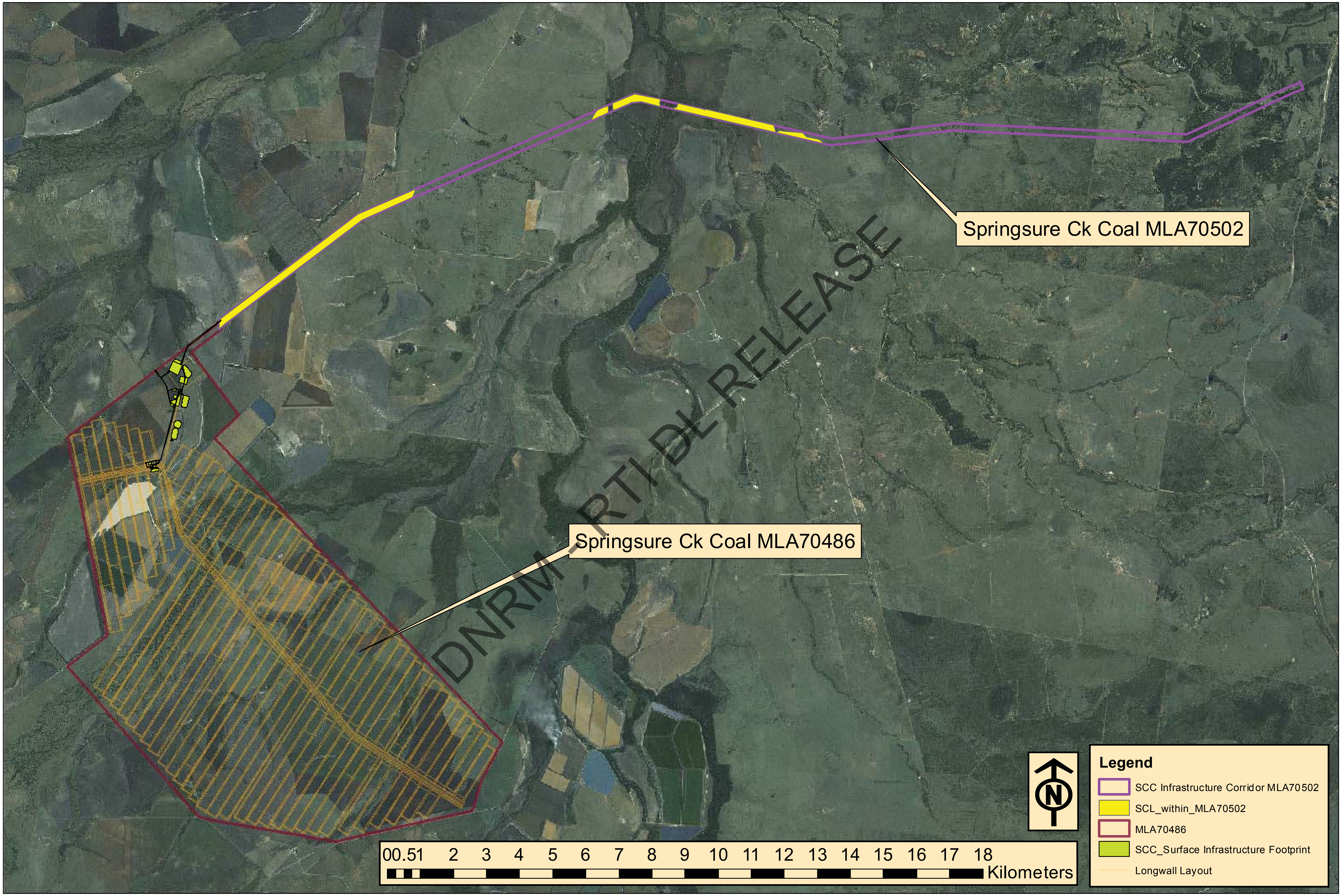


Mine Dewatering Rate (ML/day)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0
5
10
15
20
25
30
35
40
45
Mining Year


Springsure Ck Coal MLA70486
DNRM - RTI DL RELEASE
Legend
Den-Lo Park
MLA70486
Mine Access Route
Internal access roads
Indicative subsoil stockpiles
Quarry location
Indicative topsoil storage (spreading)
Infrastructure Footprint on SCL
Impeded access to SCL
Longwall Layout
Central_Highlands Watercourses
N
1:20,000
0
0.5
1
2
3
Kilometers


Springsure Ck Coal MLA70502
Springsure Ck Coal MLA70486
DNRM - RTI DL RELEASE
00.51 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Kilometers
N
Legend
SCC Infrastructure Corridor MLA70502
SCL_within_MLA70502
MLA70486
SCC_Surface Infrastructure Footprint
Longwall Layout

Queensland Government

Department of Natural Resources and Mines

Information Notice

Strategic Cropping Land Act 2011

Application Requisition

This statutory notice is issued under s.241 of the *Strategic Cropping Land Act 2011* (SCL Act).

Springsure Creek Coal Pty Ltd
c/o Bandanna Energy Limited
Level 4, 260 Queen Street
Brisbane QLD 4000

Our reference: SCLRD2013/000146

Attention: Pete Jones

Dear Pete

Re: Application requisition – Application for a strategic cropping land protection decision by Springsure Creek Coal Pty Ltd for MLA70486 pursuant to the *Strategic Cropping Land Act 2011* (SCL Act).

This requisition is in two parts:

A. Request for absent items of information that form part of the protection decision application requirements described under the SCL Act s97.

B. Request for absent items of information that are required to inform the decision making criteria described under the SCL Act s101.

Part A: Request for absent items of information that form part of the protection decision application requirements described under the SCL Act s97.

Please note: The SCL Act s240 requires that the decision maker must refuse to receive or process a purported application not made under the requirements under this Act, for making the application. Subsequently until the following information is provided, your application can not be accepted as complete. This part of the requisition provides you with an opportunity to rectify its lodgement.

Item 1: Please provide a map[1] that identifies where the development is proposed to be carried out on potential SCL.

It is noted in your response to Question 7 of the submitted application form and in the submitted application report that an SCL validation application or decision over MLA70486 does not exist and that you have elected, for the purposes of the application assessment and decision, to accept the area of mapped potential SCL as reflecting the areas of SCL to be impacted by the development. This is not reflected on any of the maps provided in the application which subsequently misrepresents the extent of development on SCL.

In responding to this request please also accurately clarify both the location and spatial extent (area in ha) of all mine activities to be carried out on MLA70486 indicated in Section 2 of the submitted application report, including but not limited to any built infrastructure, roads, drainage and erosion/sediment control, pondages and any water/waste management infrastructure, quarrying, bulk excavations, topsoil stripping and areas subject to stockpiling or respreading of borrowed soils, laydowns, hardstands and any areas of construction-related disturbance associated with the proposed operational footprint of built infrastructure. Accurate communication of this information to DNRM and the efficiency of its assessment would benefit by providing, in addition to a representative map, the above information electronically as separate ESRI Shapefiles projected in MGA94 or alternatively, Google™ KML files.

[1] The SCL Act s85(1)(a)&(b) requires that the application must contain a map that identifies all of the SCL or potential SCL on the land and identifies where the development is proposed to be carried out on SCL or potential SCL.

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Item 2: Please provide in a report[2], identification of the location and spatial extent (area in ha) of each of the impacts of the development on SCL.

In accordance with the SCL Act s14 an "impact" on SCL is taken to occur when either of the following occurs:

- The proposed mining activity introduces an impediment to cropping for any period of time, irrespective of whether the land is currently being cropped. Land may be impeded from being cropped due to its occupation by mining activities or due to logistical, safety or legal restrictions on access to particular areas of land for cropping during the mine lease period. Impediments to cropping may be partial (as in an additional restriction, complication or cost on cropping) or absolute (as in the complete exclusion of cropping). Introduced impediments to cropping may be short-lived or long term. If an impediment to cropping endures for 50 years or more, the affected land is regarded under the SCL Act as being permanently impacted by the development.
- The proposed mining activity results in land disturbance that alters the condition of the land. This could entail an alteration to the soil profile or soil properties, altering the land cover, altering existing land improvements and landform modifications (dams and drainage), changing the topography or altering the surface or subsurface drainage characteristics of the land. The land's condition at the point in time prior to the development commencing, is taken to be the benchmark against which impacts that are attributable to the development are recognised. If any alteration to the pre-development condition of the land is unable to be restored, the land is regarded under the SCL Act as being permanently impacted by the development.

Note: Introduced impediments to cropping and alterations to the predevelopment condition of the land that do not have a permanent impact are regarded as temporary impacts.

Accurate communication of this information to DNRM would be assisted by providing a map illustrating the location and extent of the various impacts that are attributable to the proposed mining development, supported by separate ESRI Shapefiles of the affected areas projected in MGA94 or alternatively, Google™ KML files.

Item 3: Please provide in a report[2], an assessment of each of the identified impacting activities that clarifies the process and characteristics of each impacting activity (how it will be carried out and what it will result in - in terms of either impediments to cropping or alterations of the land or landscape processes).

By way of your responses to Items 2 & 3 and to enable efficient assessment of your application, each impacting activity should essentially be characterised by: its location; its spatial extent (area in ha), the process by which the impact occurs; what it will result in; and ultimately its duration.

Please note: The SCL Act Schedule 2 provides definitions of particular terms that have specific meaning when used in the context of a protection decision application and its assessment. In your current application some confusion of the intended meaning is created when words such as 'restoration' and 'mitigation' have been used. For the purpose of clarity, please refrain from using the term 'restoration' unless it is used to describe a process by which land will be restored to its pre-development condition as defined. Please also refrain from using the term 'mitigation' unless it is used to refer to mitigation as defined. The term 'remediation' has been used throughout this requisition to describe any process by which the impacts on SCL of development have been sought to be combated, minimised or reduced.

Part B: Request for absent items of information that are required to inform the decision making criteria described under the SCL Act s101.

In order to decide the application the SCL Act delegate must consider the following:

a) ***The extent of the impact of the carrying out of the resource activity on SCL.***

If addressed appropriately, this information will be provided in response to the requisitioned items 2 and 3.

b) ***Whether the carrying out of the resource activity will have a permanent impact or a temporary impact on the land.***

As detailed above regarding item 2, permanent impacts (as defined under the SCL Act s14) will occur when either an impediment to cropping that is attributable to the development endures for 50 years or more, or when any alteration to the pre-development condition of the land that is attributable to the development is

[2] The SCL Act s87(a) requires that the application must contain a report that assesses the development's impact on all SCL or potential SCL on the land.

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unable to be restored. Conversely, impediments to cropping and alterations to the predevelopment condition of the land that do not have a permanent impact are regarded as temporary impacts.

In your response to Question 14 of the application form you have stated that the development as proposed will not have a permanent impact on the land. The application report also asserts that the impacts of the development on SCL will be temporary. This assertion is however unsupported by:

- full documentation of the extent and variety of development activities that will take place on SCL and identification of the associated impacts on SCL; and
- the provision of evidence that demonstrates how all introduced impediments to cropping that are attributable to the development will be reliably removed within 50 years; and
- the provision of evidence that demonstrates how all alterations to the condition of the land will be reliably restored to the predevelopment condition within the term of the development.

The assertion is also contradicted in sections of the report that describe how land which has been disturbed by mining activity may be left in a state that is not consistent with its original condition – for example: treatment of access roads, dams, mine entrance, basalt quarrying, treatment of tension cracking, deformed land and ponded depressions.

Given the scale and impact of the mining activity and the aspirational remediation and decommissioning objectives outlined in the application, it does not appear that there is a clear intention to restore all impacts on SCL to their pre-development condition. It also does not appear plausible that the objective of achieving overall a temporary impact on SCL is within the scope of the development and the 'mitigation measures' described within the application which are largely aspirational rather than demonstrated with any degree of certainty.

If it is the intention to pursue a protection decision that includes all of the [yet-to-be-documented] impacts of the development being recognised as consistent with a temporary impact as defined in the SCL Act, please provide requisition items 4 – 6 as follows:

Item 4: With respect to each impacting activity identified in the response to Item 2, please describe in detail the particular impediments to cropping that are attributable to each activity and the physical alterations to the condition of the land that are attributable to each activity with attention paid to the location, spatial extent (area in ha), the process by which the impact occurs; what it will result in; and ultimately its duration.

If addressed appropriately, this information will in the main be provided in response to the requisitioned items 2 and 3.

Item 5: For each impacting activity identified in response to Items 2 and 3, please prepare a detailed restoration plan that includes: detailed description of the benchmarked predevelopment site condition, the methods to be applied to ensure site restoration to that original condition including restoration milestones, the methods and timeframe for removal of any impediments to cropping (if unrelated to altered land condition), the restoration monitoring regime that will be in place including contingency plans in the event of failure to reach given milestones. A reliable timeframe for complete restoration to predevelopment condition and removal of impediments to cropping for each impact that is to be restored is also required.

Item 6: Based on the restoration plans prepared in response to Item 5, please provide a thorough and detailed calculation of the costs of SCL impact restoration and removal to the standard required by the temporary impact definition. By making comparisons between the calculated SCL restoration/removal costs for particular impacts and the attributable Financial Assurance required under the EP Act for mine rehabilitation where relevant to those impacts, please provide a net figure for SCL Financial Assurance liability for the project. Any SCL Financial Assurance figure quoted must be fully qualified by costings of actions required by the plan for restoration of impacts on SCL and comparison with costed actions that form part of the Financial Assurance attributable for the Environmental Authority.

[2] The SCL Act s87(a) requires that the application must contain a report that assesses the development's impact on all SCL or potential SCL on the land.

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c) *Whether the applicant has demonstrated that the impact has been avoided or minimised to the greatest extent practicable.*

Item 7: Please confirm and describe what areas of land (if any) within MLA70486 will remain available for cropping and unaltered by mining throughout the entire duration of the mining tenure.

Item 8: Please confirm and describe whether any areas of land or landscape processes (including overland flow and drainage patterns) outside MLA70486 will be altered or disrupted as a result of the proposed mining activities and consequent landscape alterations.

The application declares an intention to, where possible; bring land affected by mining activities and consequent land deformation and drainage pattern disruption back into crop production. However it is not clear what physical remediation measures will be undertaken to bring impacted land back into a condition where it may again be cropped.

Item 9: Following documentation of the extent and mode of all impacting activities in response to requisition Item 2 and 3, please document any remedial measures that will be employed to minimise the consequences of the impacts on SCL for its future productive use. Please document separately the remediation techniques that will be applied to land affected by different impacts. For example, minimising the impacts on land affected by subsidence and deformation may be treated differently than land affected by road construction or industrial infrastructure. These remedial measures must be described with a level of detail and certainty that enables both an assessment of their suitability and the scripting of protection decision conditions to ensure they are reliably implemented and able to be monitored.

If you have any questions about this notice, please contact Andrew McLaughlin whose contact details are listed below.

Yours sincerely

49-Sch4 - Personal Information

Signature

2 September 2013

Date

Errol Sander
Project Manager
Property Planning and Assessment
Central Region
Department of Natural Resources and Mines

Enquiries:
Andrew McLaughlin
Senior Natural Resource Management Officer
PO Box 383, Gympie QLD 4570
Phone: 07 5480 5336
Email: Andrew.McLaughlin@dnrm.qld.gov.au

[2] The SCL Act s87(a) requires that the application must contain a report that assesses the development's impact on all SCL or potential SCL on the land.

Author : Sue Crowley
Ref number : SCLRD2013/000146

Queensland Government

Department of Natural Resources and Mines

23 October 2013

Mr Pete Jones
Bandanna Energy Ltd
Level 4, 260 Queen Street
Brisbane QLD 4000

Re: Springsure Creek Coal Mine Project protection decision SCLRD2013/000146

Dear Pete

Thank you for the additional information, GIS files and amended application report provided by email on 18 October 2013. Please be advised that the Springsure Creek Coal Pty Ltd SCL application ref: SCLRD2013/000146 is now accepted by DNRM as fulfilling the application requirements as per *s96* and *s97* of the *SCL Act*.

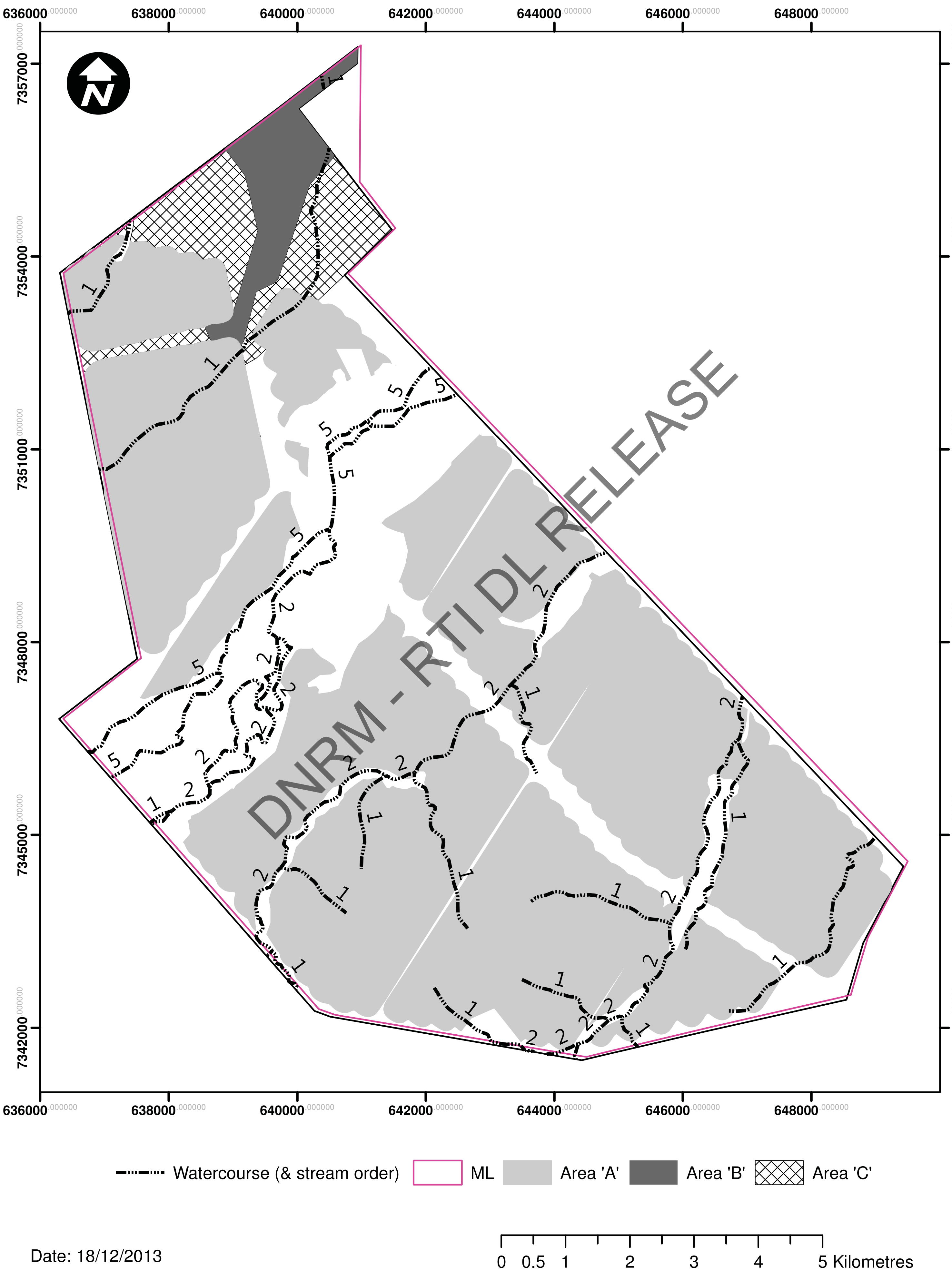
During the course of the assessment you will be contacted if any further clarification of your resource development proposal is required. Please contact Andrew McLaughlin, DNRM Senior Natural Resource Management Officer on 07 5480 5336 if you have any questions regarding the application assessment.

Yours sincerely

49-Sch4 - Personal Information

Errol Sander
Project Manager
Property Planning and Assessment
Central Region
Department of Natural Resources and Mines

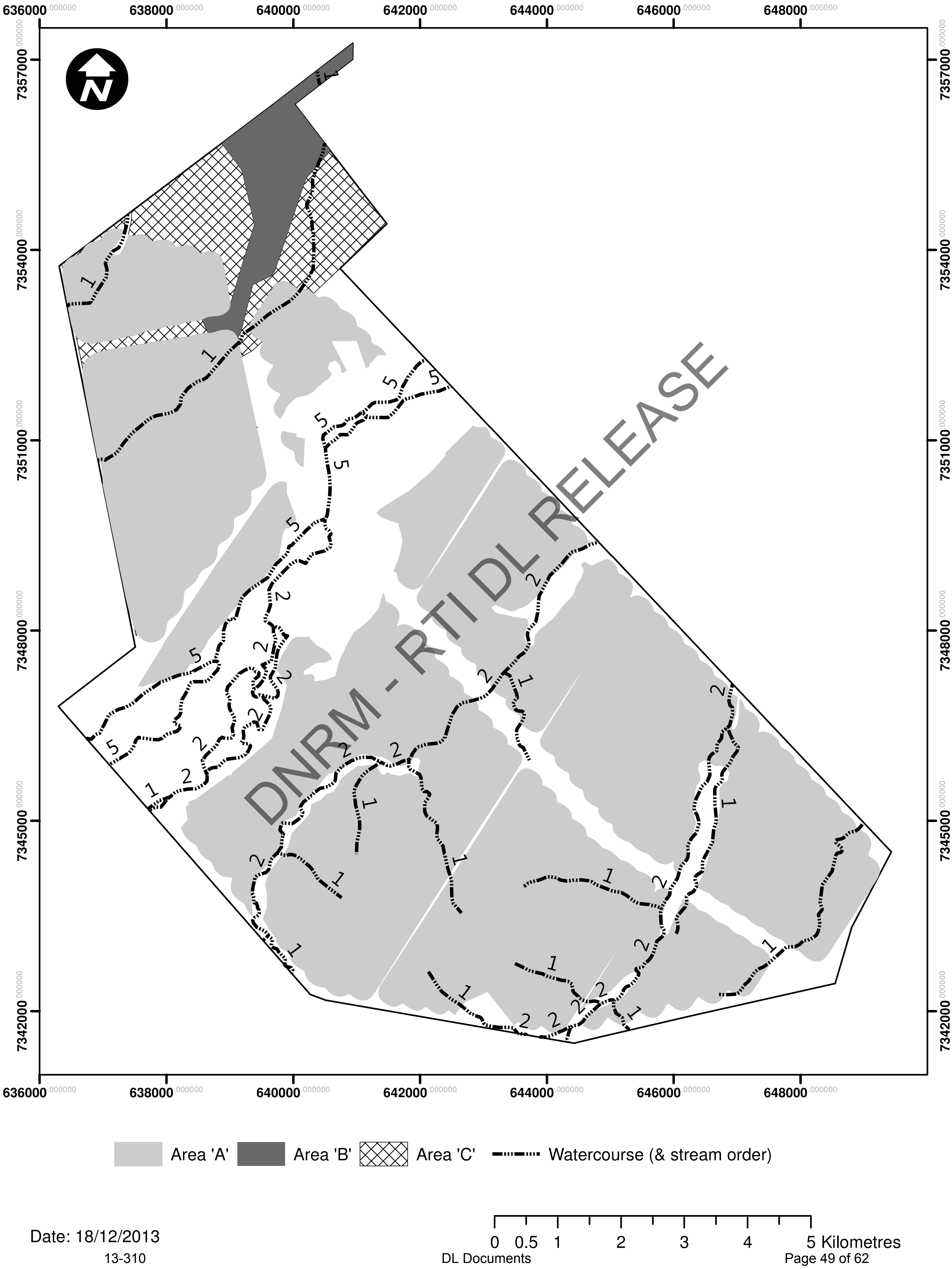
Plan SCLRD2013/000146(1): SCL Protection Decision disturbance areas and watercourses



Date: 18/12/2013

13-310

Plan SCLRD2013/000146(1):
SCL Protection Decision disturbance areas and watercourses



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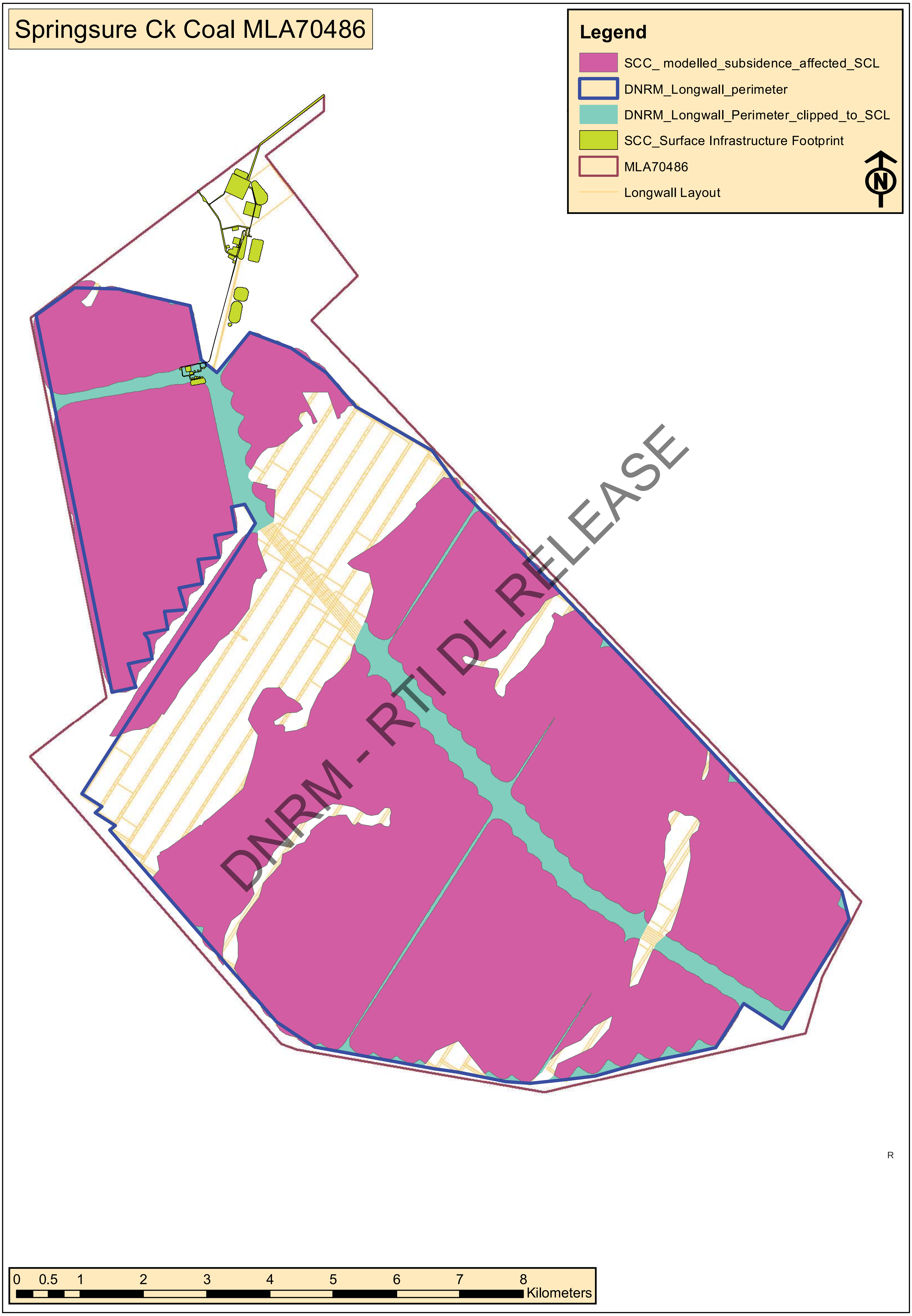


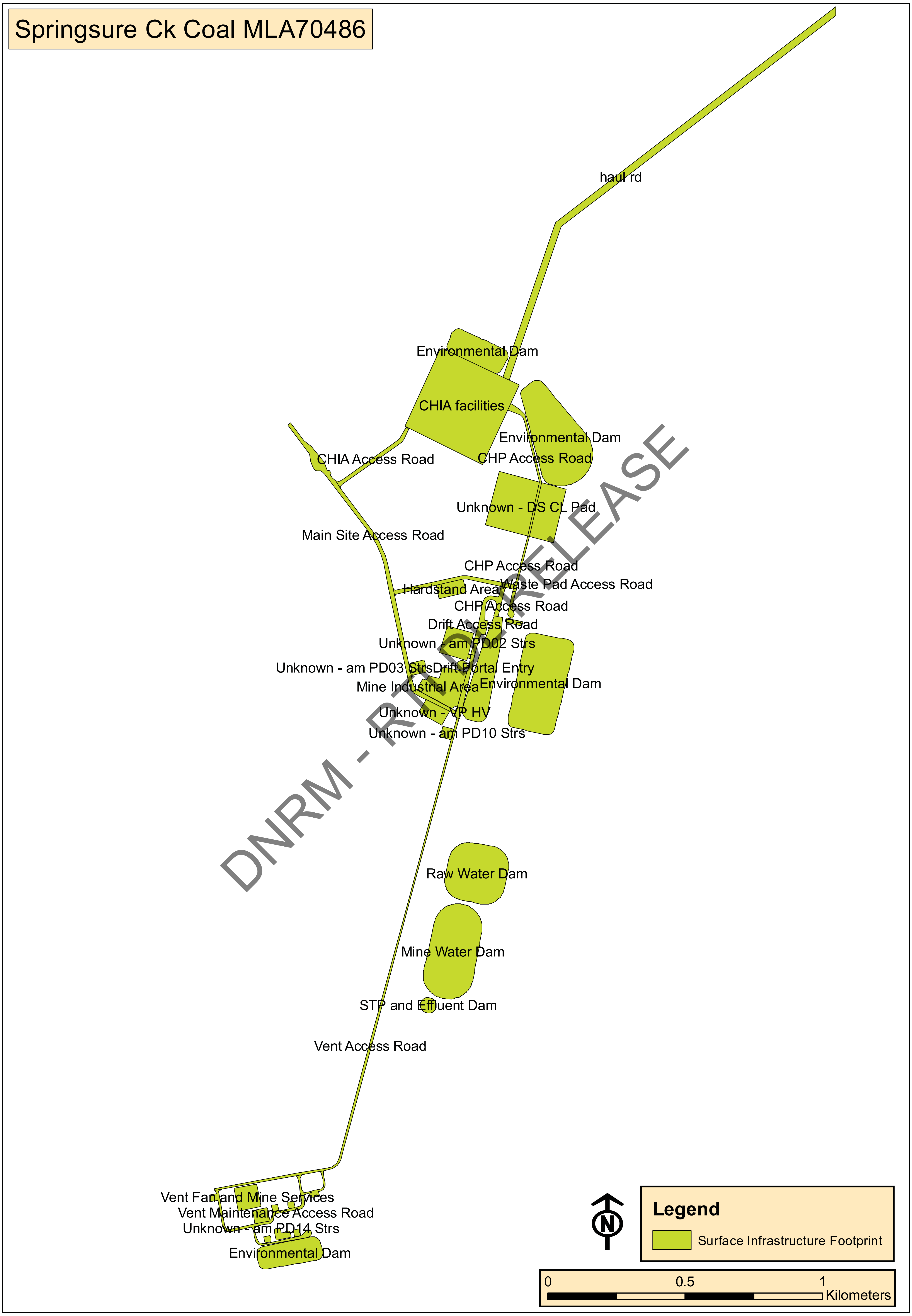
Springsure Ck Coal MLA70486
Legend
SCC_ modelled_subsidence_affected_SCL
DNRM_Longwall_perimeter
DNRM_Longwall_Perimeter_clipped_to_SCL
SCC_Surface Infrastructure Footprint
MLA70486
Longwall Layout
N
DNRM - RTI DL RELEASE
R
0 0.5 1 2 3 4 5 6 7 8
Kilometers

Parameter	Symbol	Value	Unit	
Seam characteristics				
Depth of cover	H	250	m	
Seam thickness	t_c	3.7	m	
Panel width	W	300	m	
Width: cover ratio	W/H	1.20		critical
Pillar width	Pw	40	m	
Empirical factors - select value from drop down list				*Suggested values*
k_s		0.65		**0.28**
k_1		0.4		**0.4**
k_2		1		**1.0**
k_3		3.3		**3.2**
Predicted results				
Maximum subsidence	S_{max}	2.4	m	
Tensile strain	$+E_{max}$	4	mm/m	
Compressive strain	E_{max}	10	mm/m	
Tilt	G_{max}	32	mm/m	
		3.2	%	


N
R
© CNES 2012, Distribution Astrium Services / Spot Image S.A. France
Google earth
Imagery Date: 1/1/2012 55 K 642927.71 m E 7349324.81 m S elev 191 m eye alt 21.53 km

Parameter	Symbol	Value	Unit	
Seam characteristics				
Depth of cover	H	215	m	
Panel width	W	300	m	
Seam thickness	t_c	3.7	m	
W/H		1.4		
Empirical factors		*Select list value:*		*Indicative value*
k_s		0.65		0.65
k_1		0.40		0.40
k_2		1.0		1.0
k_3		3.3		3.2
Predicted results				
Maximum subsidence	S_{max}	2.4	m	
Tensile strain	$+E_{max}$	4	mm/m	
Compressive strain	$-E_{max}$	11	mm/m	
Maximum tilt	G_{max}	37	mm/m	
	OR	3.7	%	

Parameter	Symbol	Value	Unit	
Seam characteristics				
Depth of cover	H	250	m	
Seam thickness	t_c	3.7	m	
Panel width	W	300	m	
Width: cover ratio	W/H	1.20		critical
Pillar width	Pw	40	m	
Empirical factors - select value from drop down list				*Suggested values*
k_s		0.65		**0.28**
k_1		0.4		**0.4**
k_2		1		**1.0**
k_3		3.3		**3.2**
Predicted results				
Maximum subsidence	S_{max}	2.4	m	
Tensile strain	$+E_{max}$	4	mm/m	
Compressive strain	E_{max}	10	mm/m	
Tilt	G_{max}	32	mm/m	
		3.2	%	



Springsure Ck Coal MLA70486
haul rd
Environmental Dam
CHIA facilities
Environmental Dam
CHIA Access Road
CHP Access Road
Unknown - DS CL Pad
Main Site Access Road
CHP Access Road
Hardstand Area
Waste Pad Access Road
CHP Access Road
Drift Access Road
Unknown - am PD02 Strs
Unknown - am PD03 Strs
Drift Portal Entry
Mine Industrial Area
Environmental Dam
Unknown - VP HV
Unknown - am PD10 Strs
Raw Water Dam
Mine Water Dam
STP and Effluent Dam
Vent Access Road
Vent Fan and Mine Services
Vent Maintenance Access Road
Unknown - am PD14 Strs
Environmental Dam
N
Legend
Surface Infrastructure Footprint
0
0.5
1
Kilometers

Google earth

feet 1000
meters 500

#	Sample ID	Upper	Lower	Median	pH	EC1:5	Chloride	SOC	Nitrate N	Colwell P	CEC	Ca	Mg	K	Na	ESP	Ca:Mg	Clay	Silt	FSand	CSand	Gravel	SAR	Sand	CCR	Site
1	TP1	0	0.1	0.05	7.5	0.02	100	1.75	14	25	50	35	10	0.5	3.5	7.0	3.5	65	25	5	2	3	6.2	7.2	0.77	1
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	Proportion		
Sample	Clay %	Sand %	Silt %
1	59	18	23
2	50	30	20
3	37	56	5
4	57	23	20
5	27	66	7
6	15	49	21
7	46	28	18
8	46	30	22
9	38	32	28
10	65	14	21
11	55	24	21
12	33	55	11
13	23	60	17
14	29	46	17
15	34	44	18
16	37	43	19
17	28	57	12
18	51	36	12
19	51	36	12
20	45	42	12
21	54	24	21
22	38	39	19
23	62	16	22
24	50	28	19
25	55	22	23
26	38	37	25
27	50	30	20
28	37	56	5
29	57	23	20
30	27	66	7
31	46	30	22
32	15	49	21
33	38	29	19
34	33	55	11
35	55	24	21
36	65	14	21
37	38	32	28
38	23	60	17
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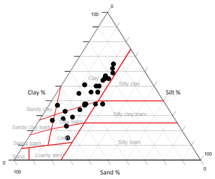
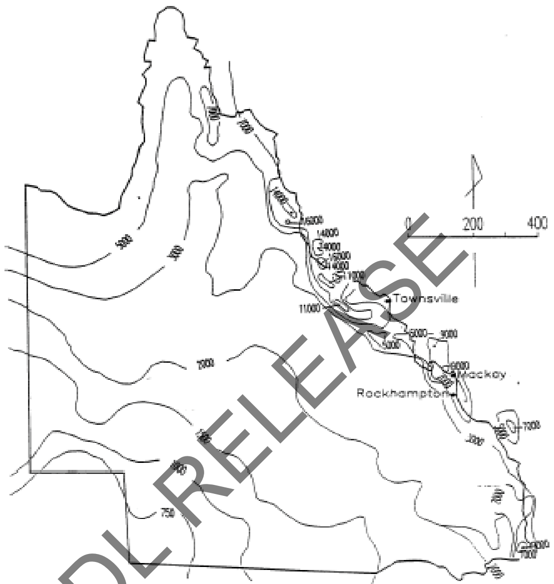


i, 2 yr, 6 hr =	10.4	mm/hr (from IFD data)	
R =	**2374**	(refer map in column E for verification)	
Soil ID	**Site 20**	**Site 62**	
% silt =	30	30	
% f sand =	11	5	
% clay =	59	65	
% OC =	1	1.3	
M =	1681	1225	
OM =	1.7	2.2	
Soil structure	Medium granular	Medium granular	
Permeability	Slow / moderate	Slow	
SS =	3	3	
PP =	4	5	
K =	**0.021**	**0.020**	
Check	OK	OK	
L=	100	100	
S=	3	4.5	
AHT=	3	4.5	
θ =	0.030	0.045	
λ =	100.045	100.101	
ε =	0.45	0.62	
m =	0.31	0.38	
L =	1.60	1.78	
S =	0.35	0.52	
LS =	**0.57**	**0.92**	
Practice	No erosion control practice	No erosion control practice	
P =	**1**	**1**	
Crop	Annual crop / average	Annual crop / average	
C =	**0.35**	**0.35**	
A =	**9.9**	**15.1**	t/ha/yr

SUMMARY TABLE

Factor	**Units**	**Site 20**	**Site 62**
Rainfall (R)	MJ.mm/ha.hr.yr	2374	2374
Erosivity (K)	t.ha.hr/ha.MJ.mm	0.021	0.020
Slope length (LS)		0.57	0.919
Practice (P)		1	1
Crop (C)		0.35	0.35
Soil loss (A)	**t/ha/yr**	**9.9**	**15.1**



$K = 2.77\ M^{1.14}\ (10^{-7})\ (12\text{-}OM) + 4.28\ (10^{-3})\ (SS\text{-}2) + 3.29\ (10^{-3})\ (PP\text{-}3)$

M = % silt & vfs x 100 - % clay
OM = % organic matter
SS = soil structure code
PP = profile permeability class

Surface soil	
Blocky, platy or mas	4
Fine granular	2
Medium granular	3
Very fine granular	1

Infiltration	
Moderate	3
Moderate / rapid	2
Rapid	1
Slow	5
Slow / moderate	4
Very slow	6

Crop	
Annual crop / averag	0.35
Annual crop / excell	0.1
Annual crop / good	0.2
Annual crop / poor	0.5
Bare soil	1
Pasture 40% cover	0.1
Pasture 80% cover	0.01
Undisturbed forest	0.003

Practice	
Contour banks 1 - 3	0.34
Contour banks 3 - 5	0.59
Contour banks 5 - 8	0.69
Contour cultivation 1	0.85
Contour cultivation 3	0.8
Contour cultivation 5	0.85
No erosion control p	1
Strip cropping	0.75

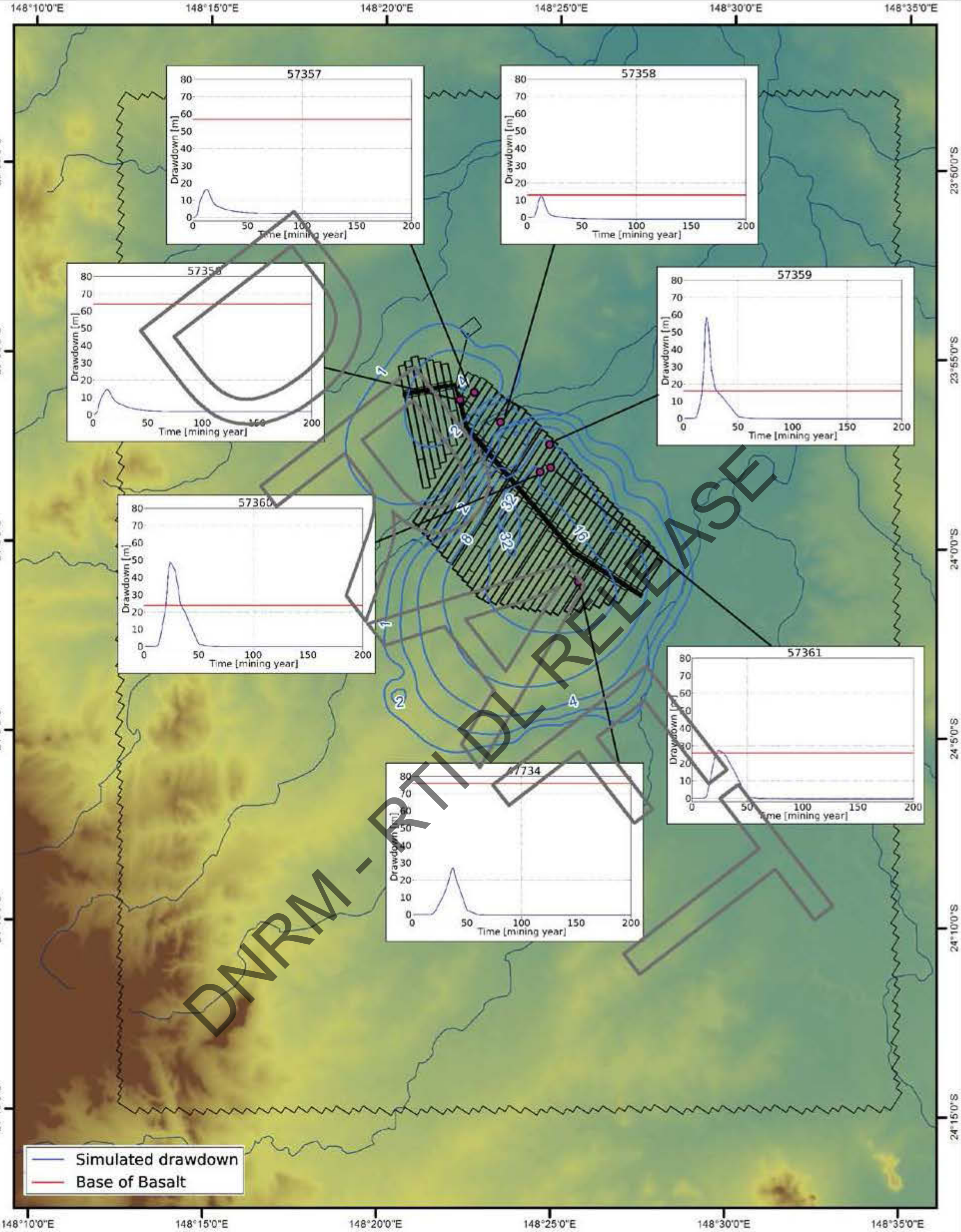


Figure X - XX Drawdown in the Basalt after mining year 40 - uncertainty case 2

Key

Drawdown contour (m) — Watercourse
Bore location
Underground mine
Model boundary
Topography (m AHD) 630 – 150

Scale 1:250000 Metres 0 2500 5000

Data Source: Topography by SRTM; Watercourse by Geoscience Australia

DISCLAIMER
CDM Smith has endeavoured to ensure accuracy and completeness of the data. CDM Smith assumes no legal liability or responsibility for any decisions or actions resulting from the information contained within this map.

Job: BEA130038_146_R1_ddnL3_UKzSs4_rev240yrs
Date: 26/07/2013

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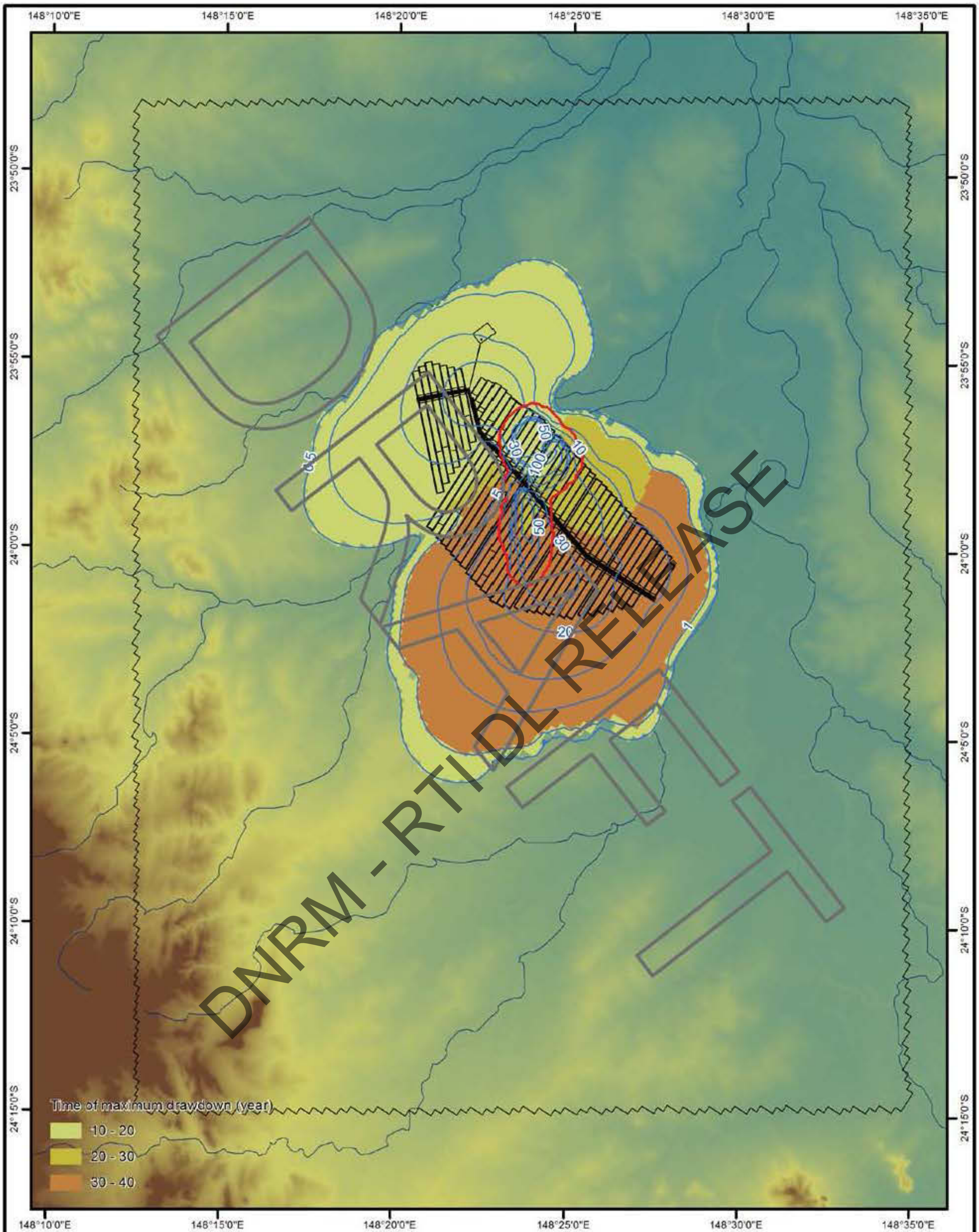

Figure X - XX Maximum drawdown at the water table and the time at which maximum drawdown occurs - uncertainty case 2

Key

- Maximum drawdown contour (m)
- Watercourse
- Basalt dry area
- Underground mine
- Model boundary

Topography (m AHD)
630
150

Data Source:
Topography by SRTM; Watercourse by Geoscience Australia

Scale 1:250000

Metres 0 2500 5000

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Date: 26/07/2013

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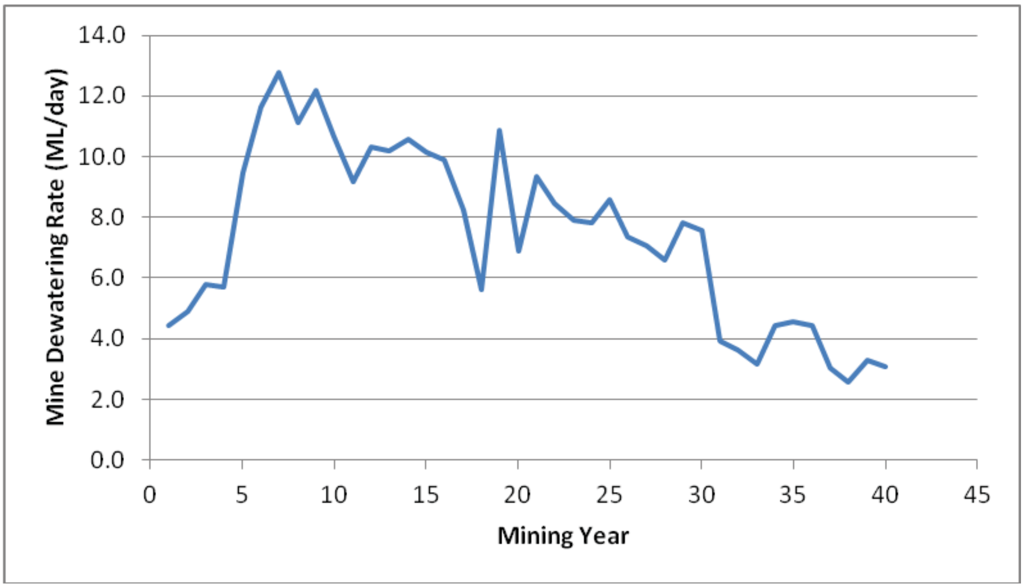
Note: area circled in red is where the Basalt is completely drained/dewatered.



Mine dewatering rate peaks at 12.8 ML/d (148 L/s), compared to approximately 3.8 ML/d (44 L/s) for the base case scenario.