BMA Broadmeadow Mine - EHP EA amendment application

(Pre-lodgement meeting)

Wednesday 22 April, 2015

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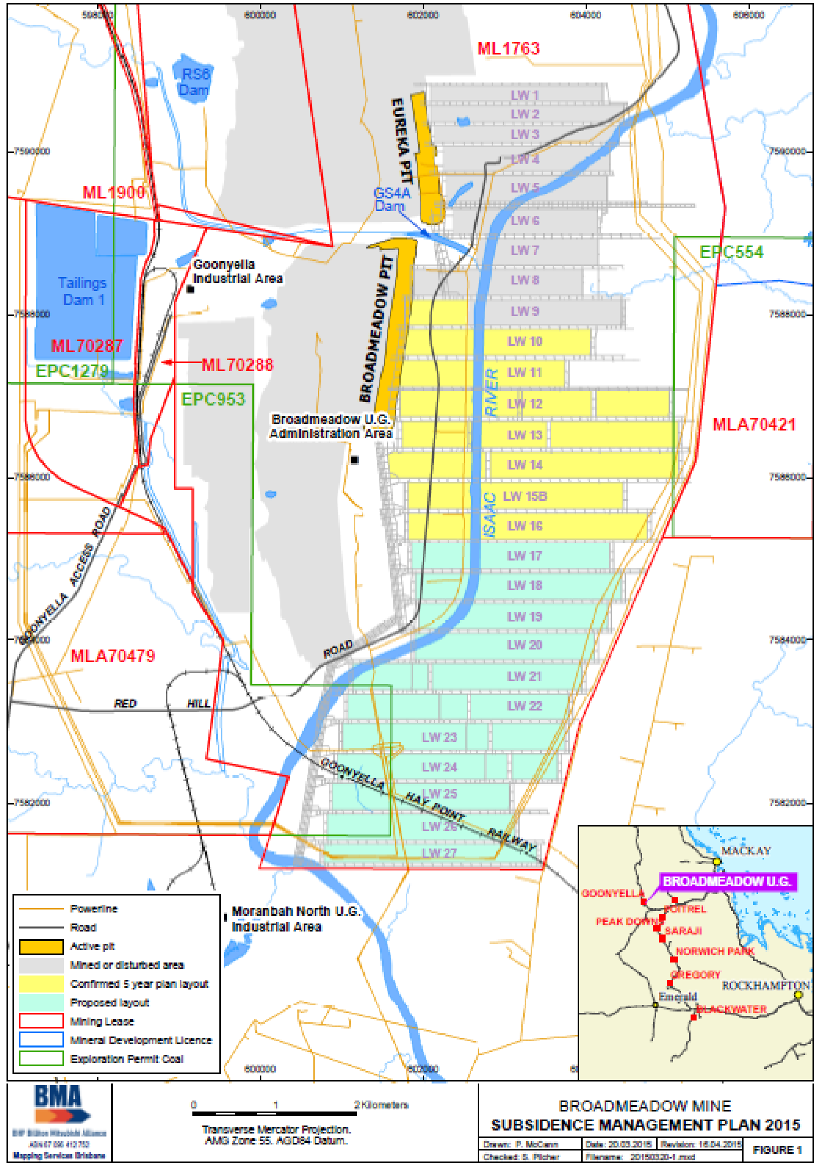
BMA

BHP Billiton Mitsubishi Alliance

Broadmeadow Mine



BRM Subsidence Management Plan

SMP – Purpose
SMP is the document that outlines the impacts likely to develop as a result of conducting mining operations under the Isaac River, and the mitigation strategy to address these impacts.

Content requirements
The SMP has been developed in accordance with the requirements of the Environmental Authority and the departmental guideline "Watercourse Subsidence – Central Queensland Mining Industry".

SMP comprises 3 main sections,

- Existing Environment
- Impact Assessment (1st, 2nd, 3rd & 4th order impacts)
- Subsidence Management (monitoring and mitigation strategy)

How the SMP works / applies in practice
The SMP outlines the actions that will be taken by detailing plans and strategies such as ;

- **Monitoring strategy –** annual subsidence monitoring and resulting works to be completed
- **Mitigation strategies –** provide direction for on ground works (river piling works, erosion control works)

SMP review process

Review of SMP

A review of the SMP is required at this point to support the EA amendment application process, which is required to obtain approval for the mining of future panels : Panel 111 – 127.

Additionally, the value of this review process is in providing the opportunity to review what's working well, areas that can be developed, and fine tuning of on the ground processes and activities.

Review of the SMP is essentially a two stage process;

Subsidence Modelling

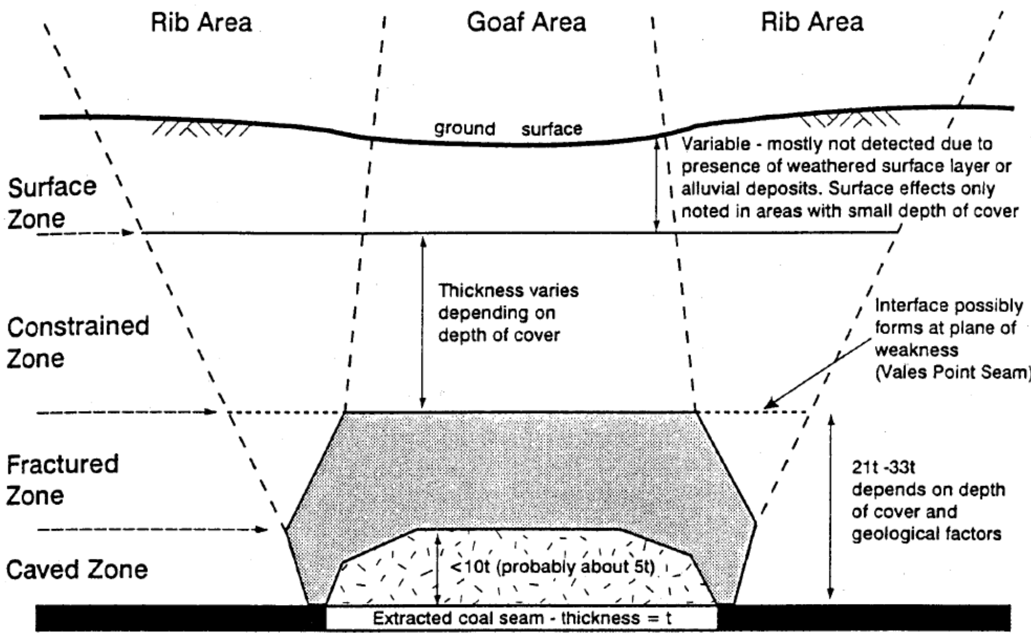
- A key component of the plan is predictive modelling of subsidence outcomes
- Model run for current mine plan and extraction plans
- Model validation by comparing predictions with actual surveyed subsidence of mined panels to date
- Prediction comparison between past and current mining technique (High Reach Longwall and Longwall Top Coal Caving)

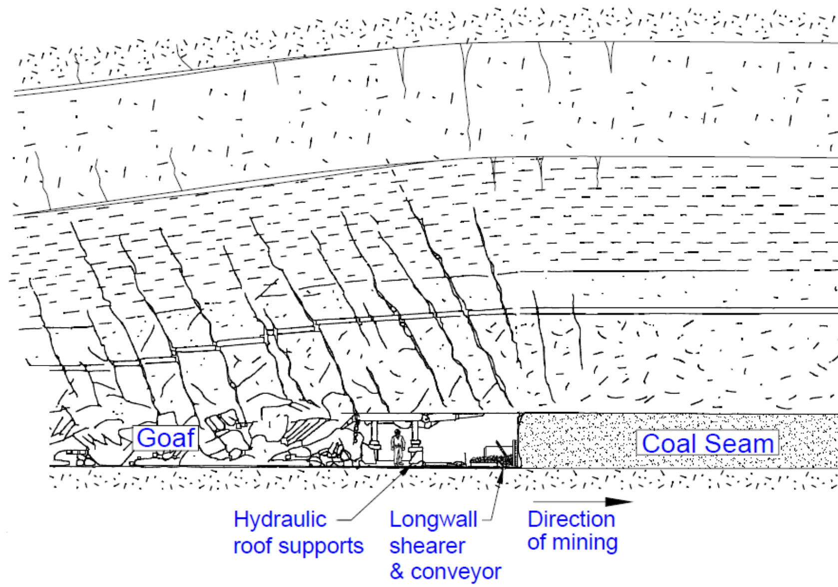
SMP content review

- Update of current Mine Plan and subsidence prediction
- An adaptive management approach to progressive rehabilitation of longwall mining with specific focus on the Isaac River
- Revision of the risk register and associated mitigation strategies

Coal Extraction – Isaac River

- Current mining strategy is not to cave under the Isaac River by turning off the caving function
- Inflow is a potential risk to the mine operation
- SMP has been developed on that basis
- Minimising coal extraction depth reduces fracture zone in overburden
- This reduces risk of fracture network connection between workings and the river channel

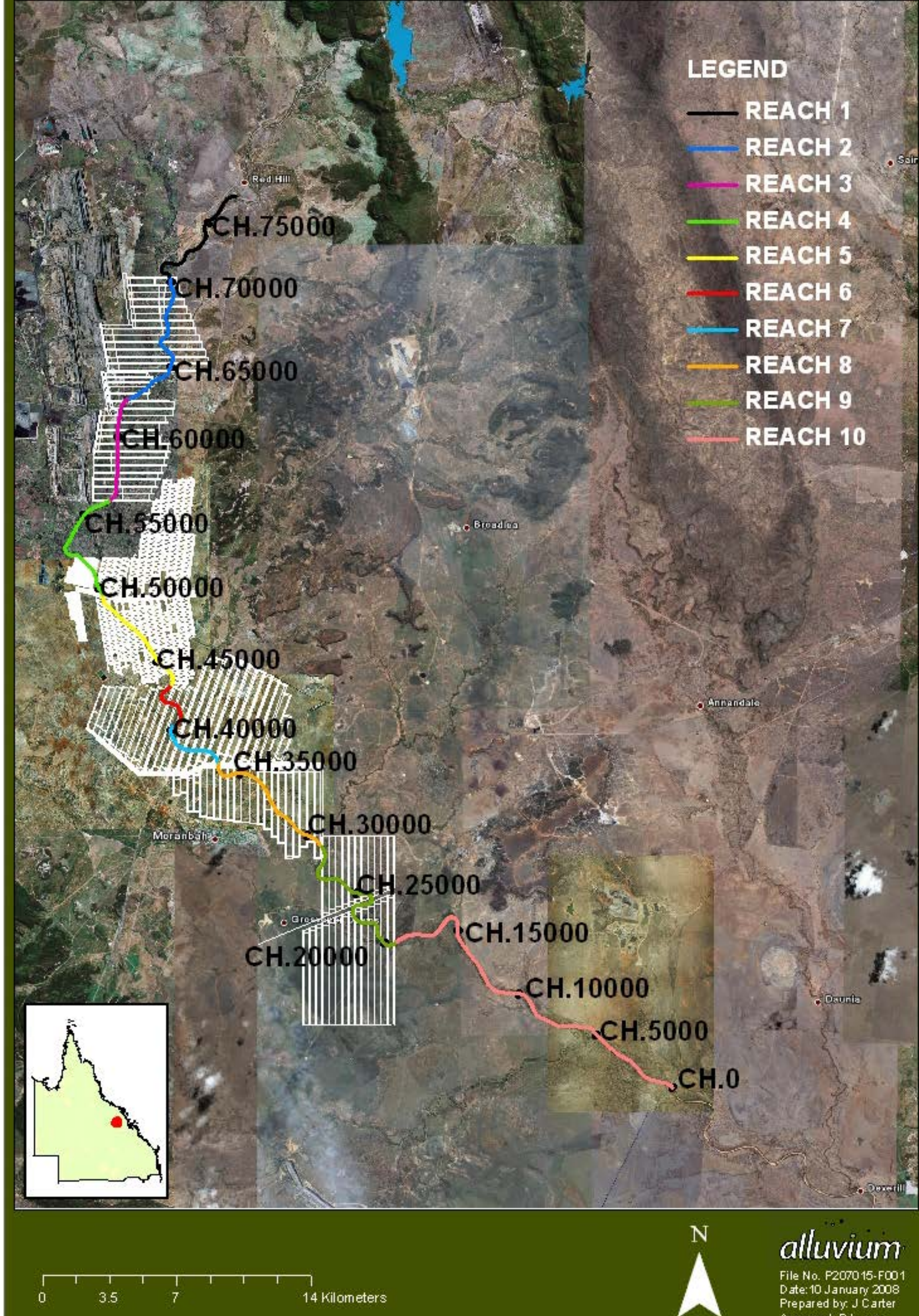




Extraction Depths Isaac River
- LTCC without caving extracts ≈ 4m of coal
- HRL previously extracting ≈ 4.2m of coal

Quick history

- Moranbah Nth - Isaac River subsidence impact assessment and management strategy (2001-3)
- Broadmeadow - Isaac River subsidence impact assessment and management strategy (2005-6)
- Early approvals method at Moranbah North and Broadmeadow – panel by panel Water Act Licence to Interfere
- Isaac River Cumulative Impact Assessment (IRCIA) – all 5 existing or proposed mine footprints (2007-9)



IRCIA overview

- Vision & objectives of assessment
  - Regulators key stakeholders during the project
- Orders of impacts
- Isaac River condition
- Sediment transport
- Subsidence void
- Is the volume of the void significant?
- Implications for management
  - Positive and negative impacts (opportunities and threats)
  - Licensing
  - Monitoring program
  - Adaptive management
- Confidence for mining investment and regulatory agencies

IRCIA - Classification of impacts

Outcomes from a DERM facilitated workshop April 2007

- 1st Order: Physical effects of subsidence
- 2nd Order: Geomorphic changes to the stream form and sediment dynamics
- 3rd Order: Changes to water quality and quantity
- 4th Order: Changes to Biology and human systems
- 5th Order: Impacts of human response to other impacts

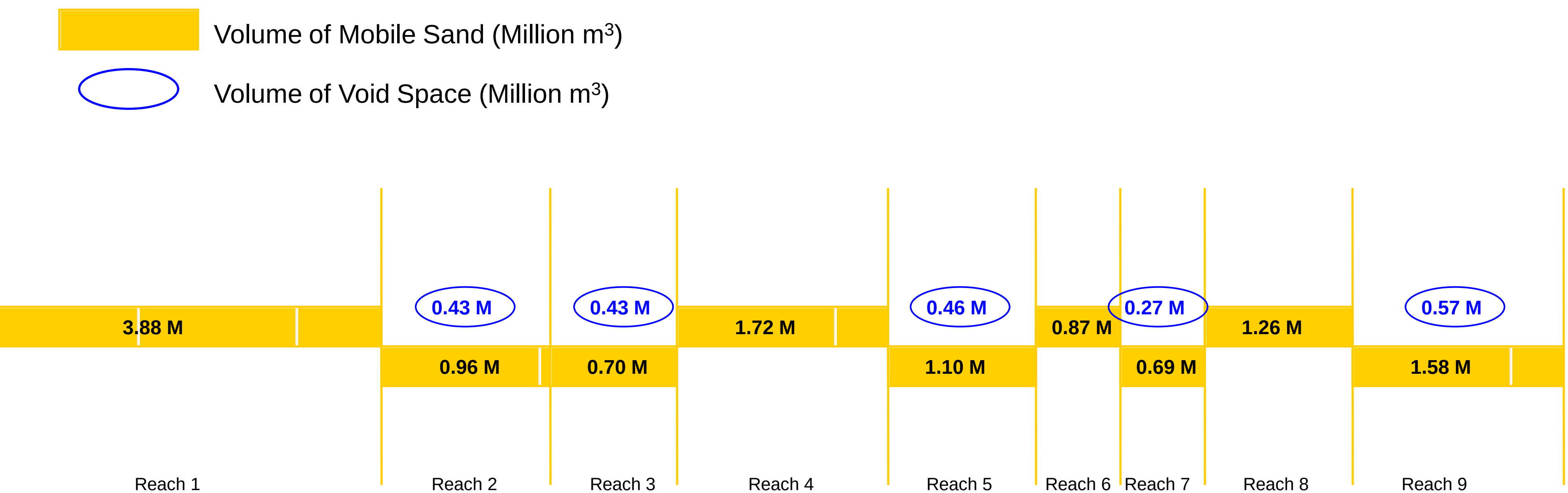
- 1st and 2nd order assessed
- 3rd and 4th order only briefly qualified

IRCIA – outputs

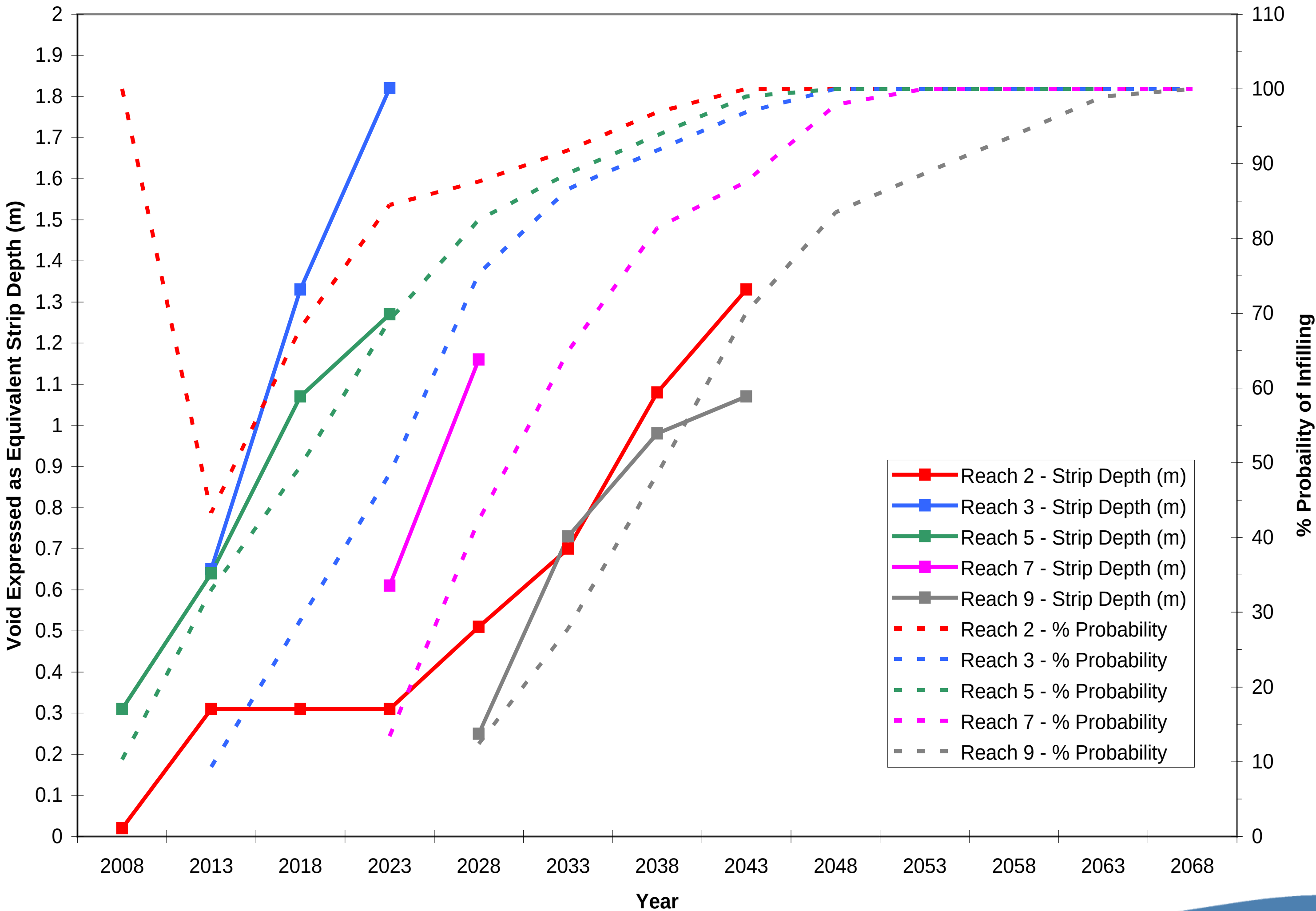
- Existing sediment in channel
- Sediment transport rates utilising IQQM flows (~100 years)
- Scale of subsidence void over time
- Location of subsidence voids and sediment stores
- Significance of the void relative to sediment transport
- Potential geomorphic impacts (channel bed deepening and subsequent responses)
- Influence of timing and magnitude of flows on risk windows and timeframes for complete infilling of voids

Key Question – Sediment Balance

- Will the sediment in the river overwhelm the subsidence voids created?
- Is there a risk window?



The risk window - strip depth and time to infill



IRCIA - Management Implications

- Establishment of Pools
  +ve increased habitat value
  -ve None
- Upstream progressing deepening
  +ve increased morphologic diversity/habitat value
  -ve infrastructure, bank instability (esp if extended inundation)
- Downstream progressing deepening
  +ve increased morphologic diversity/habitat value
  -ve infrastructure, bank instability (esp if extended inundation)
- Incision in tributaries
  +ve increased morphologic diversity/habitat value
  -ve infrastructure, bank instability, sediment export
- Potential Avulsion paths

IRCIA - Management Implications

- Short time scale and local extent
- Positive and negative impacts (opportunities and threats)
  - Mitigate against short term negative
  - Enhance/extend duration of positive
    - Improved catchment management by all
- Licencing – whole of mining influence scale as well as mine site level
- Monitoring program
- Next steps outlined

Observed

- Response at LW105-6 pillar
- Magnitude, duration and timing of flows relative to subsidence all important factors in response
- Smaller flows can have greater erosion impact on some processes
- Response in-line with predictions

Upstream view – 2009

Downstream view – 2009

Upstream view – 2010

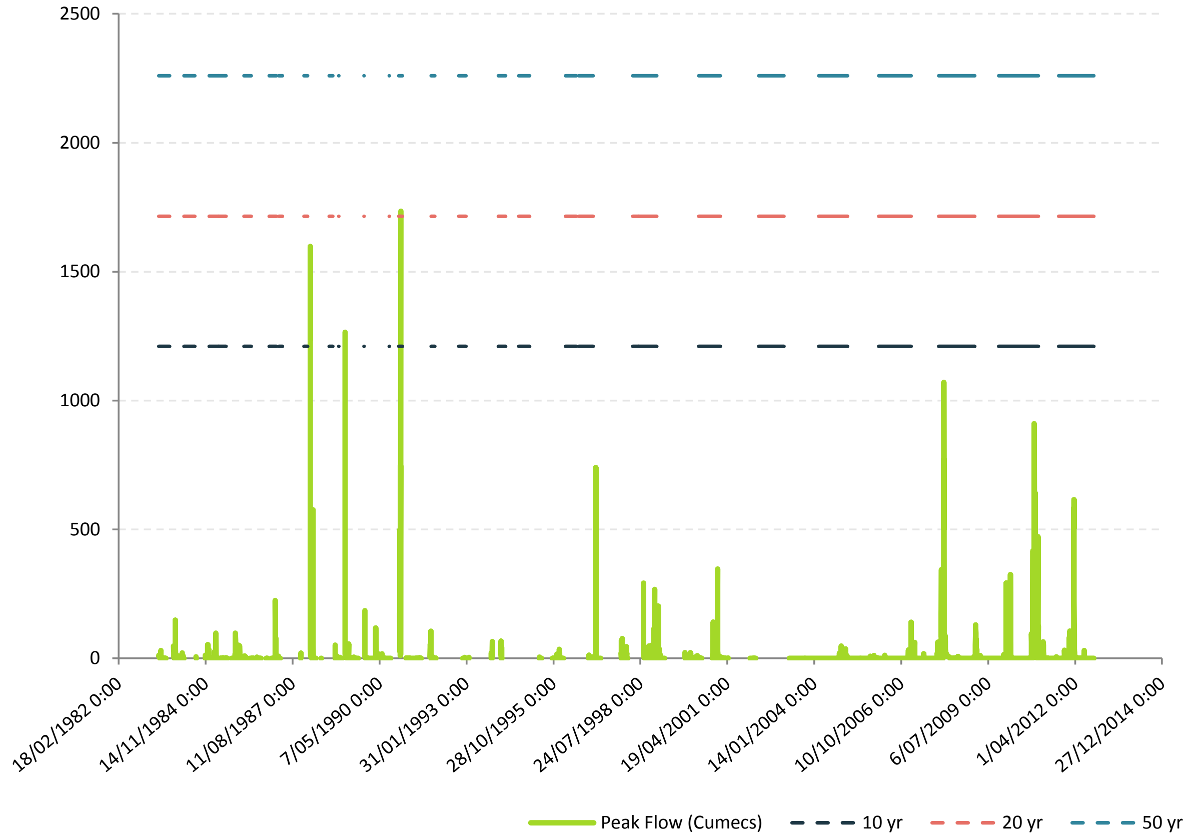
Downstream view – 2010

Upstream view – 2011

Downstream view – 2011

Hydrologic influence

- 5-7 year spells
- Potential for multiple longwalls waiting to be infilled
- Greater risk after extended dry



Observed

- LW104

Downstream view into LW104 subsidence in 2009

Downstream view into LW104 in 2012 following infilling in 2010-11 wet season, note tree die back

Timber pile fields at LW104-5 pillar have maintained a bench against toe of bank, mitigating the elevated bank erosion risk while both those longwalls have infilled

Detailed monitoring of response

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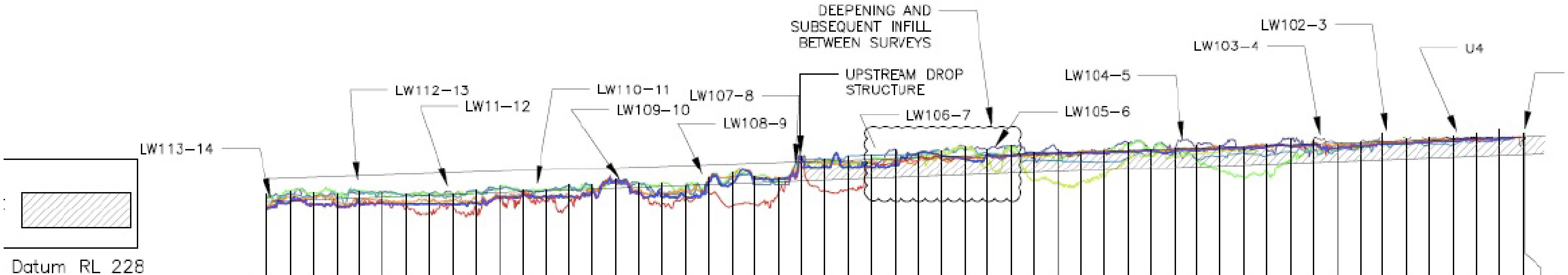

CHAINAGE	OCT 2014	NOV 2012	NOV 2011	SEPT 2010	MAY 2010	DEC 2008	MAR 2007
6400.00	235.13	235.38	235.50		236.17	236.54	236.84
6500.00	236.06	236.07	236.52		236.83	237.23	236.96
6600.00	235.82	235.80	236.49		236.68	237.03	236.62
6700.00	235.50	235.69	235.98		236.42	236.54	236.96
6800.00	235.84	235.96	236.22		237.10	237.24	236.93
6900.00	236.18	236.00	236.29		237.08	236.89	237.08
7000.00	235.56	235.86	236.13		236.84	236.88	236.84
7100.00	234.86	235.86	236.14		236.89	236.88	236.93
7200.00	235.57	235.90	236.28		236.71	236.88	236.85
7300.00	234.86	235.88	236.34		237.19	237.29	237.19
7400.00	236.26	236.51	236.55		237.45	237.73	237.45
7500.00	237.20	236.92	237.07		237.24	237.37	237.24
7600.00	236.10	236.61	236.78		237.34	237.39	237.34
7700.00	236.20	236.61	236.81		237.82	237.42	237.82
7800.00	237.21	237.16	237.37		237.43	237.83	237.43
7900.00	238.24	238.32	238.42		238.00	238.01	238.00
8000.00	236.82	237.10	237.40		238.06	238.01	237.98
8100.00	235.81	236.58	237.00		237.22	238.03	236.87
8200.00	236.30	236.62	237.40		237.24	237.68	237.24
8300.00	237.06	238.16	238.65		238.05	238.06	238.12
8400.00	235.70	238.01	238.62		238.52	239.15	238.52
8500.00	235.83	238.51	238.70		237.88	238.55	237.88
8600.00	237.36	238.43	238.58		237.88	238.24	237.88
8700.00	240.10	240.76	240.83		240.93	240.76	240.96
8800.00	237.26	239.88	240.18		240.67	240.36	240.48
8900.00	237.38	239.99	240.24		241.02	240.07	240.37
9000.00	240.09	239.87	240.49		241.09	240.48	240.24
9100.00	240.39	240.77	240.46		241.12	240.34	241.66
9200.00	240.50	241.29	240.45		241.23	241.11	240.94
9300.00	240.68	241.05	240.81	241.39	241.53	241.44	241.35
9400.00	240.79	240.66	240.92	241.87	241.58	241.79	241.99
9500.00	241.00	241.16	240.93	240.28	241.27	240.92	241.70
9600.00	240.98	240.98	241.07	241.58	241.41	241.91	242.06
9700.00	241.06	241.33	241.16	238.35	240.56	241.11	240.82
9800.00	241.16	241.26	241.32	238.23	240.53	240.73	241.69
9900.00	241.21	241.38	241.38	238.16	240.42	241.35	241.16
10000.00	241.37	241.28	241.30	239.09	240.38	241.49	241.58
10100.00	241.39	241.44	241.45	240.52	240.77	242.11	242.38
10200.00	241.59	241.57	241.53	240.93	241.28	241.62	241.49
10300.00	241.51	241.54	241.84	240.98	241.10	241.55	241.51
10400.00	241.83	241.59	241.74	241.22	240.69	240.59	242.11
10500.00	241.76	241.78	241.92	241.53	240.98	239.24	242.01
10600.00	241.86	241.78	241.94	241.53	241.31	238.67	241.40
10700.00	241.93	242.02	242.16		241.03	239.27	241.74
10800.00	241.95	241.98	242.07		241.43	240.41	242.76
10900.00	242.24	242.26	242.47		241.48	241.54	242.58
11000.00	241.83	241.80	242.18		241.56	241.67	242.28
11100.00	242.06	242.05	242.35		242.23	241.91	242.39
11200.00	242.35	242.23	242.52		242.45	242.39	243.38
11300.00	242.38	242.32	242.45		242.28	242.29	242.72
11400.00	242.51	242.43	242.70		242.21	242.38	242.86
11500.00	242.60	242.53	242.74		242.10	242.55	243.02
11600.00	242.65	242.77	242.87		242.56	242.92	243.30
11700.00	242.81	242.79	242.99		242.63	243.35	243.71
11800.00	242.86	242.98	243.07		243.20	242.80	243.30
11805.89	242.83	242.98	243.09		243.40	243.40	243.40

Adaptive management approach

- SMP adopts adaptive management as the approach to subsidence impacts, the principles are:
  - Assess the risk
  - Design operational treatments (mitigation measures)
  - Implement treatments
  - Monitor key response indicators
  - Re-evaluate effectiveness of implemented mitigation measures
  - Adjust policies and/or practices

Residual Risk Assessment

Feature / process / environmental value	Order and nature of impact	Threats and opportunities (untreated risk) associated with impact	Mitigation options	Residual risk post mitigation
Interruption to bedload sediment transport continuity by subsidence, creating deepening downstream.	2nd -4th order impacts - negative and positive	Isaac River diversion banks downstream of subsided panels waiting to be infilled when substantial flow event (100-500m^3/s) occurs will be subject to increased risk of instability. Risk is elevated where hard controls such as bedrock exist in channel bed that will resist deepening as bench retreat is the next response, meaning the high unstable banks may end up with no toe protection. This mechanism is responsible for creation of pools, which are rare aquatic refugia in the upper Isaac River.	Appropriate channel bed and toe of bank protection and enhanced riparian vegetation over pillars. Battering and revegetation of vertical upper banks through panels when infilled and low flow goes over bench level. This does not address large scale existing diversion condition issues. Rehabilitation of diversion to decrease channel gradient overall, lowers risk.	Dependent on level of intervention, low risk of bank erosion through panels and pillars can be achieved with significant intervention.
Upstream progressing deepening from subsided (but not yet infilled) zone in Isaac River channel	2nd order – negative with low potential for positive	Given the highly elevated sediment inputs to the Isaac River from broader catchment conditions, this response has not yet been observed. Should sediment inputs reduce, some increased potential for bank erosion upstream of subsidence should deepening occur.	Pillar zones presently treated. Overall reduction in mobile sand bed thickness may allow for reintroduction of morphologic diversity and associated aquatic habitat gain. No further mitigation required based on observed response to date.	Low.
Upstream drop structure	2nd order – negative with low potential for positive	Ongoing damage to the structure instigating a deepening phase upstream that may exacerbate existing instabilities in diversion or create new instabilities in upstream reach. Similar to upstream progressing deepening	As per upstream progressing deepening.	Low.
Downstream drop structure	1st order impact.	Becomes redundant as is located in centre of panel and will be subsided below adjacent pillar levels. Structure is largely redundant already. Overall threat posed by gradient of diversion.	Reinstatement of a lower gradient for the diversion as a whole.	Low.
Storage of runoff in subsided zones outside Isaac River channel	3rd and 4th order impact – positive at a local level, some potential for negative	Impacts to the hydrograph in flood events shown to be minimal, however in dry years where the river flows can be reliant on localised storm events, may provide	Maintain the net gain wherever possible by allowing the ephemeral wetlands to remain. Response to consider erosion risks associated with	Low. Dependent on objectives for management of RE's at a local level.