



Falcon Groundwater Drawdown Management Plan

1.0 OBJECTIVE

Minimise groundwater related ecological impacts resulting from mining operations. Aspects of preserving groundwater resources through water use efficiency measures are discussed in other aspects of the Cooljarloo Groundwater Operating Strategy.

2.0 KEY ISSUES

- Drawdown from mining impacting groundwater dependant vegetation and wetlands.

3.0 BACKGROUND

The mining of the Falcon resources will require some pit dewatering. This will involve directing any water collecting in the pit voids to in-pit sumps and then pumping the water for use in mineral processing. A number of detailed assessments have been undertaken to assess the risk of drawdown and associated impacts to phreatophytic vegetation including;

- PB 2006, original modelling and Mt Jetty Creek Assessment
- PB 2007 remodelling based on amended mining sequence/schedule
- PB 2007a sections and slimes plans
- Froend & Loomes 2007 mortality review

Modelling of the worse case drawdown within the superficial aquifer associated with pit dewatering indicates a moderate likelihood that phreatophytic vegetation will be adversely impacted (refer to PB 2007). This management program is designed to minimise the likelihood and extent of adverse impacts to phreatophytic vegetation.

Groundwater drawdown related impacts to vegetation have occurred at Cooljarloo in the past and have been the subject of significant study. The knowledge gained from this experience has significantly contributed to the development of this management plan. Previous work conducted, and studies currently in progress, seek to identify vegetation water stress risk. This work provides the basis for understanding the pertinent timing to avoid prolonged exposure to periods of groundwater separation and thereby these management strategies.

Past impacts have involved the severe stress and death of areas vegetation in proximity to areas of mining and groundwater abstraction bores. Impacts typically resulted from the depletion of the soil moisture store (associated with groundwater drawdown and poor winter meteoric recharge) that vegetation relies on during hot and dry summer periods. The specific mechanisms for impact vary depending on the mode of drawdown (mine void dewatering which tends to be linear versus abstraction bore point source), the hydrogeological setting (local vertical and horizontal transmissivity and depth to groundwater) and the vegetation / landform association.

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Suffice to say that particular vegetation/landform association types are greater at risk than others, in particular vegetation on lower to mid slope at a pre-impact depth to groundwater of between 2-6m.

The cessation of abstraction and backfill of mine voids have resulted in the restoration of pre-drawdown groundwater levels. Similarly vegetation in the areas affected has recovered to pre-impact composition.

4.0 MANAGEMENT PROGRAM

The program applies the control hierarchy of:

- **Avoid** – modify the plan to prevent the impact occurring;
- **Mitigate** – actions to be undertaken in the event of adverse trends in order to minimise or prevent the extent of the impact;
- **Repair/restore** – post impact respond to ensure the recovery and restoration of pre-impact conditions.

This is supported by a monitoring regime that seeks to anticipate and thereby allow the prevention of adverse impacts occurring and collect the information necessary to understand the recovery of the relevant environmental values.

4.1 Prevention (Avoid)

It is essential to ensure that the likelihood and magnitude of water stress resulting from mining activities is minimal. The specific measures required to achieve this centre around optimising the mining and backfilling sequence to minimise drawdown potential. This will be on principles of:

- minimising the period for which the pits are dewatered for thereby shortening the period of drawdown (i.e. mine as fast as practical, and also reduce the duration of mining in each individual pit by alternating between pits throughout the mine period);
- backfilling as soon as possible to enable re-instatement of the aquifer and thereby through-flow across the mine void; and
- timing dewatering within the impact risk zone (refer to Figure 2) with winter as far as practical thereby reducing likelihood of vegetation stress.

4.2 Mitigation

The overarching management objective for native vegetation across the lease is to prevent permanent impacts to biodiversity within groundwater dependant ecosystems (GDEs). However, comment in this plan is often restricted to short-term changes in vegetation condition and vigour (measured as canopy health and fullness, and species density and abundance). These parameters, along with measurements of community and population structure, provide data required to assess changes in vegetation, and thereby biodiversity, in the long term.

In the event that monitoring demonstrates adverse trends (ie divergence from defined environmental water requirement trigger levels) the following actions (individually or in combination) will be implemented:

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- There is some flexibility within the mining sequence to enable mining to move to alternative pits within the Falcon area should adverse drawdown be noted within the vicinity of one particular pit.
- Pumping water to non-active mine voids to supplement aquifer recovery.
- Short term cessation of those activities likely to be causing the drawdown may be implemented to determine aquifer response and confirm a causal relationship and, based on a definitive finding of a causal relationship, either amend those activities in order to reduce the impact or cease those activities until such time as conditions allow for recommencement (e.g. soil moisture recharge due to rainfall).
- Artificial recharge of the affected areas and / or other contingency actions including, modification of practices.

4.3 Repair/restore (in the event of adverse vegetation impact)

Experience with the Cooljarloo North Mine Bore Field (impacted in 2000/1) has shown that the vegetation does recover following an impact event of relatively short duration (eg over one or two seasons) without any significant change to the vegetation composition. It has also shown that the recovery of impacted vegetation communities is greatly assisted by fire which triggers a recovery (germination) response in many species.

As such, in the event of adverse impact to areas of vegetation, subject to the particular size and location of the area impacted and the views of the Department of Environment and Conservation, the following strategies will be employed:

- The area may be subject to a controlled burn (this may be several years after the impact has occurred, allowing recovered vegetation to set seed before a burn).
- Recovery of the vegetation will be monitored against the baseline (refer to monitoring).

Appropriate remedial works (eg infill seeding and/or planting) will be undertaken in the event of significant change to vegetation composition being evident.

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5.0 MONITORING

5.1 Goals of Monitoring Program

Provide for the management of adverse impacts resulting from mine dewatering and groundwater abstraction.

In order to understand and explain behaviour of the aquifer / soil moisture / vegetation relationship and response to circumstance the following parameters will be monitored

- Vegetation composition and health
- Groundwater levels and Soil moisture status

Of these, monitoring of ground moisture status in the saturated zone (groundwater levels in the superficial aquifer) and unsaturated zone (soil moisture/status of the vadose zone) provides the primary means of tracking performance in managing drawdown and providing warning of adverse rates and magnitudes of drawdown. Monitoring of vegetation health is a secondary indicator as typically, once vegetation exhibits signs of stress it is too late.

Populations of Declared Rare Flora species *Andersonia gracilis* are within the potential drawdown cone and thereby will be monitored.

A baseline of pre-mining data will be collected to provide a reference for future comparison. For time based measurements a period of at least 12 months pre-disturbance will be targeted.

5.2 Vegetation composition and health

Vegetation monitoring has two objectives

1. Provide a baseline of vegetation composition for recovery monitoring
2. Track the health of the vegetation, including DRF *A. gracilis*

5.2.1 Baseline of Vegetation Composition

Assessment of baseline vegetation information will follow established methodology applied in existing Cooljarloo operations. This involves the establishment of 20m x 20m quadrats, containing a series of 20 nested 2m x 2m quadrats. Within each quadrat (20m x 20m) the follow attributes will be recorded:

- 20m x 20m Quadrats:
- All tree species** – map location and tag trees
 - Give each tree a health ranking (use appropriate scale)
 - Measure height
 - Understorey** – 3 individuals of each susceptible species (previous study targets)
 - Tag each plant
 - Health ranking (alive vs. dead, stress indicator)
 - Foliage cover
 - Quadrat** – Photo-point

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2m x 2m Nested Quadrats: Full species list with %foliage covers (live and dead) and health ranking

Proposed Schedule

- Baseline biodiversity plots for each floristic community type were established in 2006 (Woodman Environmental 2007).
- Establish transects and collect baseline data in Spring 2008, targeting high-risk vegetation communities (mid to lower slopes).
- During mining operations, health rankings will be undertaken each April, to confirm the adequacy of groundwater and soils moisture limits, and in the event that environmental water requirement trigger levels are exceeded.

5.2.2 Vegetation Health

The health of vegetation is a primary indicator of when an adverse impact has occurred but a poor indicator for use as a preventative measure. The reason for this is that generally, once the vegetation begins to express water stress to the point where it is clearly visible, it is too late to significantly affect the final outcomes of the event (i.e. save the vegetation). As such, while vegetation health will be routinely monitored the primary reason for this is to confirm that an impact has occurred, when required, quantify the extent of impact and provide information to assist understand the mode of impact.

Vegetation health monitoring is in two parts, the first is quantitative health ranking associated with quadrat monitoring as described in Section 5.2.1. The second is casual observation by site environmental staff as part of routine groundwater and soil moisture measurement. Specifically, during regular groundwater / soil moisture monitoring rounds (refer to Section 5.3) staff will observe and record the condition of vegetation within the proximity of the monitoring locations.

5.2.3 Status of *A. gracilis*

Populations in areas where the modelled maximum drawdown exceeds 0.75m will be monitored as part of the general vegetation health monitoring proposed. This means that each population will be visited and assessed regularly throughout the project. Given that these species are only readily identifiable/locatable during spring, each population will be visited and its health assessed, annually during spring.

In the event that monitoring identifies adverse trends in health of *A. gracilis* attributable to mining related groundwater drawdown the same hierarchy of management responses proposed in Section 4.2 of the management plan (EPS Attachment 18) will be implemented for that area. Recovery of communities will be monitored and, should recovery prove inadequate, restoration activities as in Section 4.3 (e.g. seeding) will be undertaken.

Locations of populations to be monitored are shown in Figure 7.2 the falcon EPS (Tiwest 2008 *Cooljarloo Mine (M268SA) Falcon Extension Environmental Protection Statement*, 15 May 2008)

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5.2.4 Groundwater and Soil Moisture

Monitoring of ground moisture status in the saturated zone (groundwater levels in the superficial aquifer) and unsaturated zone (soils moisture) provides the primary means of tracking performance in managing drawdown and providing warning of adverse rates and magnitudes of drawdown. Comparison of monitoring data against predetermine limits provides impetus for a management response.

What is to be monitored?

Groundwater levels are measured in all relevant piezometers (refer to Figure 1) including control (outside influence of mining) and compared to predetermined limits a monthly basis. Monitoring commenced during 2006 to provide a baseline for comparison.

Soil moisture monitoring will be in accordance with recommendation of Froend and Loomes 2007. Four locations are planned; three encompassing five probes at varying depths within the soil profile, 0.5m, 1.0m, 1.5m, 2.0m, and 3.5m; the fourth location will have four probes and a rainfall gauge. Soil moisture and rainfall data will be tracked continuously via electronic loggers. Data from the loggers will be downloaded and reviewed monthly. Monitoring will commence February 2008.

Ecological Limits

Absolute magnitude and rates of groundwater drawdown (namely ecological water limits or EWs), beyond which it is probable that vegetation with high groundwater dependency will be impacted have been defined by (Froend, R. & Loomes, R. 2007). The key principles upon which these are based include:

1. The degree of groundwater dependency decreases with depth to water table. For Cooljarloo, tree species within 10m of water table are assumed to be phreatophytic and derive some water from groundwater throughout the year. Of these the 0-3m and 3-6m have the highest dependency, with more than 50% of daily summer water use from groundwater. At water table depths of 6-10m and greater than 10m, the increased depth also increases the proportion of soil moisture stored beyond the influence of evaporation and proportionally more water is available, and thereby sourced, from the upper layers of the soil profile.
2. The process and timing of response to groundwater decline follows that shown in Figure 1. From this it can be seen that the effects of water table decline on phreatophytes are related to the duration and magnitude of decline, the rate of drawdown and antecedent conditions such as depth to groundwater, soil stratigraphy and availability of moisture from other sources (such as meteoric soil moisture).
3. Rapid groundwater decline will result in the process of impacts (stages 1 to 4 in Figure 1) to be accelerated. Gradual reduction of the water table provides a greater opportunity for recharge to occur and for plants to adapt (if possible) to the altered groundwater regime (i.e. root growth, physiological adjustments).

Based on this a framework for estimating the risk of impact to phreatophytic terrestrial vegetation from groundwater drawdown was developed as depicted in Figure 2A-C (Froend and Loomes, 2007). The framework Rates of drawdown (m/yr)

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are read from the y axis and the magnitudes (m) from the x axis. Risk of impact can be scored and defined as low, moderate, high or severe risk of measurable impact from groundwater regime change.

Recharge of the vadous zone (from meteoric inputs for example) will lessen the risk of impact to phreatophytic vegetation from groundwater drawdown.

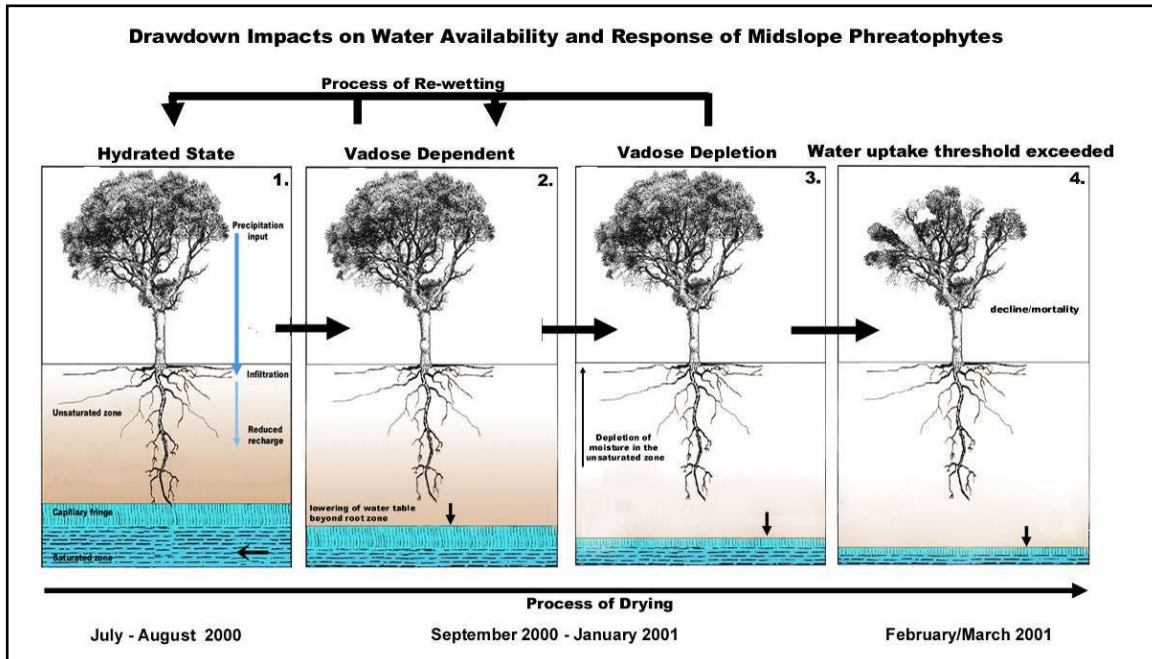
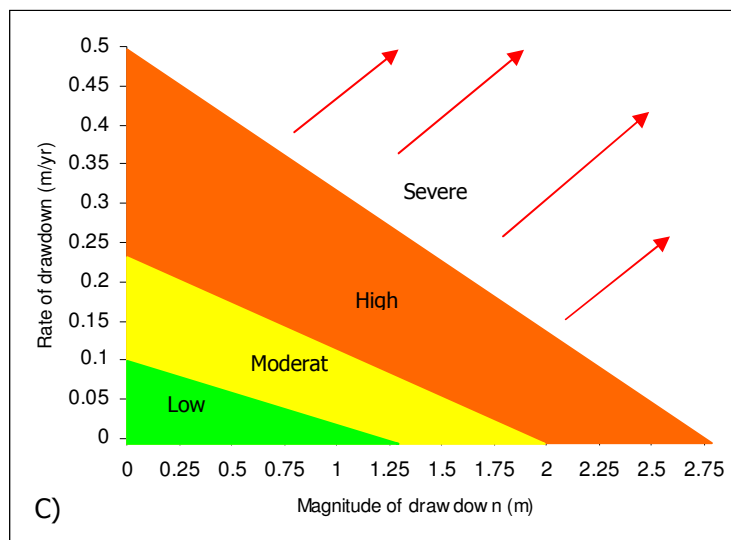
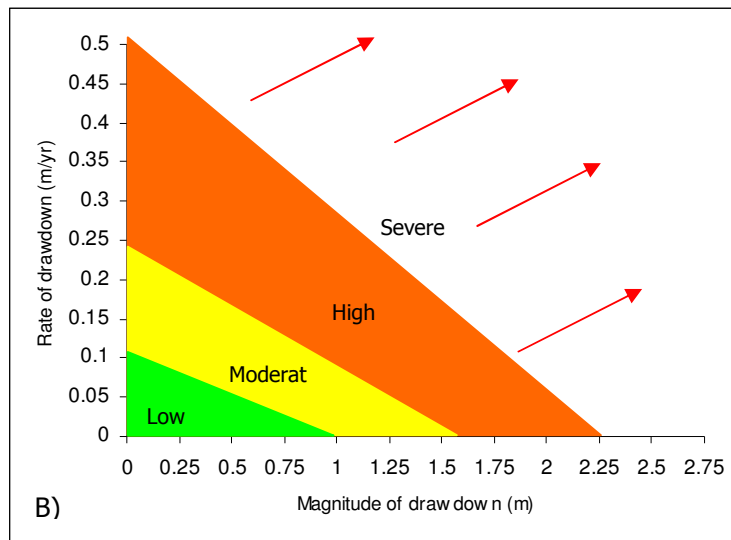
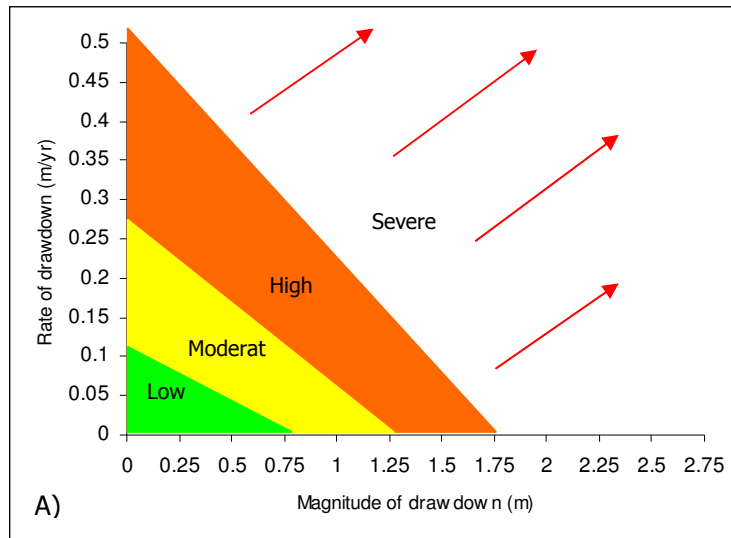


Figure 1: Process and timing of groundwater drawdown impacts at mid-slope sites. Mid-slope represents the 3-6 m depth to groundwater category. (Froend and Loomes 2007)

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Figure 2: Risk of impact to phreatophytic vegetation in the different depth to groundwater grouping based on rate and magnitude of groundwater level change a) 0-3 m, b) 3-6 m, c) 6-10 m (Froend & Loomes, 2004).

It has been determined that vegetation within 1 km of active mining operations within which drawdown is expected to exceed 0.75 m was at moderate to high risk of impact. To ascertain the spatial area of drawdown impacts, risk categories were overlain with modelled maximum drawdown contours within areas not underlain by a thick clay horizon. Areas were then calculated for each category of risk, low-high.

5.3 Establishment of trigger levels

From Froend and Loomes work it has been determined that both magnitude and rate of decline must be considered when establishing trigger levels.

Drawdown thresholds based on rate and magnitude were calculated for the 2006 GW levels and saw all bores breach the minimum trigger levels over the summer autumn pattern due to the exceptionally poor winter. Although vegetation monitoring has not been undertaken specifically at these sites during the late summer period of 2007, it is possible that impacts to vegetation have already occurred in the vicinity of the OB bores.

Based on the table below charts with trigger levels have been developed and will be followed with respect to preferred minimum magnitude, preferred minimum rate, absolute minimum magnitude and absolute minimum rate. These charts are attached to the end of the plan.

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Table 1: Recommended trigger levels as mAHD and mb TOC (metres below top of casing)

Bore	¹ DTGW (m) Sept 06	DTGW category	³ Preferred minimum- magnitude		⁴ Preferred minimum- rate		⁵ Absolute minimum - magnitude		⁶ Absolute minimum - rate	
			mAHD	m bTOC	mAHD	m bTOC	mAHD	m bTOC	mAHD	m bTOC
MSBO1s	² 3.87	3-6 m	59.91	³ 4.87	60.81	³ 3.97	59.31	³ 5.47	60.76	³ 3.72
MSBO2s	² 2.72	0-3 m	69.69	³ 3.47	70.34	³ 2.82	69.19	³ 3.97	70.29	³ 2.57
OB15d	5.91	3-6 m	58.62	6.91	59.52	6.01	58.02	7.51	59.47	6.06
OB16d	4.79	3-6 m	60.70	5.79	61.60	4.89	60.10	6.39	61.55	4.94
OB16s	4.75	3-6 m	60.77	5.75	61.67	4.85	60.17	6.35	61.62	4.90
OB17d	3.00	0-3 m	55.48	3.75	56.13	3.1	54.98	4.25	56.08	3.15
OB17s	2.88	0-3 m	55.50	3.63	56.15	2.98	55.00	4.13	56.10	3.03
OB18d	2.98	0-3 m	52.90	3.73	53.55	3.08	52.40	4.23	53.50	3.13
OB18s	3.05	0-3 m	52.88	3.80	53.53	3.15	52.38	4.30	53.48	3.20
OB19d	3.05	0-3 m	54.97	3.80	55.62	3.15	54.47	4.30	55.57	3.20
OB19s	2.98	0-3 m	55.01	3.73	55.66	3.08	54.51	4.23	55.61	3.13
OB20d	3.32	3-6 m	51.94	4.32	52.84	3.42	51.34	4.92	52.79	3.47
OB20s	3.20	3-6 m	52.05	4.20	52.95	3.30	51.45	4.80	52.90	3.35
OB21d	4.40	3-6 m	49.22	5.40	50.12	4.50	48.62	6.00	50.07	4.55
OB21s	4.22	3-6 m	49.56	5.22	50.46	4.32	48.96	5.82	50.41	4.37

¹ Depth to groundwater.

² Mean min dtgw 2001-06.

³ Calculated from average annual minimum 2001-06 or Sept 06 level and max acceptable magnitude of drawdown under low risk of impact.

⁴ Calculated from average annual minimum 2001-06 or Sept 06 level and max acceptable rate of drawdown under low risk of impact after 1 year.

⁵ Calculated from average annual minimum 2001-06 or Sept 06 level and max acceptable magnitude of drawdown under moderate risk of impact.

⁶ Calculated from average annual minimum 2001-06 or Sept 06 level and max acceptable rate of drawdown under moderate risk of impact after 1 year.

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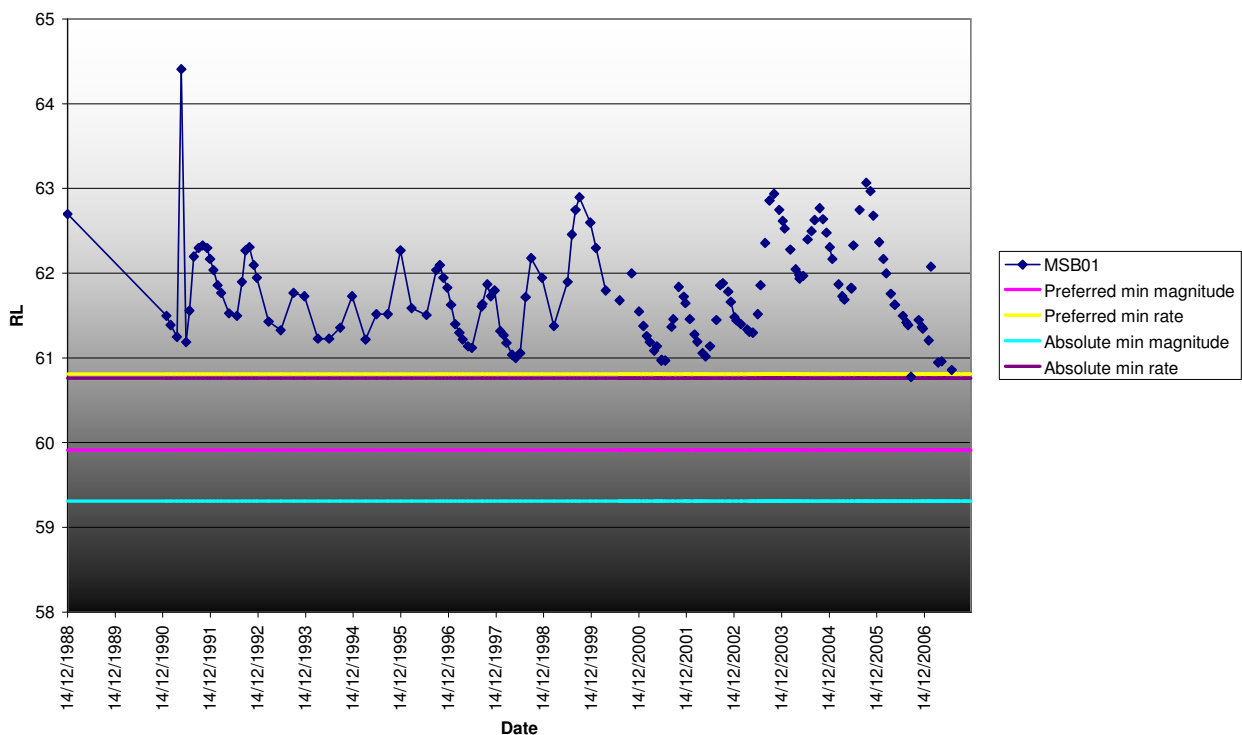


It is desirable to have both preferred and absolute trigger levels (for both rate and magnitude) in the case of minimum groundwater levels in monitoring bores. A preferred minimum level may represent the level above which no or low risk of impact due to excessive drawdown is probable. A breach of the preferred minimum would estimate a higher risk, which will alert Tiwest to take remedial action/caution or, the higher risk which may be acceptable under some circumstances. In the case of an absolute minimum, which could be represented by levels greater than low risk but less than severe risk, remedial management action will be taken before a breach occurs.

The preferred min rate and absolute min rate will be recalculated in 2008 to reflect the changes that have occurred in 2007.

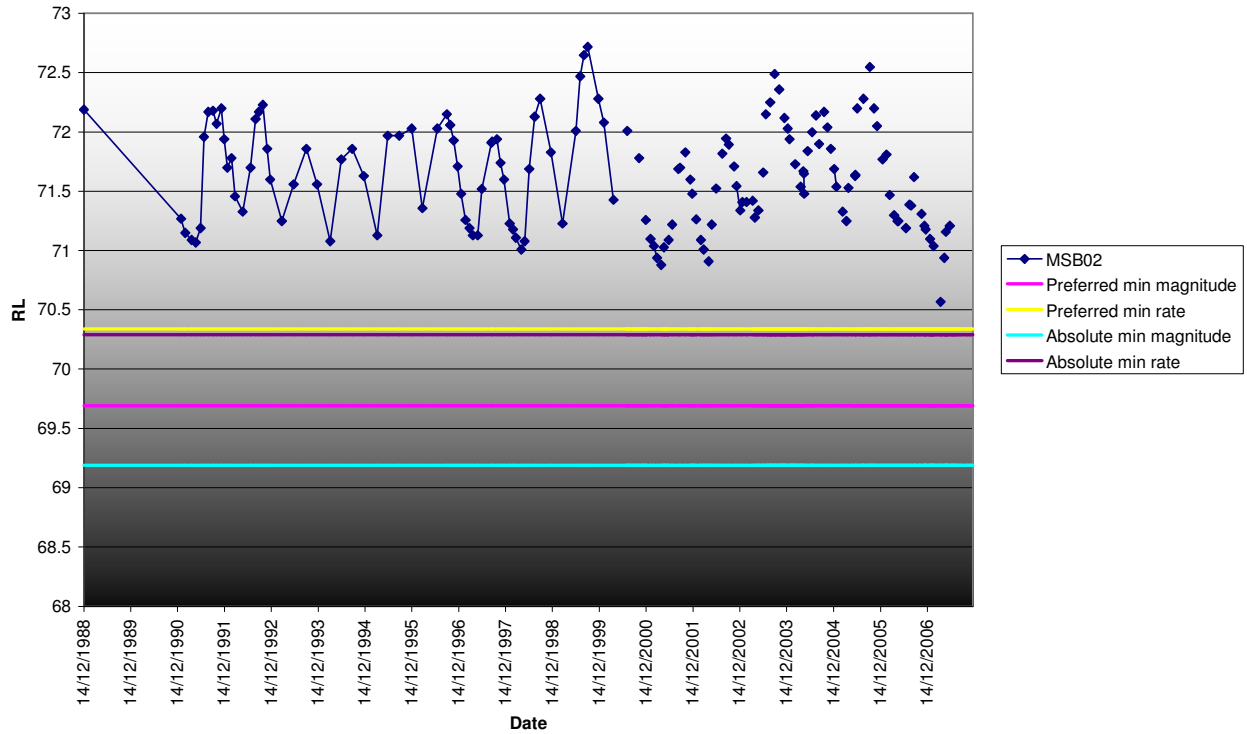
Modelling has shown that trigger levels are unlikely to be breached at bores OB16d, OB20d and OB21d (Table 2). However, OB15d triggers may be exceeded from June 2009 to January 2013 when drawdown is at its greatest spatial extent. Both the preferred absolute minimums may also be breached at OB17d from December 2008 to January 2013, at OB18d in April 2009 and at OB19d from April 2009 to January 2011.

Below are the charts of the monitoring bores and their associated trigger levels. It is when these levels are approached that action will be taken to avoid vegetation loss. This action is outlined in Section 4.2 mitigation.

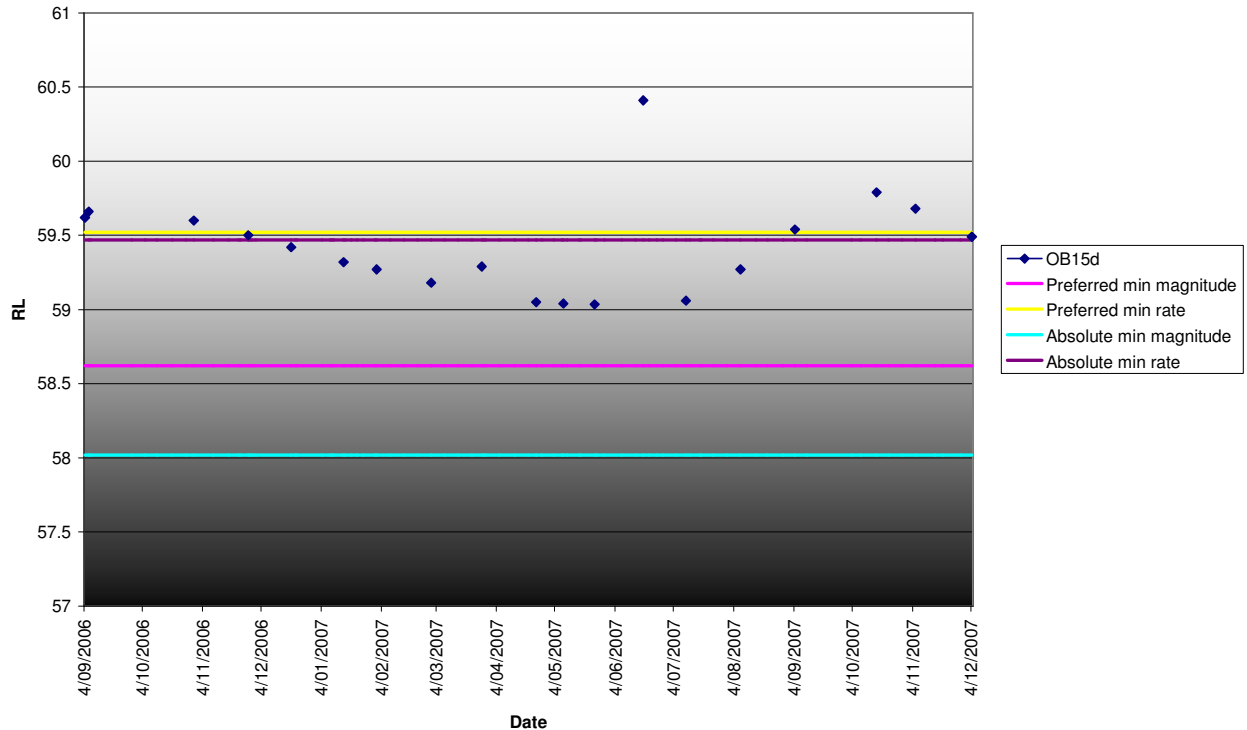


Monitoring Bore MSB01

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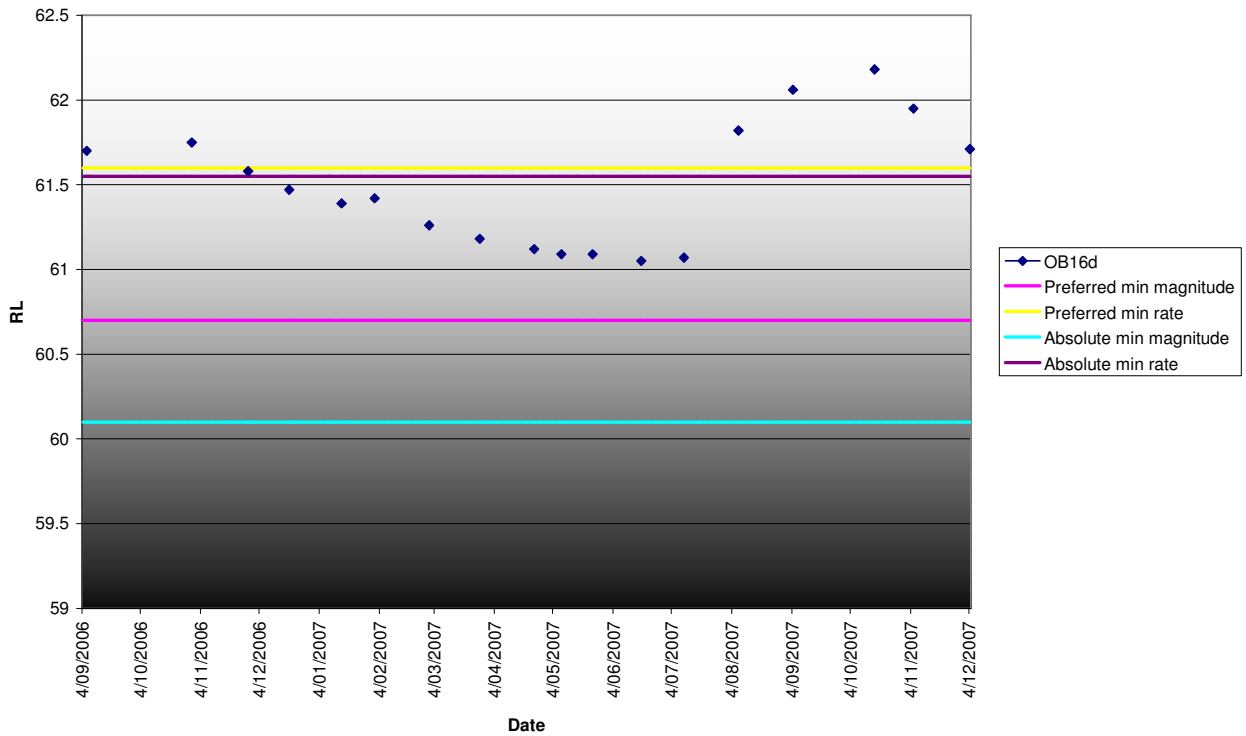


Monitoring Bore MSB02

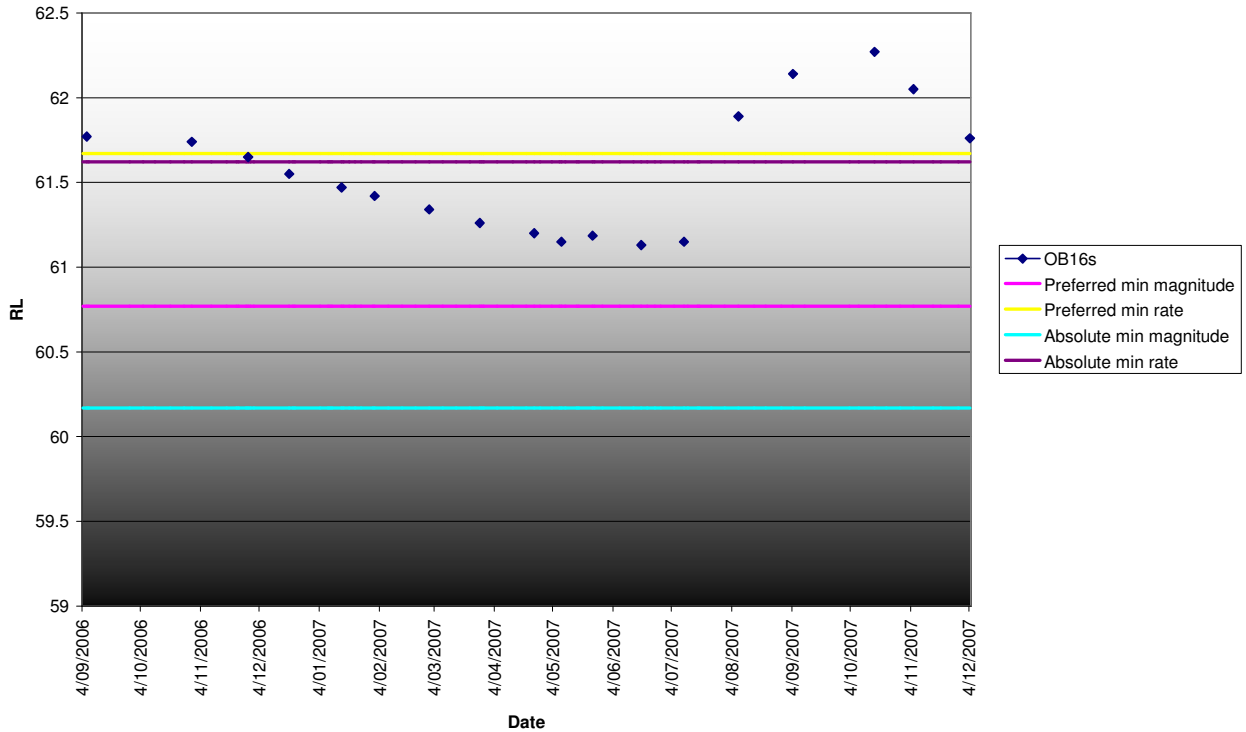


Monitoring Bore OB15d

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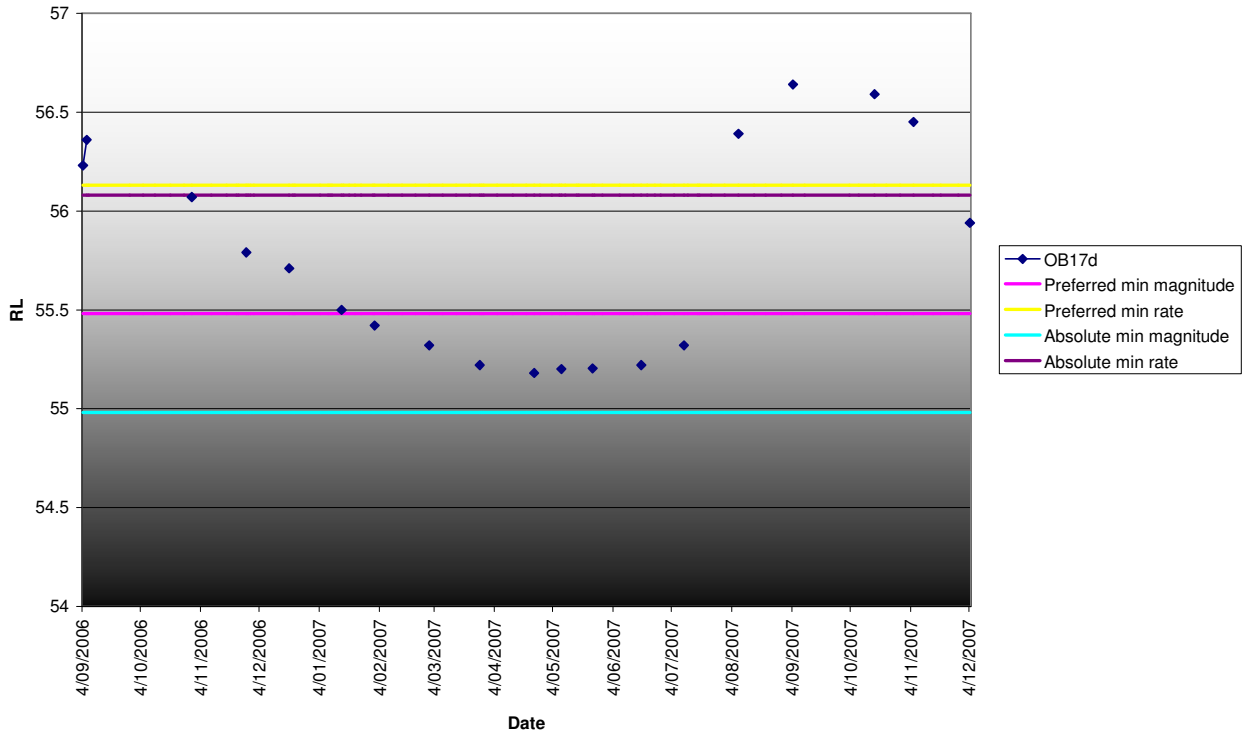


Monitoring Bore OB16d

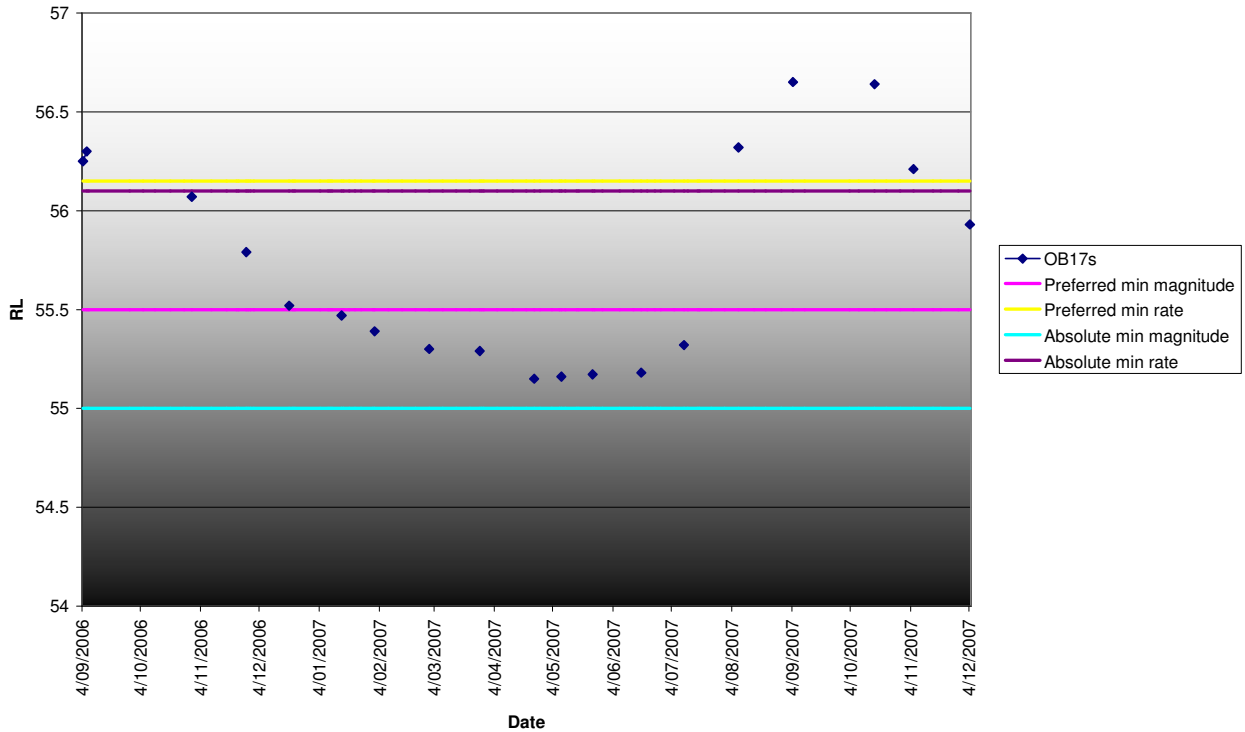


Monitoring Bore OB16s

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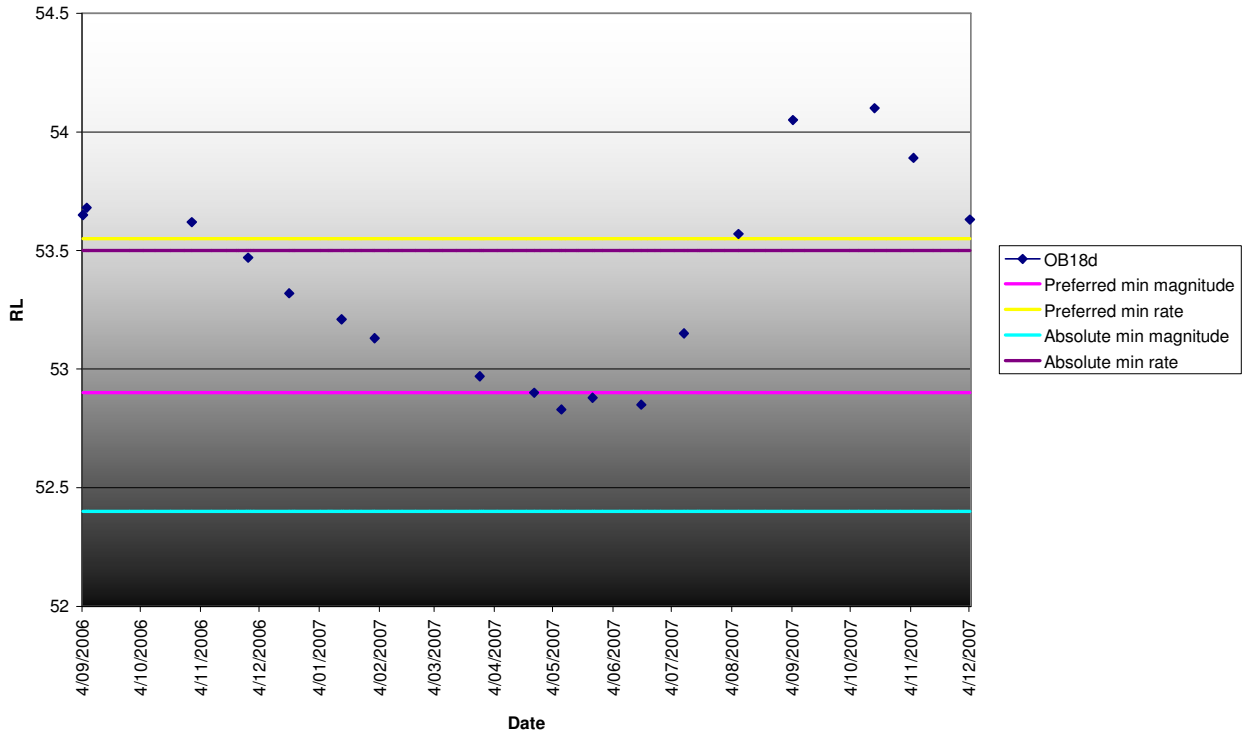


Monitoring Bore OB17d

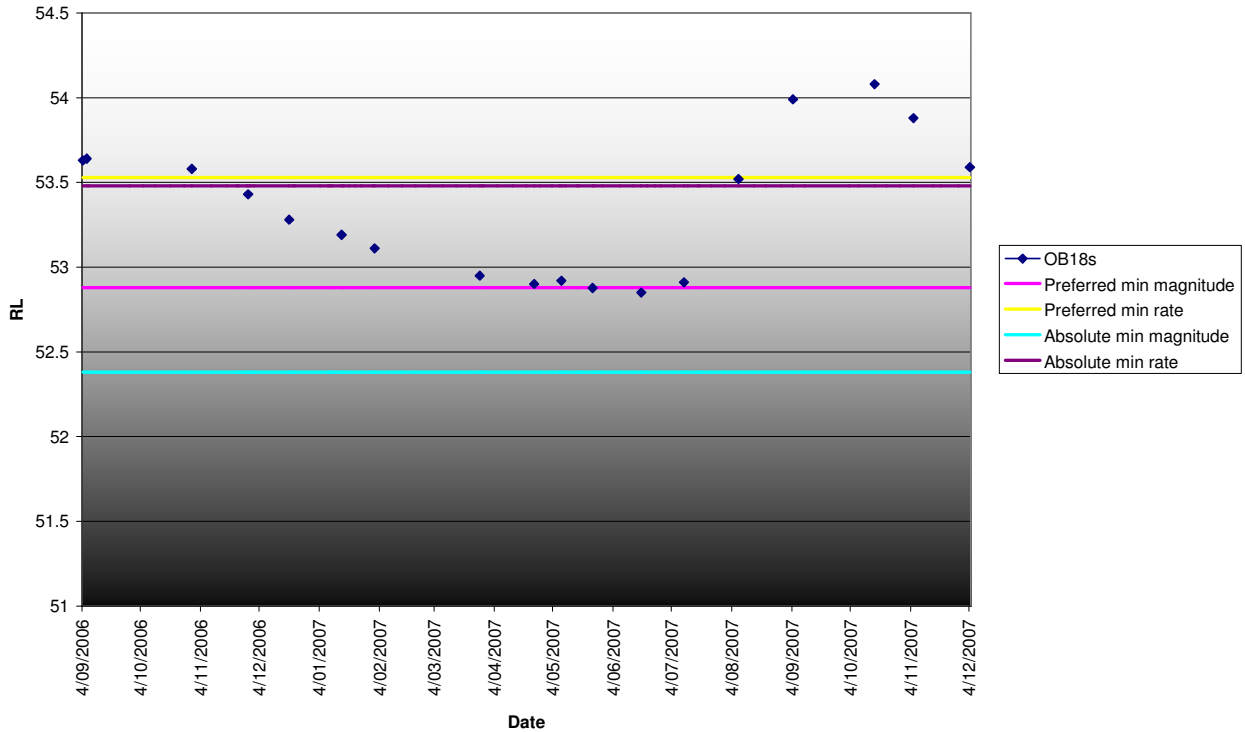


Monitoring Bore OB17s

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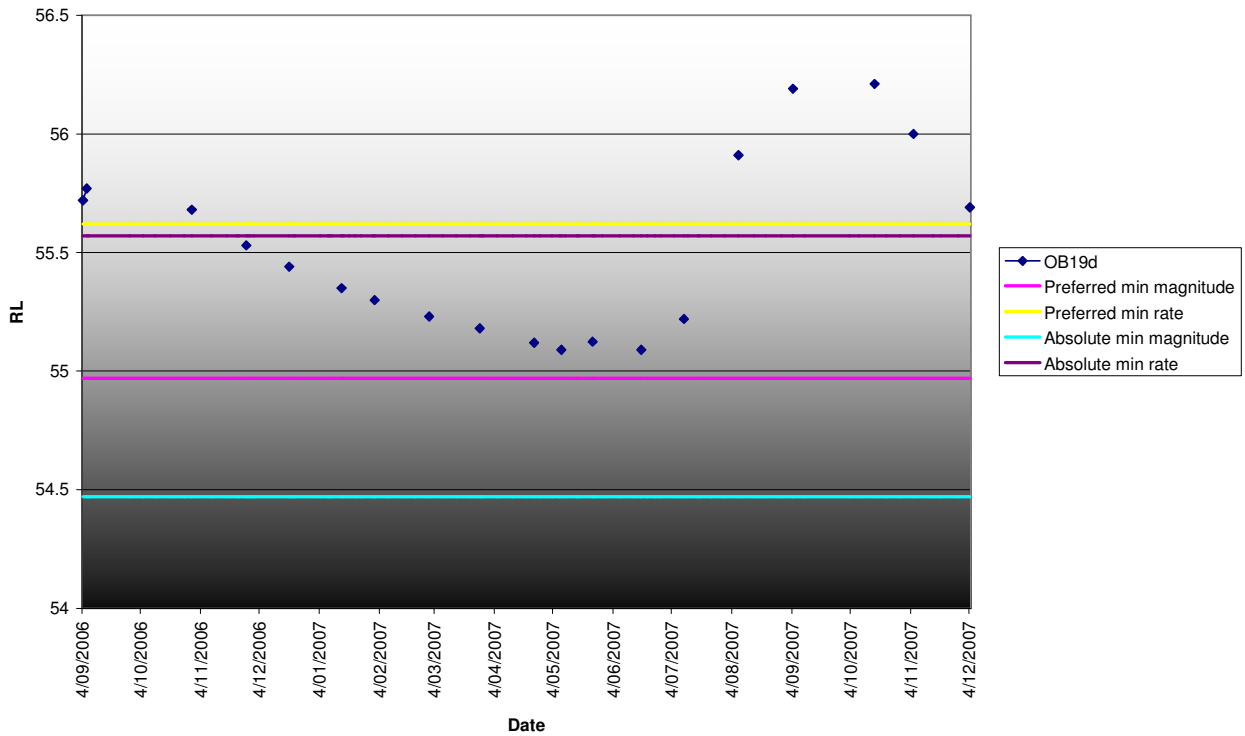


Monitoring Bore OB18d

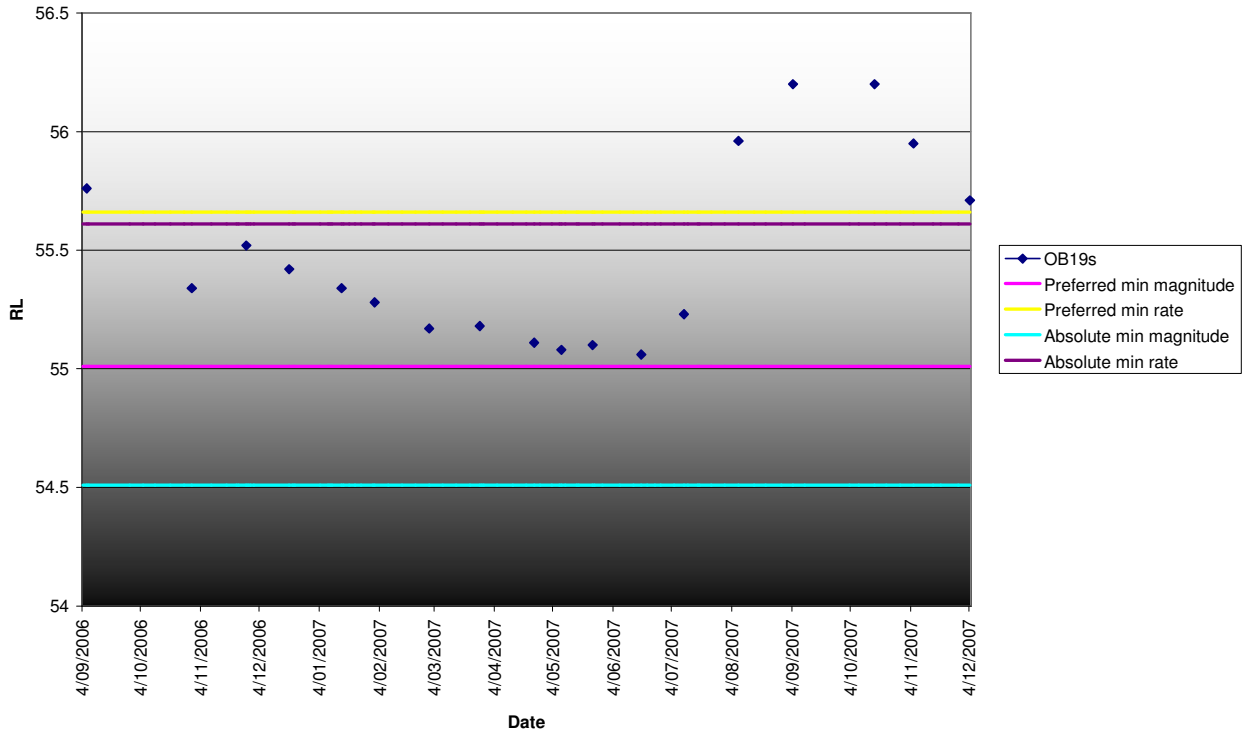


Monitoring Bore OB18s

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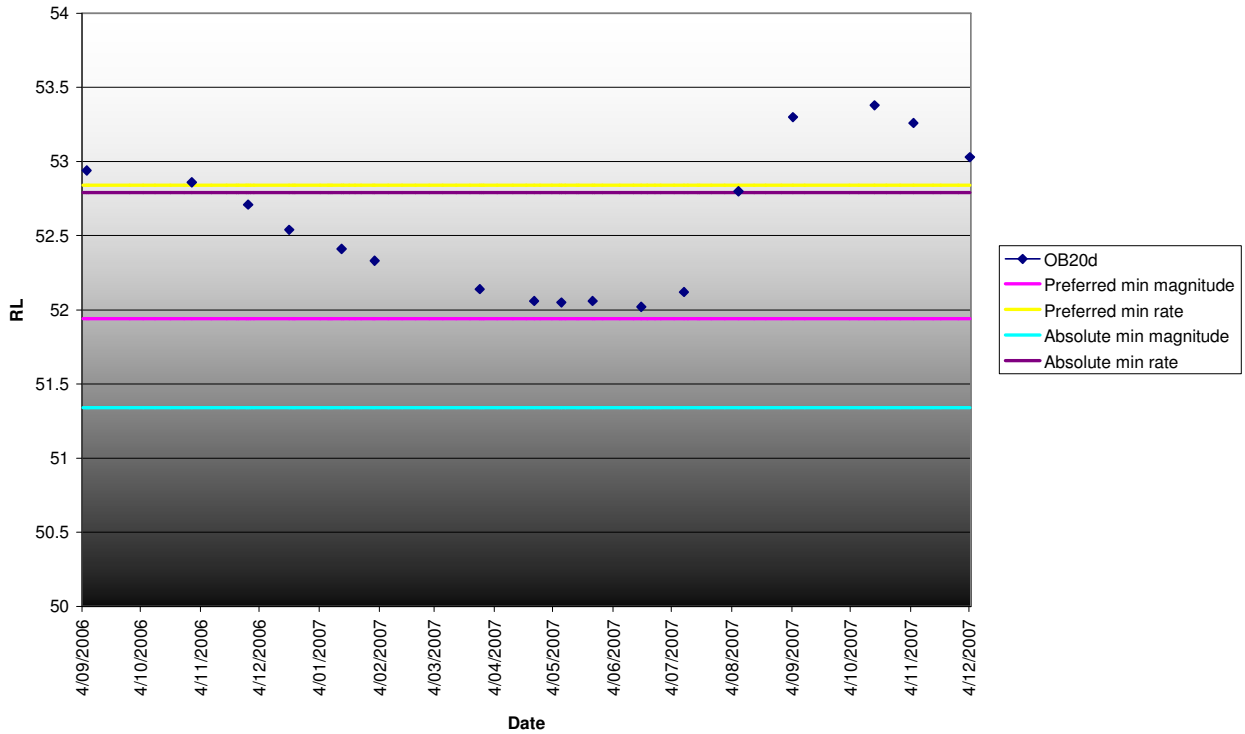


Monitoring Bore OB19d

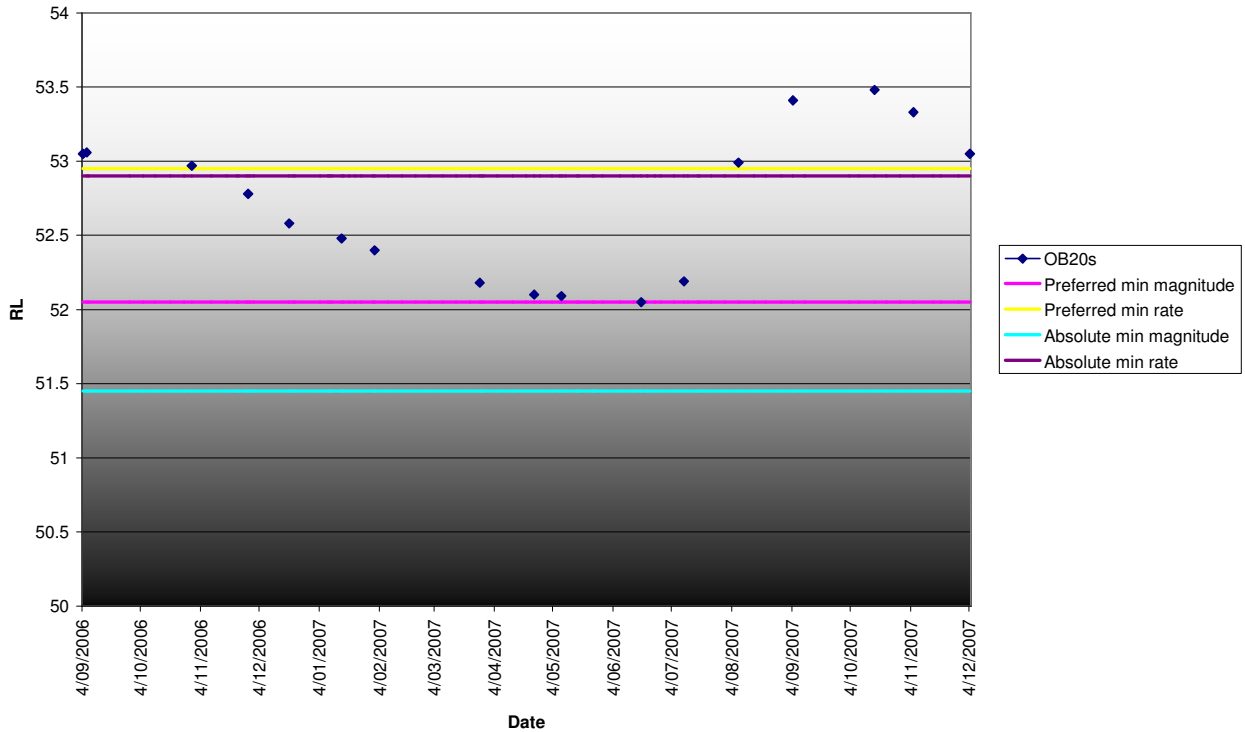


Monitoring Bore OB19s

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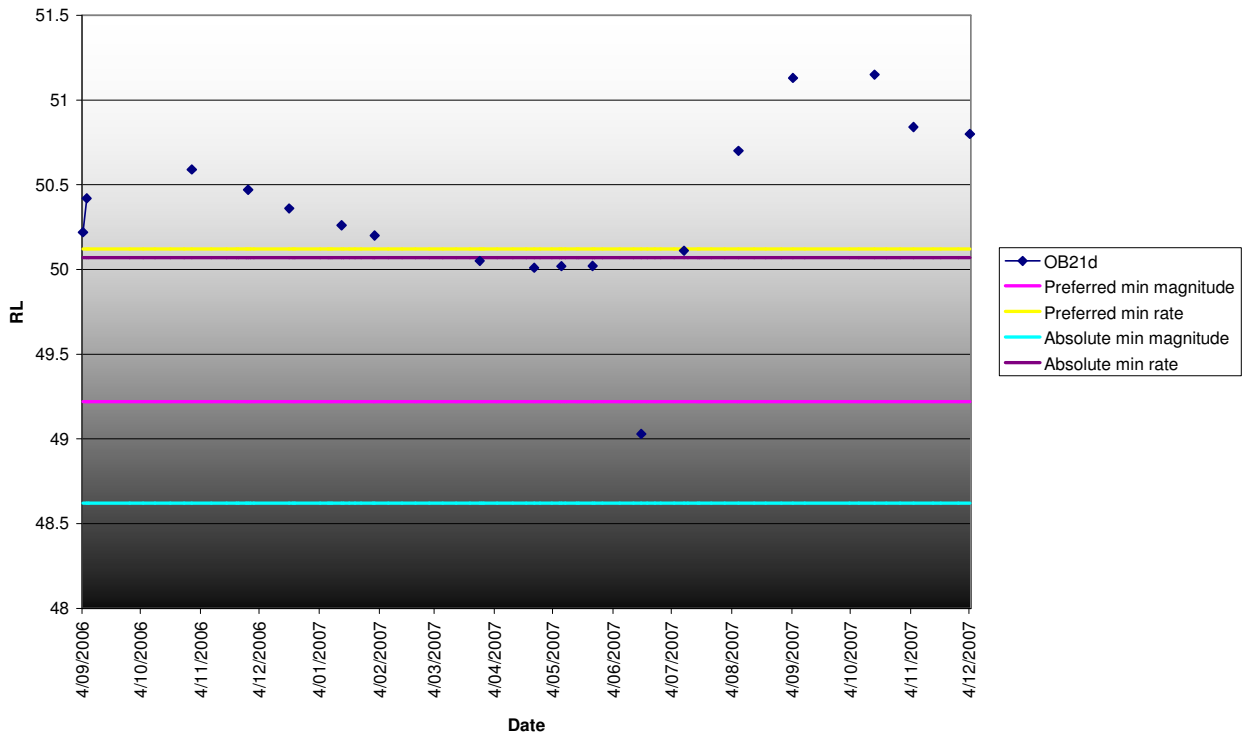


Monitoring Bore OB20d

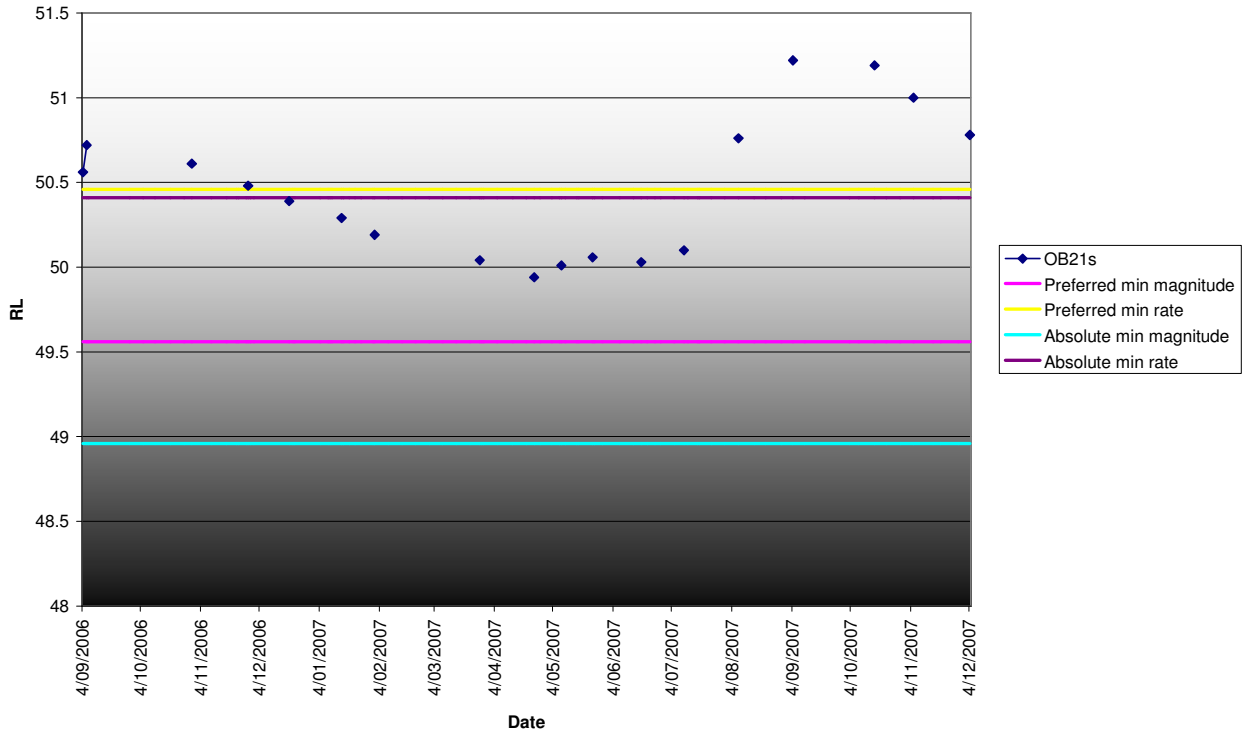


Monitoring Bore OB20s

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Monitoring Bore OB21d



Monitoring Bore OB21s

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Table 2: Potential breaches of magnitude trigger levels at OB series bores during mining drawdown.

Bore	Sept 06 g/w level (mAHD)	Drawdown model scenario	Modelled drawdown (m)	Preferred min magnitude	Trigger level breached	Absolute min magnitude	Trigger level breached				
OB15d	59.62	Dec 08	0.02	58.62	No	58.02	No				
		Apr 09	0.02		No		No				
		Jun 09	1.06		Yes		No				
		Sep 09	4.01		Yes		Yes				
		Nov 09	5.59		Yes		Yes				
		Jan 10	5.53		Yes		Yes				
		Jan 11	1.81		Yes		Yes				
		Jan 12	1.45		Yes		No				
		Jan 13	1.21		Yes		No				
		OB16d	61.70		Dec 08		0.03	60.70	No	60.10	No
					Apr 09		0.03		No		No
					Jun 09		0.21		No		No
					Sep 09		0.44		No		No
Nov 09	0.40			No	No						
Jan 10	0.44			No	No						
Jan 11	0.55			No	No						
Jan 12	0.59			No	No						
Jan 13	0.59			No	No						
OB17d	55.48			Dec 08	1.35	55.23	Yes		54.98		Yes
				Apr 09	1.27		Yes				Yes
				Jun 09	0.96		Yes				Yes
				Sep 09	1.05		Yes				Yes
		Nov 09	0.99	Yes	Yes						
		Jan 10	0.99	Yes	Yes						
		Jan 11	0.94	No	Yes						
		Jan 12	0.86	No	Yes						
		Jan 13	0.77	No	Yes						
		OB18d	53.65	Dec 08	0.6		52.90	No		52.40	No
				Apr 09	1.44			Yes			Yes
				Jun 09	0.70			No			No
				Sep 09	0.74			No			No
Nov 09	0.69			No	No						
Jan 10	0.68			No	No						
Jan 11	0.66			No	No						
Jan 12	0.62			No	No						
Jan 13	0.59			No	No						
OB19d	55.72			Dec 08	0.46	54.97		No	54.47		No
				Apr 09	2.13			Yes			No
				Jun 09	2.27			Yes			Yes
				Sep 09	1.99			Yes			Yes
		Nov 09	1.81	Yes	Yes						
		Jan 10	1.66	Yes	Yes						
		Jan 11	1.04	Yes	No						
		Jan 12	0.72	No	No						
		Jan 13	0.52	No	No						
		OB20d	52.94	Dec 08	0.10		51.94	No		51.34	No
				Apr 09	0.59			No			No
				Jun 09	1.14			No			No
				Sep 09	0.46			No			No
Nov 09	0.46			No	No						
Jan 10	0.46			No	No						
Jan 11	0.45			No	No						
Jan 12	0.44			No	No						
Jan 13	0.42			No	No						
OB21d	50.22			Dec 08	0.04	49.22		No	48.62		No
				Apr 09	0.05			No			No
				Jun 09	0.06			No			No
				Sep 09	0.08			No			No
		Nov 09	0.09	No	No						
		Jan 10	0.10	No	No						
		Jan 11	0.15	No	No						
		Jan 12	0.20	No	No						
		Jan 13	0.23	No	No						



5.4 Risk of drawdown to phreatophytic vegetation

Work conducted by Froend and Loomes used modelled drawdowns predicted for each mine pit compared to depth to groundwater contours to determine the risk of impact (ROI) to vegetation. Mapping of vegetation communities has also allowed the identification of specific community types at risk under each scenario.

Results indicate that vegetation within the drawdown footprint of S18P1 may be at moderate-severe ROI from December 2008 to January 2010 falling to a low- moderate ROI to January 2012 as the drawdown footprint contracts (Table 3). A similar pattern of risk may occur in the footprint of S18P2 however, the level of risk falls to low-moderate by January 2011, one year earlier, with no risk predicted for 2012 and 2013 as the footprint contracts. There is no ROI predicted from S17P2 until June 2009 when vegetation may be at a moderate-high risk. Under the following scenario, September 2009, the ROI increases to moderate-severe, falling to moderate-high by January 2011 and then to low for 2012 and 2013. A similar pattern of risk may occur in the vicinity of S17P1, with no risk indicated until a moderate-high ROI by June 2009. This continues to September 2009 before increasing to a moderate-severe risk by November 2009. The ROI falls back to moderate-high until January 2011 and to low for January 2012 and 2013.

Nine vegetation communities occur within areas identified as being at risk of impact. Of these, three are heath communities, three *Melaleuca* dominated woodlands, two *Banksia/ Eucalyptus* communities and one the creek line community. It is probable that the *Melaleuca* and heath communities occur in wetlands on clay-rich soils which may mitigate the impacts of groundwater drawdown. The species composition of the creek line community suggests it may be halophytic. It is also potentially dependent on surface water run-off rather than underlying groundwater. The *Banksia/ Eucalyptus* communities however, are likely to be highly groundwater dependent, based on the shallow depth to groundwater across most of their distribution on the Falcon lease. These communities are therefore likely to be at greatest risk of impact from mining-induced groundwater drawdown.

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Table 3: Depth to groundwater in proximity to mining voids, drawdown scenario, magnitude, ROI and veg communities at risk of predicted drawdown Dec-08 to Jan 2013.

Mine void/ DTGW cat	Drawdown model scenario	Predicted drawdown (m)	ROI - magnitude	Vegetation communities	Comments
S18P1					
0-3 m	Dec 08	1-2	Mod - severe	W3, HS1, T4	
	Apr 09	1-2	Mod - severe	W3, HS1, T4, T2	
	Jun 09	1-3	Mod - severe	W3, HS1, T4, T2	
	Sep 09	1-2	Mod - severe	W3, HS1, T4, T2	Expanding footprint
	Nov 09	1-2	Mod - severe	W3, HS1, T4, T2	Expanding footprint
	Jan 10	1-2	Mod - severe	W3, HS1, T4, T2	Contracting footprint
	Jan 11	0-1	Low - mod	W3, HS1, T4, T2	Contracting footprint
	Jan 12	0-1	Low - mod	W3, HS1, T4	Contracting footprint
	Jan 13	0	-	-	-
S18P2					
0-3 m	Dec 08	1-3	Mod - severe	W3, HS1	
	Apr 09	1-3	Mod - severe	W3, HS1, T3, C1	
	Jun 09	1-3	Mod - severe	W3, HS1, T3, C1	
	Sep 09	1-2	Mod - severe	W3, HS1, T3, C1	Expanding footprint
	Nov 09	1-2	Mod - severe	W3, HS1, T3, C1	Expanding footprint
	Jan 10	1-2	Mod - severe	W3, HS1, T3, C1	Contracting footprint
	Jan 11	0-1	Low - mod	W3, HS1, C1	Contracting footprint
	Jan 12	0	-	-	-
	Jan 13	0	-	-	-
S17P2					
3-6 m	Dec 08	0	-	-	North of OB15
	Apr 09	0	-	-	-
	Jun 09	1-2	Mod - high	HS1, W3	
	Sep 09	1-3	Mod - severe	HS1, W3, T4, HS3	
	Nov 09	1-3	Mod - severe	HS1, W3, T4, HS3	Expanding footprint
	Jan 10	1-3	Mod - severe	HS1, W3, T4, HS3	Expanding footprint
	Jan 11	1-2	Mod - high	HS1, W3, T4, HS3	Expanding footprint
	Jan 12	0-1	Low	HS1, W3, T4, HS3	Contracting footprint
	Jan 13	0-1	Low	HS1, W3, HS3	
S17P1					
3-6 m	Dec 08	0	-	-	-
	Apr 09	0	-	-	-
	Jun 09	1-2	Mod - high	HS1, W3	
	Sep 09	1-2	Mod - high	HS1, HS2, W3, W4	
	Nov 09	1-3	Mod - severe	HS1, HS2, W3, W4	Expanding footprint
	Jan 10	1-2	Mod - high	HS1, HS2, W3, W4	Expanding footprint
	Jan 11	1-2	Mod - high	HS1, HS2, W3, W4	Expanding footprint
	Jan 12	0-1	Low	HS1, HS2, W3, W4	Contracting footprint
	Jan 13	0-1	Low	HS1, HS2, W3, W4	Contracting footprint

HS1 – dense heath dominated by *Banksia telmatiaea* with mixed herbs on grey sand.

HS2 – Heath dominated by *X. ?drummondii*, *H. hypericoides* and *G. ?plicatum* on grey sand.

HS3 – Heath dominated by *B. telmatiaea* and *Melaleuca viminea* subsp. *viminea* on grey sand on lower slopes and valley floors.

W3 – Low woodland of *E. todtiana*, *B. menziesii* and *B. attenuata* over mixed shrubs on grey sand.

W4 – Open low woodland of *B. ilicifolia*, *B. menziesii* and *B. attenuata* over mixed shrubs in a swale.

T2 – Thicket dominated by *M. raphiophylla* and *M. viminea* subsp. *viminea* over *B. telmatiaea* on grey sands.

T3 – Thicket dominated by *M. raphiophylla* and *M. viminea* subsp. *viminea* over sedges on grey sands in drainage lines.

T4 – Thicket dominated by *Melaleuca* sp. on grey sand in a basin.

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C1 – Minor creek line with sparse *Halosarcia indica* subsp. *bidens*, *Drosera gigantean* and *Samolus junceus*.

6. References

- Nicoski, S. J., & Froend, R. (2000). *Cooljarloo Vegetation Mortality Review*. Unpublished report to Tiwest Pty Ltd. Joondalup: Report No 2000-08. Centre for Ecosystem Management, Edith Cowan University.
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