Our Reference: 24160.92351
Your Reference: Legacy Way Ground Water Levels - July 2017

03 August 2017

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Mr Luke Jerdan
41 O'Connell Terrace,
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Dear Luke,

Re: Legacy Way Groundwater Levels July 2017

As requested by Egis, on 21 July 2017 EnviroAg Australia undertook a groundwater survey of the existing monitoring bores along the Legacy Way Tunnel alignment. Monitoring of groundwater levels is required as part of the Coordinator Generals conditions for the Operation and Maintenance phase of the Legacy Way Tunnel.

During the fieldworks on 21 July 2017 it was noted that all vegetation on the Mount Coot-Tha roundabout had been cleared, and fill material had been used to resurface the cleared area. Due to these works, monitoring well NL3-05S located on the roundabout has been buried and could not be located during this investigation.

1. Groundwater July 2017

Groundwater monitoring has been conducted in compliance with the Hydrogeology and Groundwater Environmental Management Plan (LWTP-ENV-PLA-005). Monitoring locations were previously selected due to their location, geology and accessibility along the Legacy Way Tunnel corridor. The quarterly groundwater works included measuring standing water levels along the tunnel alignment and downloading data from *in situ* water level loggers. For the purpose of this study the monitoring wells are targeting bedrock (confined) and alluvial (unconfined) aquifers.

2. Groundwater Monitoring Locations

The monitoring locations assessed during this month's works are outlined in Table 1.

Table 1 – Groundwater Locations

Locality	ID	Reference	Geology	Monitoring
West	NL2-02	Toowong	Bedrock	Groundwater level
	NL3-16	Toowong	Alluvium	Groundwater level
Alignment	BH108	Toowong	Bedrock	Groundwater level
	BH320	Toowong	Bedrock	Groundwater level
	NL2-12	Toowong	Bedrock	Groundwater level
	NL2-14	Auchenflower	Open Bore – Bedrock and Alluvium	Groundwater level
	BH309	Rosalie	Bedrock	Groundwater level
	BH311	Rosalie	Bedrock	Groundwater level
	BH312	Rosalie	Bedrock	Groundwater level
	BH313	Rosalie	Bedrock	Groundwater level
	BH313A	Rosalie	Alluvium	Groundwater level
	NL4-HG10	Rosalie	Alluvium	Groundwater level
	NL4-HG6A	Paddington	Alluvium	Groundwater level
	NL4-5	Paddington	Bedrock	Groundwater level
	NL4-A2	Rosalie	Bedrock	Groundwater level
	NL2-06	Red Hill	Bedrock	Groundwater level
	NL2-09	Red Hill	Bedrock	Groundwater level
East	BH221	Kelvin Grove	Bedrock	Groundwater level
	BH222	Inner City Bypass	Bedrock	Groundwater level

The groundwater locations in Table 2 have previously been decommissioned and/or destroyed. It is understood that most have been destroyed since the commencement of the project. The quantity of the remaining monitoring locations is deemed sufficient for the purposes of the groundwater monitoring and no additional replacement wells are planned. Monitoring had previously ceased in the Botanic Gardens following handback of the tunnel conveyor to Brisbane City Council.

Table 2 - Decommissioned Groundwater locations

Locality	ID	Reference	Geology	Monitoring
West	BH503	Botanic Gardens	Bedrock	Conveyor Tunnel no longer in use - no further monitoring to be conducted
	BH502	Botanic Gardens	Bedrock	Conveyor Tunnel no longer in use – no further monitoring to be conducted
	BH104D	Botanic Gardens	Bedrock	Destroyed
	NL3-05S	Toowong	Alluvium	Destroyed
	BHSC1A	Botanic Gardens	Alluvium	Destroyed
	BHSC1B	Botanic Gardens	Bedrock	Destroyed
Alignment	NL5-4	Sleath Street	Bedrock	Decommissioned due to damaged casing
	BH314	Toowong	Bedrock	Lost – Note NL2-14 located nearby this location
	BH310	Rosalie	Alluvium	Replaced by BH313A
	BH307	Red Hill	Bedrock	Decommissioned, due to proximity to the alignment
East	NL4-HG4	Brisbane Grammar	Bedrock	Destroyed
	NL4-HG5	Brisbane Grammar	Bedrock	Destroyed
	BH205	Inner City Bypass	Bedrock	Decommissioned due to damaged casing
	BH203	Brisbane Grammar	Bedrock	Destroyed
	BH220	Kelvin Grove	Bedrock	Decommissioned due to damaged casing

3. Groundwater Monitoring Results

3.1 Groundwater Level Monitoring

Groundwater levels below ground surface were collected along the tunnel corridor at 19 locations. All locations monitored were equipped with Solinst Level Loggers (automated water data) loggers, which were calibrated via the static water groundwater level measurements and corrected for barometric pressure. Static groundwater level measurements are detailed in Table 3.

Table 3 – Groundwater elevation

Locality	West	Alignment												East		West	Alignment		
Geology	Bed rock	Bedrock												Bedrock		Alluvium	Alluvium		
Location	NL2-02	BH108	BH320	NL2-12	NL2-14	BH309	BH311	BH312	BH313	NL4-5	NL4-A2	NL2-06	NL2-09	BH221	BH222	NL3-16	BH313A	NL4-HG10	NL4-HG6A
Units	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD	mAHD
Ground Elevation mAHD	25.78	23.65	47	26.07	47.7	4.1	4	4.1	3.8	5.6	2.2	63.9	41.4	29.3	23.9	18.9	3.8	2.2	5.58
Water Elevation mAHD June 2017	15.95	18.73	18.48	17.06	3.71	-0.25	-0.18	0.64	-0.53	4.34	0.81	36.53	29.06	18.37	18.44	15.45	0.34	0.58	2.19

3.2 Groundwater Level Results

Figure 1 and Figure 2 demonstrate water level variations in the bedrock and alluvium respectively.

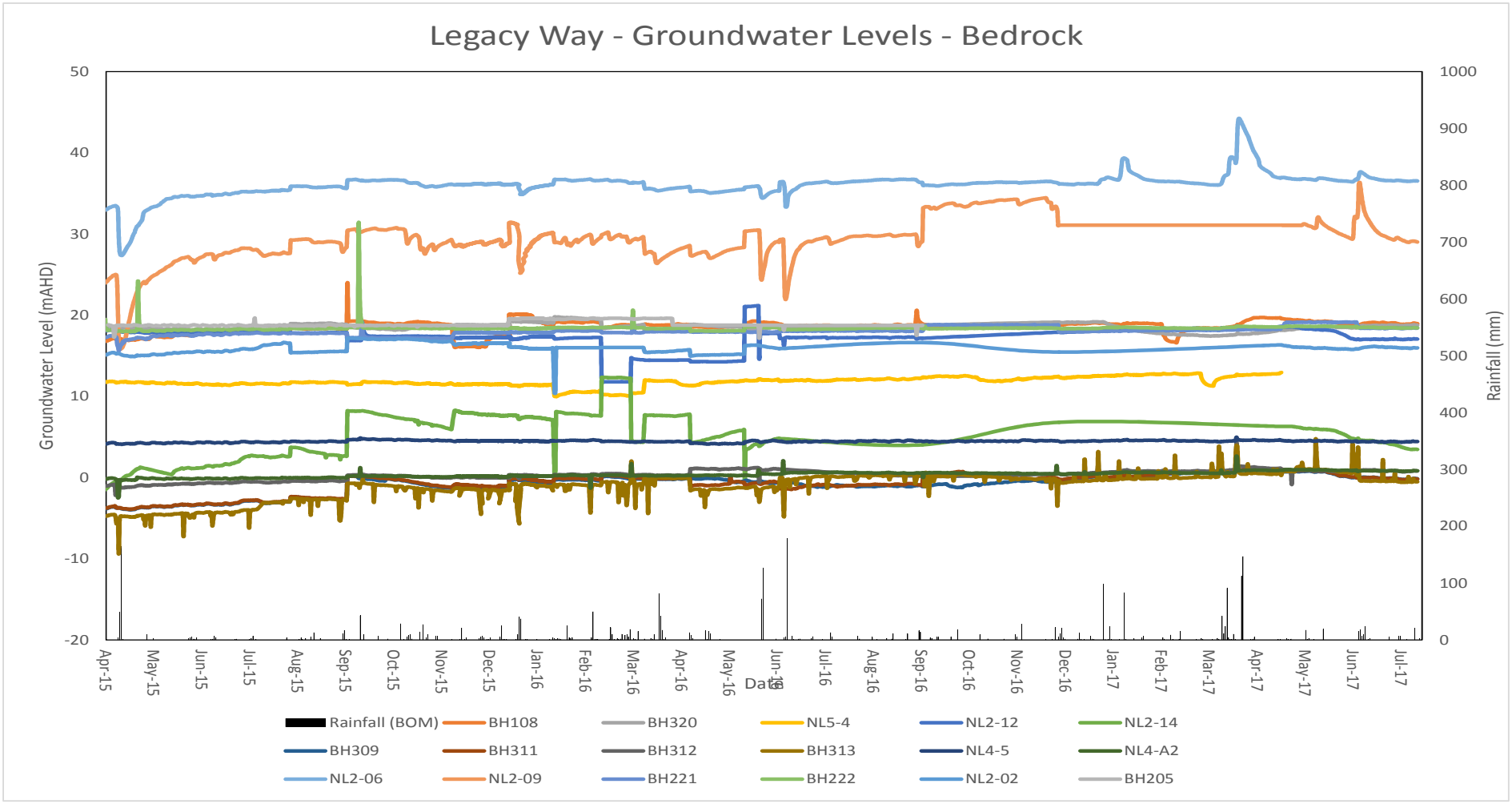

Figure 1 - Groundwater levels – bedrock

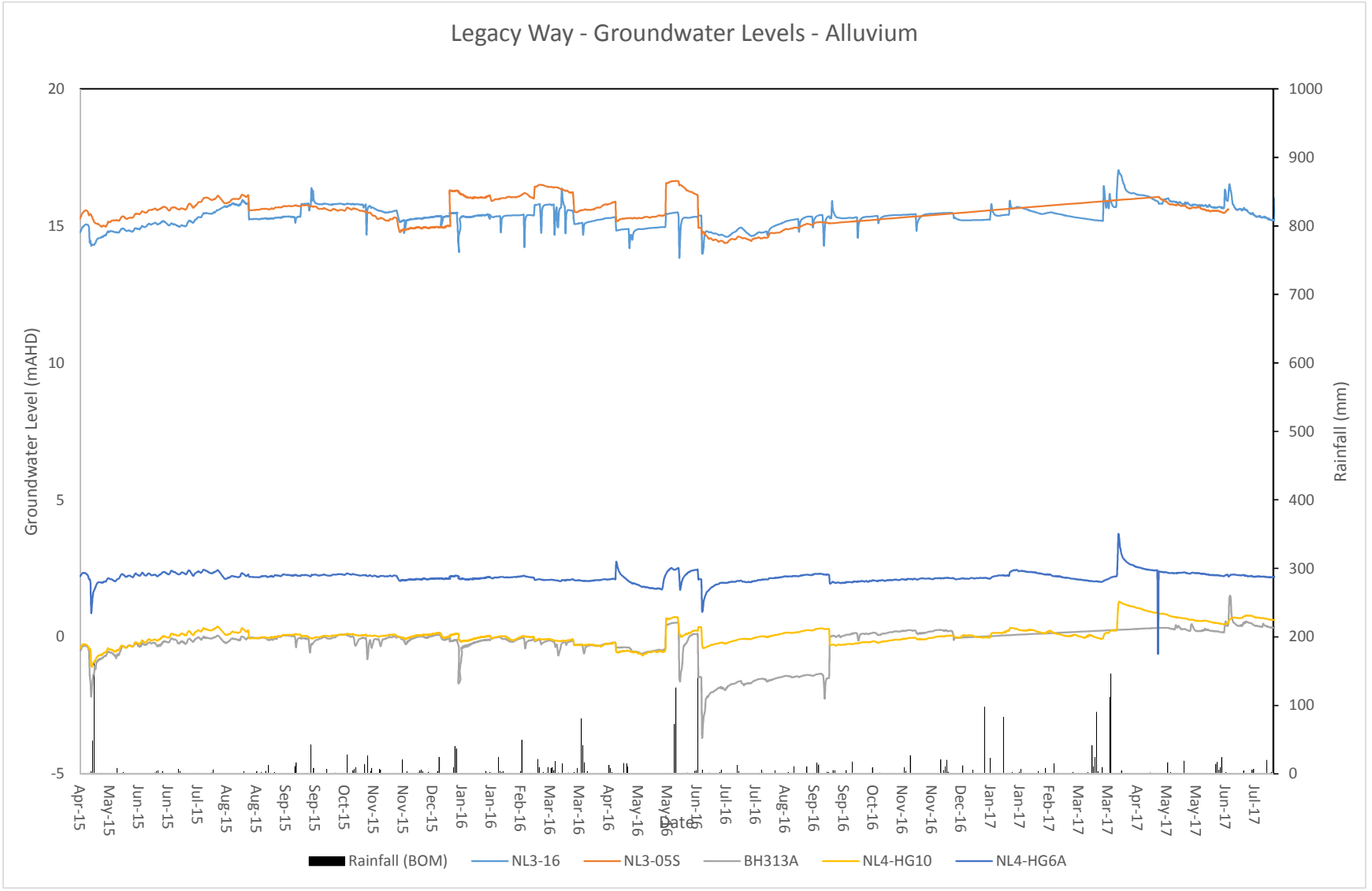

Figure 2 - Groundwater levels – alluvium

4. Discussion

The standing water levels continue to follow previous trends displayed during the construction phase i.e. relationship of groundwater fluctuations to rainfall levels, with the following of note:

Groundwater in the Toowong Cemetery and surrounds, the groundwater level in boreholes BH108, BH320, NL2-14 had historically been reported as exceeding the 200% of the natural variation and was associated with the tunnelling activities in close proximity to the boreholes. BH108 showed slight increases in groundwater levels corresponding with the moderate rainfall events of 15th-18th June and 16th July, and a gradual decrease in groundwater levels over the rest of the month. BH320 showed a gradual increase in water levels until the end of June, after which groundwater levels were stable. Groundwater levels in NL 2-14 showed a steady decrease in groundwater level since the last monitoring round on 13th June, corresponding with the drier winter climate. NL 2-14 has historically displayed a high variation of up to 3.5m since the March 2016 monitoring period. It is expected that this location will continue to fluctuate based on seasonal trends.

Along the tunnel alignment in Rosalie and surrounding areas, the groundwater level in boreholes BH309, BH311, BH312, BH313 had previously been reported as historically exceeding the 200% of the natural variation and was associated with tunnelling activities in close proximity to the boreholes. These boreholes are assessing water levels in the bedrock, and drawdown from tunnelling operations was predicted in this area. BH313 continued to show sudden increases in groundwater levels corresponding to rainfall events confirming observations from the previous monitoring round that the well has been compromised due to roadway water ingress. BH309 and BH311 have decreased slightly since the June 2017 monitoring event, corresponding with decreased rainfall.

Of the alignment borehole locations monitoring the alluvium adjacent to the tunnel alignment, water levels in well NL4-HG6A have been stable since the June monitoring round, and NL4-HG10 showed a slight increase in water levels through June, and a gradual decrease in levels during July. Wells NL3-16 and BH313A showed an overall decrease in water levels in the June – July monitoring period, but both wells showed spikes in elevation corresponding to the rainfall events of 11th – 18th June and 16th July.

Groundwater monitoring of the Eastern Portal area continued, with slow recovery noted in the bores. BH221 and BH222 remained static since the June 2017 monitoring period with no fluctuation noted due to rainfall events. NL2-06, and NL2-09 in upper Clifton Terrace and lower Clifton Terrace, respectively, both showed significant groundwater elevation increases correlating with the rainfall events of 11th – 18th June. Groundwater levels in both wells then decreased over the remainder of the monitoring period, and by 21st July were consistent with levels recorded in the week 4th – 10th June.

At the Western portal, groundwater levels in NL2-02 were consistent with the June monitoring round. It has been previously noted that levels at this site may be impacted by localised rainfall events and potentially influenced from external activities (i.e. Mt Coot-Tha Quarry and the botanic garden ponds). The monitoring well showed groundwater levels increased slightly in June and were stable in July.

It should be noted that at this stage Egis does not propose any mitigation strategies in regards to fluctuations in groundwater levels. Ongoing monitoring will be undertaken to assess any impacts and stabilisation of water levels.

Yours sincerely,

Matthew Conroy
Principal Environmental Scientist
EnviroAg Australia Pty Limited