



SLR

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Hatfield Aerodrome Mineral Development Site

SoCG Questions and Clarifications

28/10/2021

Objective – Finalise SoCG

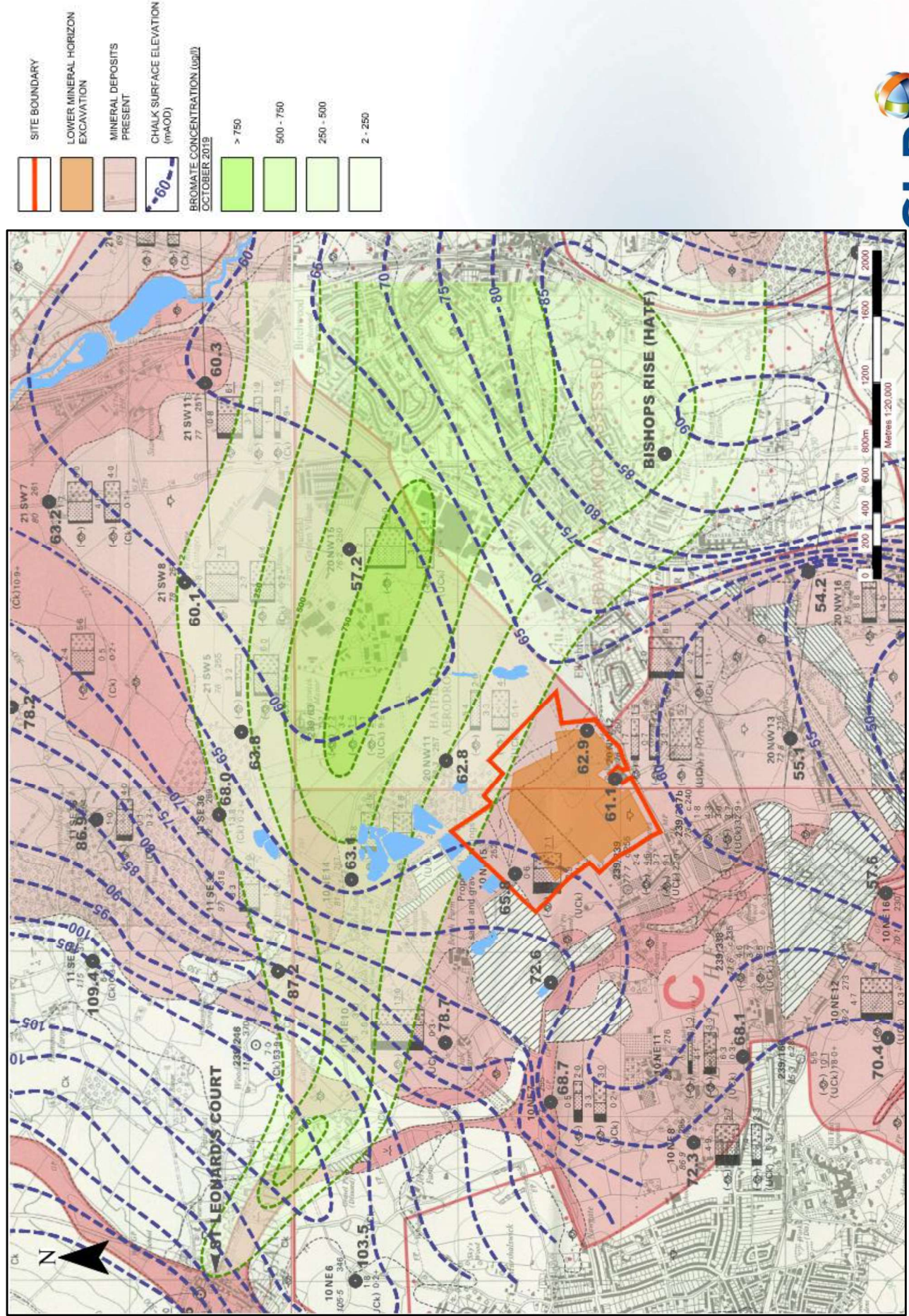
- HCC expert questions
- Regional setting, Bromate Plume
- Pumping test data
- Operational Concept & Method
- Monitoring & Compliance
- SoCG – Final Discussion

Jenny Lightfoot Comments on SoCG

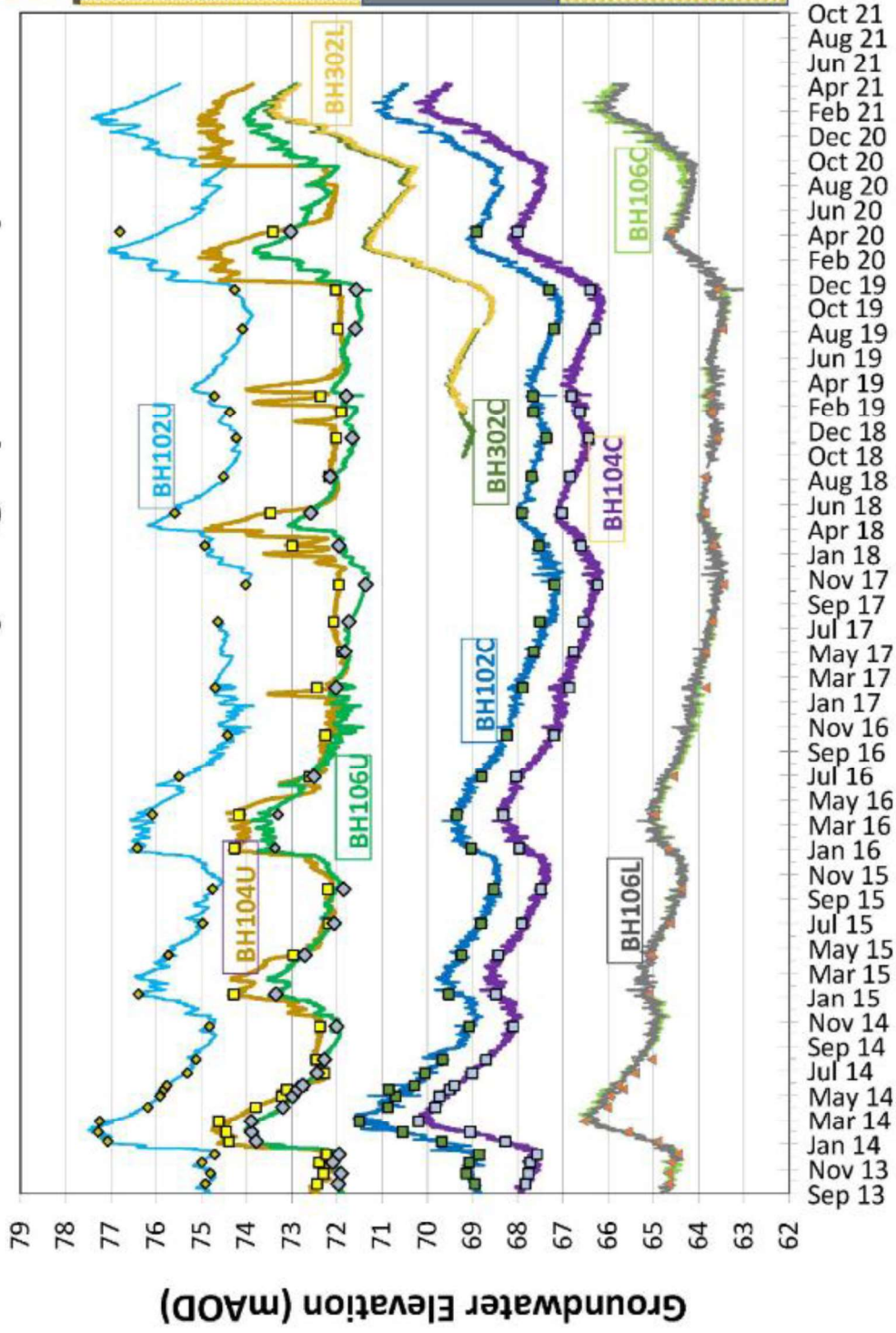
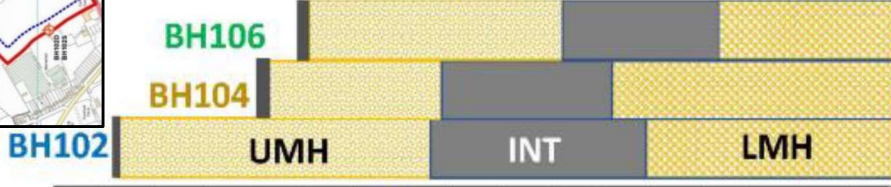
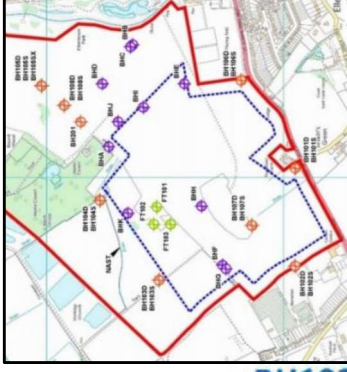
I have reviewed the Water SoCG and I cannot agree to this yet because:

- *I have not seen assessment from the appellant to demonstrate the LMH pumping will not result in potentially adverse changes to groundwater levels and plume movement, and, also related to LMH pumping, detail on the hierarchy of contingency actions that will be implemented and demonstration that these will be adequate. It is possible this could be addressed by prohibiting any pumping from LMH with a planning condition.*

- *In relation to the effects of HATF pumping on bromate plume, risks to other public supply sources and the relationship to levels at the proposed quarry, I haven't seen the assessments, monitoring plan or contingency actions that have provided Affinity Water with assurance of the acceptability of the proposals. Therefore I am unable to assess for myself the adequacy of the proposal to protect public water supply.*



Hatfield Groundwater Hydrograph- All Aquifers



Map of the site showing bromate concentrations at various monitoring points. The map includes a legend for bromate concentration ranges (ug/l) and a scale bar in meters. Monitoring points are labeled with IDs and values: BH302L&C (72.85), BH103L&C (71.24), BH107L&C (69.82), BH102L&C (70.4), BH101L&C (68.2), BH101U (67.6), BH101L&C (67.6), BH101U (67.6), BH101L&C (67.6), BH101U (67.6), BH101L&C (67.6), BH101U (67.6), BH101L&C (67.6), BH101U (67.6).

Legend: BROMATE CONCENTRATION (ug/l)

71.7	200 - 300
ND	100 - 200
400 - 500	2 - 100
300 - 400	NOT DETECTED

Scale: 0 100 200 300 400 500 METERS

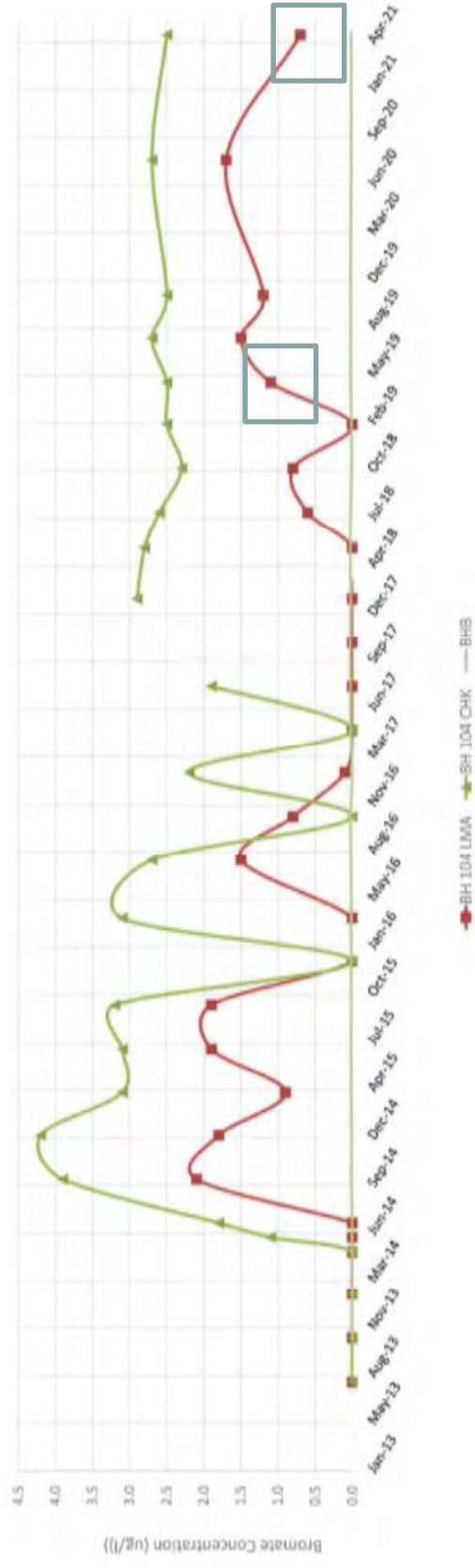
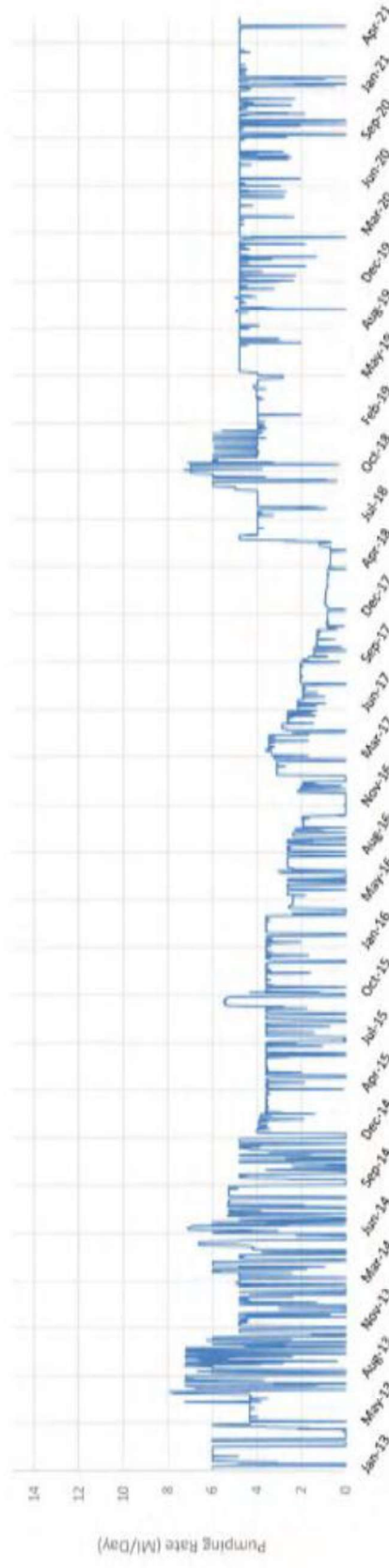
Map labels: BH302L&C 72.85, BH103L&C 71.24, BH107L&C 69.82, BH102L&C 70.4, BH101L&C 68.2, BH101U 67.6, BH101L&C 67.6, BH101U 67.6, BH101L&C 67.6, BH101U 67.6, BH101L&C 67.6, BH101U 67.6, BH101L&C 67.6, BH101U 67.6.

Map features: ELLENBROOK ROAD, ASSUMED ROUTE, ROADSIDE LAGOON.

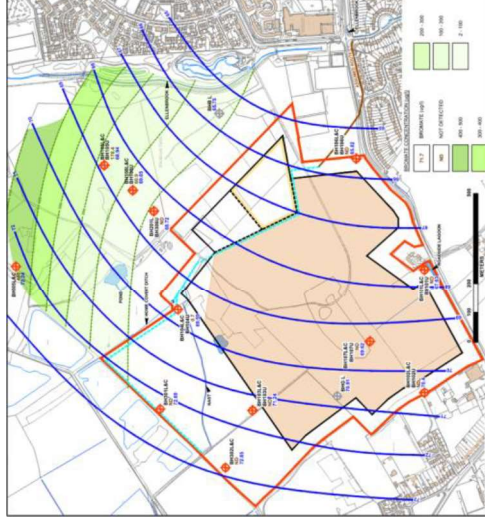
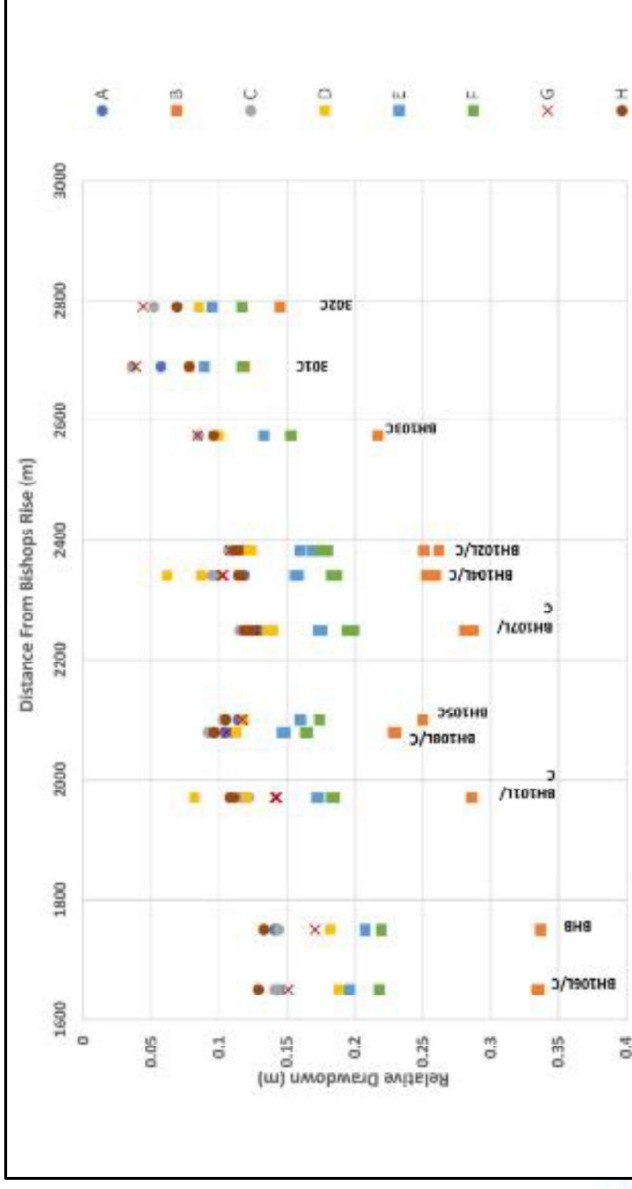
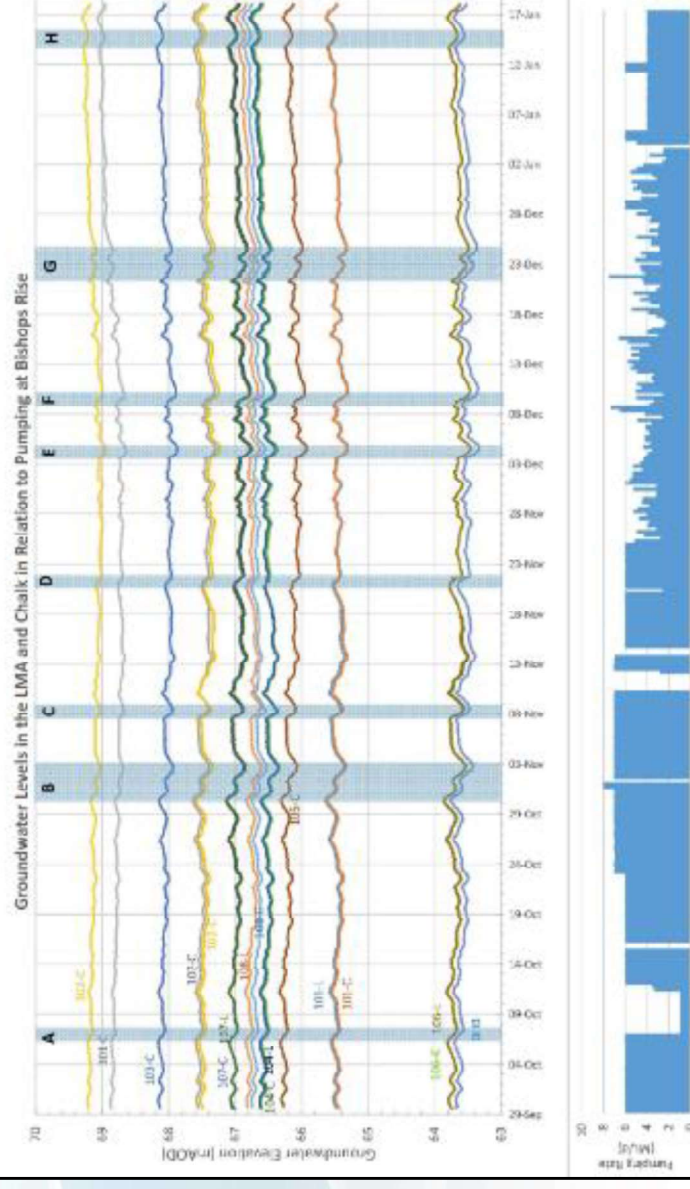


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Bishops Rise Abstraction vs BH 104 Bromate Concentration



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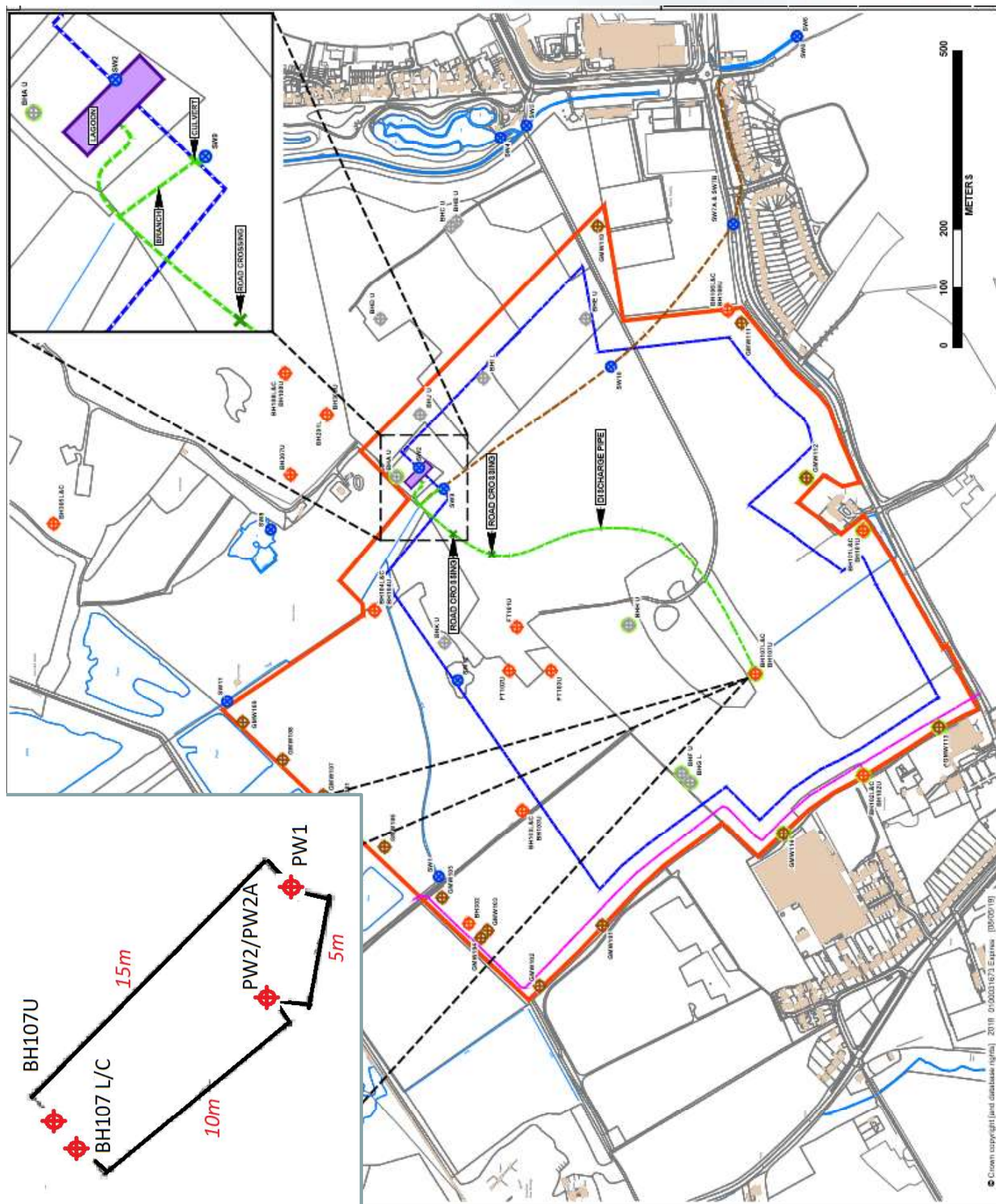


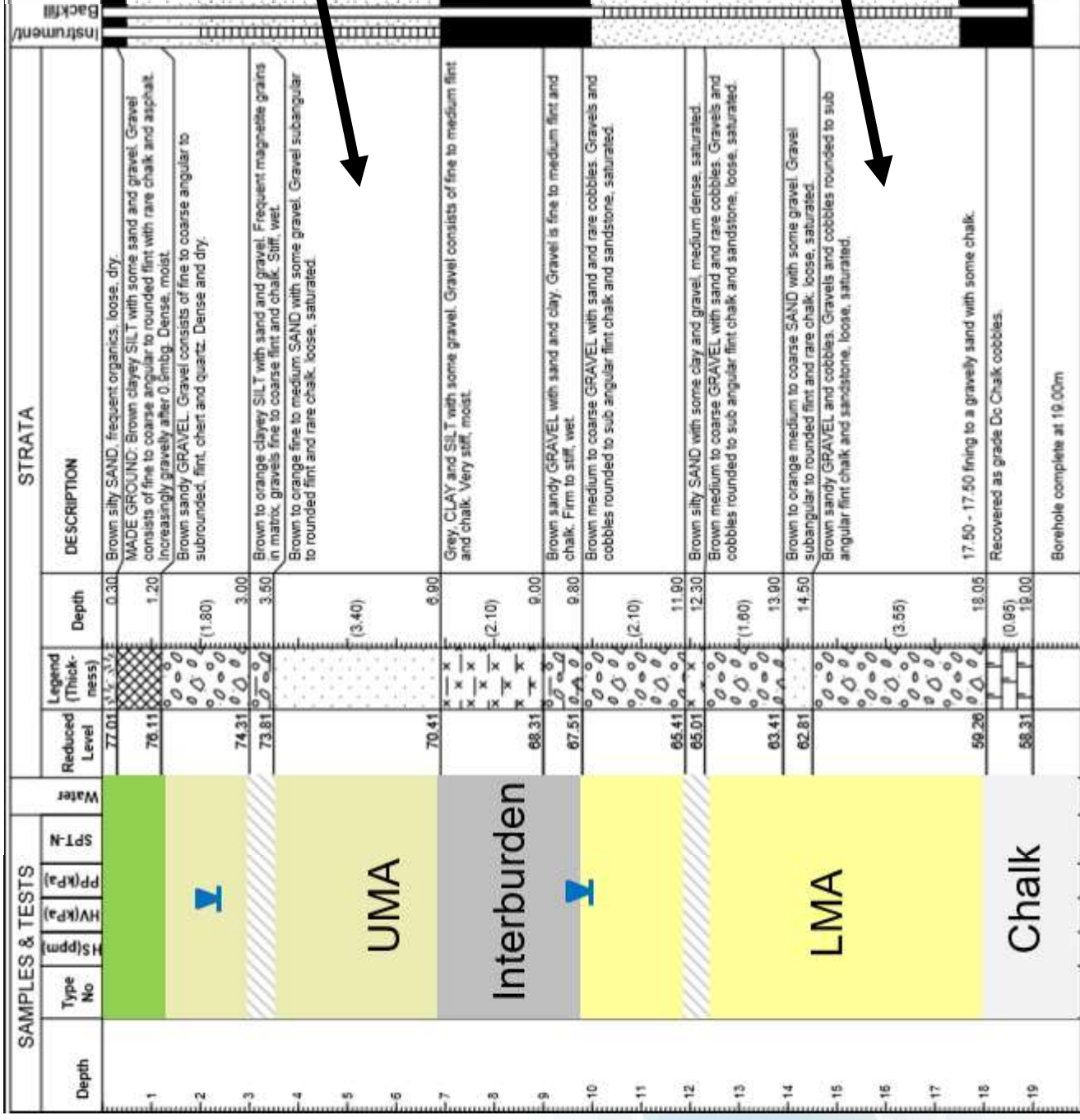
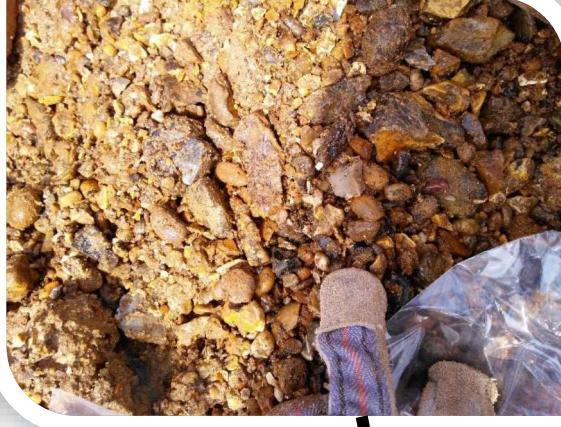
Pumping Tests

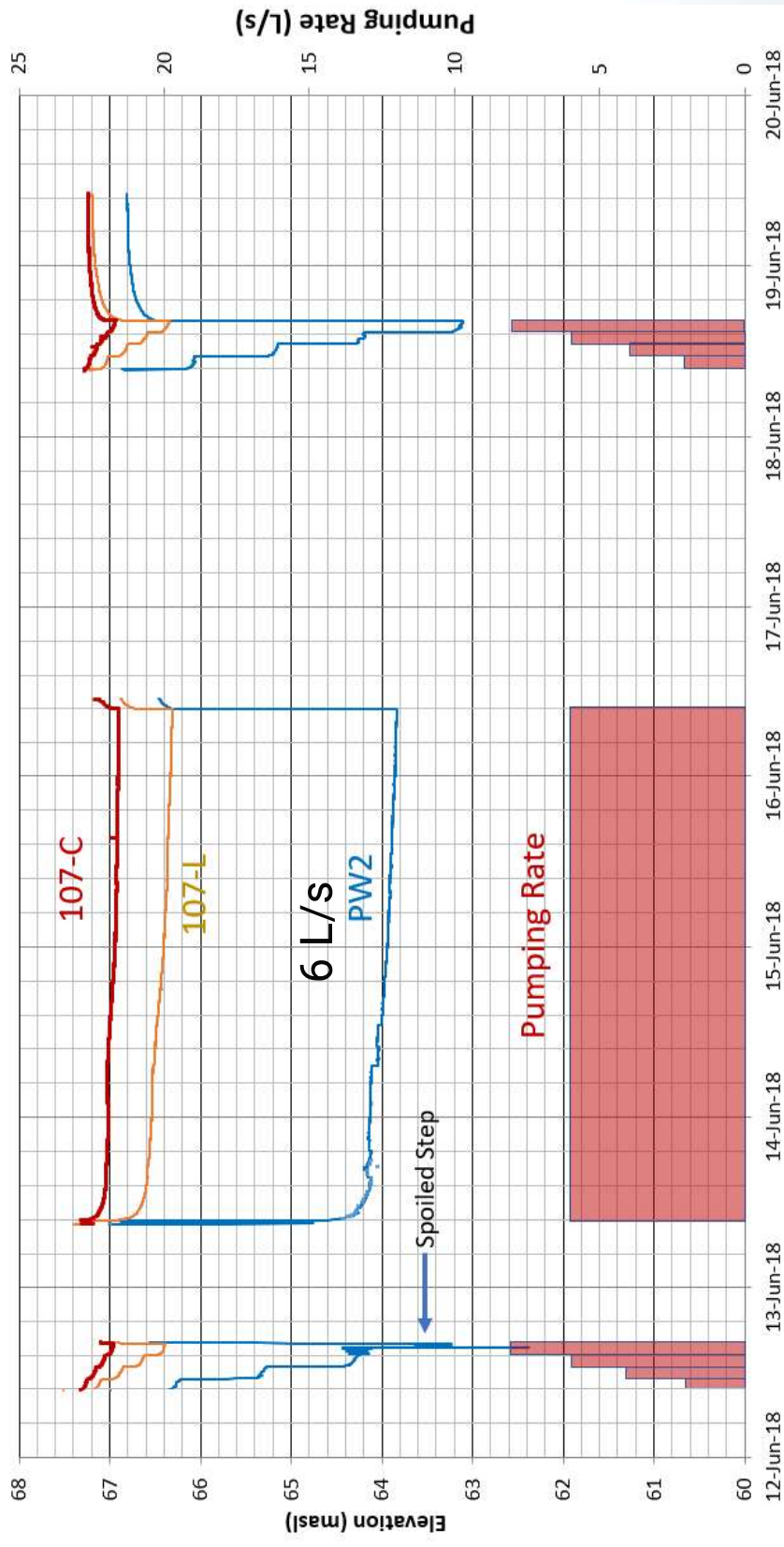
- Location –
 - representative geology
 - proximity of an existing monitoring wells as observation wells.
- Drilling – Cable Percussive technique
 - PW1 was screened in the UMA
 - PW2 in the LMA
 - A standpipe (PW2A) was also placed in the PW2 bore but screened in the UMA.
- Development -
 - Wells were developed and surged using eductor pumps to remove fines in the vicinity of the well and stabilize the filter pack
- Step Test –
 - 4 constant discharge steps of identical time length
- Constant-Rate Tests –
 - Constant discharge rate determined from drawdown encountered in step test
 - 3-day constant rate tests in PW1 and PW2.

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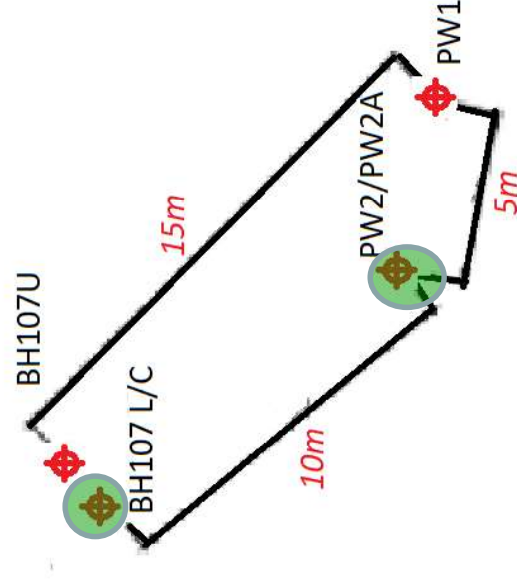




LMA Pumping Test

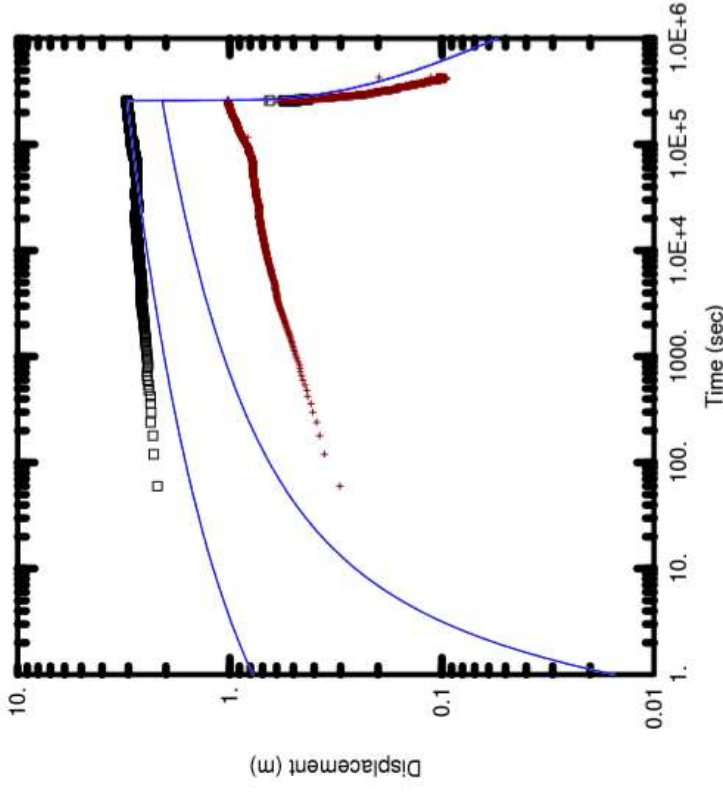
- Step Test was conducted a 2 L/s, 4 L/s, 6 L/s and 8 L/s.
- 6 L/s was concluded to be the optimal pumping rate for the constant-rate test.

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Test Analysis-LMA

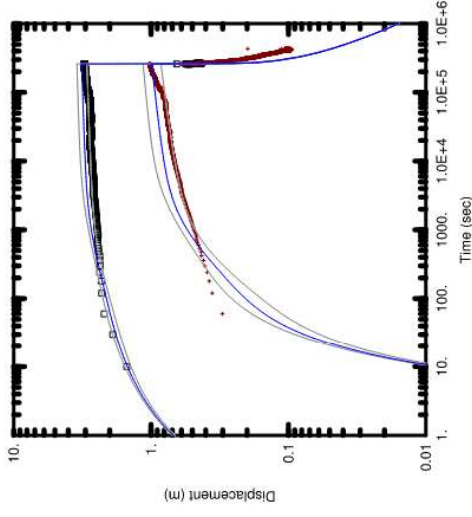
- LMA analysis was complicated by the influence of the underlying Chalk.
- All analytical solutions which considered only the LMA predicted more drawdown in the observation well (BH107-L) than was observed.



Test Analysis-LMA

- To try and account for the influence of the Chalk a “partially penetrating” scenario was modelled.
- This treats the UMA and the Chalk as one aquifer. More reasonable matches were attained by assuming an aquifer c.60m thick.
- Partially penetrating Neuman solution:
Transmissivity (T) = c.800m² /d
Storativity (S) = c.0.08
Hydraulic Conductivity (K) = c.15m/d
- Ro c.300m

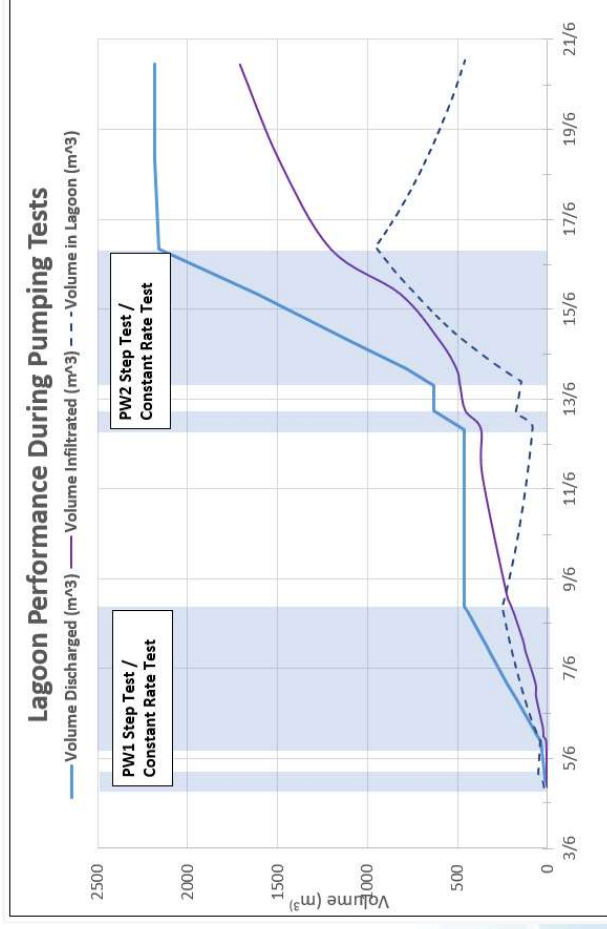
Appendix 6- Figure 10
PW2 Constant Rate Test (Neumann)
Partial Penetration (b=60m)



WELL TEST ANALYSIS											
Data Set: C:\Users\lgordon\Desktop\Analyses\PW2Constant Rate 107-60m.aqt											
Date: 09/03/18 Time: 11:45:04											
PROJECT INFORMATION											
Company: <u>Brett</u>											
Client: <u>SLR</u>											
Project: <u>402.01009.00226</u>											
Test Well: <u>PW2</u>											
Test Date: <u>13 June 2018</u>											
AQUIFER DATA											
Saturated Thickness: <u>60</u> m											
WELL DATA											
Pumping Wells					Observation Wells						
Well Name		X (m)		Y (m)		Well Name		X (m)		Y (m)	
PW2		0		0		PW2		0		0	
						+ 107-L		0		10.3	
SOLUTION											
Aquifer Model: <u>Unconfined</u>					Solution Method: <u>Neuman</u>						
T = <u>777</u> m ² /day					S = <u>0.008348</u>						
Sy = <u>0.001955</u>					Kz/Kr = <u>0.2073</u>						

Infiltration Lagoon Performance

- Infiltration rate was observed to increase with the water stage in the lagoon.
- Mostly a result of increased applied head driving water into the unsaturated surrounding formation.
- Calculated infiltration rates ranged between 1.27x10⁻⁶ m/s and 3.38 x10⁻⁶ m/s.
- The lagoon was heavily vegetated during the programme which likely reduced the infiltration capacity in comparison to an open formation.



Lagoon Infiltration Rates

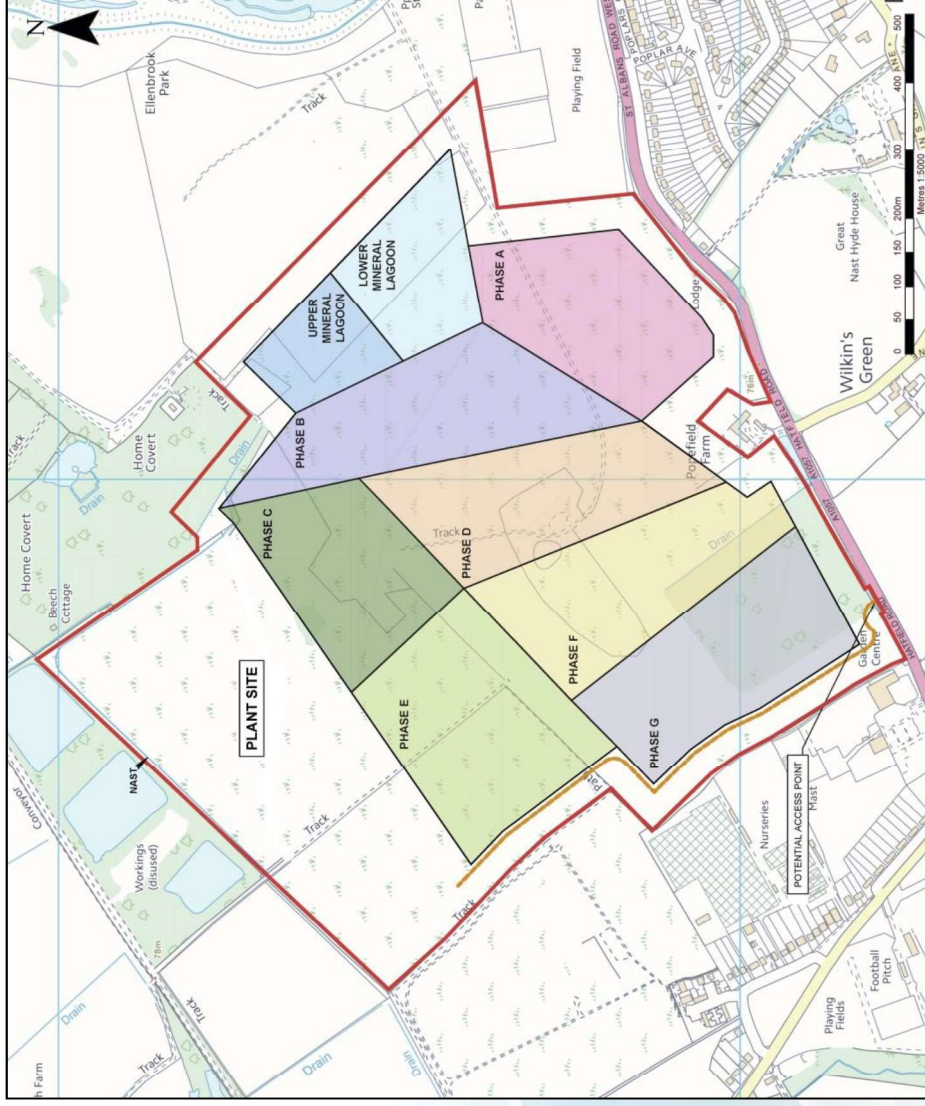
Recovery Period	1	2	3	4
Infiltration rate ($\text{m}^3/\text{m}^2/\text{s}$)	1.27x10 ⁻⁶	2.42x10 ⁻⁶	2.52x10 ⁻⁶	3.38x10 ⁻⁶
Recovery Interval (mAOD)	72.46-74.36	73.4-72.75	73.18-73.03	75.45-74.22
Volume Lost (m^3/day)	15	42	36	120

2016 LMH Operational Concept

- UMA and LMA will be kept separate
- UMH will be worked dry, and LMH worked wet
- Avoid the need to lower LMA groundwater by phasing and seasonal working (align operations with LMA water levels)
- 100m x 30m working areas (windows) through the IB
- Maintain an option to lower LMA to facilitate short term excavation of IB layer, then stop pumping
- Recharge excess water back into the aquifer via LML
- Excavate LMH, concurrently filling with site won low permeability material in a rolling
- Install engineered geological barrier (CQA)
- Move to next working area

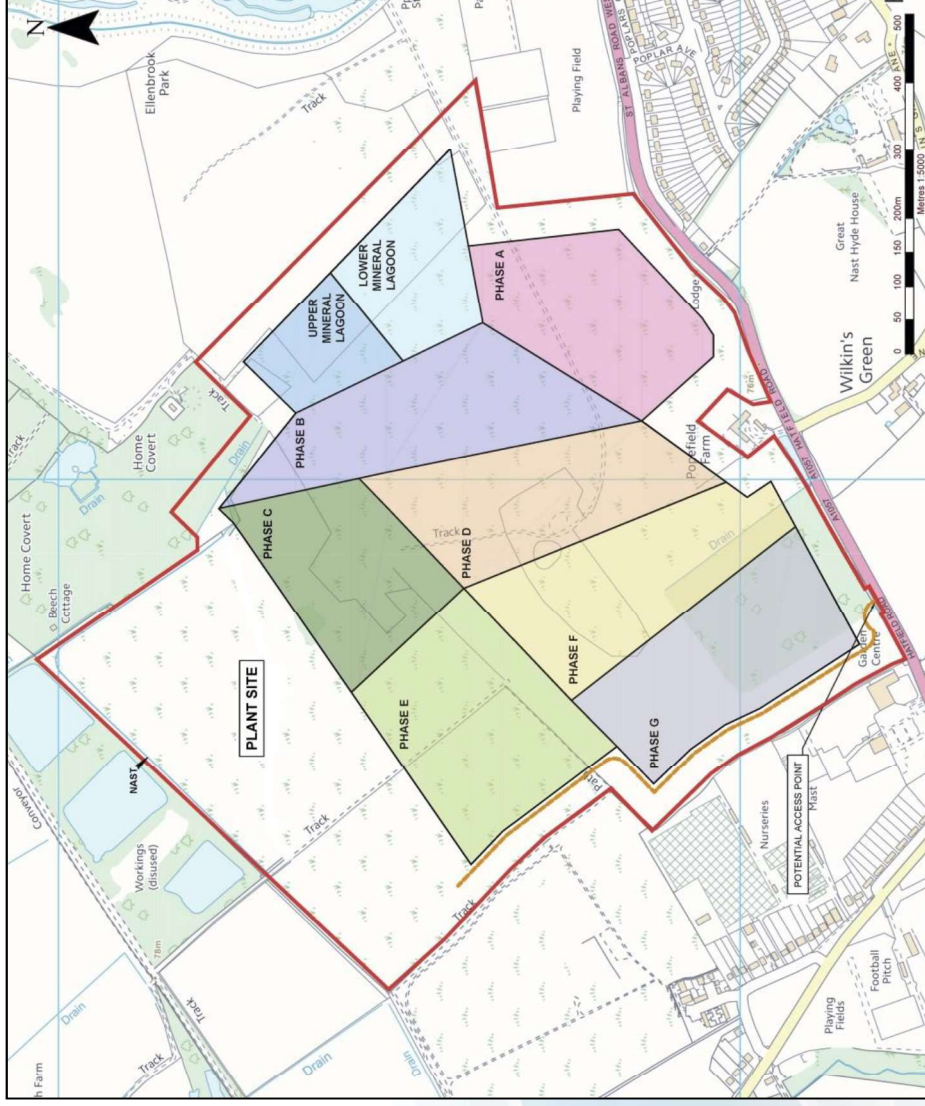
Phasing and Lagoon Rationale

- Western side of lagoons (Phase A & B) will be sealed when filled
- Lagoon location will reduce the potential for lateral LMA plume movement by creating a hydraulic barrier
- UMA water can be groundwater to the UML and LMA (subject to testing), if required
- LMA water will only be discharged into the LMA



LMH/LMA Working

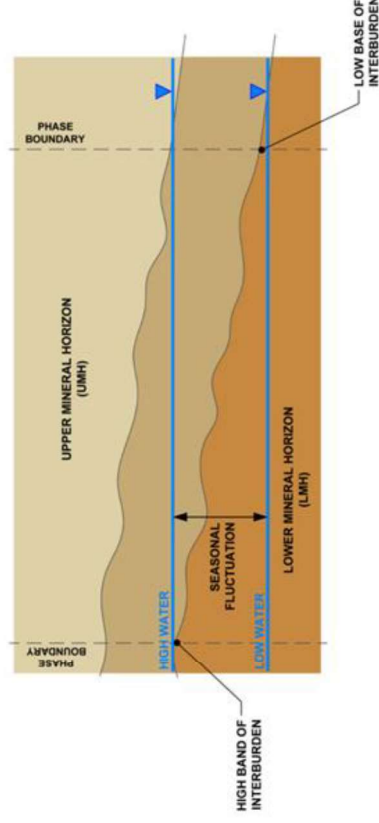
- LMH will be worked wet
- LMA elevations vary seasonally resulting in an unconfined aquifer for c.6 months per year (typically June – November +/-)
- Campaign dig early phases when the Aquifer is in an unconfined state and in an confined state (A through F) – **no** groundwater abstraction
- Schematic section and saturation chart illustrates why this is possible



LMA Seasonal Aquifer Conditions

Phase	Groundwater Elevation (Lowest and Highest)				Base of Interburden		Groundwater Elevation Period							
	Min (Nov 17)		Max (Mar 14)		High	Low	Low (June -Dec)				High (Jan-May)			
							Minimum		Maximum		Minimum		Maximum	
	LL	HL	LH	HH	H	L	H	L	H	L	H	L	H	L
UM Lagoon	65.5	66.5	68	69	66.8	65.6								
LM Lagoon	64	65.5	66.5	68	66.3	65.6								
A	64.5	66	66.5	68	66.8	65.7	-2.3	-1.2	-0.8	0.3	-0.3	0.8	1.2	2.3
B	65.4	66.9	68	70	67.5	66.1	-2.1	-0.7	-0.6	0.8	0.5	1.9	2.5	3.9
C	66	67.5	69.5	71	68.3	66.9	-2.3	-0.9	-0.8	0.6	1.2	2.6	2.7	4.1
D	65.5	66.5	68	70	68.1	65.7	-2.6	-0.2	-1.6	0.8	-0.1	2.3	1.9	4.3
E	67	69	70	72	69.5	68.3	-2.5	-1.3	-0.5	0.7	0.5	1.7	2.5	3.7
F	66	67.5	68.5	71	68.2	66.5	-2.2	-0.5	-0.7	1	0.3	2	2.8	4.5
G	67	69	69	71.5	68.1	67	-1.1	0	0.9	2	0.9	2	3.4	4.5

PHASE X



Base of Interburden Elevation	
H	Highest Interburden Elevation in Phase
L	Lowest Interburden Elevation in Phase

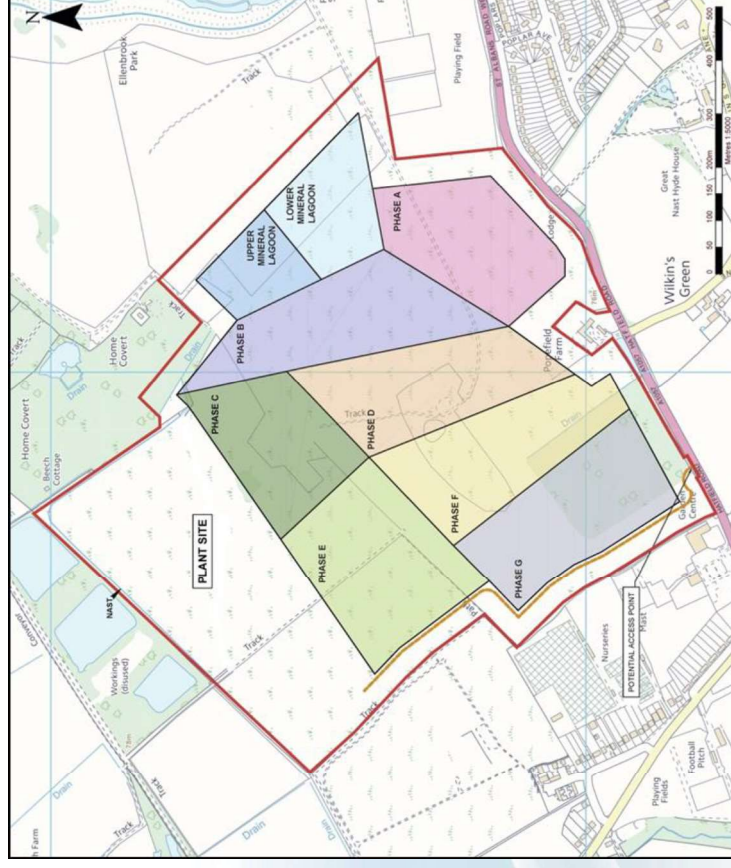
	Unconfined and Unsaturated Conditions (-ve Head in LMA)
	Confined Conditions (+0 to 1m head in LMA)
	Confined Conditions (1> to 2 m head in LMA)
	Confined Conditions (> 2 m head in LMA)

Groundwater Elevation	
LL	Lowest Low in Phase
HL	Highest Low in Phase
LH	Lowest High in Phase
HH	Highest High in Phase

Key Principles – 2016 Application & GWMP

Although Brett intends to avoid pumping the LMA, the GWMP makes it clear that last phase would benefit from minor pumping (short time periods) to sustain extracted mineral quality.

- Based on current understanding phase G (Yr. 24)
- Pumping would be for short periods in discrete zones
- Lagoons – hydraulic barrier
- Phases A to F will be filled with low permeability material
- 750m west of eastern site boundary
- >20 years of additional data



Calculation (2016)

Assumptions (2016) GWMP

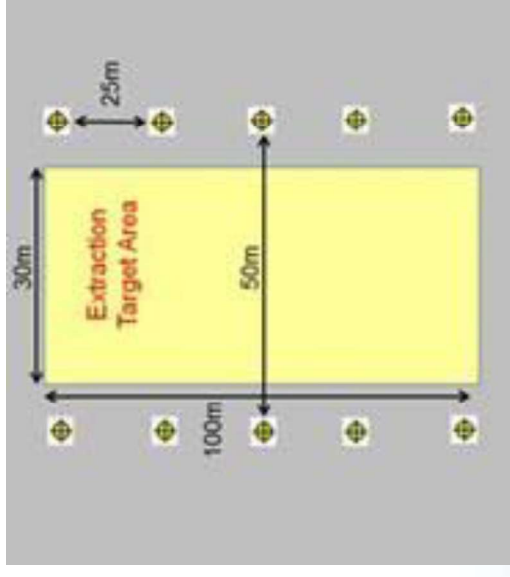
- 100m x 30m window in IB
- Objective
 - Up to 2.5m drawdown objective

Parameters

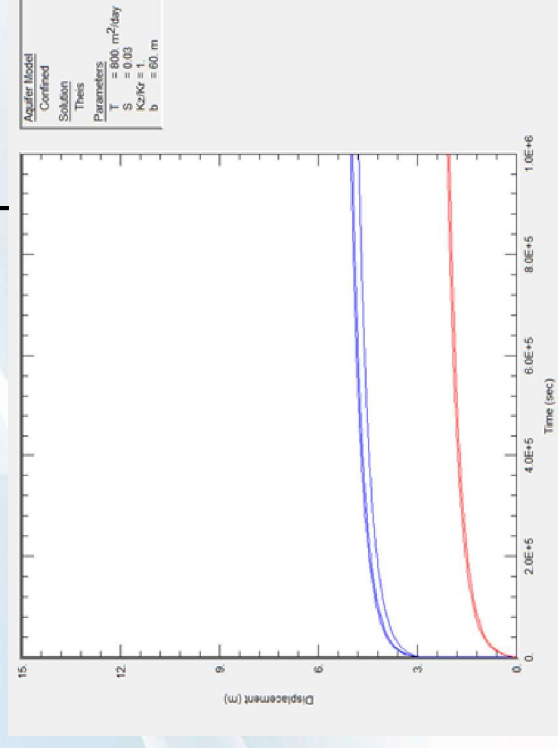
- Transmissivity = 800 m²/d
- S = 0.03
- Partial penetration solution

10 abstraction wells

- 1m drawdown = 20 l/s
- 2m drawdown = 40 l/s
- 2.5m drawdown = 50 l/s
- c. 2.5 MI/d – 4.5 MI/d

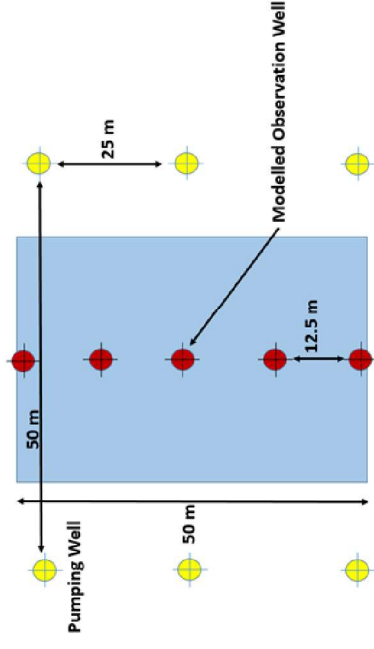
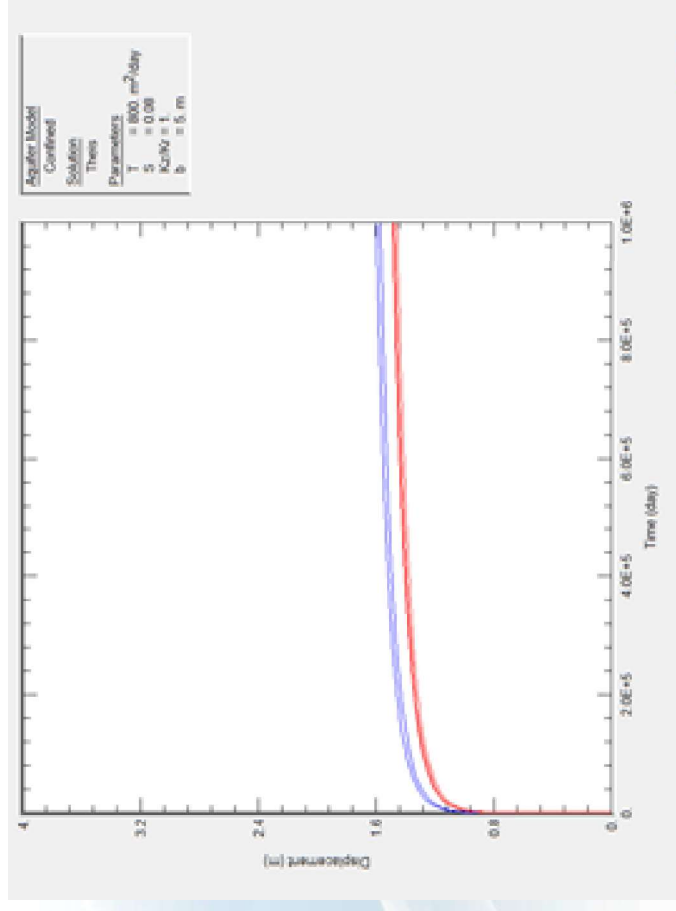


2m Drawdown Example



Re-calculation (2021 calculation of 2016 App)

- Phase A,B,C,D,E,F no pumping
- Phase G (optional pumping)
- 50m x 30m window in IB
- <1.5m drawdown objective
- 6 abstraction wells
- Average 1.7 l/sec from each well = 0.9 MI/d
- Pumping c.1~2 day/week for up to 20 weeks / annum (campaign period)
- Max. drawdown to 68mAOD
- Flow direction from the northwest



Phase-Specific GWMP (Condition 1)

Pre-Phase Investigations

- Geology (OB, UMH, IB (top, base), Chalk surface)
 - Levels, volumes, quality
- Groundwater levels - hydrographs across the site and phase
- Groundwater quality (bromate, bromide, other)

Operational Plan (site areas, procedures, controls)

- Sub-phase layout
- Mineral storage & processing
- Backfill volumes, storage areas
- Barrier material and CQA
- Water management methods and safeguards
 - UMA, LMA, Surface water

Operating Schedule

- Excavation and barrier placement programme

Stakeholder Agreement to Commence

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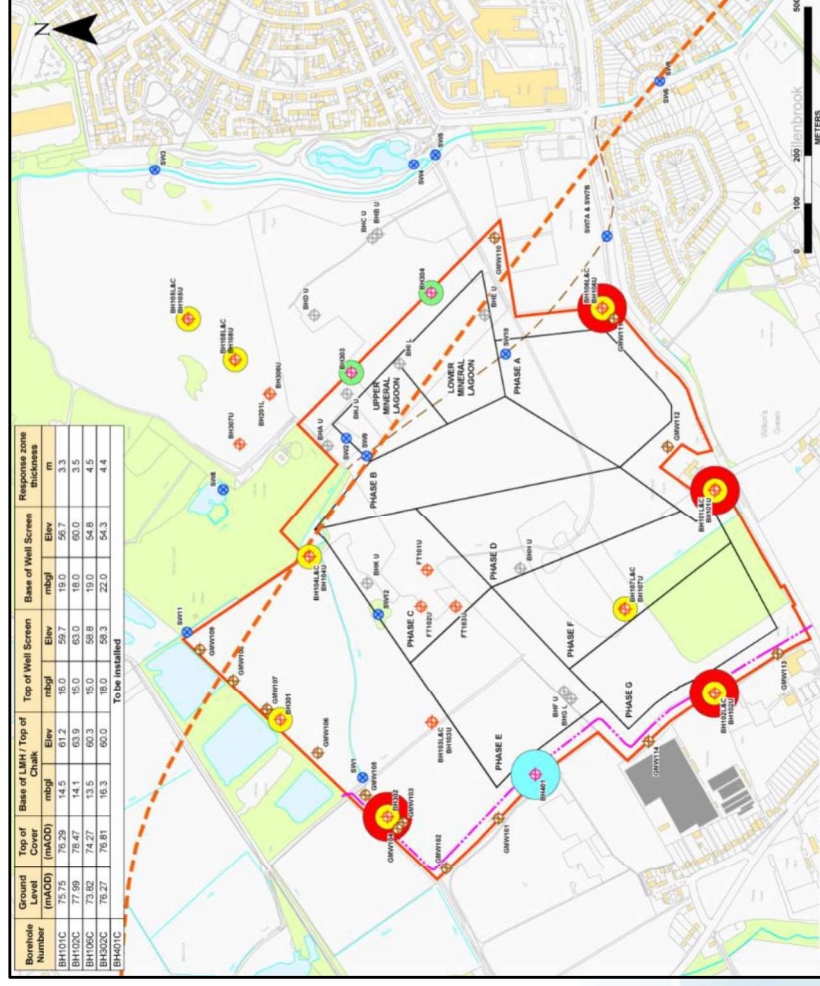


Data Gathering & Frequency

- Objectives & Monitoring Scope
 - Evidence of change (water levels, bromate concentrations)
- Scope – Water levels
 - 20 Automatic (logger) water level monitoring locations
 - 5 Real time telemetry water level monitoring wells
 - Low groundwater Trigger Levels - BH102LMA (TBC)
 - Water level monitoring (M & Q) – all other wells
- Scope - Groundwater Quality (See GWMP)
 - Location – see plans
 - Frequency – (M & Q)

[illegible]

G W M P



- 5 boreholes along south and west boundary
 - 4 exist already, 1 additional
- 50m buffer zone
- Data logger in each well
- Manual dips monthly
- Water samples monthly
- Tests for bromate, bromide, metals
- BH102 “Trigger” Well (Low Level)
- 5 wells to be equipped with telemetry connection
- Data download and share – within 1 day of data receipt
- Meetings – at least 6 monthly

Data Management & Review

- Data Sharing with Stakeholders
 - Direct data access for Affinity and Brett
 - Monthly electronic data transfer to EA and HCC (5 wells)
 - Field data (groundwater levels)
 - Lagoon water levels, discharge volumes
 - Groundwater quality data (bromate, bromide)
 - Affinity data (abstraction data, bromate, bromide)
- Meetings (in person/virtual)
 - Phase Specific – 6 Monthly
 - Upon request - every 2 months during extraction period

Contingency Action Approach

- Trigger Events (evidence of change)
 - Water levels
 - Groundwater quality
- Event Response
 1. Alert Affinity/stakeholders & share data, cease LMA groundwater pumping (if pumping)
 2. Re-dip and re-sample well and surrounding wells
 3. Assess regional context of detection
 4. Operational Review and Root Cause
 5. Risk Assessment & Action plan
 6. Monitor, assess, report
 7. Stakeholder agreement to continue operations

Conclusions

- We have provided the rationale for LMH pumping & shown that:
 - Regional plume & influence of geology is carefully considered.
 - Hydraulic properties of the aquifers are understood.
 - All phases can be worked without pumping.
 - Pumping was only considered for the late phases and for short duration (IB removal).
- We have provided detail on the contingency action approach to ‘evidence of change’ triggers such as water levels and quality:
 - Phase specific GWMP comprising investigations, will develop the detail.
 - Real Time Data and exchange with Affinity
 - Comprehensive monitoring (wells and frequency)
 - Frequent Stakeholder Meetings (Affinity, Brett, EA & HCC).
 - Trigger Events & Contingency Actions.