

APPENDIX A

Figures and drawings



Figure 1 : Location of the Site

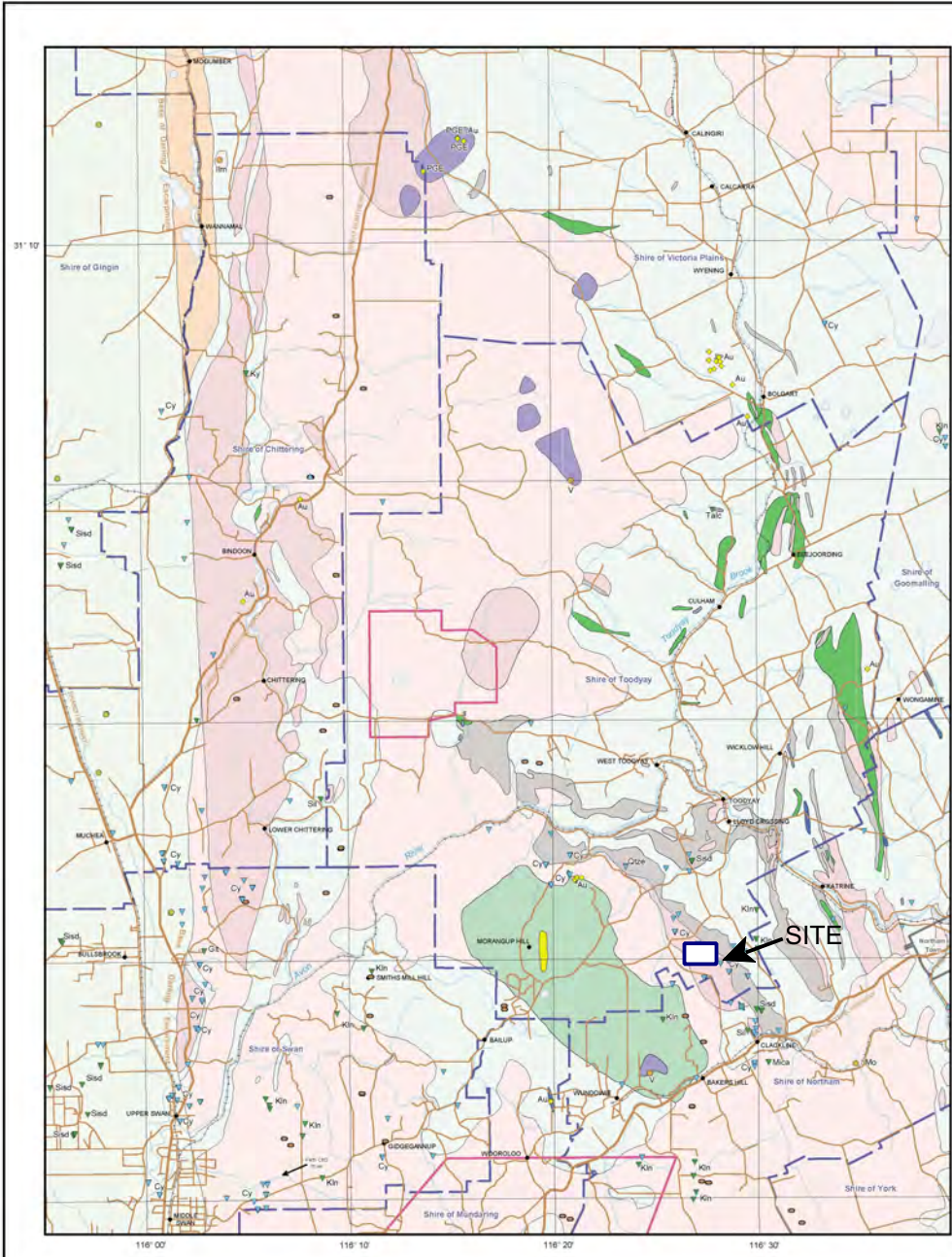


Purple dots show locations of registered bores
Source: DoW geographical atlas, DECEMBER 2011

Figure 1a : Registered bores adjacent to site



Figure 2 : Site Layout and Monitoring Bore Locations



RESOURCE POTENTIAL FOR LAND USE PLANNING TOODYAY AREA

- | Rock types | Mineral potential | Regional planning implications |
|---|---|---|
| Sedimentary rocks of the Perth Basin | Low for gold, high for dimension stone | Unknown |
| Granitic rock | Unknown | High for industrial minerals (silimanite, kyanite, graphite) |
| Granite, gneiss, migmatite | High for base and other metals (copper, zinc, and lead) | High for iron ore |
| Schist, granulites | High for iron ore | High for construction materials (crushed rock) and building stone |
| Calc-silicate gneiss, mylonite | High for gold and base metals | Very high for gold |
| Banded iron-formation, metamorphosed | Very high for gold | Very high for platinum group metals and steel industry metals |
| Quartzite | Very high for gold | |
| Felsic volcanic rock, metamorphosed | Very high for platinum group metals and steel industry metals | |
| Mafic volcanic rock, metamorphosed | | |
| Altered mafic intrusive to volcanic rock, metamorphosed | | |
| Mafic to ultramafic rock, metamorphosed | | |
-
- Overlying weathered materials (widespread but not shown on map)**
- Laterite, widespread on hills
 - Alluvial and eolian sand, in valleys
- Mineral occurrences, deposits, and mines by groups**
- Precious metal
 - Steel industry metal
 - Specialty metal
 - Iron
 - Alumina
 - Industrial mineral
 - Construction material
- (Note, may not include mines authorized by Shires)
-
- Resource**
- Gold (Au), platinum-group metals (PGE)
 - Vanadium (V), molybdenum (Mo)
 - Heavy mineral sands (zircon and titanium minerals)
 - Iron ore
 - Bauxite
 - limestone (lm), glauconite (Gt), kyanite (Ky), silimanite (Sl), silice sand (Ssd), kaolin (Kn), mica, talc
 - Unspecified unless indicated, rock, sand, gravel, clay (Cy), quartzite as dimension stone (Qzst)
-
- Legend**
- Geological boundary
 - Major road / Highway
 - Minor road
 - Railway
 - Localities
 - Town of Northern
 - Shire boundary
 - Watercourse
 - Waterbody
 - Bauxite tenement (Mining Lease 15A)



Department of Industry and Resources
Geological Survey of Western Australia

SCALE 1:200 000

0 10 Kilometres

Fig 3 - Geology of the area indicating the location of the site.



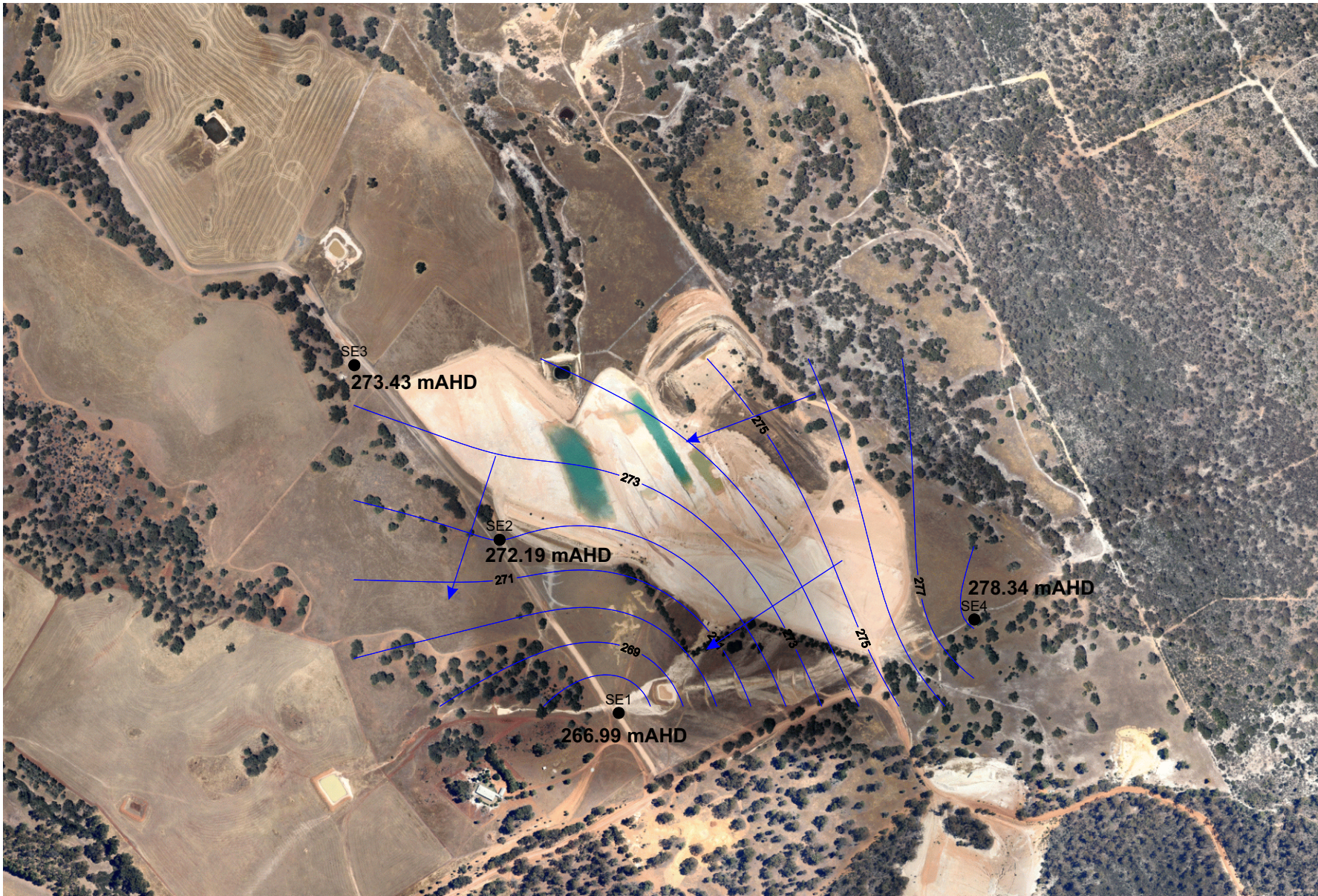


Figure 4a :Static Water Level and Ground Water Flow Direction - July 2011



Figure 4b : Highest recorded ground water levels, September 2013 and flow directions

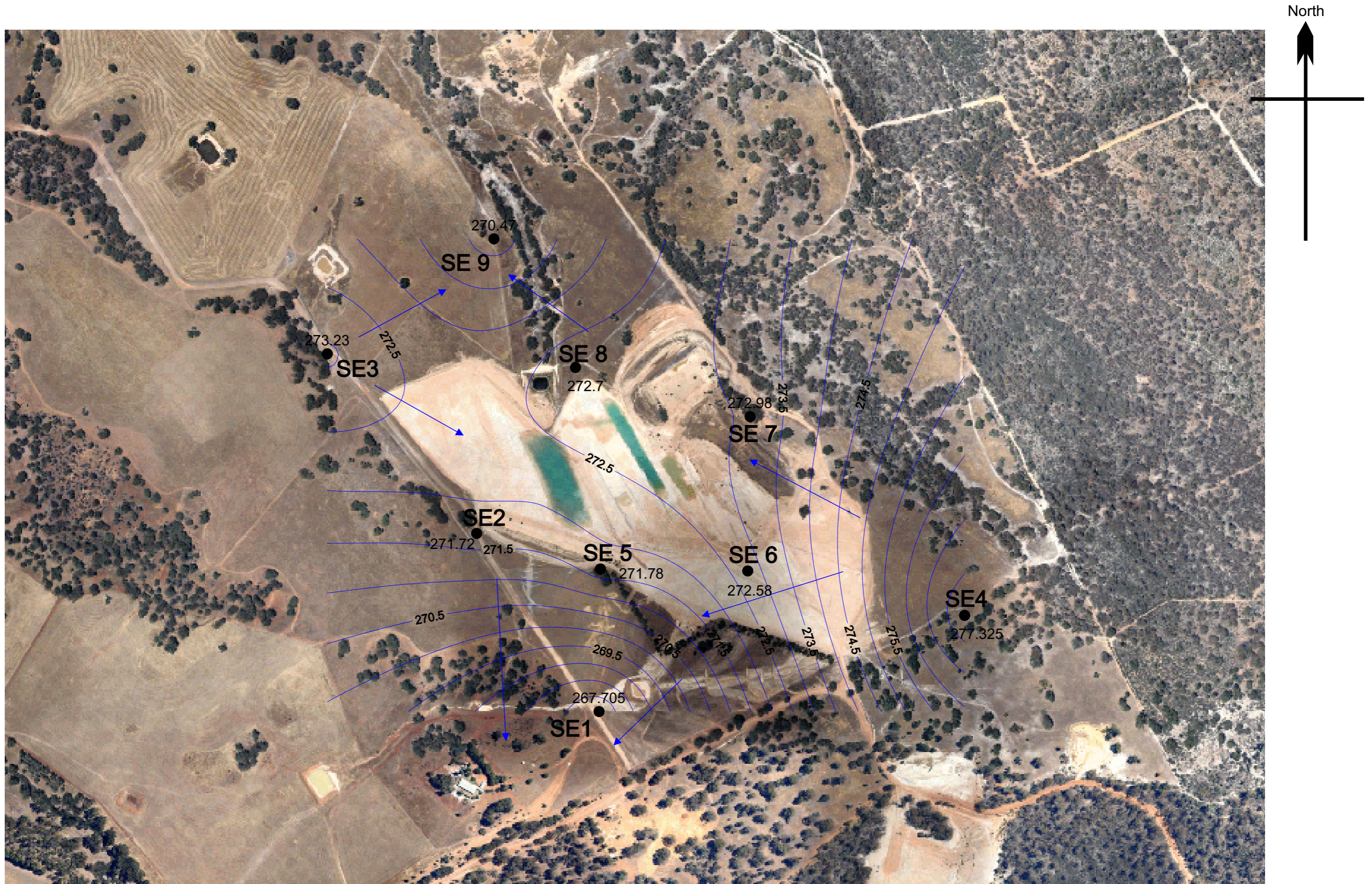
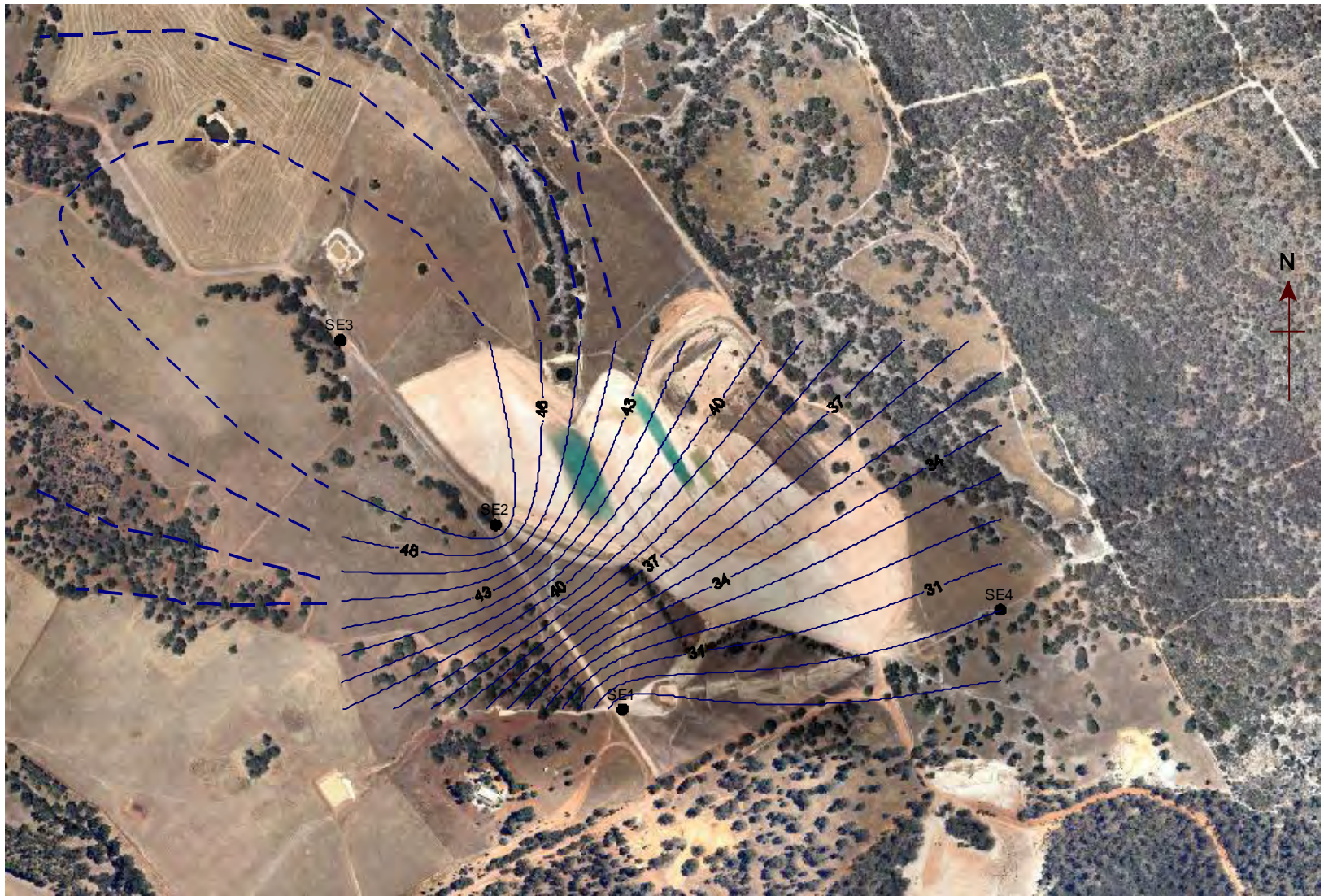


Figure 4c : Highest recorded ground water levels, November 2014 and flow directions



— Recorded depths to water
- - - Estimated depth contour lines of the top of the water body

Figure 5 : Depth to water strikes recorded during drilling

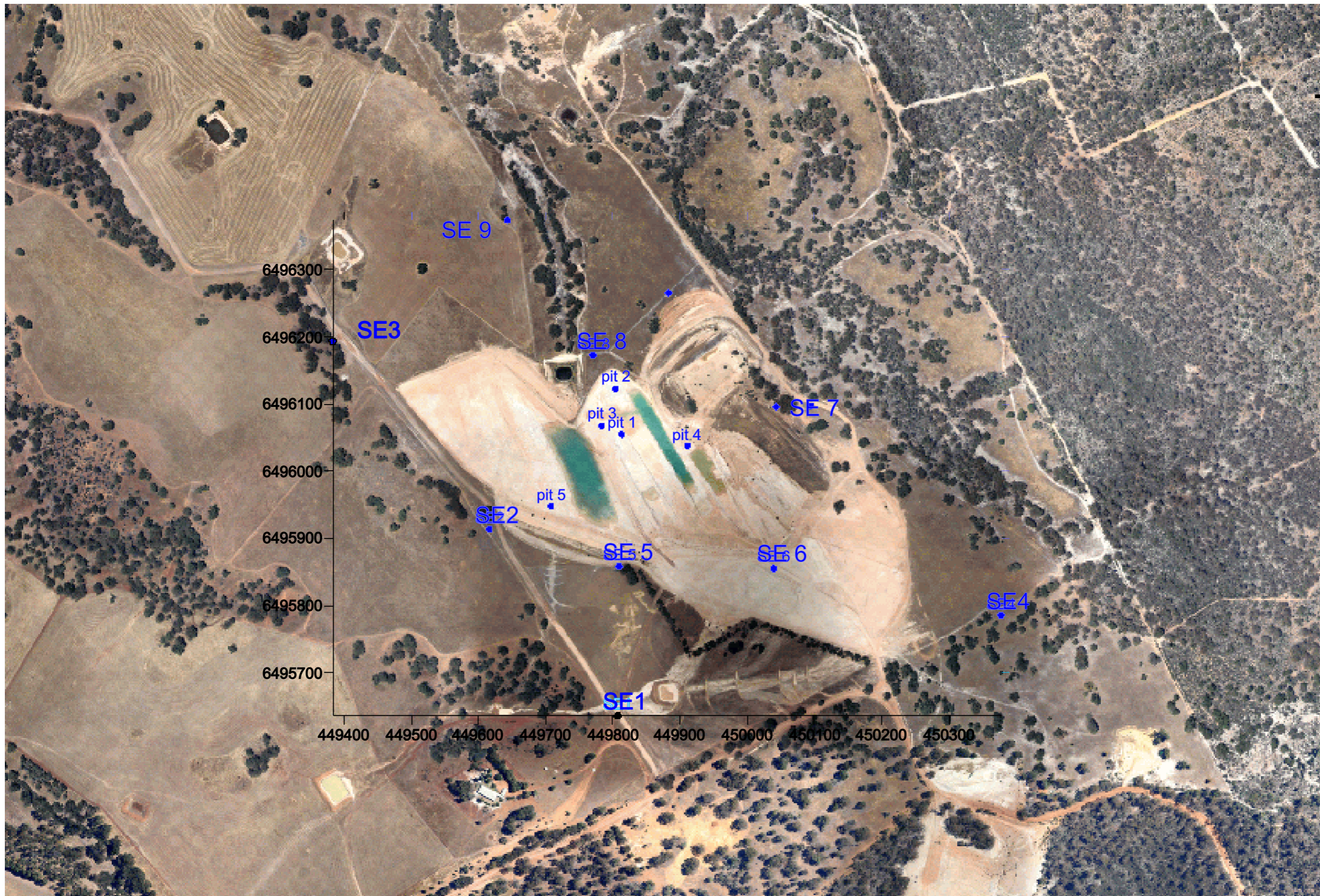
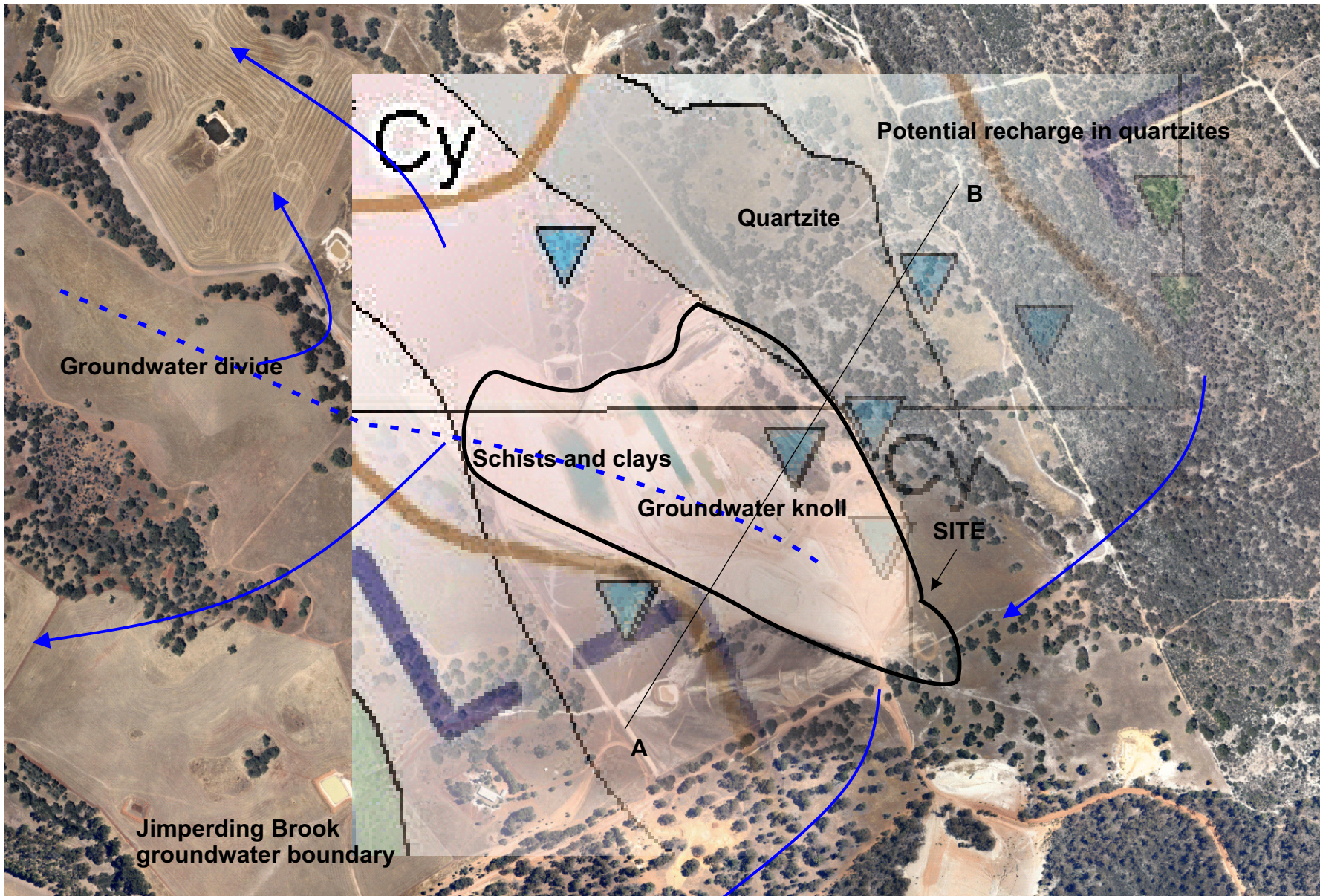


Figure 6 : Location of all bores installed at the site, from 2011 to 2013



A - B Shows HCM Cross Section

Figure 7a :Plan of the Conceptual Hydrogeological Model overlain by geology (transparency)

Opalvale Quarry, Chitty Road Ground Water Conceptual Model

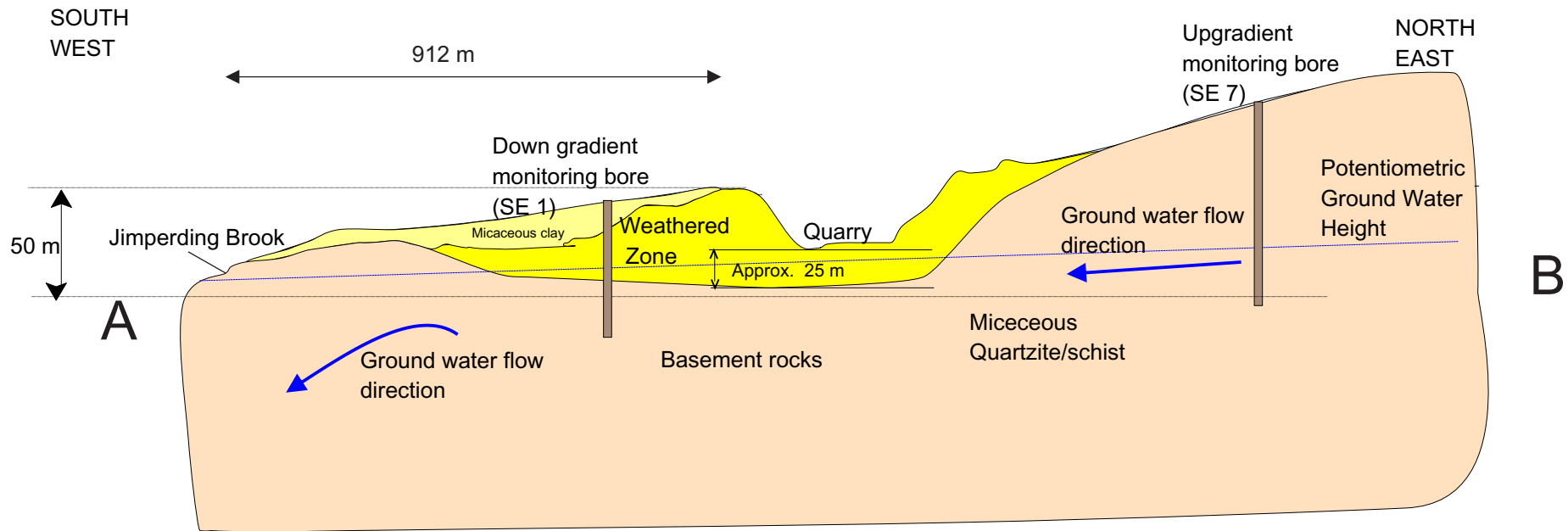


Figure 7b :Hydrogeological Conceptual Model Cross Section A-B

BORE CONSTRUCTION





			Coords: 449807.2 East 6495636 North, RL 274.40 mAHD				
			Drill Rig: Mick Lewis Drilling DHH		Date Drilled: 27 June 2011	Logged By: A. Stass	
			Boring Dia: Auger 150 mm		Boring Number: Bore SE 1		
Sample	Casing Type	Completion	SWL Metres	Depth Meters	Lithology	Description	
	Surface					Sandy, medium grained brown colour. Contains organic material, humus. Well sorted.	
	Blank Casing			5			Grey to beige fine grained clay. Some muscovite present 30% silts. Static water level at 7.41 m below the surface (measured 4 days after drilling).
	Gravel packed			10			Lithology as above
	Slotted Casing			15			Creamy to white fine grained clay. Some muscovite present
	Cap at base			20			Some zoning of quartz grains - approx 2 to 5 mm in diameter, intermixed with muscovite flakes. Up to 50% quartz/muscovite at defined zones, up to 2 m thick.
			25			Creamy/ beige to white fine grained clay. Some muscovite present.	
			30			Water strike at 28 m below the surface.	
			35			Medium grained sand, light beige/yellow coloured clay up to 80% content.	
			40				
			45				
Completion Notes: Piezometer SE1 Class 12, 55 mm blank PVC casing from 0 to 26m bgs; Class 12, 55 mm, slotted, PVC casing from 26 to 32 mbgs; Colar is set at 0.55 m above gs Water field quality: pH = 4.28, EC = 4060 uS/cm, TDS 2340 mg/l REDOX = 145 mV Piezometer was capped at base.						Site: Opalvale Clay Quarry 11 Chitty Road Toodyay	
Project No.: Ovale 001						Page 1	

Figure 8 - Geological and construction log of Bore SE 1

BORE CONSTRUCTION




			Coords: 449616.1East by 6495914 North, RL 285.59 m AHD				
			Drill Rig: Mick Lewis Drilling DHH		Date Drilled: 27 June 2011	Logged By: A. Stass	
			Boring Dia: DHH 150 mm		Boring Number: Bore SE 2		
Sample	Casing Type	Completion	SWL Metres	Depth Meters	Lithology	Description	
	Surface				Grey to beige medium grained sand. 30% clay.		
	Blank Casing			6		Grey to beige fine grained clay. Some muscovite present 30% silts.	
					12		
	Gravel packed			18			Static water level at 13.39 below the surface (measured 3 days after drilling) Lithology as above
	Slotted Casing			24		Lithology as above, some colour change to more beige	
	Cap at base			30			
				36			
				42			
				48		Water strike at 48 m below the surface.	
				54			
Completion Notes: Piezometer SE 2 Class 12, 55 mm blank PVC casing from 0 to 47 mbgs; Class 12, 55 mm, slotted, PVC casing from 47 to 53 mbgs; Colar is set at 0.55 m above g.s. Water field quality: pH = 4.99, EC = 4890 uS/cm, TDS 2830 mg/l REDOX = 105 mV Piezometer was capped at base.						Site: Opalvale Clay Quarry 11 Chitty Road Toodyay	
						Project No.: Ovale001	
						Page 2	

Figure 9 - Geological and construction log of Bore SE 2

BORE CONSTRUCTION

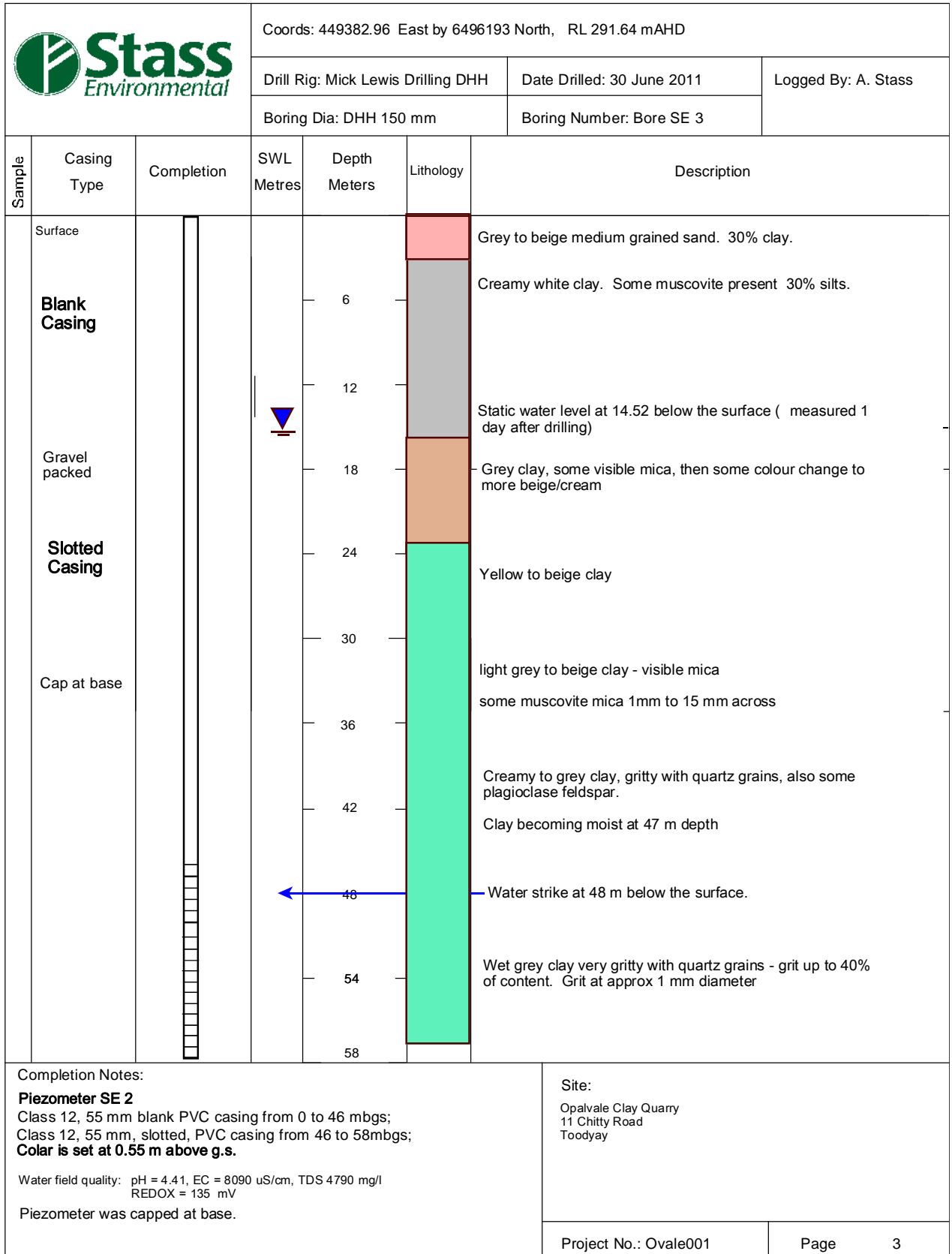


Figure 10 - Geological and construction log of Bore SE 3

BORE CONSTRUCTION






		Coords: 450377.89 East by 6495785.76 North, RL 299.86 mAHD					
		Drill Rig: Mick Lewis Drilling DHH		Date Drilled: 29 June 2011		Logged By: A. Stass	
		Boring Dia: DHH 150 mm		Boring Number: Bore SE 4			
Sample	Casing Type	Completion	SWL Metres	Depth Meters	Lithology	Description	
	Surface				Coffee rock. Yellow to orange laterite pebbles		
	Blank Casing			6	Dark beige clay. Very gritty 30% grit. Grit diameter at an average of 2 mm		
				12	White to grey clay, some grit approx 20% content		
			Gravel packed		18	Coarse white to creamy sand. Quartz grit at 80% some clay	
	Slotted Casing			18		Static water level at 18.21 below the surface (measured 2 days after drilling)	
				24	Very coarse grit, mostly quartz		
				30	Creamy to grey clay, gritty with quartz grains, also some plagioclase feldspar. 10% mica, 50% quartz grains, 40% clay		
	Cap at base				30	First water strike at 30 m	
				36	Coarse white quartz grit, grains at 1mm to 8mm. Clay 10% by content, patches of orange clay. Uniform to 40m depth. Dry to moist ground.		
				42	Quartz gravel. 2mm to 20mm diameter. Average 5mm diameter. Fractured quartzite rock, no mica. White to translucent quartz fragments.		
				46	Water strike at 46 m below the surface.		
				48	Clay, getting finer, no grit. White to grey clay.		
				54			
				58			
Completion Notes: Piezometer SE 2 Class 12, 55 mm blank PVC casing from 0 to 42 mbgs; Class 12, 55 mm, slotted, PVC casing from 42 to 53mbgs; Color is set at 0.55 m above g.s. Water field quality: pH = 6.2, EC = 430 uS/cm, TDS 223 mg/l REDOX = 38 mV Piezometer was capped at base.			Site: Opalvale Clay Quarry 11 Chitty Road Toodyay				
			Project No.: Ovale001		Page 4		

Figure 11 - Geological and construction log of Bore SE 4

Sample	Casing Type	Completion	SWL Metres	Depth Meters	Lithology	Description	
	Surface				Yellow	Coffee rock. Brown to orange laterite pebbles	
	Blank Casing		6		Grey	Dark beige clay. Very gritty 30% grit. Grit diameter at an average of 2 mm	
			12		Orange	White to grey clay, some red grit	
	Gravel packed			15.44		Blue triangle	Static water level at 15.44m below the surface (measured 2 days after drilling)
			18		Grey	Coarse white to creamy sand. Quartz grit at 80% clay	
	Slotted Casing		24		Light grey	Creamy to grey clay, gritty with quartz grains, also some plagioclase feldspar.	
			30		Light purple	10% mica, 50% quartz grains, 40% clay	
	Cap at base		36		Light purple	Coarse white quartz grit, grains at 1mm to 8mm. Clay 10% by content, patches of orange clay. Uniform to 40m depth. Dry to moist ground.	
			42		Pink	Medium grey clayey Cream clayey material - getting moist	
			48		White	Large clayey balls cream in colour wet Water strike at 47 m below the surface.	
				54			
				58			

Completion Notes:


Piezometer SE 5
 Class 12, 55 mm blank PVC casing from 0 to 36 mbgs;
 Class 12, 55 mm, slotted, PVC casing from 38 to 47mbgs;
 Collar is set at 0.65 m above g.s.

Water field quality: pH = 5.7, EC = 4260 uS/cm, TDS 2130 mg/l
 REDOX = 157 mV
 Piezometer was capped at base.

Site:

Opalvale Clay Quarry
 11 Chitty Road
 Toodyay

Figure 12 - Geological and construction log of Bore SE 5

Sample	Casing Type	Completion	SWL Metres	Depth Meters	Lithology	Description	
	Surface				Brown sand and mica		
	Blank Casing		6		Red medium clay. Very gritty 80% grit. Grit diameter at an average of 2 mm. Quartz cuttings.		
			12		White to cream clay cuttings, some red grit		
				16.700			Static water level at 16.700 m below the surface (measured 2 days after drilling)
	Gravel packed		18		Fine browny red clayey cuttings, 60% clay		
	Slotted Casing		24		Purple sandy cuttings, quartz pieces evident.		
	Cap at base		30		Coarse white quartz grit, grains at 1mm to 8mm. Clay 10% by content, patches of red clay. Dry to moist ground.		
			36				
			42		Medium grey clayey, a lot of mica		
			48		Brown mud at 35 m		
		54					
		58					

Completion Notes:


Piezometer SE 5
 Class 12, 55 mm blank PVC casing from 0 to 36 mbgs;
 Class 12, 55 mm, slotted, PVC casing from 38 to 47mbgs;
 Collar is set at 0.65 m above g.s.

Water field quality:pH = 4.8, EC =6050 uS/cm, TDS 3020 mg/l
 REDOX = 210 mV
 Piezometer was capped at base.

Site:

Opalvale Clay Quarry
 11 Chitty Road
 Toodyay

Figure 13 - Geological and construction log of Bore SE 6

Sample	Casing Type	Completion	SWL Metres	Depth Meters	Lithology	Description	
	Surface				Brown clay and mica		
	Blank Casing			6		White to cream clay cuttings, some red grit	
	Gravel and cement grout packed			12		Brown to cream clay cuttings, some red grit fine creamy clay cuttings	
	1 m bentonite seal above slotted casing			18			
	Slotted Casing			21.700			Static water level at 21.700 m below the surface (measured 2 days after drilling)
	Cap at base			24		Fine yellow to grey cuttings, 60% clay. Very dusty. Coarse white quartz grit, grains at 1mm to 10mm. Clay 80% creamy clay by content, patches of red clay. moist ground.	
				30			Water strike at 29.5 m below the surface.
				36			
				42			
				48			
			54				
			58				

Completion Notes:

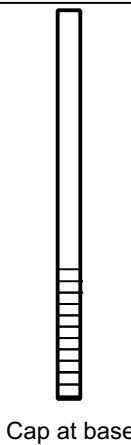




Piezometer SE 7
 Class 12, 55 mm blank PVC casing from 0 to 22 mbgs;
 Class 12, 55 mm, slotted, PVC casing from 23.5 to 29.5mbgs;
 Colar is set at 0.65 m above g.s.

Water field quality:pH = 4.4, EC =5260 uS/cm, TDS 2620 mg/l
 REDOX = 230 mV
 Piezometer was capped at base.

Site:

Opalvale Clay Quarry
 11 Chitty Road
 Toodyay

Figure 14 - Geological and construction log of Bore SE 7

Sample	Casing Type	Completion	SWL Metres	Depth Meters	Lithology	Description
	Surface Blank Casing Gravel and cement grout packed 1 m bentonite seal above slotted casing Slotted Casing	 Cap at base		6 12 18 24 30 36 42 48 54 58	  	Surface detritus Fine white clayey cuttings, very little mica Static water level at 7.700 m below the surface (measured 2 days after drilling) Brown to creamy clay cuttings, 20% mica. Creamy coloured sand with mica cuttings. Pink medium grained sand, mica and clay cuttings moist ground. Water strike at 17.00 m below the surface.

Completion Notes:

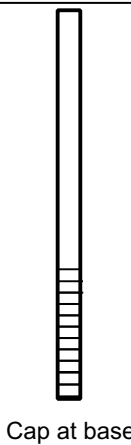




Piezometer SE 8
Class 12, 55 mm blank PVC casing from 0 to 12 mbgs;
Class 12, 55 mm, slotted, PVC casing from 12 to 18mbgs;
Collar is set at 0.65 m above g.s.

Water field quality: pH = 6.59, EC = 1583 uS/cm, TDS 792 mg/l
REDOX = 76.3 mV
Piezometer was capped at base.

Site:

Opalvale Clay Quarry
11 Chitty Road
Toodyay

Figure 15 - Geological and construction log of Bore SE8

Sample	Casing Type	Completion	SWL Metres	Depth Meters	Lithology	Description
	Surface Blank Casing Gravel and cement grout packed 1 m bentonite seal above slotted casing Slotted Casing	 Cap at base		6		Medium grained brown sand, clay and some mica
						Static water level at 5.200 m below the surface (measured 2 days after drilling) Cream to white clay cuttings, a lot of mica.
				12		Dark brown cuttings, clay and a lot of mica.
				18		Water strike at 14.00 m below the surface. Creamy clay, wet
				24		
				30		
				36		
				42		
				48		
				54		
				58		

Completion Notes:

Piezometer SE 9
 Class 12, 55 mm blank PVC casing from 0 to 12 mbgs;
 Class 12, 55 mm, slotted, PVC casing from 12 to 18mbgs;
 Colar is set at 0.65 m above g.s.

Water field quality:pH = 6.23, EC =630 uS/cm, TDS 315 mg/l
 REDOX = 21.2 mV
 Piezometer was capped at base.

Site:

Opalvale Clay Quarry
 11 Chitty Road
 Toodyay

Figure 16 - Geological and construction log of Bore SE9



Coords: 449707.85 East by 6495948.38 North, RL 299.86 mAHD

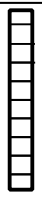
Drill Rig: Hollow Stem Auger

Date Drilled: 1 May 2013

Logged By: N Grobler

Boring Dia: DHH 180 mm

Boring Number: Bore Pit 5

Sample	Casing Type	Completion	SWL Metres	Depth Meters	Lithology	Description
	Surface	 <p>Cap at base</p>		3		Cream to white clay cuttings, a lot of mica.
	Slotted Casing			6		
				9		Hard quartzite at base, auger refusal at 8.5 m
				12		Bore dry to bottom
				18		
				24		
				30		
				36		
				42		
				48		
		54				
				58		

Completion Notes:

Piezometer Pit 5

Class 9, 55 mm, slotted, PVC casing from 0 to 8.5mbgs;

Colar is set at 0.55 m above g.s.

Piezometer was capped at base.

Site:

Opalvale Clay Quarry
11 Chitty Road
Toodyay

Project No.: Ovale001

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Figure Pit bores - Geological and construction log of Bore Pit 5



Coords: 449911.15 East by 6496037.54 North, RL 291.64 mAHD


Drill Rig: Hollow Stem Auger

Date Drilled: 30 April 2013

Logged By: N Grobler

Boring Dia: DHH 180 mm

Boring Number: Bore Pit 4

Sample	Casing Type	Completion	SWL Metres	Depth Meters	Lithology	Description
	Surface Slotted Casing	 Cap at base		3 6 9 12 18 24 30 36 42 48 54 58		Cream to white clay cuttings, a lot of mica. Bore dry to bottom

Completion Notes:

Piezometer Pit 4

Class 9, 55 mm, slotted, PVC casing from 0 to 10mbs;

Collar is set at 0.55 m above g.s.

Piezometer was capped at base.

Site:

Opalvale Clay Quarry

11 Chitty Road

Toodyay

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Coords: 449783.51 East by 6496067.8 North, RL 285.58 mAHD

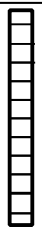

Drill Rig: Hollow Stem Auger

Date Drilled: 30 April 2013

Logged By: N Grobler

Boring Dia: DHH 180 mm

Boring Number: Bore Pit 3

Sample	Casing Type	Completion	SWL Metres	Depth Meters	Lithology	Description
	Surface Slotted Casing	 Cap at base		3 6 9 12 18 24 30 36 42 48 54 58		Static water level at 2.54 m below the surface (measured 1 days after drilling) Cream to white clay cuttings, a lot of mica. Hard quartzite intercepted 4 m depth

Completion Notes:

Piezometer Pit 3

Class 9, 55 mm, slotted, PVC casing from 0 to 10mbs;

Collar is set at 0.35 m above g.s.

Piezometer was capped at base.

Site:

Opalvale Clay Quarry

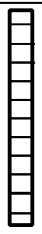

11 Chitty Road

Toodyay

Project No.: Ovale001

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Figure Pit bores - Geological and construction log of Bore Pit 3

Sample	Casing Type	Completion	SWL Metres	Depth Meters	Lithology	Description
	Surface Slotted Casing	 Cap at base		3 6 9 12 18 24 30 36 42 48 54 58		Static water level at 1.69 m below the surface (measured 1 days after drilling) Cream to white clay cuttings, a lot of mica. Hard quartzite intercepted 2 m depth Wet from 3 m below ground

Completion Notes:

Piezometer Pit 2

Class 9, 55 mm, slotted, PVC casing from 0 to 10mbs;

Collar is set at 0.35 m above g.s.

Piezometer was capped at base.

Site:

Opalvale Clay Quarry

11 Chitty Road

Toodyay



Coords: 449813.3 East by 6496054.74 North, RL 274.89 mAHD

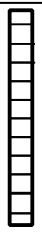
Drill Rig: Hollow Stem Auger

Date Drilled: 29 April 2013

Logged By: N Grobler

Boring Dia: DHH 180 mm

Boring Number: Bore Pit 1

Sample	Casing Type	Completion	SWL Metres	Depth Meters	Lithology	Description
	Surface	 <p>Cap at base</p>		3		Static water level at 5.06 m below the surface (measured 1 days after drilling) Cream to white clay cuttings, a lot of mica.
	Slotted Casing			6		
				9		Dry during drilling Some moisture at 10 m depth
				12		
				18		
				24		
				30		
				36		
				42		
				48		
			54			
			58			

Completion Notes:

Piezometer Pit 1

Class 9, 55 mm, slotted, PVC casing from 0 to 10mbs;

Collar is set at 0.35 m above g.s.

Piezometer was capped at base.

Site:

Opalvale Clay Quarry

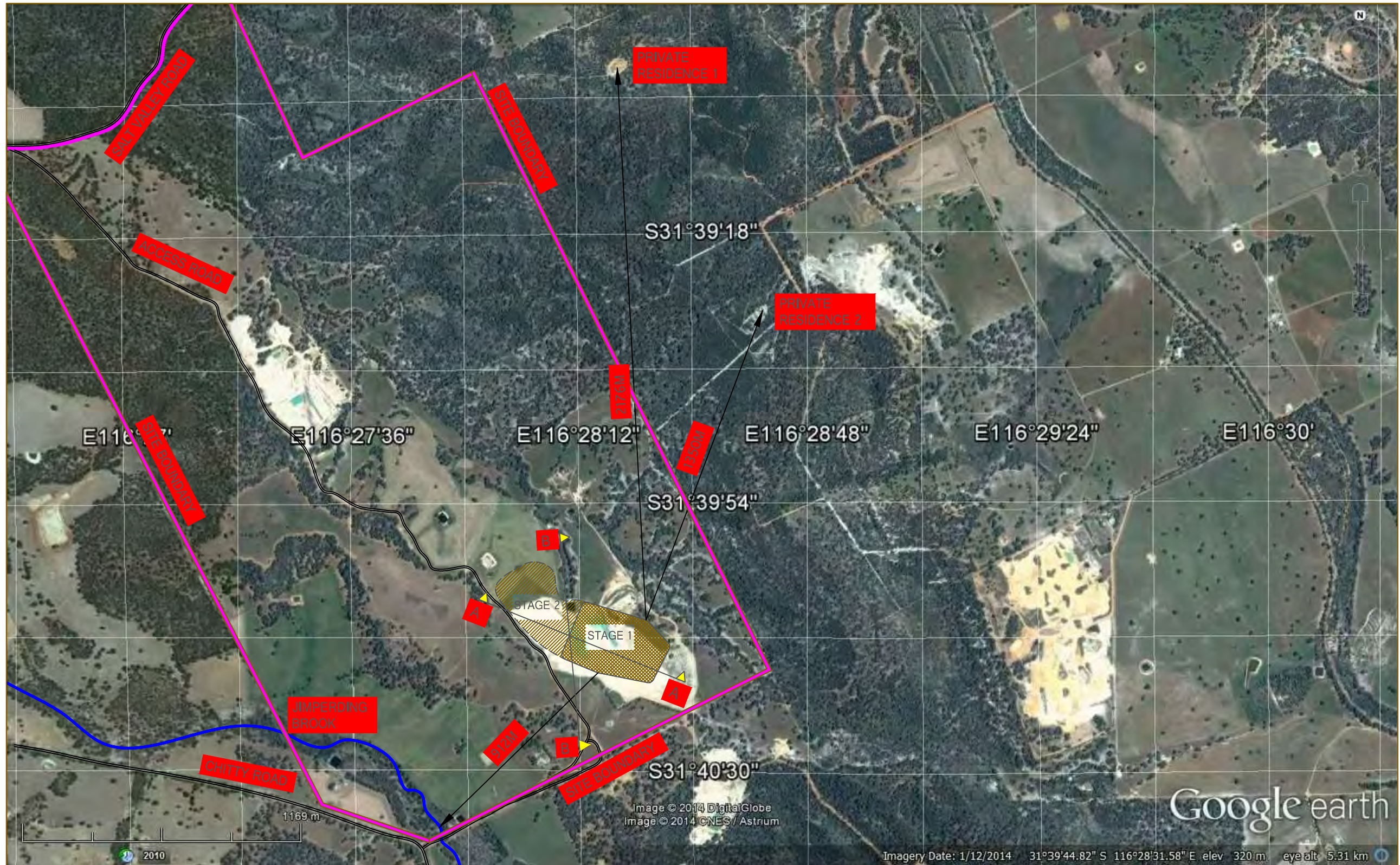
11 Chitty Road

Toodyay

Project No.: Ovale001

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Figure Pit bores - Geological and construction log of Bore Pit 1



5	06/12/14	REVISED PROP BOUNDARY
4	06/12/14	REVISED ROAD NAME
3	05/12/14	ADDED SITE BOUNDARY
2	03/12/14	ADDED BACKGROUND MASKS TO NOTES
1	02/12/14	PRELIMINARY
No	DATE	REVISION

OPAL VALE -
 PROPOSED CLASS II LANDFILL
 LOT 11 CHITTY ROAD
 TOODYAY

DRN: ACW DATE: 01/12/14

RECEPTOR PATHWAYS
 SITE PLAN

CHKD :AS SCALE : 1:17000


Stass Environmental
 Environmental Science & Engineering

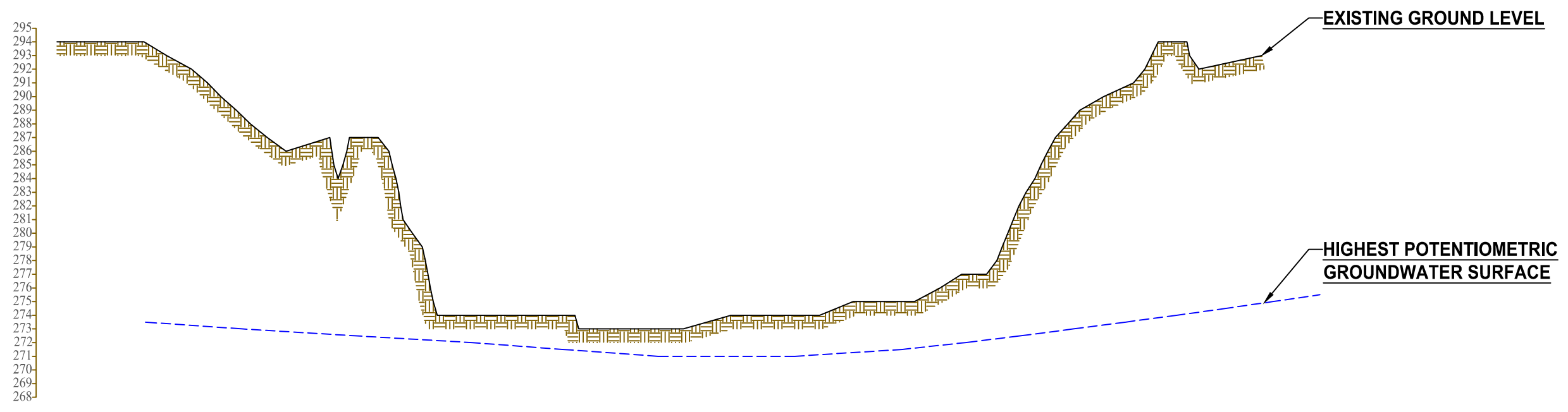
PO BOX 11, KALAMUNDA
 WA 6926
 T: (08)63635276 F: (08)
 WWW.stass.com.au

DWG No:
 OV-01-ACW REV: 5

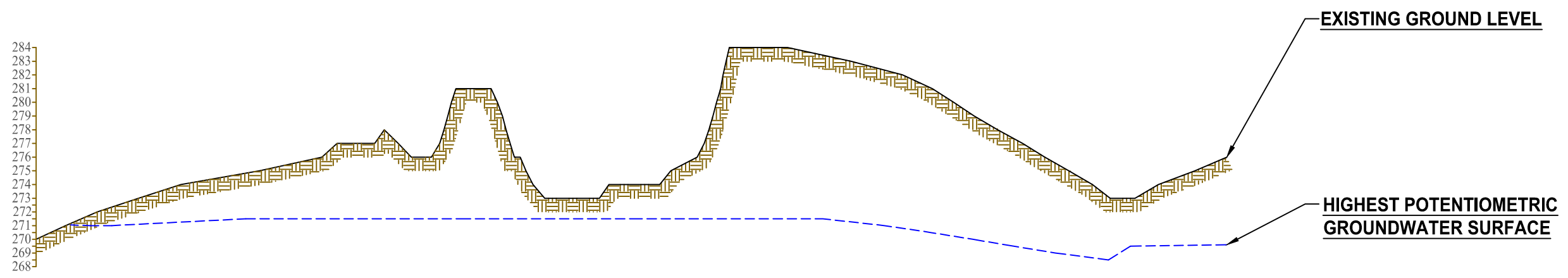


- 1 DENOTES SURFACE WATER FLOW DIRECTION
- 2 DENOTES SURFACE WATER CHANNELS FLOW DIRECTION
- 3 DENOTES VEGETATED SCREEN
- 4 DENOTES GROUND WATER FLOW DIRECTION


			OPAL VALE - PROPOSED CLASS II LANDFILL LOT 11 CHITTY ROAD TOODYAY		RECEPTOR PATHWAYS SITE LAYOUT PLAN		 Stass Environmental Environmental Science & Engineering PO BOX 11, KALAMUNDA WA 6926 T: (08)63635276 F: (08) WWW.stass.com.au	
3	05/12/14	ADDED GROUND WATER FLOWS AND SITE BOUNDART	DRN: ACW	DATE: 01/12/14	CHKD :AS	SCALE : 1:9500	DWG No: OV-02-ACW	REV: 3
2	04/12/14	REVISED LINE THICKNESS AND COLOURS						
1	02/12/14	PRELIMINARY						
No	DATE	REVISION						



SECTION A - A



SECTION B - B

			OPAL VALE - PROPOSED CLASS II LANDFILL LOT 11 CHITTY ROAD TOODYAY		RECEPTOR PATHWAYS SECTIONS		 Stass Environmental Environmental Science & Engineering PO BOX 11, KALAMUNDA WA 6926 T: (08)63635276 F: (08) WWW.stass.com.au	
3	04/12/14	REVISED TITLE BLOCK						
2	03/12/14	REVISED NOTES						
1	02/12/14	PRELIMINARY						
No	DATE	REVISION	DRN: ACW	DATE: 01/12/14	CHKD :AS	SCALE : 1:3500 HORIZONTAL 1:350 VERTICAL	DWG No: OV-03-ACW	REV: 3