Appendix A1

Summary of Ground Investigation Records

Hole No.	Easting	Northing	Ground Level (mPD)	Orientation (degrees)	Hole Depth (m)	From Depth (m)	To Depth (m)	Description	Weathering Grade
13713/P-1A	819604.7	835636.7	+51.82	90	1.85	0.00	1.85	Soil	-
13713/P4	819643.0	835525.0	+70.20	90	14	0.00	14.00	Soil	-
13713/P5_A	819591.8	835180.8	+45.70	90	1.17	0.00	1.17	Soil	-
13713/P5-B	819591.8	835480.6	+45.30	90	1.07	0.00	1.07	Soil	-
2878/K-2	819736.8	835487.1	+110.8	90	30.25	0.0	15.0	(C.W.V) Clayey silt with some gravels	5
2878/K-2						15.0	19.75	(C.W.V) Silty fine sand with some gravels	5
2878/K-2						19.75	24.6	Fine grained moderately metamorphosed weathered volcanic with joints	3
2878/K-2						24.6	30.25	Fine grained, slightly to moderately weathered volcanic with some joints	2/3

Appendix A2

Ground Investigation Borehole Logs

GROUND INVESTIGATION LOG 13713

PROJECT: YUEN LONG IND., ESTATE DEVELOPMENT.

LOCATION: YUEN LONG.

COORDINATES
NORTH: 35636.70
EAST: 19604.70
G.~~S.~~L. LEVEL: +51.82m
INCL: VERTICAL

HOLE NO.: P-1A.

TYPE OF HOLE: ROTARY | FLUSHING MEDIUM: WATER | SHEET NO: 1 OF 1

WATER LOSS / RETURN	CASING DIA DEPTH	TOOL DIA TYPE	IN-SITU TEST & SAMPLES	IN-SITU TEST RESULTS	W.L. Reading	DEPTH m	LEVEL mPD	RUNS m	CORE RECOV. %	R.Q.D. %	LEG/END	DESCRIPTION	STRATA
						0.00	51.82					EXISTING GRD./SURFACE	
	NX-C 1.85m											SOIL.	SOIL.
					29/12	1.85						TOUCH ROCK SURFACE AT 1.85m	
												Bottom of Hole.	

U Undisturbed Samples
D Disturbed Samples
M Mazier
J Jar
S.P.T.
Vane Test
HE Hand Excavation
Permeability Test

CHECKED BY: SIBL/wen.

CONTRACT NO.:

CONTRACTOR:

DATE STARTED:

COMPLETED: 29/12/78

ARCHITECT/ENGINEER:

impact IMPACT FOUNDATIONS (H.K.) LTD.
307, SHELL HOUSE, QUEEN'S RD. C., HONG KONG.
TEL: 5-262001 TELEX: 83509 GROUT HX

ROUND INVESTIGATION LOG

PROJECT: YUEN LONG IND. ESTATE DEVELOPMENT

COORDINATES
NORTH: 35525.00
EAST: 19643.00
G./~~P.~~D. LEVEL: +79.20
INCL: VERTICAL

HOLE NO.: P4

LOCATION: YUEN LONG.

TYPE OF HOLE: ROTARY | FLUSHING MEDIUM: WATER | SHEET NO: 1 OF 1

CASING DIA DEPTH	TOOL DIA TYPE	IN-SITU TEST & SAMPLES	IN-SITU TEST RESULTS	W.L. Reading	DEPTH m	LEVEL mPD	RUNS m	CORE RECOV. %	R.Q.D. %	LEGEND	DESCRIPTION	STRATA
					0.00	+79.20					EXISTING GROUND SURFACE	
14.00m				AM. NIL ▽ PM: 11.70m	14.00						SOIL. TOUCH ROCK SURFACE AT 14.00 M.	14.00
											Bottom of Hole.	

SCALE

Undisturbed Samples
Disturbed Samples
M Mazier
J Jar
S.P.T.
Vane Test
Permeability Test
HE Hand Excavation

CHECKED BY: SIRIUS.

CONTRACT NO.:

CONTRACTOR:

Impact IMPACT FOUNDATIONS (H.K.) LTD.
307, SHELL HOUSE, QUEEN'S RD. C., HONG KONG.
TEL. 5-263001 TELEX: 83508 GROUT HX

DATE STARTED: 19/11/82
COMPLETED: 19/11/82

ARCHITECT / ENGINEER:

GROUND INVESTIGATION LOG

PROJECT: YUEN LONG IND. ESTATE DEVELOPMENT

LOCATION: YUEN LONG.

COORDINATES
NORTH: 35180.20
EAST: 19591.80
G./S.B. LEVEL: 45.70
INCL: VERTICAL

HOLE NO.: P.5-A.

TYPE OF HOLE: ROTARY
FLUSHING MEDIUM: WATER
SHEET NO: 1 OF 1

WATER/MUD RETURN	CASING DIA DEPTH	TOOL DIA TYPE	IN-SITU TEST & SAMPLES	IN-SITU TEST RESULTS	W.L. Reading	DEPTH m	LEVEL mPD	RUNS m	CORE RECOV. %	R.Q.D. %	LEGEND	DESCRIPTION	STRATA
						0.00	+45.70					EXISTING GRD. SURFACE	
	NX-C 1.20m				AM: NIL PM 0.33m							SOIL. TOUCH ROCK SURFACE AT 1.17 M.	SOIL
					23/11	1.17							
												Bottom of Hole.	

SCALE ▮ Undistrubed Samples • Distrubed Samples M Mazier J Jar ↓ S.P.T. Φ Vane Test |—o—| Permeability Test HE Hand Excavation

CHECKED BY: [illegible]

CONTRACT NO.:

CONTRACTOR:

DATE STARTED: 23/11

COMPLETED: 23/11

ARCHITECT / ENGINEER:

impact IMPACT FOUNDATIONS (H.K.) LTD.
307, SHELL HOUSE, QUEEN'S RD. C., HONG KONG.
TEL. 5-263001 TELEX: 83508 GROUT HX

GROUND INVESTIGATION LOG

PROJECT: YUEN LONG IND. ESTATE DEVELOPMENT

COORDINATES
NORTH: 25180.60
EAST: 19591.80
G.S.B. LEVEL: +45.30
INCL: VERTICAL

HOLE NO.: PS-B.

LOCATION: YUEN LONG

TYPE OF HOLE: ROTARY | **FLUSHING MEDIUM:** WATER | **SHEET NO:** 1 OF 1

WATER MUD RETURN	CASING DIA DEPTH	TOOL DIA TYPE	IN-SITU TEST & SAMPLES	IN-SITU TEST RESULTS	W.L. Reading	DEPTH m	LEVEL mPD	RUNS m	CORE RECOV. %	R.Q.D. %	LEGEND	DESCRIPTION	STRATA
						C.D.	+45.30					EXISTING GRD. SURFACE	
0	NX-C 1.10m											SOIL.	
					23/11	1.07						TOUCH ROCK SURFACE AT 1.07m	SOIL.
1												Bottom of Hole.	
2													

SCALE P.O. — ▲ Undisturbed Samples ● Disturbed Samples — M Mazier J Jar — S.P.T. Vane Test — Permeability Test HE Hand Excavation — CHECKED BY: S.P.L.

CONTRACT NO.:

CONTRACTOR:

impact IMPACT FOUNDATIONS (H.K.) LTD.
307, SHELL HOUSE, QUEEN'S RD. C., HONG KONG.
TEL 5-263001 TELEX: 83508 GROUT HX

DATE STARTED:

COMPLETED: 23/11/78

ARCHITECT/ENGINEER:

2878

P.W.D. CONTRACT No. 402/80

CONTRACTOR'S NAME: ENPACK (H.K.) LTD.

DRILLHOLE RECORD

WORKS ORDER OR JOB NUMBER: 87/2/38 <17>

SITE NAME: BORROW AREA KNORTHWEST, NT

HOLE NUMBER: K2

RIG TYPE: DIAMOND CORE DRILL

RIG NUMBER: DR2

OPERATOR: [redacted]

METHOD: ROTARY DRILL

CO-ORDINATES: E 19736.8, N 35487.1

HOLE DIAMETER: NX

CASING DIAMETER: NX

DATE: FROM 28-12-80 TO 2-1-81

SHEET: 1 OF 3

GROUND LEVEL: +110.8 mPD

ORIENTATION: 90°

Drilling progress	Casing depth size	Water level	Water recovery %	Core recovery %	RQD %	Fracture index	Tests	Samples	Depth (metres)	Reduced level	Legend	Description	Grade
30/12	NX		60				N=7		0–10			REDDISH BROWN CLAYEY SILT WITH SOME GRAVELS <C.W.V.>	W H

LINER SAMPLE
WATER TABLE
STANDARD PENETRATION TEST

REMARKS

FIELD INSTALLATION

P.W.D. CONTRACT No. 402[illegible]

CONTRACTOR'S NAME: ENPACK (H.K.) LTD.

DRILLHOLE RECORD

WORKS ORDER OR JOB NUMBER 87/2/3.8 <17

SITE NAME BORROW AREA 'K' NORTH WEST N.T.

HOLE NUMBER K2

RIG TYPE DIAMOND CORE DRILL

RIG NUMBER DR2

OPERATOR [redacted]

METHOD ROTARY DRILL

CO-ORDINATES E 19736.8 N 35487.1

HOLE DIAMETER NX

CASING DIAMETER NX

DATE FROM 28-12-80 TO 2-1-81

SHEET 2 OF 3

GROUND LEVEL + 110.8 mPD

ORIENTATION 90°

Drilling progress	Casing depth size	Water level	Water recovery %	Core recovery %	R.Q.D. %	Fracture index	Tests	Samples	Depth (metres)	Reduced level	Legend	Description	Grade
								2	10				
							N=35		11			REDDISH BROWN CLAYEY SILT WITH SOME GRAVELS <C.W.V.>	W V
									12				
									13				
									14				
31/12	NX	4.10m @ 18:00							15				
			60				N=213	3					
		13.40m @ 8:00							16			REDDISH BROWN SILTY FINE SAND WITH SOME GRAVELS <C.W.V.>	W V
		2.20m @ 12:00							17				
									18				
									19				
				100	56	6		TNW CORE	19.75 20	91.05		REDDISH BROWN FINE-GRAINED MODERATELY METAMORPHOSED WEATHERED VOLCANIC WITH JOINTS <TUFF>	W III

LINER SAMPLE

WATER TABLE

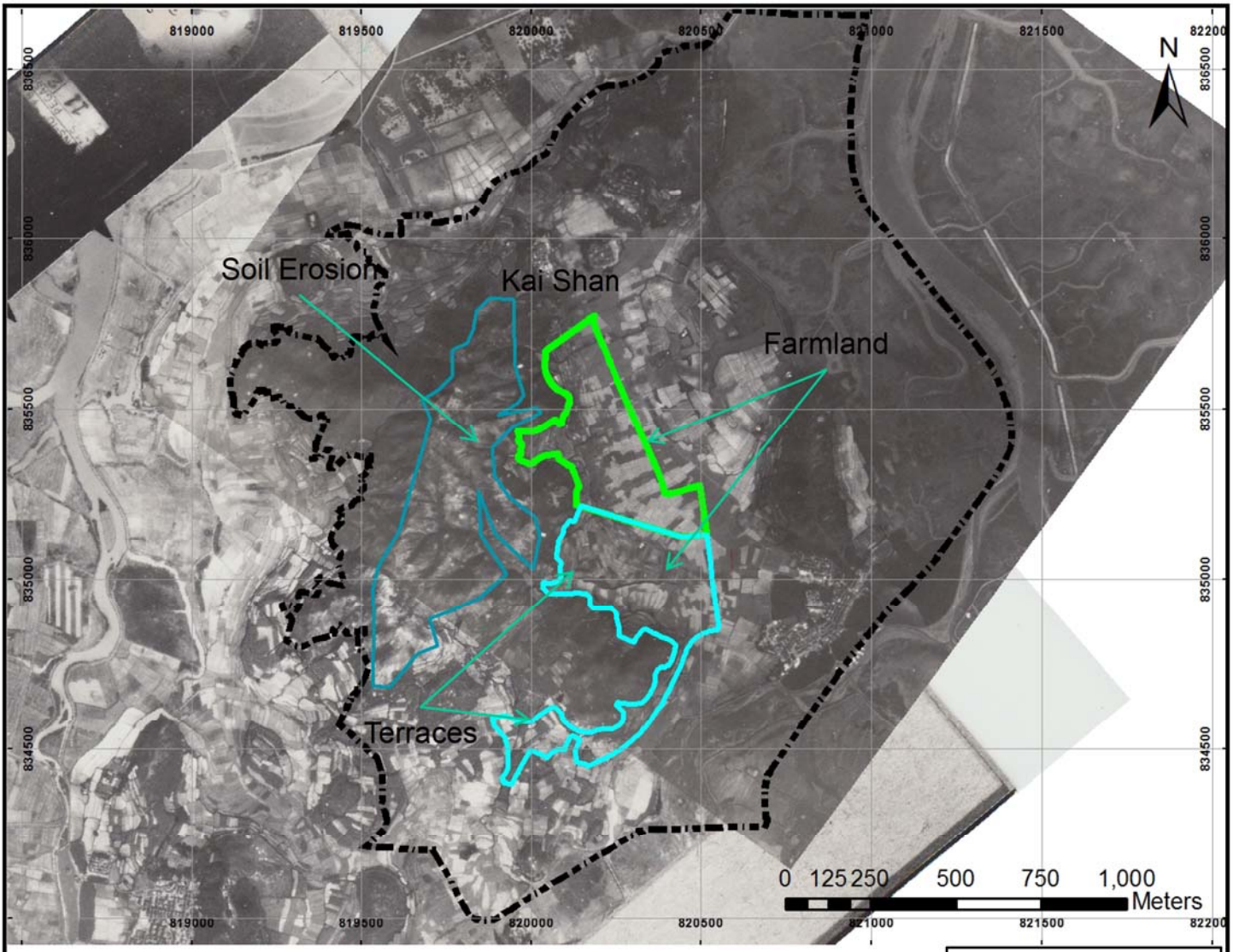
STANDARD PENETRATION TEST

REMARKS

FIELD INSTALLATION

Appendix B

Aerial Photograph Interpretation



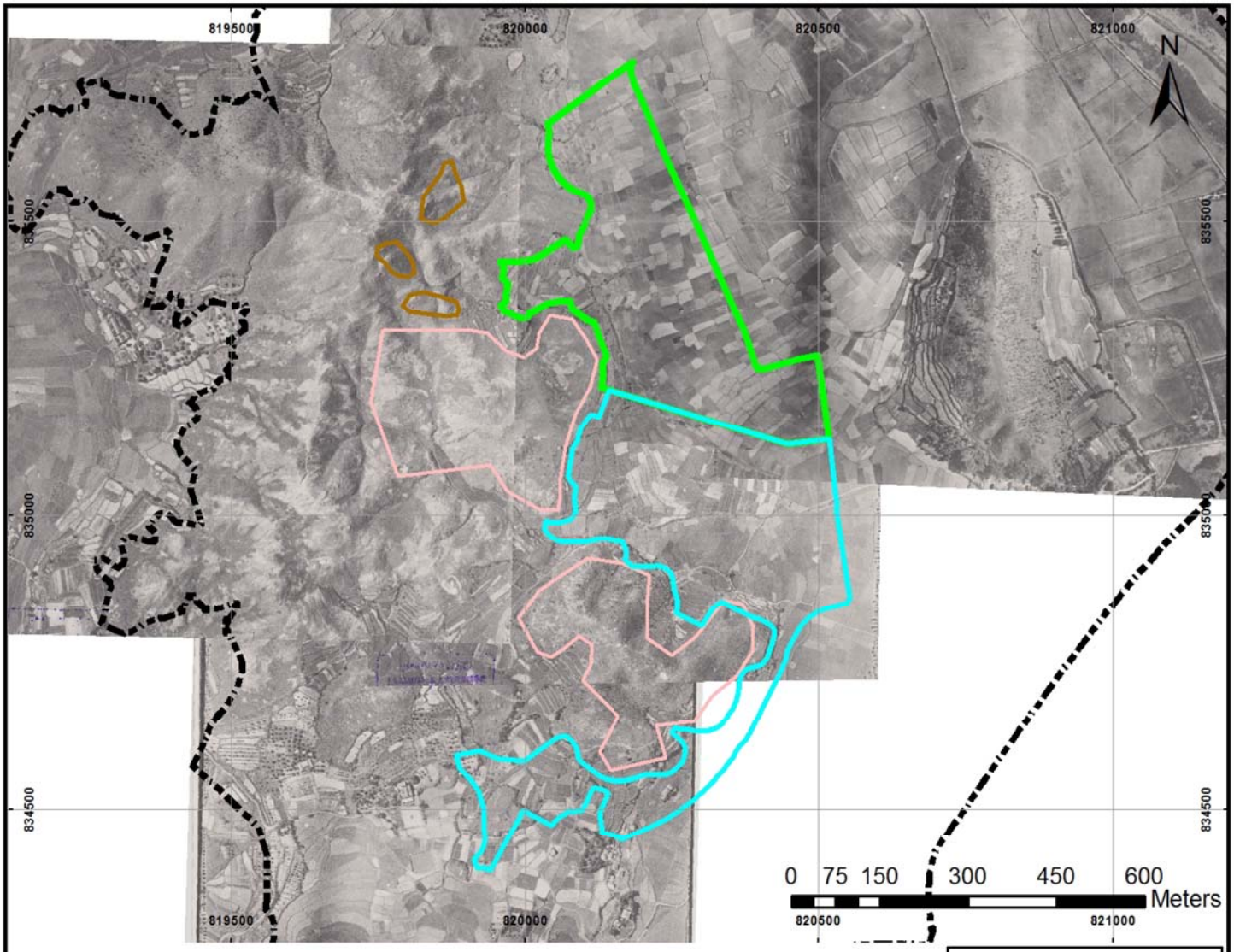
Year 1924

- Farmland and terraces on the flat land surrounding the foot hills occupied the Public Housing (PH) Site and Yuen Long Industrial Estate Extension (YLIEE).
- No man-made structures were identified.
- A small number of graves were identified at the foot hills adjacent to the proposed development site.
- Sparse vegetation was observed across the natural terrain to the west of the PH Site and YLIEE.
- Soil erosion was observed mainly on the hill top.

Legend

- Study Area
- YLIEE Site
- PH Site
- Soil Erosion
- Farmland/Terrace Boundary

Job Title Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau	Figure Title **Aerial Photo Interpretation** (Sheet 1 of 8)	ARUP Ove Arup & Partners Hong Kong Limited Scale N.T.S. Drn. ELCF Date 09/2012 Chd. AN Approved SWM Job No. 226464 Figure No. A1



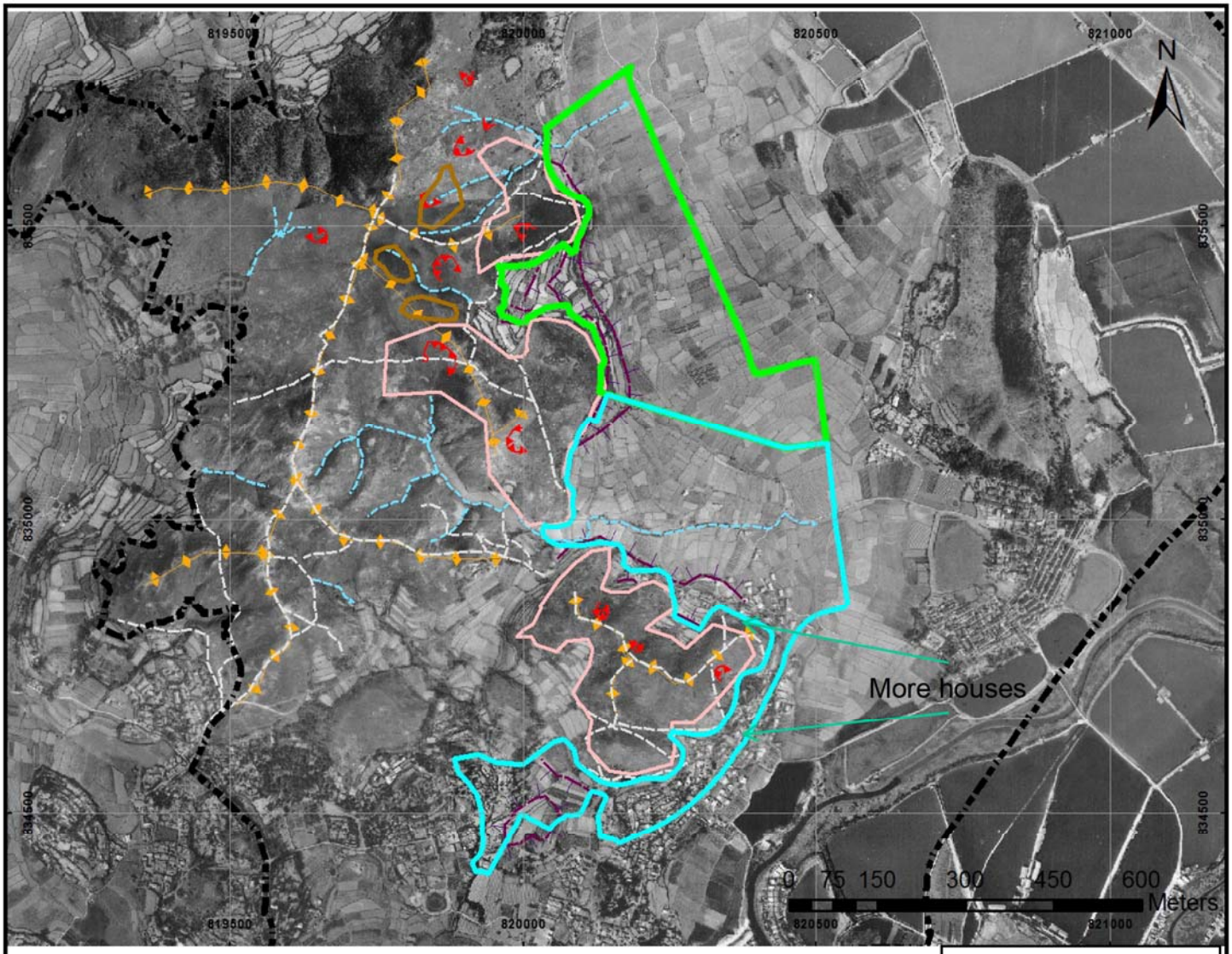
Year 1949

- Additional graves were observed in the area to the west of proposed development.
- Further small trees and vegetation can be observed within the natural terrain area to the west of the proposed PH Site and YLIEE.
- Further rock outcrops and boulders were observed in the natural terrain to the west of proposed development sites.
- No other significant changes were observed.

Legend

- Study Area
- YLIEE Site
- PH Site
- Rock Outcrop/ Boulders
- Grave Area

Job Title Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau	Figure Title **Aerial Photo Interpretation** (Sheet 2 of 8)	ARUP Ove Arup & Partners Hong Kong Limited Scale N.T.S. Drn. ELCF Date 09/2012 Chd. AN Approved SWM Job No. 226464 Figure No. A2



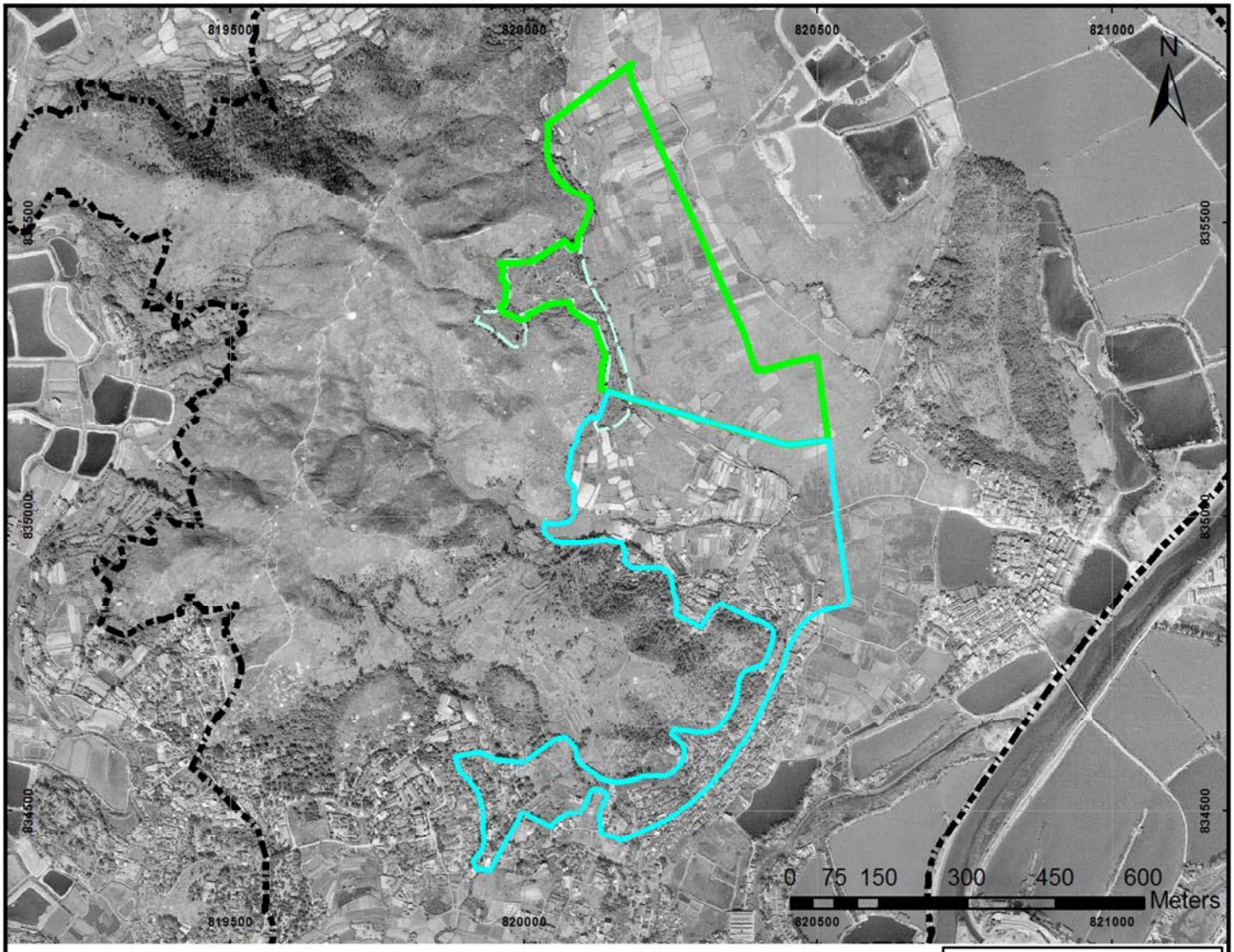
Year 1963

- The majority of the land within the PH and YLIEE sites and adjacent areas was still used for agricultural purposes. However, more low-rise houses were observed, especially concentrated in the southern portion of the PH site. Low-rise structures were observed within the agricultural area.
- Natural incised drainage lines were observed predominantly in the central sites and northern portions of the natural terrain hillside orientated towards the PH and YLIEE sites. These drainage line converge forming two drainage lines, one passing through the PH site, and one passing through the YLIEE site. Most of the drainage lines identified were NE to SW trending with some minor drainage lines trending NW to SE.
- No recent landslide scars were observed but morphological depressions were noted in the hills to the West of the PH and YLIEE sites, which may be related to previous landslide activities.
- Rock outcrops and boulders were observed along the major drainage lines and spurlines suggesting shallow rockhead level in these areas.
- More graves were mainly distributed over the small hills and foot slope.
- Footpaths were mainly observed along the ridgelines and along the foot hills.
- No other significant changes were observed

Legend

- Study Area
- YLIEE Site
- PH Site
- Drainage line
- Spurline
- Convex Break
- Terrace
- Footpaths
- Rock Outcrop/ Boulders
- Grave Area

Job Title	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau
Figure Title	**Aerial Photo Interpretation** (Sheet 3 of 8)
ARUP	Ove Arup & Partners Hong Kong Limited
Scale	N.T.S.
Drn. ELCF	Date 09/2012 Chd. AN Approved SWM
Job No.	226464
Figure No.	A3



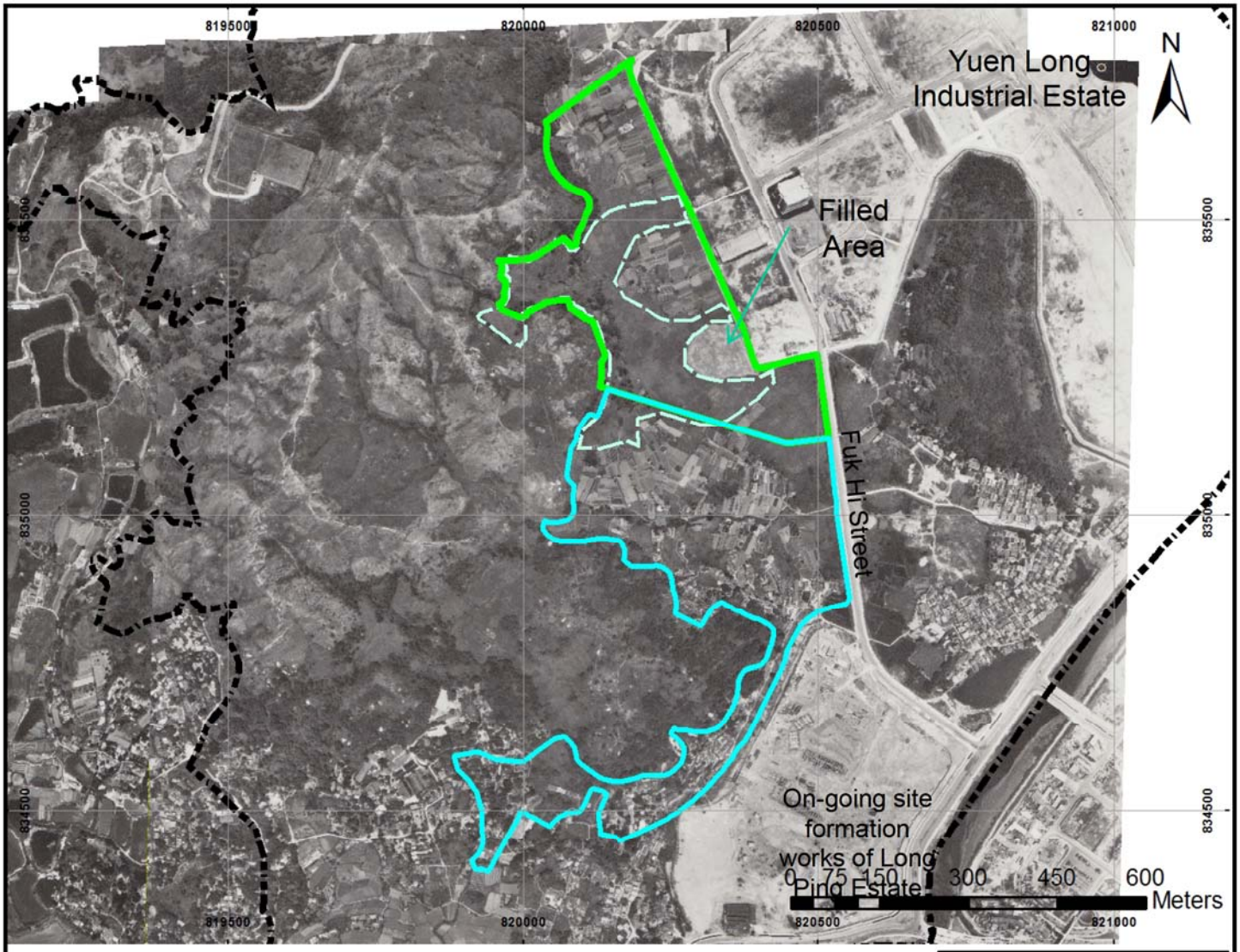
Year 1973

- A significant portion of farmland and terraces at foot hills remained active within the YLIEE.
- More houses were observed in the southern portion of the proposed PH Site.
- More vegetation was observed to the west of the PH Site.
- No other significant changes were observed.

Legend

- Study Area
- YLIEE Site
- PH Site
- Abandoned Farmland

Job Title Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau	Figure Title **Aerial Photo Interpretation** (Sheet 5 of 8)	ARUP Ove Arup & Partners Hong Kong Limited Scale N.T.S. Drn. ELCF Date 09/2012 Chd. AN Approved SWM Job No. 226464 Figure No. A4



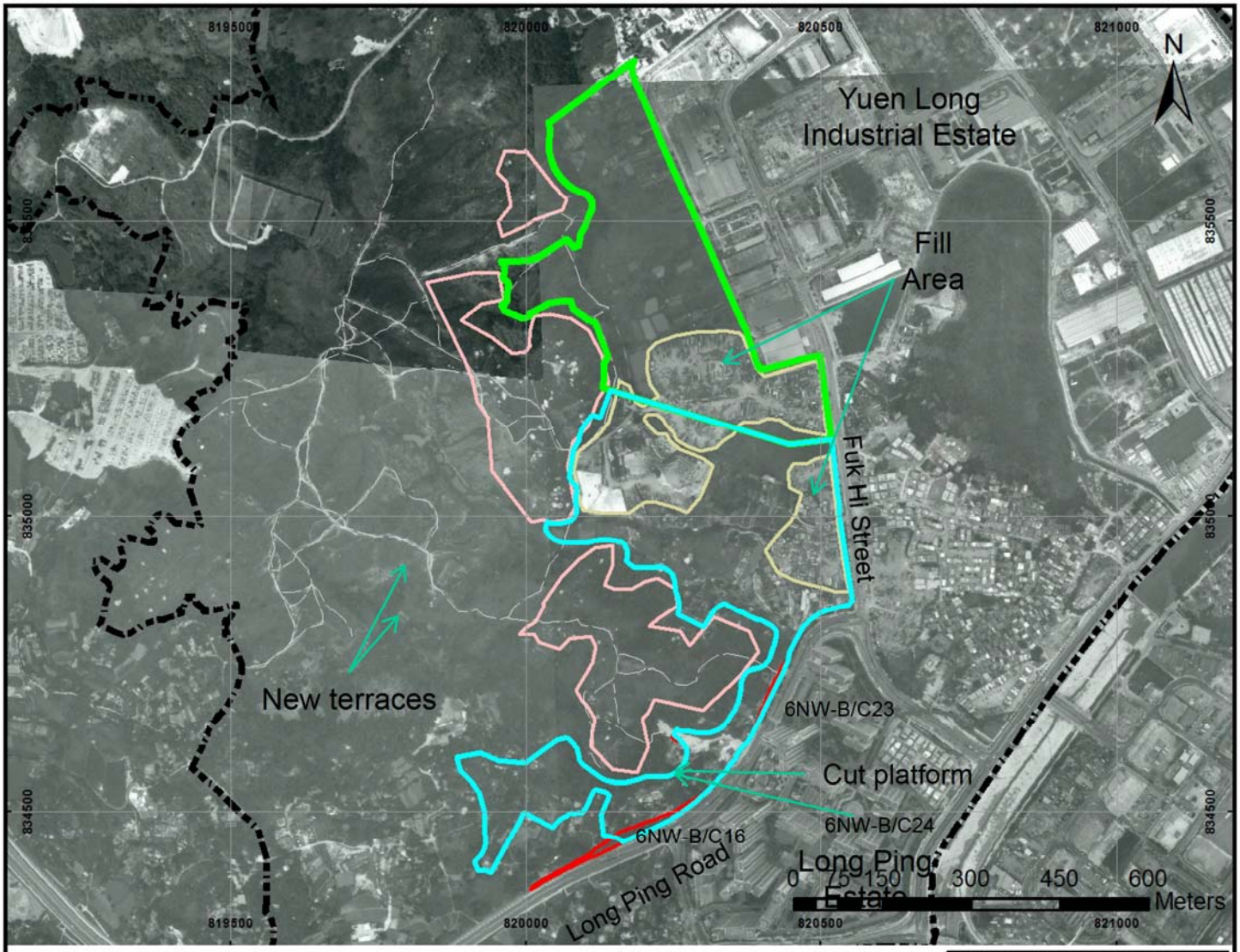
Year 1984

- A significant portion of farmland and terraces in the foot hills appear to have been abandoned.
- Part of the southern portion of the YLIEE has been filled.
- Due to the site formation work to the east of the PH Site, some of the houses were cleared.
- The Yuen Long Industrial Estate was being constructed and Fuk Hi Street was formed within the east of the YLIEE.
- No other significant changes were observed.

Legend

- Study Area
- YLIEE Site
- PH Site
- Abandoned Farmland

Job Title Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau	Figure Title **Aerial Photo Interpretation** (Sheet 5 of 8)	ARUP Ove Arup & Partners Hong Kong Limited Scale N.T.S. Drn. ELCF Date 09/2012 Chd. AN Approved SWM Job No. 226464 Figure No. A5



Year 1994

- In the northern portion of the PH Site and southern portion of the YLIEE, a significant portion of agricultural land was filled and converted into container storage areas.
- More low-rise houses were observed to the east of the PH Site.
- To the southeast of the PH Site, site formation work was completed and Long Ping Estate and Long Ping Road were built. The associated cut slopes 6NW-B/C16 and 6NW-B/C23 were observed.
- Man-made feature 6NW-B/C24 and a cut platform were observed in the southern portion of the PH Site.
- Construction of the Yuen Long Industrial Estate had been completed.
- Fewer houses were observed in the southern portion of the PH Site.
- Two areas of new terrace and some new graves were observed in the natural terrain to the west of the PH Site.
- More dense vegetation cover was observed to the west of the PH Site.
- Foot paths were more extensively formed on the natural terrain.
- No other significant changes were observed.

Legend

- Study Area
- YLIEE Site
- PH Site
- Cut Slope
- Grave Area
- Fill Area
- Footpath

Job Title

Agreement No. CB20120293

Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau

Figure Title

Aerial Photo Interpretation
(Sheet 6 of 8)

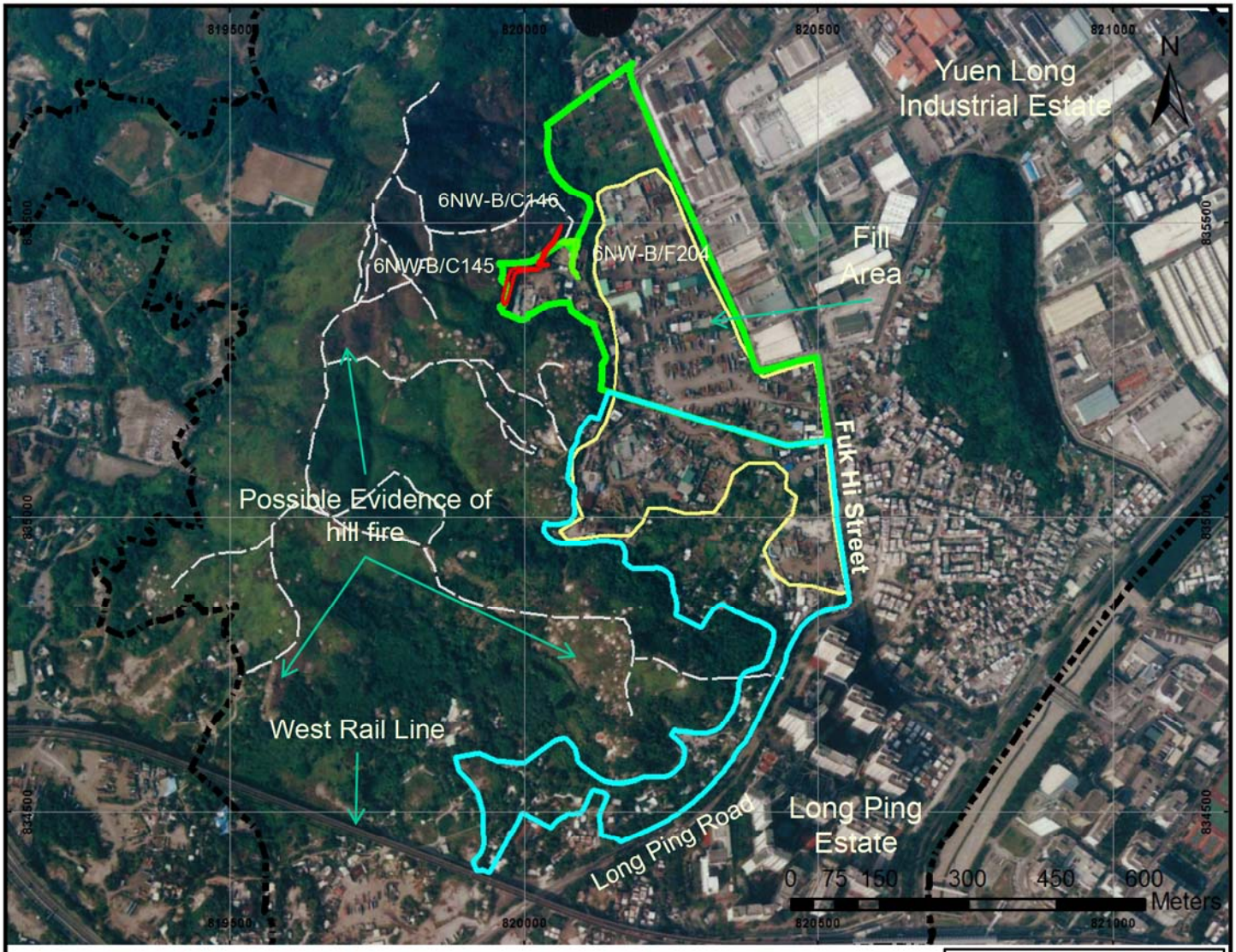
ARUP **Ove Arup & Partners Hong Kong Limited**

Scale N.T.S.

Drn. ELCF Date 09/2012 Chd. AN Approved SWM

Job No. 226464

Figure No. A6



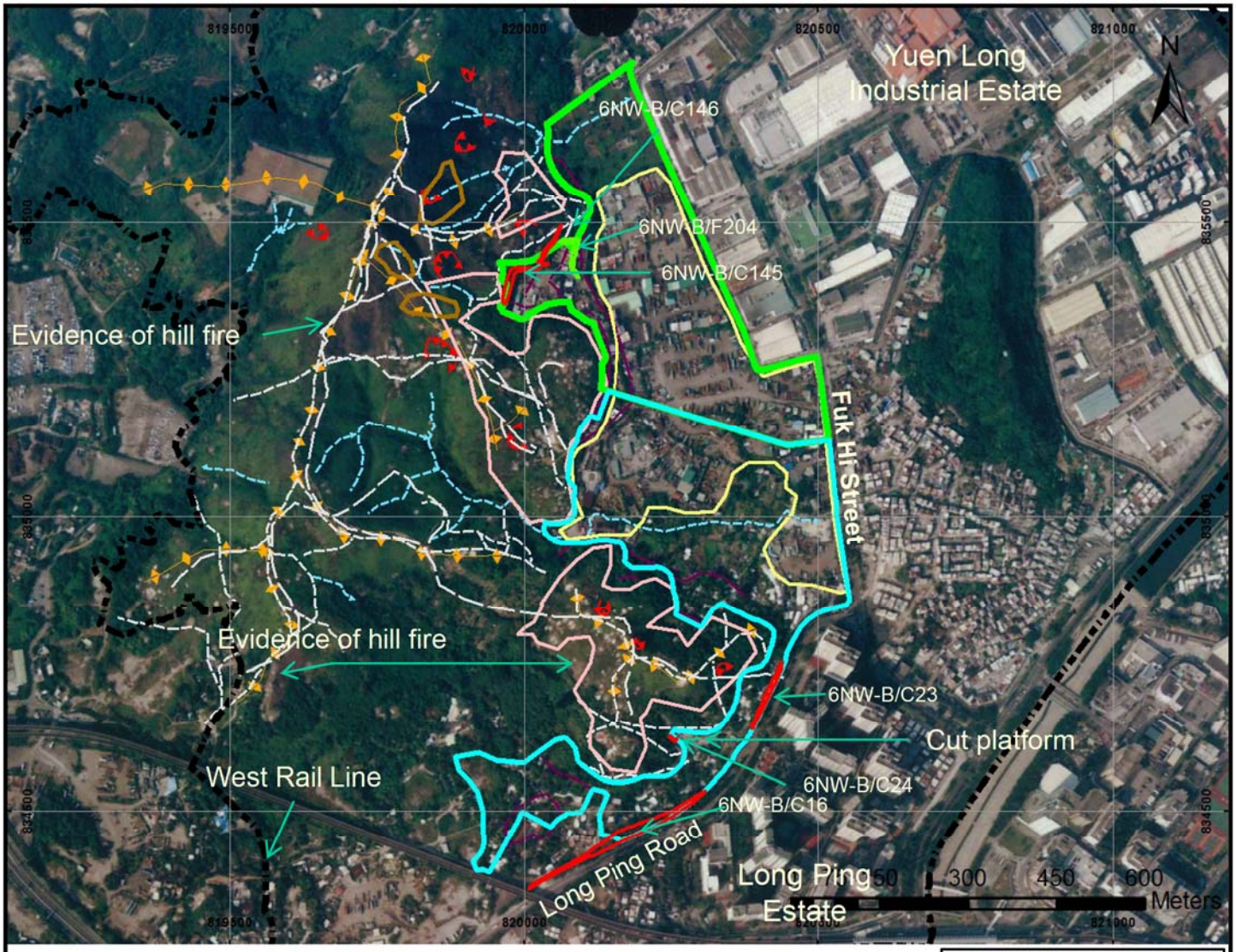
Year 2010

- More agricultural land was filled and container storage area became the major land use within the PH Site and YLIEE.
- Man made features 6NW-B/F204, 6NW-B/C145, 6NW-B/C146 were built by 2010.
- The West Rail Line was observed adjacent to the south of the PH Site.
- More graves were observed throughout the natural terrain.
- Those areas near graves were poorly vegetated which was possibly caused by hill fire.
- Generally more dense vegetation cover was observed to the west of the PH Site.
- No other significant changes were observed.

Legend

- Study Area
- YLIEE Site
- PH Site
- Cut Slope
- Fill Slope
- Fill Area

Job Title Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau	Figure Title **Aerial Photo Interpretation** (Sheet 7 of 8)	ARUP Ove Arup & Partners Hong Kong Limited Scale N.T.S. Drn. ELCF Date 09/2012 Chd. AN Approved SWM Job No. 226464 Figure No. A7



Summary

- The PH Site and YLIEE were largely composed of agricultural land prior to 1973. In the past 20 years, most of the agricultural areas were filled and became a container storage area in the northern portion of the PH Site and the YLIEE. The southern portion of the PH Site was mainly residential areas from the 1960s until present.
- Yuen Long Industrial Estate and Fuk Hi Street were built by 1984. More residential areas and Long Ping Road were observed to the east and northeastern portion of the PH Site. The West Rail Line was built by 2010.
- Man-made features 6NW-B/C16, 6NW-B/C23, 6NW-B/C24, 6NW-B/C145, 6NW-B/C146 and 6NW-B/F204 were formed by 2010.
- Graves were observed to the west of the PH Site and YLIEE. Prior to 1963 the grave area was relatively small compared to present. In the past 20 years, more concrete based graves were observed in the hills. Evidence of hill fire near those graves was observed.
- No recent landslide scars have been observed but morphological depressions were noted.
- Incised drainage lines starting within the natural terrain with flow towards the PH Site and YLIEE.
- Streams were observed across the northern portion and middle part of proposed development sites in 1960s.

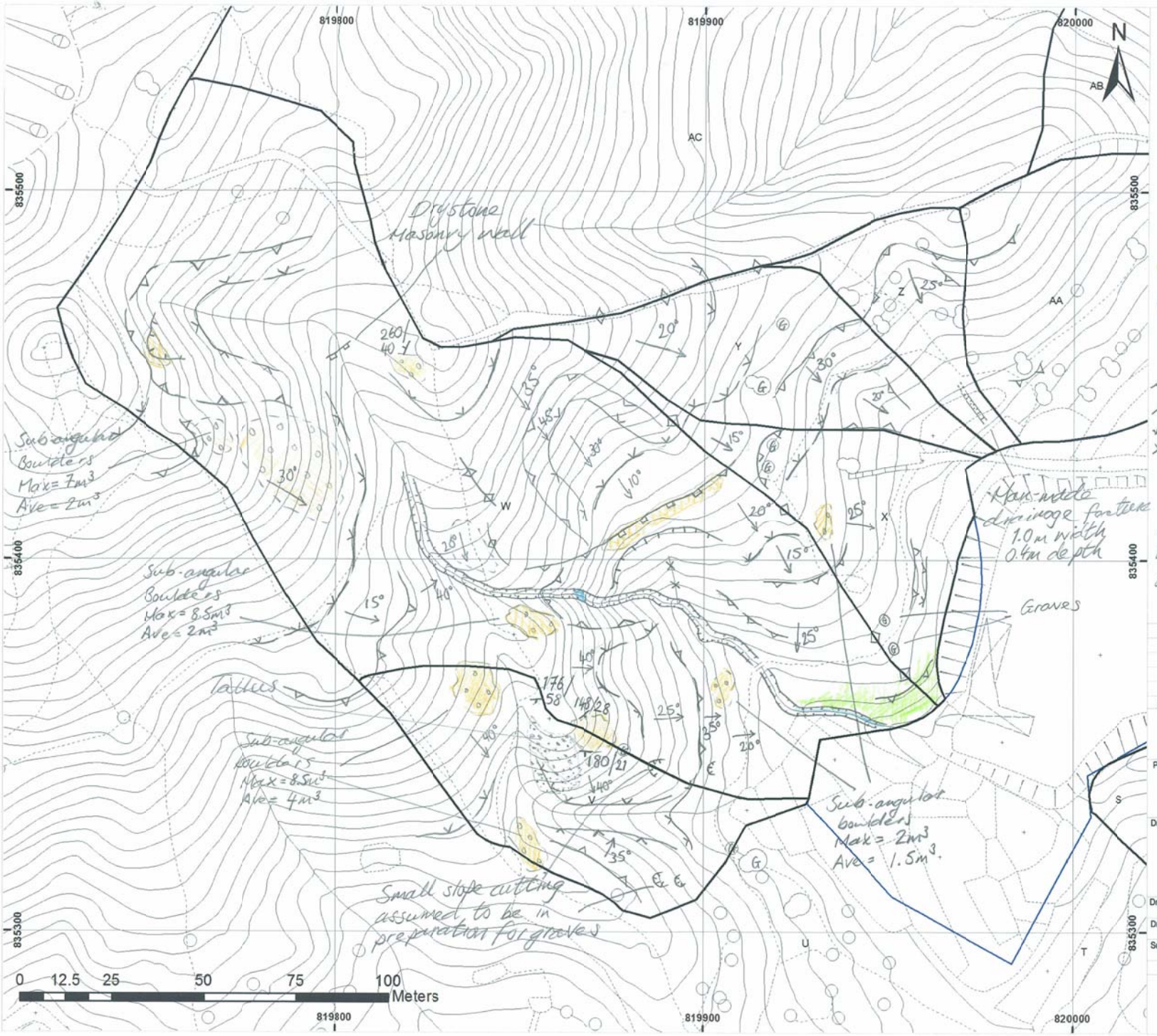
Legend

- Study Area
- YLIEE Site
- PH Site
- Drainage line
- Spurline
- Convex Break
- Terrace
- Footpaths
- Cut Slope
- Fill Slope
- Fill Area
- Grave Area
- Rock Outcrop/ Boulders

Job Title: Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau	Figure Title: **Aerial Photo Interpretation** (Sheet 8 of 8)	ARUP Ove Arup & Partners Hong Kong Limited
		Scale N.T.S.
		Drn. ELCF Date 09/2012 Chd. AN Approved SWM
		Job No. 226464 Figure No. A8

Appendix C

Detailed Field Mapping



Legend

- Catchment Boundary
- Site Boundary
- Rock outcrop
- Boulders or outcropping Rock Blocks
- Dense Vegetation
- Channel / Water
- (G) Grave
- Convex Break of Slope
- Convex Change of Slope
- Concave Break of Slope
- Concave Change of Slope
- 15° Terrain Angle

Note
Evidence of wildfire at catchments V, W, X, Y

Rev	Description	By	Date

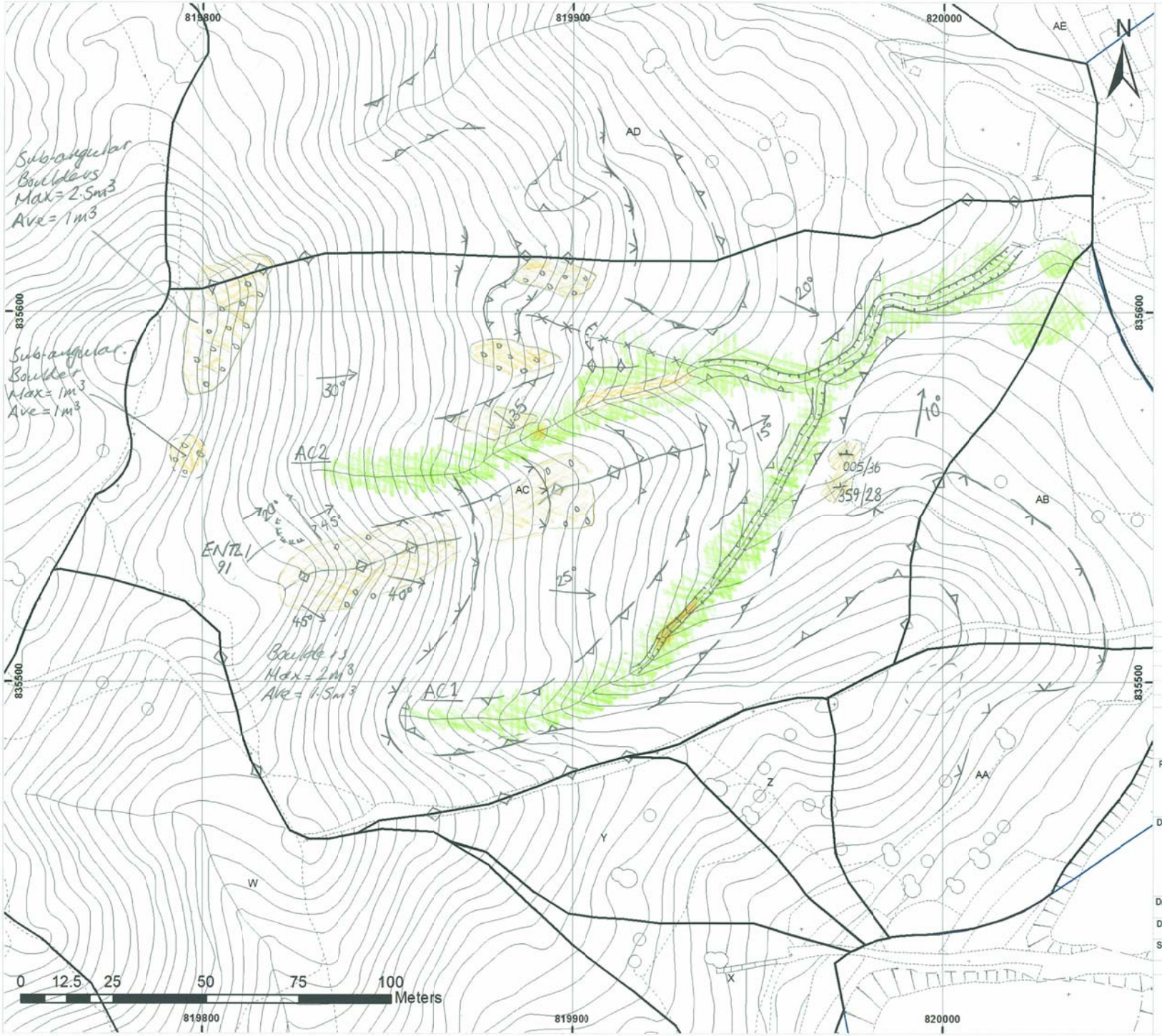
Project title

Drawing title

NTHS Site Visit
Catchments V, W, X, Y, Z

Drawing no.	Sheet 1		Rev.
Drawn JC	Date April 2013	Checked	Approved
Scale 1:1000 (A3)	Status Site Record Sketch		

ARUP



Legend

- Catchment Boundary
- Site Boundary

Refer to Sheet 1

Rev	Description	By	Date

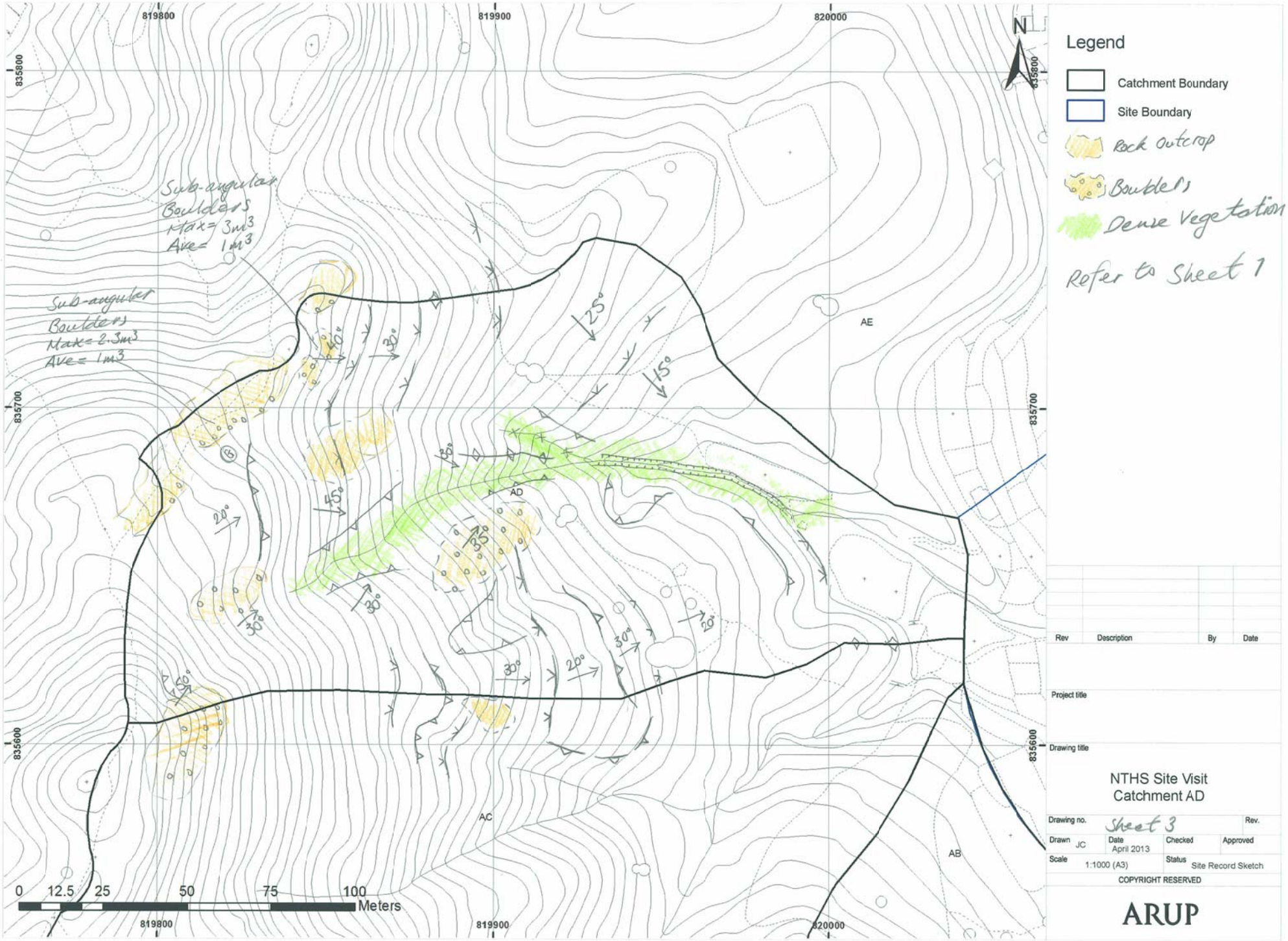
Project title

Drawing title

NTHS Site Visit
Catchment AC

Drawing no. Sheet 2			Rev.
Drawn JC	Date April 2013	Checked	Approved
Scale 1:1000 (A3)		Status Site Record Sketch	

ARUP



Legend

- Catchment Boundary
- Site Boundary
- Rock outcrop
- Boulders
- Dense Vegetation

Refer to Sheet 1

Rev	Description	By	Date

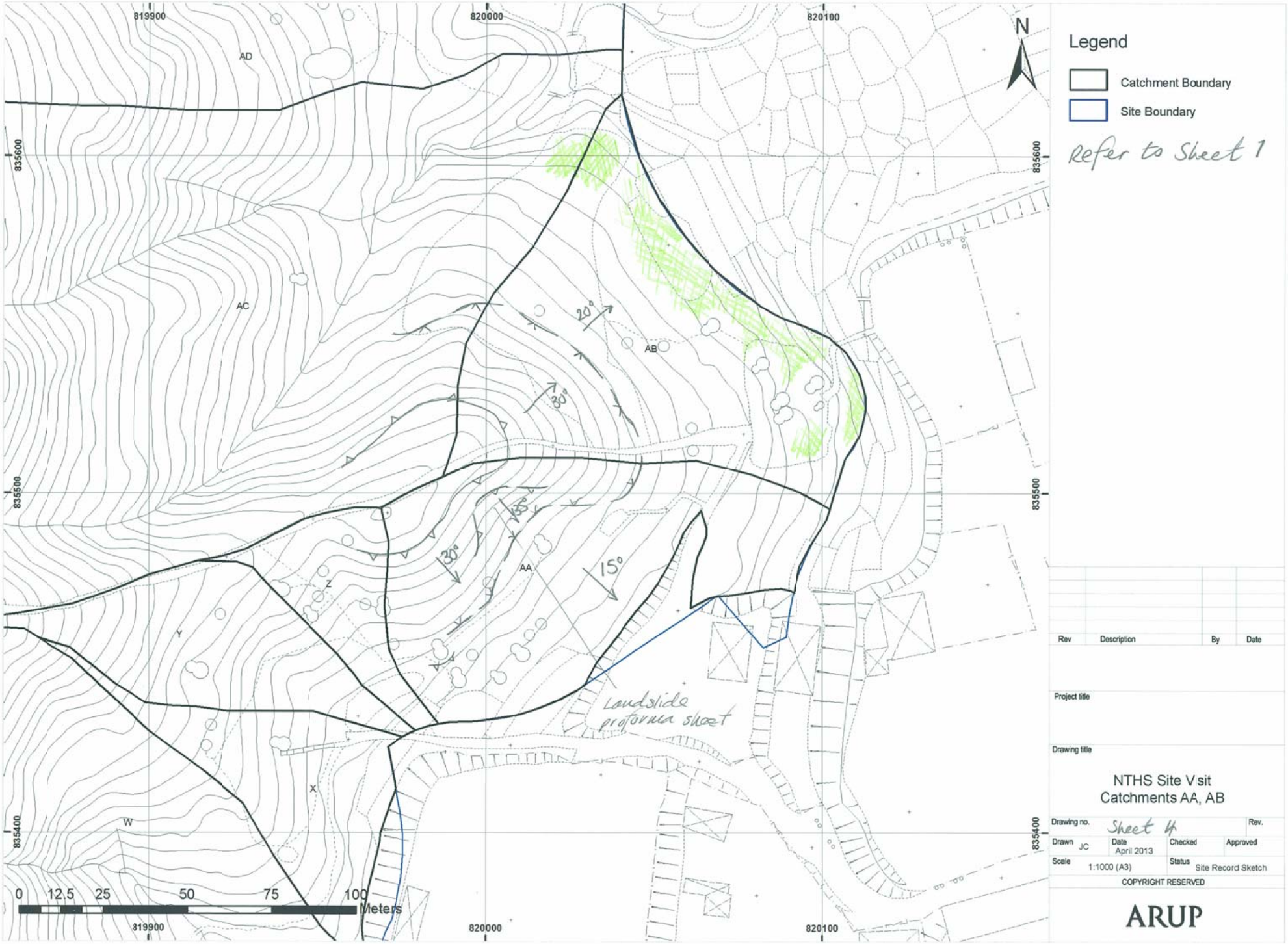
Project title

Drawing title

NTHS Site Visit
Catchment AD

Drawing no. Sheet 3			Rev.
Drawn JC	Date April 2013	Checked	Approved
Scale 1:1000 (A3)		Status Site Record Sketch	

ARUP



Rev	Description	By	Date

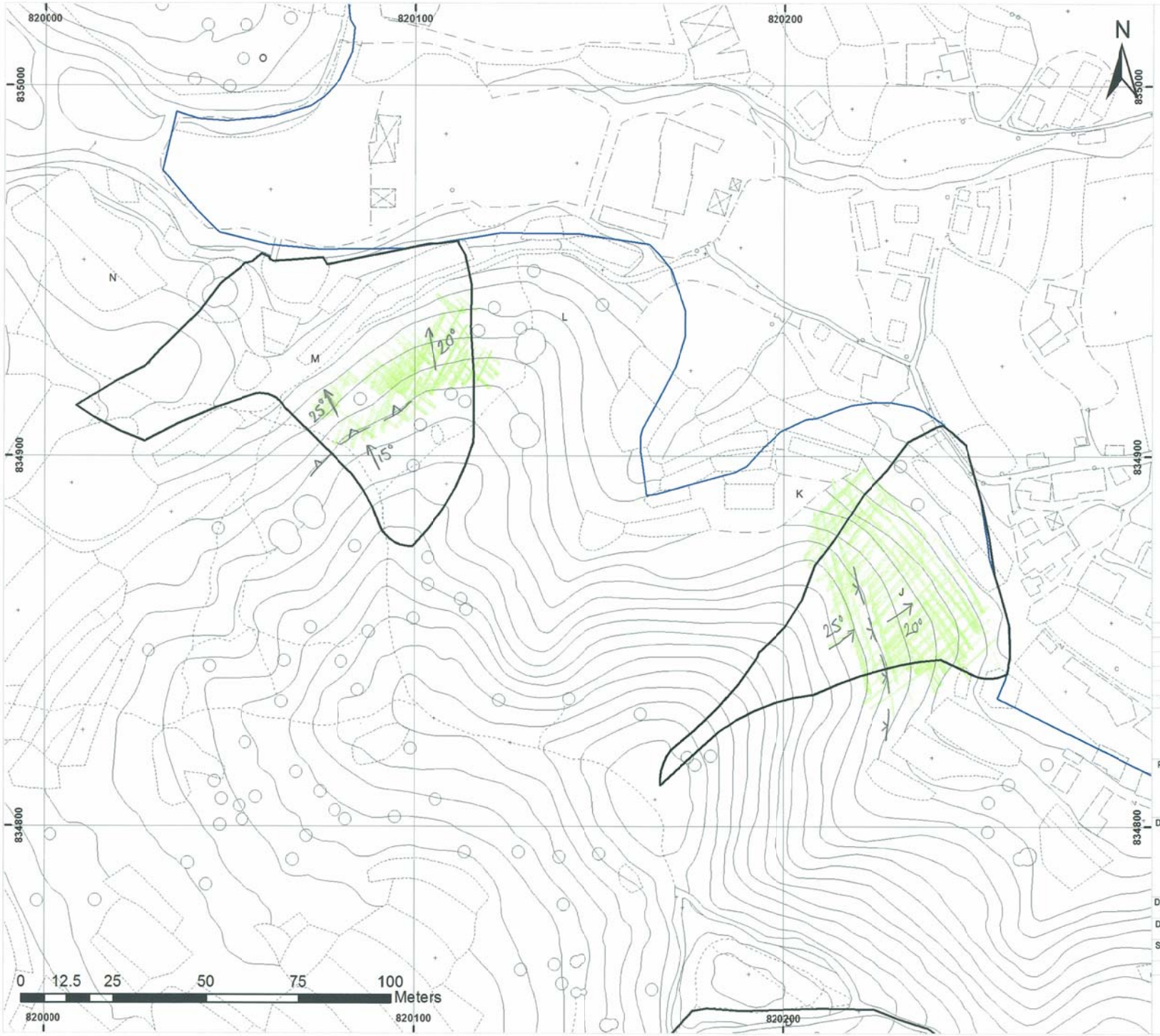
Project title

Drawing title

NTHS Site Visit
Catchments AA, AB

Drawing no. Sheet 4			Rev.
Drawn JC	Date April 2013	Checked	Approved
Scale 1:1000 (A3)		Status Site Record Sketch	

ARUP



N

Legend

Catchment Boundary

Site Boundary

Refer to Sheet 1

Rev	Description	By	Date

Project title

Drawing title

NTHS Site Visit
Catchments J, M

Drawing no. Sheet 5			Rev.
Drawn JC	Date April 2013	Checked	Approved
Scale 1:1000 (A3)		Status Site Record Sketch	

ARUP

Rev	Description	By	Date

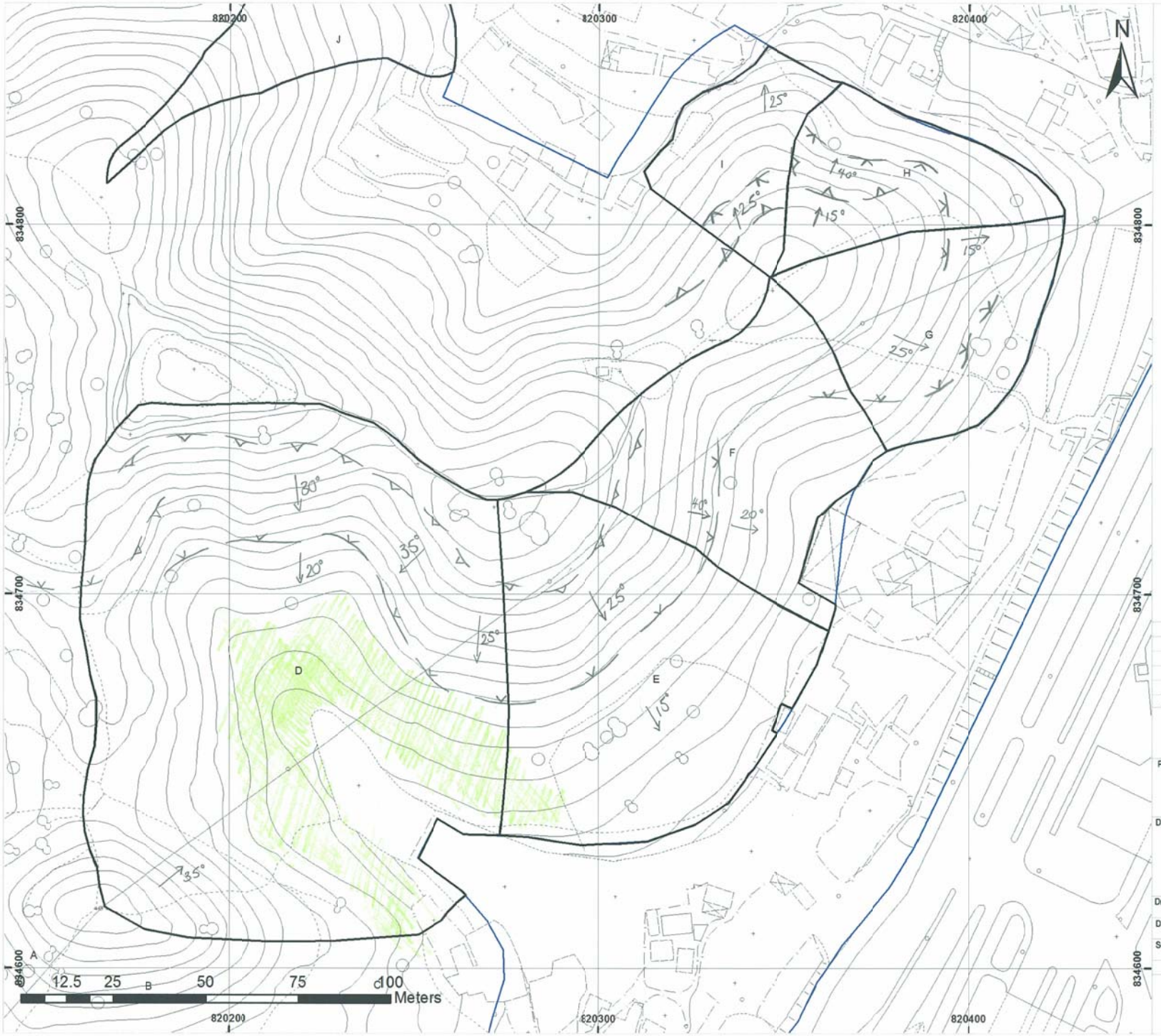
Project title

Drawing title

NTHS Site Visit
Catchments R, S

Drawing no.	Sheet 6		Rev.
Drawn JC	Date April 2013	Checked	Approved
Scale 1:1000 (A3)		Status Site Record Sketch	

ARUP



Legend

- Catchment Boundary
- Site Boundary

Refer to Sheet 1

Rev	Description	By	Date

Project title

Drawing title

NTHS Site Visit
Catchments D, E, F, G, H, I

Drawing no. Sheet 7			Rev.
Drawn JC	Date April 2013	Checked	Approved
Scale 1:1000 (A3)		Status Site Record Sketch	

ARUP

Appendix D1

Landslide Proforma Record Sheet

ARUP	Ove Arup & Partners Hong Kong Limited - Calculation Sheet	Job No: 226464	Sheet No: 1	Revision: -
Job Title:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau	Mapping by: JC	Checked by. JH	Date: Apr-12

Subject: Landslide Mapping Records

SECTION 1: Survey Reference Data

Location: Catchment AD - at location of ENTLI 06NWB0084E

Landslide Ref: LSAD-1 (ENTLI 06NWB0085E)

Coordinates: E819936 N835666

Date: 24/4/2012 Weather: Sunny and Dry

Inspecting Personnel: [redacted]

SECTION 2: Basic Landslide Data

Lithology within Landslide Scarp:

Main Types: Colluvial Meta-Siltstone

	%
Fill	-
Colluvium	100
Saprolite	-
Rock	-

Source Dimensions (m):

Length:	Width:	Depth:
9	10	2
(measured normal to contour)	*(measured along contour)*	

(∴ Volume of Source: 94.25 m^3)

Volume of Entrainment/Deposition

Deposition in source area	0
Entrainment along debris trail	0
Deposition along debris trail	0
Others	0

Comments:
Relict landslide feature
Vegetated

Vegetation Cover *(tick one)*

Bare		Grass		Plantation/Trees	
Low Shrub		L. Shrub + Grass	✓		
Tall Shrub		T. Shrub + Grass			

Slope Angle (°):

Above scar: 25 Below scar: 35 General 30

If the angle below boulder > 50° (i.e. the boulder rests on a ledge), enter the height of ledge (m):

Travel Path:

		(tick one)
Viable travel path affects hazards at slope toe: *(See Appendix D2)*	Yes	✓
	No	

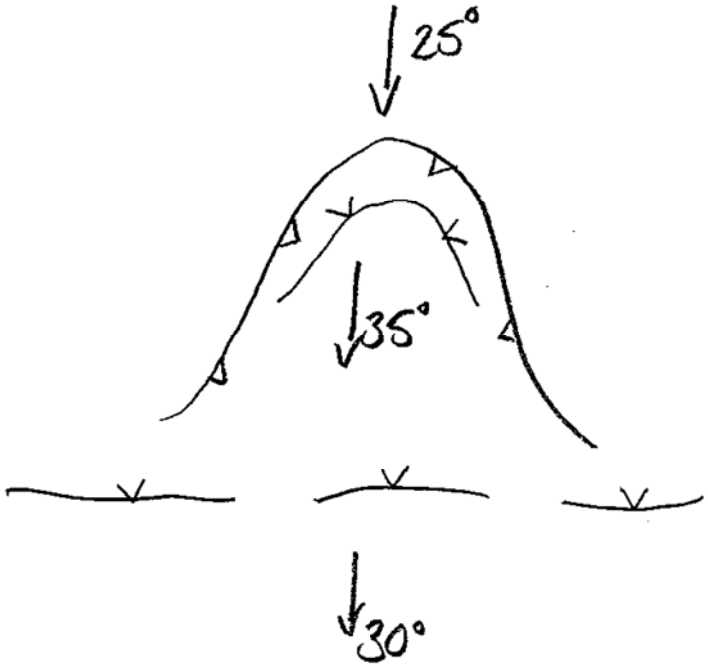
Travel path vegetation type and density: Dense brush, with trees at foot slopes

ARUP	Ove Arup & Partners Hong Kong Limited - Calculation Sheet	Job No: 226464	Sheet No: 2	Revision: -
Job Title:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau	Mapping by: JC	Checked by. JH	Date: Apr-12
Subject:	Landslide Mapping Records			

SECTION 4: Schematic / Photograph

Sketch the landslide scar and debris run-out trail

PLAN



SECTION

ARUP	Ove Arup & Partners Hong Kong Limited - Calculation Sheet	Job No: 226464	Sheet No: 3	Revision: -
Job Title:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau	Mapping by: JC	Checked by. JH	Date: Apr-12
Subject:	Landslide Mapping Records			

SECTION 4: Schematic / Photograph

Sketch the landslide scar and debris run-out trail

PHOTOGRAPH(S)

Photo above: Re-vegetated ladslide scar is at the hillslope.

ARUP	Ove Arup & Partners Hong Kong Limited - Calculation Sheet	Job No: 226464	Sheet No: 1	Revision: -
Job Title:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau	Mapping by: JC	Checked by. JH	Date: Apr-12

Subject: Landslide Mapping Records

SECTION 1: Survey Reference Data

Location: Catchment AD - at location of ENTLI 06NWB0084E

Landslide Ref: LSAD-2 (ENTLI 06NWB0084E)

Coordinates: E819892 N835631

Date: 24/4/2012 Weather: Sunny and Dry

Inspecting Personnel: [redacted]

SECTION 2: Basic Landslide Data

Lithology within Landslide Scarp:

Main Types: Colluvial Meta-Siltstone

	%
Fill	-
Colluvium	100
Saprolite	-
Rock	-

Source Dimensions (m):

Length: 8 *(measured normal to contour)* Width: 9 *(measured along contour)* Depth: 2

(∴ Volume of Source: 75.40 m^3)

Volume of Entrainment/Deposition

Deposition in source area	0
Entrainment along debris trail	0
Deposition along debris trail	0
Others	0

Comments:
Relict landslide feature
Vegetated

Vegetation Cover *(tick one)*

Bare		Grass		Plantation/Trees	
Low Shrub		L. Shrub + Grass	✓		
Tall Shrub		T. Shrub + Grass			

Slope Angle (°):

Above scar: 30 Below scar: 35 General 25

If the angle below boulder > 50° (i.e. the boulder rests on a ledge), enter the height of ledge (m):

Travel Path:

		(tick one)
Viable travel path affects hazards at slope toe: *(See Appendix D2)*	Yes	✓
	No	

Travel path vegetation type and density: Dense brush, with trees at foot slopes

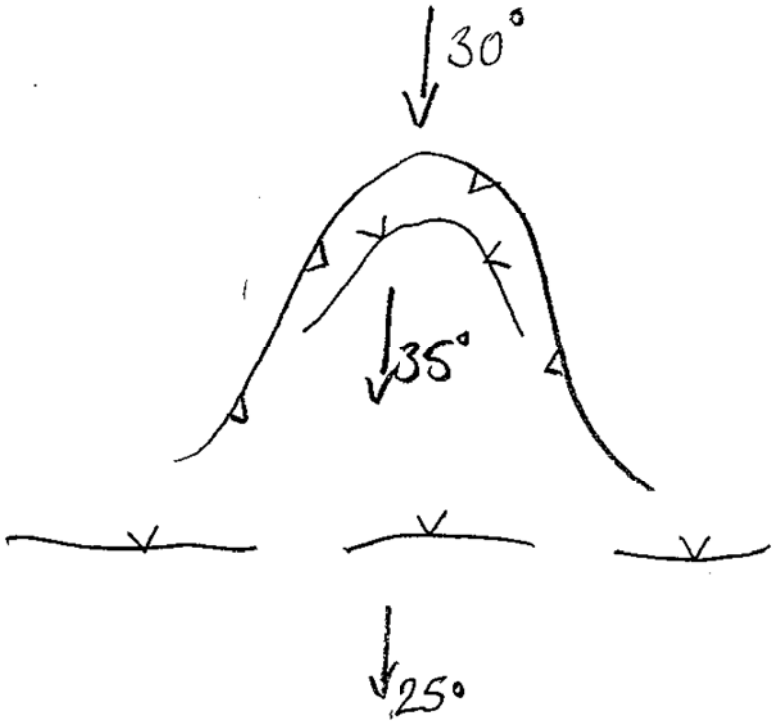
ARUP	Ove Arup & Partners Hong Kong Limited - Calculation Sheet	Job No: 226464	Sheet No: 2	Revision: -
Job Title:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau	Mapping by: JC	Checked by. JH	Date: Apr-12

Subject: Landslide Mapping Records

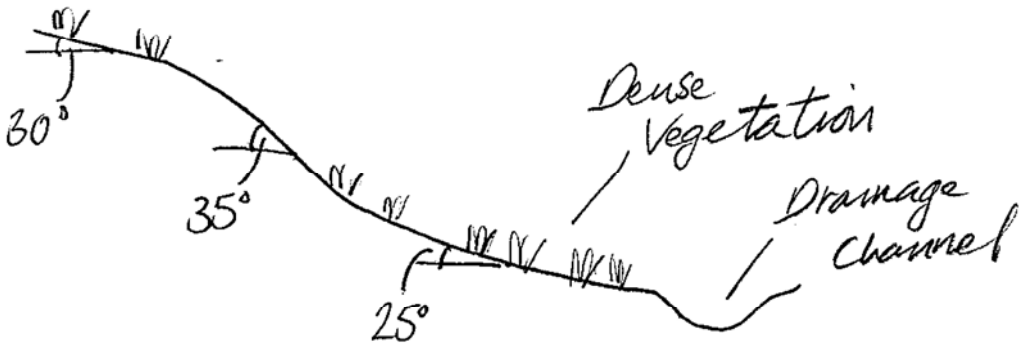
SECTION 4: Schematic / Photograph

Sketch the landslide scar and debris run-out trail

PLAN



SECTION



ARUP	Ove Arup & Partners Hong Kong Limited - Calculation Sheet	Job No: 226464	Sheet No: 3	Revision: -
Job Title:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau	Mapping by: JC	Checked by. JH	Date: Apr-12
Subject:	Landslide Mapping Records			

SECTION 4: Schematic / Photograph

Sketch the landslide scar and debris run-out trail

PHOTOGRAPH(S)

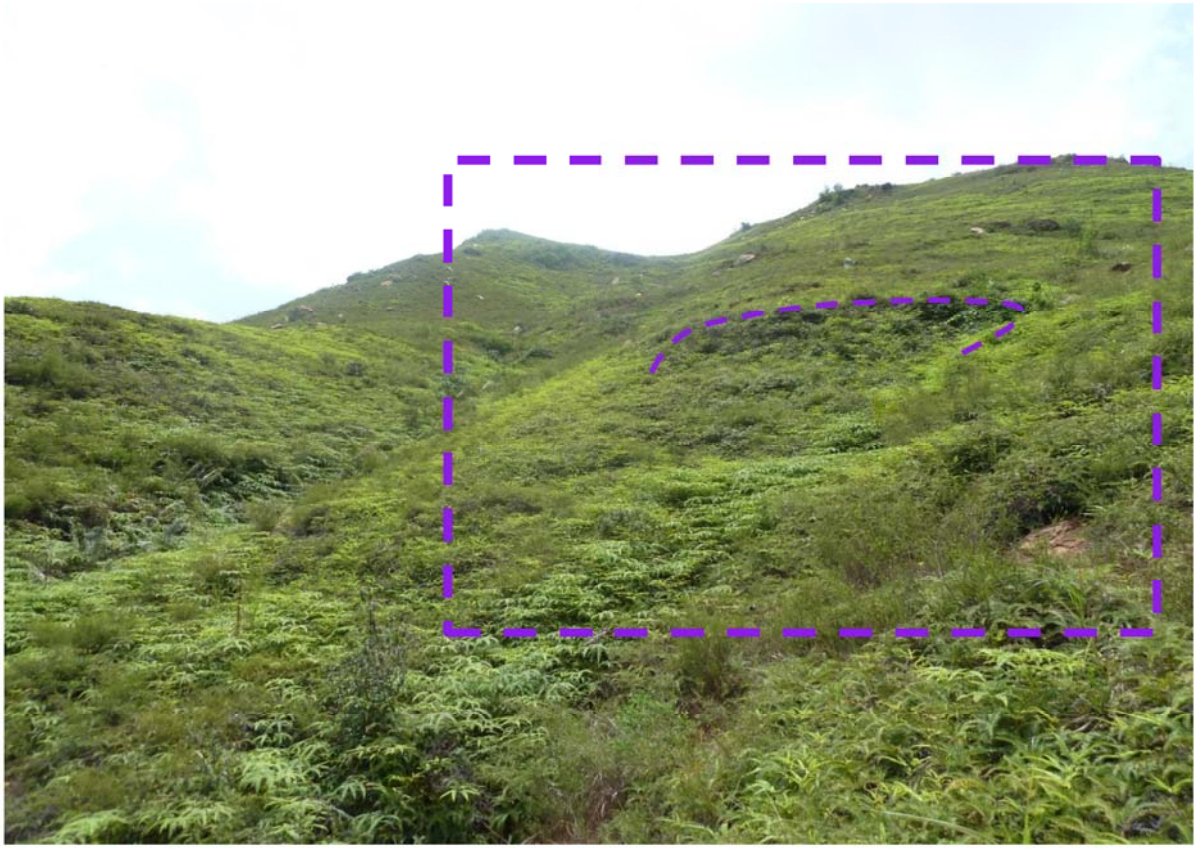
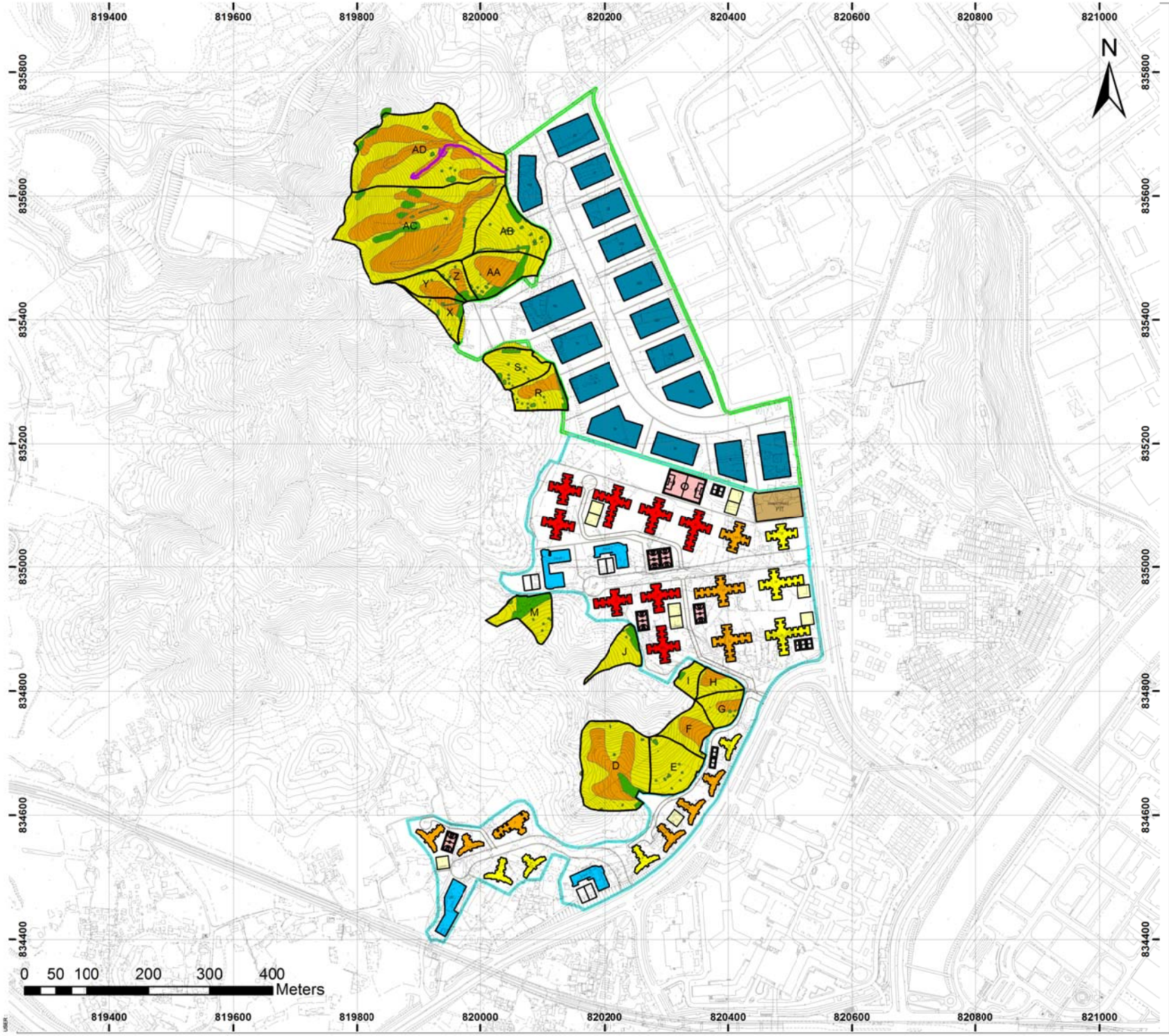


Photo above: Re-vegetated landslide scar was observed.

Appendix D2

Viable Travel Paths for Mapped Landslides



Legend

- Public Housing (PH) Site
- Yuen Long Industrial Estate Extension (YLIEE) Site
- Study Catchments
- Landslide Viable Travel Path

Landslide Hazard Unit

- Medium Volume (100m³)
- Low Volume (50m³)
- Very Low Volume (<50m³)

Rev	Description	By	Date
0	Draft Report	JC	22 Oct 2013

Consultant

ARUP

Project title

Agreement No. CB20120293
Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau

Drawing title

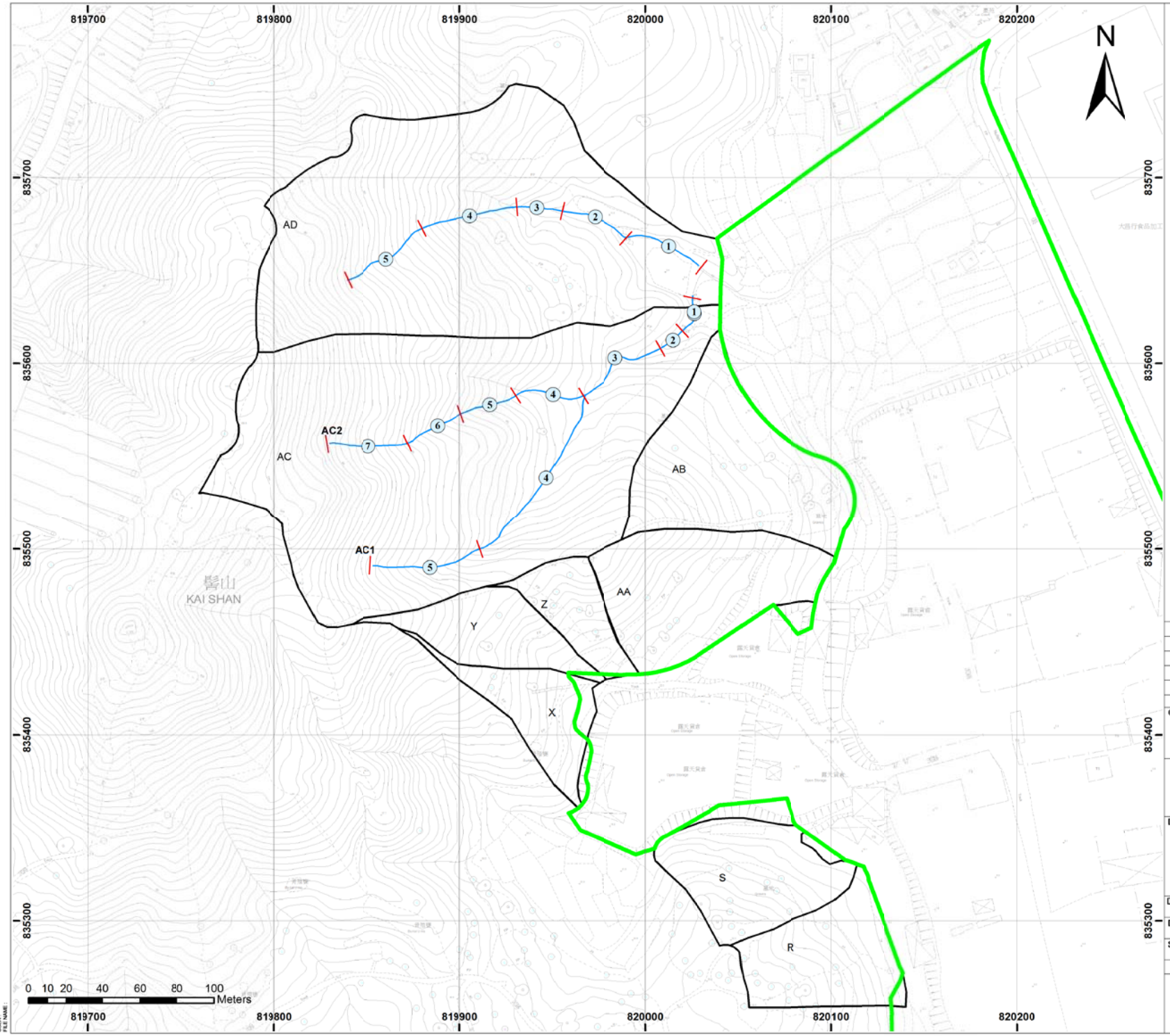
Natural Terrain Hazard Study
Viable Travel Paths for Mapped Landslides

Drawing no.	Figure D		Rev. C
Drawn JC	Date October 2013	Checked JH	Approved ST
Scale 1:6000 (A3)		Status For Issue	

HONG KONG HOUSING AUTHORITY

Appendix E1

Drainage Line Map



Legend

- Yuen Long Industrial Estate Extension (YLIEE) Site
- Study Catchments
- Drainage Line
- Drainage Line Section Breaks

Rev	Description	By	Date
0	Draft Report	JC	22 Oct 2013

Consultant

ARUP

Project title

Agreement No. CB20120293
Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau

Drawing title

Natural Terrain Hazard Study
Drainage Line Locations

Drawing no.	Figure E1		Rev. 0
Drawn JC	Date October 2013	Checked JH	Approved ST
Scale 1:6000 (A3)		Status For Issue	

HONG KONG HOUSING AUTHORITY

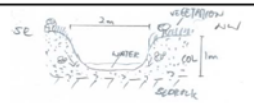
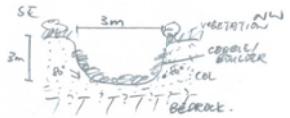
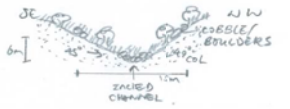
Appendix E2

Drainage Line Proforma Record Sheets

ARUP	Ove Arup & Partners Hong Kong Limited Calculation Sheet	Sheet No. 1	Study Area: Natural Terrain to the West of Wang Chau Catchment No. AC Weather: Bright and warm	Field Mapping by: JC and ELCF Checked by: JH Date: 26/4/2013

Job No. 226464	Job Title:	NTHS for Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau

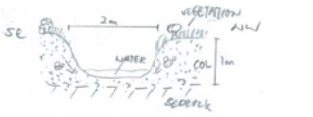
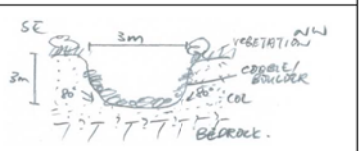
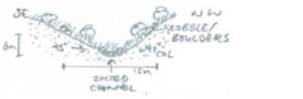
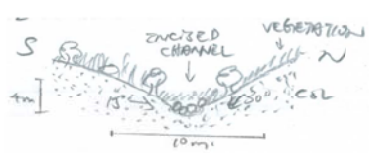
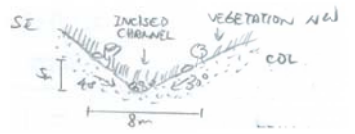
Drainage Line Mapping Records for Drainage Line within Catchment AC — **Drainage Line ID:** AC1

Channel Section	Channel Orientation	Length of Section (m)	Inclination of Channel Bed	Channel Cross Section Summary				General Description (Geology)	Channel Shape Factor	Estimated Channel Yield (m^3/m)	Other Observations	Sketch Section
				Width (m)	Depth (m)	Bank Angle	Typical thickness of loose deposits (m)					
1	80°	21	5°	2	1	NW: 80° SE: 80°	0.1	1m exposure in channel bank. Yellow and brown, gravelly silt within the channel bank and bed. Gravel is fine to coearse sub-angular meta-siltsone. (COLLUVIUM) at channel banks.	1.00	0.20	Small incised channel observed. Slow water flow within the channel. For modelling purposes perhaps consider area to be open hillslope.	
2	62°	15	10°	3	3	NW: 80° SE: 80°	0.1	3m exposure in channel bank. Yellow and brown, gravelly silt, Gravel is fine to coarse, sub-angular to sub-rounded meta-siltstone (COLLUVIUM) at channel banks. Angular and sub-angular cobbles and boulders (<1.0m^3) located at the base of the channel.	1.00	0.30	The channel bed was wet but no water flow was found. Occasional boulders with Max. boulder size: ~1m^3	
3	40°	54	20°	15	6	NW: 40° SE: 45°	0.1	Yellow brown, gravelly silt. Gravel is fine to coarse, sub-angular to sub-rounded meta-siltstone (COLLUVIUM) at channel banks. Sub-angular cobbles and boulders (<1.0m^3) on the channel sides.	0.50	0.75	No water flow observed. Very dense vegetation limited observations. Entrainable material observed within 2m of channel width only. Max. boulder size: ~1.0m^3	
4	40°	102	30°	16	6	NW: 35° SE: 40°	0.1	Yellow brown, gravelly silt. Gravel is fine to coarse, sub-angular to sub-rounded meta-siltstone (COLLUVIUM) at channel banks. Sub-angular cobbles and boulders (<1.0m^3) on the channel sides.	0.50	0.80	No water flow observed. Very dense vegetation in the incised channel and both banks limited observations.	
5	95°	61	40°	15	5	N: 30° S: 35°	0.1	Yellow brown, gravelly silt. Gravel is fine to coarse, sub-angular to sub-rounded meta-siltstone (COLLUVIUM) at channel sides. Sub-angular cobbles, boulders (<1.0m^3) and occasional outcrops within the channel sides.	0.50	0.75	No water flow observed. Dense vegetation limited observations. Broad open drainage channel.	

ARUP	Ove Arup & Partners Hong Kong Limited Calculation Sheet	Sheet No. 1	Study Area: Natural Terrain to the West of Wang Chau Catchment No. AC Weather: Bright and warm	Field Mapping by: JC and ELCF Checked by: JH Date: 26/4/2013

Job No. 226464	Job Title: NTHS for Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau

Drainage Line Mapping Records for Drainage Line within Catchment AC — **Drainage Line ID:** AC2

Channel Section	Channel Orientation	Length of Section	Inclination of Channel Bed	Channel Cross Section Summary: Width	Depth	Bank Angle	Typical thickness of loose deposits	General Description (Geology)	Channel Shape Factor	Estimated Channel Yield (m^3/m)	Other Observations	Sketch Section
1	80°	21	5°	2	1	NW: 80° SE: 80°	0.1	1m exposure in channel bank. Yellow and brown, gravelly silt. Gravel is fine to coearse sub-angular meta-siltsone (COLLUVIUM) at channel banks.	1.00	0.20	Small incised channel observed. Slow water flow within the channel. For modelling purposes perhaps consider area to be open hillslope.	
2	62°	15	10°	3	3	NW: 80° SE: 80°	0.1	3m exposure in channel banks: Yellow and brown, gravelly silt, Gravel is fine to coarse, sub-angular to sub-rounded meta-siltstone (COLLUVIUM) at channel banks. Angular and sub-angular cobbles and boulders (<1.0m^3) located at the base of the channel.	1.00	0.30	The channel bed was wet but no water flow was found. Occasional boulders with Max. boulder size: ~1m^3	
3	40°	54	20°	15	6	NW: 40° SE: 45°	0.1	Yellow and brown, gravelly silt. Gravel is fine to coarse, sub-angular to sub-rounded meta-siltstone (COLLUVIUM) at channel banks. Sub-angular cobbles and boulders (<1.0m^3) on the channel sides.	0.50	0.75	No water flow observed. Very dense vegetation limited observations. Entrainable material observed within 2m of channel width only. Max. boulder size: ~1.0m^3	
4	108	38	20	10	4	NW: 30° SE: 15°	0.15	Yellow and brown, gravelly silt. Gravel is fine to coarse, sub-angular to sub-rounded meta-siltstone (COLLUVIUM) at channel banks. Angular and sub-anuglar cobbles and boulders (<1.0m^3) and cobbles located at the base of the channel.	0.50	0.75	No water flow observed. Dense vegetation limited observation. Max. boulder size: ~1m^3.	
5	45	31	35	8	5	NW: 30° SE: 40°	0.05	Yellow brown, gravelly silt. Gravel is fine to coarse, sub-angular to sub-rounded meta-siltstone (COLLUVIUM) at channel banks at channel banks. Meta-sedimentary bedrock was exposed in the base of the incised channel.	0.50	0.60	No water flow observed. Dense vegetation limited observation. Max. boulder size: ~1m^3.	
6	45	33	30	10	4	NW: 30° SE: 35°	0.10	Yellow and brown, gravelly silt. Gravel is fine to coarse, sub-angular to sub-rounded meta-siltstone (COLLUVIUM) at channel banks. Occasional rock outcrops was identified.	0.50	0.75	No water flow observed. Dense vegetation limited observation. Max. boulder size: ~1m^3.	
7	90	44	30	10	4	NW: 30° SE: 35°	0.10	Yellow and brown, gravelly silt. Gravel is fine to coarse, sub-angular to sub-rounded meta-siltstone (COLLUVIUM) at channel sides. Sub-angular cobbles and boulders (<1.0m^3) at the base of the channel.	0.50	0.75	No water flow observed. Dense vegetation is within the channel and on the banks. Broad channel - not incised. Max. boulder size: ~1m^3.	

ARUP

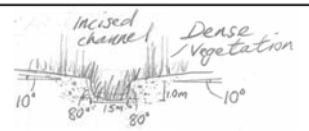
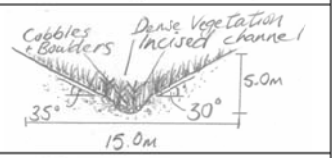
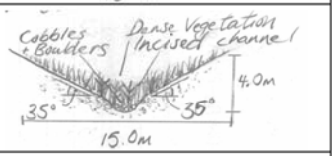
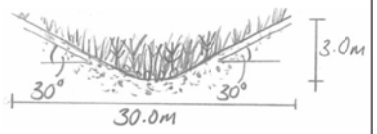
Ove Arup & Partners Hong Kong Limited
Calculation Sheet

Sheet No.	1	Study Area:	Natural Terrain to the West of Wang Chau
		Catchment No.	AD
		Weather:	Bright and warm
Field Mapping by:		JC and ELCF	
Checked by:		JH	
Date:		26/4/2013	

Job No. 226464

Job Title: NTHS for Agreement No. CB20120293
Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau

Drainage Line Mapping Records for Drainage Line within Catchment AD — **Drainage Line ID:** AD1

Channel Section	Channel Orientation	Length of Section (m)	Inclination of Channel Bed	Channel Cross Section Summary: Width (m)	Depth (m)	Bank Angle	Typical thickness of loose deposits (m)	General Description (Geology)	Channel Shape Factor	Estimated Channel Yield (m^3/m)	Other Observations	Sketch Section
1	100°	45	10°	~1.5	<1.0	N: 10° S: 10°	0.1	No access to channel section 1. Geology is assumed to be consistent with surrounding area - Gravelly silt, with gravel of meta-siltstone and occasional cobbles (COLLUVIUM).	0.75	0.15	No access to channel. Small incised channel was observed from a distance, considered to have only a minor capability to channel debris flow. For modelling purposes perhaps consider area to be open hillslope.	
2	100°	40	10°	3	1	N: 10° S: 10°	0.1	0.5m exposure in channel banks. Yellow brown, gravelly silt. Gravel is fine to coarse, sub-angular to sub-rounded meta-siltstone (COLLUVIUM) at channel banks.	0.67	0.30	Very small amount of water flow at the channel bed. Very dense vegetation limited observations.	
3	90°	24	20°	15	5	NE: 35° SW: 30°	0.1	Yellow brown, gravelly silt. Gravel is fine to coarse, sub-angular to sub-rounded meta-siltstone (COLLUVIUM) at channel banks. Boulders (<1.0m^3) and cobbles located at the base of the channel.	0.50	0.20	No water flow observed. Very dense vegetation limited observations. Entrainable material observed within ~2m of channel width only. Max. boulder size: ~1.0m^3	
4	85°	50	25°	15	4	E: 35° W: 35°	0.2	Yellow brown, gravelly silt. Gravel is fine to coarse, sub-angular to sub-rounded meta-siltstone (COLLUVIUM) at channel banks. Sub-angular cobbles and boulders (<1.0m^3) located at the base of the channel.	0.50	0.60	No water flow observed. Very dense vegetation limited observations. Entrainable material within ~3m of channel width only. Max. boulder size: ~1.0m^3	
5	60°	49	30°	20	3	E: 30° W: 30°	0.2	Yellow brown, gravelly silt. Gravel is fine to coarse, sub-angular to sub-rounded meta-siltstone (COLLUVIUM) at channel sides. Boulders (<1.0m^3) and cobbles located on the channel sides.	0.50	0.45	No water flow observed. Very dense vegetation limited observations. Entrainable material ~3m of channel width only. Max. boulder size: ~1.0m^3	

Appendix F1

Boulder Inspection Record Sheet

BOULDER SURVEY

SECTION 1: Survey Reference Data

Location: Catchment AD

Boulder Field Ref: AD-B1

Coordinates: E 819847 N 835712

Date: 13th May 2013 Weather: Clear, humid

Inspecting Personnel: [redacted]

SECTION 2: Basic Boulder Data

Lithology:

Rock type: Meta-Sedimentary Grade: III

	(tick one)
Isolated Boulder	
Boulder Cluster	✓
Rock Outcrop	

Dimensions (m):

Length: 2 *(measured normal to contour)* Breadth: 1.5 *(measured along contour)* Height: 1

(∴ Volume: 3 m^3)

Shape:

		(tick one)
Sub-rounded	(e.g. ○)	
Angular	(e.g. □)	✓
Slender - upright	(e.g. ▯)	
Slender - reposed	(e.g. ▭)	

Comment: Sub-angular boulders

(Slender - longest dimension > 2 x shortest dimension; upright - longest dimension is the height; reposed - not upright)

Foundation:

	(tick one)
Soil	✓
Rock	

Condition: Boulder in good contact with the ground

Slope Angle (°):

Above boulder: 30 Below boulder: 40 General surrounding area: 30

If the angle below boulder > 50° (i.e. the boulder rests on a ledge), enter the height of ledge (m):

Travel Path:

Viable travel path intercepts facility: *(See Appendix F2)*

	(tick one)
Yes	✓
No	

Travel path vegetation type and density: Dense brush with trees at foot slopes

BOULDER SURVEY

SECTION 3: Photo of the Boulders

Photo 1: Angular boulder is in good contact of soil and stacking on top of another boulder.

BOULDER SURVEY

SECTION 1: Survey Reference Data

Location: Catchment AC

Boulder Field Ref: AC-B1

Coordinates: E 819804 N 835598

Date: 13th May 2013 Weather: Clear, humid

Inspecting Personnel: [redacted]

SECTION 2: Basic Boulder Data

Lithology:

Rock type: Meta-Sedimentary Grade: III

	(tick one)
Isolated Boulder	
Boulder Cluster	✓
Rock Outcrop	

Dimensions (m):

Length: 1.25 *(measured normal to contour)* Breadth: 1.5 *(measured along contour)* Height: 1

(∴ Volume: 2.5 m^3)

Shape:

		(tick one)	Comment:
Sub-rounded	(e.g. ○)		Sub-angular boulders
Angular	(e.g. □)	✓	
Slender - upright	(e.g. 0)		
Slender - reposed	(e.g. ⬭)		

(Slender - longest dimension > 2 x shortest dimension; upright - longest dimension is the height; reposed - not upright)

Foundation:

	(tick one)	Condition:
Soil	✓	Boulder in good contact with the ground
Rock		

Slope Angle (°):

Above boulder: 25 Below boulder: 35 General surrounding area: 30

If the angle below boulder > 50° (i.e. the boulder rests on a ledge), enter the height of ledge (m):

Travel Path:

Viable travel path intercepts facility: *(See Appendix F2)*

	(tick one)
Yes	✓
No	

Travel path vegetation type and density: Dense brush with trees at foot slopes

BOULDER SURVEY

SECTION 3: Photo of the Boulders

Photo 1: Sub-angular boulder cluster was observed at hilltop.

BOULDER SURVEY

SECTION 1: Survey Reference Data

Location: Catchment AC

Boulder Field Ref: AC-B2

Coordinates: E 819839 N 835529

Date: 13th May 2013 Weather: Clear, humid

Inspecting Personnel: [redacted]

SECTION 2: Basic Boulder Data

Lithology:

Rock type: Meta-Sedimentary Grade: III

	(tick one)
Isolated Boulder	
Boulder Cluster	✓
Rock Outcrop	

Dimensions (m):

Length: 1.5 *(measured normal to contour)* Breadth: 1.5 *(measured along contour)* Height: 0.9

(∴ Volume: 2 m^3)

Shape:

		(tick one)
Sub-rounded	(e.g. ○)	
Angular	(e.g. □)	✓
Slender - upright	(e.g. ▯)	
Slender - reposed	(e.g. ▭)	

Comment: Sub-angular boulders

(Slender - longest dimension > 2 x shortest dimension; upright - longest dimension is the height; reposed - not upright)

Foundation:

	(tick one)
Soil	✓
Rock	

Condition: Boulder in good contact with the ground

Slope Angle (°):

Above boulder: 45 Below boulder: 40 General surrounding area: 35

If the angle below boulder > 50° (i.e. the boulder rests on a ledge), enter the height of ledge (m):

Travel Path:

Viable travel path intercepts facility: *(See Appendix F2)*

	(tick one)
Yes	✓
No	

Travel path vegetation type and density: Dense brush with trees at foot slopes

BOULDER SURVEY

SECTION 3: Photo of the Boulders

Photo 1: Sub-angular boulder cluster on ridgeline was observed.

BOULDER SURVEY

SECTION 1: Survey Reference Data

Location: Catchment X

Boulder Field Ref: X-B1

Coordinates: E 819931 N 835407

Date: 13th May 2013 Weather: Clear, humid

Inspecting Personnel: [redacted]

SECTION 2: Basic Boulder Data

Lithology:

Rock type: Meta-Sedimentary Grade: III

	(tick one)
Isolated Boulder	
Boulder Cluster	✓
Rock Outcrop	

Dimensions (m):

Length: 1.5 *(measured normal to contour)* Breadth: 1.5 *(measured along contour)* Height: 0.9

(∴ Volume: 2 m^3)

Shape:

		(tick one)
Sub-rounded	(e.g. ○)	
Angular	(e.g. □)	✓
Slender - upright	(e.g. 0)	
Slender - reposed	(e.g. ⬭)	

Comment: Sub-angular boulders

(Slender - longest dimension > 2 x shortest dimension; upright - longest dimension is the height; reposed - not upright)

Foundation:

	(tick one)
Soil	✓
Rock	

Condition: Boulder in good contact with the ground

Slope Angle (°):

Above boulder: 30 Below boulder: 40 General surrounding area: 30

If the angle below boulder > 50° (i.e. the boulder rests on a ledge), enter the height of ledge (m):

Travel Path:

Viable travel path intercepts facility: *(See Appendix F2)*

	(tick one)
Yes	✓
No	

Travel path vegetation type and density: Dense brush with trees at foot slopes

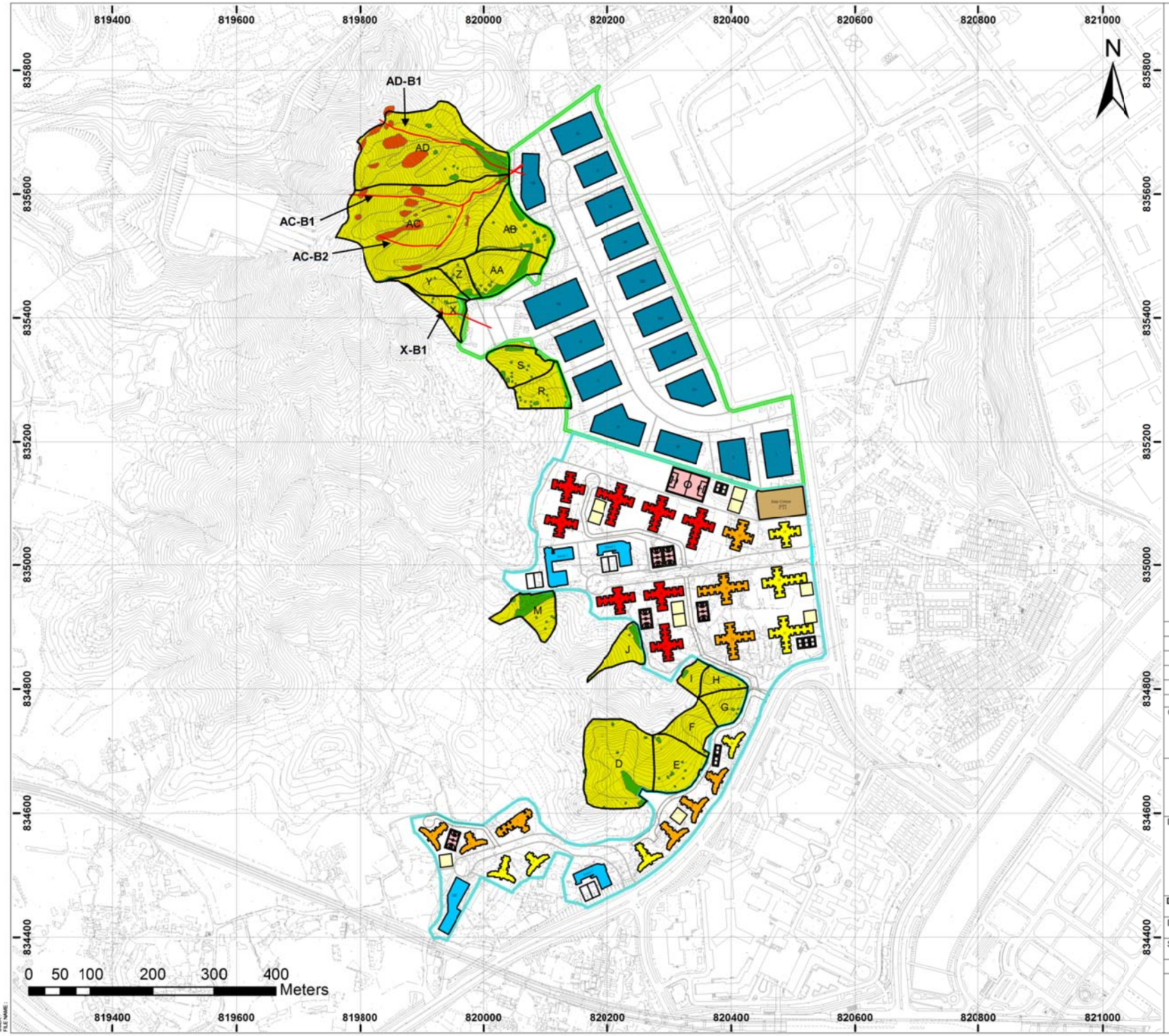
BOULDER SURVEY

SECTION 3: Photo of the Boulders

Photo 1: Sub-angular boulder cluster was observed.

Appendix F2

Viable Travel Paths for Mapped Boulders



Legend

- Public Housing (PH) Site
- Yuen Long Industrial Estate Extension (YLIEE) Site
- Study Catchments
- Boulder Fall Viable Travel Paths

Boulder/Rock Hazard Unit

- No Hazard
- Negligible Hazard
- Notable Hazard

Rev	Description	By	Date
0	Draft Report	JC	22 Oct 2013

Consultant

ARUP

Project title

Agreement No. CB20120293
Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau

Drawing title

Natural Terrain Hazard Study
Viable Travel Paths for Mapped Boulder Falls

Drawing no.	Figure F		Rev. C
Drawn JC	Date October 2013	Checked JH	Approved ST
Scale 1:6000 (A3)		Status For Issue	

HONG KONG HOUSING AUTHORITY

Appendix G

Landslide Debris Mobility Modelling

ARUP	Ove Arup & Partners Hong Kong Ltd.	**CALCULATION SHEET -** DAN-W DEBRIS FLOW ANALYSIS

JOB TITLE	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau	
JOB NUMBER	226464	
REPORT TITLE	Debris Flow Analysis for Wang Chau	**Initial**
MADE BY	[redacted]	[redacted]
CHECKED BY	[redacted]	[redacted]
APPROVED BY	[redacted]	[redacted]
DATE	Jun-13	

CONTENTS OF SPREADSHEET

REVISIONS: Current Revision: 0

Rev.	Date	Made by	Check	Description

1.0 INTRODUCTION

The mobility of potential landslides within the study area has been assessed based on the hazard models generated and the predicted Worst Credible Events/Conservative Events for each catchment.

2.0 METHOD OF ANALYSES

2.1 DAN-W Software

The analysis has been carried out using the computer programme DAN/W developed by O. Hungr Geotechnical Research Inc. This is a windows based programe used to model post failure motion of rapid landslides. It implements a Lagrangian solution of the equations of motion for a mass of earth material which starts from a prescribed static configuration and flows according to one of several rheological relationships.

The critical sections for analysis were identified based on the location of probable landslide source areas, as determined by the hazard model, and a GIS assessment of potential debris flow trajectory. Debris flow widths were assessed based on engineering judgement of the probable channelisation potential along the debris flow path.

No termination criteria was applied to the model and it was allowed to run until the debris had ceased to move as a result of its own properites.

2.2 Assumptions for DAN-W Software

- The material unit weight has been assumed to be 20 kN/cu.m for all analysis
- The material internal friction angle has been assumed to be 35 degrees for all analysis
- The pore pressure coefficient (Ru) has been set as zero for all analysis
- For a frictional rheology analysis, the only variable is the Friction Angle
- For a Voellmy rheological analysis, both the Friction Coefficient (dimensionless) and Turbulence Coefficient (m/s2) are variable parameters
- A cross-sectional shape factor of 0.67 has been appied to represent flow along a non-circular channel
- Erosion depths have been specified based on field observations of potentially entrainable material. These may have been averaged over a specified channel length so as to represent field conditions
- Cross-sectional profiles have been generated based on the 1:1,000 scale digital maps obtained from Lands Survey Office.

2.3 Back Analysis vs. Predictive Approach

Where possible, a back analysis method should be utilized based on previously observed landslide dimesions and volumes identified in the desk study investigation. Otherwise, a predictive approach should be taken based on engineering judgment as described in Section 2.1. Due to the lack of recent landslides observed within or in the proximity of the Study Area, a predictive approach will be adopted in this report.

2.4 Material Properties

The rheology is defined by the landslide or hazard type. An Open Hillside Landside (OHL) has been modelled using a 'Frictional' rheology whereas a Channelized Debris Flow (CDF) has been modelled using a 'Voellmy' rheology.

The parameters specified in the Material Properties table are defined by the rheological model used. Friction Angle only applies to Frictional models. Friction Coefficient, Turbulence Coefficient and Erosion Depth only applies to Voellmy models.

ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau			
Sheet No.: 2	JOB NUMBER:	226464	SHEET DESCRIPTION:	Analysis Summary	
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0	

3.0 DEBRIS MOBILITY ANALYSIS

3.1 Summary of Analysis Input Parameters and Results

Hazard Type/ID	Catchment ID	AD	AD	AC	AC	AB	AA	S
	Section ID	SSAD1	SSAD2	SSAC1	SSAC2	SSAB1	SSAA1	SSS1
	Failure ID	F-AD1	F-AD2	F-AC1	F-AC2	F-AB1	F-AA1	F-S1
	Hazard Type	OHL > CDF	OHL	CDF	CDF	OHL	OHL	OHL
Source Area Geometry	Slope Length (m)*	10	10	10	10	10	10	10
	Slope Width (m)*	10	10	10	10	10	10	10
	Failure Depth (m)*	2	2	1	2	2	2	1
Failure Volume	Estimated Source Volume (m^3)*	100.00	100.00	50.00	100.00	100.00	50.00	50.00
	Computed Source Volume (m^3)	101.61	100.18	59.14	102.43	99.28	49.59	49.49
	Computed Entrainment Vol. (m^3)	109.63	0.00	151.74	153.58	0.00	0.00	0.00
	Total Debris Volume (m^3)	211.24	100.18	210.88	256.01	99.28	49.59	49.49
Run-out characteristics	Total Debris Volume at OP (m^3)	-	-	-	-	-	-	0.07
	Maximum Debris Thickness at OP (m)	-	-	-	-	-	-	0.01
	Maximum Debris Velocity (m/s)	15.26	4.57	7.62	9.01	2.40	4.80	4.56
	Maximum Debris Velocity at OP (m/s)	-	-	-	-	-	-	2.25

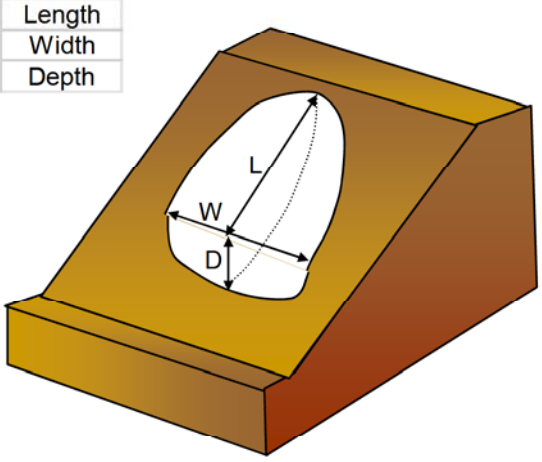
**See below for landslide dimensions and calculations*

CALCULATIONS

$$\text{Total Volume} = \text{Source Volume} + \text{Entrainment Volume}$$

$$\text{Landslide Source Volume} = \frac{1}{6}\pi(L \times W \times D)$$

L -	Length
W -	Width
D -	Depth



Hazard Type

OHL - Open Hillside Landslide

CDF - Channelized Debris Flow

Run-out Characteristics

OP - Observation Point

ADDITIONAL COMMENTS:

NOTE: *See **Figure F1** for Study Area, NT Catchment locations, section lines and source area locations*

ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau					
Sheet No.: 3	JOB NUMBER:	226464	SHEET DESCRIPTION:	Analysis Summary			
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0			

3.1 cont. **Summary of Analysis Input Parameters and Results**

Hazard Type/ID	Catchment ID	R	M	J	I	H	G	F
	Section ID	SSR1	SSM1	SSJ1	SSI1	SSH1	SSG1	SSF1
	Failure ID	F-R1	F-M1	F-J1	F-I1	F-H1	F-G1	F-F1
	Hazard Type	OHL	OHL	OHL	OHL	OHL	OHL	OHL
Source Area Geometry	Slope Length (m)*	10	10	10	10	10	10	10
	Slope Width (m)*	10	10	10	10	10	10	10
	Failure Depth (m)*	2	2	2	2	2	2	2
Failure Volume	Estimated Source Volume (m^3)	50.00	50.00	50.00	50.00	50.00	100.00	100.00
	Computed Source Volume (m^3)	48.38	48.22	49.85	49.76	49.70	99.33	101.00
	Computed Entrainment Vol. (m^3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total Debris Volume (m^3)	48.38	48.22	49.85	49.76	49.70	99.33	101.00
Run-out characteristics	Total Debris Volume at OP (m^3)	-	-	-	-	5.99	-	-
	Maximum Debris Thickness at OP (m)	-	-	-	-	0.02	-	-
	Maximum Debris Velocity (m/s)	2.16	0.78	0.78	2.86	8.08	4.96	4.02
	Maximum Debris Velocity at OP (m/s)	-	-	-	-	3.50	-	-

**See below for landslide dimensions and calculations*

Hazard Type

OHL - Open Hillside Landslide

CDF - Channelized Debris Flow

Run-out Characteristics

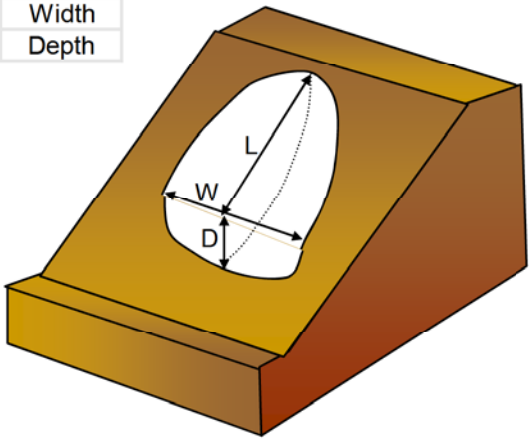
OP - Observation Point

CALCULATIONS

$$\text{Total Volume} = \text{Source Volume} + \text{Entrainment Volume}$$

$$\text{Landslide Source Volume} = \frac{1}{6}\pi(L \times W \times D)$$

L -	Length
W -	Width
D -	Depth



ADDITIONAL COMMENTS:

*See **Figure F1** for Study Area, NT Catchment locations, section lines and source area locations*

ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau				
Sheet No.: 4	JOB NUMBER:	226464	SHEET DESCRIPTION:	Analysis Summary		
Date: 41426	Drawn: JC	Checked: JH	Approved: SM	Revision: 0		

3.1 cont. **Summary of Analysis Input Parameters and Results**

Hazard Type/ID	**Catchment ID**	E	D	D				
	Section ID	SSE1	SSD1	SSD2				
	Failure ID	F-E1	F-D1	F-D2				
	Hazard Type	OHL	OHL	OHL				
Source Area Geometry	Slope Length (m)*	10	10	10				
	Slope Width (m)*	10	10	10				
	Failure Depth (m)*	1	2	2				
Failure Volume	Estimated Source Volume (m^3)	50.00	100.00	50.00				
	Computed Source Volume (m^3)	53.60	100.86	50.27				
	Computed Entrainment Vol. (m^3)	0.00	0.00	0.00				
	Total Debris Volume (m^3)	0.00	0.00	0.00				
Run-out characteristics	Total Debris Volume at OP (m^3)	-	-	-				
	Maximum Debris Thickness at OP (m)	-	-	-				
	Maximum Debris Velocity (m/s)	1.48	5.55	4.18				
	Maximum Debris Velocity at OP (m/s)	-	-	-				

**See below for landslide dimensions and calculations*

Hazard Type

OHL - Open Hillside Landslide

CDF - Channelized Debris Flow

Run-out Characteristics

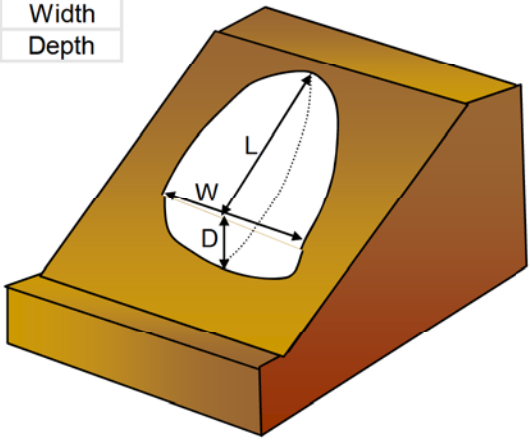
OP - Observation Point

CALCULATIONS

$$\text{Total Volume} = \text{Source Volume} + \text{Entrainment Volume}$$

$$\text{Landslide Source Volume} = \frac{1}{6}\pi(L \times W \times D)$$

L -	Length
W -	Width
D -	Depth



ADDITIONAL COMMENTS:

*See **Figure X** for Study Area, NT Catchment locations, section lines and source area locations*

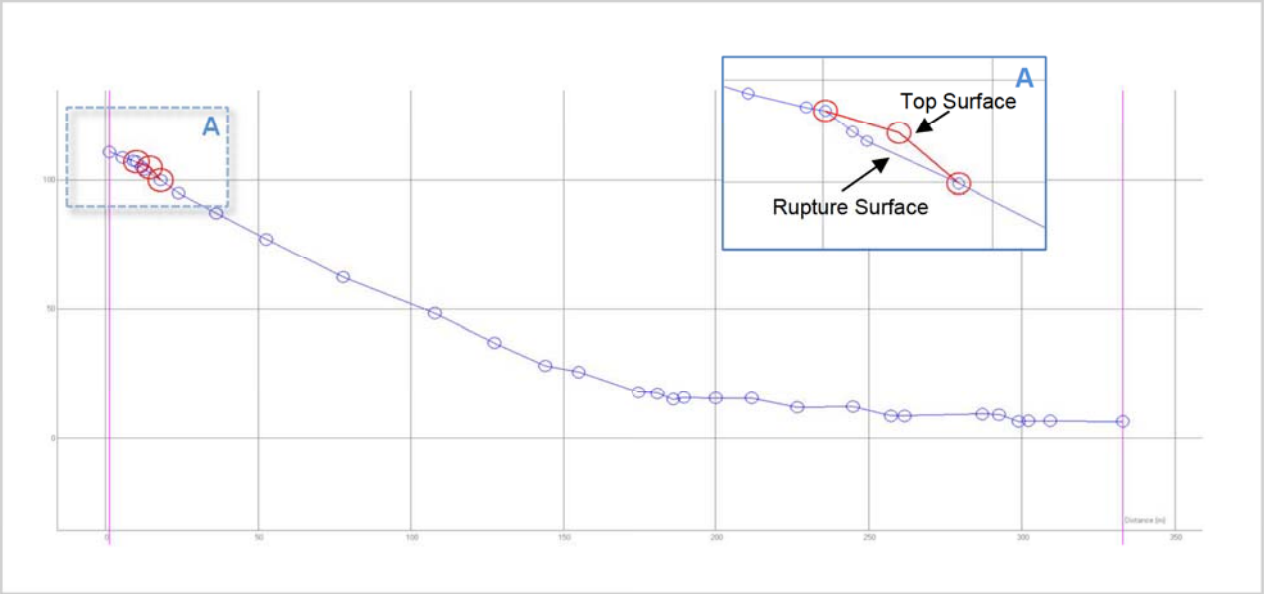
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau			
Sheet No.: 5	JOB NUMBER:	227725	SHEET DESCRIPTION:	Input Parameters	
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0	

3.2 Details of Analysis Results by Failure

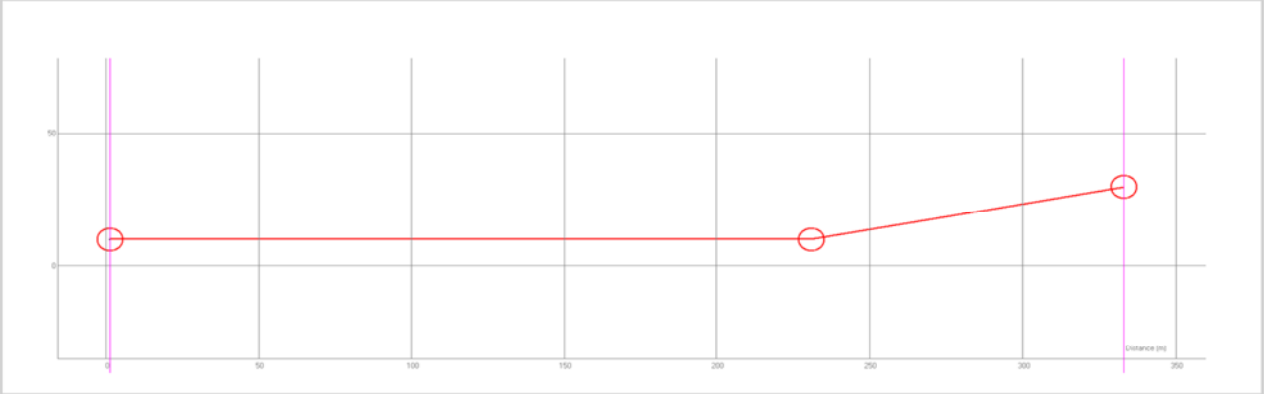
Failure ID	F-AD1		Estimated Source Volume	100.00	m³
Hazard Type	OHL > CDF		Estimated Entrainment Volume	0	m³

SECTIONAL PROFILE

(**INSET** - Detailed view of rupture surface)



WIDTH PROFILE



MATERIAL PROPERTIES

Rheology	Unit Weight (kN/m³)	Friction Angle (°)	Pore Pressure Coefficient	Friction Coefficient	Turbulence Coefficient	Internal Angle of Friction (°)	Erosion Depth (m) Min	Erosion Depth (m) Max
Frictional	20	25	-	-	-	35	0	0
Voellmy	20	-	-	0.19	500	-	0.1	0.2

NOTE: *See Section 2.4 for explanation of Material Properties*

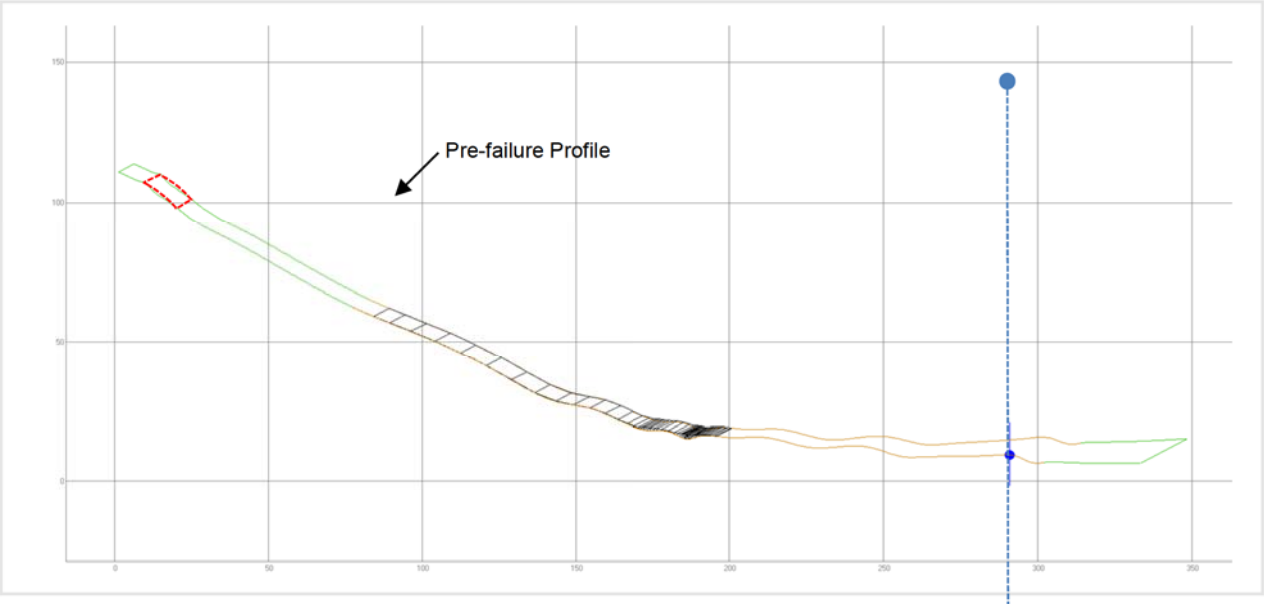
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau			
Sheet No.: 6	JOB NUMBER:	227725	SHEET DESCRIPTION:	Output Results	
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0	

Failure ID	F-AD1
Hazard Type	OHL > CDF

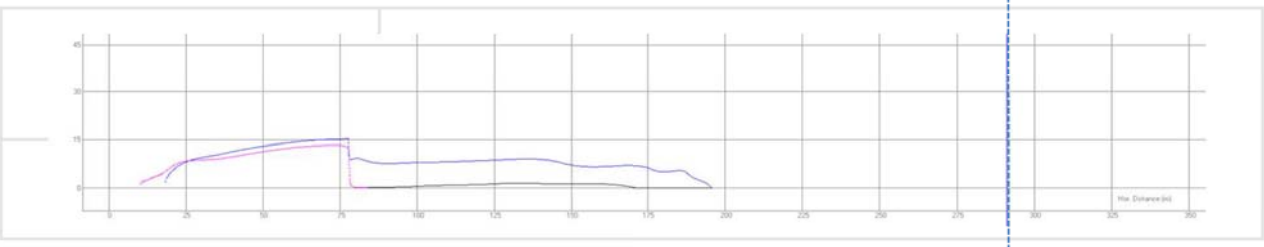
DEBRIS VOLUME

Computed Source Volume	101.61	m^3
Computed Entrainment	109.63	m^3

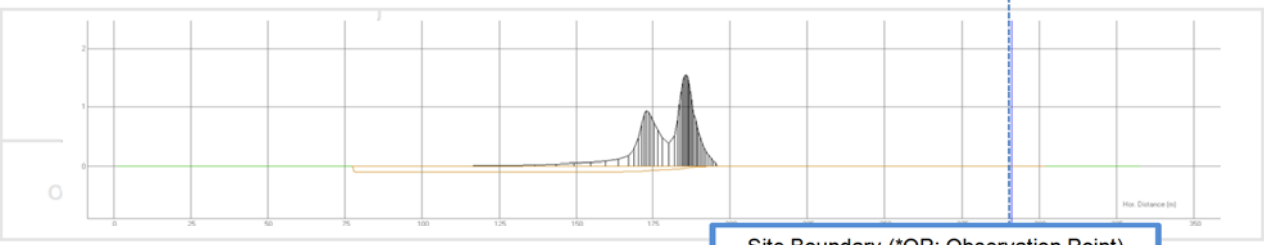
FAILURE PROFILE



VELOCITY PROFILE



THICKNESS PROFILE



Site Boundary (*OP: Observation Point)

DEBRIS RUN-OUT CHARACTERISTICS

Total Debris Volume	211.24	m^3
Total Debris Volume at OP	-	m
Maximum Debris Thickness at OP	-	m
Maximum Debris Velocity	15.26	m/s
Maximum Debris Velocity at OP	-	m/s

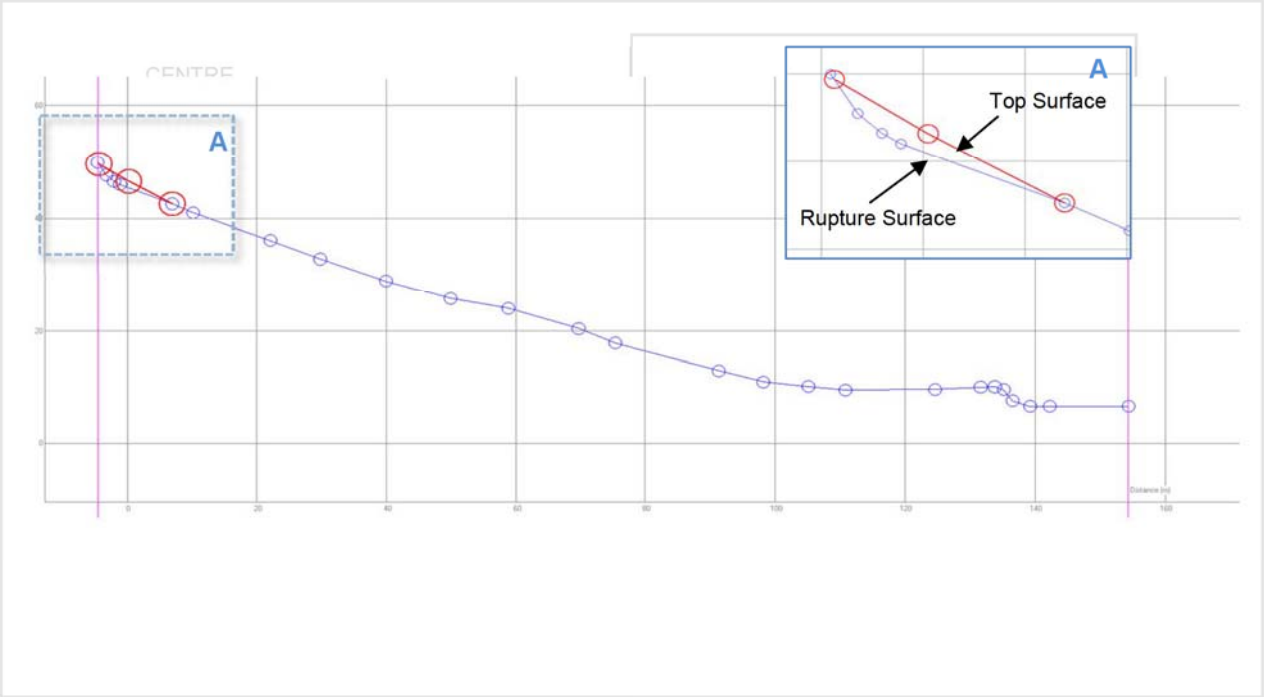
ADDITIONAL COMMENTS:

3.2 cont. **Details of Analysis Results by Failure**

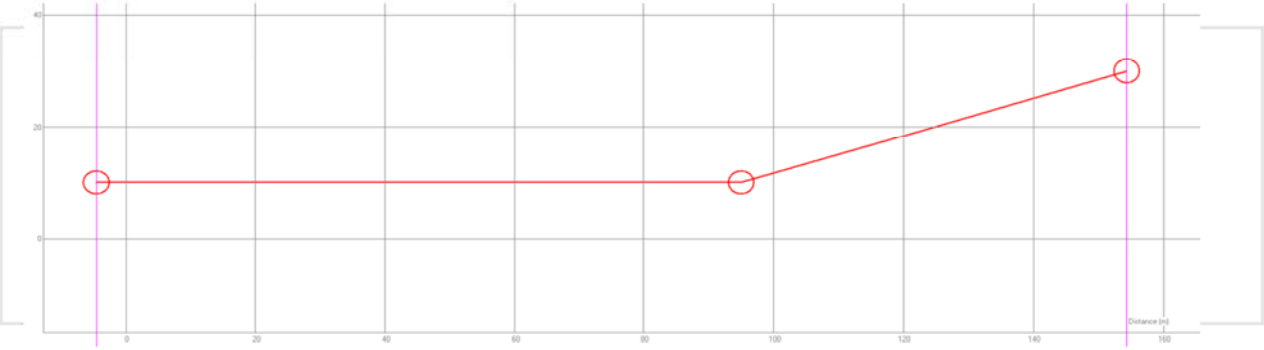
Failure ID	F-AD2	Estimated Source Volume	100.00 m³
Hazard Type	OHL	Estimated Entrainment Volume	0 m³

SECTIONAL PROFILE

(**INSET** - Detailed view of rupture surface)



WIDTH PROFILE



MATERIAL PROPERTIES

Rheology	Unit Weight (kN/m³)	Friction Angle (°)	Pore Pressure Coefficient	Friction Coefficient	Turbulence Coefficient	Internal Angle of Friction (°)	Erosion Depth (m) Min	Erosion Depth (m) Max
Frictional	20	25	-	-	-	35	0	0

NOTE: *See Section 2.4 for explanation of Material Properties*

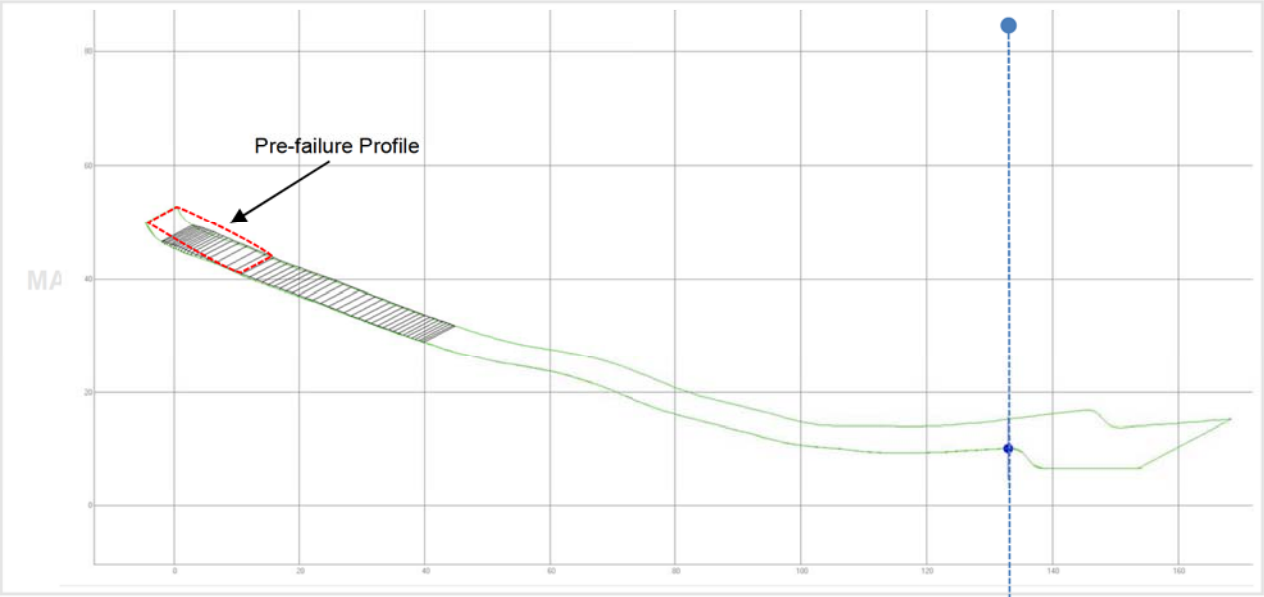
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau			
Sheet No.: 8	JOB NUMBER:	226464	SHEET DESCRIPTION:	Output Results	
Date: Jun-13	Drawn: JL	Checked: JH	Approved: SM	Revision: 0	

Failure ID	F-AD2
Hazard Type	OHL

DEBRIS VOLUME

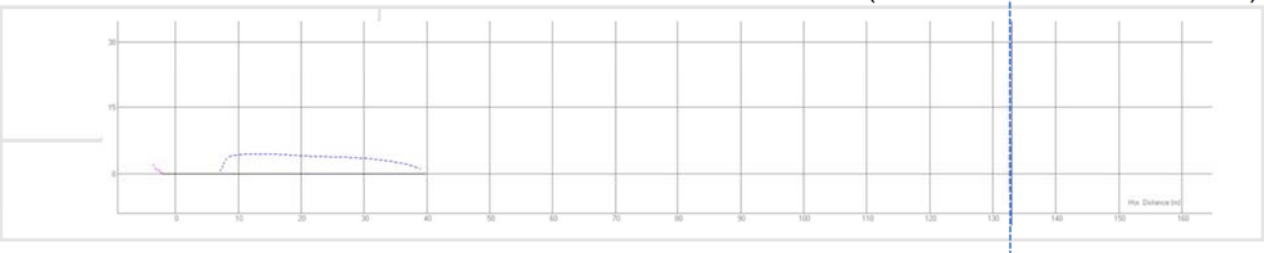
Computed Source Volume	100.18	m^3
Computed Entrainment	0	m^3

FAILURE PROFILE



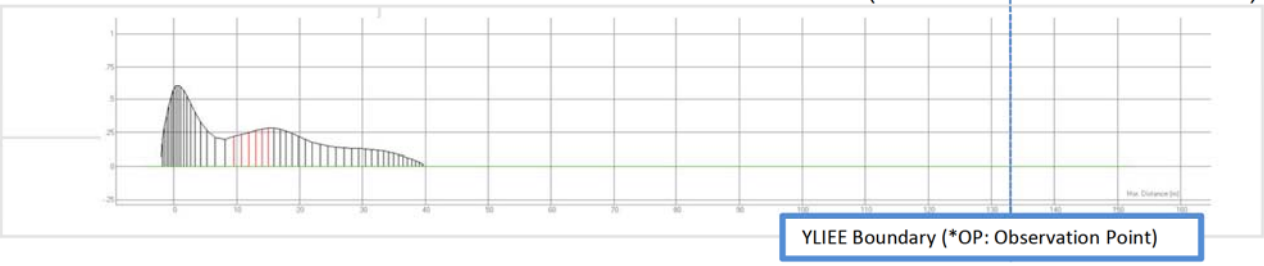
VELOCITY PROFILE

(**INSET** - Observation Point data)



THICKNESS PROFILE

(**INSET** - Observation Point data)



YLIEE Boundary (*OP: Observation Point)

DEBRIS RUN-OUT CHARACTERISTICS

Total Debris Volume	100.18	m^3
Total Debris Volume at OP	-	m
Maximum Debris Thickness at OP	-	m
Maximum Debris Velocity	4.57	m/s
Maximum Debris Velocity at OP	-	m/s

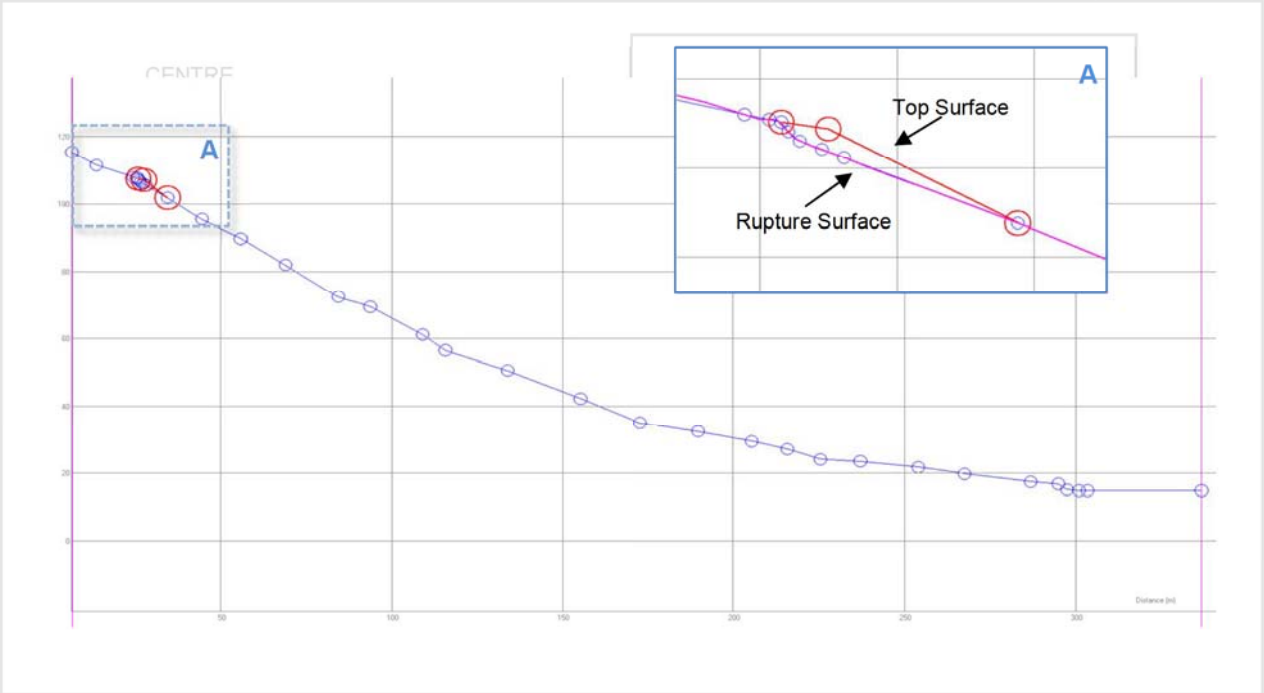
ADDITIONAL COMMENTS:

3.2 cont. **Details of Analysis Results by Failure**

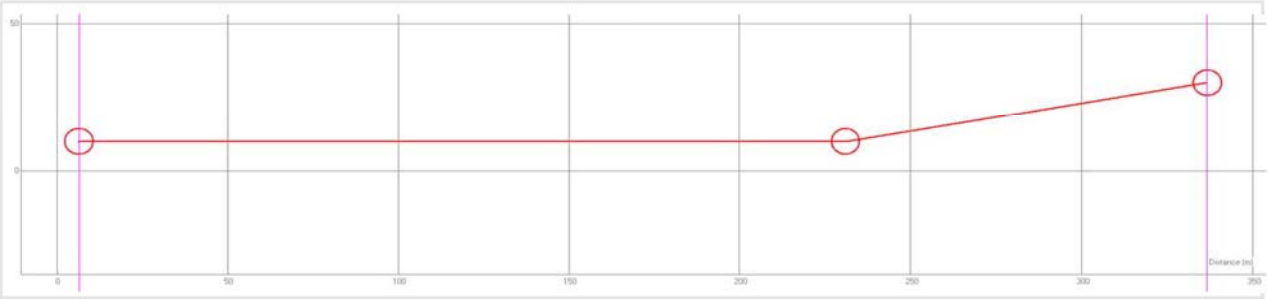
Failure ID	F-AC1	Estimated Source Volume	50.00	m³
Hazard Type	CDF	Estimated Entrainment Volume	0	m³

SECTIONAL PROFILE

(**INSET** - Detailed view of rupture surface)



WIDTH PROFILE



MATERIAL PROPERTIES

Rheology	Unit Weight (kN/m³)	Friction Angle (°)	Pore Pressure Coefficient	Friction Coefficient	Turbulence Coefficient	Internal Angle of Friction (°)	Erosion Depth (m) Min	Erosion Depth (m) Max
Frictional	20	25	-	-	-	35	0	0
Voellmy	20	-	-	0.19	500	-	0.1	0.1

NOTE: *See Section 2.4 for explanation of Material Properties*

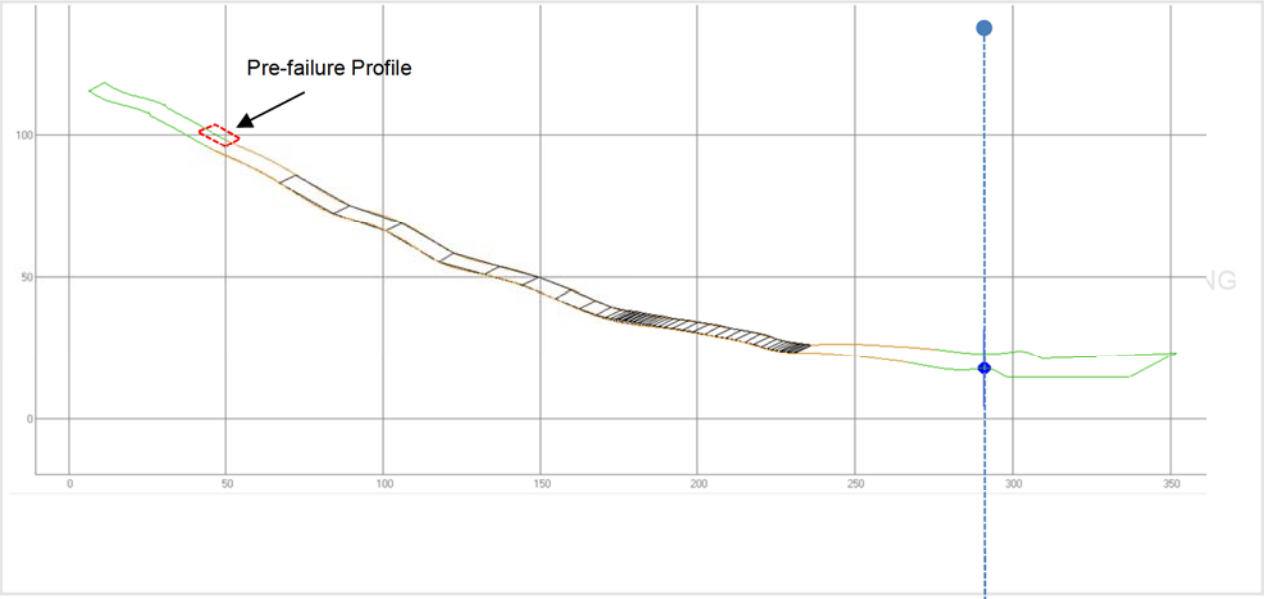
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau			
Sheet No.: 10	JOB NUMBER:	226464	SHEET DESCRIPTION:	Output Results	
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0	

Failure ID	F-AC1
Hazard Type	CDF

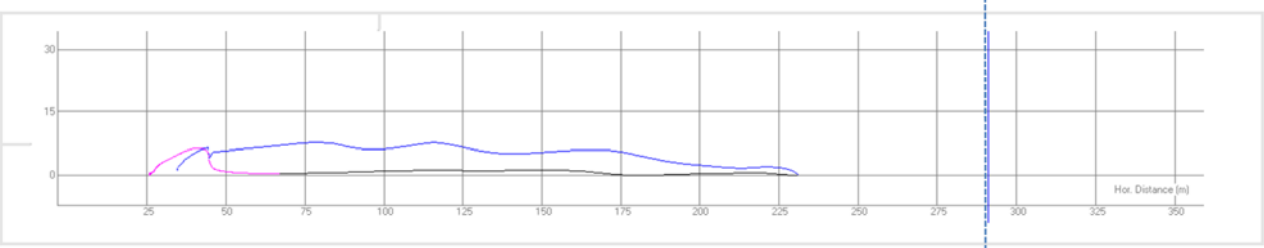
DEBRIS VOLUME

Computed Source Volume	59.14	m^3
Computed Entrainment	151.74	m^3

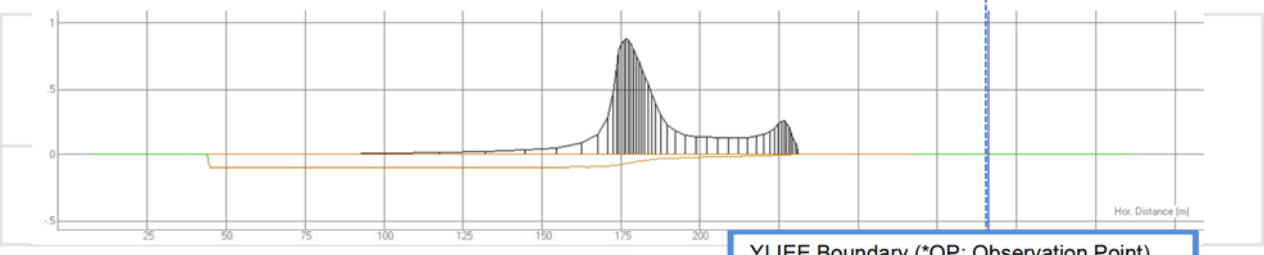
FAILURE PROFILE



VELOCITY PROFILE



THICKNESS PROFILE



YLIEE Boundary (*OP: Observation Point)

DEBRIS RUN-OUT CHARACTERISTICS

Total Debris Volume	210.88	m^3
Total Debris Volume at OP	-	m
Maximum Debris Thickness at OP	-	m
Maximum Debris Velocity	7.62	m/s
Maximum Debris Velocity at OP	-	m/s

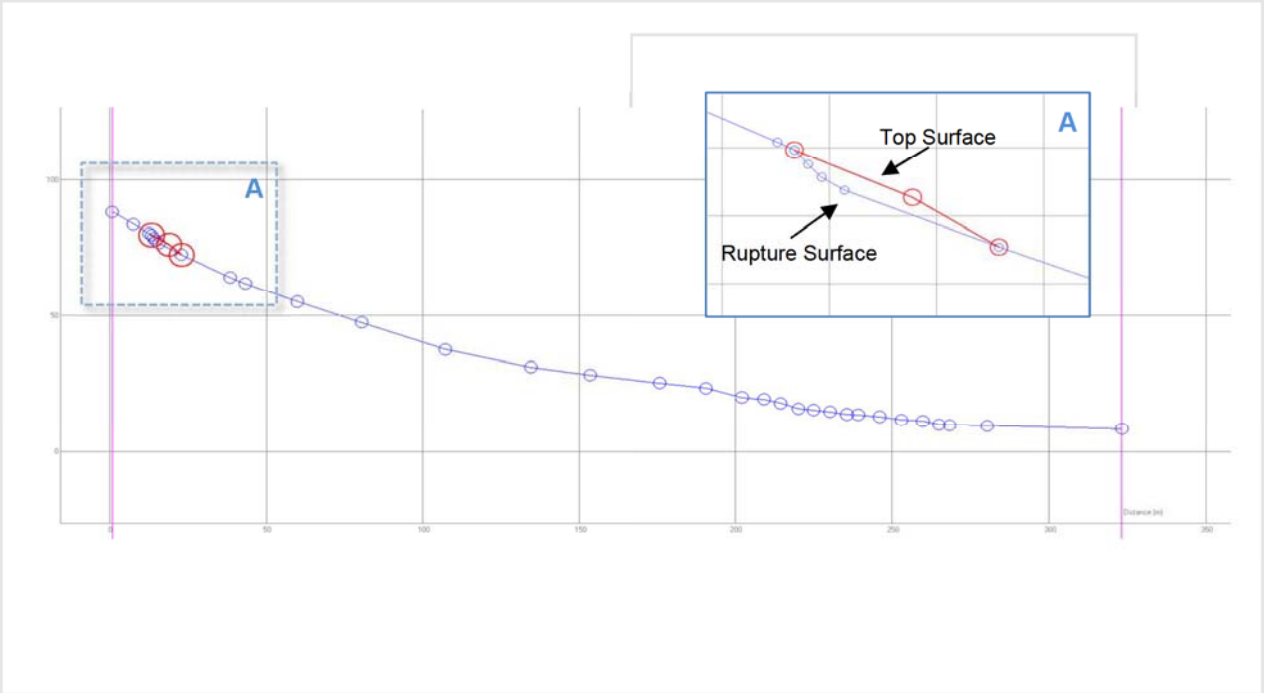
ADDITIONAL COMMENTS:

3.2 cont. **Details of Analysis Results by Failure**

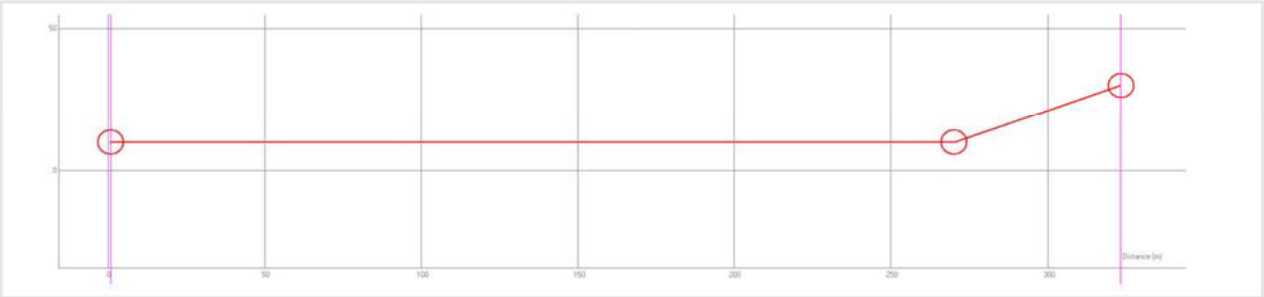
Failure ID	F-AC2	Estimated Source Volume	100.00 m³
Hazard Type	CDF	Estimated Entrainment Volume	0 m³

SECTIONAL PROFILE

(**INSET** - Detailed view of rupture surface)



WIDTH PROFILE



MATERIAL PROPERTIES

Rheology	Unit Weight (kN/m³)	Friction Angle (°)	Pore Pressure Coefficient	Friction Coefficient	Turbulence Coefficient	Internal Angle of Friction (°)	Erosion Depth (m) Min	Erosion Depth (m) Max
Frictional	20	25	-	-	-	35	0	0
Voellmy	20	-	-	0.19	500	-	0.05	0.15

NOTE: *See Section 2.4 for explanation of Material Properties*

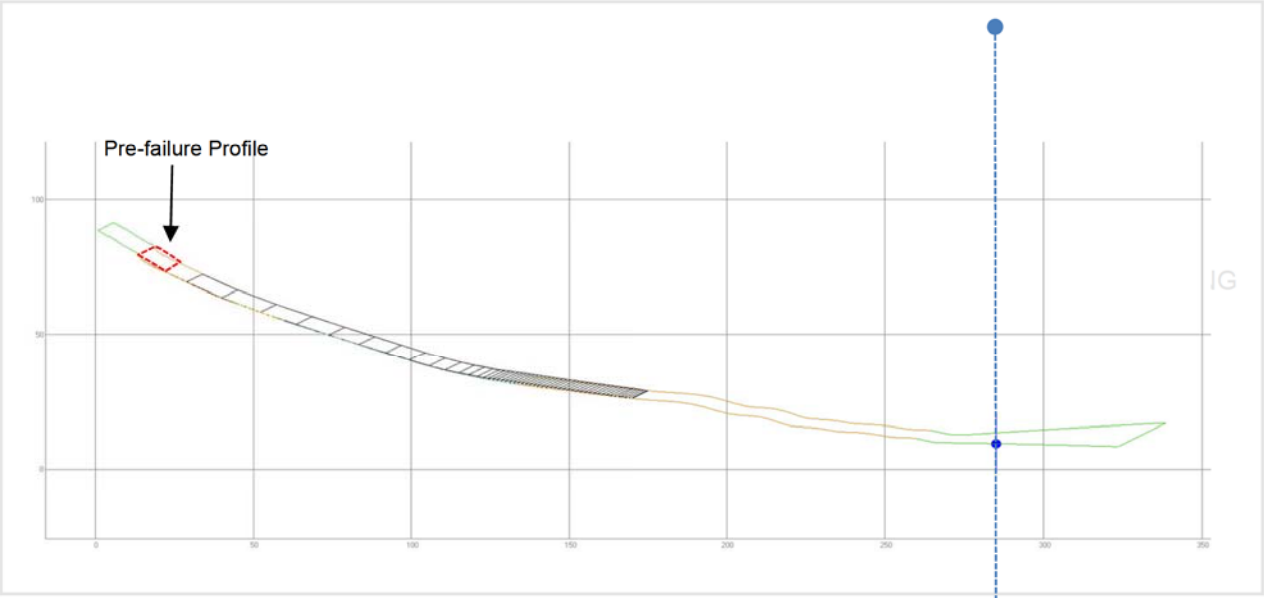
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau			
Sheet No.: 12	JOB NUMBER:	226464	SHEET DESCRIPTION:	Output Results	
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0	

Failure ID	F-AC2
Hazard Type	CDF

DEBRIS VOLUME

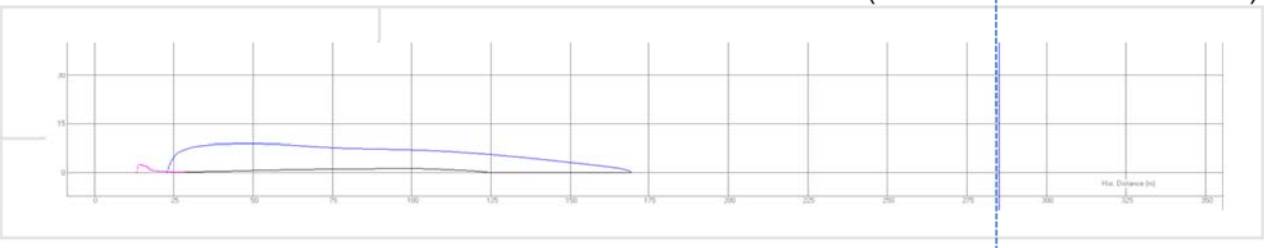
Computed Source Volume	102.43	m^3
Computed Entrainment	153.58	m^3

FAILURE PROFILE



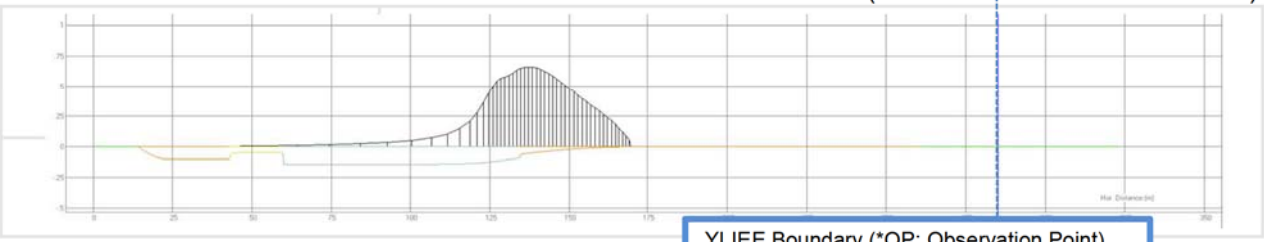
VELOCITY PROFILE

(**INSET** - Observation Point data)



THICKNESS PROFILE

(**INSET** - Observation Point data)



YLIEE Boundary (*OP: Observation Point)

DEBRIS RUN-OUT CHARACTERISTICS

Total Debris Volume	256.01	m^3
Total Debris Volume at OP	-	m
Maximum Debris Thickness at OP	-	m
Maximum Debris Velocity	9.01	m/s
Maximum Debris Velocity at OP	-	m/s

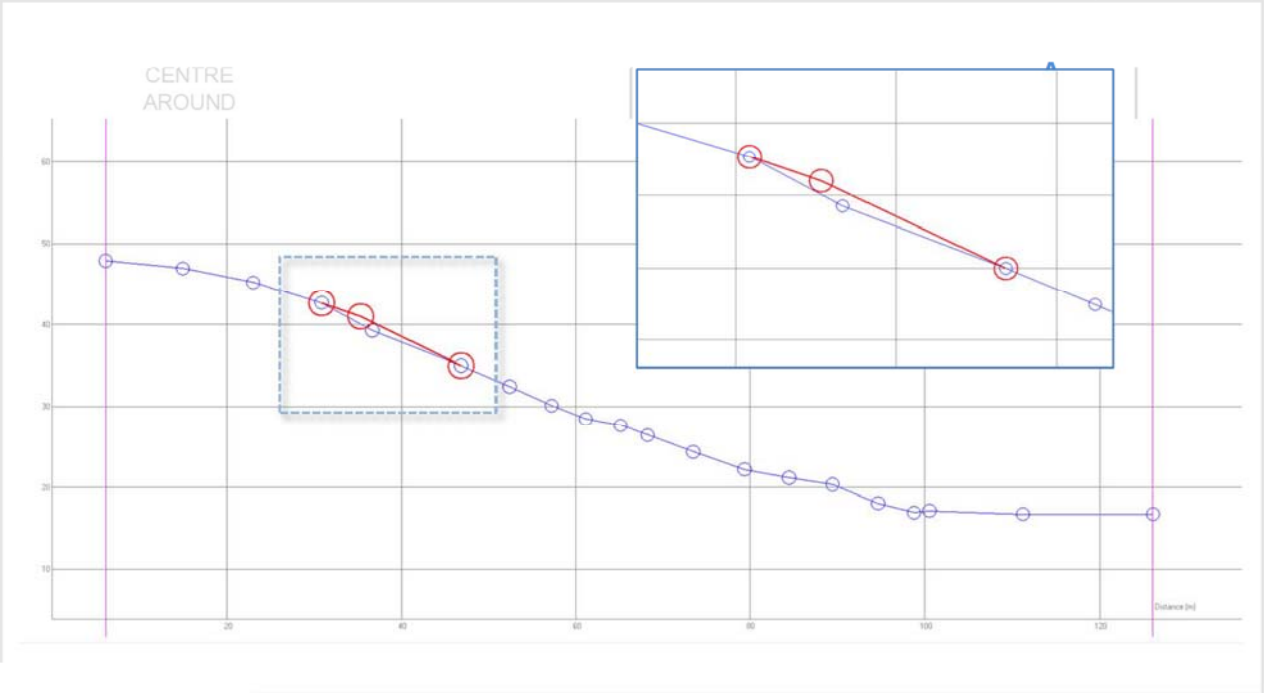
ADDITIONAL COMMENTS:

3.2 cont. **Details of Analysis Results by Failure**

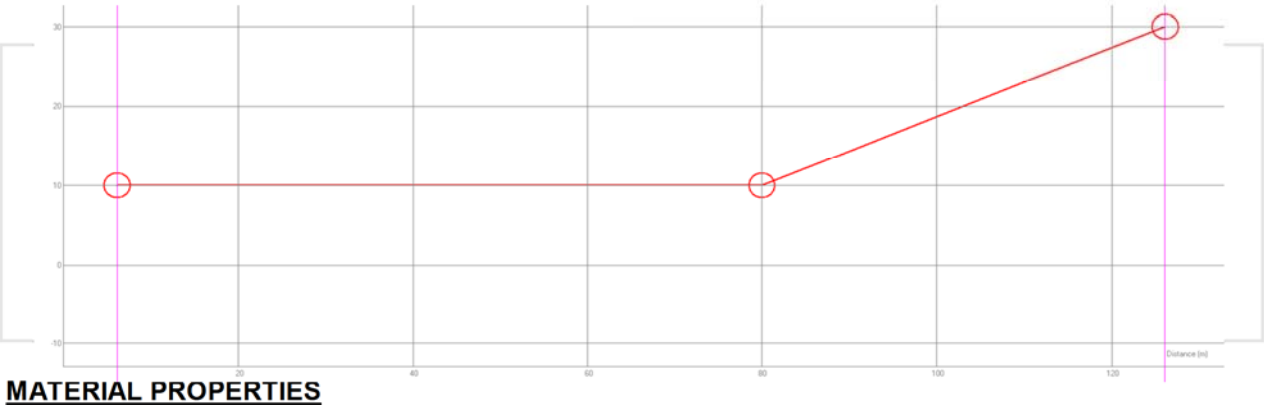
Failure ID	F-AB1	Estimated Source Volume	100.00	m³
Hazard Type	OHL	Estimated Entrainment Volume	0	m³

SECTIONAL PROFILE

(**INSET** - Detailed view of rupture surface)



WIDTH PROFILE



MATERIAL PROPERTIES

Rheology	Unit Weight (kN/m³)	Friction Angle (°)	Pore Pressure Coefficient	Friction Coefficient	Turbulence Coefficient	Internal Angle of Friction (°)	Erosion Depth (m) Min	Erosion Depth (m) Max
Voellmy	20	25	-	-	-	35	0	0

NOTE: *See Section 2.4 for explanation of Material Properties*

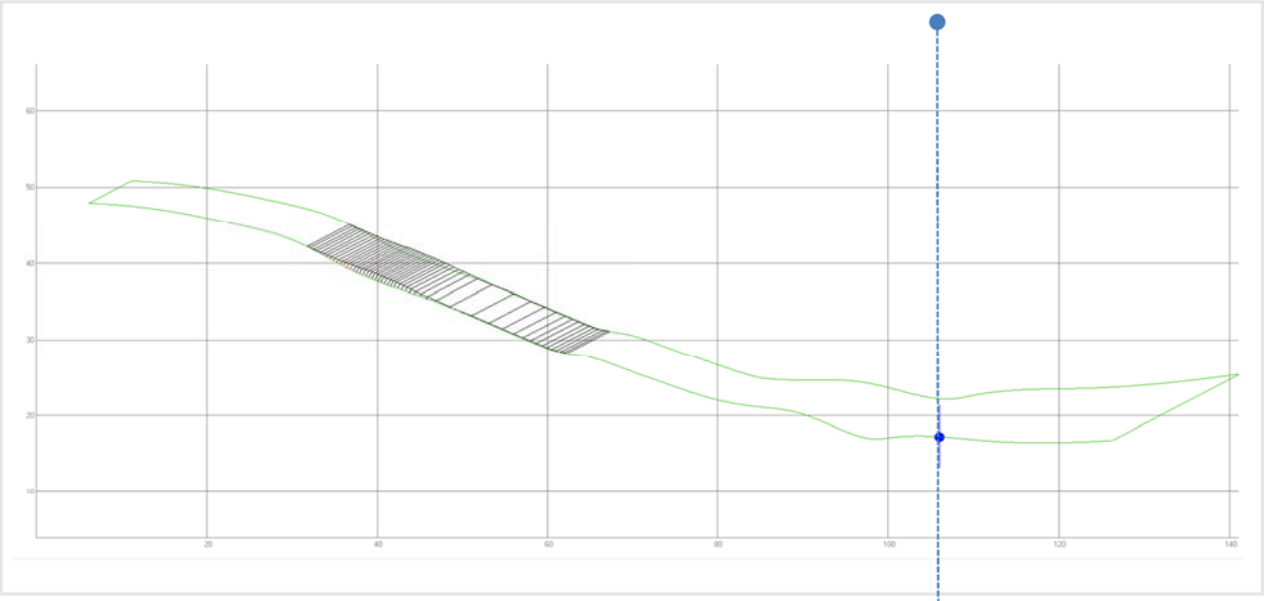
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau		
Sheet No.: 14	JOB NUMBER:	226464	SHEET DESCRIPTION:	Output Results
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0

Failure ID	F-AB1
Hazard Type	OHL

DEBRIS VOLUME

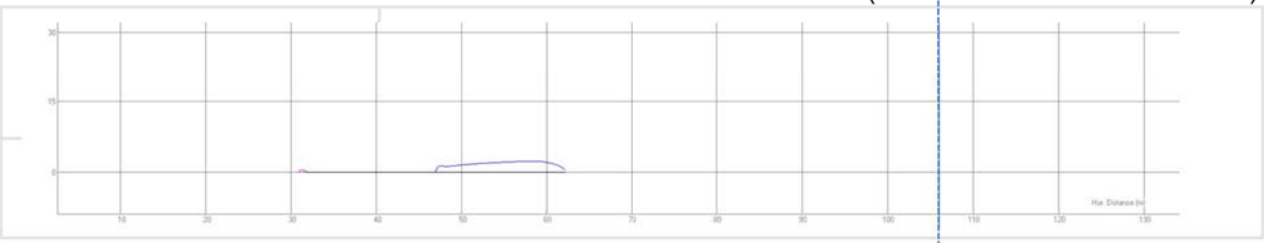
Computed Source Volume	99.28	m^3
Computed Entrainment	0	m^3

FAILURE PROFILE



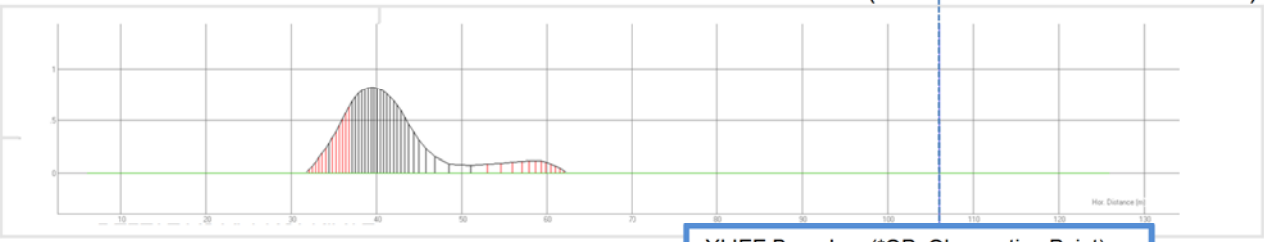
VELOCITY PROFILE

(**INSET** - Observation Point data)



THICKNESS PROFILE

(**INSET** - Observation Point data)



YLIEE Boundary (*OP: Observation Point)

DEBRIS RUN-OUT CHARACTERISTICS

Total Debris Volume	99.28	m^3
Total Debris Volume at OP	-	m
Maximum Debris Thickness at OP	-	m
Maximum Debris Velocity	2.4	m/s
Maximum Debris Velocity at OP	-	m/s

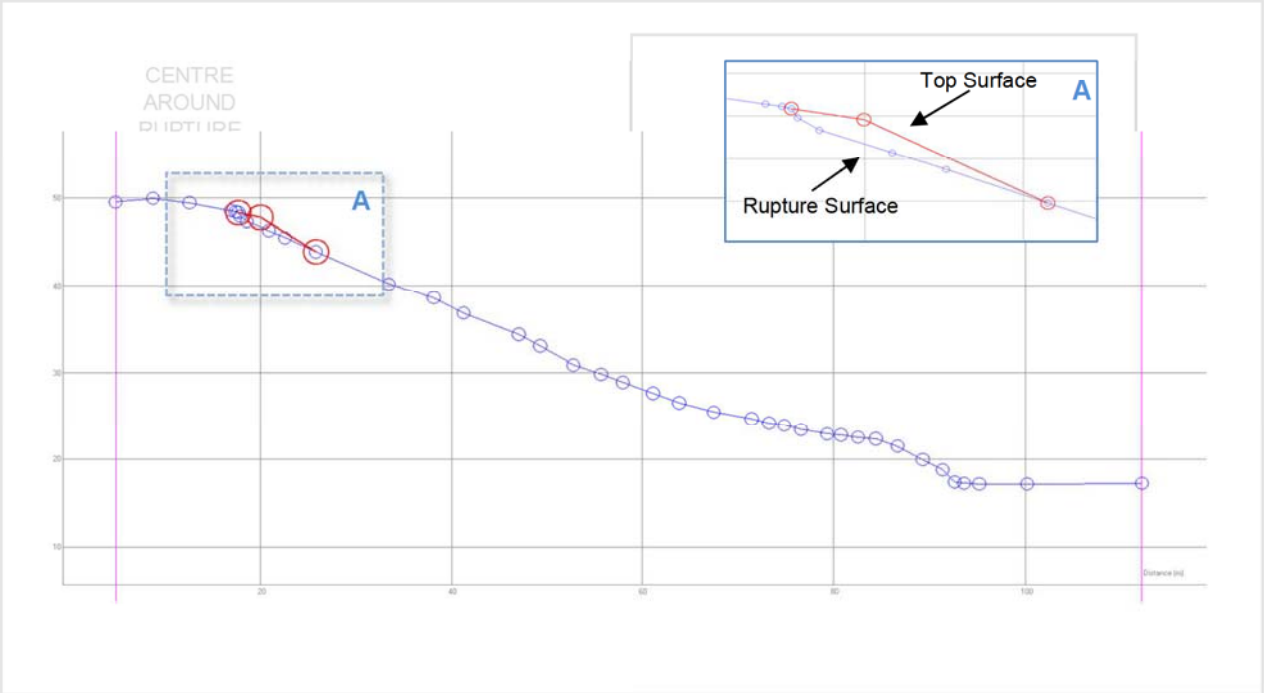
ADDITIONAL COMMENTS:

3.2 cont. **Details of Analysis Results by Failure**

Failure ID	F-AA1	Estimated Source Volume	50.00 m³
Hazard Type	OHL	Estimated Entrainment Volume	0 m³

SECTIONAL PROFILE

(**INSET** - Detailed view of rupture surface)



WIDTH PROFILE

MATERIAL PROPERTIES

Rheology	Unit Weight (kN/m³)	Friction Angle (˚)	Pore Pressure Coefficient	Friction Coefficient	Turbulence Coefficient	Internal Angle of Friction (˚)	Erosion Depth (m)	
							Min	Max
Voellmy	20	25	-	-	-	35	0	0

NOTE: *See Section 2.4 for explanation of Material Properties*

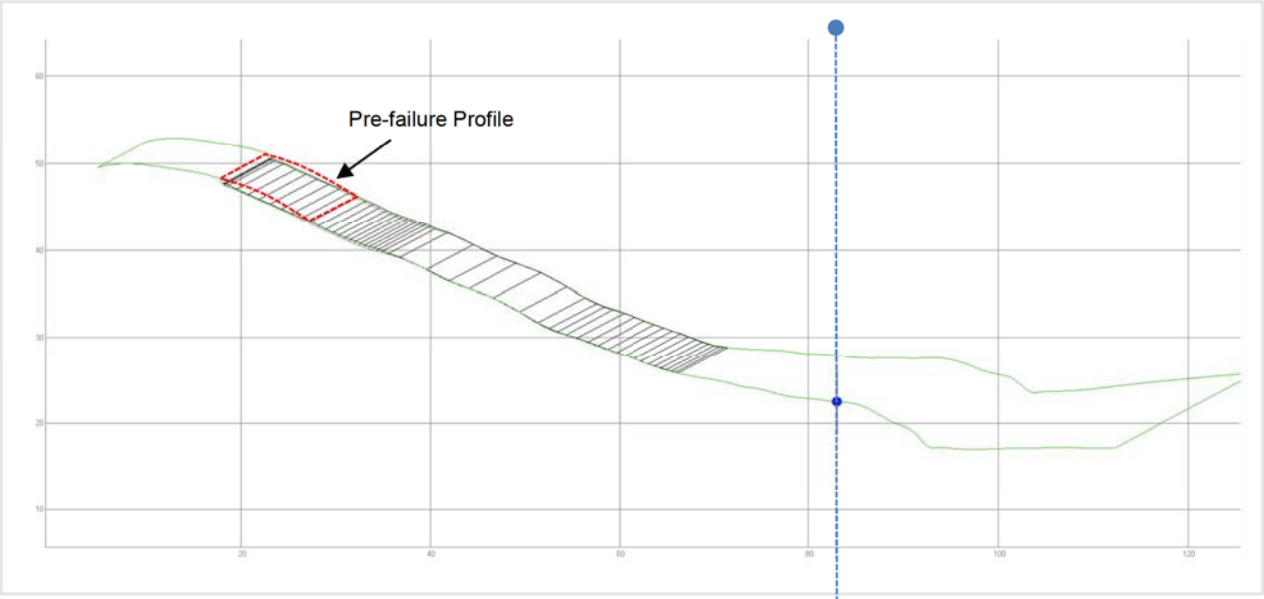
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau			
Sheet No.: 16	JOB NUMBER:	226464	SHEET DESCRIPTION:	Output Results	
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0	

Failure ID	F-AA1
Hazard Type	OHL

DEBRIS VOLUME

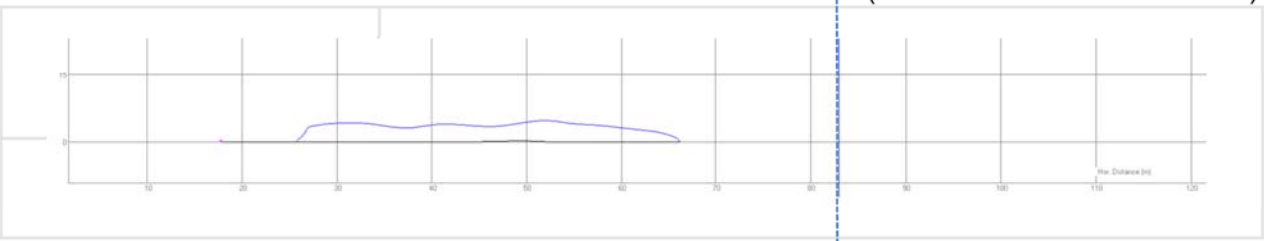
Computed Source Volume	49.59	m^3
Computed Entrainment	0	m^3

FAILURE PROFILE



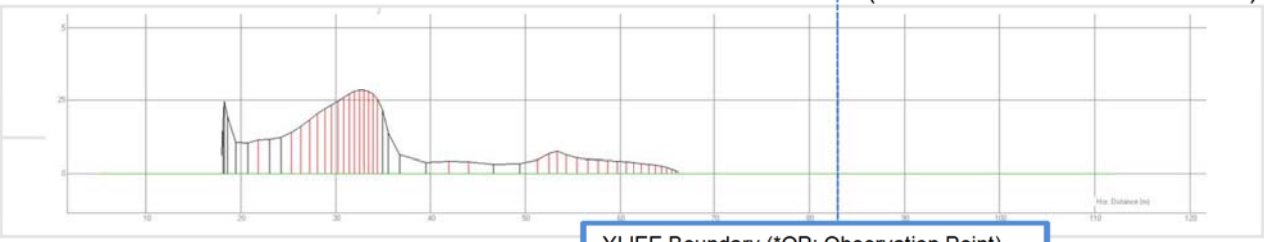
VELOCITY PROFILE

(**INSET** - Observation Point data)



THICKNESS PROFILE

(**INSET** - Observation Point data)



YLIEE Boundary (*OP: Observation Point)

DEBRIS RUN-OUT CHARACTERISTICS

Total Debris Volume	49.59	m^3
Total Debris Volume at OP	-	m
Maximum Debris Thickness at OP	-	m
Maximum Debris Velocity	4.8	m/s
Maximum Debris Velocity at OP	-	m/s

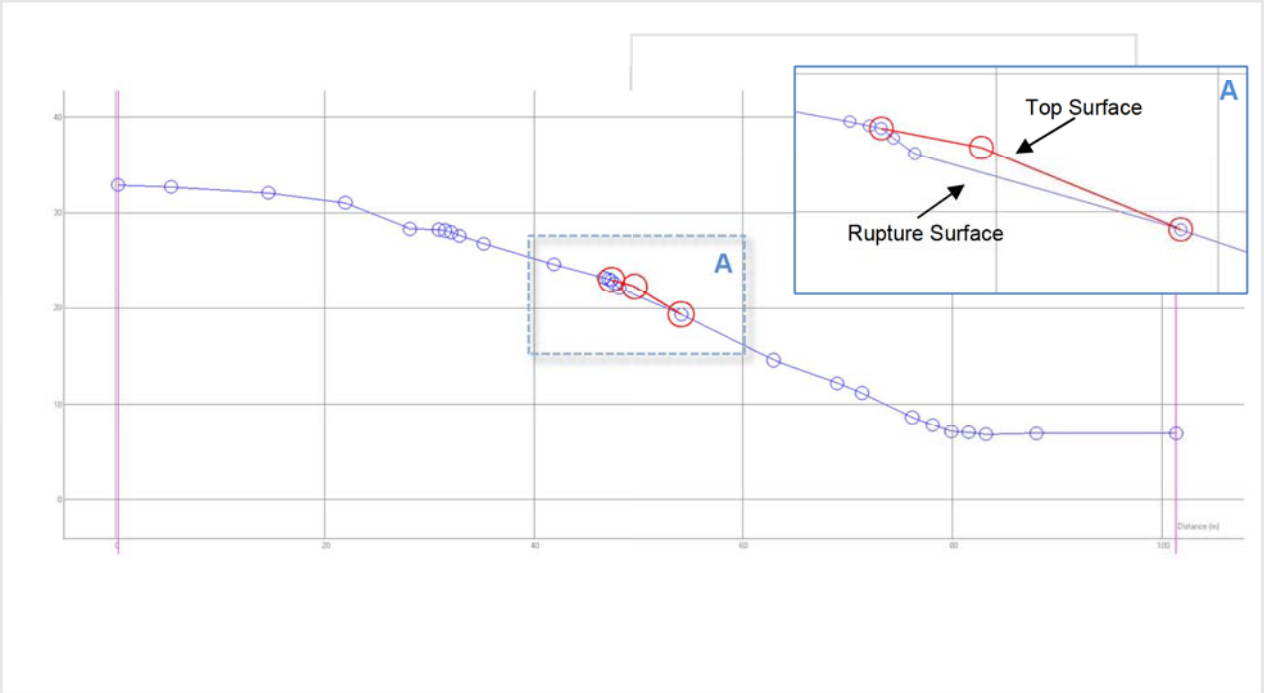
ADDITIONAL COMMENTS:

3.2 cont. **Details of Analysis Results by Failure**

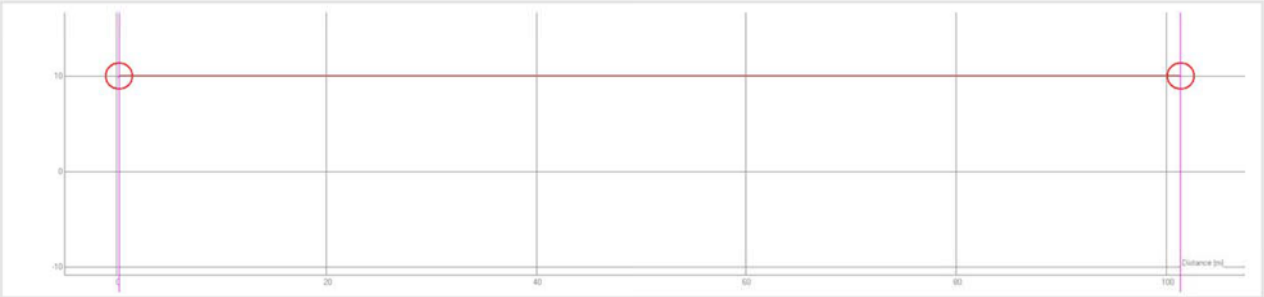
Failure ID	F-S1	Estimated Source Volume	50.00	m³
Hazard Type	OHL	Estimated Entrainment Volume	0	m³

SECTIONAL PROFILE

(**INSET** - Detailed view of rupture surface)



WIDTH PROFILE



MATERIAL PROPERTIES

Rheology	Unit Weight (kN/m³)	Friction Angle (°)	Pore Pressure Coefficient	Friction Coefficient	Turbulence Coefficient	Internal Angle of Friction (°)	Erosion Depth (m)	
							Min	Max
Voellmy	20	25	-	-	-	35	0	0

NOTE: *See Section 2.4 for explanation of Material Properties*

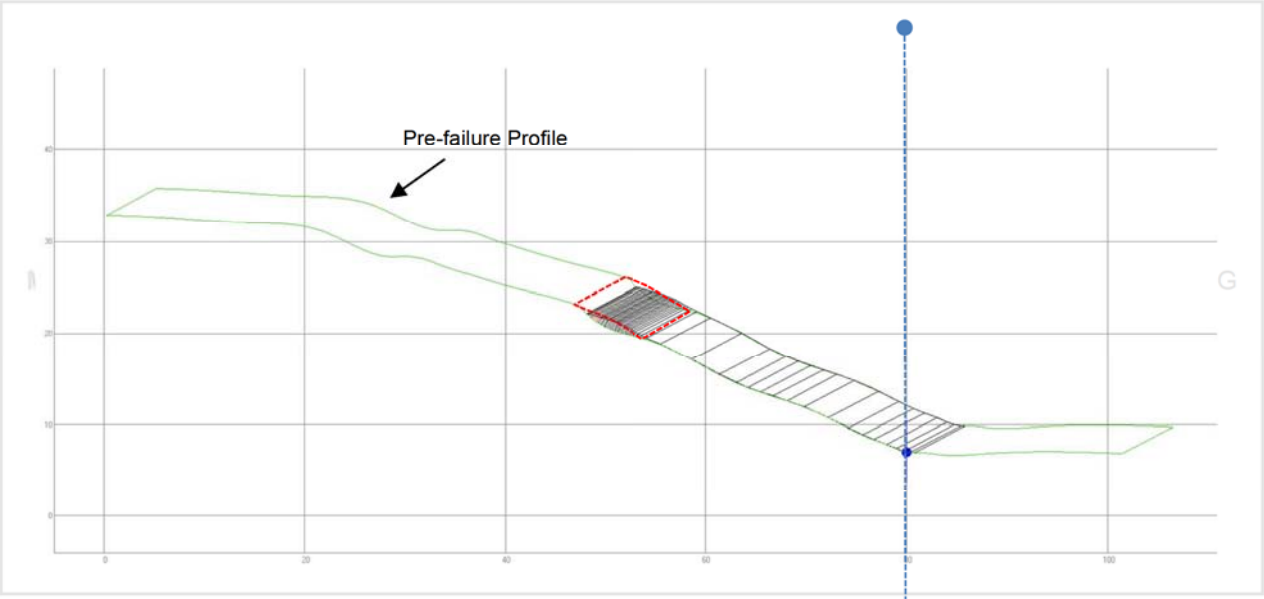
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau			
Sheet No.: 18	JOB NUMBER:	226464	SHEET DESCRIPTION:	Output Results	
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0	

Failure ID	F-S1
Hazard Type	OHL

DEBRIS VOLUME

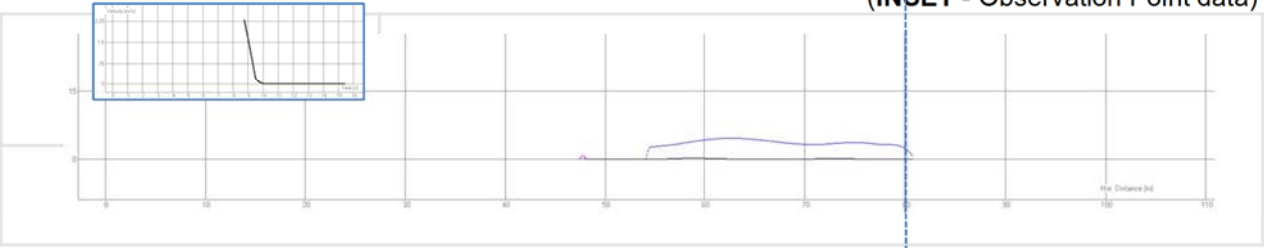
Computed Source Volume	49.49	m^3
Computed Entrainment	0	m^3

FAILURE PROFILE



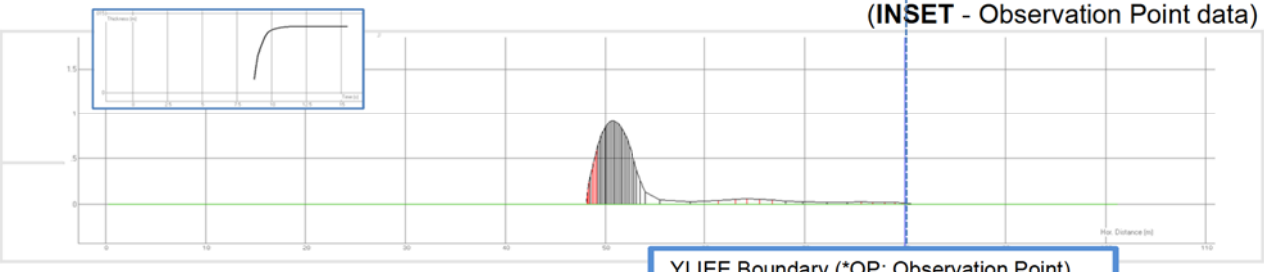
VELOCITY PROFILE

(**INSET** - Observation Point data)



THICKNESS PROFILE

(**INSET** - Observation Point data)



YLIEE Boundary (*OP: Observation Point)

DEBRIS RUN-OUT CHARACTERISTICS

Total Debris Volume	49.49	m^3
Total Debris Volume at OP	0.07	m^3
Maximum Debris Thickness at OP	0.01	m
Maximum Debris Velocity	4.56	m/s
Maximum Debris Velocity at OP	2.3	m/s

ADDITIONAL COMMENTS:

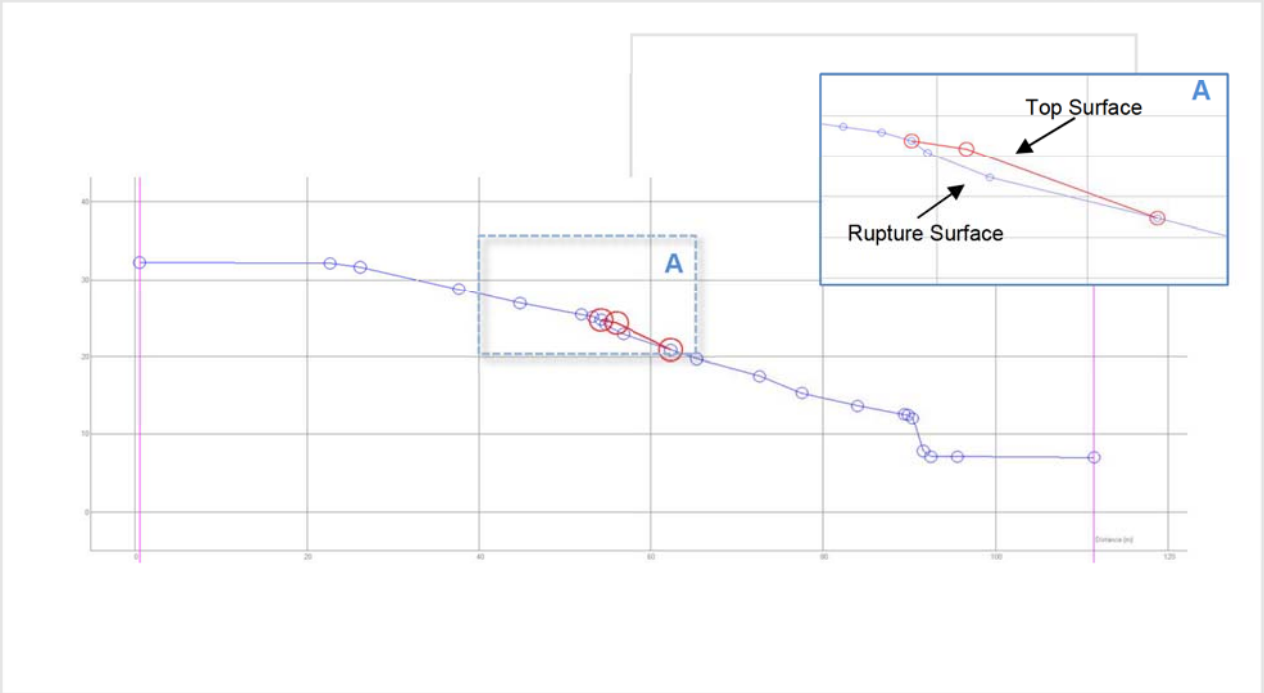
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau			
Sheet No.: 19	JOB NUMBER:	226464	SHEET DESCRIPTION:	Input Parameters	
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0	

3.2 cont. **Details of Analysis Results by Failure**

Failure ID	F-R1	Estimated Source Volume	50.00	m³
Hazard Type	OHL	Estimated Entrainment Volume	0	m³

SECTIONAL PROFILE

(**INSET** - Detailed view of rupture surface)



WIDTH PROFILE

MATERIAL PROPERTIES

Rheology	Unit Weight (kN/m³)	Friction Angle (°)	Pore Pressure Coefficient	Friction Coefficient	Turbulence Coefficient	Internal Angle of Friction (°)	Erosion Depth (m)	
							Min	Max
Voellmy	20	25	-	-	-	35	0	0

NOTE: *See Section 2.4 for explanation of Material Properties*

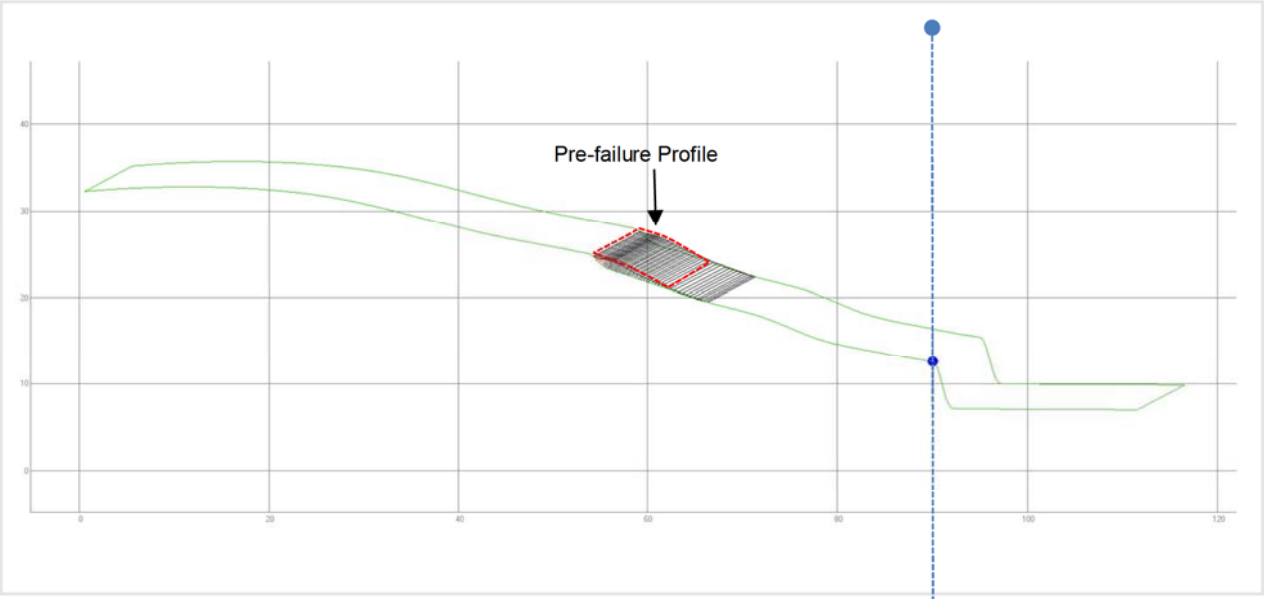
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau		
Sheet No.: 20	JOB NUMBER:	226464	SHEET DESCRIPTION:	Output Results
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0

Failure ID	F-R1
Hazard Type	OHL

DEBRIS VOLUME

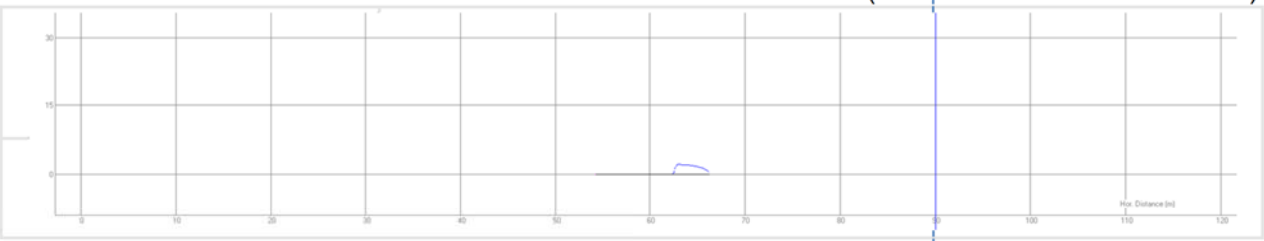
Computed Source Volume	48.38	m^3
Computed Entrainment	0	m^3

FAILURE PROFILE



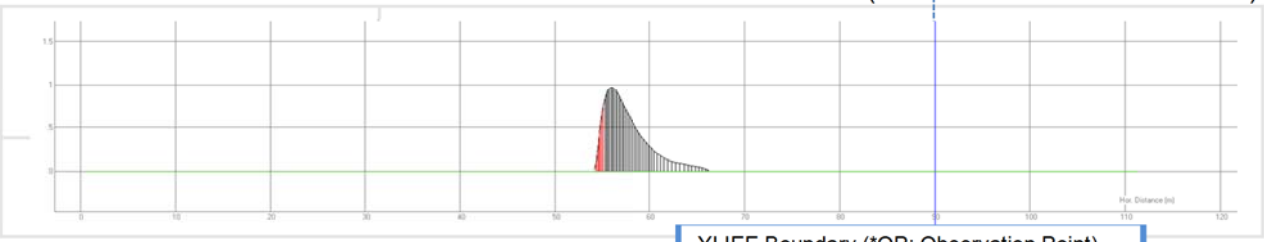
VELOCITY PROFILE

(**INSET** - Observation Point data)



THICKNESS PROFILE

(**INSET** - Observation Point data)



YLIEE Boundary (*OP: Observation Point)

DEBRIS RUN-OUT CHARACTERISTICS

Total Debris Volume	48.38	m^3
Total Debris Volume at OP	-	m
Maximum Debris Thickness at OP	-	m
Maximum Debris Velocity	2.16	m/s
Maximum Debris Velocity at OP	-	m/s

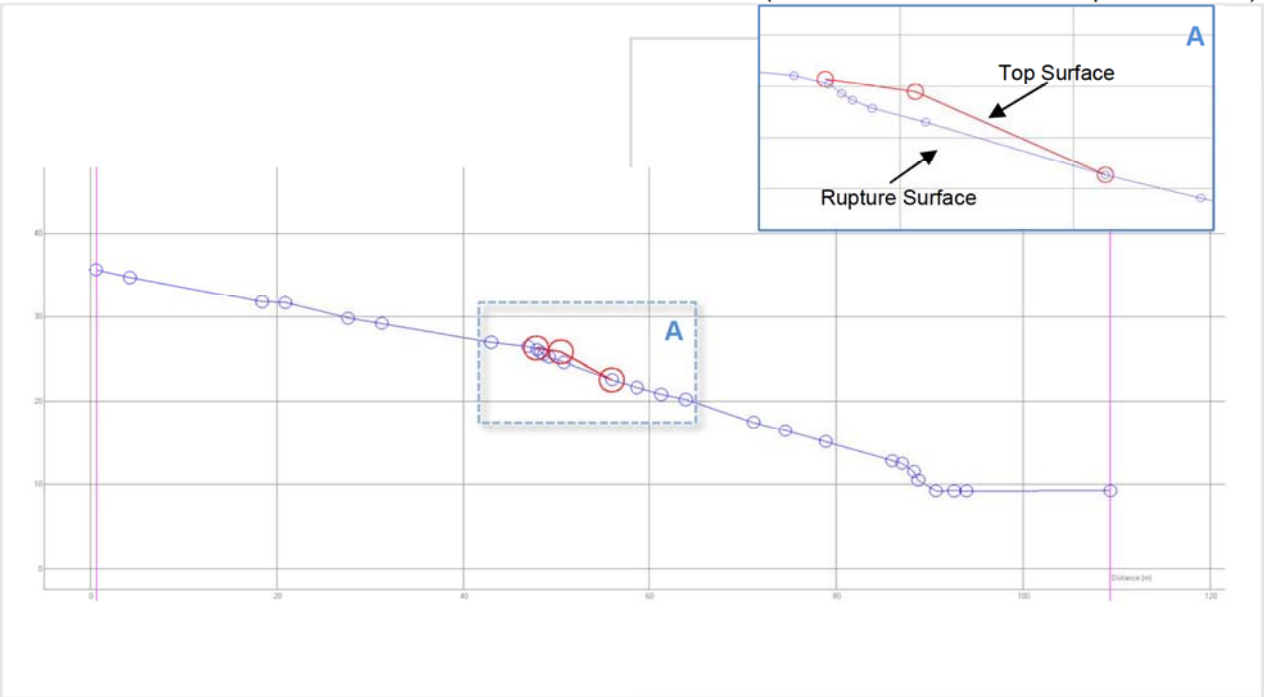
ADDITIONAL COMMENTS:

3.2 cont. **Details of Analysis Results by Failure**

Failure ID	F-M1	Estimated Source Volume	50.00 m³
Hazard Type	OHL	Estimated Entrainment Volume	0 m³

SECTIONAL PROFILE

(**INSET** - Detailed view of rupture surface)



WIDTH PROFILE

MATERIAL PROPERTIES

Rheology	Unit Weight (kN/m³)	Friction Angle (˚)	Pore Pressure Coefficient	Friction Coefficient	Turbulence Coefficient	Internal Angle of Friction (˚)	Erosion Depth (m)	
							Min	Max
Voellmy	20	25	-	-	-	35	0	0

NOTE: *See Section 2.4 for explanation of Material Properties*

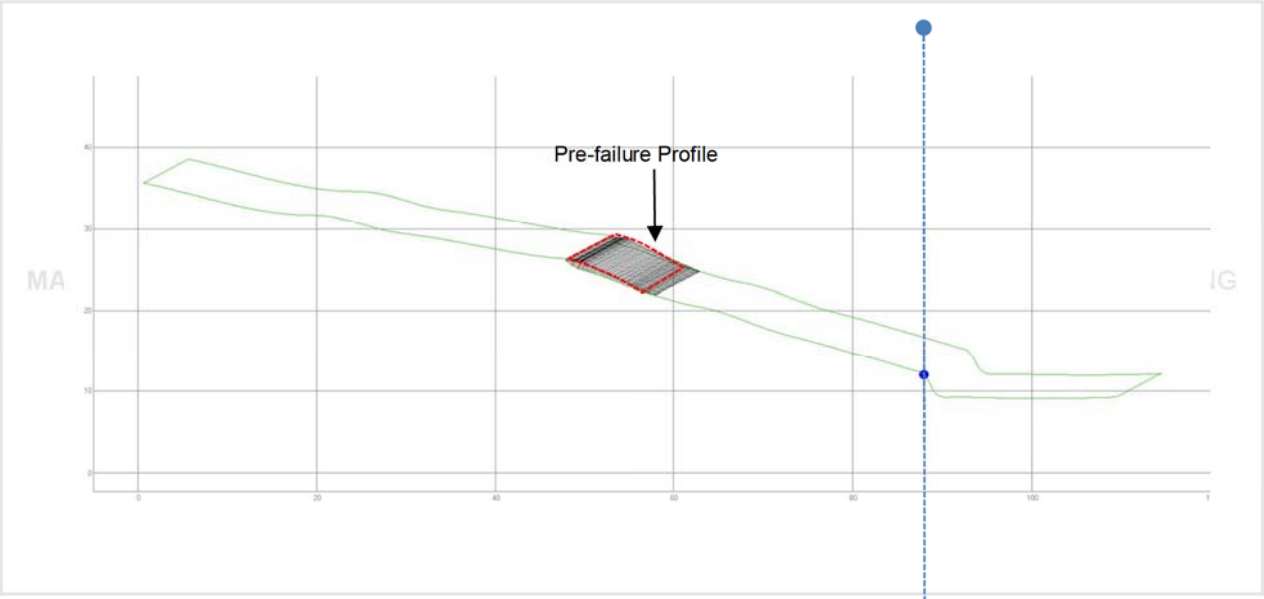
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau			
Sheet No.: 22	JOB NUMBER:	226464	SHEET DESCRIPTION:	Output Results	
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0	

Failure ID	F-M1
Hazard Type	OHL

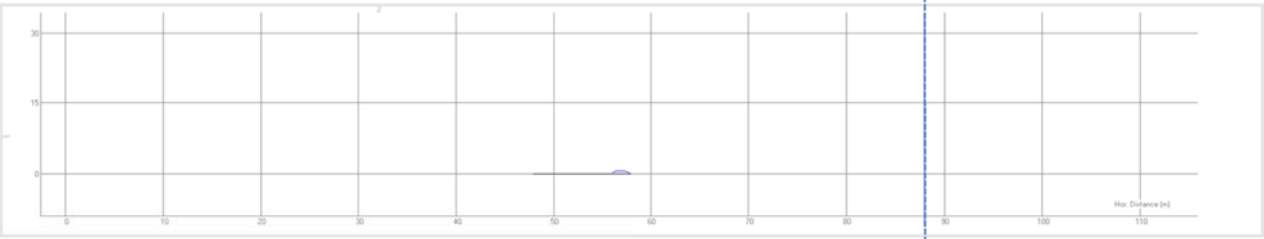
DEBRIS VOLUME

Computed Source Volume	48.22	m^3
Computed Entrainment	0	m^3

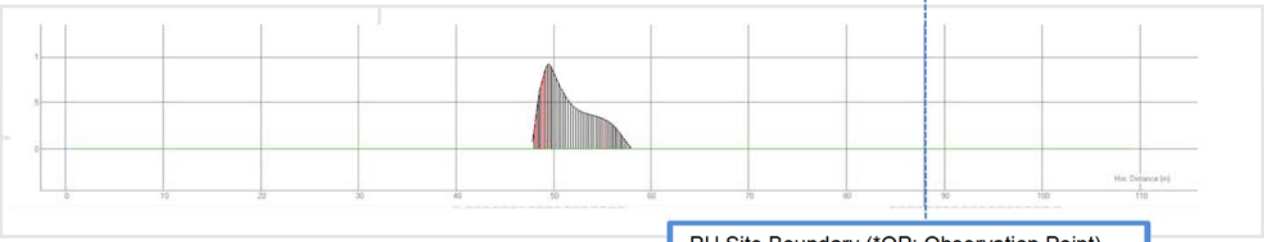
FAILURE PROFILE



VELOCITY PROFILE



THICKNESS PROFILE



PH Site Boundary (*OP: Observation Point)

DEBRIS RUN-OUT CHARACTERISTICS

Total Debris Volume	48.22	m^3
Total Debris Volume at OP	-	m
Maximum Debris Thickness at OP	-	m
Maximum Debris Velocity	0.78	m/s
Maximum Debris Velocity at OP	-	m/s

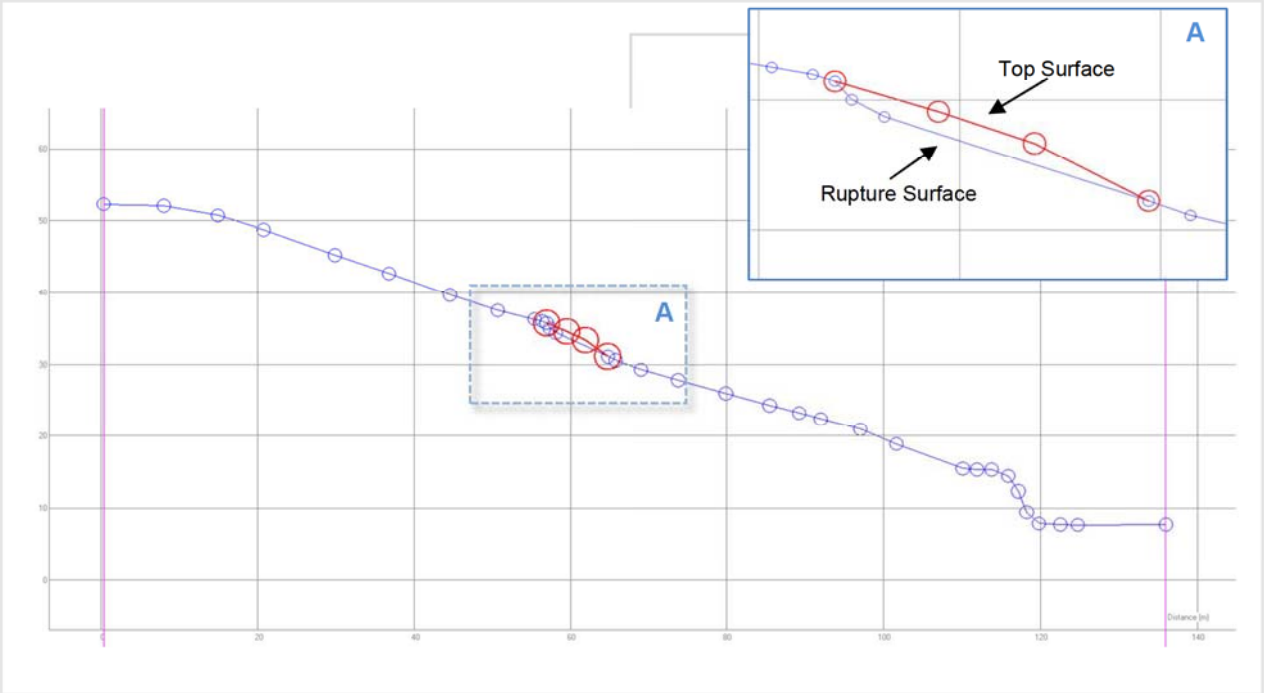
ADDITIONAL COMMENTS:

3.2 cont. **Details of Analysis Results by Failure**

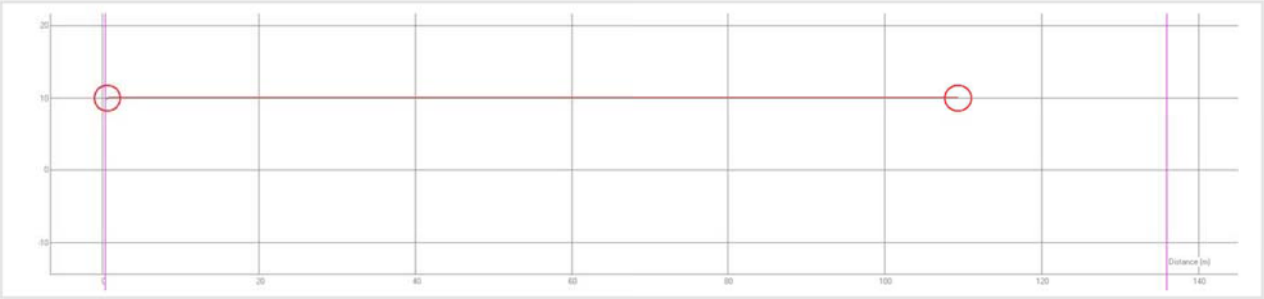
Failure ID	F-J1	Estimated Source Volume	50.00	m³
Hazard Type	OHL	Estimated Entrainment Volume	0	m³

SECTIONAL PROFILE

(**INSET** - Detailed view of rupture surface)



WIDTH PROFILE



MATERIAL PROPERTIES

Rheology	Unit Weight (kN/m³)	Friction Angle (°)	Pore Pressure Coefficient	Friction Coefficient	Turbulence Coefficient	Internal Angle of Friction (°)	Erosion Depth (m)	
							Min	Max
Voellmy	20	25	-	-	-	35	0	0

NOTE: *See Section 2.4 for explanation of Material Properties*

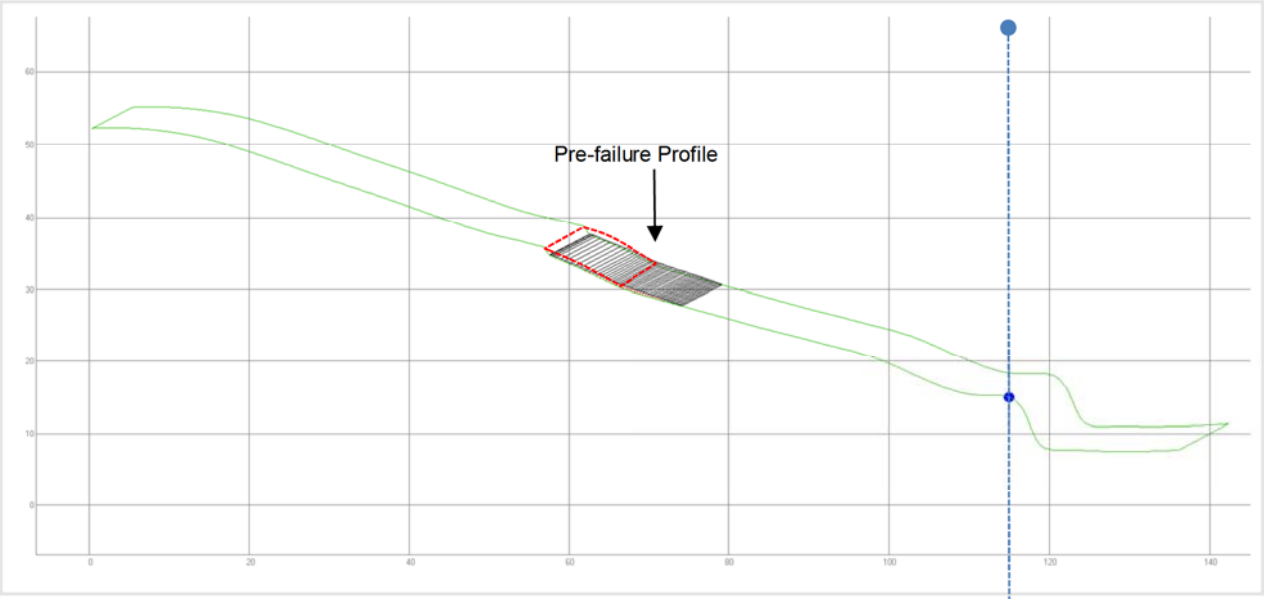
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau		
Sheet No.: 24	JOB NUMBER:	226464	SHEET DESCRIPTION:	Output Results
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0

Failure ID	F-J1
Hazard Type	OHL

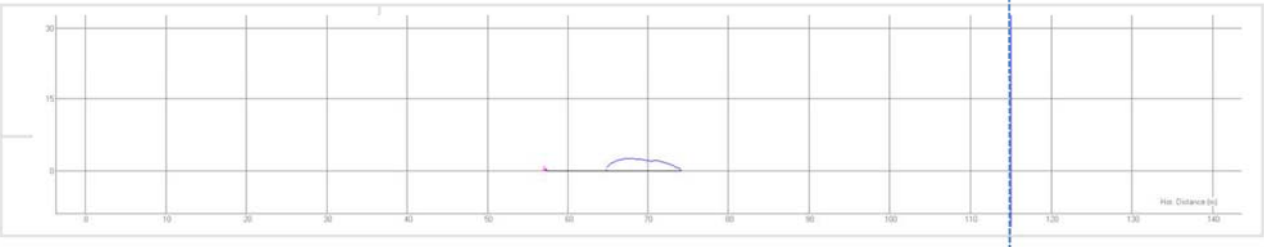
DEBRIS VOLUME

Computed Source Volume	49.85	m^3
Computed Entrainment	0	m^3

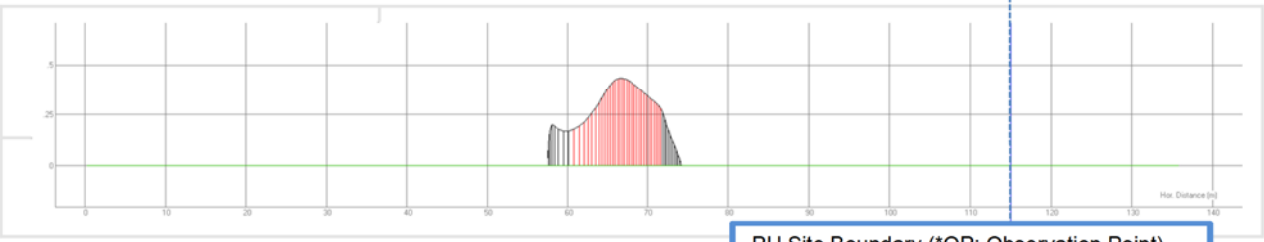
FAILURE PROFILE



VELOCITY PROFILE



THICKNESS PROFILE



PH Site Boundary (*OP: Observation Point)

DEBRIS RUN-OUT CHARACTERISTICS

Total Debris Volume	49.85	m^3
Total Debris Volume at OP	-	m
Maximum Debris Thickness at OP	-	m
Maximum Debris Velocity	0.78	m/s
Maximum Debris Velocity at OP	-	m/s

ADDITIONAL COMMENTS:

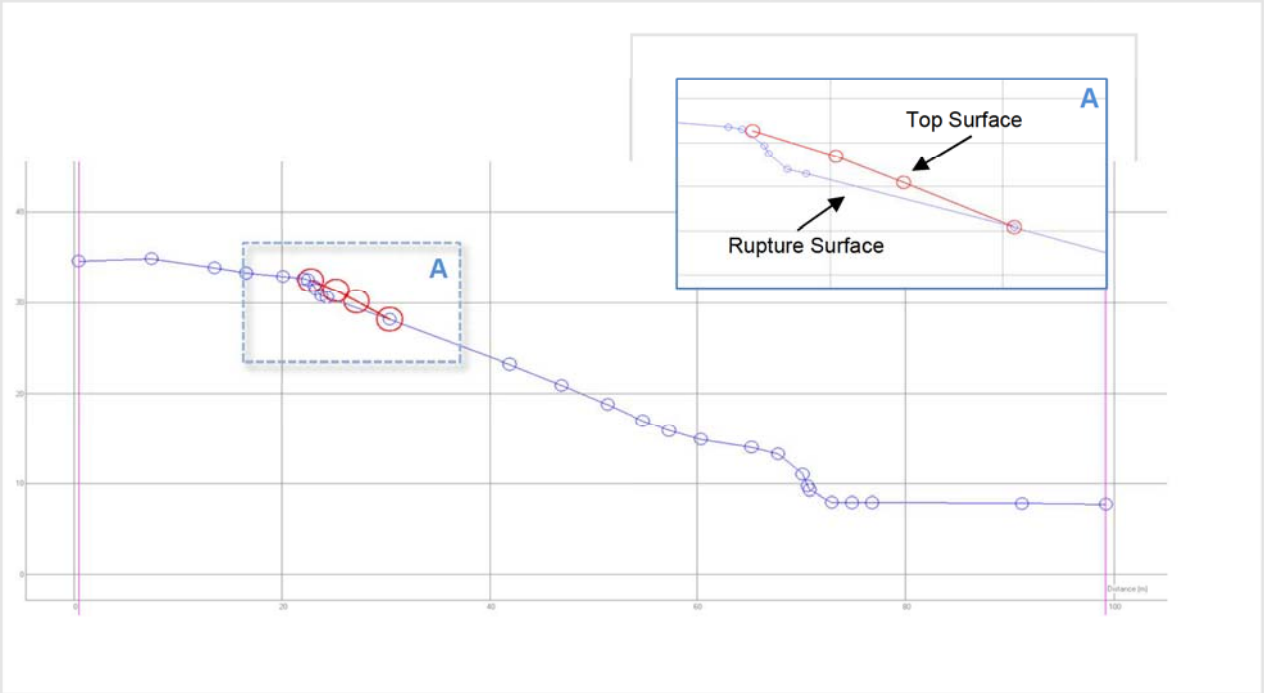
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau			
Sheet No.: 25	JOB NUMBER:	226464	SHEET DESCRIPTION:	Input Parameters	
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0	

3.2 cont. **Details of Analysis Results by Failure**

Failure ID	F-I1	Estimated Source Volume	50.00 m³
Hazard Type	OHL	Estimated Entrainment Volume	0 m³

SECTIONAL PROFILE

(**INSET** - Detailed view of rupture surface)



WIDTH PROFILE

MATERIAL PROPERTIES

Rheology	Unit Weight (kN/m³)	Friction Angle (°)	Pore Pressure Coefficient	Friction Coefficient	Turbulence Coefficient	Internal Angle of Friction (°)	Erosion Depth (m)	
							Min	Max
Voellmy	20	25	-	-	-	35	0	0

NOTE: *See Section 2.4 for explanation of Material Properties*

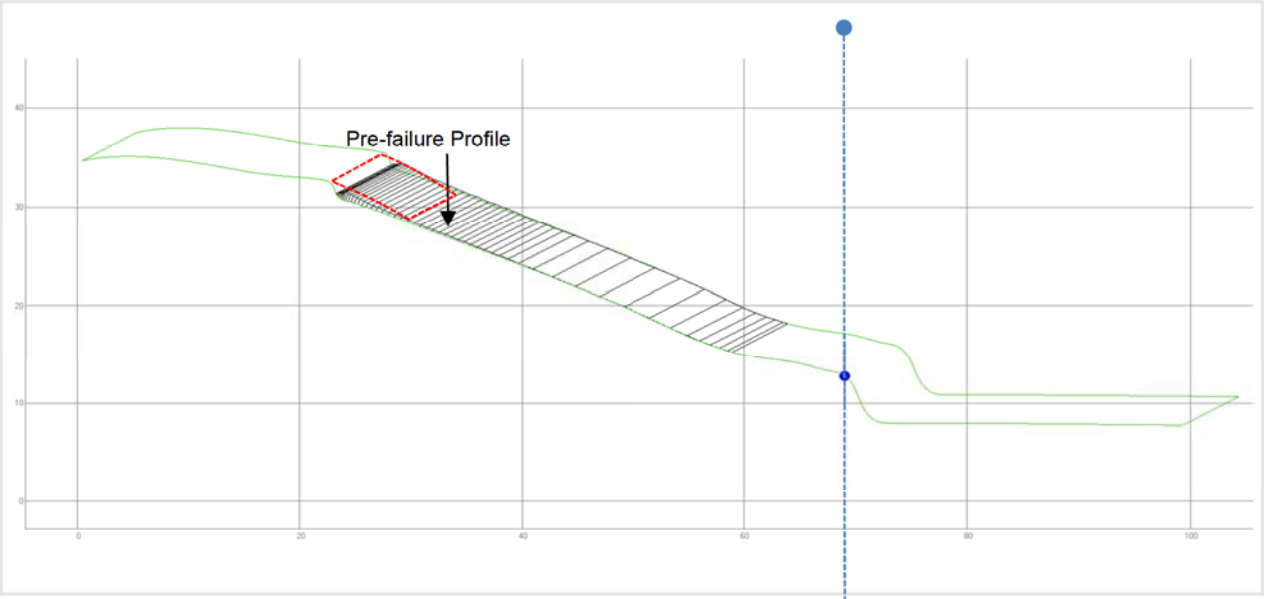
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau			
Sheet No.: 26	JOB NUMBER:	226464	SHEET DESCRIPTION:	Output Results	
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0	

Failure ID	F-I1
Hazard Type	OHL

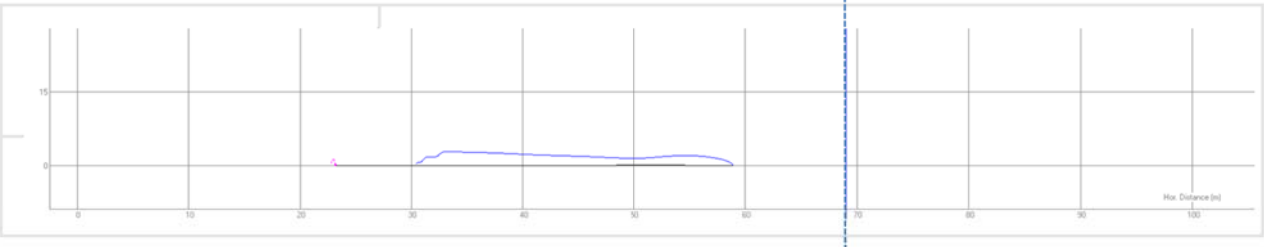
DEBRIS VOLUME

Computed Source Volume	49.76	m^3
Computed Entrainment	0	m^3

FAILURE PROFILE



VELOCITY PROFILE



THICKNESS PROFILE

PH Site Boundary (*OP: Observation Point)

DEBRIS RUN-OUT CHARACTERISTICS

Total Debris Volume	49.76	m^3
Total Debris Volume at OP	-	m
Maximum Debris Thickness at OP	-	m
Maximum Debris Velocity	2.86	m/s
Maximum Debris Velocity at OP	-	m/s

ADDITIONAL COMMENTS:

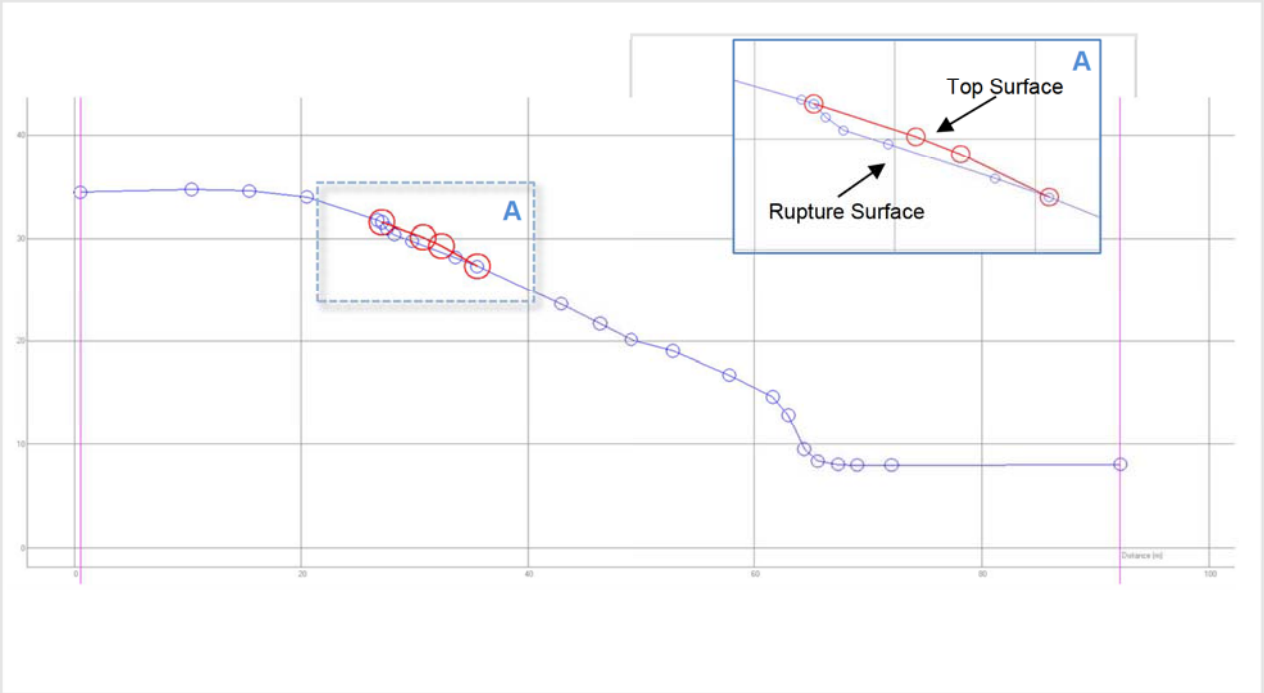
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau			
Sheet No.: 27	JOB NUMBER:	226464	SHEET DESCRIPTION:	Input Parameters	
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0	

3.2 cont. **Details of Analysis Results by Failure**

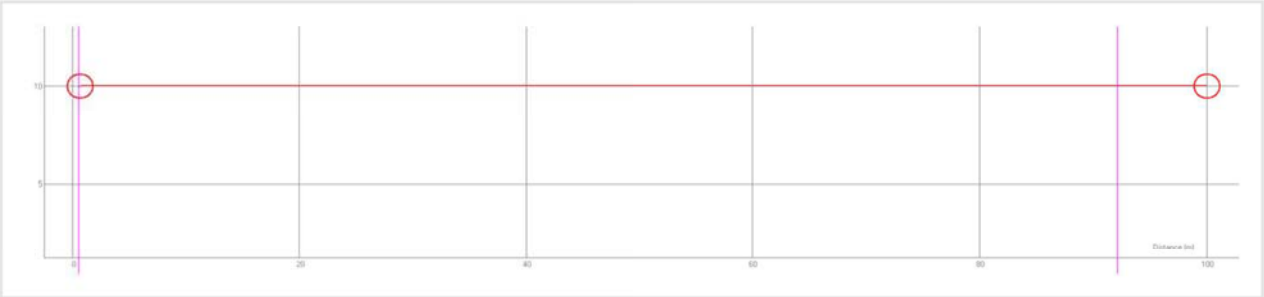
Failure ID	F-H1		Estimated Source Volume	50.00	m³
Hazard Type	OHL		Estimated Entrainment Volume	0	m³

SECTIONAL PROFILE

(**INSET** - Detailed view of rupture surface)



WIDTH PROFILE



MATERIAL PROPERTIES

Rheology	Unit Weight (kN/m³)	Friction Angle (°)	Pore Pressure Coefficient	Friction Coefficient	Turbulence Coefficient	Internal Angle of Friction (°)	Erosion Depth (m)	
							Min	Max
Voellmy	20	25	-	-	-	35	0	0

NOTE: *See Section 2.4 for explanation of Material Properties*

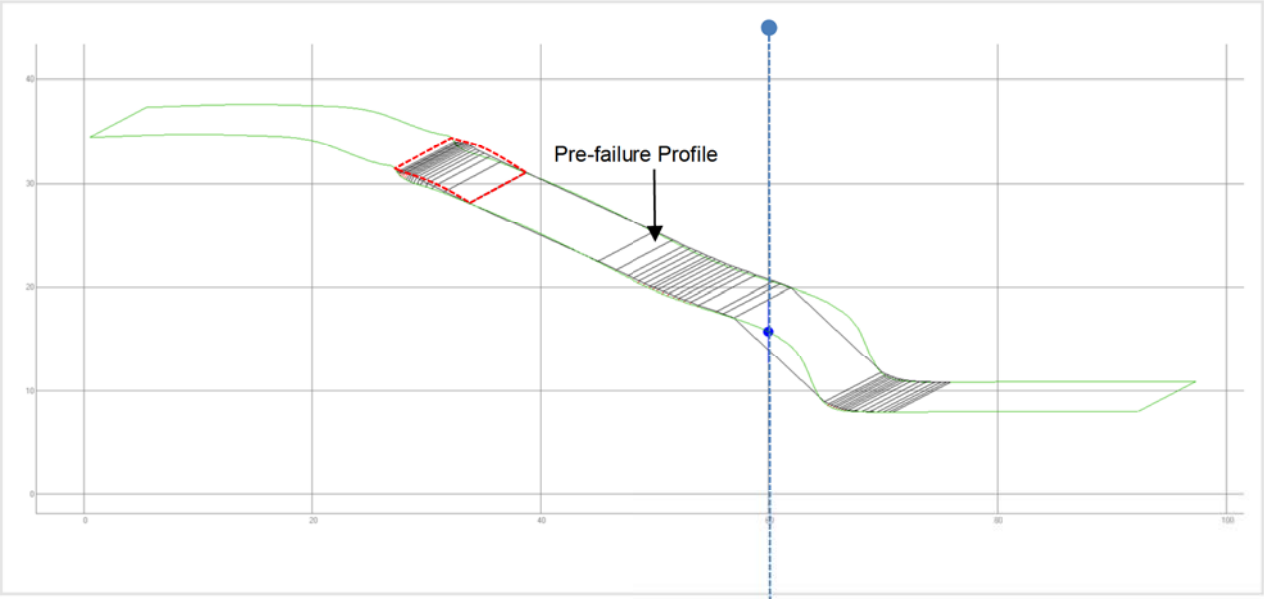
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau			
Sheet No.: 28	JOB NUMBER:	226464	SHEET DESCRIPTION:	Output Results	
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0	

Failure ID	F-H1
Hazard Type	OHL

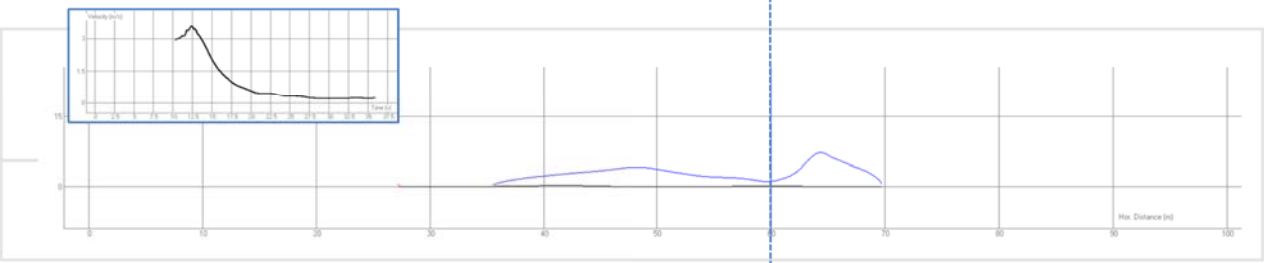
DEBRIS VOLUME

Computed Source Volume	49.7	m^3
Computed Entrainment	0	m^3

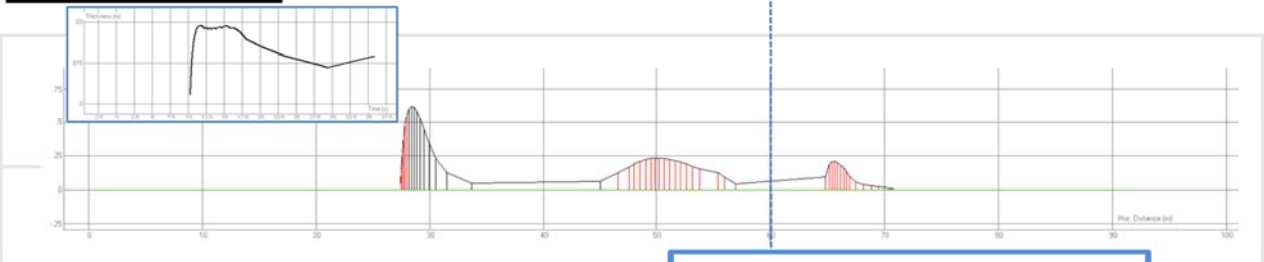
FAILURE PROFILE



VELOCITY PROFILE



THICKNESS PROFILE



PH Site Boundary (*OP: Observation Point)

DEBRIS RUN-OUT CHARACTERISTICS

Total Debris Volume	49.70	m^3
Total Debris Volume at OP	5.99	m^3
Maximum Debris Thickness at OP	0.02	m
Maximum Debris Velocity	8.08	m/s
Maximum Debris Velocity at OP	3.5	m/s

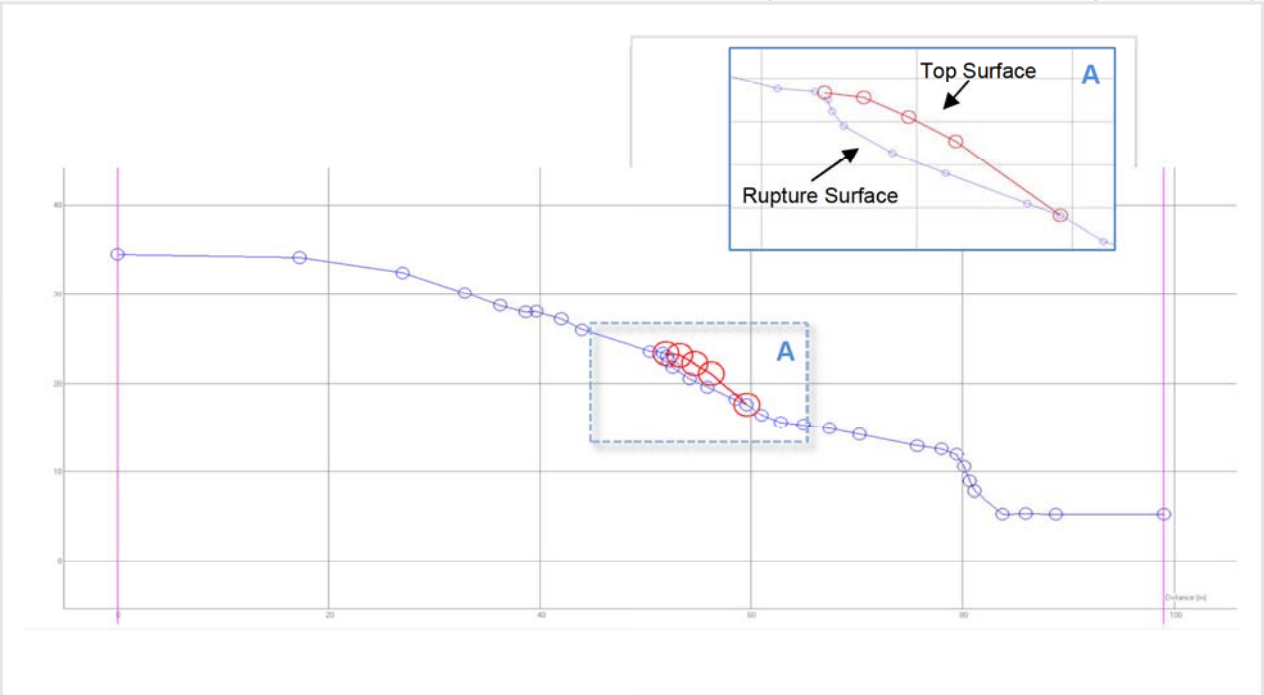
ADDITIONAL COMMENTS:

3.2 cont. **Details of Analysis Results by Failure**

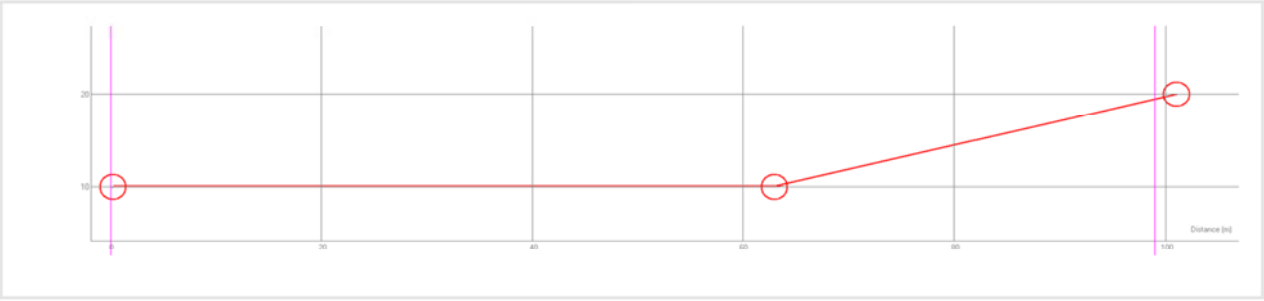
Failure ID	F-G1	Estimated Source Volume	100.00 m³
Hazard Type	OHL	Estimated Entrainment Volume	0 m³

SECTIONAL PROFILE

(**INSET** - Detailed view of rupture surface)



WIDTH PROFILE



MATERIAL PROPERTIES

Rheology	Unit Weight (kN/m³)	Friction Angle (°)	Pore Pressure Coefficient	Friction Coefficient	Turbulence Coefficient	Internal Angle of Friction (°)	Erosion Depth (m)	
							Min	Max
Voellmy	20	25	-	-	-	35	0	0

NOTE: *See Section 2.4 for explanation of Material Properties*

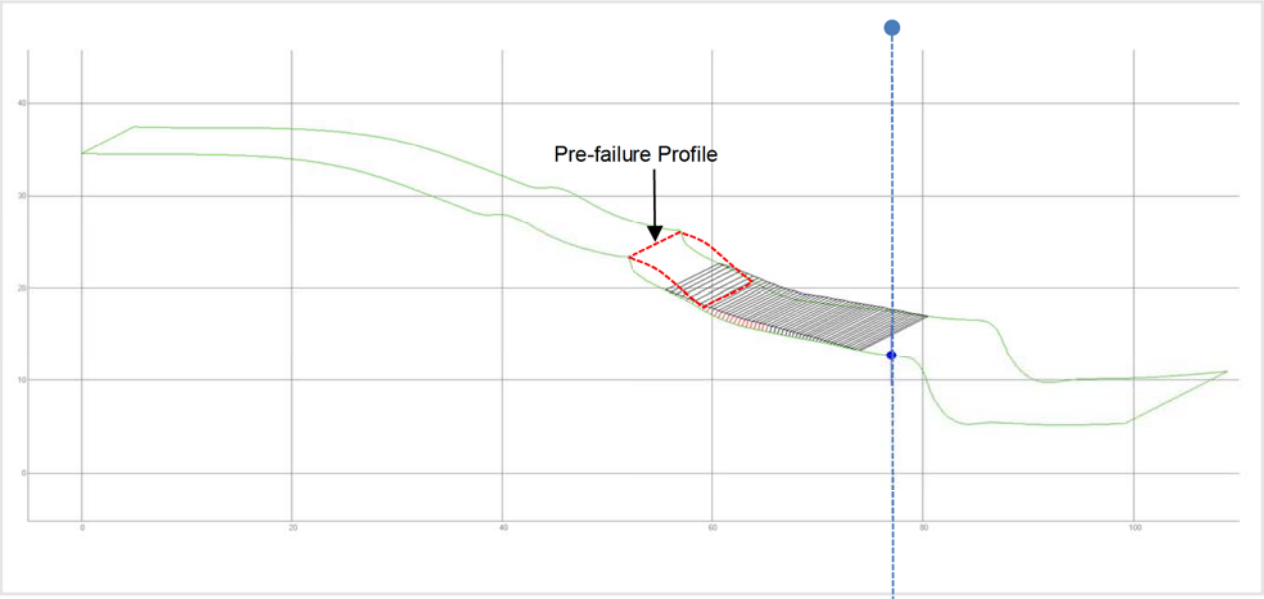
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau			
Sheet No.: 30	JOB NUMBER:	226464	SHEET DESCRIPTION:	Output Results	
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0	

Failure ID	F-G1
Hazard Type	OHL

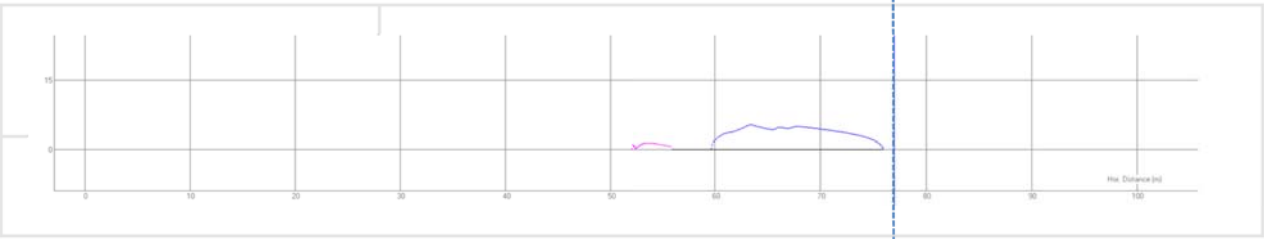
DEBRIS VOLUME

Computed Source Volume	99.33	m^3
Computed Entrainment	0	m^3

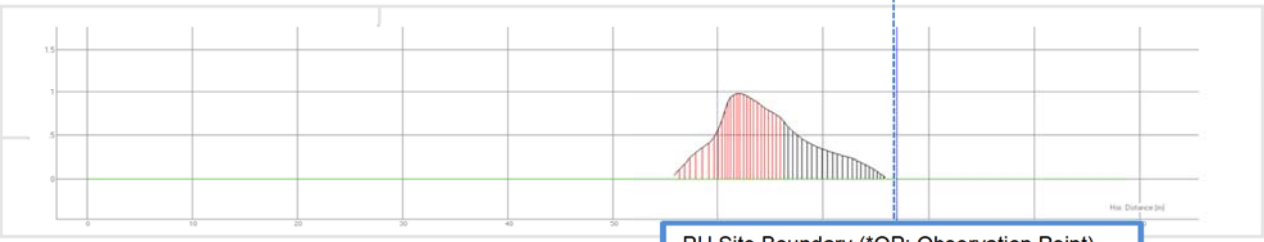
FAILURE PROFILE



VELOCITY PROFILE



THICKNESS PROFILE



PH Site Boundary (*OP: Observation Point)

DEBRIS RUN-OUT CHARACTERISTICS

Total Debris Volume	99.33	m^3
Total Debris Volume at OP	-	m
Maximum Debris Thickness at OP	-	m
Maximum Debris Velocity	4.96	m/s
Maximum Debris Velocity at OP	-	m/s

ADDITIONAL COMMENTS:

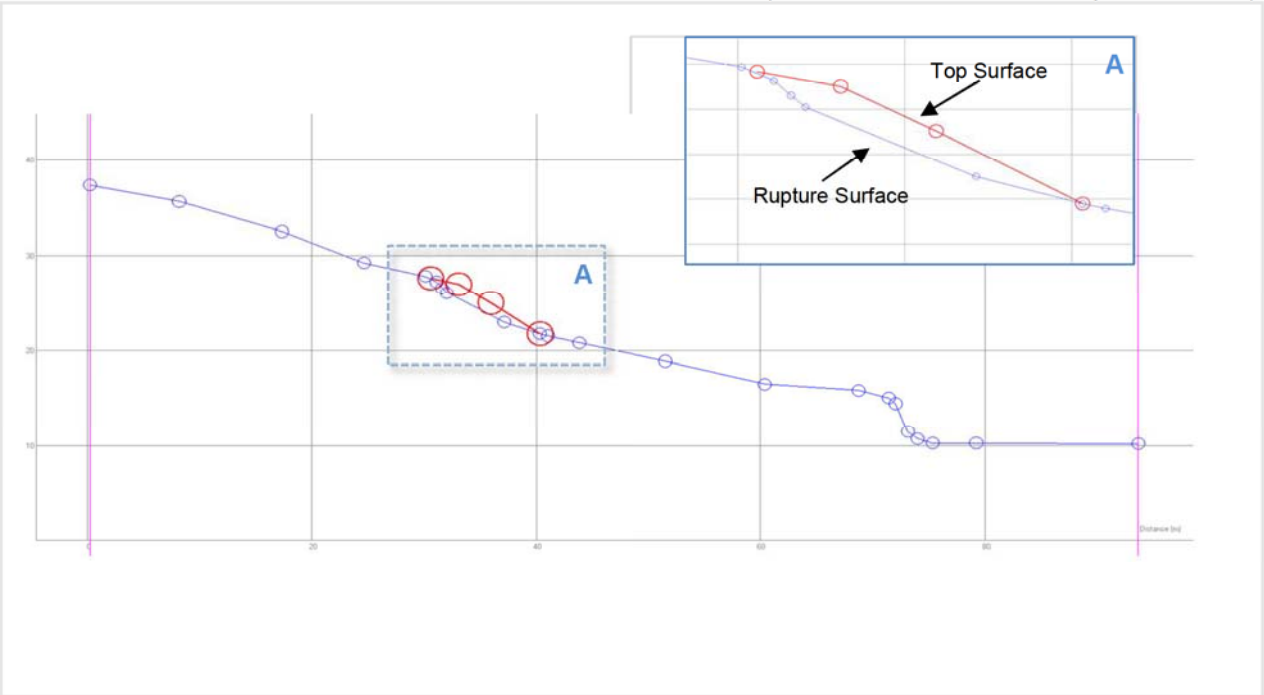
Debris modelling stops immediately before the site boundary. Adjustments were made to the failure geometry in order to encourage flow of the debris beyond the observation point, but this could not be achieved.

3.2 cont. **Details of Analysis Results by Failure**

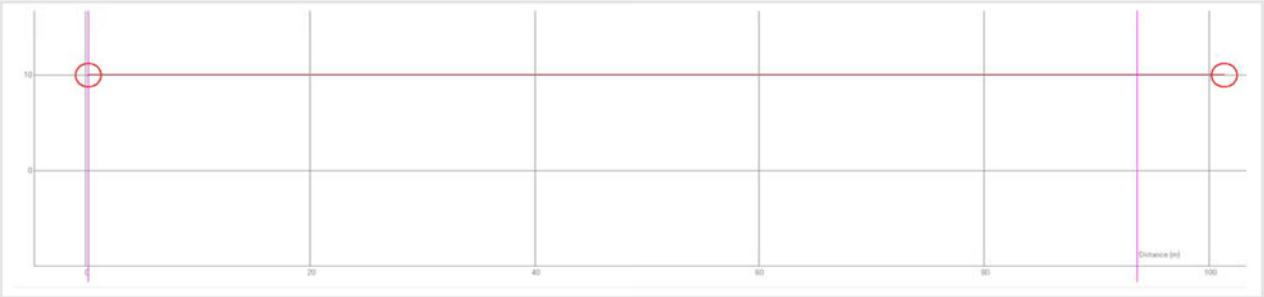
Failure ID	F-F1	Estimated Source Volume	100.00	m³
Hazard Type	OHL	Estimated Entrainment Volume	0	m³

SECTIONAL PROFILE

(**INSET** - Detailed view of rupture surface)



WIDTH PROFILE



MATERIAL PROPERTIES

Rheology	Unit Weight (kN/m³)	Friction Angle (°)	Pore Pressure Coefficient	Friction Coefficient	Turbulence Coefficient	Internal Angle of Friction (°)	Erosion Depth (m)	
							Min	Max
Voellmy	20	25	-	-	-	35	0	0

NOTE: *See Section 2.4 for explanation of Material Properties*

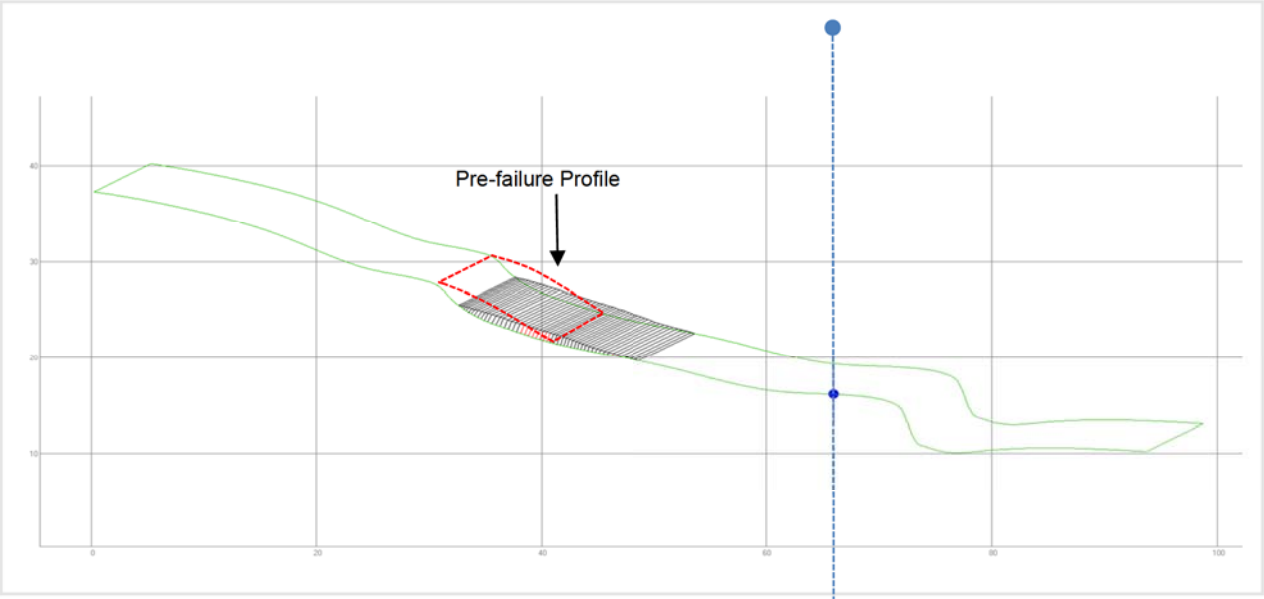
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau			
Sheet No.: 32	JOB NUMBER:	226464	SHEET DESCRIPTION:	Output Results	
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0	

Failure ID	F-F1
Hazard Type	OHL

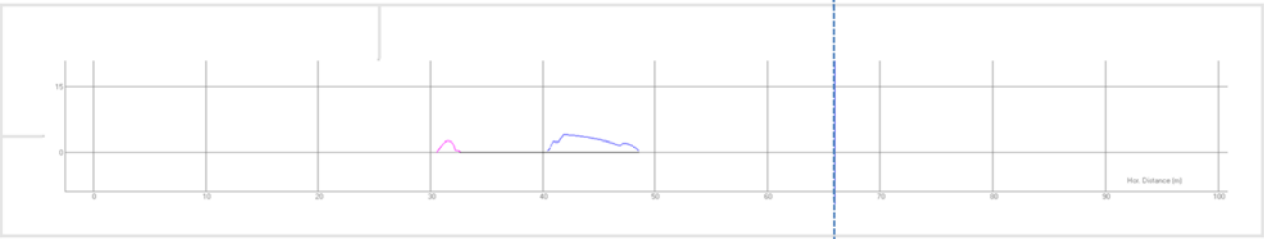
DEBRIS VOLUME

Computed Source Volume	101	m^3
Computed Entrainment	0	m^3

FAILURE PROFILE



VELOCITY PROFILE



THICKNESS PROFILE

PH Site Boundary (*OP: Observation Point)

DEBRIS RUN-OUT CHARACTERISTICS

Total Debris Volume	101.00	m^3
Total Debris Volume at OP	-	m
Maximum Debris Thickness at OP	-	m
Maximum Debris Velocity	4.02	m/s
Maximum Debris Velocity at OP	-	m/s

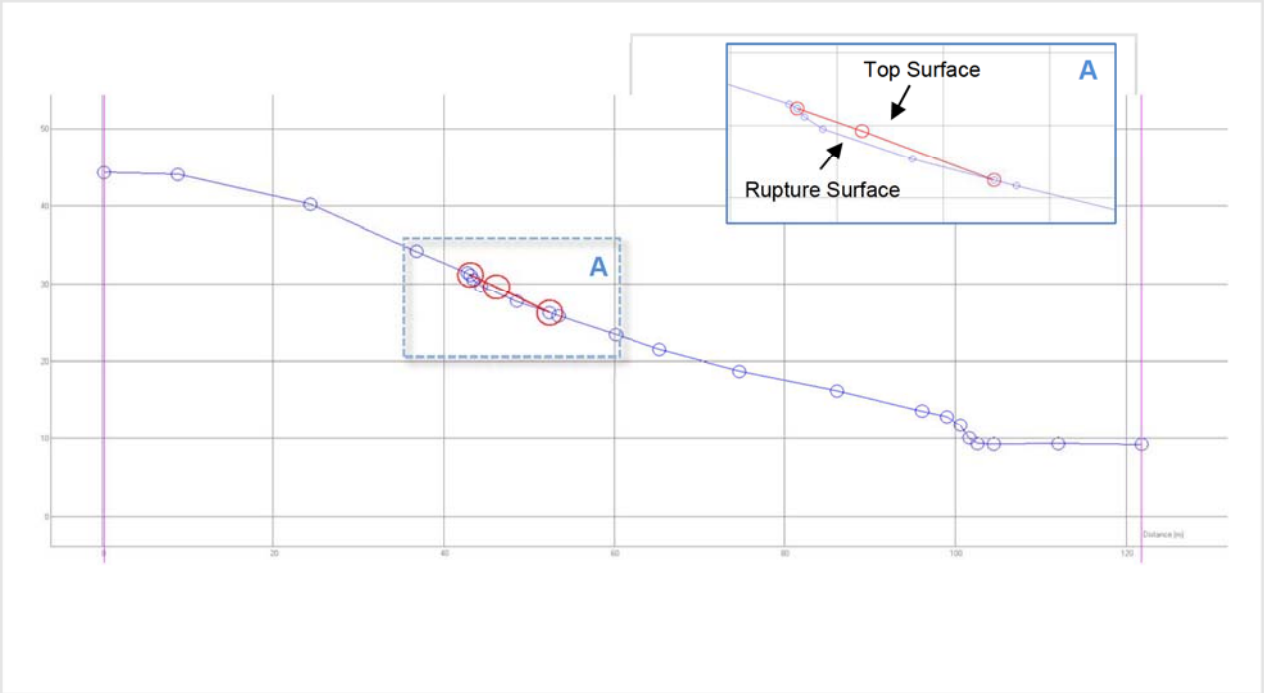
ADDITIONAL COMMENTS:

3.2 cont. **Details of Analysis Results by Failure**

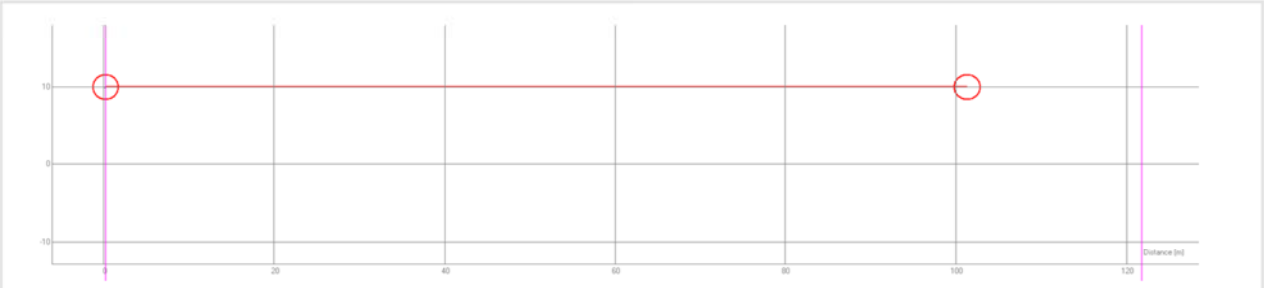
Failure ID	F-E1	Estimated Source Volume	50.00	m³
Hazard Type	OHL	Estimated Entrainment Volume	0	m³

SECTIONAL PROFILE

(**INSET** - Detailed view of rupture surface)



WIDTH PROFILE



MATERIAL PROPERTIES

Rheology	Unit Weight (kN/m³)	Friction Angle (°)	Pore Pressure Coefficient	Friction Coefficient	Turbulence Coefficient	Internal Angle of Friction (°)	Erosion Depth (m)	
							Min	Max
Voellmy	20	25	-	-	-	35	0	0

NOTE: *See Section 2.4 for explanation of Material Properties*

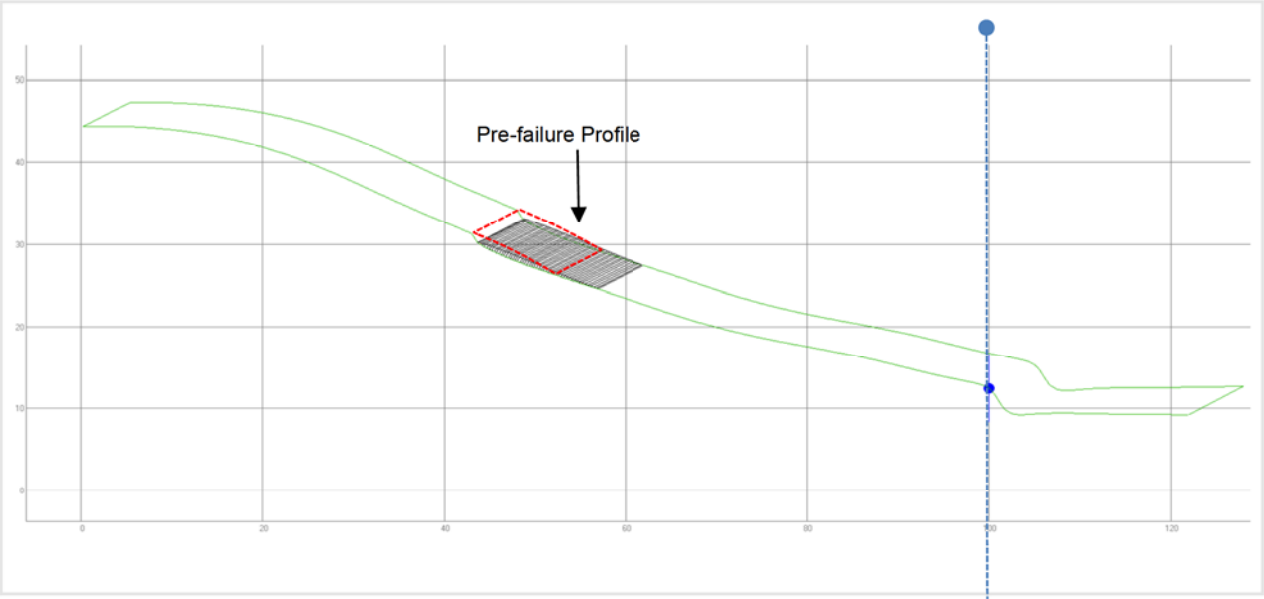
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau		
Sheet No.: 34	JOB NUMBER:	226464	SHEET DESCRIPTION:	Output Results
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0

Failure ID	F-E1
Hazard Type	OHL

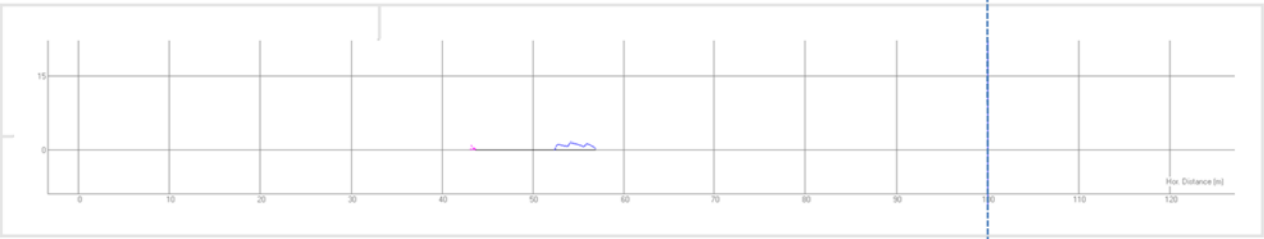
DEBRIS VOLUME

Computed Source Volume	53.6	m^3
Computed Entrainment	0	m^3

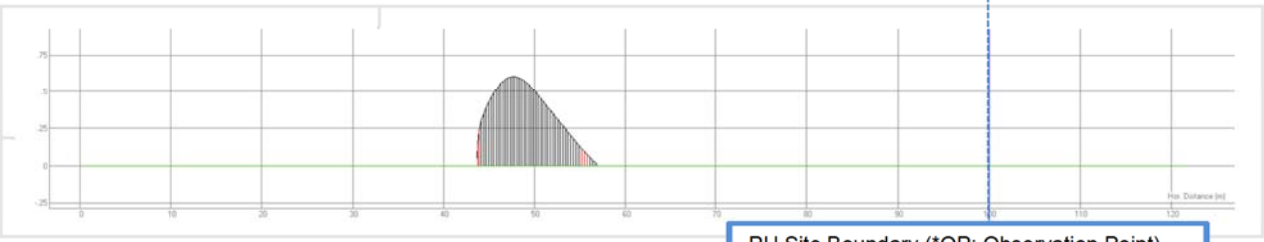
FAILURE PROFILE



VELOCITY PROFILE



THICKNESS PROFILE



PH Site Boundary (*OP: Observation Point)

DEBRIS RUN-OUT CHARACTERISTICS

Total Debris Volume	53.60	m^3
Total Debris Volume at OP	-	m
Maximum Debris Thickness at OP	-	m
Maximum Debris Velocity	1.48	m/s
Maximum Debris Velocity at OP	-	m/s

ADDITIONAL COMMENTS:

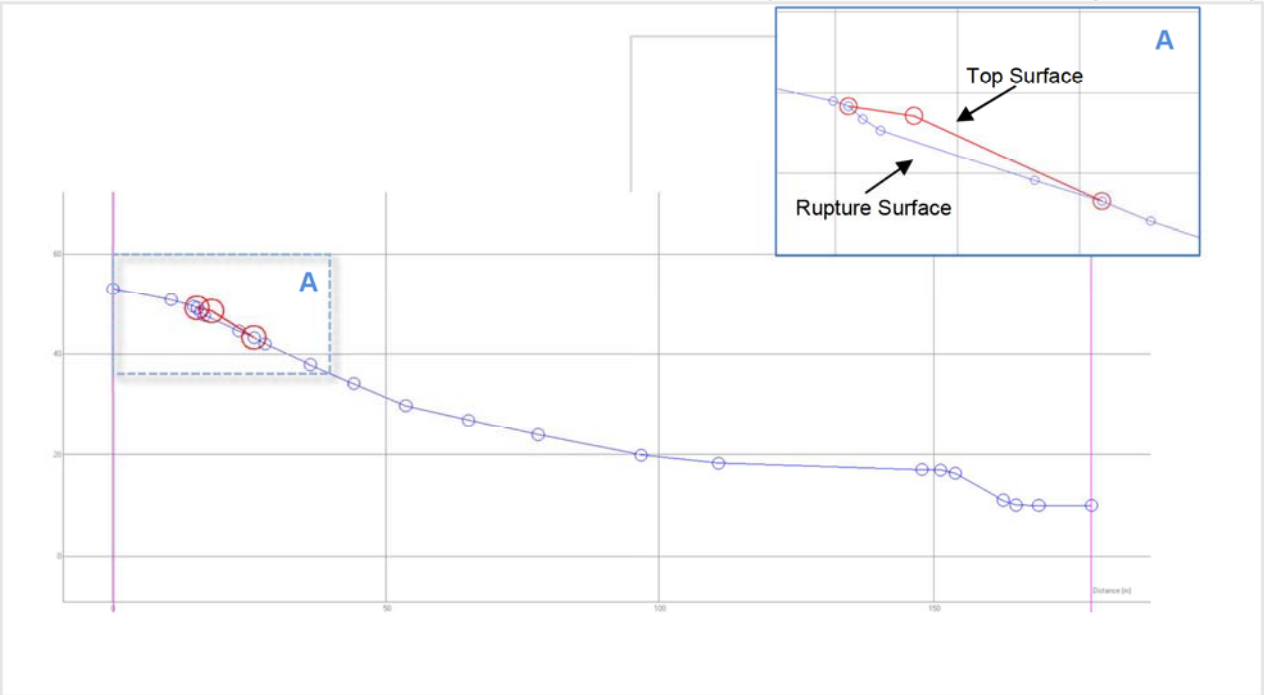
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau			
Sheet No.: 35	JOB NUMBER:	226464	SHEET DESCRIPTION:	Input Parameters	
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0	

3.2 cont. **Details of Analysis Results by Failure**

Failure ID	F-D1	Estimated Source Volume	100.00 m³
Hazard Type	OHL	Estimated Entrainment Volume	0 m³

SECTIONAL PROFILE

(**INSET** - Detailed view of rupture surface)



WIDTH PROFILE

MATERIAL PROPERTIES

Rheology	Unit Weight (kN/m³)	Friction Angle (°)	Pore Pressure Coefficient	Friction Coefficient	Turbulence Coefficient	Internal Angle of Friction (°)	Erosion Depth (m)	
							Min	Max
Voellmy	20	25	-	-	-	35	0	0

NOTE: *See Section 2.4 for explanation of Material Properties*

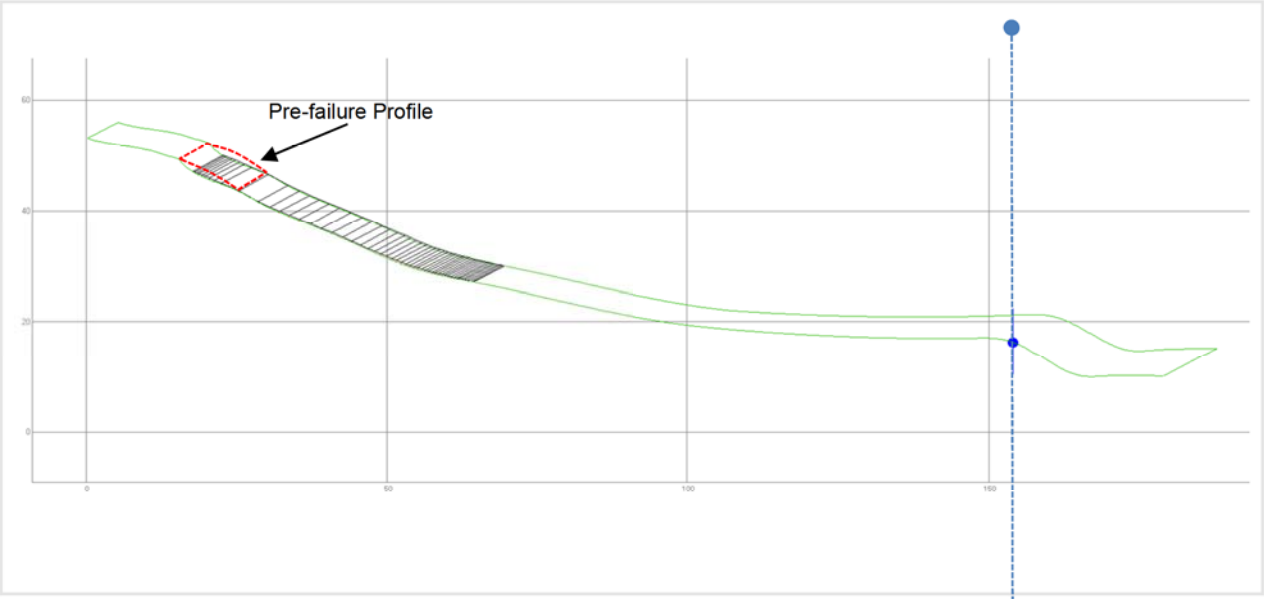
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau			
Sheet No.: 36	JOB NUMBER:	226464	SHEET DESCRIPTION:	Output Results	
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0	

Failure ID	F-D1
Hazard Type	OHL

DEBRIS VOLUME

Computed Source Volume	100.86	m^3
Computed Entrainment	0	m^3

FAILURE PROFILE



VELOCITY PROFILE

THICKNESS PROFILE

PH Site Boundary (*OP: Observation Point)

DEBRIS RUN-OUT CHARACTERISTICS

Total Debris Volume	100.86	m^3
Total Debris Volume at OP	-	m
Maximum Debris Thickness at OP	-	m
Maximum Debris Velocity	5.55	m/s
Maximum Debris Velocity at OP	-	m/s

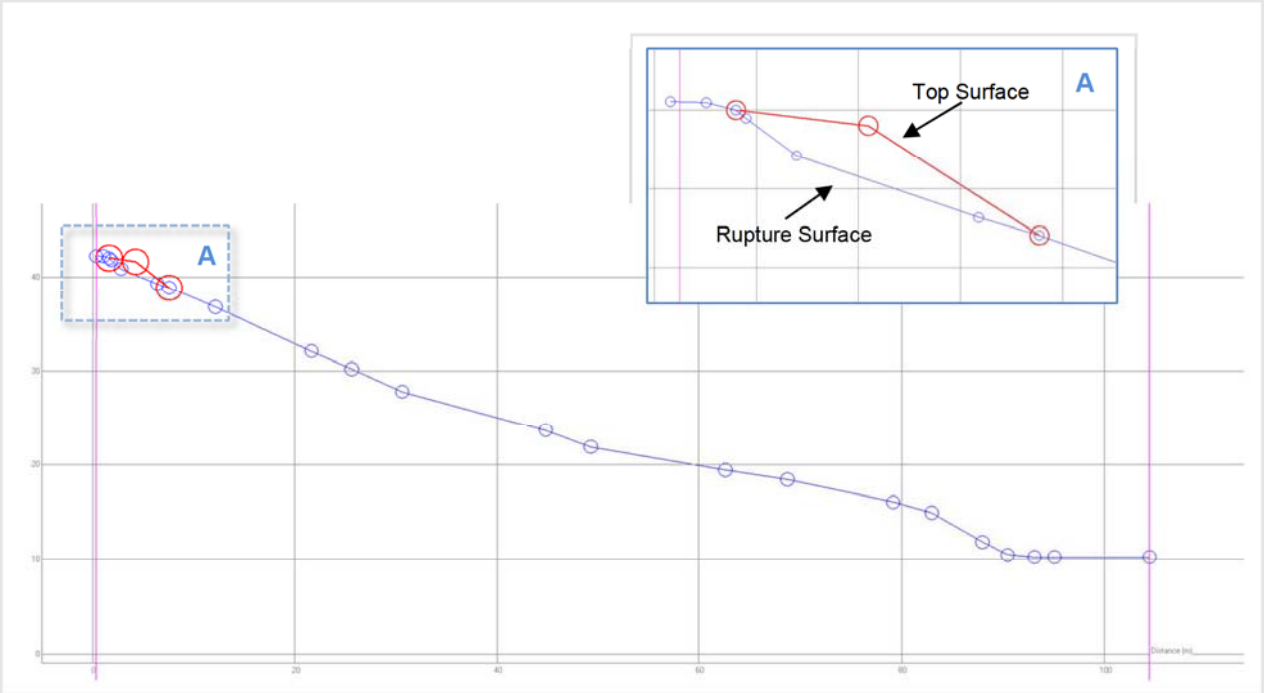
ADDITIONAL COMMENTS:

3.2 cont. **Details of Analysis Results by Failure**

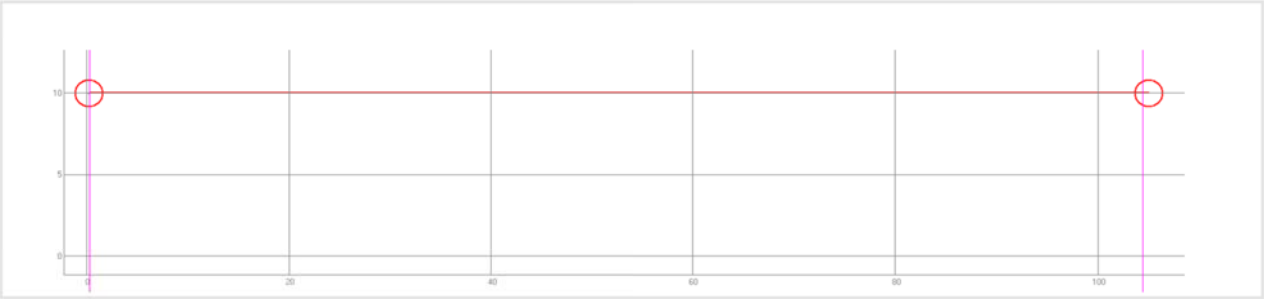
Failure ID	F-D2	Estimated Source Volume	50.00 m³
Hazard Type	OHL	Estimated Entrainment Volume	0 m³

SECTIONAL PROFILE

(**INSET** - Detailed view of rupture surface)



WIDTH PROFILE



MATERIAL PROPERTIES

Rheology	Unit Weight (kN/m³)	Friction Angle (°)	Pore Pressure Coefficient	Friction Coefficient	Turbulence Coefficient	Internal Angle of Friction (°)	Erosion Depth (m)	
							Min	Max
Voellmy	20	25	-	-	-	35	0	0

NOTE: *See Section 2.4 for explanation of Material Properties*

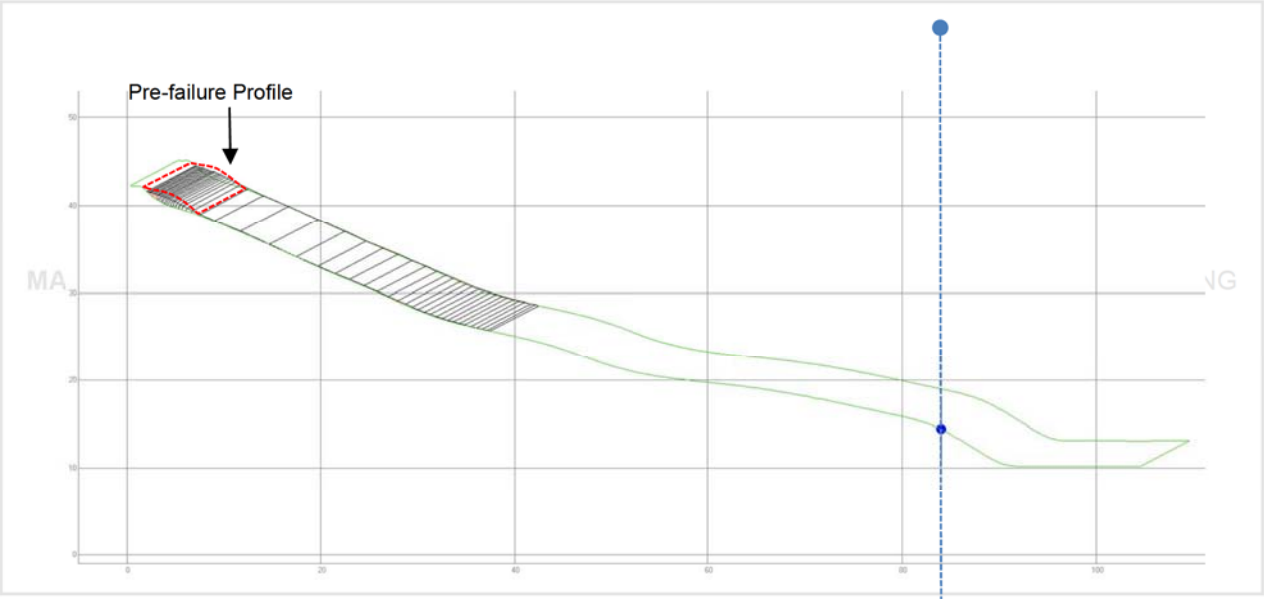
ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau			
Sheet No.: 38	JOB NUMBER:	226464	SHEET DESCRIPTION:	Output Results	
Date: Jun-13	Drawn: JC	Checked: JH	Approved: SM	Revision: 0	

Failure ID	F-D2
Hazard Type	OHL

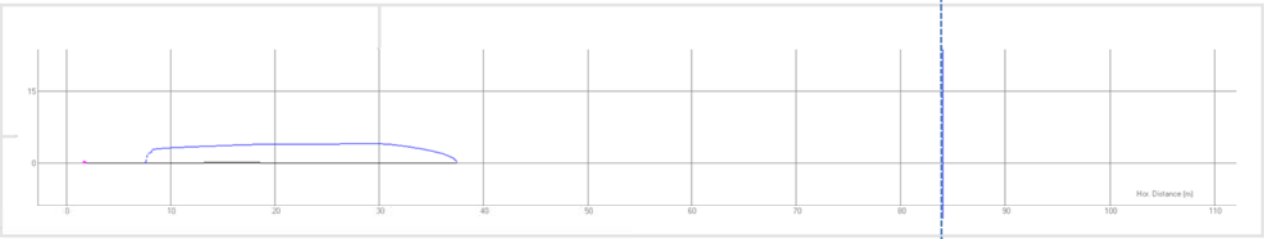
DEBRIS VOLUME

Computed Source Volume	50.27	m^3
Computed Entrainment	0	m^3

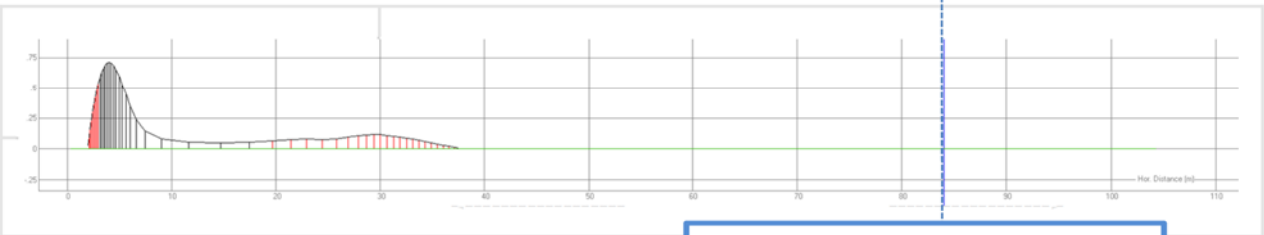
FAILURE PROFILE



VELOCITY PROFILE



THICKNESS PROFILE



PH Site Boundary (*OP: Observation Point)

DEBRIS RUN-OUT CHARACTERISTICS

Total Debris Volume	50.27	m^3
Total Debris Volume at OP	-	m
Maximum Debris Thickness at OP	-	m
Maximum Debris Velocity	4.18	m/s
Maximum Debris Velocity at OP	-	m/s

ADDITIONAL COMMENTS:

Appendix H

Boulder Fall Analysis

ARUP	Ove Arup & Partners Hong Kong Ltd.	CALCULATION SHEET - RocFall BOULDER FALL ANALYSIS

JOB TITLE	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau
JOB NUMBER	226464
REPORT TITLE	Natural Terrain Hazard Assessment
CALCULATED BY	[redacted]
CHECKED BY	[redacted]
APPROVED BY	[redacted]
DATE	Jun-13

CONTENTS OF SPREADSHEET

REVISIONS Current Revision: 0

Rev.	Date	Calculated by	Checked by	Description

1.0 INTRODUCTION

The potential boulder fall movements within critical catchment areas were analyzed based on the findings of the boulder survey and field inspections of the sites.

2.0 METHOD OF ANALYSES

2.1 RocFall Software

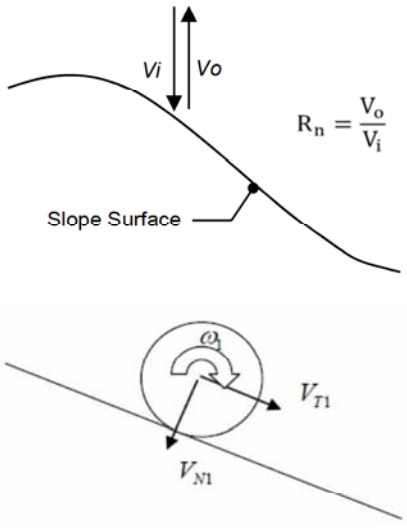
The computer programme RocFall has been used for the probabilistic simulation and statistical analysis of potential boulder falls. Analysis of boulder falls has been carried out based on the critical slope geometry, friction angles and material properties (coefficients of restitution) of the sliding surface identified from the field inspections and boulder survey data. The maximum travel distance of rocks, total kinetic energy, translational velocity and bouncing height of the potential boulder have been measured and plotted against the distance from the boulder source. The results have then used to determine appropriate mitigation strategies.

The critical sections for analysis were identified based on a GIS assessment of potential boulder fall trajectory and the slope friction angle, which is the same as the slope angle but with a 1° to 3° standard deviation of each segment assigned. The material coefficients, the coefficient of normal restitution (Rn) and coefficient of tangential restitution (Rt) are illustrated below and were determined based on the site inspection and with due reference to the default values provided by the computer program. The material coefficients used for the analysis are summarised as follows:

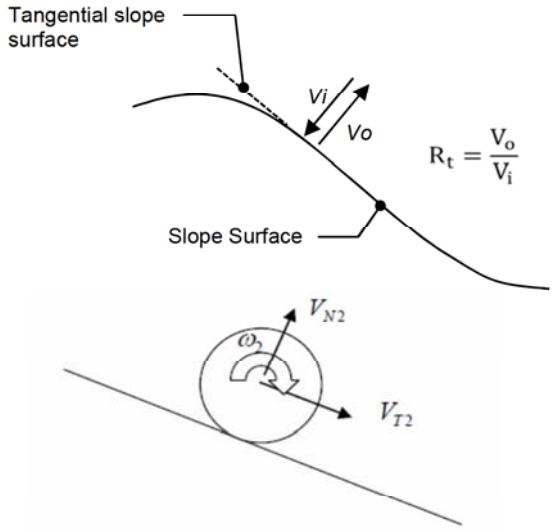
Materials	Rn	Rt
Soil with vegetation	0.3	0.8
Asphalt	0.4	0.9

Rock Type	Rock Density (kg/m³)
Metasiltstone	2600

Coefficient of Normal Restitution (Rn):



Coefficient of Tangential Restitution (Rt):



V_i	Incoming Velocity
V_o	Outgoing Velocity

2.2 Assumptions for RocFall Analysis

- Each rock block or boulder is modelled as a particle.
- The particle is an infinitesimal circle.
- There is no interaction between particles, only with slope segments and barriers.
- The mass of the particle is determined at the beginning of the stimulation and stays constant throughout the simulation. That is the rock cannot split into multiple pieces during the simulation.
- The friction angle of the slope segment is assumed to be the slope angle of that segment as the rock is presently stable on the slope.
- 1000 iterations are carried out for each analysis for a reasonable result based on probability.
- Boulder fall initiation point was input using the 'point seeder' function in order to indicate boulder falls within those zones / clusters identified as having potential for instability.

2.3 Maximum Values/Data Collectors

For each analysis the following values will be indicated along the trajectory of the boulders:

- Global Maximum
- Data Collector (DC) Maximum

Global maximum value indicates the overall highest value for a given output parameter.

A "data collector" is a line segment that gathers information about the rocks that pass through the data collector while the rocks are being thrown down the slope. "Data collectors" record the velocity, kinetic energy and bounce height of all rocks that pass through the data collector as they travel down the slope. Data collectors can be added onto the slope profile to determine such information at specified locations without altering the boulder fall trajectory down slope.

There is no restriction on the number of data collectors or where they can be placed. Data collectors are optional and can be added to RocFall analysis to indicate the boulder fall data at the proposed mitigation measures for reference purpose.

3.0 BOULDER FALL ANALYSIS

3.1 Summary of Input Parameters

Hazard Type/ID	Catchment ID	AD	AC	AC	X	-	-	-
	Section ID	AD-B1	AC-B1	AC-B2	X-B1	-	-	-
	Seeder Type	Line	Line	Line	Line	-	-	-
	Failure ID	AD-B1	AC-B1	AC-B2	X-B1	-	-	-
Boulder/Slope Geometry	Estimated Boulder size (m^3)	3.0	2.5	2.0	2.0	-	-	-
	Estimated Boulder mass (kg)	7,800	6,500	5,200	5,200	-	-	-
	Average Slope Gradient (°)	27	28	20	30	-	-	-

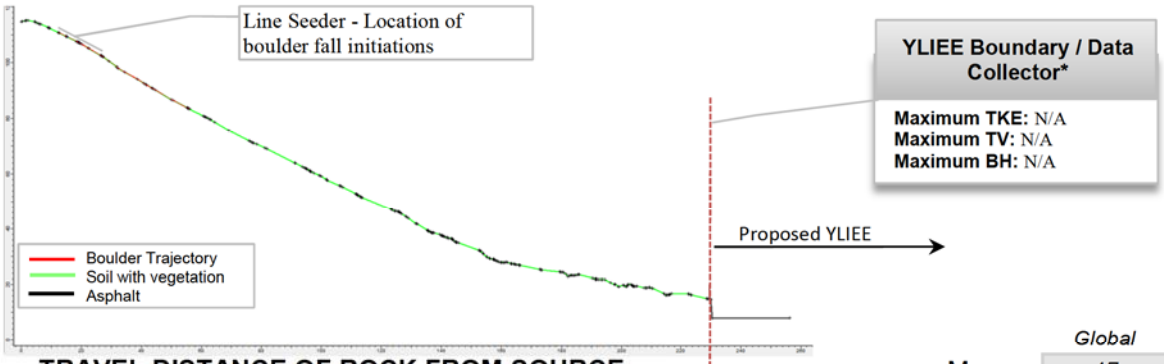
NOTE: *See **Figure F2** for Study Area, NT Catchment locations, section lines and seeder locations*

ARUP	JOB TITLE:	Agreement No. CB20120293 Planning and Engineering Study for the Public Housing Site and Yuen Long Industrial Estate Extension at Wang Chau			
Sheet No.: 4	JOB NUMBER:	226464	SHEET DESCRIPTION:	Detailed RocFall Analysis	
Date: Jun-13	Prepared by: JC	Checked by: JH	Approved by: SWM	Revision: 0	

3.2 Details of RocFall Analysis Along Section Line

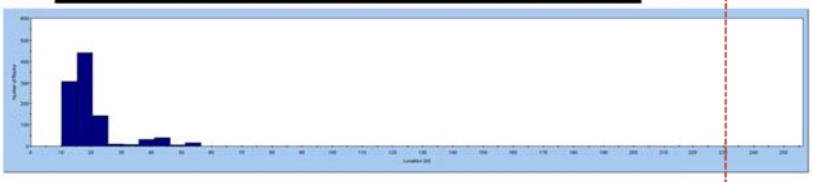
Catchment ID:	AD	Failure ID:	AD-B1
Section ID:	AD-B1	Estimated Boulder Size:	3.0 m³

SLOPE PROFILE AND TRAJECTORY OF BOULDERS



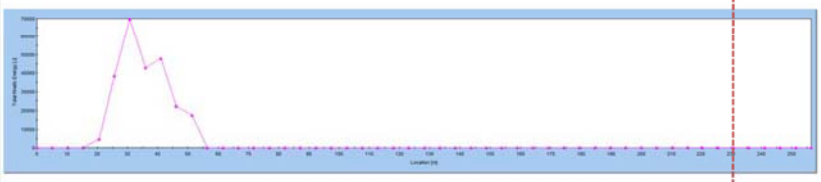
TRAVEL DISTANCE OF ROCK FROM SOURCE

	Global	
Max.:	47	m



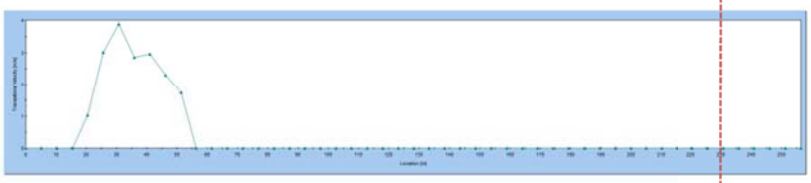
TOTAL KINETIC ENERGY (TKE)

	Global	DC*	
Max.:	7	0	kJ



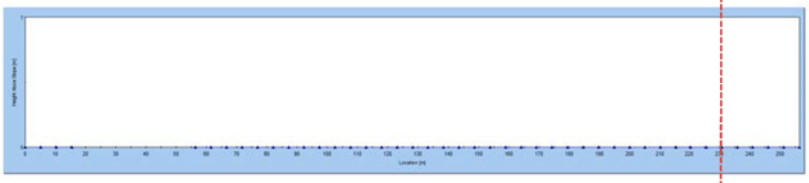
TRANSLATIONAL VELOCITY (TV)

	Global	DC*	
Max.:	3.9	0	m/s



BOUNCE HEIGHT (BH)

	Global	DC*	
Max.:	0	0	m



*Data Collector

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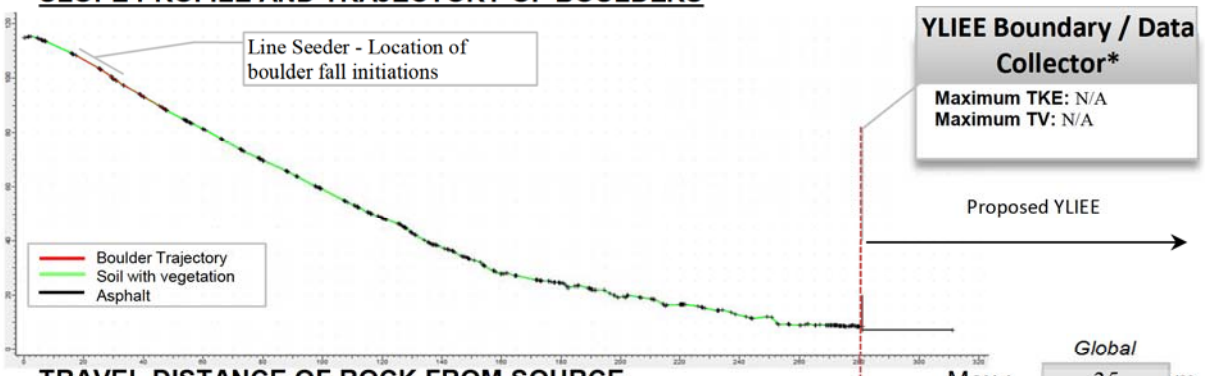
Sheet No.: 5	JOB NUMBER:	226464	SHEET DESCRIPTION:	Detailed RocFall Analysis			
Date: Jun-13	Prepared by: JC	Checked by: JH	Approved by: SWM	Revision: 0			

3.2 Details of RocFall Analysis Along Section Line *(continued)*

Catchment ID:	AC	Failure ID:	AC-B1
Section ID:	AC-B1	Estimated Boulder Size:	2.5 m³

SLOPE PROFILE AND TRAJECTORY OF BOULDERS

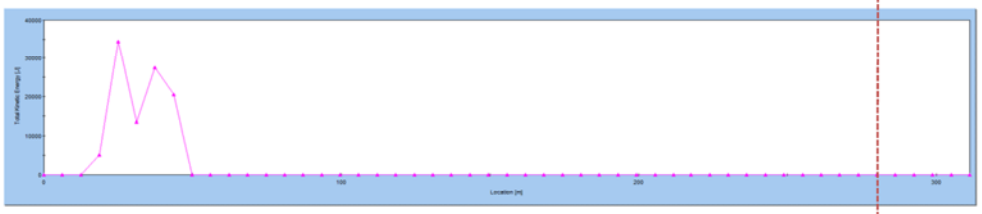


TRAVEL DISTANCE OF ROCK FROM SOURCE

	Global
Max.:	35 m

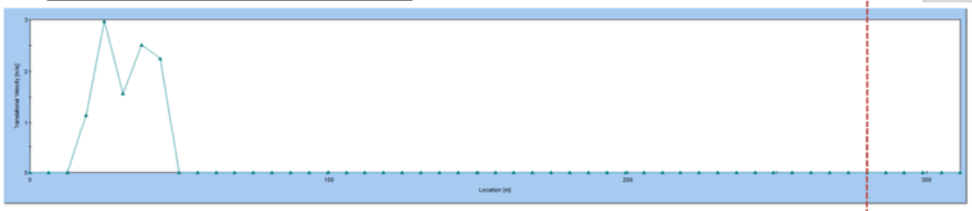
TOTAL KINETIC ENERGY (TKE)

	Global	DC*
Max.:	30	0 kJ



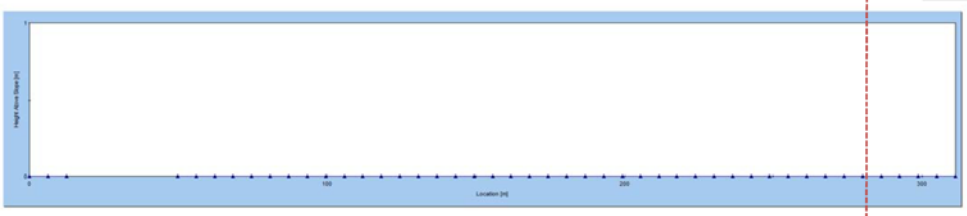
TRANSLATIONAL VELOCITY (TV)

	Global	DC*
Max.:	3	0 m/s



BOUNCE HEIGHT (BH)

	Global	DC*
Max.:	0	0 m



*Data Collector

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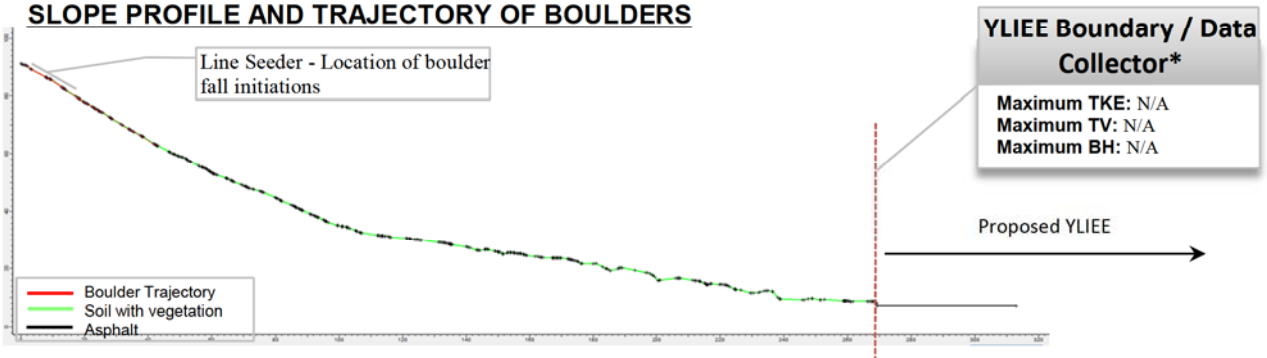
Sheet No.: 6	JOB NUMBER:	226464	SHEET DESCRIPTION:	Detailed RocFall Analysis			
Date: Jun-13	Prepared by: JC	Checked by: JH	Approved by: SWM	Revision: 0			

3.2 Details of RocFall Analysis Along Section Line *(continued)*

Catchment ID:	AC	Failure ID:	AC-B2
Section ID:	2	Estimated Boulder Size:	2.0 m³

SLOPE PROFILE AND TRAJECTORY OF BOULDERS

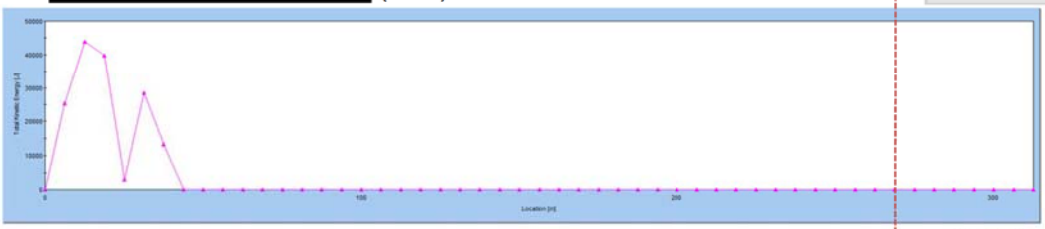


TRAVEL DISTANCE OF ROCK FROM SOURCE

	Global	
Max.:	45	m

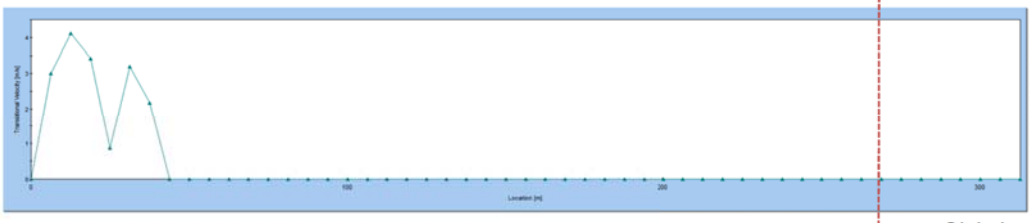
TOTAL KINETIC ENERGY (TKE)

	Global	DC*	
Max.:	4.5	0	kJ



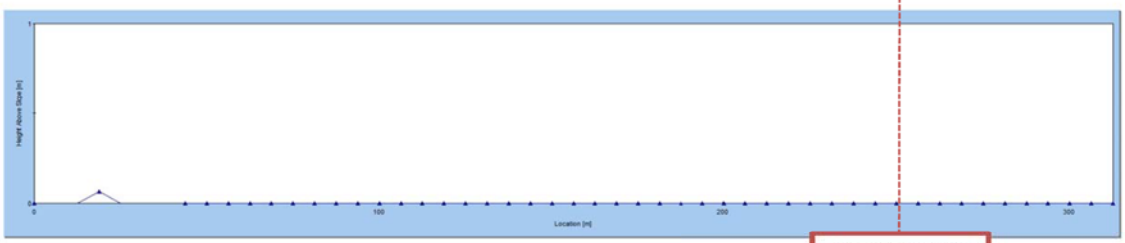
TRANSLATIONAL VELOCITY (TV)

	Global	DC*	
Max.:	4.1	0	m/s



BOUNCE HEIGHT (BH)

	Global	DC*	
Max.:	0.07	0	m



*Data Collector

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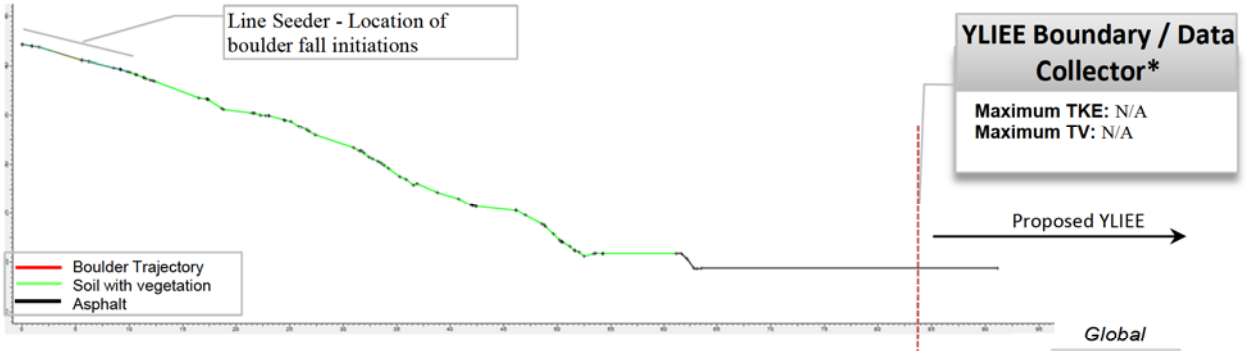
Sheet No.: 7	JOB NUMBER:	226464	SHEET DESCRIPTION:	Detailed RocFall Analysis			
Date: Jun-13	Prepared by: JC	Checked by: JH	Approved by: SWM	Revision: 0			

3.2 Details of RocFall Analysis Along Section Line *(continued)*

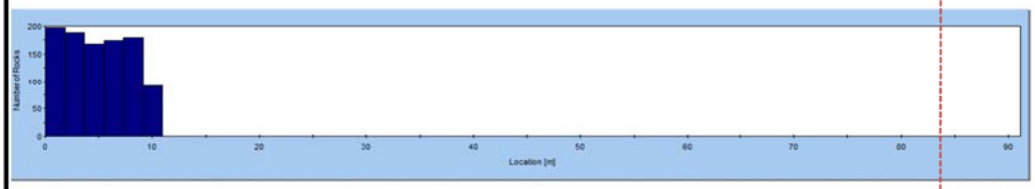
Catchment ID:	X	Failure ID:	X-B1
Section ID:	1	Estimated Boulder Size:	2.0 m³

SLOPE PROFILE AND TRAJECTORY OF BOULDERS



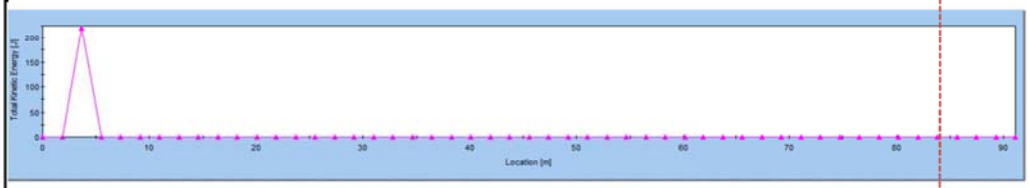
TRAVEL DISTANCE OF ROCK FROM SOURCE

	Global	
Max.:	10	m



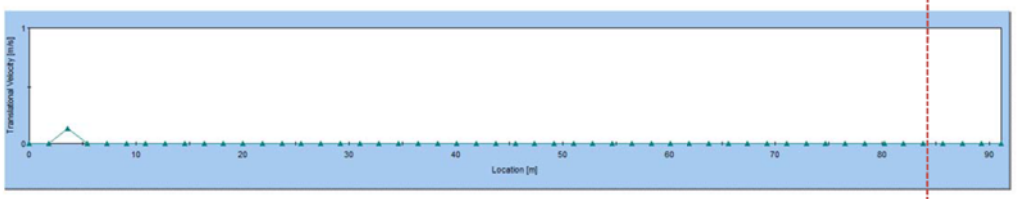
TOTAL KINETIC ENERGY (TKE)

	Global	DC*	
Max.:	0.25	0	kJ



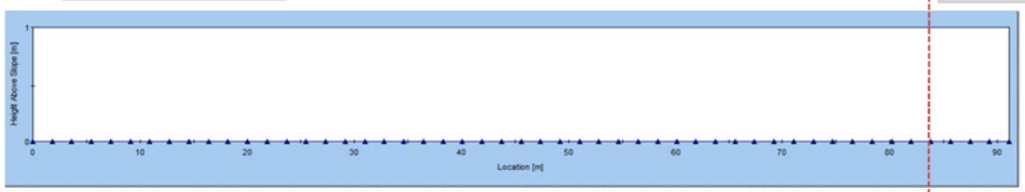
TRANSLATIONAL VELOCITY (TV)

	Global	DC*	
Max.:	0.13	0	m/s



BOUNCE HEIGHT (BH)

	Global	DC*	
Max.:	0	0	m



*Data Collector

4.0 SUMMARY OF ROCFALL ANALYSIS

4.1 Summary of Results

Hazard Type/ID	Catchment ID	AD	AC	AC	X	-	-	-
	Section ID	AD-B1	AC-B1	AC-B2	X-B1	-	-	-
	Seeder Type	Line	Line	Line	Line	-	-	-
	Failure ID	AD-B1	AC-B1	AC-B2	X-B1	-	-	-
Global Maximums	Travel Distance from Source (m)	47	35	45	1	-	-	-
	Total Kinetic Energy (kJ)	7	30	5	0	-	-	-
	Translational Velocity (m/s)	3.9	3.0	4.1	0.1	-	-	-
	Bounce Height (m)	0.0	0.0	0.1	0.0	-	-	-
Data Collector Maximums	Max. Total Kinetic Energy (kJ)	0	0	0	0	-	-	-
	Max. Translational Velocity (m/s)	0.0	0.0	0.0	0.0	-	-	-
	Max. Bounce Height (m)	0.0	0.0	0.0	0.0	-	-	-
Boulder reaches site platform		No	No	No	No	-	-	-
Mitigation Works Required		No	No	No	No	-	-	-

NOTE: *See **Figure F2** for Study Area, NT Catchment locations, section lines and seeder locations*

5.0 CONCLUSIONS

Based on the boulder fall analyses of the natural terrain adjacent to the proposed development, it can be concluded that the proposed site is unlikely to be affected by boulder fall hazards. Although a number of boulders, if initiated, may travel within the natural terrain, the modelling shows that they travel less than 50m from the source, and will come to rest within the natural terrain, not impacting on the proposed development. As a result of site incpection, and subsequent modelling mitigation measures for boulder fall hazard are not required for the proposed development.