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CRCC - HC - CR15G JV

Groundwater Monitoring And Contingency Plan

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CRCC – HC – CR15G JV

Express Rail Link

Contract 826 – Huanggang to Mai Po Tunnels

Groundwater Monitoring and Contingency Plan

July 2013

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Quality Information

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Approved by	Josh Lam

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Revision	Date of Issue	Prepared	Reviewed	Approved	Description
---	June 2010	Various	Gigi Lam	Josh Lam	First Draft
A	July 2010	Various	Gigi Lam	Josh Lam	Second Draft
B	July 2013	Various	Gigi Lam	Josh Lam	Third Draft

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Abbreviations

AAA	Alert, Action and Alarm
AECOM	AECOM Asia Company Ltd
CRCC-HC-CR15G JV	China Railway Construction Corporation Limited-Hsin Chong Construction Company Limited-China Railway 15 Bureau Group Corporation Joint Venture
DAP	Detailed Action Plan
DEP	Director of Environmental Protection
EAP	Emergency Access Point
EIA	Environmental Impact Assessment
EIAO	Environmental Impact Assessment Ordinance
ETL	Environmental Team Leader
EM	Engineering Manager
EO	Environmental Officer
EP	Environmental Permit
ET	Environmental Team
HKSAR	Hong Kong Special Administrative Region
IAP	Immediate Action Plan
IEC	Independent Environmental Checker
MPV	Mai Po Ventilation Building
MTRCL	Mass Transit Railway Corporation Limited
NB	Northbound
PME	Power Mechanical Equipment
PS	Contract 826 - Particular Specification
SB	Southbound
TBM	Tunnel Boring Machine
XRL	Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link

1. INTRODUCTION

1.1 Project Background

1.1.1 The "Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link" Project (hereinafter known as "the XRL") covers a 26km long underground rail line on a dedicated track that runs from the terminus in West Kowloon to the boundary at Huanggang, where is connect with the XRL Mainland section. XRL Project also covers ventilation buildings, emergency access points, stabling sidings and maintenance facilities and an emergency rescue station.

1.1.2 An Environmental Impact Assessment (EIA) study for the Project was conducted in accordance with the EIA Study Brief No. ESB-197/2008. The EIA study concluded that the Project would be environmentally acceptable with the implementation of mitigation measures.

1.1.3 The EIA Report (Register No.: AEIA-143/2009) was approved on 28 September 2009 by the Director of Environmental Protection (DEP) under the Environmental Impact Assessment Ordinance (EIAO). Following the approval of the EIA Report, an environmental permit (EP) was granted on 16 October 2009 (EP No: EP-349/2009) for the construction and operation of the Project.

1.1.4 According to Sections 4.21 to 4.25 of XRL EIA Report, the potential groundwater drawdown and associated impact on fish ponds above the bored tunnels in Mai Po area is not anticipated with implementation of appropriate construction practice. However, monitoring of groundwater levels and implementation of emergency response plan should be conducted to avoid/minimize the potential impact during construction phase.

1.1.5 China Railway Construction Corporation Limited-Hsin Chong Construction Company Limited-China Railway 15 Bureau Group Corporation JV (CRCC-HC-CR15G JV) was appointed by the MTRCL in March 2010 as the Contractor of the Express Rail Link Works Contract 826 – Hong Kong Boundary to Mai Po Tunnels (in the HKSAR zone).

1.1.6 AECOM Asia Co. Ltd has been commissioned by the CRCC-HC-CR15G JV (hereinafter referred to "the Joint Venture") to prepare a Groundwater Monitoring and Contingency Plan.

1.2 Scope / Structure of Report

1.2.1 According to the Environmental Permit No. EP-349/2009/I 2.11, the Contractor is required to prepare a contingency plan to deal with any unforeseeable incidents which might affect the groundwater level.

1.2.2 This Plan is prepared to specify the details of groundwater monitoring locations and programme, the mechanism to monitor the implication from the works to the groundwater system and fish ponds including their water levels, action levels and contingency responses such as immediate action, remedial action and investigation.

1.2.3 This document has been organized as follows:

Section 1: Project introduction and the scope of the report.

Section 2: describes the general site conditions and project's scope of work.

Section 3: discusses the potential cause and impact of groundwater drawdown.

Section 4: outlines the instrumentation to be adopted in the baseline monitoring.

Section 5: presents the purpose, programme and parameters of monitoring; and briefs the monitoring programme.

Section 6: presents the Contingency Plan, with the definition and determination of the Alert, Action and Alarm (AAA) Levels, and recommendations on the precautionary measures and mitigation measures upon reaching the AAA Levels.

Section 7: outlines the reporting requirements.

Section 8: conclusion.

1.3 Information Reviewed

1.3.1 The following information has been reviewed for the preparation of this report:

- Consultancy Agreement No. NOL/ERL-300 – Environmental Impact Assessment of Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link – Environmental Impact Assessment Report May 2009.
- Consultancy Agreement No. NOL/ERL-300 – Environmental Impact Assessment of Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link – Environmental Monitoring and Audit Manual May 2009.
- Contract No. LDB201 Sheung Shui to Chau Tau Tunnels Generalised Plan of Action, (LDB201/16/C93/001 Rev. C) November 2003.

2. PROJECT DESCRIPTION

2.1.1 The C826 Hong Kong Boundary to Mai Po Tunnel section of the XRL alignment locates at approximately -30mPD, running approximately 20m beneath fish ponds in the Mai Po Wetland Conservation Area and Wetland Buffer Area. Large-scale active fishponds were located in Mai Po Area and the tunnels will pass under about 10 fish ponds north of Mai Po Ventilation Building (MPV) before crossing into Mainland.

2.1.2 The section of running tunnel of approximately 1490m long (the total length of two tunnels is 2980m) to be constructed in XRL Contract 826 between the Boundary and Mai Po are twin bore single track tunnels with an internal diameter of 8.7m and 450mm thick precast segmental lining. The twin-bored tunnels will be constructed by mean of two Mix-shield TBMs of diameter 9.96m.

2.1.3 The twin tunnels will drive through soft and mixed geological ground condition. The excavated materials of the bored tunnels are anticipated to be in the proportion of 90% soft materials and 10% of hard materials. Soft materials are mainly consist of alluvium sand / silt, completely decomposed meta-siltstone, highly to moderately decomposed meta-siltstone. Hard materials are mainly consist of slightly decomposed meta-siltstone and marble.

2.1.4 The construction period of the tunneling shall be end of October 2013 to June 2014.

3. POTENTIAL CAUSE AND IMPACT OF GROUNDWATER DRAWDOWN

3.1 Potential Cause and Impact of Groundwater Drawdown

3.1.1 The Hong Kong Boundary to Mai Po Tunnel section would be constructed by bored tunneling. Two closed face slurry type Tunnel Boring Machines (TBM), will be used for tunneling work. During excavation, the TBM will provide full support to the face of the excavation so as to limit face (volume) losses. The permanent ground support will be in the form of an undrained precast reinforced concrete segmental lining which will be installed at the tailskin of the TBM as it advances so as to provide immediate ground support. In order to further control ground settlement, it is anticipated that the overcut annulus will be back-grouted as, or immediately after, the lining (ring) leaves the tailskin of the TBM. The use of two closed face slurry type TBMs in conjunction with an "undrained" tunnel lining effectively precludes the ingress of water into the tunnel during and following construction. It is therefore anticipated that the bored tunneling would not affect the hydrological conditions.

3.1.2 The major concern of the hydrogeological impact assessment is the potential groundwater drawdown in any soil and aquifer layers. Any potential drawdown could result in different degrees of settlement and dewatering of surface water features, thus affecting the ecology supported by the habitats.

3.1.3 Bored tunneling methods were deployed in some similar large scale projects in Hong Kong such as West Rail and Lok Ma Chau Spur Line. Comprehensive hydrological survey was carried out at Long Valley throughout the tunnel construction period of the Lok Ma Chau Spur Line project. A year-round ground water baseline was established prior to the commencement of the TBM tunneling to record ground water level behaviour in respective wet and dry seasons. Ground water level was closely monitored before, during and after each TBM drive. No significant deviations of ground water level from the baseline resulted from the tunneling works were identified.

3.1.4 Although potential impact of groundwater drawdown is unlikely, monitoring of groundwater level before and during bored tunneling works, as well as development of contingency plan, are suggested as precautionary measures to further minimize the potential risk and impact.

4. INSTRUMENTATION MONITORING

4.1 Monitoring Locations

4.1.1 The locations of the existing installed standpipe/piezometer are shown in **Figure Nos. C826/C/310/CRH/C06/001 – 004,007** and a summary of findings is shown in **Table 4.1**.

Table 4.1 Summary findings of existing standpipe/piezometer

Drill Hole no.	Location
SPP-D269	Mai Po Fish Pond
SPP-A003	Mai Po Fish Pond
SPP-D264	Mai Po Fish Pond
SPP-D263	Mai Po Fish Pond
SPP-D262	Mai Po Fish Pond
SPP-D261	Mai Po Fish Pond
SPP-PZ2	Hop Shing Wai, San Tin
SPP-PZ4	Tam Kon Chau Road, San Tin
SPP1	Mai Po Fish Pond
SPP2	Mai Po Fish Pond
ABH1	Mai Po Fish Pond
ABH2	Mai Po Fish Pond
ABH3	Mai Po Fish Pond
ABH4	Mai Po Fish Pond
SPP-3	Mai Po Fish Pond
SPP4	Mai Po Fish Pond
SPP5	Mai Po Fish Pond
SPP6	Mai Po Fish Pond
SPP-7	Mai Po Fish Pond
SPP8	Mai Po Fish Pond
SPP9	Mai Po Fish Pond
SPP10	Mai Po Fish Pond
SPP11	Within 825 Site boundary
SPP12	Within 825 Site Boundary

5.0 BASELINE AND IMPACT MONITORING

5.1 Purpose of Baseline Monitoring

5.1.1 Baseline monitoring of the groundwater level serves the following purposes:

(i) Establish the existing levels and possible flow of groundwater in the vicinity of the C826 tunnel;

(ii) Provide baseline data for the determination of Alert, Action and Alarm Levels for impact monitoring during construction stage;

(iii) Identify external activities that could affect the groundwater level for determination of possible mitigation measures and contingency responses;

(iv) Allows analysis of natural groundwater variations, including meteorological/seasonal effects on groundwater level and regular operation of fish ponds, which would provide justification on possible mitigation measures and contingency plan.

5.2 Baseline Monitoring Parameters

5.2.1 The Hydrogeological Impact Assessment of the approved XRL EIA (Appendix 11.8) suggested there was very little tidal influence on the groundwater regime in the Mai Po Marches.

5.2.2 It is anticipated that lowest groundwater level would occur during dry season, presenting worst case condition (see **Section 6.3**). The Alert, Action and Alarm (AAA) Levels shall therefore be determined based on the baseline monitoring data of the dry season.

5.2.3 To achieve a better understanding of the meteorological/seasonal and groundwater relationship, monthly monitoring of groundwater level in each monitoring event are proposed. Different sets of AAA Levels for dry/ wet seasons would be proposed for impact monitoring.

5.3 Baseline Monitoring Programme

5.3.1 Baseline monitoring is being conducted at the installed locations of standpipes / piezometers (see **Section 4**), there should be no active construction works carried out during baseline monitoring.

5.3.2 Monthly piezometric readings was taken for at least one year. The date, pipe level and the corrected water level (mPD) of groundwater should be recorded. Graphical plots of the groundwater response should be provided in the analysis.

5.4 Construction Stage - Impact Monitoring

5.4.1 Active Monitoring should be carried out during active tunneling works of C826 within 50m of the instrument. Daily piezometric reading should be taken during the monitoring.

5.4.2 Standard Monitoring should be carried out weekly during the times which do not require background monitoring or active monitoring, e.g. if active construction activities are being conducted further than 50m away and within 100m, or works taking place within 50m are, in the opinion of the Engineer, minor activities that are considered likely to lead to insignificant changes in the conditions of the ground.

5.4.3 Site observation of human activities which would affect the groundwater level, as stated in **Section 1.1** but not limited to, should be recorded during each monitoring event.

5.4.4 Graphical plots of the groundwater response should be provided in the analysis. Detailed requirements of reporting are presented in **Section 7**.

6. CONTINGENCY PLAN

6.1 Groundwater Monitoring

6.1.1 As part of the contingency plan, groundwater level would be monitored during the construction of C826 tunnel as stated in **Section 5.4** to avoid significant groundwater drawdown. Response Values of Alert, Action and Alarm (AAA) Levels would be determined based on the baseline monitoring data. Specific actions/measures, subject to the cause of drawdown and site condition, would be determined when groundwater level reaching AAA Levels.

6.1.2 Definitions and determinations of AAA Levels, as well as general actions to be taken when reaching of AAA Levels are discussed in the following sections.

6.2 Definitions of Alert, Action and Alarm (AAA) Levels

6.2.1 The following definitions of Response Values of Alert, Action and Alarm (AAA) Levels are used:

- Alert Level is the lowest Response Value, which signifies the reading for an instrument at which closer attention needs to be paid to the instrument data in case of subsequent reaching of the Action Level.
- Action Level is the intermediate Response Value, which signifies the reading for an instrument at which Response Action is mandatory. A Response Action shall comprise active and passive measures by the Contractor to be taken when the Action Level is reached.
- Alarm Level is the urgent Response Value, which signifies a reading at which point urgent actions shall be taken to prevent further displacement, and the reading for an instrument which shall not be reached in all areas other than the C826 tunnel vicinity.

6.3 Determination of AAA Levels

6.3.1 According to N9 of Appendix N of PS (Appendix B), the general AAA Levels of Groundwater drawdown would be determined as follow:

- Alert Level: 500mm with reference to lowest historical groundwater level
- Action Level: 800mm with reference to lowest historical groundwater level
- Alarm Level: 1000mm with reference to lowest historical groundwater level

6.4 Actions to be Taken when Reaching AAA Levels

6.4.1 Ad-hoc meeting shall be held amongst MTRCL, CRCC-HC-CR15G JV and other relevant parties to review the groundwater monitoring results in case of any reaching AAA levels. Should it be considered necessary, a brief report will be issued to address the trend of any groundwater drawdown/movement, which has been highlighted in the area of concern.

6.4.2 When an Alert Level has been reached, the following general actions should be carried out:

(i) Verify the instrument reading;
(ii) Notify MTRCL, Environmental Team Leader (ETL), Independent Environmental Checker (IEC) and Residence Site Engineer (RSE);
(iii) Submit a Detailed Action Plan (DAP) within 24 hours; and
(iv) Increase the frequency of monitoring; and

6.4.3 When an Action Level has been reached, the following general actions should be carried out:

(i) Verify the instrument reading;
(ii) Responsible members of CRCC-HC-CR15G JV staff or where appropriate the Specialist Instrumentation Subcontractors staff will inspect the affected areas and will physically monitor the situation;
(iii) Notify MTRCL, ETL, IEC and RSE;
(iv) Implement the appropriate response actions in accordance with the submitted Detailed Action Plan (DAP); and
(v) Submit Immediate Action Plan (IAP) within 24 hours.

6.4.4 When an Alarm Level has been reached, the following general actions should be carried out:

(i) Verify the instrument reading;
(ii) Notify relevant personnel in the Monitoring and Report Team;
(iii) Notify MTRCL, ETL,IEC and RSE;
(iv) Responsible members of CRCC-HC-CR15G JV staff or where appropriate the Specialist Instrumentation Subcontractors staff will inspect the affected areas and will physically monitor the situation;
(v) Implement Immediate Action Plan (IAP);
(vi) Construction activities directly causing the exceedance maybe suspended, depending on the actual case. For TBM, however, it may not be safe or appropriate to stop activities, and thus will be reviewed on a case by case basis;
(vii) Carry out inspection of the incidence and emergency review meeting;
(viii) Further mitigating actions shall be agreed before recommencement of the works until the result back to compliance level; and
(ix) Inform AFCD immediately and submit an interim report to AFCD within 3 working days.

6.5 Monitoring and Report Team

The contact of Monitoring and Report Team of CRCC-HC-CR15G JV is given in **Table 6.1**. Project Manager will be the key person in relation to groundwater drawdown issues during the tunneling works. Construction Manager and Engineer Manager will assist in the investigation and be responsible to identify the possible mitigation measures for alleviating the impact on groundwater / fish ponds. EO shall ensure the monitoring programme is smoothly implement and check the compliance with the project's environmental performance requirements during construction.

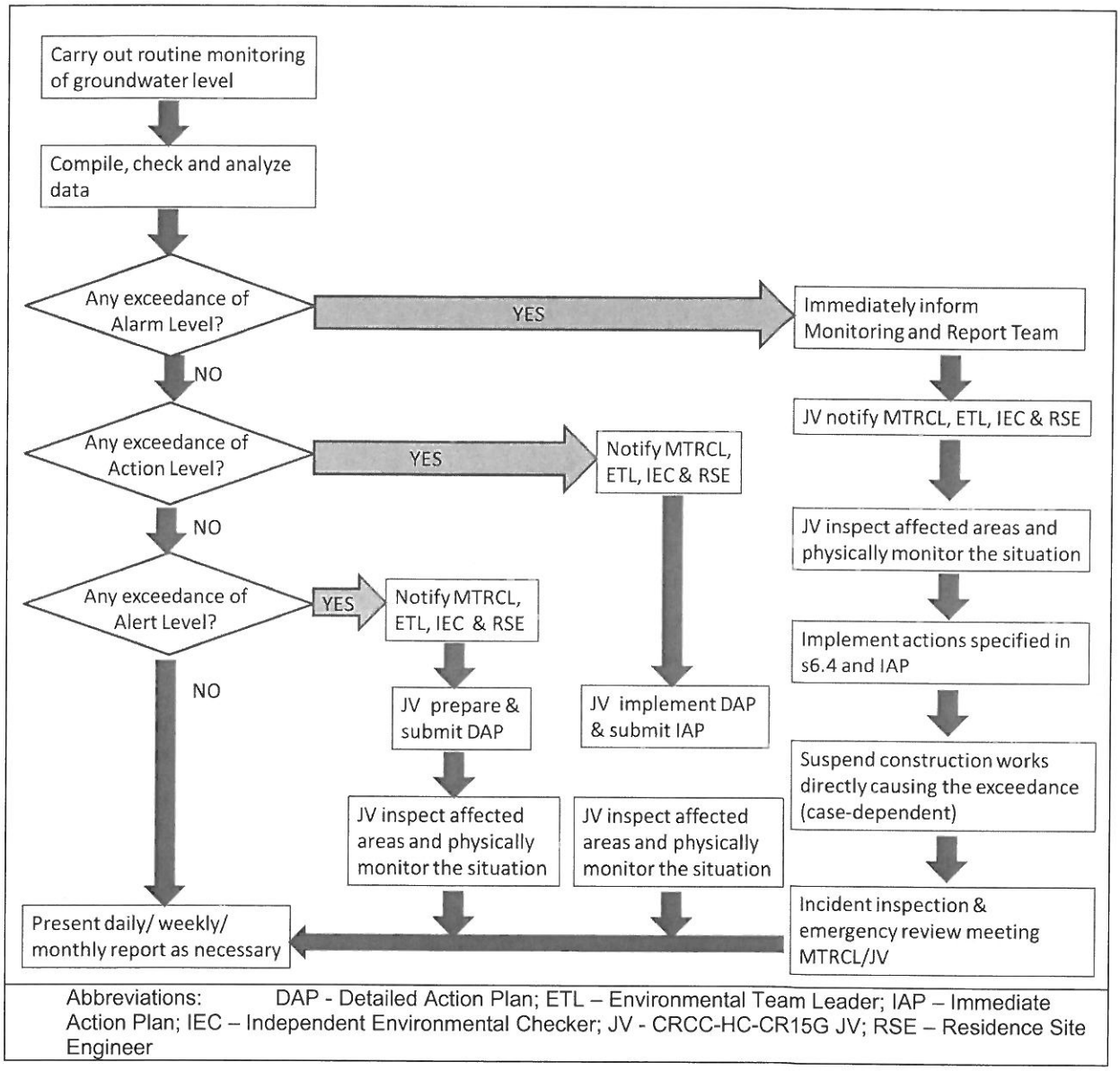
Table 6.1 Contacts of Monitoring and Report Team

Name	Position	Contact No.	E-mail
Steven Meredith	Project Manager / Tunnel Expert	6395 5215	stevenjm@chc15jv.com.hk
John Wong	Engineering Manager	9094 9900	johnwong@chc15jv.com.hk
Zhang Qi	Construction Manager	86-138 2798 5238	zhangqilxzy@126.com
Stanley Tung	Assistant Project Safety Manager	6037 9088	stanleyt@chc15jv.com.hk
Edward Tam	Environmental Officer	9287 8270	edwardt@chc15jv.com.hk

6.6 Activity Flow Chart

6.6.1 The activity flow chart for monitoring procedures is presented in **Figure 1**.

Figure 1 Activity Flow Chart for Monitoring Procedures



Abbreviations: DAP - Detailed Action Plan; ETL – Environmental Team Leader; IAP – Immediate Action Plan; IEC – Independent Environmental Checker; JV - CRCC-HC-CR15G JV; RSE – Residence Site Engineer

6.7 Mitigation Measures

6.7.1 A closed face slurry mixed shield TBM has been proposed for the construction of tunnel to minimise the chance of potential groundwater drawdown. The TBM will be designed to maintain pressure on the excavation ground at all time and thus control the groundwater inflow and face collapse. Besides, the proposed slurry machine provides a sensitive control of face pressure by the compressed air system. However, mitigation measures should also be developed specifically to the site condition to tackle in the case of unacceptable groundwater drawdown as detail below:

The TBM support pressure can be accurately controlled by use of the air cushion. In the event of unacceptable drawdown resulting from an inadequate face support pressure the TBM operator can quickly and accurately increase the face support pressure by increasing the air cushion pressure.

In addition a reserve supply of fresh slurry is available at all times for the TBM operator to use should slurry loss occur or loss of slurry quality take place, to prevent ground water drawdown which could result from both of these problems.

Slurry quality is closely monitored and gives early warning of the need to change slurry.

6.7.2 Possible mitigation measures as summarized below should be adopted as far as practicable.

Tunnel Lining Waterproofing Design and Installation

6.7.3 The tunnel will be design as undrained tunnel in order to limit the groundwater drawdown. The segmental lining and the segmental joints including the water proofing gasket must be designed to withstand the anticipated water head and must be durable for the working life of tunnel. Besides, it is anticipated that back grouting should be carried out immediately after installation of the segmental linings.

Probing Ahead and Grouting from inside of TBM

6.7.4 In view of the complex ground conditions and possible cavities in the marble area of the tunnel alignment, the TBM will be equipped with probing and grouting devices from inside of TBM. The probing pattern is to be designed in a way that that no large cavities or water bearing stratum would remain undetected with the probe holes forming the conduit through which all voids encountered will be treated.

Ground Treatment

6.7.5 For the break-out of TBM in Mai Po Shaft, the slurry pressure of TBM will gradually reduce to atmospheric pressure. In order to prevent possible groundwater leakage to the shaft and subsequently groundwater drawdown, the TBM arrival method will allow for full grout support and groundwater inflow precaution during TBM break through into the shaft. Details of method statement would be given in DAP/IAP where applicable.

7. MONITORING REPORT

All the data collected shall be submitted to MTR for review after the monitoring events. The template of the field record sheet is attached in Appendix C.

8. CONCLUSION

8.1.1 This Plan specified the details, requirements and programme of groundwater monitoring, as well as a mechanism to monitor the implication from the works to the groundwater system and fish ponds, including the determination of Alarm, Action and Alert Levels, and recommendations on contingency plan.

8.1.2 Regular monitoring work would be conducted and contingency actions would be followed if there is any exceedance.

9. REFERENCES

[1] Kowloon-Canton Railway Corporation (2002). *Sheung Shui to Lok Ma Chau Spur Line Hydrology Baseline Report & Action Plan.* Hong Kong.

List of Drawings

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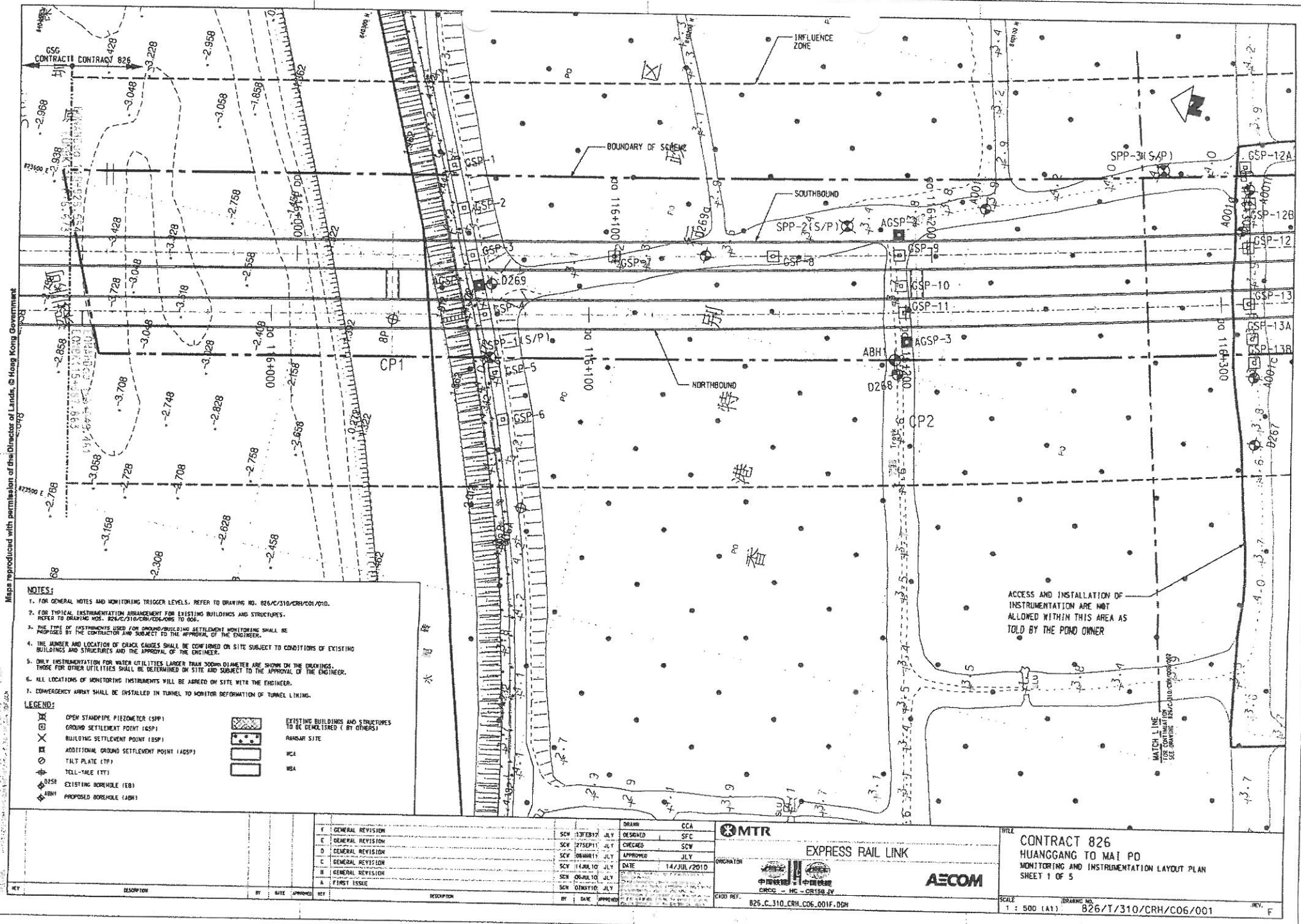

NOTES:

1. FOR GENERAL NOTES AND MONITORING TRIGGER LEVELS, REFER TO DRAWING NO. 826/C/310/CRH/C01/010.
2. FOR TYPICAL INSTRUMENTATION ARRANGEMENT FOR EXISTING BUILDINGS AND STRUCTURES, REFER TO DRAWING NOS. 826/C/310/CRH/C06/005 TO 006.
3. THE TYPE OF INSTRUMENTS USED FOR GROUND/BUILDING SETTLEMENT MONITORING SHALL BE PROPOSED BY THE CONTRACTOR AND SUBJECT TO THE APPROVAL OF THE ENGINEER.
4. THE NUMBER AND LOCATION OF CRACK GAUGES SHALL BE CONFIRMED ON SITE SUBJECT TO CONDITIONS OF EXISTING BUILDINGS AND STRUCTURES AND THE APPROVAL OF THE ENGINEER.
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LEGEND:

- OPEN STANDPIPE PIEZOMETER (SPP)
- GROUND SETTLEMENT POINT (GSP)
- BUILDING SETTLEMENT POINT (BSP)
- ADDITIONAL GROUND SETTLEMENT POINT (AGSP)
- TILT PLATE (TP)
- TELL-TALE (TT)
- D258 EXISTING BOREHOLE (EB)
- ABH1 PROPOSED BOREHOLE (ABH)
- EXISTING BUILDINGS AND STRUCTURES TO BE DEMOLISHED (BY OTHERS)
- RAMSAR SITE
- WCA
- MBA

REV	DESCRIPTION	BY	DATE	APPROVED
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E	GENERAL REVISION	SCW	27SEP11	JLY
D	GENERAL REVISION	SCW	08MAR11	JLY
C	GENERAL REVISION	SCW	14JUL10	JLY
B	GENERAL REVISION	SCW	06JUL10	JLY
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TITLE

CONTRACT 826

HUANGGANG TO MAI PO

MONITORING AND INSTRUMENTATION LAYOUT PLAN

SHEET 1 OF 5

SCALE 1 : 500 (A1)

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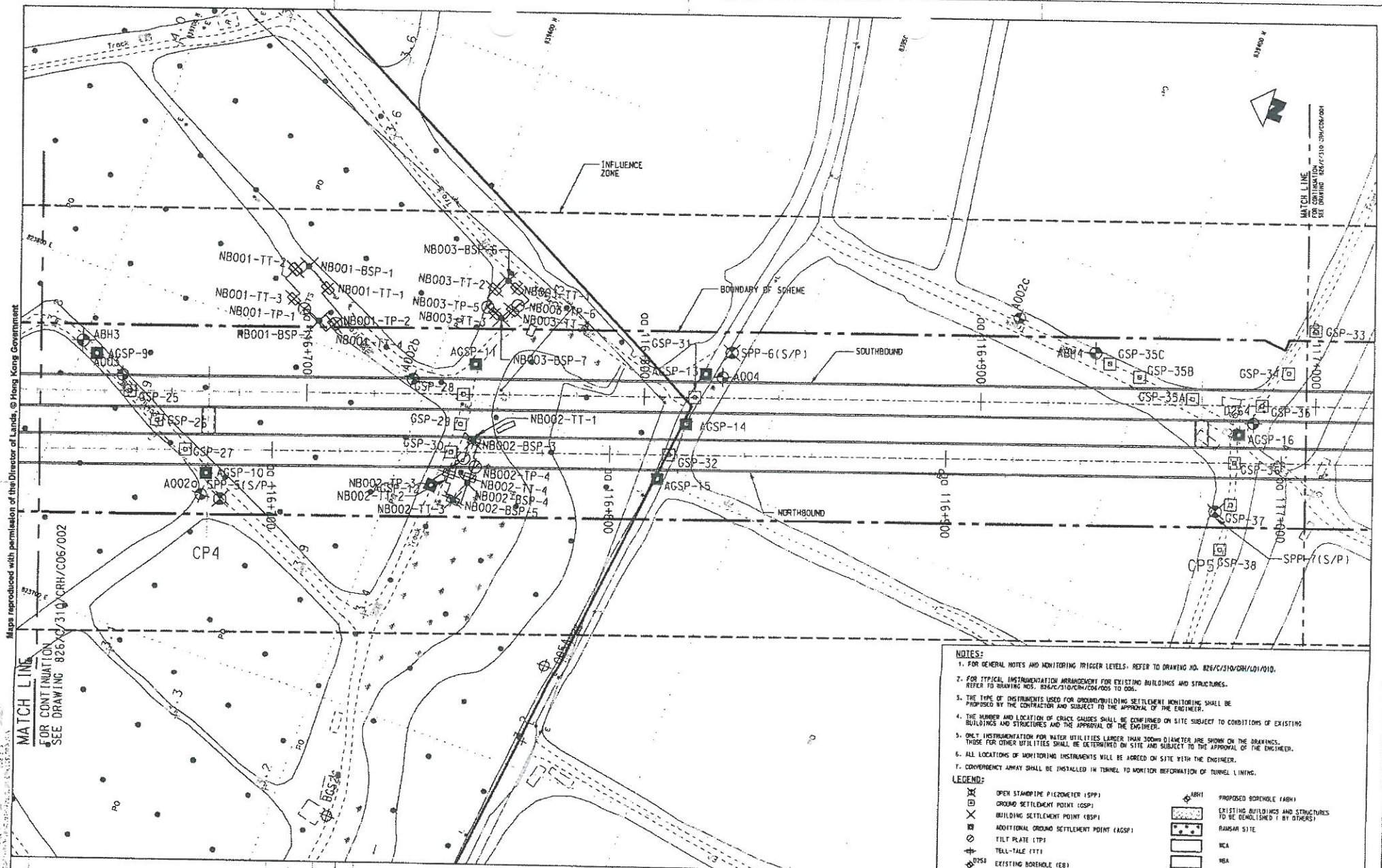

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A	FIRST ISSUE	SCW	07MAY10	JLY

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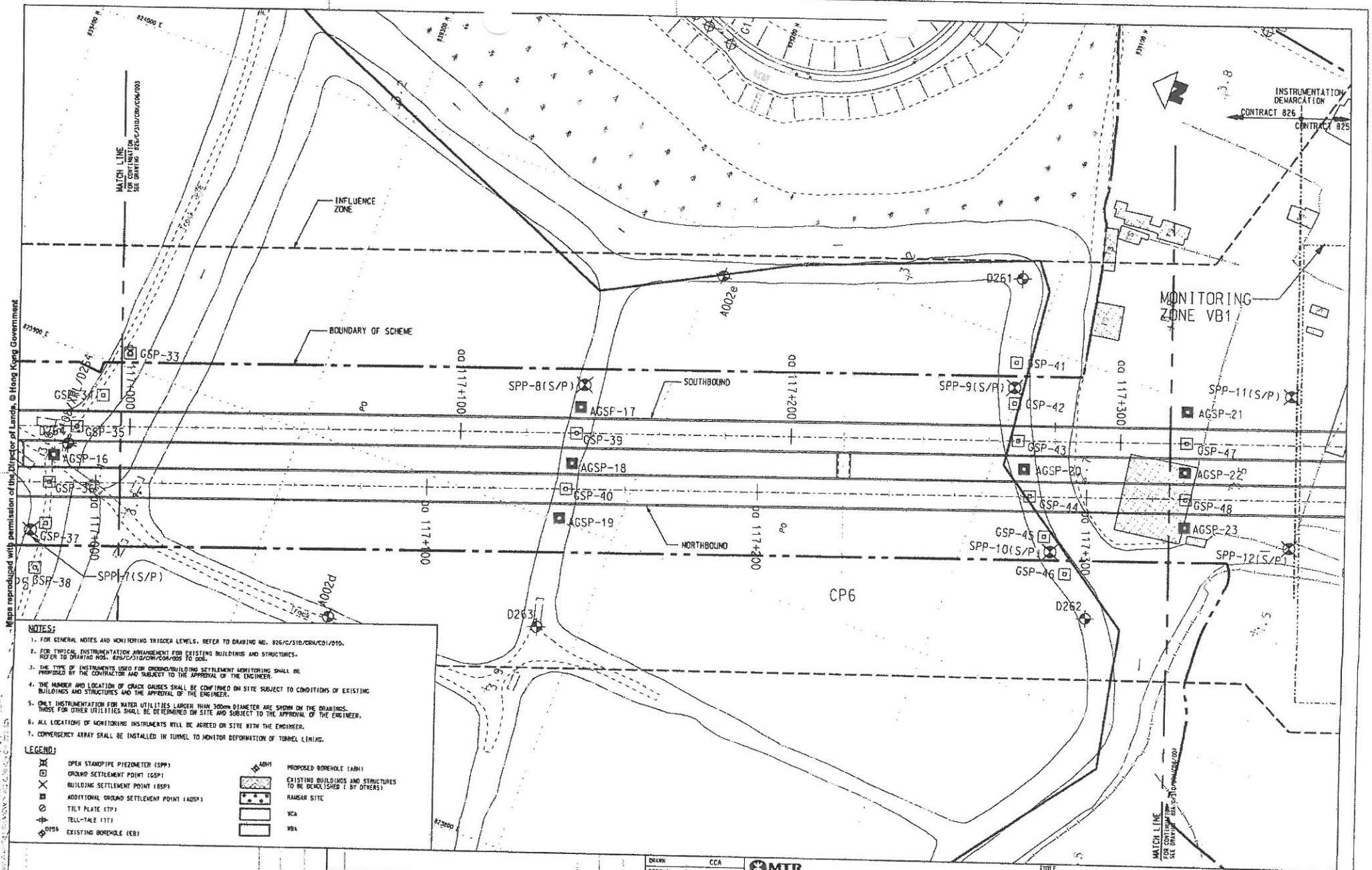
TITLE

CONTRACT 826
HUANGGANG TO MAI PO
MONITORING AND INSTRUMENTATION LAYOUT PLAN
SHEET 3 OF 5

SCALE 1 : 500 (A1)

DRAWING NO. 826/C/310/CRH/C06/003

REV. F



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7. CONVERGENCY ARRAY SHALL BE INSTALLED IN TUNNEL TO MONITOR DEFORMATION OF TUNNEL LINING.

LEGEND:

- OPEN STANDPIPE PIEZOMETER (SPP)
- GROUND SETTLEMENT POINT (GSP)
- BUILDING SETTLEMENT POINT (BSP)
- ADDITIONAL GROUND SETTLEMENT POINT (AGSP)
- TILT PLATE (TP)
- TELL-TALE (TT)
- D255 EXISTING BOREHOLE (EB)
- ABH1 PROPOSED BOREHOLE (ABH)
- EXISTING BUILDINGS AND STRUCTURES TO BE DEMOLISHED (BY OTHERS)
- RAMSAR SITE
- VCA
- VBA

REV	DESCRIPTION	BY	DATE	APPROVED
C	GENERAL REVISION	SCW	27SEP10	JLY
B	GENERAL REVISION	SCW	06JUL10	JLY
A	FIRST ISSUE	SCW	07MAY10	JLY

DRAWN	CCA
DESIGNED	SFC
CHECKED	SCW
APPROVED	JLY
DATE	14/JUL/2010

MTR

EXPRESS RAIL LINK

ORIGINATOR

CRCC – HC – CR150.JV

AECOM

CADD REF. 826_C_310_CRH_C06_004E.DGN

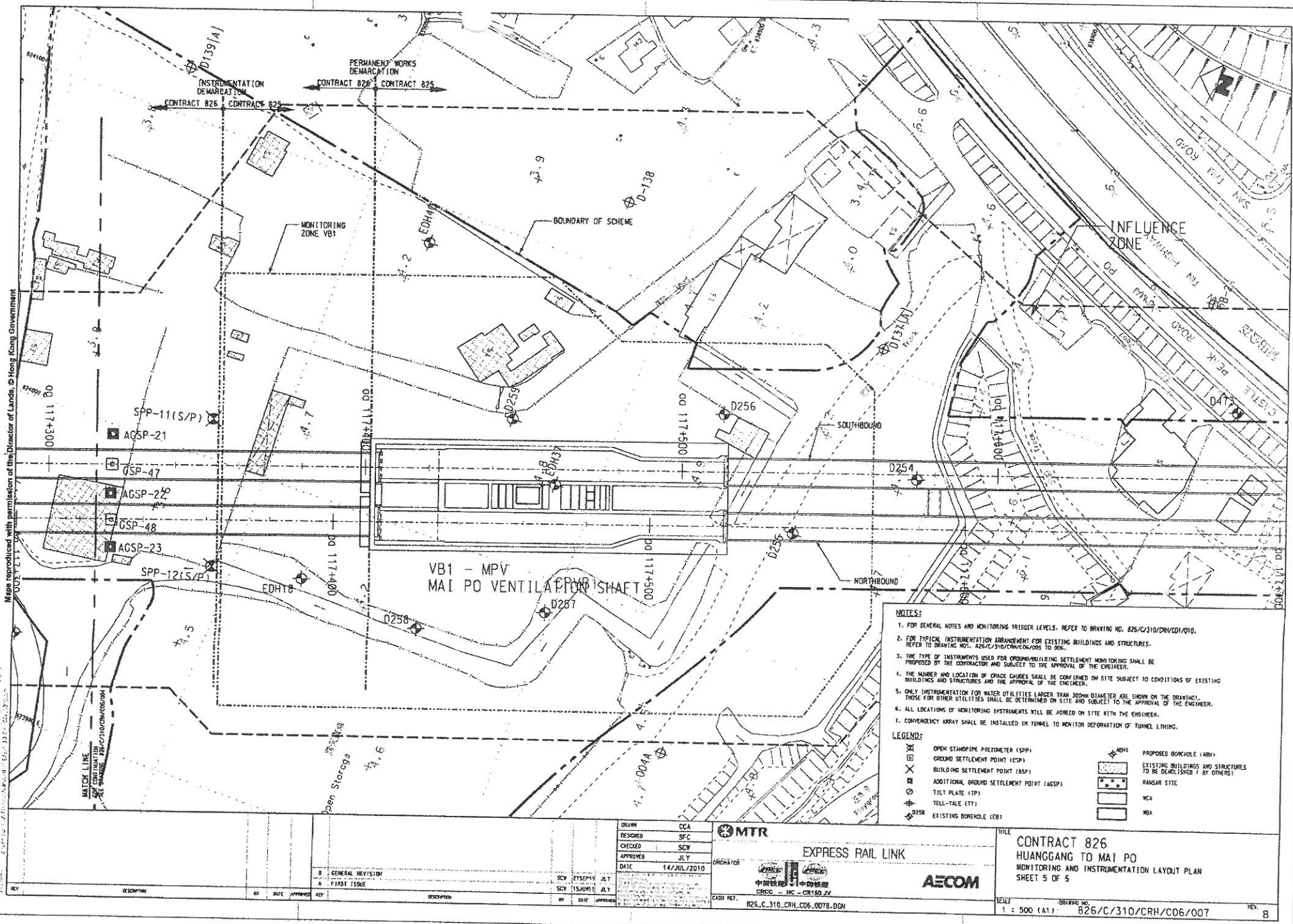
TITLE

CONTRACT 826
HUANGGANG TO MAI PO
MONITORING AND INSTRUMENTATION LAYOUT PLAN
SHEET 4 OF 5

SCALE 1 : 500 (A1)

DRAWING NO. 826/C/310/CRH/C06/004

REV. E



NOTES:

1. FOR GENERAL NOTES AND MONITORING TRIGGER LEVELS, REFER TO DRAWING NO. 826/C/310/CRH/C01/010.
2. FOR TYPICAL INSTRUMENTATION ARRANGEMENT FOR EXISTING BUILDINGS AND STRUCTURES, REFER TO DRAWING NOS. 826/C/310/CRH/C06/005 TO 006.
3. THE TYPE OF INSTRUMENTS USED FOR GROUND/BUILDING SETTLEMENT MONITORING SHALL BE PROPOSED BY THE CONTRACTOR AND SUBJECT TO THE APPROVAL OF THE ENGINEER.
4. THE NUMBER AND LOCATION OF CRACK GAUGES SHALL BE CONFIRMED ON SITE SUBJECT TO CONDITIONS OF EXISTING BUILDINGS AND STRUCTURES AND THE APPROVAL OF THE ENGINEER.
5. ONLY INSTRUMENTATION FOR WATER UTILITIES LARGER THAN 300mm DIAMETER ARE SHOWN ON THE DRAWINGS. THOSE FOR OTHER UTILITIES SHALL BE DETERMINED ON SITE AND SUBJECT TO THE APPROVAL OF THE ENGINEER.
6. ALL LOCATIONS OF MONITORING INSTRUMENTS WILL BE AGREED ON SITE WITH THE ENGINEER.
7. CONVERGENCY ARRAY SHALL BE INSTALLED IN TUNNEL TO MONITOR DEFORMATION OF TUNNEL LINING.

LEGEND:

- OPEN STANDPIPE PIEZOMETER (SPP)
- GROUND SETTLEMENT POINT (GSP)
- BUILDING SETTLEMENT POINT (BSP)
- ADDITIONAL GROUND SETTLEMENT POINT (AGSP)
- TILT PLATE (TP)
- TELL-TALE (TT)
- D258 EXISTING BOREHOLE (EB)
- ABH1 PROPOSED BOREHOLE (ABH)
- EXISTING BUILDINGS AND STRUCTURES TO BE DEMOLISHED BY OTHERS
- HANSAR SITE
- WCA
- WBA

REV	DESCRIPTION	BY	DATE	APPROVED
B	GENERAL REVISION	SCW	27SEP11	JLY
A	FIRST ISSUE	SCW	15JUN11	JLY

DRAWN	CCA
DESIGNED	SFC
CHECKED	SCW
APPROVED	JLY
DATE	14/JUL/2010

MTR

EXPRESS RAIL LINK

ORIGINATOR: CRCC – HC – CR150 JV

AECOM

CADD REF. B26_C_310_CRH_C06_0078.DGN

TITLE

CONTRACT 826
HUANGGANG TO MAI PO
MONITORING AND INSTRUMENTATION LAYOUT PLAN
SHEET 5 OF 5

SCALE 1 : 500 (A1)

DRAWING NO. 826/C/310/CRH/C06/007

REV. B

Appendix B

Appendix N of Contract 826 - Particular Specification

APPENDIX N

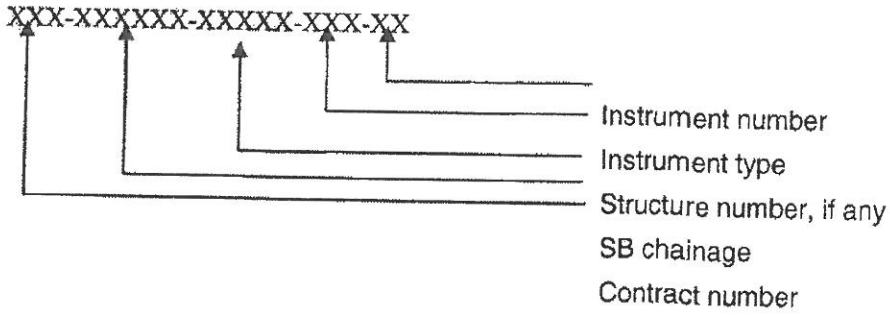
INSTRUMENTATION AND MONITORING

Appendix N – Instrumentation and Monitoring

N1. The Contractor shall provide and implement instrumentation and monitoring of the works, ground surfaces, temporary works, EBS, access adit, roads, footpaths, slopes, retaining walls, services and utility services as shown on the Drawings and shall make all necessary alterations to suit his proposed method of construction.

Any instrumentation and monitoring scheme suggested by the Engineer is the minimum requirement. The Contractor shall establish his own plan with reference to this minimum requirement to the approval of the Engineer.

N2. The Contractor shall adopt the following instrument numbering system:



N3. The instrument types, purpose and depth are summarised in Table N1. Locations of the proposed instruments are shown on the Drawings. The Contractor shall notice the demarcation of different monitoring zones as shown on drawings.

Table N1 : Proposed Instrument Types, Purpose and Depth

Instrument Type	Purpose	Depth / Location
Open standpipes / piezometers / observation wells	To monitor change in groundwater level and piezometric heads	To be confirmed on site. For those within monitoring zone VB1, the depth shall be at temporary wall toe level.
Inplace/ Vertical inclinometer	To monitor subsurface lateral ground movement or the temporary retaining wall deflection	In rock or at least 40m below proposed tunnel invert level, whichever shallower. For those within monitoring zone VB1, the depth shall be at temporary retaining wall toe.

Instrument Type	Purpose	Depth / Location
Ground settlement point	To monitor vertical and horizontal ground movement	On ground surface
Building settlement point	To monitor building settlement	On selected buildings and structure
Tilt plate	To monitor building tilt	On selected buildings and structure
Utility settlement marker	To monitor utility settlement	On selected utilities
Magnetic probe extensometer	To monitor subsurface soil settlement	In rock or at least 40m below proposed tunnel invert level, whichever shallower.
Tell-tale	To monitor any cracks	On buildings and structures
Convergence Array	To monitor deformation of permanent tunnel linings	25m c/c along TBM tunnel 1 no. at the centre per cross passage

N4. The Contractor shall review the existing instrumentation installed by the Employer and agree with the Engineer to take over and maintain the instruments. For each of the existing instruments, the Contractor shall identify the location, check that the instrument is still in working condition and indicate it on the instrument location plan as required under Clause 23.11 of the M&W Specification.

N5. The Contractor shall monitor the instruments with due regard to the construction activities, ground conditions, anticipated ground movements, adjacent structures, method of construction and any other construction constraints.

The monitoring phases are defined as follows:

(1) Background Monitoring - monitoring carried out over an initial phase to establish the existing conditions of the ground, feature or facility prior to commencement, in the vicinity of works which are anticipated to affect those conditions. It is to be carried out also when the likelihood of significant changes in conditions is remote. Background monitoring also allows the natural variations and repeatability of the monitoring to be established.

(2) Active Monitoring - monitoring during active construction works within 50m of the instrument. Active construction works that require active monitoring are those that could potentially lead to significant changes in the conditions of the

ground, feature or facility; these include dewatering, excavation and backfilling activities, and construction of piles.

(3) Standard Monitoring - monitoring during times which do not require background monitoring or active monitoring, e.g. if active construction activities are further than 50m away and within 100m, or works taking place within 50m are, in the opinion of the Engineer, minor activities that are considered likely to lead to insignificant changes in the conditions of the ground, feature or facility.

N6. After agreement with the Engineer of the formal initial reading, the Contractor shall initiate background monitoring. During background monitoring the Contractor shall not carry out any active construction works within 100m.

N7. After the Engineer has accepted that the background conditions have been established, regular monitoring shall commence. The requirements for the different phases of regular monitoring for each instrumentation type are listed in Table N2 and N3. Unless shown otherwise, these requirements shall be followed throughout the monitoring of the instruments. The Engineer will advise and may amend the list of construction activities that require active monitoring and the stages that will permit background monitoring to be undertaken.

Table N2 : Requirements for Minimum Regular Monitoring Frequency for Different Instrument Types

Instrument Type	Background Monitoring	Standard Monitoring	Active Monitoring
Open standpipes / piezometers	Monthly for at least one year	Weekly	Daily
Inplace/ Vertical inclinometer	Weekly	Weekly	Daily
Ground settlement point	Weekly	Weekly	Daily
Building settlement point	Weekly	Weekly	Daily
Tilt plate	Weekly	Weekly	Daily
Utility settlement marker	Weekly	Weekly	Daily
Magnetic probe extensometer	Weekly	Weekly	Daily
Tell-tale	Weekly	Weekly	Daily

N8. The monitoring frequency may be increased or relaxed by the Engineer on Site to suit site conditions as appropriate.

N9. The general limits of movement control and groundwater drawdown level are as defined in the alert, action and alarm levels given in Tables N3.

Table N3 : General Alert, Action and Alarm Levels Limits For Monitoring Points

Structure / Monitoring Point	Alert	Action	Alarm
Ground settlement	25mm	40mm	50mm
Existing registered features (slope and retaining wall)	25mm or 1:600	40mm or 1:375	50mm or 1:300
Existing buildings (settlement)	13mm or 1:600	20mm or 1:375	25mm or 1:300
Utilities(1)	13mm or 1:600	20mm or 1:375	25mm or 1:300
Groundwater drawdown	500mm with reference to lowest historical groundwater level	800mm with reference to lowest historical groundwater level	1000mm with reference to lowest historical groundwater level

Note : (1) Or other values specified by respective utility undertakers, whichever is more onerous.

In case the 'Alert', 'Action' or 'Alarm' value is reached the Contractor shall be required to take actions as stipulated in Section 23.1 of the M&W Specification.

The 'Alert', 'Action' or 'Alarm' values for the settlement of some particular buildings have been set individually which are presented in Table N4 below.

Table N4 : Alert, Action and Alarm Levels Limit for Building Settlement of Particular Buildings

XRL REF. No.	ADDRESS	BUILDING TYPE / DETAILS	BUILDING SETTLEMENT (mm)		
			ALERT	ACTION	ALARM
NB002	Mai Po (SB Chainage 116+745)	Residential	15	24	30

N10. In addition to the instrumentation specified herein, the Contractor shall propose and install instrumentation to monitor temporary works. Installation of instruments in new underground excavations shall be carried out at the earliest opportunity.

N11. Results from instrumentation installed to monitor the performance of temporary support and new excavations shall be assessed in conjunction with a visual

examination of the structure to record signs of distress such as cracks and sections of splitting and falling rock or a loosening of ground support material. Subject to the findings of both the deformation results and any signs of distress, any adjustment to the existing level of support shall be determined and installed by the Contractor.

N12. The Contractor shall develop procedures for prompt data collection and interpretation as well as communication with the Engineer of any critical readings and implementation of immediate remedial measures. The procedures shall be comprehensive in nature clearly defining individual responsibilities for installation, readings, maintenance, recording, assessment and criteria for action.

N13. The Contractor's instrumentation personnel shall be responsible for taking all readings and their proper recording. Monitoring results shall be reported as required under section 23 of the M&W Specification.

N14. The Contractor shall take over the instrumentation as set out in the table below upon the Date for Commencement.

Hole No.	Pipe
NEX2108/XRL/	P/S & Tip (P - Piezometer; S - Standpipe)
D261	P 15.00 S 5.00
D262	P 15.00 S 3.00
D263	P 16.00 S 13.00
D264	P 19.00 S 5.00
D265	P 22.50 P 33.00
D267	P 9.00 P 21.00 S 6.00

Hole No.	Pipe
NEX2108/XRL/	P/S & Tip (P - Piezometer; S - Standpipe)
D268	P 25.00 S 22.20
PZ2	P 4.50 P 27.00
PZ4	P 12.50 P 30.00
A003	P 23.00 S 6.00
A004	P 15.00 S 5.00
D269	P 20.00 S 6.00

Appendix C

Templates of Monitoring Records

XRL 826 -Huanggang to Mai Po Tunnels

Monitoring Records of Water Levels in Existing Standpipes/Piezometers

Date of monitoring:

CRCC – HC – CR15G

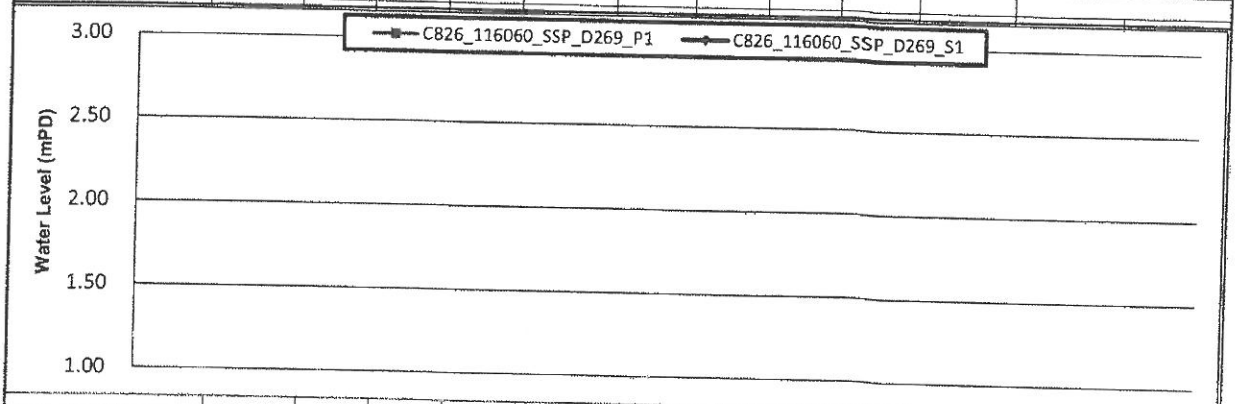
Drill Hole No.	Instrumentation Type (According to PS App N)	Date of Initial Readings	Water Level Initial Readings (mPD)	Date of Monitoring	Top Level of Riser Pipe (mPD)	Depth of W.L.below Top of Riser Pipe (m)	Measured Water Level (mPD)	Remarks
826-116060-SPP-D269	P							
	S							
826-116640-SPP-A003	P							
	S							
826-116980-SPP-D264	P							
	S							
826-117130-SPP-D263	P							
	S							
826-117300-SPP-D262	P							
	S							
826-117270-SPP-D261	P							
	S							
826-116600-SPP-PZ2	P							
	P							
826-116990-SPP-PZ4	P							
	P							
826-SPP1	P							
	S							
826-SPP2	P							
	S							
826-ABH3	P							
	S							
826-SPP4	P							
	S							
826-SPP5	P							
	S							
826-SPP6	P							
	S							
826-SPP8	P							
	S							
826-SPP9	P							
	S							
826-SPP10	P							
	S							
826-SPP11	P							
	S							
826-SPP12	P							
	S							

Legend: p - Piezometer

SP-Standpipe

Project :	MTRC XRL Contract 826		
	Huanggang to Mai Po Tunnels		
Site ID :	C826		
Instrument Type:	Open Standpipe Piezometer	PZ	
Contract :	XRL826		
Instrument No. :	C826_116060_SSP_D269_P1	C826-116060-SPP-D269_S1	
Date of Initial Reading:	4-Jun-10	4-Jun-10	
Easting:	823598.16		
Northing:	840243.65		
Tip Level (mPD)	-15.69	-0.680	
Tube Top Level (mPD)	4.31	4.320	
Initial reading (mPD):	2.70	1.950	
Chainage No.			
Location:	Mai Po Area		

Response Level	Response Value (m)
Alert	N/A
Action	N/A
Alarm	N/A



Date	C826_116060_SSP_D269_P1					C826_116060_SSP_D269_S1					Remarks
	Time	Water Depth (m)	Water Level (mPD)	cum. change (m)	Response Level	Time	Water Depth (m)	Water Level (mPD)	cum. change (m)	Response Level	

* The data provided by MTRC is for reference only.