

## **APPENDIX – 4-1**

### General Description of Various Tunnel Construction Methodologies

## Construction Methodologies Considered

### 1. Cut-&-Cover Tunnelling

Cut-&-cover construction is a proven and common method of excavation and construction for stations, concourses and tunnels in built-up areas. This construction methodology has a long history in Hong Kong and the techniques are well established locally.

Cut-&-cover typically requires several overlapping stages of work to be carried out in sequence. Most of these stages are similar to other engineering works for road construction except that the level of excavation could be deeper and it would involve the construction of tunnel structures.

A summary of the key stages and the associated construction plant items is given below:

**Table 1 :** Typical key stages of work and plant items for cut-&-cover method

Key Stages	Typical Plant Items	Remarks
Remove obstruction, expose and divert any existing utilities	Handheld breaker / Mini excavator / crane lorry	Work sites are typically 40-50m long to minimise the impacts on local traffic. Plant items are at ground level.
Install pipe pile wall or D-wall	Pilepile wall: Pipe pile rig / air compressor / generator  D-wall: Hydraulic extractor mobile crane / concrete pump truck / bentonite filtering and mixing plant	Plant items are at ground level.
Grouting	Drill hole machine / grout pump, grout mixer / generator	Plant items are at ground level.
Install decking (If required to maintain any traffic arrangement)	Crane lorry / welding machine	Plant items are at ground level.
Soil excavation and install shoring	Excavator / generator / ventilation fan / lorry / mobile crane / welding machine	Except lorry and mobile crane, other items can be placed under the deck (if decking is installed). Spoil will be removed from the mucking out positions.
Construction	Generator / ventilation fan / mobile crane / air compressor / concrete pump / concrete lorry mixer / poker / mini excavator	Ditto
Water proofing, backfilling and reinstatement	Excavator / generator / roller / lorry	Plant items are at ground level.

### 2. Bored Tunnelling

Similar to the cut-&-cover method, bored tunnelling also requires several stages of work to be carried out in sequence. However, most of the work will be carried out underground and along the route alignment. There would be relatively limited amount of work at the TBM launching and retrieval shafts.

A summary of the key stages and the associated construction plant items is given below:

**Table 2 :** Typical key stages of work and plant items in the launching and retrieval shafts

Key Stages	Typical Plant Items	Remarks
Remove obstruction, expose and divert any existing utilities	Handheld breakers / mini excavators / crane lorries	Plant items are at ground level.

Key Stages	Typical Plant Items	Remarks
Install diaphragm wall	Mobile cranes / circulation pumps / silos / desander / rock chisels / welding machines / generators / concrete pumps / concrete mixers / lorries	Plant items are inside the shaft
Soil & rock excavation and install shoring	Excavators / generators / ventilation fans / lorries / welding machines	Plant items are inside the shaft
Construction	Generators / ventilation fans / mobile cranes / air compressors / circular saws / concrete pumps / concrete mixers / pokers / excavators	Plant items are inside the shaft
Water proofing, backfilling and reinstatement	Excavators / generators / rollers / lorries	Plant items are inside the shaft except the final stage which is near the ground level.

### 3. Mined Tunnelling

Mined tunnelling is another approach to construct tunnels. Hydraulic breakers are often used to make way for the tunnel. Alternatively, drill & blast technique could be used instead of hydraulic breakers. In this case, drilling rigs with booms will be used for drilling an array of blast holes onto the tunnel face to a designated depth. The holes are then loaded with explosives and timed detonators, which will ensure the blasting occurs at the correct sequence. After the detonation, the spoil will be transported out of the tunnels.

Temporary support for the tunnels will be provided using rock dowels and shotcrete. Typical plant items required for drill-&-blast include crawler drills, excavators, lorries, generators, concreting plant and ventilation fans. All major excavation and construction activities would be conducted within the tunnel section except transportation of spoil out of the tunnel by mobile cranes and lorries.

### 4. Benefits and Disbenefits of Construction Approaches

A comparison of the benefits and disbenefits on the above construction approaches for tunnels is given below:

**Table 4-4 :** Benefits and disbenefits of construction approaches for tunnels

Approaches	Benefits	Disbenefits
Cut-&-cover tunnelling	<ul style="list-style-type: none"> <li>Well proven and commonly used in other infrastructure projects.</li> <li>Flexible and not constraint by geological conditions</li> </ul>	<ul style="list-style-type: none"> <li>Larger amount of spoil needs to be excavated and disposed.</li> <li>More underground utilities need to be diverted prior to construction.</li> <li>More construction plant on ground level. This would generate more noise and dust impacts.</li> <li>More interruption to receivers along the alignment but the use of temporary decks could minimize the associated impacts.</li> <li>More carefully planned temporary traffic management would be required.</li> <li>Bentonite (e.g. for D-wall) would need to be recycled.</li> </ul>
Bored tunnelling	<ul style="list-style-type: none"> <li>No need to open up extensive amount of road surface and public areas and hence</li> </ul>	<ul style="list-style-type: none"> <li>Water would need to be used as lubricant during tunnel boring. Bentonite would need to be recycled.</li> </ul>

Approaches	Benefits	Disbenefits
	<p>less disturbance (in noise, air quality and visual impacts) to sensitive receivers along the alignment. Only receivers near to the launching and retrieval shafts would be affected. This can be mitigated by installing temporary decks over the shaft openings.</p> <ul style="list-style-type: none"> <li>• Fewer disturbances to local traffic conditions. This offers particular advantages in urban built-up areas with severe traffic constraints.</li> <li>• The amount of excavated materials would be much less than the cut-&amp;-cover approach.</li> <li>• Less impact to commercial activities in the vicinity of the alignment</li> </ul>	<ul style="list-style-type: none"> <li>• Constraint by geological conditions</li> <li>• Requires sufficient soil cover</li> </ul>
Mined tunnelling	<ul style="list-style-type: none"> <li>• No need to open up extensive amount of road surface and public areas and hence less disturbance (in noise, air quality and visual impacts) to sensitive receivers along the alignment. Only receivers near to the portal would be affected. This can be mitigated by installing temporary decks over the portal.</li> <li>• Fewer disturbances to local traffic conditions. This offers particular advantages in urban built-up areas with severe traffic constraints.</li> <li>• The amount of excavated material would be much less than the cut-&amp;-cover approach.</li> </ul>	<ul style="list-style-type: none"> <li>• Timed detonation (if blasting is required) would result in vibration and groundborne noise for receivers very close to the blasting point. This could be alleviated by optimizing the charge amount and coordinating with the operators of the neighbouring sensitive uses.</li> <li>• Constraint by geological conditions</li> </ul>

## **APPENDIX - 4-2**

### Construction Plant Inventory

**Job Title :** KCRC KSL 100 EIA

**Heading :** Plant Inventory

**Appendix No.** 4-2a

**Section :** C&C Tunnel from Salisbury Road to FMPHQ

Description	Period	PME	Unit
Remove obstruction, expose and divert existing utilities	Mar 05 - Jul 05	Breaker handheld	4
		Mini excavator	4
		Crane lorry	2
Install pipe pile wall	Jun 05 - Mar 06	Pipe pile rig	4
		Air compressor	7
		Generator, silenced	3
		Water pump	5
		Filtering plant / desander	2
		Crawler Crane	2
Grouting	Jun 05 - Mar 06	Drill hole machine (electric)	2
		Electric grout pump	2
		Grout mixer (electric)	2
		Generator, silenced	2
Install decking	Jun 05 - Mar 06	Crane lorry	1
		Welding machine	2
		Mobile crane	2
Soil excavation for tunnels	Apr 06 - Oct 06	*Hydraulic excavator	5
		*Hydraulic breaker	2
		*Generator, silenced	3
		*Ventilation fan	2
		+Mobile crane	1
		+Dump Truck	1
		*Welding machine	6
Construction & waterproofing of tunnels	Nov 06 - Jul 07	*Generator, silenced	3
		*Ventilation fan	2
		+Crane lorry	1
		+Mobile crane	1
		*Air compressor	2
		*Circular saw	4
		+Concrete pump truck	1
		+Concrete lorry mixer	1
		*Pokers	4
		*Mini excavator	1
Backfilling & reinstatement works	Aug 07 - Nov 07	Excavator	2
		Lorry	1
		Generator, silenced	1
		Roller	2
		Asphalt paver	1

Note:

\* Plants to be operated inside tunnel/decking

+ Plants to be located at the nearest worksite to the receivers

Welding machine is not a PME

**Job Title :** KCRC KSL 100 EIA  
**Heading :** Plant Inventory  
**Section :** Tunnel under FMPHQ

**Appendix No.** 4-2b

Description	Period	PME	Unit
Mined tunnel, excavation	Apr 06 - Feb 07	**Crawler drill	2
		**Excavator	2
		+Dump Truck	1
		**Generator, silenced	2
		**Hydraulic breaker	2
		**Ventilation fan	2
		+Mobile crane	1
		**Air compressor	2
		**Circular saw	4
		+Concrete pump truck	1
		+Concrete lorry mixer	1
		**Pokers	4

**Note:**

The TBM recovery shaft is used as the access shaft for mined tunnelling

\* Plants to be operated inside tunnel / decking

\*\* Plants to be operated underground

+ Plants to be located at shaft area

**Job Title :** KCRC KSL 100 EIA  
**Heading :** Plant Inventory  
**Section :** Construction Access Shaft

**Appendix No.** 4-2c

Description	Period	PME	Unit
Remove obstruction, expose and divert existing utilites	Mar 05 - Jun 05	Breaker handheld	2
		Mini excavator	1
		Crane lorry	1
Install pipe pile walls	Jul 05 - Oct 05	Pipe pile rig	1
		Air compressor	1
		Generator, silenced	1
		Water pump	1
		Filtering plant / desander	1
		Crawler Crane	1
Install decking	Oct 05	Crane lorry	1
		Welding machine	2
		Mobile crane	1
Excavation	Nov 05 - Mar 06	*Hydraulic excavator	2
		*Generator, silenced	3
		*Ventilation fan	2
		+Mobile crane	1
		+Dump Truck	1
		*Welding machine	2
Deassambling TBM (for one tube)	Sep 06 - Oct 06	*Generator, silenced	4
		*Ventilation fan	2
		+Crane lorry	1
		+Lorry	1
		* Welding machine	4
Deassambling TBM (for another tube)	Feb 07 - Mar 07	*Generator, silenced	4
		*Ventilation fan	2
		+Crane lorry	1
		+Lorry	1
		* Welding machine	4
Shaft fitout	Mar 07 - Apr 07	+Crane lorry	2
		+Mobile crane	2
		*Air compressor	1
		*Circular saw	1
		+Concrete pump truck	2
		+Concrete lorry mixer	2
		*Pokers	1
		*Mini excavator	1
Backfilling and reinstatement	May 07 - Jun 07	Excavator	1
		Lorry	1
		Generator,silenced	1
		Roller	1
		Asphalt paver	1

Note:

\* Plants to be operated inside tunnel/decking

+ Plants to be located at access shaft area

Welding machine is not a PME

**Job Title :** KCRC KSL 100 EIA  
**Heading :** Plant Inventory  
**Section :** Canton Road Plant Building

**Appendix No.** 4-2d

Description	Period	PME	Unit
Remove obstruction, expose and divert existing utilities (for the C&C shaft in front of China HK Centre)	Mar 05 - Jun 05	Breaker handheld	1
		Mini excavator	1
		Crane lorry	1
Install pipe pile walls (for the C&C shaft in front of China HK Centre)	Jul 05 - Dec 05	Pipe pile rig	1
		Air compressor	1
		Generator, silenced	1
		Water pump	1
		Filtering plant / desander	1
		Crawler Crane	1
Install decking (for the C&C shaft in front of China HK Centre)	Dec 05	Crane lorry	1
		Welding machine	1
		Mobile crane	1
Excavation (for the C&C shaft in front of China HK Centre)	Sep 06 - Nov 06	*Hydraulic excavator	2
		*Generator, silenced	2
		*Ventilation fan	2
		*Welding machine	6
		+Mobile crane	1
		+Dump Truck	1
Construction of plant building	Feb 07 - Jun 07	Generator, silenced	2
		Crane lorry	2
		Mobile crane	1
		Air compressor	1
		Circular saw	4
		Concrete pump truck	1
		Concrete lorry mixer	1
		Pokers	4
		Excavator	2
Backfilling and reinstatement (for the C&C shaft in front of China HK Centre)	Jul 07 - Sep 07	Excavator	1
		Lorry	1
		Generator, silenced	1
		Roller	1
		Asphalt paver	1

Note:

\* Plants to be operated inside tunnel / decking

+ Plants to be located at C&C shaft in front of China HK Centre

Welding machine is not a PME

**Job Title :** KCRC KSL 100 EIA

**Heading :** Plant Inventory

**Appendix No.** 4-2e

**Section :** Bored tunnelling & Launching shaft

Description	Period	PME	Unit
Ground treatment along Canton Road including recovery shaft (working from north to south on 2 fronts down the Canton Rd, one from WKN to Canton Rd. Plant Building and one from Canton Rd. Plant Building to recovery shaft, 50m long each 2 months)	Jul 05 -Mar 06	Drill Hole Machine (Electric)	2
		Electric Grout Pump	2
		Crane lorry	1
		Air compressor	2
Diaphragm wall at launching shaft	Jun 05 - Jul 05	Mobile crane	1
		Lorry	1
		Concrete lorry mixer	1
		Concrete pump truck	1
		Excavator	1
Excavation at launching shaft	Aug 05 - Feb 06	Chisel	1
		Excavator	1
		Mobile Crane	1
		Dump Truck	1
		Welding Machine	1
Assembling of TBM in launching shaft (for one tube)	Mar 06 - May 06	Mini excavator	1
		*Generator, silenced	4
		*Ventilation fan	2
		Crane lorry	1
Assembling of TBM in launching shaft (for another tube)	Sep 06 - Oct 06	Lorry	1
		*Welding machine	4
		*Generator, silenced	4
		*Ventilation fan	2
Operation in launching shaft (for one tube)	Jun 06 - Aug 06	Crane lorry	1
		Lorry	1
		*Welding machine	4
		Gantry	1
		+Generator	1
		+Air compressor	1
		Conveyor belt	1
		Ventilation fan	1
		Mortar plant	1
		Mortar pump	1
		+Water pump (S.M)	1
Water pump (for WWTP)	1		
+Diesel Train	1		
+Mortar Car	1		
+TBM	1		
Foundation	Jun 06 - Jan 07	+ Piling, large diameter bored, oscillator	1
Operation in launching shaft (for another tube)	Nov 06 - Jan 07	Gantry	1
		+Generator	1
		+Air compressor	1
		Conveyor belt	1
		Ventilation fan	1
		Mortar plant	1
		Mortar pump	1
		+Water pump (S.M)	1
		Water pump (for WWTP)	1
		+Diesel Train	1
		+Mortar Car	1
+TBM	1		
Construction and Waterproofing	Feb 07 - Mar 07	Generator, silenced	1
		Crane Lorry	1
		Mobile Crane	1
		Air Compressor	1
		Circular Saw	1
		Concrete pump truck	1
		Lorry	1
		Pokers	1
		Mini excavator	1
		Welding Machine	1

Note:

\* Plants to be operated inside tunnel/decking

+ Plants to be operated on the bottom of launching shaft

Welding machine is not a PME

**Job Title :** KCRC KSL 100 EIA  
**Heading :** Plant Inventory  
**Section :** WKN Northern Tunnels

**Appendix No.** 4-2f

Description	Period	PME	Unit
Remove Obstructions, Expose and Divert Existing Utilities (for each 100m sub-section)	Mar 05 - Jul 06	Breaker handheld	4
		Mini Excavator	4
		Crane Lorry	2
Diaphragm wall (for each 100m sub-section)	Jul 05 - Nov 06	Hydraulic extractor	1
		Mobile crane	1
		Lorry	4
		Concrete lorry mixer	3
		Concrete pump truck	1
Bentonite Filtering & Mixing for D-wall only (for each 100m sub-section)	Jul 05 - Nov 06	Bentonite filtering and mixing plant	1
		Excavator	1
		Lorry	1
Temporary Decking (where required, (between Lin Cheung Rd and Lai Cheung Rd)	Jul 05 - Nov 06	Mobile crane	1
		Welding Machine	1
		Lorry	1
Excavation (for each 100m sub-section)	Oct 05 - Feb 07	*Hydraulic Excavator	3
		*Generator, silenced	3
		Mobile Crane	3
		Dump Truck	4
		*Welding Machine	3
Construction and Waterproofing (for each 100m sub-section)	Jan 06 - Mar 07	*Generator, silenced	2
		Crane Lorry	1
		Mobile Crane	1
		*Air Compressor	2
		*Circular Saw	1
		Concrete Pump Truck	1
		Concrete Lorry Mixer	1
		*Pokers	2
		*Mini excavator	1
		Backfilling and Reinstatement Works (for each 100m sub-section)	Mar 06 - May 07
Generator, silenced	1		
Roller	1		
Asphalt Paver	1		
Lorry	3		

Note:

\* Plants to be operated inside tunnel/decking for section between Lin Cheung Road & Lai Cheung Road

Schedule of construction period should be referred to the detailed construction programme

Welding machine is not a PME

**Job Title :** KCRC KSL 100 EIA  
**Heading :** Plant Inventory  
**Section :** WKN Northern Tunnels  
(other associated construction activities)

**Appendix No.** 4-2g

Description	Period	PME	Unit
Demolition of Footbridge 14	Jan 05 - Mar 05	Breaker handheld	1
		Excavator	1
		Circular saw	1
		Lorry	2
Box Culvert Diversions and Underpass, Jordan Rd (JR) - Breaking	Apr 05 - Apr 05	Excavator	1
	Jul 06 - Jul 06	Hydraulic Breaker	1
		Lorry	1
Box Culvert Diversions and Underpass, Jordan Rd (JR) - Prepare for concreting	May 05 - May 05	Generator, silenced	1
	Aug 06 - Aug 06	Mobile crane	1
Box Culvert Diversions and Underpass, Jordan Rd (JR) - Concreting	Jun 05 - Jun 05	Concrete Pump Truck	1
	Sep 06 - Sep 06	Concrete lorry mixer	1
		Pokers	1
		Circular saw	2
		Lorry	1
Box Culvert Diversions and Underpass, Jordan Rd (PS, WR, DS)	Mar 06 - Feb 07 (PS)	Excavator	1
	Jun 06 - Apr 07 (WR & DS)	Hydraulic Breaker	1
		Concrete Pump Truck	1
		Concrete lorry mixer	1
		Pokers	2
		Generator, silenced	1
		Mobile crane	1
		Circular saw	2
		Lorry	1
Reinstatement Footbridge 14	Aug 05 - Nov 05	Concrete Pump Truck	1
		Concrete Lorry Mixer	1
		Pokers	2
		Mobile Crane	1
		Mini Excavator	1
Construction of YMT Ventilation building	Jun 06 - Feb 07	Generator, silenced	2
		Crane Lorry	1
		Mobile Crane	1
		Air Compressor	2
		Circular Saw	1
		Concrete Pump Truck	1
		Concrete Lorry Mixer	3
		Pokers	3
		Mini excavator	1
Box Culvert Diversions under Cherry Street	Nov 05 - Jan 07	Excavator	1
	(Nov 05 - May 06 for box culverts 1 & 3; Jun 06 - Jan 07 for box culverts 2 & 4)	Hydraulic Breaker	1
		Concrete Pump Truck	1
		Concrete lorry mixer	1
		Pokers	2
		Generator, silenced	1
		Mobile crane	1
		Circular saw	2
Lorry	1		

**Job Title :** KCRC KSL 100 EIA

**Heading :** Plant Inventory

**Appendix No.** 4-2h

**Section :** Underpinning Bridge A & A1

<b>Description</b>	<b>Period</b>	<b>PME</b>	<b>Unit</b>
Underpin Bridge A & A1	May 05 - Nov 05	Mini Excavator	2
		Generator, silenced	2
		Crane Lorry	1
		Down the Hole Rig (Electric)	2
		Air Compressor	2
		Pipe Pile Rigs	1
		Concrete Pump Truck	1
		Concrete Lorry Mixer	4
		Pokers	3

**Job Title :** KCRC KSL 100 EIA  
**Heading :** Plant Inventory  
**Section :** Stockpiling & Barging facility

**Appendix No.** 4-1i

<b>Description</b>	<b>Period</b>	<b>PME</b>	<b>Unit</b>
Barging point at WKCD	Jan 05 - Dec 07	Derrick barge Excavator Dump Truck	2 1 1
Stockpile	Jan 05 - Dec 07	Excavator Lorry	1 1

**Job Title :** KCRC KSL 100 EIA

**Heading :** Plant Inventory

**Appendix No.** 4-2j

**Section :** WKN Station

Description	Period	PME	Unit
Remove Obstructions, Expose and Divert Existing Utilities	Apr 05 - Jul 05	Breaker handheld	4
		Mini Excavator	2
		Crane Lorry	2
		Excavator	2
		Concrete pump truck	2
		Concrete lorry mixer	4
		Lorry	2
Diaphragm wall	Aug 05 - May 06	Mobile crane	3
		Lorry	4
		Concrete lorry mixer	8
		Concrete pump truck	1
		Excavator	1
Bentonite Filtering & Mixing for D-wall only	Aug 05 - May 06	Bentonite filtering and mixing plant (for both southern & northern stations)	1
Bored piling	Aug 05 - May 06	Pilling, Crawler crane/ chisel/oscillator/RCD	2
		lorry	3
		Concrete pump truck	1
		Concrete lorry mixer	3
Soil & Rock Excavation and shoring	Nov 05 - Sep 06	Auger	8
		Excavator	5
		Mobile Crane	1
		Dump Truck	4
		Welding Machine	3
Construction and Waterproofing	Mar 06 - Sep 07	Mini excavator	3
		Generator, silenced	5
		Crane Lorry	2
		Mobile Crane	2
		Air Compressor	5
		Circular Saw	3
		Concrete pump truck	2
		Lorry	8
		Pokers	5
		Mini excavator	3
Welding Machine	2		

Note:  
Welding machine is not a PME

**Job Title :** KCRC KSL 100 EIA

**Heading :** Plant Inventory

**Appendix No.** 4-2k

**Section :** Operation of Launching shaft at Restricted Hour

Description	Period	PME	Unit
Operation in launching shaft (for one tube)	Jun 06 - Aug 06	+Generator	1
		+Air compressor	1
		Conveyor belt	1
		Ventilation fan	1
		Mortar plant	1
		Mortar pump	1
		+Water pump (S.M)	1
		Water pump (for WWTP)	1
		+Diesel Train	1
		+Mortar Car	1
		+TBM	1
		Foundation	Jun 06 - Jan 07
Operation in launching shaft (for another tube)	Nov 06 - Jan 07	+Generator	1
		+Air compressor	1
		Conveyor belt	1
		Ventilation fan	1
		Mortar plant	1
		Mortar pump	1
		+Water pump (S.M)	1
		Water pump (for WWTP)	1
		+Diesel Train	1
		+Mortar Car	1
		+TBM	1

Note:

\* Plants to be operated inside tunnel/decking

+ Plants to be operated on the bottom of launching shaft





## **APPENDIX – 4-3**

### **Construction Programme**

