Submission No 298

INQUIRY INTO FEASIBILITY OF UNDERGROUNDING THE TRANSMISSION INFRASTRUCTURE FOR RENEWABLE ENERGY PROJECTS

Organisation: Specialist Tunnel Excavation

Date Received: 11 August 2023

HumeLink Underground Analysis

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Introductions

- , General Manager
- , Engineering and Systems Manager,
- , Third Party Interface Manager,
- , Estimator and Tender Manager
- , Managing Director
- , Project Manager
- , Director
- , Manager Transmission
- , Policy Officer,

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Meeting Agenda

- Introduction
- Objectives
- High level cost comparison
- Elements of civil work resulting in greatest cost impact
  - TSB
  - Disposal
  - Excavation methodology
  - Productivity
- Conclusion

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Introduction

- Video link

- Garde – Who are we?
  - Garde has been operating in NSW for over 40 years, specializing in Extra high-voltage cable projects.
  - We are the marker leader of Extra high-voltage cable installation in NSW
  - We have completed over $500m worth of Electrical Infrastructure Projects in the past 15 years
  - We have delivered 9 of the 11 major transmission projects for the Main Electrical Authorities (Transgrid, Ausgrid, Endeavour Energy) in the past 20 years. This has led to Garde becoming the contractor of choice for Transmission installation projects in NSW
  - We have the largest fleet of transmission cable installation equipment in Australia, including the largest cable drum trailer in Australia (designed by Garde) which was manufactured in New Zealand and delivered to Australia specifically for the PSF Project which is capable of carrying 6.5m wide x 60t drums of cable.

- Major Current & Past Projects
  - Endeavour Energy – 132kV backbone feeder for the Aerotropolis Project
  - Transgrid – 330kV Powering Sydney's Future (PSF) Project
  - Ausgrid – 132kV Matraville to Maroubra (M2M) Project
  - Transgrid/Lumea – 330kV Port Kembla ECI Phase
  - Currently in final tendering stages of Marinus Link 320kV DC Project

Our key customers:

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Specialist Utility Infrastructure

- Part of the STE Group
- Specialist Excavation Business, with focus on major infrastructure projects and utility projects.
- Proven capability on NSW government projects including Western Sydney Airport, WestConnex, NorthConnex and Sydney Metro
- Partnership with OEM suppliers of the specialist excavation equipment.

Major Projects

- Recent award of the Gladstone to Fitzroy major water pipeline project in QLD. The 120km project method of excavation was chosen over conventional to provide programme & cost savings to the project and lower carbon footprint by reducing number of other equipment items across the construction.

Our key customers:

Objectives

- Greater understanding of cost make up for cable trenching works
- Greater understanding of alternative construction systems and efficiencies within civil cable works
- High level cost comparison with comparable works within the current market
- Greater understanding of cost saving options

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High level cost comparison - selection

4.1.3 Capital cost estimate summary

A summary of the capital cost estimates for the preferred options are displayed below. Sections 4.2 – 4.5 contain detailed capital cost breakdown for each preferred option.

Table 4.4 Capital Cost Estimate Summary Table

Variant	Description	Route	Total Capex (AUD)	Life Cycle
OHL	Overhead AC (2020 estimate)	1 - via Tumut North	$3,300,000,000	50 years
1A	Underground HVAC	1 - via Tumut North	$17,140,000,000	50 years
2A-1	Underground HVDC	1 - via Tumut North	$11,490,000,000	50 years
2B-1	Underground HVDC	1 - via Tumut North	$8,992,000,000	50 years
3A-3	Overhead in public land, HVAC & HVDC Hybrid	2/3 – via Blowering and Kosciusko combination	$9,626,000,000	50 years
3B-3	Overhead in public land, HVAC & HVDC Hybrid	2/3 – via Blowering and Kosciusko combination	$7,464,000,000	50 years
4A-5	HVAC & HVDC Hybrid	4 - via Hume Highway	$11,450,000,000	50 years
4B-5	HVAC & HVDC Hybrid	4 - via Hume Highway	$9,053,000,000	50 years
4C-2	HVAC & HVDC Hybrid	4 - via Hume Highway	$10,420,000,000	50 years

Table 4.5 Capital Cost Estimate Summary Table – Gugaa to Wagga Wagga

Variant	Description	Total Capex (AUD)	Life Cycle
Gugaa to Wagga Wagga	330kV underground HVAC	$754,000,000	50 years

4.3.2 Option 2B-1 - Our estimate for civils & cable = $4,900/m

Terrain factors applied to Option 2B-1 are as displayed below:

Table 4.12 Option 2B-1 Terrain Factors

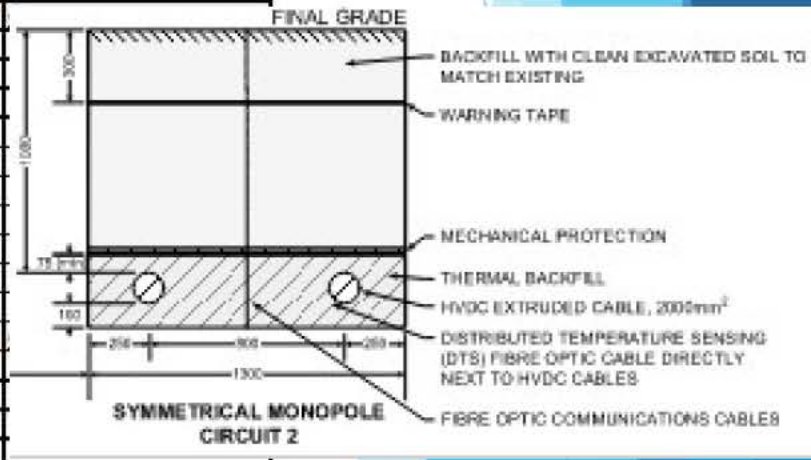
Terrain Factor	Clearing	Geotech	Topography	Easement Access
Difficulty	Easy	Medium	Medium	Medium

The cost estimate for the preferred solution, Option 2B-1, is summarised in Table 4.13.

Table 4.13 Option 2B-1 cost estimate

Case Scenario Capex Report			
Project	Hume Link - Underground Options Comparative Estimates		
Project Variant	2B-1		
Capex Total	$ 8,992,000,000	AUD	
Transmission Line Capex	$ 6,407,000,000	AUD	

Tranmission Cable	TC1	TC2	TC3		
Capital Cost				Unit	Comments
Subtotal	$ 3,495,000,000	$ 3,656,000,000	$ 1,841,000,000	AUD	All in costs (including offsets, convertor stations, reactor stations and UGOHs)
Installed Rate per km	$ 12,630,000	$ 12,480,000	$ 16,820,000	AUD/km	
Installed Cost per km/MW	$ 9,827	$ 9,713	$ 13,090	AUD/km/MW	
Subtotal	$ 2,605,000,000	$ 2,757,000,000	$ 1,045,000,000	AUD	Excludes offsets, convertor stations, reactor stations and UGOHs
Installed Rate per km	$ 9,412,000	$ 9,412,000	$ 9,545,000	AUD/km	
Installed Cost per km/MW	$ 7,325	$ 7,325	$ 7,428	AUD/km/MW	
Line Design				Unit	
HVAC/HVDC	HVDC direct buried cable	HVDC direct buried cable	HVDC direct buried cable	-	
Voltage	400	400	400	kV	
Power/Rating	1,285	1,285	1,285	MW	
Circuit configuration	Symmetrical Monopole	Symmetrical Monopole	Symmetrical Monopole	-	
Location	NSW	NSW	NSW	-	
Country	Australia	Australia	Australia	-	
Length	277	293	109	km	
Number of Reactor Stations	0	0	0	-	
Number of Transition Stations	0	0	0	-	
Number of Converter Stations	2	2	2	-	
Cost Basis				Unit	
Labour	$ 888,700,000	$ 940,400,000	$ 351,300,000	AUD	
Materials	$ 667,700,000	$ 706,500,000	$ 264,000,000	AUD	
Equipment	$ 569,200,000	$ 602,300,000	$ 225,000,000	AUD	
Engineering & PM	$ 175,100,000	$ 185,300,000	$ 69,240,000	AUD	
Pre-Construction	$ 145,700,000	$ 154,200,000	$ 57,600,000	AUD	
Distribs	$ 105,000,000	$ 111,100,000	$ 51,070,000	AUD	
Allowances	$ 54,070,000	$ 57,210,000	$ 26,310,000	AUD	



4.3 Option 2

4.3.1 Option 2A-1 - Our estimate for civil & cable = $7,000/m

Terrain factors applied to Option 2A-1 are as displayed below:

Table 4.10 Option 2A-1 Terrain Factors

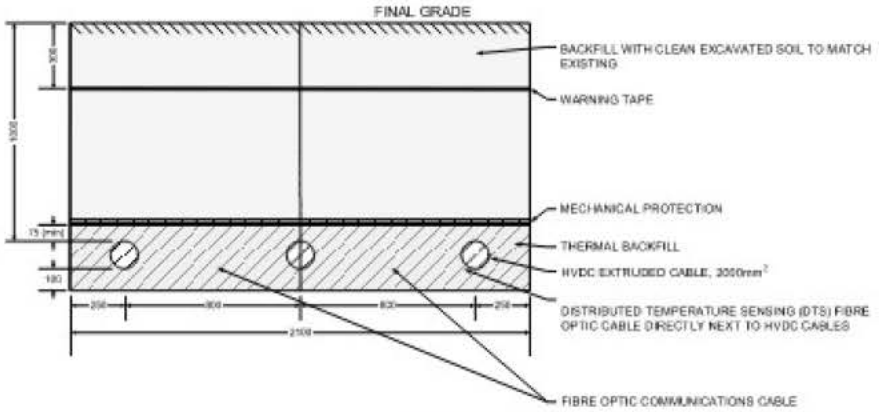
Terrain Factor	Clearing	Geotech	Topography	Easement Access
Difficulty	Easy	Medium	Medium	Medium

The cost estimate for the preferred solution, Option 2A-1, is summarised in Table 4.11 below.

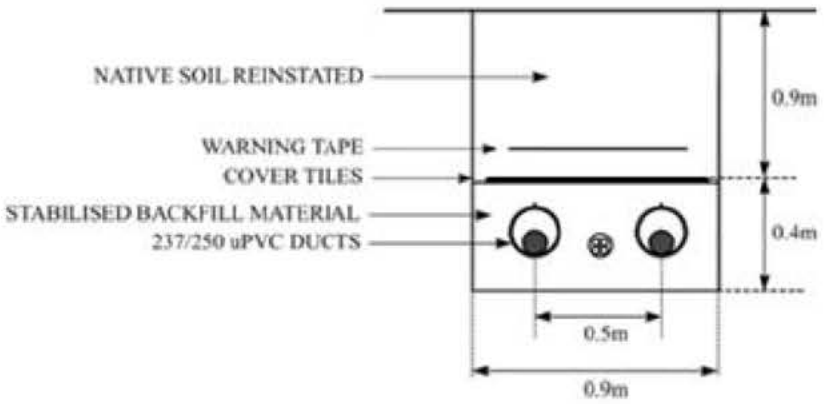
Table 4.11 Option 2A-1 cost estimate

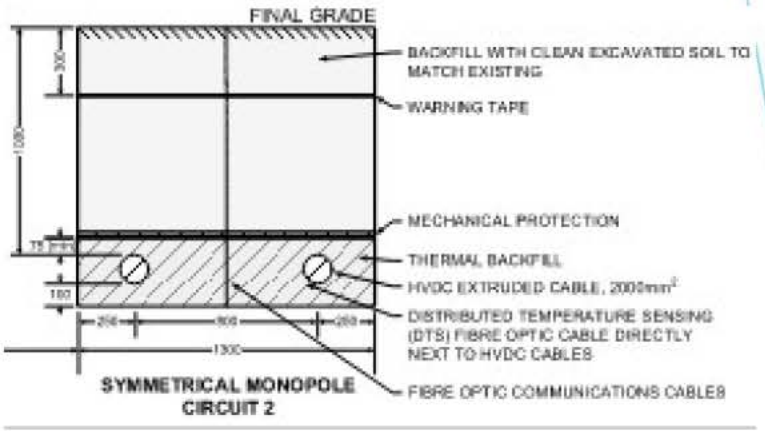
Case Scenario Capex Report			
Project	Hume Link - Underground Options Comparative Estimates		
Project Variant	2A-1		
Capex Total	$ 11,490,000,000	AUD	
Transmission Line Capex	$ 7,717,000,000	AUD	

Tranmission Cable	TC1	TC2	TC3		
Capital Cost				**Unit**	**Comments**
Subtotal	$ 4,431,000,000	$ 4,624,000,000	$ 2,431,000,000	AUD	All in costs (including offsets, convertor stations, reactor stations and UGOHs)
Installed Rate per km	$ 16,010,000	$ 15,790,000	$ 22,210,000	AUD/km	
Installed Cost per km/MW	$ 9,345	$ 9,216	$ 12,970	AUD/km/MW	
Subtotal	$ 3,143,000,000	$ 3,326,000,000	$ 1,248,000,000	AUD	Excludes offsets, convertor stations, reactor stations and UGOHs
Installed Rate per km	$ 11,350,000	$ 11,350,000	$ 11,410,000	AUD/km	
Installed Cost per km/MW	$ 6,628	$ 6,628	$ 6,659	AUD/km/MW	
Line Design				**Unit**	
HVAC/HVDC	HVDC direct buried cable	HVDC direct buried cable	HVDC direct buried cable	-	
Voltage	525	525	525	kV	
Power/Rating	1,713	1,713	1,713	MW	
Circuit configuration	Bipole	Bipole	Bipole	-	
Location	NSW	NSW	NSW	-	
Country	Australia	Australia	Australia	-	
Length	277	293	109	km	
Number of Reactor Stations	0	0	0	-	
Number of Transition Stations	0	0	0	-	
Number of Converter Stations	2	2	2	-	
Cost Basis				**Unit**	
Labour	$ 1,072,000,000	$ 1,134,000,000	$ 423,800,000	AUD	
Materials	$ 805,400,000	$ 852,300,000	$ 318,400,000	AUD	
Equipment	$ 686,600,000	$ 726,500,000	$ 271,500,000	AUD	
Engineering & PM	$ 211,300,000	$ 223,500,000	$ 83,520,000	AUD	
Pre-Construction	$ 175,700,000	$ 186,000,000	$ 69,480,000	AUD	
Distribs	$ 126,600,000	$ 134,000,000	$ 53,900,000	AUD	
Allowances	$ 65,220,000	$ 69,010,000	$ 27,770,000	AUD	



High level cost comparison:
Hume Link (option 2B) Vs Project X





Project X

- Single circuit HVDC trench profile
- Civil cost = Approx ~ $2,500/m

Hume Link

- **Option 2B** - Single circuit HVDC trench
- **Install rate = $9,500/m** *(GHD report Table 4.13)*
- Our high-level estimate for Humelink
  - Civil cost = $2,500/m (comparable with Project X)
    - Further optimization options to reduce costs to be assessed
  - 2x cables = $2,400/m (per circuit)
    - AC cable = $1,200/m *(Current Supplier quote)*
  - **Total Civils & cable = $4,900/m**

4.2 Option 1A

The cost estimates for civil installation and cable supply have been benchmarked against the Transgrid 330 kV Powering Sydney's Future project. The respective contractors have also provided estimation guidance on this potential project.

The cost estimate has additionally been benchmarked against a confidential 330 kV Australian project currently in feasibility stage.

Terrain factors applied to Option 1A are as displayed below:

Table 4.8 Option 1A Terrain Factors

Terrain Factor	Clearing	Geotech	Topography	Easement Access
Difficulty	Easy	Medium	Medium	Medium

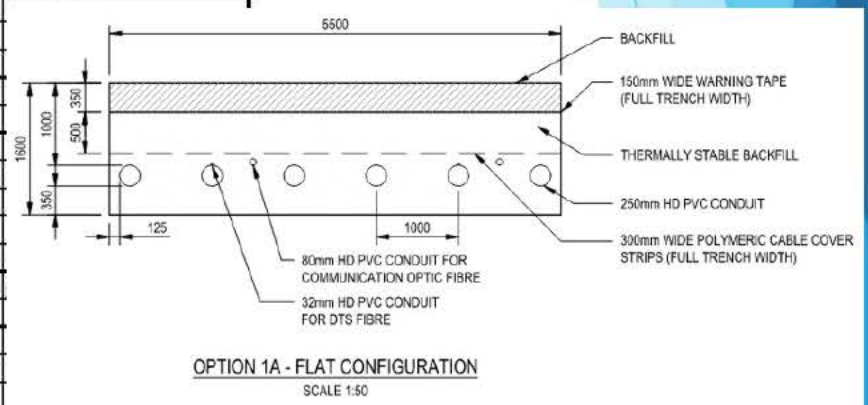
The cost estimate for the preferred solution, Option 1A, is summarised in Table 4.8 below.

Table 4.9 Option 1A Cost Estimate

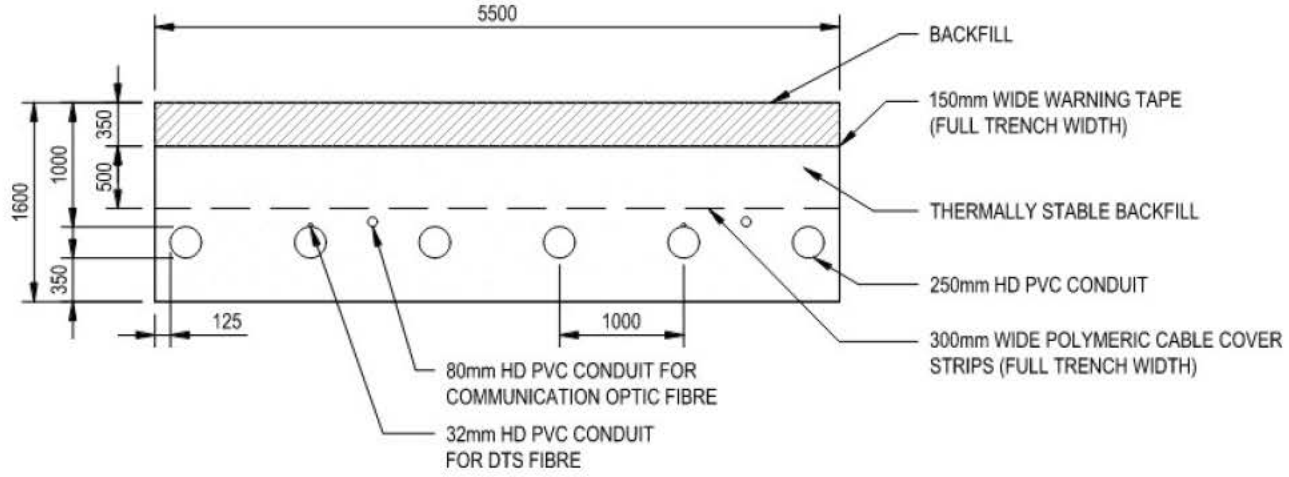
Case Scenario Capex Breakdown

Project	Hume Link - Underground Options Comparative Estimates		
Project Variant	1A - Undeground HVAC		
Capex Total	$	17,140,000,000	AUD
Transmission Cable Capex	$	15,920,000,000	AUD

Tranmission Cable	TC1	TC2	TC3		
Capital Cost				**Unit**	**Comments**
Subtotal	$ 6,958,000,000	$ 7,428,000,000	$ 2,751,000,000	AUD	All in costs (including
Installed Rate per km	$ 25,120,000	$ 25,350,000	$ 25,240,000	AUD/km	offsets, convertor stations,
Installed Cost per km/MW	$ 9,774	$ 9,864	$ 9,822	AUD/km/MW	reactor stations and UGOHs)
Subtotal	$ 6,442,000,000	$ 6,807,000,000	$ 2,577,000,000	AUD	Excludes offsets, convertor
Installed Rate per km	$ 23,260,000	$ 23,540,000	$ 23,640,000	AUD/km	stations, reactor stations
Installed Cost per km/MW	$ 9,049	$ 9,159	$ 9,198	AUD/km/MW	and UGOHs
Line Design				**Unit**	**Comments**
HVAC/HVDC	HVAC duct bank cable	HVAC duct bank cable	HVAC duct bank cable	-	
Voltage	500	500	500	kV	
Power/Rating	2,570	2,570	2,570	MW	
Circuit configuration	Single circuit	Single circuit	Single circuit	-	
Location	NSW	NSW	NSW	-	
Country	Australia	Australia	Australia	-	
Length	277	293	109	km	
Number of Reactor Stations	7	7	2	-	
Number of Transition Stations	0	0	0	-	
Number of Converter Stations	0	0	0	-	
Cost Basis				**Unit**	
Labour	$ 1,557,000,000	$ 1,667,000,000	$ 622,600,000	AUD	
Materials	$ 1,170,000,000	$ 1,252,000,000	$ 467,800,000	AUD	
Equipment	$ 2,506,000,000	$ 2,683,000,000	$ 1,002,000,000	AUD	
Engineering & PM	$ 445,600,000	$ 477,000,000	$ 178,200,000	AUD	
Pre-Construction	$ 370,700,000	$ 396,800,000	$ 148,200,000	AUD	
Distribs	$ 259,500,000	$ 277,800,000	$ 103,800,000	AUD	
Allowances	$ 133,700,000	$ 143,100,000	$ 53,470,000	AUD	

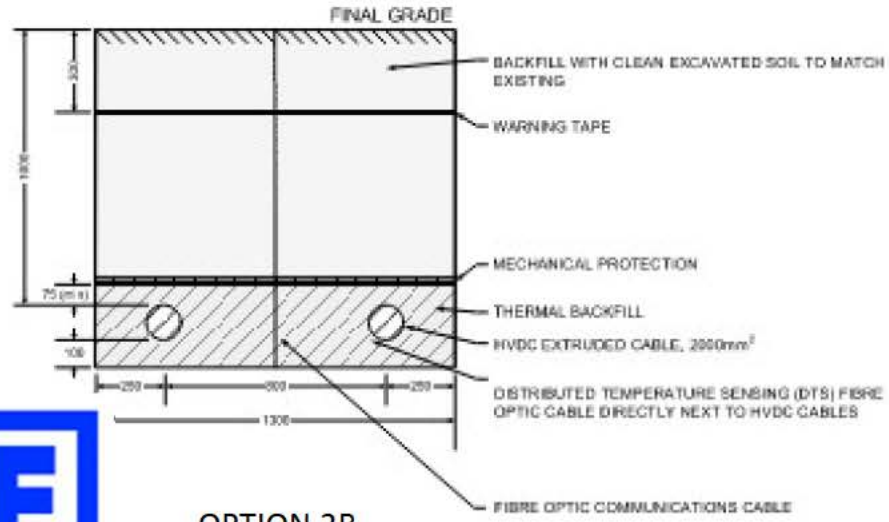


Cost Variance due to TSB Volume Increase & Disposal Increase



OPTION 1A - FLAT CONFIGURATION

SCALE 1:50



OPTION 2B

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Elements of Civil Work Resulting in Greatest Cost Impact

- Thermal backfill material (TSB)
- Disposal of excavated material
- Excavation productivity
- Open trenches (direct lay); Any cable supply delays will have a huge impact on program & cost

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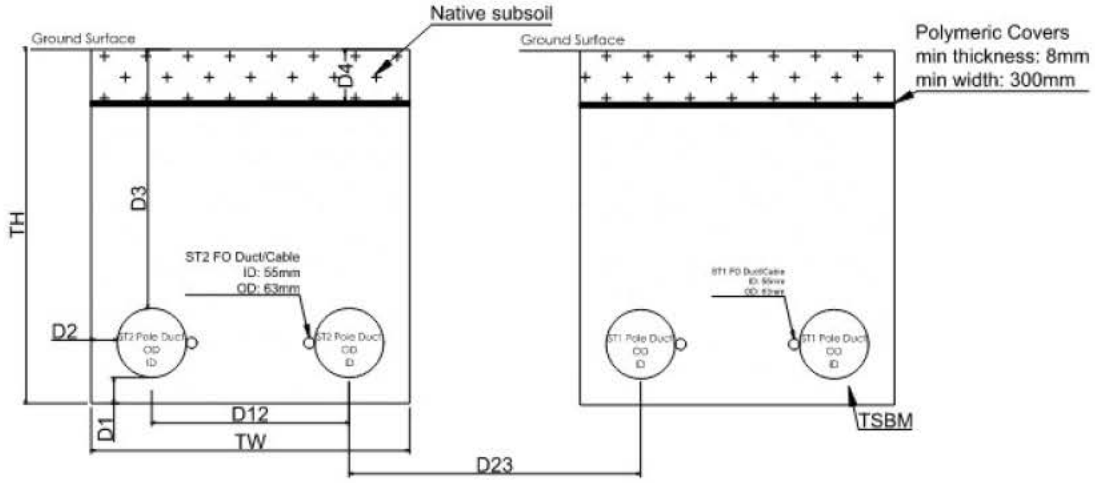
Cost Variance due to TSB Volume Increase

Soil TR	Distance between adjacent pole cables	Distance between trench wall and duct	Trench Width	Trench Depth	Backfill Area TSB	Cost
K.m/W	mm	mm	mm	mm	m^2	per m
Column1	D12	D2	TW	TH	Column17	Column2
1.4	1000	100	1511	1611	1.37	$ 1,061.70
1.4	1000	100	1511	1511	0.61	$ 782.16
1.4	1000	100	1511	2011	1.97	$ 1,285.33
1.4	1500	150	2111	2611	4.51	$ 2,223.43
3	1000	100	1511	1511	1.60	$ 1,145.56
3	1000	100	1511	2011	2.58	$ 1,508.96
3	1500	200	2211	2661	5.28	$ 2,509.75
3	1000	100	1555.6	1555.6	1.44	$ 1,086.77
3	1000	100	1555.6	2005.6	2.60	$ 1,518.45
3	1300	200	2055.6	2655.6	4.84	$ 2,346.86

Trench Design for Land Cable



Excavation productivity

- 2 types of trenchers to cover all geotechnical conditions to be expected. Both types of machines will replace up to 15 x large excavators to perform same job. That is also lower Carbon footprint for the project. (study report example can be provided)
- Any trench width can be tailored to cut in one pass
- Bucket wheels trenchers for OTR ground conditions, minimum 8 x times faster than conventional excavator crews. Program & cost savings
- Chain trenchers for rock & mixed ground conditions, minimum 6 x faster than conventional excavator crews. Program & cost savings. We were contracted to Snowy 2.0 hydro to excavate the 33kV underground power supplies for all TBM sites. Our smallest rock trenchers were excavating 500m a shift
- Trenchers can work in the minimal construction corridor
- Trenchers excavated material is a ground up 25mm minus sizing so can be easily windrowed on site after work is completed as dressing across trench with no oversize.
- Trenchers have been chosen for a new major water pipeline in QLD, 130km - Gladstone to Fitzroy, construction only 10 months, and is 70% rock


TSM 07

Conduit/pipe options

- Replace conduits with on-site extrusion of HDPE pipe
- Reduce labour
- Reduce transport, storage & handling costs of traditional stick pipe method
- Expedite program by quicker conduit installation & backfill process
- Continuous conduit from Joint Bay to Joint Bay, reduce risk of defects at joints.

Backfill materials

- TSB - low TR, low strength concrete mix
  - Higher cost
- Low TR sand
  - Low cost

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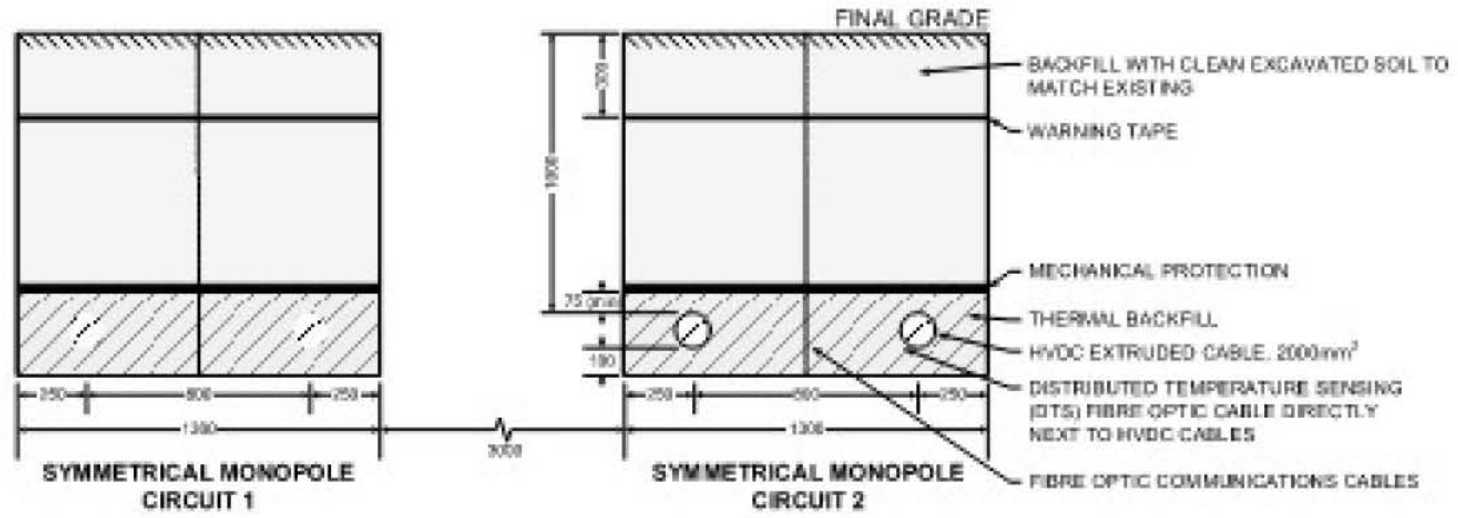
Conclusion

Optimal trenching solution – Option 2B (with conduits)



- Mitigation of delays of cable supply by installing conduits/ducts
- Reduced TSB
- Reduced/zero disposal
- Reduce labour & crew size
- Greatest excavation productivity

Meeting Close

- What's next
  - Issue meeting review comments or summary.
  - Garde and STE to provide any support to further evaluate time and cost saving options.

Thank you for your attendance and contributions

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