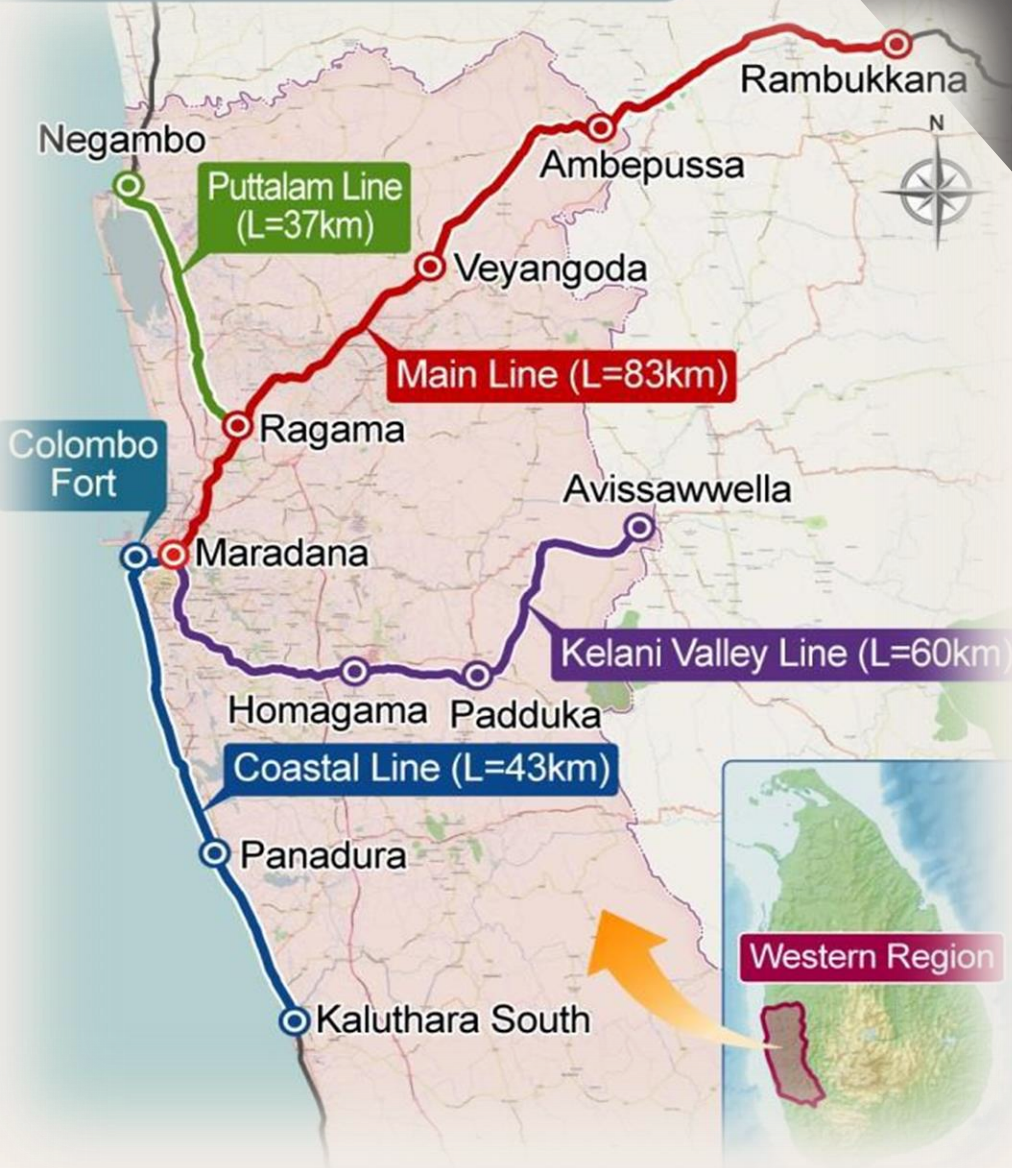


***Colombo Suburban Railway Project ;
Transport Project Preparatory Facility 3425 SRI***



Project Area

Colombo Suburban Railway Network



- 210 km of existing railway track rehabilitation
- 105 km of new track construction
- 210 km - Electrification
- New EMU (E' Train) Procurement
- 210 km – Signalling
- Relocation of 3200 (approx.) families

COLOMBO SUBURBAN RAILWAY PROJECT (L3425-SRI)

Loan Milestones		Amounts (\$ million)	
Approval	22.09.2016		
		Original Loan	\$ 10.0 Mn
Signing	28.10.2016	Interest Rate	2.0%
		Grace Period/Loan Period	05 years / 25 Years
Loan Effective	21.12.2016		
Original Closing	30.06.2023	Contract Award*	\$ 9.9 Mn
Revised Closing	Cumulative Disbursement*	\$ 5.67 Mn (57%)

Railway Development in New Govt. Policy (pg. 65)

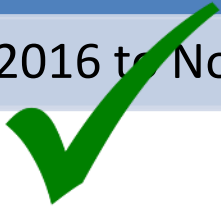
- Colombo-Panadura-Veyangoda, Ragama-Katunayake-Negombo, and Maradana -Homagama rail lines will be converted into electric train routes and thereby ensure the public is provided with a luxury transport service similar to that planned for the buses.
- E-ticketing system will be provided and introduced for all train transportation.

Process

Pre-Feasibility Study including KV Line Study and Long Distance Study

June 2016 to November 2017

Technical Committee and NPSC



Feasibility Study on KV Line, Main Line, Coastal Line and Puttlam Line

January 2018 to February 2019

NPSC and SPSC



Detailed Design of KV Line, Main Line, Coastal Line and Puttlam Line

August 2018 and Continuing

NPSC and SPSC



KV Line

Designs and Bid Docs,

Completed



Main Line

Designs

90% Completed



Coastal Line

Designs

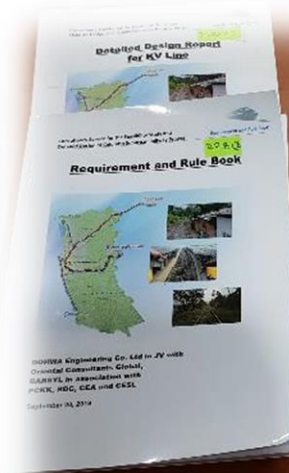
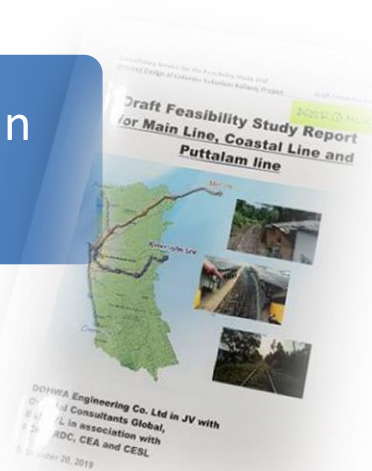
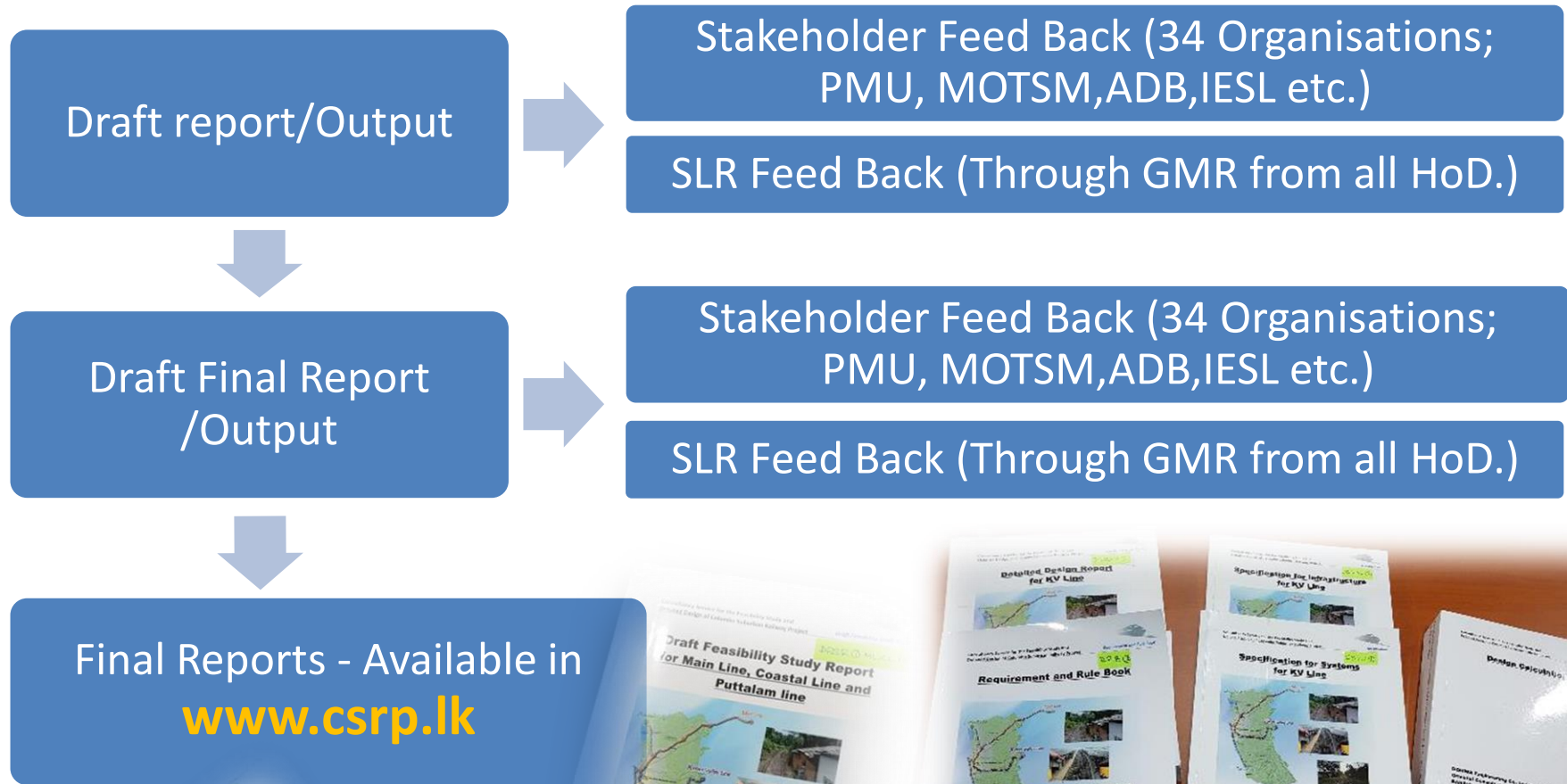
60% Completed

Puttlam Line

Designs

40% Completed

Output Approval Process



Railway Development : KV Line

✓ Today :

- ✓ Addresses two Corridors ; Avissawella Corridor and Horana Corridor
- ✓ Daily Ridership : 14,500
- ✓ Train Operation is limited to Peak Hours (Morning and Evening)
- ✓ Weakest Infrastructure among all 04 lines
- ✓ Unable to operate more trains due to limitations of Infrastructure

✓ **After Development :**

- ✓ Attract passengers from Bus and Car to Rail
- ✓ Daily Ridership in 2035: 200,000
- ✓ Trains operate uniformly throughout the day (train in every 7 minutes in Peak Hrs.)
- ✓ Park and Ride facility at every railway station (Parking for 100 cars and Bus Bays)
- ✓ Immediate solution to congestion in Colombo and High Level Road
- ✓ Isolated line ; ideal for electrification with less impact to people during construction

Railway Development : Main Line

✓ Today :

- ✓ Addresses Kandy Corridors ;
- ✓ Daily Ridership : 100,000
- ✓ Uniform Train Operation throughout the day
- ✓ Infrastructure – Maintained well by SLR

✓ **After Development :**

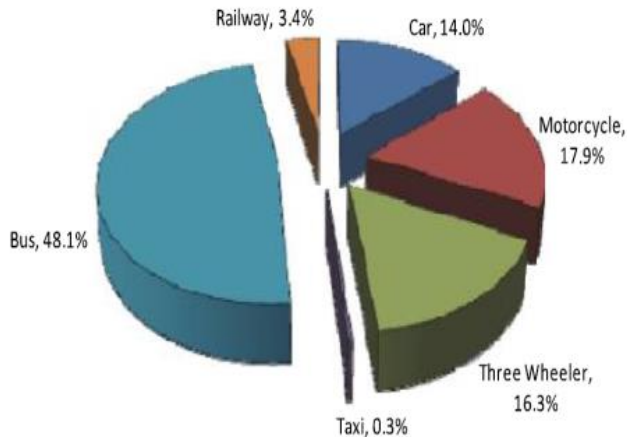
- ✓ Attract passengers from Bus and Car to Rail
- ✓ Daily Ridership in 2035:
- ✓ Trains operate uniformly throughout the day (train in every 3 minutes in Peak Hrs.)
- ✓ Park and Ride facility at every railway station (Parking for 100 cars and Bus Bays)
- ✓ Serves other lines, Ridership is high and Impact to passengers during construction - high

Passenger Demand Study

- We use this to,
 - Decide Passenger Volume for Peak Hour Peak Direction by year 2034
 - Decide Train Set Composition (in our case 6+6 EMU with capacity of 2400 passengers)
 - Decide Number of Train sets to operate in the line and whether the number of railway lines enough.
 - Obtain data for Financial Analysis

Existing Traffic Data

Modal Share in Western Province (excluding NMT)
(N=7.9 mill. trips/day)



2013: 246,000 Pax
Peak Rail 43%

2013: 438,000 Pax
Peak Rail - 39%

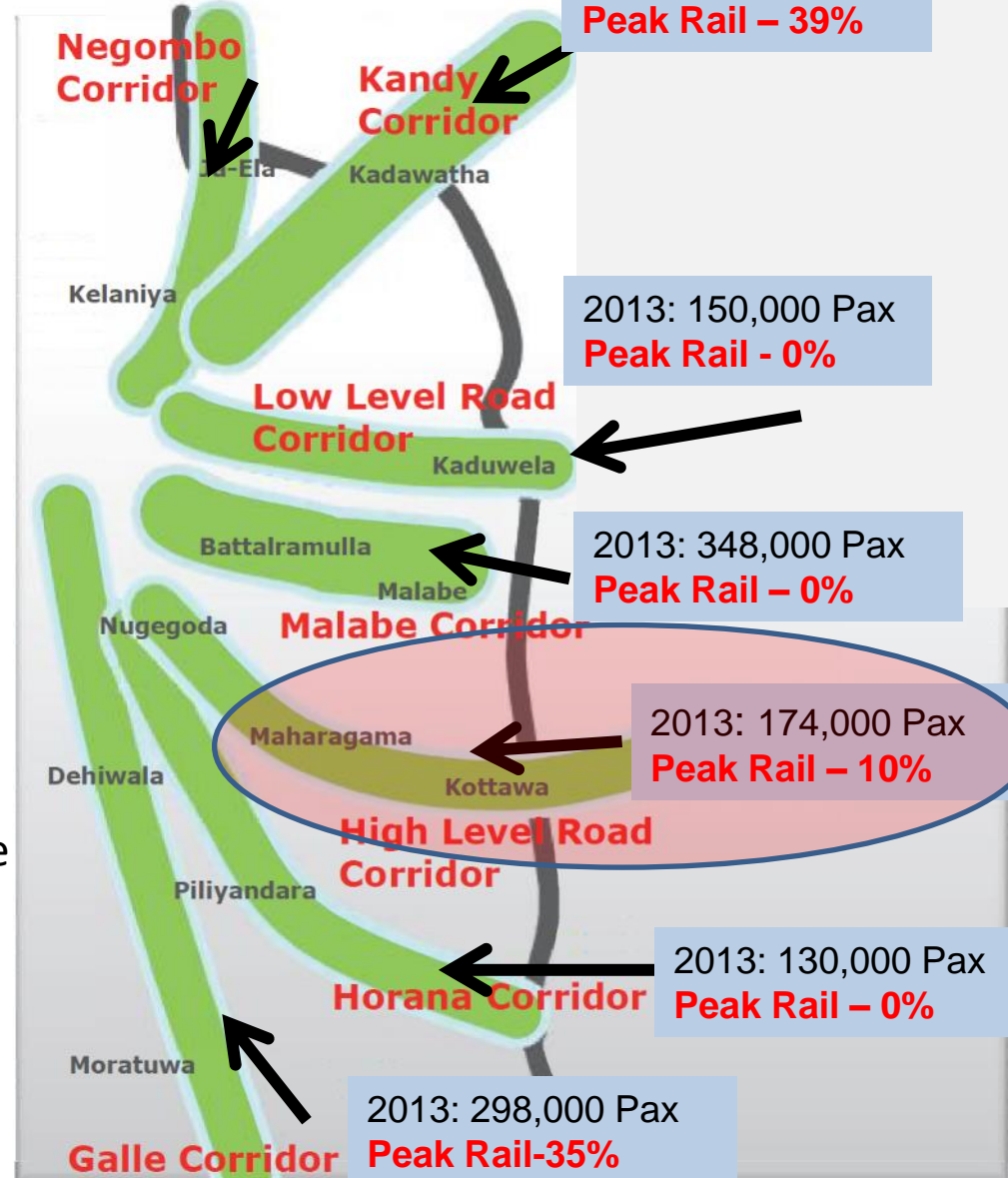
2013: 150,000 Pax
Peak Rail - 0%

2013: 348,000 Pax
Peak Rail - 0%

2013: 174,000 Pax
Peak Rail - 10%

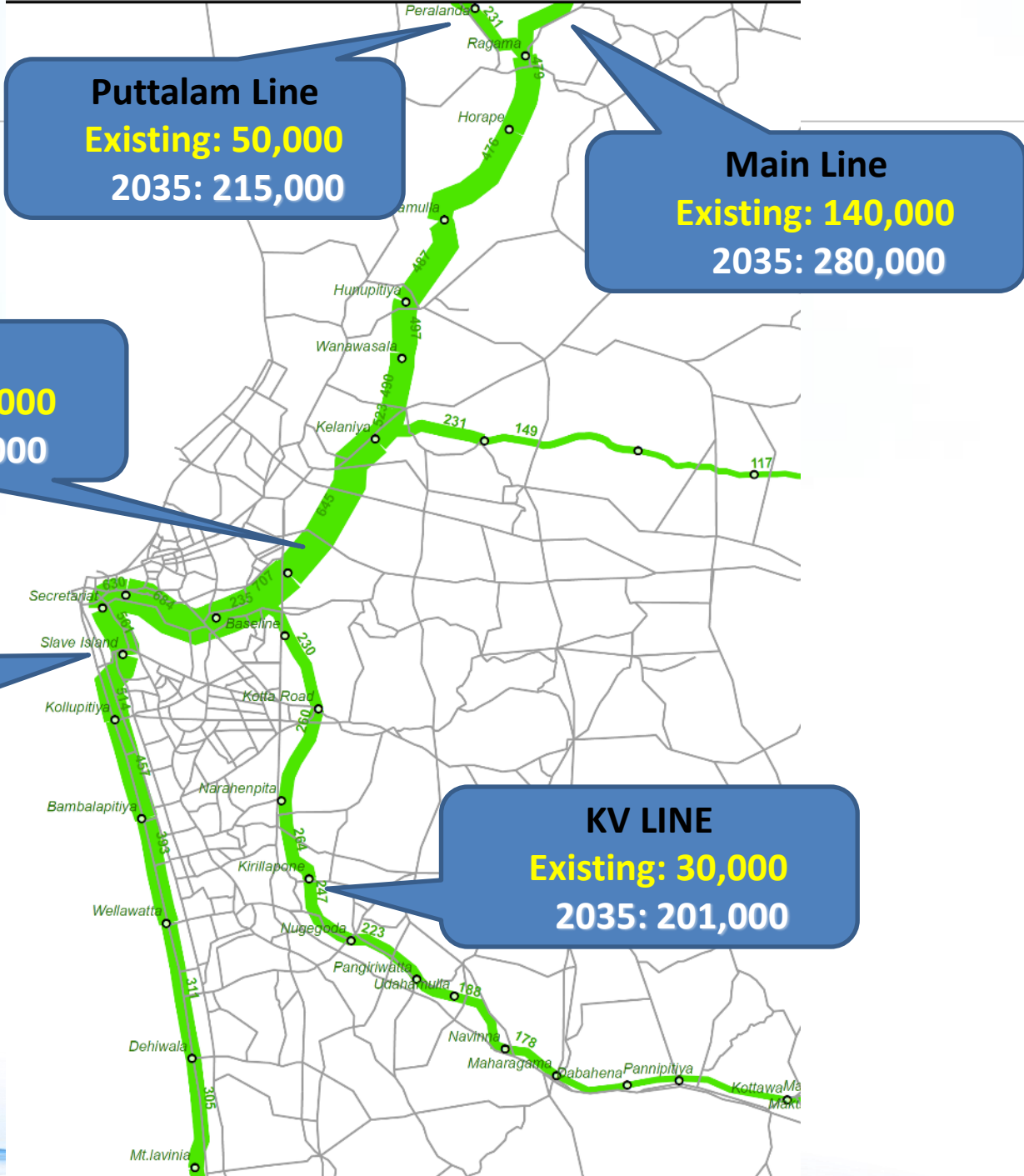
2013: 130,000 Pax
Peak Rail - 0%

2013: 298,000 Pax
Peak Rail-35%



- 1.9 Million Daily Pax to/from CMC
- Rail Share – 4% (CMR)
- With Approx. 200km of Rail
- Bus Share – 48% (CMR)
- With Approx. 2500 km network
- Peak Rail Share on Corridors are high Except for KV line
 - Galle Road – 35%
 - Negambo – 43%
 - Kandy - 39%
 - **KV Line – 10%**

Daily Passenger Demand (2035)



Demand Study

Decision of Number of Railway Lines

Railway Line	Section	Number of Tracks	
		Existing	Future
Kelani Valley	Colombo - Padukka	1	2
	Padukka - Avissawella	1	1
Main Line	Colombo - Ragama	3	4
	Ragama - Veyangoda	2	3
	Veyangoda - Rambukkana	2	2
Coastal Line	Colombo - Panadura	2	3
	Panadura - Kaluthara	2	2
Puttlam Line	Ragama - Negambo	2	2

Decision on Train Set Composition :

Number of Coaches : **6+6 coach EMU**

Capacity per Train Set : **2400 passengers**

Track Alignment - Option Study


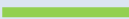
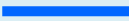
- We consider few possible solutions and use this to,
 - Decide **best option for Horizontal Alignment** which solves requirements and issues
 - Decide **best option for Vertical Alignment**
- **Requirements and Issues** are,
 - Social and Environment Safeguard, Land Acquisition, Level Crossings
 - Speed, Travel Time,
 - cost of construction

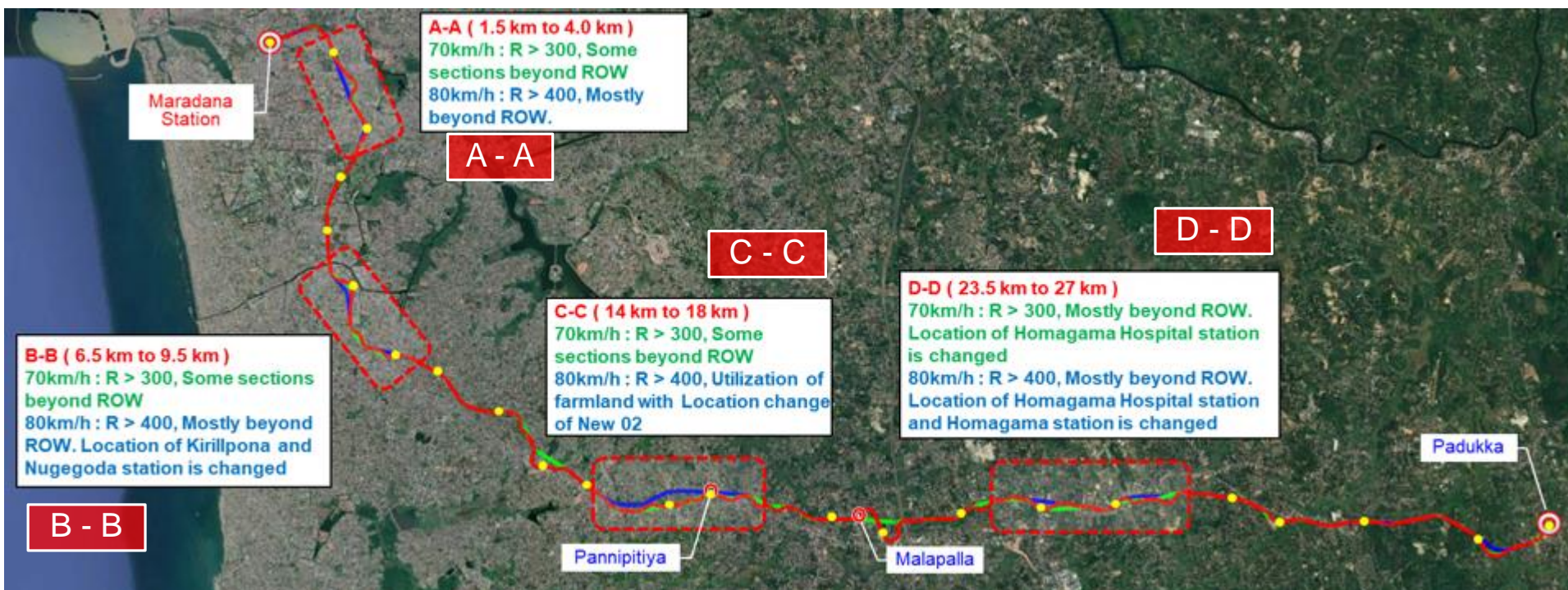
Kelani Valley Railway Development

- Option Studies
- Decision and reasons for such decisions
- Financial Analysis – Option evaluation
- Operation and Time Saving to Passenger

Design Concept: Horizontal Alignment

Three Options considered

Option 1	Alignment with, curves straightened, but within the existing Railway ROW.	
Option 2	Alignment with speed limit of 70km/h and minimum radius of curve at 300m .	
Option 3	Alignment with speed limit of 80km/h and minimum radius of curve at 400m .	

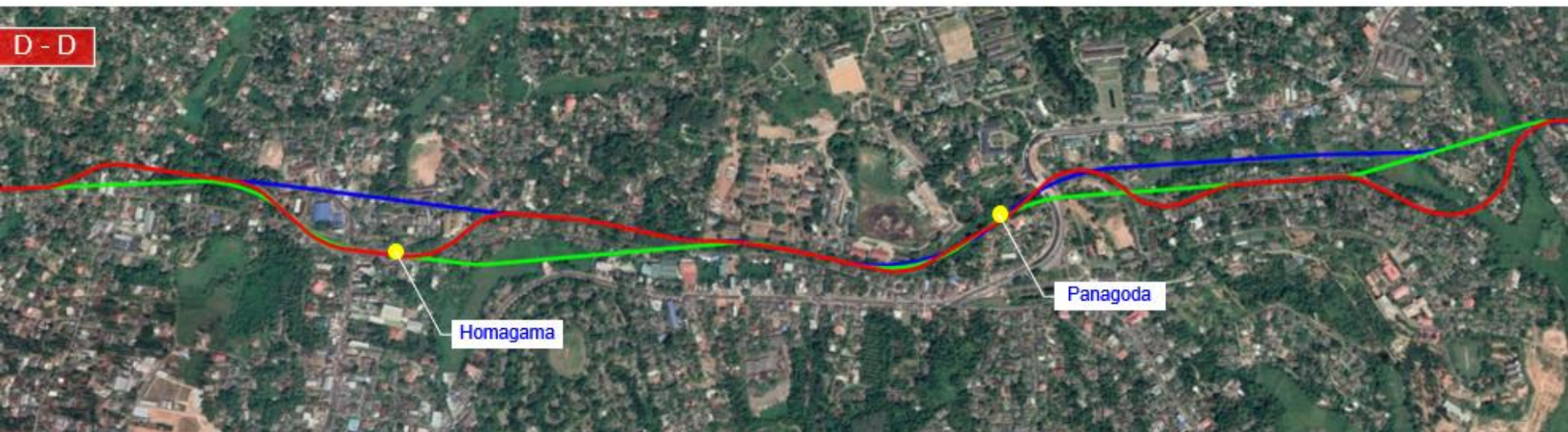


Yellow Dots indicate Railway Stations which are only 0.6 to 1.5 km apart

Design Concept: Horizontal Alignment



Design Concept: Horizontal Alignment



Design Concepts - Horizontal Alignment

Horizontal Alignment - Option Study Summary

Classification	Min. Radius	Max. Speed	Additional Land Acquisition		Time Saving
			Area	Estimated Cost	
Option 1	120 m	40 km/h	29,209 m²	USD 8.5 Mn.	26.4 min.
Option 2	300 m	70 km/h	110,022 m ²	USD 32.0 Mn.	31.4 min.
Option 3	400 m	80 km/h	171,996 m ²	USD 50.0 Mn.	31.8 min.

- ✓ Curves can be straightened to increase Speed
- ✓ This involves Land acquisition resulting high cost
- ✓ However, KV Line (in first 20 km section) has Railway Stations in every 0.6 to 1.5 km. This disallows the train to achieve the higher speeds.
- ✓ Therefore, even if we straighten curves, the commercial speed will not be increased correspondingly.
- ✓ Our expected outcome is to reduce travel time. But, this can not be achieved as expected due to existence of Railway Stations
- ✓ **So, after discussing (in about 04 meetings), Project Steering Committee , approved Option - 1**

Design Concepts – Vertical Alignment

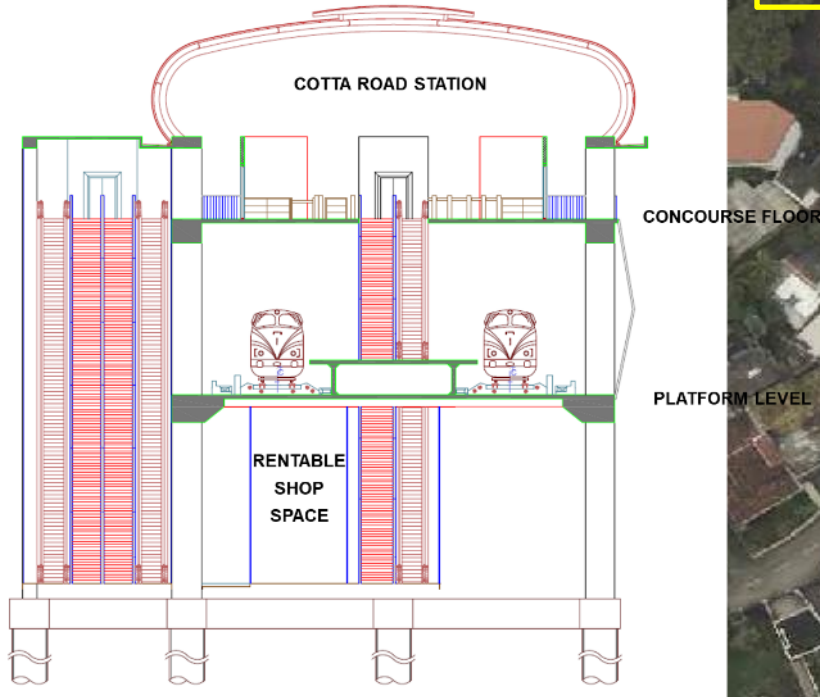
Four Options considered

Option 1	Elevated Line
Option 2	Underground Line
Option 3	Elevated + Underground Line
Option 4	Elevated + Underground + At grade Line

- Social and Environment Safeguard – 2400 families in SLR Lands
- Land Acquisition - Lands are expensive in the corridor
- Level Crossings – 145 Level Crossings from Maradana to Padukka
- ‘At Grade’ construction require wider corridor (14.5 m wide)
- Cost of construction – must select the low cost option which solve the issues

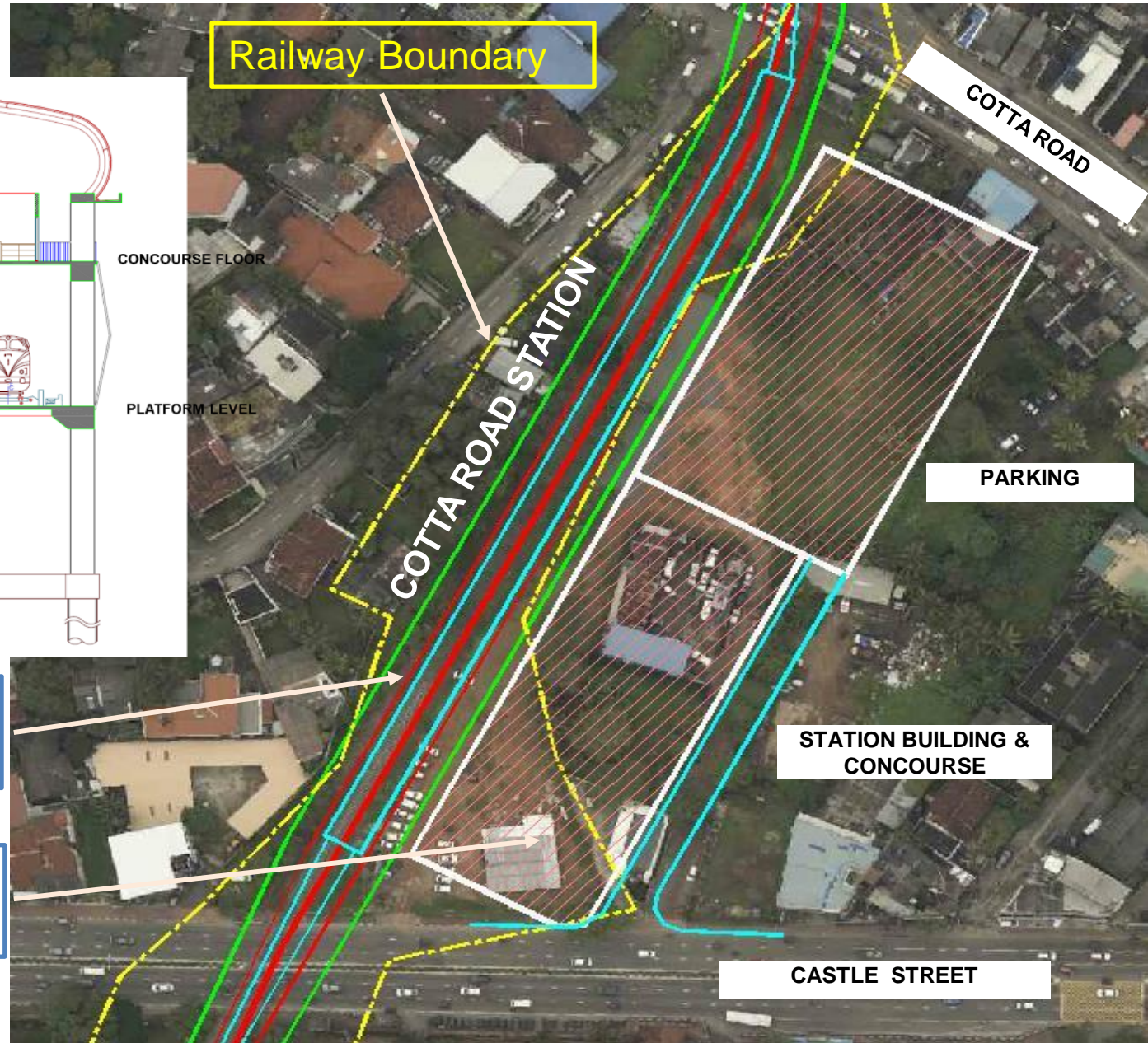
Design Concepts – Vertical Alignment

Railway Station Construction



Elevated Station ; No Land Acquisition

Land Required, if constructed "at grade"



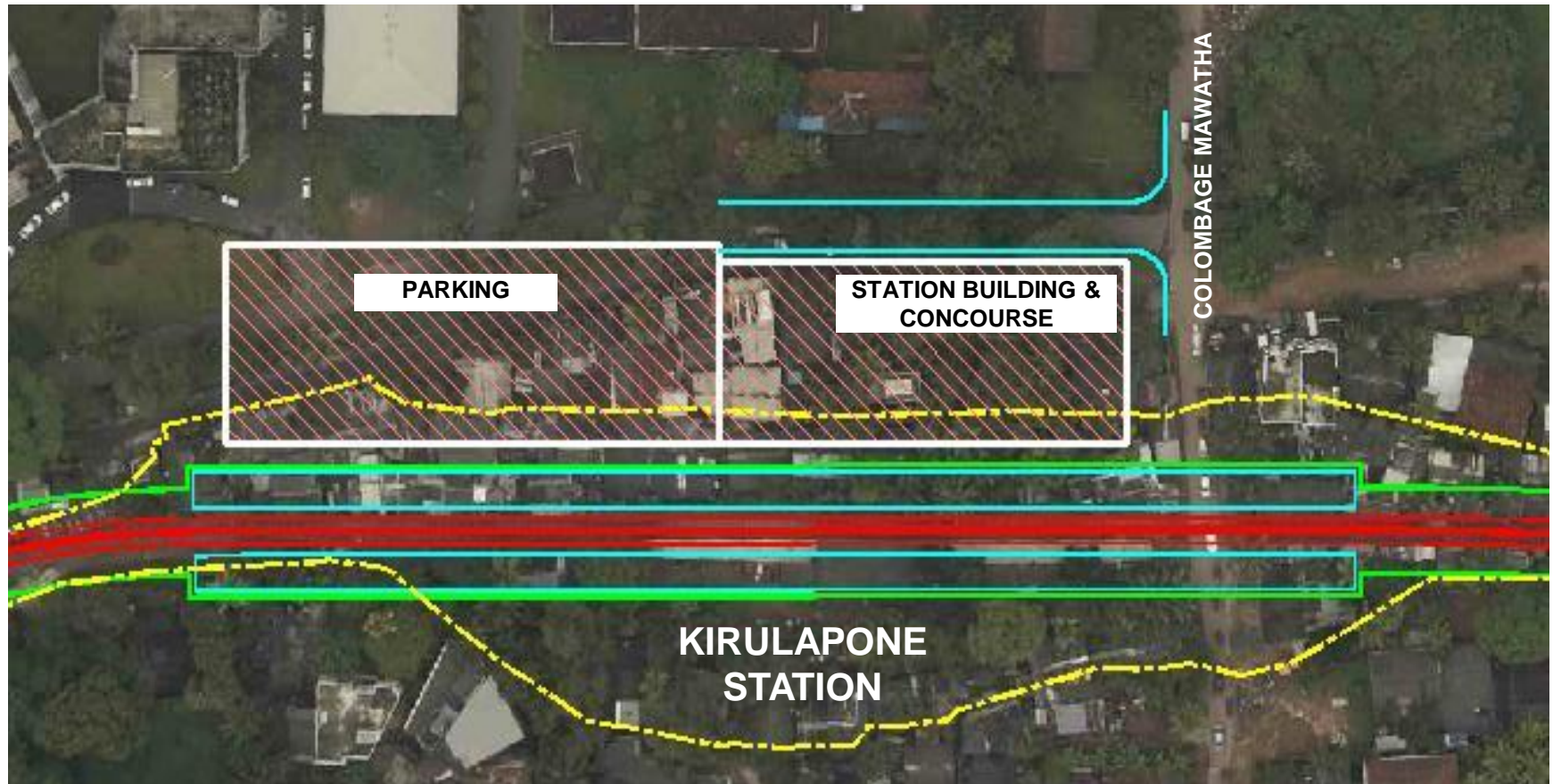
Design Concept – Vertical Alignment

Railway Station Construction

Total Land Acquisitions for Station Construction –

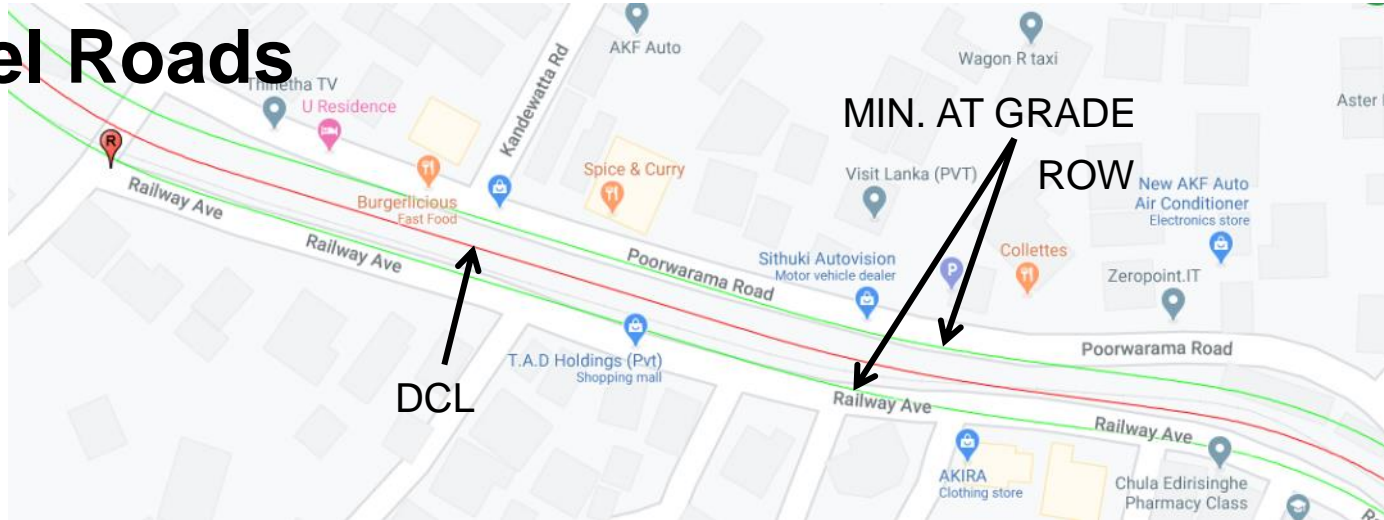
“At grade” Construction : **USD 36 Mn for Land Acquisitions**

Elevated Construction : **No Land Acquisition**



Design Concepts – Vertical Alignment

Parallel Roads



Land Required, if constructed "at grade"

Elevated Construction ; No disturbance to Parallel Roads



Design Concept – Vertical Alignment

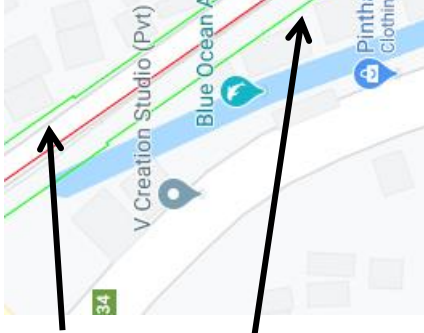
Parallel Roads

Total Length of Parallel Roads along KV Line – 09 km in 20 km

Land Acquisitions for Parallel Road Construction –

“At grade” Construction: **785 p of Land Acq. & Demolitions**

Elevated Construction: **No Land Acquisition**



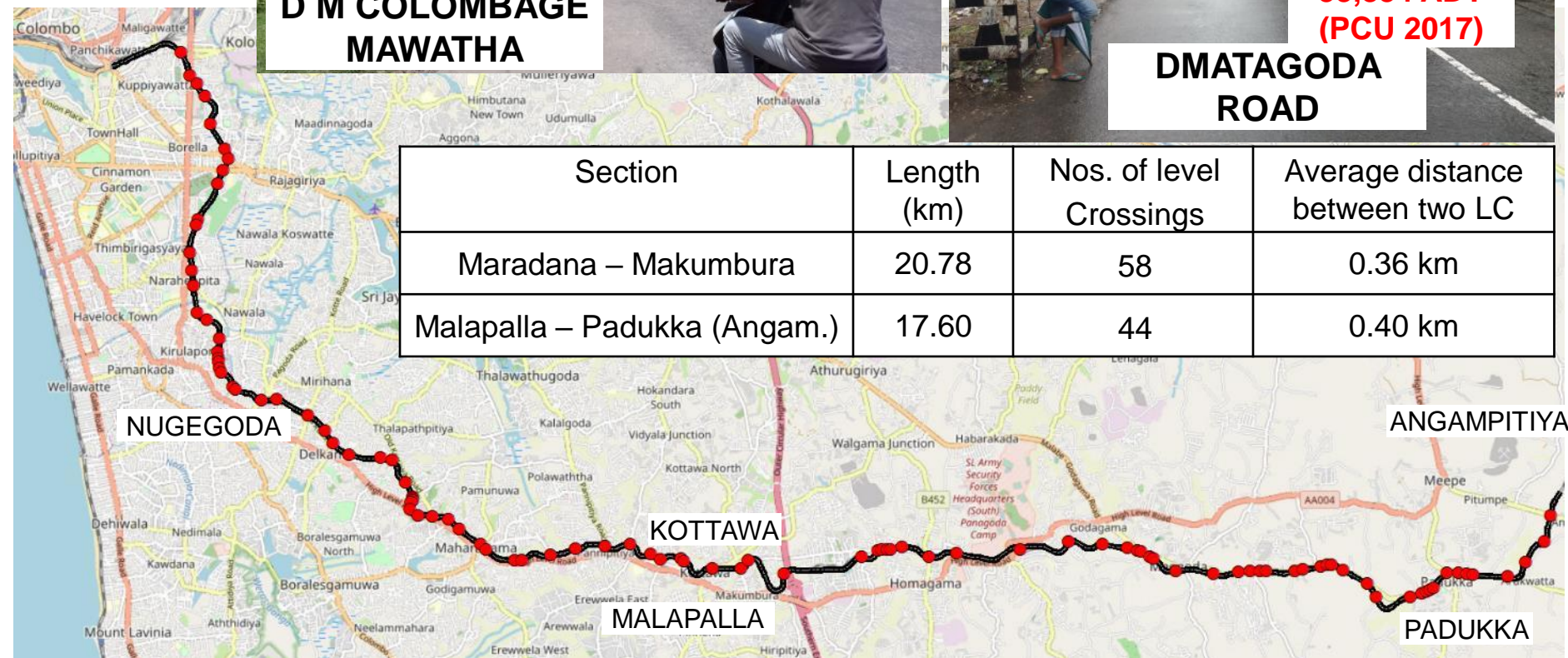
Pangiriwatta 1st Lane

Design Concept – Vertical Alignment

Level Crossings



Section	Length (km)	Nos. of level Crossings	Average distance between two LC
Maradana – Makumbura	20.78	58	0.36 km
Malapalla – Padukka (Angam.)	17.60	44	0.40 km



Design Concept – Vertical Alignment

Level Crossings – Vehicle Flow Based Analysis

Chainage	Location Num in googleMap	Location	ADT (PCU) 2017	ADT(PCU) 2035 From Model	Peak Hour flow Peak Direction	Total Number lanes	PCU/L/p.D	Capacity per Lane	V/C	Elevated	Notes
1+240	1	Dematagoda Rd	33,834		2,199	2	2,199	1,400	1.57	✓	
1+700	2	Baseline rd	83,895	85,000	5,453	6	1,818	1,600	1.14	✓	
1+900	3	Sri Nigrodharama mw	12,544		815	2	815	1,200	0.68	✓	
2+827	5	Leslie Rangala Mw	23,916		1,555	2	1,555	1,200	1.30	✓	Expressway ramp
3+360	6	Ruhunukala Mw	8,168		531	2	531	1,200	0.44	✗	
3+550	7	Cotta Rd	45,772	47,000	2,975	4	1,488	1,200	1.24	✓	
3+800	8	Sri Jayawardenapura Mw	88,867	76,000	5,776	6	1,925	1,400	1.38	✓	
5+490	13	Muhandiram Rd	19,895		1,293	2	1,293	1,200	1.08	✓	
5+820	14	Kirimandala Mw	18,503	16,500	1,203	2	1,203	1,200	1.00	✓	
6+110	15	Narahenpita Nawala Rd	30,203	20,000	1,963	2	1,963	1,200	1.64	✓	
7+350	18	D.M. Colombage Mw	18,027	15,000	1,172	2	1,172	1,200	0.98	✓	
8+950	22	B120 at Nugegoda	49,701	31,000	3,231	4	1,615	1,200	1.35	✓	
9+270	23	Old Kespbewa	28,390	20,000	1,845	4	923	1,200	0.77	✓	20 m from B120
9+930	24	Mirihana Rd	25,004	21,000	1,625	4	813	1,200	0.68	✓	500m from Previous
13+370	31	Old Kottawa rd	26,233	12,000	1,705	2	1,705	1,200	1.42	✓	
14+470	33	Pamunuwa RD	17,378	20,000	1,130	2	1,130	1,000	1.13	✓	
17+520	41	Pannipitiya Malabe rd	14,519	14,000	944	2	944	1,000	0.94	✓	
19+400	46	Athurugiriya Rd	26,918	24,000	1,750	2	1,750	1,200	1.46	✓	
19+930	47	Kottawa Malabe Rd	8,049	11,000	523	2	523	1,200	0.44	✓	500 m from Previous
	52	Galawila Rd	10,759	11,000	699	2	699	1,200	0.58	✓	
	57	Athurugiriya Rd 2	20,141	26,000	1,309	2	1,309	1,200	1.09	✓	
25+010	58	Wimana Rd Level Crossing	3,468		225	2	225	800	0.28	✗	
26+330	59	Panagoda Station Rd Level Crossing	4,391		285	2	285	800	0.36	✗	
27+360	60	Godagamawatta Rd Level Crossing	1,491		97	2	97	800	0.12	✗	

Flyovers Requires (20)

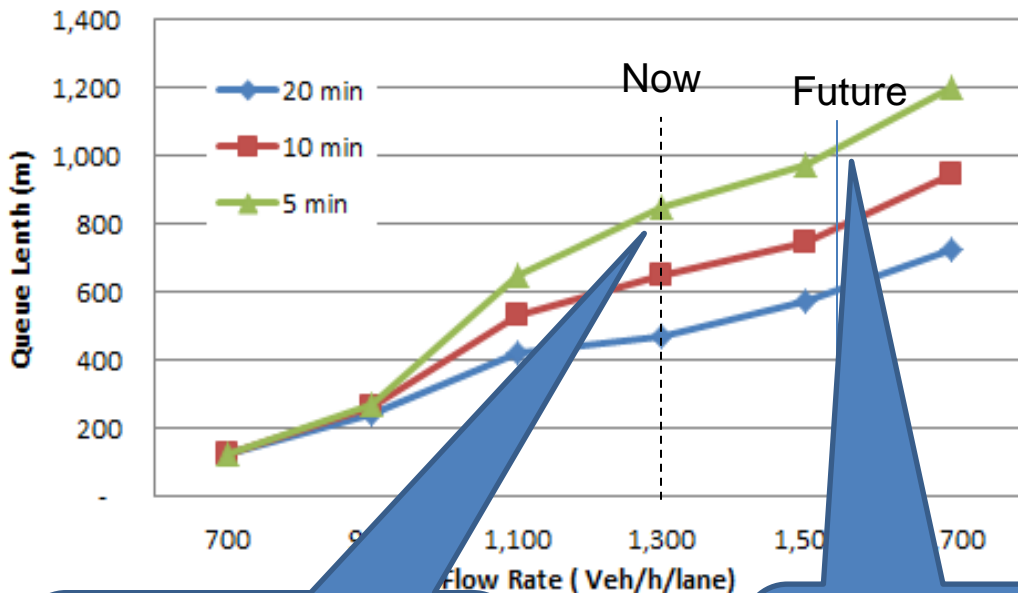
Cost of 20 Flyovers with Land Acquisition (RDA Estimate) = USD 311.5 Mn

28+720	63	Samadhi Mw	39		3	2	3	800	0.00	✗	
28+790	64	Palpolawatta Rd Level Crossing	1,364		89	2	89	800	0.11	✗	
28+980	65	Asiri Uyana Rd	319		21	2	21	800	0.03	✗	
29+060	66	Puwakwatta Rd Level Crossing	7,407	6,000	481	2	481	800	0.60	✗	
29+600	67	Meegoda Station	8,618	5,000	560	2	560	800	0.70	✗	
30+300	68	Udagewatte Rd	2,032		132	2	132	800	0.17	✗	
30+820	69	Madulawa Rd	5,482		356	2	356	800	0.45	✗	
31+850	70	Opathaella Rd	1,722		112	2	112	800	0.14	✗	
33+630	71	Kurugala Rd	2,546		165	2	165	800	0.21	✗	
34+440	72	Level Crossing C4	-		-	2	-	800	-	✗	
34+660	73	Polwatta Rd C1	-		-	2	-	800	-	✗	
34+750	74	Polwatta Rd C2	1,816		118	2	118	800	0.15	✗	
34+900	75	Padukka Road Level Crossing	11,165	9,000	726	2	726	1,200	0.60	✗	

Vert. Alignment: Grade Separation Analysis

- Based on Vehicle Flows with Traffic Simulation
- Based on UN Criteria of Train Vehicle Units (TVU)
 - Defines a Grade Separation is needed when $TVU > 100,000$

Maximum Queue Length by Train frequency



Baseline Rd

234m
Queue

438m
Queue

Gate Close
3 min

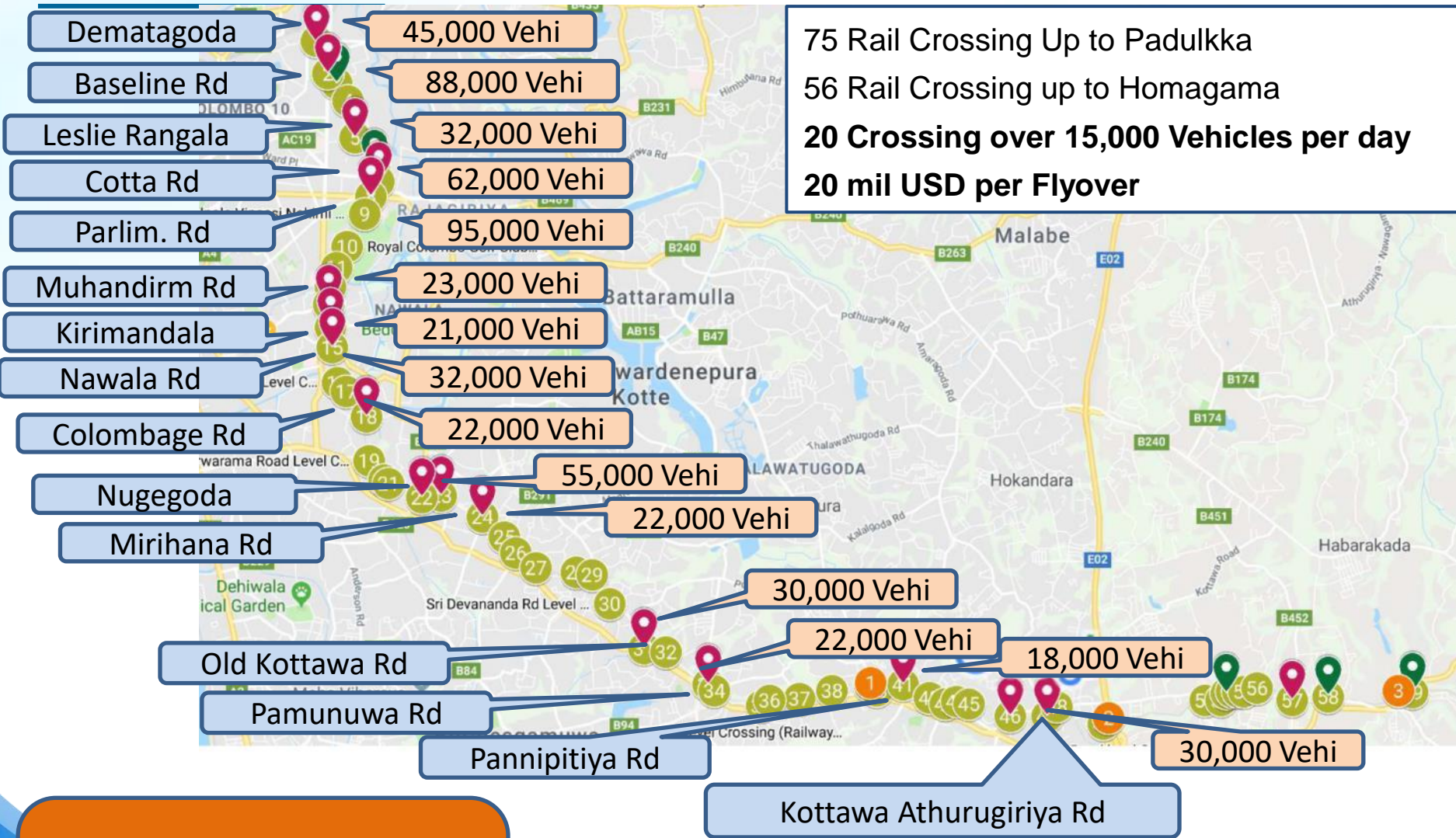
@ Current Traffic

Existing Queue 450m @
20 min Freq. Trains
@5 min Freq. Trains
Queue length 800m

@ Future Traffic

@5 min Freq. Trains
Queue length 1km

Vert. Alignment : Vehicle Flows at Rail Crossings



All Major Road Crossings will lead to a Grid lock of the Road Network

Need Grade Separation from Maradana to Malapalla

Design Concept – Vertical Alignment

Vertical Alignment (Option Study)

Option 1	Elevated Line – Lowest Cost and high Revenues
Option 2	Underground Line – High Cost and High Revenues
Option 3	Elevated + Underground Line - High Cost and High Revenues
Option 4	Elevated + Underground + At grade Line – High Cost and Low revenues

✓ **So, after discussing (in about 04 meetings), Project Steering Committee , approved Option - 1**

Classification		Option 1	Option 2	Option 3	Option 4
Structure	Elevated	18.9 km	-	13.74 km	9.5 km
	Under ground	-	18.17 km	3.1 km	3.1 km
	At grade	1.86 km	2.59 km	3.92 km	8.16 km
Construction Cost		USD 883.6 Mn.	USD 900.9 Mn.	USD 948.0 Mn.	USD 921.5 Mn.
Land acquisition Cost		USD 91.5 Mn.	USD 89.9 Mn.	USD 91.4 Mn.	USD 98.2 Mn.
Total Cost		USD 975.1 Mn.	USD 990.8 Mn.	USD 1,039.4 Mn.	USD 1,019.7 Mn.

Financial Analysis with Comparison of Options

- ✓ Passenger and Parcel Demands by 2035 were considered.
- ✓ Today, Fare per Passenger – km is Rs. 1.10. Once this is increased to Rs. 2.20, the annual Operation and Maintenance Cost will be covered and 20% of Capital will be recovered in 30 Years. **This is a favourable situation.**
- ✓ Three Solution Options were evaluated purpose.
- ✓ **Elevated Construction from Colombo to Makumbura and then ‘At Grade’**: Lowest Construction Cost because least Land Acquisition. Revenue from Transit Oriented Development (ToD) is high
- ✓ **‘At Grade’ construction throughout with fly overs for 20 Major Roads** : Construction Cost is high and ToD revenues = 0
- ✓ **‘At Grade’ construction with throughout with Level Crossing Protection Systems for Roads** : Moderate Construction Cost with high annual cost due to Fuel and Man-Hour wastage. Very Low human safety and Tod Revenues = 0

The KV Line's Investment Justification :Economic and Financial



Hard Core Economic Analysis and Economic Sensitivity Analysis

- EIRR = 15.77%.
- ENPV (USD Millions) = 325.47.
- C/B ratio = 1.29.
- Economic Sensitivity Analysis - It is a moderately robust project with changes of demand, costs, construction period and the change of other key input variables together.



Hard Core Financial Analysis, Source of Funds and Financial Sensitivity Analysis.

- The KV Line's O&M Cost fully recovered.
- Within 50 years, 28% of capital costs will be recovered.
- Within 30 years, 21% of capital costs will be recovered.
- This is a very commendable situation and many heavy railways around the world are not even recovering full O&M.



Investment Costs Analysis

Cost per Km.

- Line distance-wise (Km. 60.00) cost per km. USD Million 23.73.
- Total investment costs USD Million 1424.32.
- Annual average O&M cost between USD Million 19 to 27.
- All these costing figures are comparable with international elevated railway investment.



Poverty Impact Assessment Analysis (PIR) and Extended Costs Benefits Analysis (ECBA)

- The overall PIR value of the KV Line 73.25. This shows more benefits will go for low and mid income people.
- ECBA - adjusting economic analysis to social and environmental analysis.
- ECBA shows KV line project is viable project.



Project Impact Monitoring Framework Analysis (PIMF)

- PIMF shows that identified 33 baseline indicators under impact, outcome and output will definitely be improved in direct and indirect project impact areas.
- Later it spillover to the regional and national economy with full operation of the project.

Conclusion

Economic and financial analysis showed all E&F aspects will be comprehensively satisfied by the KV Line project, therefore can recommend project for implementation with greater care for cost minimizing value engineering solutions with more focus on new railway business models.

Maradana – Avissawella (64km) : Cost Comparison Between Elevated & At grade Construction

No	Classification	Elevated Cost USD (Mn)	At grade Cost USD(Mn)
1	Construction costs		
1.1	<i>Demolition Cost</i>	1.30	1.30
1.2	<i>Elevated construction</i>	420.50	
1.3	<i>Bridge construction</i>	2.70	3.50
1.4	<i>Under Pass Construction</i>	12.20	12.16
1.5	<i>Station Construction</i>	64.40	64.37
1.6	<i>Embankment</i>	202.20	402.20
1.7	<i>Track Construction</i>	45.83	45.83
1.8	<i>Flyovers</i>		311.50
2	Resettlement costs	70.80	169.44
3	Electrification costs	30.12	30.12
4	Signaling costs	78.41	78.41
5	Telecommunication	25.00	25.00
6	Rolling stock costs	300.00	300.00
7	Utility shifting costs	1.76	1.76
8	Environment mitigation costs	19.39	19.39
<i>Sub Total – 1</i>		1,274.61	1,464.98
9	Construction supervision costs (4%)	50.98	58.60
<i>Sub Total – 2</i>		1,325.59	1,523.58
10	Physical contingencies (5%)	66.28	73.25
11	Price contingencies (5%)	66.28	73.25
Total Cost		1,458.15	1,670.08

Financial analysis on KV line's three options

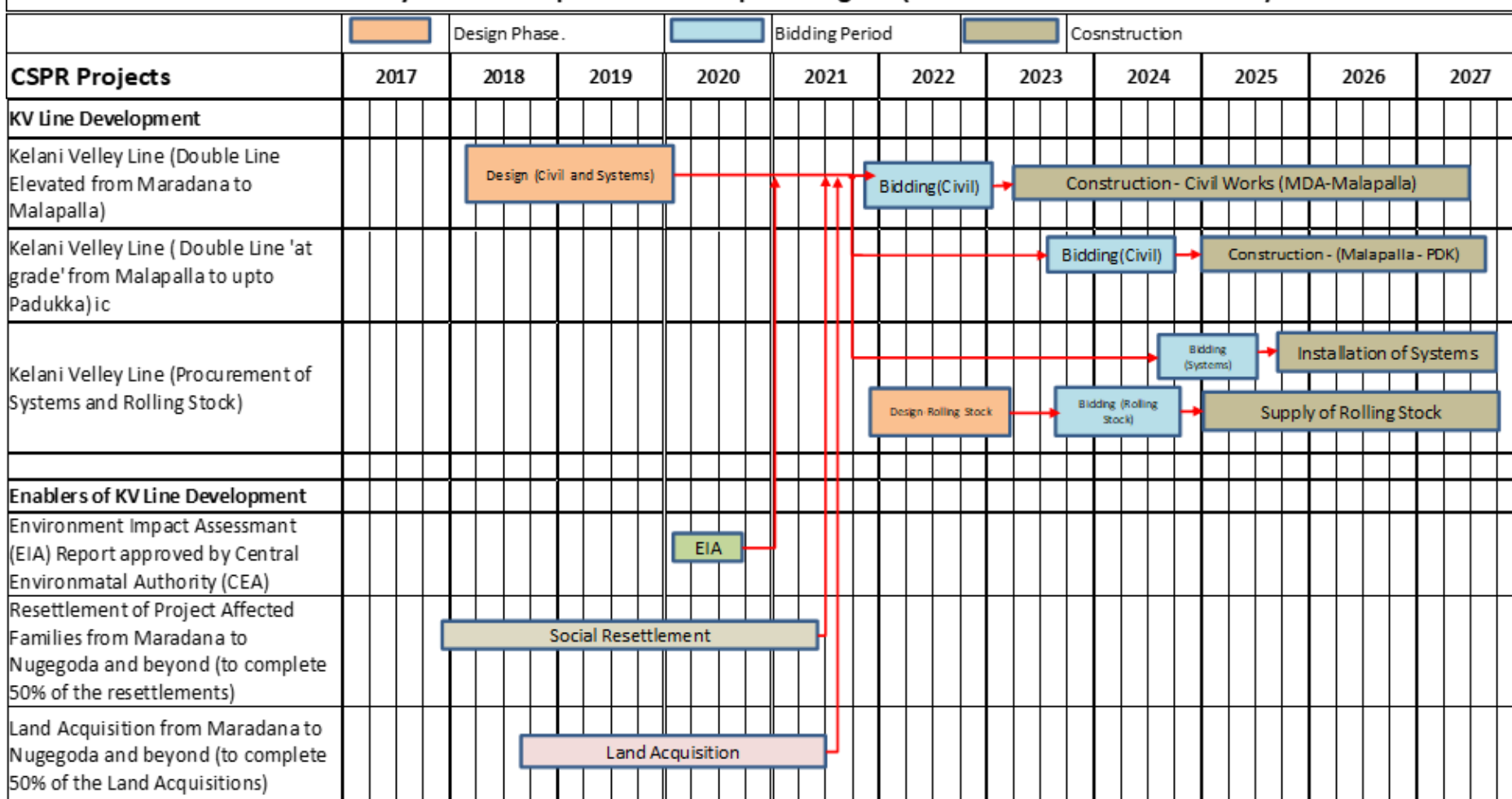
Options	Investment (USD Millions)	Income (30 year) USD Millions	FIRR	FPV	WACC	Investment recovery rate %	The best option Rank
Elevated	1274.61 (Ignored O&M and Replacement cost of 719.12)	2277 (including 50% income from TOD)	3.04%	0.0	3.04%	100.00 (30 years)	1
At-grade Flyovers in busy roads	1464.98 (Ignored O&M and Replacement cost of 719.12)	1146 (No TOD income)	Negative	Minus	FIRR<WACC	21% (30 years)	3
At-grade 56 level crossing	1153.48 (Ignored O&M and Replacement cost of 719.12)	1146 (No TOD income)	Negative	Minus	FIRR<WACC	23% (30 years)	2

Therefore, by looking at the results of the financial analysis, the best option is elevated option.

KV Line Road Map

Need Financing only in 2023 (with Fund Flow of 2023 – USD 100 Mn, 2024 – USD 100 Mn , 2025 – USD 200 Mn etc.)

Kelani Valley Line Development Roadmap for Stage - I (Maradana to Padukka : 35 km)



Operation Plan

Peak Periods : Train in every 07 Minutes

Off-Peak Periods : Train in every 15 Minutes

Peak Periods : From 07.00 to 09.00 am and from 04.00 to 06.00 pm

Other Features

1. **Planned Bus Operation** upto the Railway Stations
2. **Car Parking (about 100 cars)** at Railway Stations
3. **Platforms and trains at same level** to reduce Boarding Time and to enable Universal Access
4. **Train Stopping is aligned with Passenger Queues** at Platforms
5. **Comfortable Trains** with wider doors
6. Reliable and timely service

Train Operation Highlights after Development

Maradana – Padukka

- Travel Time : **64 Minutes**
- Time Saving for Train Passenger : **26 Minutes**
(assuming trains run on time today)
- Time Saving for Bus Passenger : **100 Minutes**

Train Operation Highlights after Development

Maradana – Homagama

- Travel Time : **42 Minutes**
- Time Saving for Train Passenger : **22 Minutes**
(assuming trains run on time today)
- Time Saving for Bus Passenger : **79 Minutes**

Train Operation Highlights after Development

Maradana – Maharagama

- Travel Time : **26 Minutes**
- Time Saving for Train Passenger : **14 Minutes**
(assuming trains run on time today)
- Time Saving for Bus Passenger : **45 Minutes**

Cotta Road – Designed to generate revenue through ToD



Nugegoda - Designed to generate revenue through ToD



Veyangoda/Gampaha - Designed to generate revenue through ToD

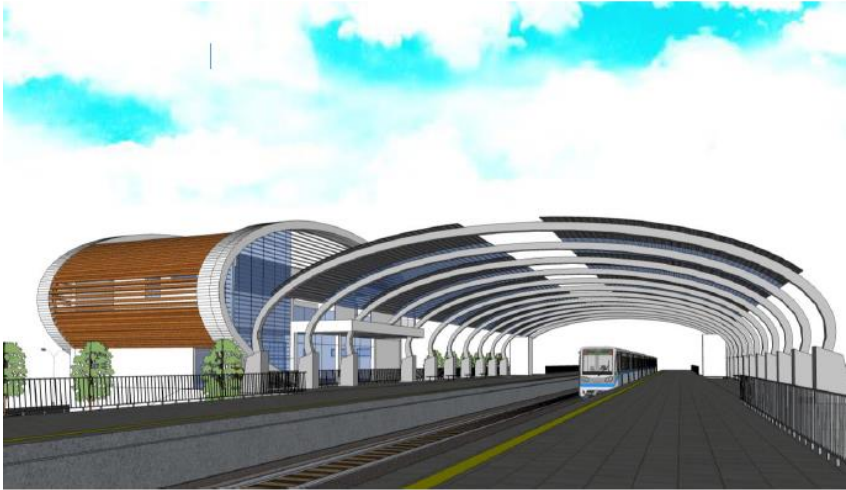


Small Scale 'At Grade' Stations

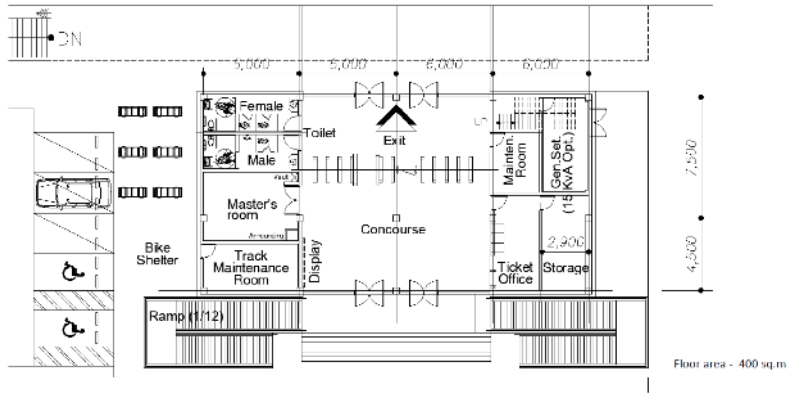
At-grade Railway Station typical design
Architectural Design



Perspective views – Bird eye view of the station



Ground Floor Plan (Concourse & Platform)





**Please view
CSRP.lk
For more details**

THANK YOU