1/3

2.3 | א30/

MASTER SCHEDULE - Red Line project, (Western Segment) Narrative

1. Purpose

This document shows process of construction plan, for all different entities and type of works including milestones needed to develop the Red Line project, (Western Segment). This document complies with the terms laid down by the Contract and the bid as described in NTA bidding forms Vol. 01 Pt. IV

2. PREAMBLE

This document shows process and milestones considered to develop the project, from the effective date to the issuance of the completion document.

3. CODIFICATION

The Master Schedule, built on the Critical Path Method (CPM), uses Work Breakdown Structures as handed by NTA according to NTA bidding forms Vol. 01 Pt. IV. It covers both the Tunneling sequences and the Stations Boxes for the Red Line project, Western Segment. The Work Breakdown System (WBS) is defined by Location, & Type of work.

This type of WBS, effectively reflects the linear type of the work, such as the tunneling process. Since the work is done under the ground it has a minor impact over the daily life above ground – the city. It is not effected by traffic arrangements, and can be done in a 24/7 sequence.

When it comes to construction of boxes, inner box construction, entrances and the shafts, including all the development works above ground the WBS method is less effective for work description and management. Due to the traffic arrangements, in a crowded surrounding of a "living city", works are executed in a relative small area and in sequences driven by the traffic diversions possibilities. Breaking works into different types of locations (box/inner box/entrances etc.) in a relative small area, gives a less effective description and understanding of work sequence.

Although all the activities comprising the Master Schedule are part of the same critical path network, Different cycles of activities work in parallel, each act individually, in a separate environment (Boxes and TBMs) and carry it's own critical path. It is due to Milestones which connect activities, locations, and dates together that brings the entire project to a mutual CP.

The Master Schedule is produced by Prima Vera which is the base for the Tilos added.

Calendar(s) in use – included holidays

Calendars used for the schedule, based on the calendars accepted from NTA (given with WBS):

- 7 Working days calendar name: NTA 7D, which takes in consideration, a week that starts on Sunday, and consists of 7 working days without holidays. This calendar is attached to all the TBM activities.
- 5 working days calendar name: NTA 5D, which takes in consideration, a week that starts on Sunday, and consists of 5 working days, with Jewish holidays. This calendar is attached to all the rest of construction activities.

2/3

Basic scheduling assumptions/ Shifts of Work, pace of Works

- **Shifts of work:**

The TBM, teams will work two ten (10) hour's shifts. The teams will work 7 days/week but every second Friday; the TBMs will stop its work for maintenance for 12 hours. This time will be used also for the change of shifts as the workers, working the night shift will change shifts with the morning team.
The construction of the Boxes is based on 8 hours working shift, since the noise laws do not allow work during the night at populated areas. The teams will work 5 days a week, and by that leave works on Friday as a built in buffer in case mitigation will be needed along the execution of the project.

- **Pace of Works:**

TBM: the Fab. Details:

- Average working rate of 10.5 m/day.
- The Tunnel Boring Machines will be able to produce a rate as mentioned and construct of 7rings/day.
- During construction the schedule shows a learning curve which starts rates at 2.5 m/day, up to 10.5 m/day

Boxes: work rates on the boxes are subject to different phases of construction:

- Construct of diaphragm walls at a rate of 100 m^2/day – 2 m' length wall/day
- Excavation of the box at average a rate of 600 m^3/day. *
- Anchor pilling of the base slab at a rate of 12 piles/day.
- Construction of base slab for the station boxes at a rate of 200 m^3/day.
- Cast of station walls (including waterproofing) at a rate of 50 m^3/day. *
- Cast of inter level floors (technical, concourse floors) at a rate of 100 m^3/day. *

c) Major resources used

Item	No.
TUNNEL	
TBM	6
Locomotives system	12
Gantry Crane	5
2 Component Batching Plant	2
Ventilation System	6
Cooling tower	3
crawler crane	2
Belt Conveyor System	2
Compress air Plant	2
Muck Disposal Lorries	Variable
Segment Factory	1
STATION	
Hydromill	6
Crane (inner station works)	6 *
Crane (slurry works)	6
Slurry Treatment Plant	6
Drilling rig	Variable (4-6)
Precast concrete elements factory	1
Steel Strut manufactory	1
Concrete Batching Plant	2
All kinds of Excavator	Variable
Muck Disposal Lorries	Variable
Rebar manufactory	2

} = one for each station

d) Envisaged average and peak manpower levels

- **Management manpower**: The head management on site ~100 personnel
- **Tunnels crew** – the tunnel team will be between 170-200 personnel (including management)
- **Boxes crews** – in average, the manpower used to construct the boxes will include 60 - 90 working personnel on each stage..Since there is a peak of 6 stations construction at a given time it is estimated to have between 350 – 550 working personnel (including management).

(= 58 ÷ 92 Per station)

e) A description of the main processes and sequence

The project is based on two main processes:

1. Construction, shipment assembly and excavations done by six TBMs. Excavation of connecting tunnels (done manually - NATAM).
2. Construction of station boxes. Work which is done in stages, affected by the temporary traffic arrangements as a preliminary activity.

- **TBM process:**

TBMs are considered both as "Long Lead Items" in the procurement process, and as "Single Resource Items" hence SRI. The **SRI**, is the activity which has to be given priority in construction. Most cases the SRI is the backbone of the critical path and as so all other activities have to meet the work rates and restrictions implied by this source.

Being LLI, means that the procurement process will start as one of the first activities in the project. The design, fabrication, shipment, reassembly and start of works of the TBMs is programed to be on site between 21 to 30 months from commencement Date. This period of time is the main time for the erection of the station boxes

Intermediate milestones are driven from the work planning of the TBMs. Main effort is put to keep a continuous work flow of the tunnel machines, effecting (among other) the need to finish the station Boxes peripheral walls, excavations and bottom slab, prior to the advance of the machines.

In order to achieve the continuity of work to the TBMs, the diaphragm construction resources (both machinery and teams) are calculated to adjust the needed dates. During the construction phase of the boxes, Temporary Traffic Arrangement have to be determined for different sections of diaphragms walls.

As the TBMs approach the boxes, the D wall team will accomplish the casting of the bottom beam (lower than the final elevation), and leave enough time for curing.

During the breakthrough, and the movement of the TBMs trough the box, no work will be done in the box and this time will be used mainly for the excavation and construction of the Cross Passages.

Material transportation such as the concrete elements, are being brought to site and sent to the TBM in the tunnels by electric locomotive. Construction of the locomotive and all the logistics of the TBM are done in parallel.

At the end of tunneling the Machines will be dismantled and carried out of the tunnels to the lunching shafts and out of the worksite.

- **Station boxes process:**

In general, the process starts with TTAs (Temporary Traffic Arrangements). Construction of the stations depends on the ability to open an area for works, which solely depends on the planning and timing of the TTA.