# Downeast Rapid Transit Authority

the underground connects us all

## Construction Cost Estimates

### DRT Technical Note #2015-0411

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**Abstract**

We estimate the total construction cost of the DRT through comparison with the construction costs of previous underground transit system projects around the world. As the longest underground train system ever built (total track length 760km), the DRT will also be the costliest (approximately $100B). The per-km cost ("linear cost"), however, will be lower than, or comparable to, many other existing subway systems.

The DRT system is unique in the history of underground transit. It includes six underground subway lines, 56 stations, and a total track length of approximately 760km (475 miles). It is the longest subway system ever built—more than one-third longer than the Shanghai Metro, which has until now been the world's longest.[1] Although developing a realistic cost estimate for a project of this unprecedented magnitude is a challenge, it is possible to extrapolate from the experience of other, more modest, underground systems to come up with plausible cost figures.

The cost of any transit system depends upon a host of complex and interrelated political, social, economic, environmental, and geographic factors that are unique to each system. A survey of recent major underground transit projects around the world reveals a greater than thirty-fold range in the linear cost (cost per kilometer):

| Rank | Underground System | Length (km) | Linear cost ($Million per km) |
|---|---|---|---|
| 1 | **New York IND Second Avenue Line** | 13.7 | 1240 |
| 2 | **Singapore Thomson MRT Line** | 30 | 600 |
| 3 | **Hong Kong Sha Tin to Central Link** | 1 | 586 |
| 4 | **Budapest Metro Line 4** | 7.4 | 358 |
| 5 | **Cairo Metro Line 3, Phase 1** | 4.3 | 310 |
| 6 | **Sao Paulo Metro Line 4** | 12.8 | 223 |
| 7 | **Malmö City Tunnel** | 4.65 | 212 |
| 8 | **Lucern Zentralbahn** | 1.32 | 151 |
| 9 | **Downeast Rapid Transit** | 760 | 132 |
| 10 | **Seoul Sin-Bundang Line** | 18 | 87 |
| 11 | **Barcelona Sants-La Sagrera tunnel** | 5.8 | 39 |

**Table 1.** Estimated per-km construction costs for recent underground transit systems around the world.[2] Systems are ranked by linear cost.

There are several unique and attractive aspects of the DRT system service area that help to keep costs down:

1. **This is a rural area.** The absence of significant subterranean civil infrastructure (water, sewer, electrical, and other systems) means that there will be few costs associated with diverting tunnels around preexisting systems.[3] Tunnels may therefore be bored along routes that closely mirror the straight-line inter-station paths as mapped on the surface. By contrast, New York City's 13.7 km Second Avenue Subway extension project, now under construction, presents a monumental tangle of subterranean engineering challenges, all of which contribute to its hefty price tag of $17B — a staggering linear cost of $1.24 B/km.
2. **Long inter-station distances.** The long distances between stations and of the subway lines themselves present an opportunity for significant economies of scale in tunnel boring costs. Once the tunnel boring machine is installed underground, it can remain in continuous operation for many years, thus reducing the relative impact of end-of-line set-up and take-down costs.
3. **Flexible construction practices.** Rural Maine is open-minded and lenient regarding construction practices and code enforcement. Although safety will always be of paramount concern, the absence of existing regulations and guidelines regarding subway construction will conduce to imaginative and innovative approaches both to system design and to cost containment.

4. **Political compactness.** The entire DRT system falls within a single Congressional District (Maine 2nd), and within just two counties (Washington and Hancock). This greatly reduces political lobbying costs that might otherwise be associated with a project of this enormous geographic scale.

When formulating the total construction cost of any underground transit system, it is useful to subdivide it into three categories: (**1**) cost of boring tunnels and station caverns; (**2**) cost of installing track and associated electrical, hydraulic, ventilation and communications infrastructure; (**3**) cost of erecting stations, including surface entrances, parking, etc.

**1. Tunnels and caverns**

The Barcelona Sants-La Sagrera tunnel consists of a single straight tunnel through a mountain, with no intermediate stations.[4] Its cost of $39M/km is thus a reasonable estimate for inter-station tunnels on the DRT.

**2. Track and infrastructure**

We assume a cost of $1M/km.

**3. Stations**

Assume a cost of $10M to build and fit out each station. Assume that each transfer hub will cost twice this amount, to accommodate the pedestrian and train crossings, larger station platform area, concession stands, etc.

Using these assumptions we arrive at an absolute minimum total construction cost of $31.6B. Given the uncertainties inherent in a project of this scale, it is helpful to build in a substantial cost buffer. We therefore double this amount and apply a 50% contingency, arriving at a total cost of $94.8B. For planning purposes, we will henceforth use a working number of $100B.

This figure corresponds to a linear cost of $132M/km, ranking the DRT at 9th place among modern large subway systems, between Lucern's Zentralbahn and Seoul's Sin-Bundang Line, and about one-tenth the linear cost of the New York Second Avenue Subway project.

Operating costs will be addressed in a forthcoming Technical Note.

# Notes

[1] Even longer systems have been proposed—for example, the Transatlantic Tunnel. Unlike the DRT, these are purely conceptual and theoretical exercises of imagination.

[2] Figures for the New York IND project are from "Second Avenue Subway " (Wikipedia, http://en.wikipedia.org/wiki/Second_Avenue_Subway , retrieved 20150411). Figures for Downeast Rapid Transit are from this document. The remaining data are from "Comparative Subway Construction Costs, Revised", posted in "Pedestrian Observations" (https://pedestrianobservations.wordpress.com/2013/06/03/comparative-subway-construction-costs-revised), originally posted on 20130603, retrieved 20150411.

[3] Some care will be required around existing underground sewer and water facilities in the towns of Ellsworth, Milbridge, Machias, Lubec, Eastport, and Calais.

[4] See "Túnel de alta velocidad Barcelona Sants-La Sagrerah", Wikipedia, http://es.wikipedia.org/wiki/T%C3%BAnel_de_alta_velocidad_Barcelona_Sants-La_Sagrera , retrieved 20150411.