LP Assignment

In a transportation problem, shipments are allowed only between source-sink pairs. In many applications, this assumption is too strong. For example, it is often the case that shipments may be allowed between sources and between sinks. Moreover, there may also exist points through which units of a product can be transshipped from a source to a sink. Models with these additional features are called transshipment problems. Any given transshipment problem can be modeled as an equivalent transportation problem.

Since transshipment points can both receive and send out products, they play the dual roles of being a sink and a source. This naturally suggests that we could attempt a reformulation in which each transshipment point is "split" into a corresponding sink and a corresponding source. A bit of reflection, however, leads us to the realization that while the demand and the supply at such a pair of sink and source should be set at the same level (since there is no gain or loss in units), it is not clear what that level should be. This is a consequence of the fact that we do not know *a priori* how many units will be sent into and hence shipped out of a transshipment point. Fortunately, it turns out that this difficulty can actually be circumvented by assigning a "sufficiently-high" value as the demand and the supply for such a sink-source pair and by allowing fictitious 'shipments' from a given transshipment point back to itself at zero cost.

Consider:

A company manufactures a product in two cities, Dallas and Philadelphia. The weekly production capacities are 5000 and 3000, respectively. Products are shipped to three warehouse locations in Seattle, Boston, and Atlanta, which in turn supply eight regional distributers in Los Angeles, San Francisco, Phoenix, Houston, Chicago, New York, Boston, and Miami. The respective weekly demand from these distributors is 1400, 500, 700, 1100, 1200, 1300, 1000, 700.

The warehouses each have a limited capacity of 4000/week. There is also a company policy to not allow shipments longer than 2000 miles.

Note: If there is infeasibility, you should resolve by identifying the most appropriate constraint(s) to relax, motivate why these are most appropriate and provide your best resulting plan.

Questions:

1. What should be the weekly shipments from the plants to each warehouse, and from each warehouse to each distributor, if minimizing travel cost? (assume cost is proportional to distance-gathered from googlemaps, apple maps, or mapquest: city center to city center distances are sufficient here)

2. Assuming a shipment uses a full truckload, and at $2/truckload-mile, what is the cost per week for the plan in #1?

3. In addition to the above, we now have the capability to supply the distributors directly from Dallas up to a total of 3000 units of the 5000 produced per week. What is the new cost and plan?

4. [extra credit 10%] Produce an effective data visualization of your solution