Assignment 4 : Quantitative Management Modelling

Oil Distribution Texxon Oil Distributors, Inc., has three active oil wells in a west Texas oil field. Well 1 has a capacity of 93 thousand barrels per day (TBD), Well 2 can produce 88 TBD, and Well 3 can produce 95 TBD. The company has five refineries along the Gulf Coast, all of which have been operating at stable demand levels. In addition, three pump stations have been built to move the oil along the pipelines from the wells to the refineries. Oil can flow from any one of the wells to any of the pump stations, and from any one of the pump stations to any of the refineries, and Texxon is looking for a minimum cost schedule. The refineries' requirements are as follows.

Refinery	R1	R2	R3	R4	R5
Requirement (TBD)	30	57	48	91	48

The company's cost accounting system recognizes charges by the segment of pipeline that is used. These daily costs are given in the tables below, in dollars per thou- sand barrels.

To		Pump A	Pump B	Pump C
From	Well 1	1.52	1.60	1.40
	Well 2	1.70	1.63	1.55
	Well 3	1.45	1.57	1.30

To		R1	R2	R3	R4	R5
From	Pump A	5.15	5.69	6.13	5.63	5.80
	Pump B	5.12	5.47	6.05	6.12	5.71
	Pump C	5.32	6.16	6.25	6.17	5.87

1. What is the minimum cost of providing oil to the refineries? Which wells are used to capacity in the optimal schedule? Formulation of the problem is enough.

Decision Variables:

L_{pqr} – Where L represents the units of oil (in TBD) extracted from well i and moved to refinery k via pump station j. (w = 1,2,3) (p = A, B, C) (r = 1,2,3,4,5)

Objective Function:

Z = (1.52 + 5.15)*L_{1A1} + (1.52 + 5.69)*L_{1A2} + (1.52 + 6.13)*L_{1A3} + (1.52 + 5.63)*L_{1A4} + (1.52 + 5.80)*L_{1A5} + (1.60 + 5.12)*L_{1B1} + (1.60 + 5.47)*L_{1B2} + (1.60 + 6.05)*L_{1B3} + (1.60 + 6.12)*L_{1B4} + (1.60 + 5.71)*L_{1B5} + (1.40 + 5.32)*L_{1C1} + (1.40 + 6.16)*L_{1C2} + (1.40 + 6.25)*L_{1C3} + (1.40 + 6.17)*L_{1C4} + (1.40 + 5.87)*L_{1C5} + (1.70 + 5.15)*L_{2A1} + (1.70 + 5.69)*L_{2A2} + (1.70 + 6.13)*L_{2A3} + (1.70 + 5.63)*L_{2A4} + (1.70 + 5.80)*L_{2A5} + (1.63 + 5.12)*L_{2B1} + (1.63 + 5.47)*L_{2B2} + (1.63 + 6.05)*L_{2B3} + (1.63 + 6.12)*L_{2B4} + (1.63 + 5.71)*L_{2B5} + (1.55 + 5.32)*L_{2C1} + (1.55 + 6.16)*L_{2C2} + (1.55 + 6.25)*L_{2C3} + (1.55 + 6.17)*L_{2C4} + (1.55 + 5.87)*L_{2C5} + (1.45 + 5.15)*L_{3A1} + (1.45 + 5.69)*L_{3A2} + (1.45 + 6.13)*L_{3A3} + (1.45 + 5.63)*L_{3A4} + (1.45 + 5.80)*L_{3A5} + (1.57 + 5.12)*L_{3B1} + (1.57 + 5.47)*L_{3B2} + (1.57 + 6.05)*L_{3B3} + (1.57 + 6.12)*L_{3B4} + (1.57 + 5.71)*L_{3B5} + (1.30 + 5.32)*L_{3C1} + (1.30 + 6.16)*L_{3C2} + (1.30 + 6.25)*L_{3C3} + (1.30 + 6.17)*L_{3C4} + (1.30 +5.87)*L_{3C5}

Z = (6.67)*L_{1A1} + (7.21)*L_{1A2} + (7.65)*L_{1A3} + (7.15)*L_{1A4} + (7.32)*L_{1A5} + (6.72)*L_{1B1} + (7.07)*L_{1B2} + (7.65)*L_{1B3} + (7.72)*L_{1B4} + (7.31)*L_{1B5} + (6.72)*L_{1C1} + (7.56)*L_{1C2} + (7.65)*L_{1C3} + (7.57)*L_{1C4} + (7.27)*L_{1C5} + (6.85)*L_{2A1} + (7.39)*L_{2A2} + (7.83)*L_{2A3} + (7.33)*L_{2A4} + (7.50)*L_{2A5} + (6.75)*L_{2B1} + (7.10)*L_{2B2} + (7.68)*L_{2B3} + (7.75)*L_{2B4} + (7.34)*L_{2B5} + (6.87)*L_{2C1} + (7.71)*L_{2C2} + (7.80)*L_{2C3} + (7.72)*L_{2C4} + (7.42)*L_{2C5} + (6.60)*L_{3A1} + (7.14)*L_{3A2} + (7.58)*L_{3A3} + (7.08)*L_{3A4} + (7.25)*L_{3A5} + (6.69)*L_{3B1} + (7.04)*L_{3B2} + (7.62)*L_{3B3} + (7.69)*L_{3B4} + (7.28)*L_{3B5} + (6.62)*L_{3C1} + (7.46)*L_{3C2} + (7.55)*L_{3C3} + (7.47)*L_{3C4} + (7.17)*L_{3C5}

Subject to Constraints:

$L_{1A1} + L_{1A2} + L_{1A3} + L_{1A4} + L_{1A5} + L_{1B1} + L_{1B2} + L_{1B3} + L_{1B4} + L_{1B5} + L_{1C1} + L_{1C2} + L_{1C3} + L_{1C4} + L_{1C5} <= 93$

$L_{2A1} + L_{2A2} + L_{2A3} + L_{2A4} + L_{2A5} + L_{2B1} + L_{2B2} + L_{2B3} + L_{2B4} + L_{2B5} + L_{2C1} + L_{2C2} + L_{2C3} + L_{2C4} + L_{2C5} <= 88$

$L_{3A1} + L_{3A2} + L_{3A3} + L_{3A4} + L_{3A5} + L_{3B1} + L_{3B2} + L_{3B3} + L_{3B4} + L_{3B5} + L_{3C1} + L_{3C2} + L_{3C3} + L_{3C4} + L_{3C5} <= 95$

$L_{1A1} + L_{1B1} + L_{1C1} + L_{2A1} + L_{2B1} + L_{2C1} + L_{3A1} + L_{3B1} + L_{3C1} = 30$

$L_{1A2} + L_{1B2} + L_{1C2} + L_{2A2} + L_{2B2} + L_{2C2} + L_{3A2} + L_{3B2} + L_{3C2} = 57$

$L_{1A3} + L_{1B3} + L_{1C3} + L_{2A3} + L_{2B3} + L_{2C3} + L_{3A3} + L_{3B3} + L_{3C3} = 48$

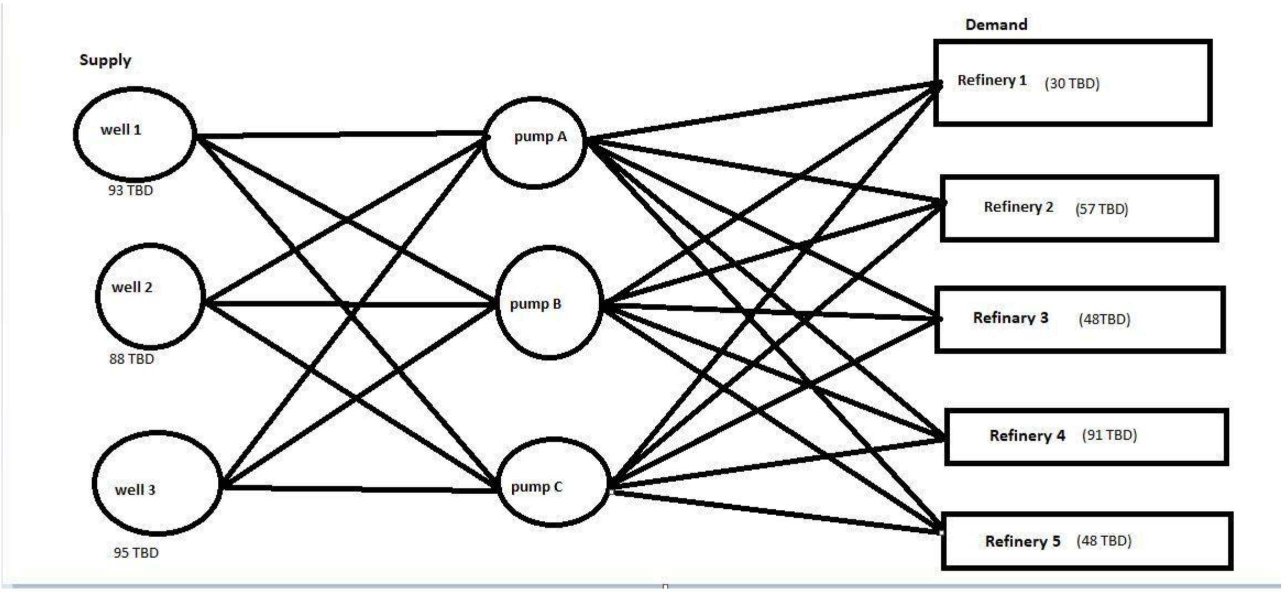
$L_{1A4} + L_{1B4} + L_{1C4} + L_{2A4} + L_{2B4} + L_{2C4} + L_{3A4} + L_{3B4} + L_{3C4} = 91$

$L_{1A5} + L_{1B5} + L_{1C5} + L_{2A5} + L_{2B5} + L_{2C5} + L_{3A5} + L_{3B5} + L_{3C5} = 48$

And

L_{wpr} >= 0 (w = 1,2,3) (p = A,B,C) (r = 1,2,3,4,5)

2. Show the network diagram corresponding to the solution in (a). That is, label each of the arcs in the solution and verify that the flows are consistent with the given information.



Relationships:

Well 1 to Pump A = 1.52
Well 1 to Pump B = 1.60
Well 1 to Pump C = 1.40
Well 2 to Pump A = 1.70
Well 2 to Pump B = 1.63
Well 2 to Pump C = 1.55
Well 3 to Pump A = 1.45
Well 3 to Pump B = 1.57
Well 3 to Pump C = 1.30

Pump A to Refinery 1 = 5.15
Pump A to Refinery 2 = 5.69
Pump A to Refinery 3 = 6.13
Pump A to Refinery 4 = 5.63
Pump A to Refinery 5 = 5.80
Pump B to Refinery 1 = 5.12
Pump B to Refinery 2 = 5.47
Pump B to Refinery 3 = 6.05
Pump B to Refinery 4 = 6.12
Pump B to Refinery 5 = 5.71
Pump C to Refinery 1 = 5.32
Pump C to Refinery 2 = 6.16
Pump C to Refinery 3 = 6.25
Pump C to Refinery 4 = 6.17
Pump C to Refinery 5 = 5.87