2)

a) The decision variable should represent the number of units shipped from well to each transshipment point(pump) to each destination (refinery points), The decision variable shipped from location i to j

Where i = 1,2,3,4

j=4,5,6,7,8,9,10,11,12

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | R1 | R2 | R3 | R4 | R5 | Dummy |
| Pump A | 5.15 | 5.69 | 6.13 | 5.63 | 5.80 | 0 |
| Pump A | 5.12 | 5.12 | 5.47 | 6.05 | 6.12 | 0 |
| Pump A | 5.32 | 6.16 | 6.25 | 6.17 | 5.87 | 0 |
| Demand | 30 | 57 | 48 | 91 | 48 | 2 |

Minimize total cost:

1.52x14 + 1.60x15 + 1.40x16 + 1.70x24 + 1.63x25 + 1.55x26 + 1.45x34 + 1.57x35 + 1.30x36 + 5.15x47+5.69 x48 +6.13x49 +5.63x4,10 +5.80x4,11 +x4,12+5.12x57 +5.47x58 +6.05x59 +6.12x5,10 +5.71x5,11 + x5,12 +5.32x67 +6.16x68 +6.25x69 + 6.17x6,10 + 5.87x6,11 +x6,12

s.t.

x14 + x15 + x16 <= 93 Supply at Well 1 [node 1]

x24 + x25 +x26 <=88 Supply at Well 2 [node 2]

x34 +x35 +x36 <=95 Supply at Well 3 [node 3]

x47 + x57 +x67 = 30 (Demand at Refinery 1 [node 7])

x48+ x58+x68 = 57 (Demand at Refinery 2 [node 8])

x49+x59+x69 = 48 (Demand at Refinery 3 [node 9])

x4,10 +x5,10 +x6,10 = 91 (Demand at Refinery 4 [node 10])

x4,11+ x5,11 +x6,11 = 48 (Demand at Refinery 5 [node 11])

x4,12 +x5,12 +x6,12 = 2 (Dummy Variable [node 12])

x14+x24+x34 = x47+x49+x4,10+x4,11+x4,12 ((Shipping through Pump 1 [node 4])

x15+x25+x35 = x57+x58+x59+x5,10+x5,11+x5,12 (Shipping through Pump 2 [node 5])

x15+x26+x36 = x67+ x68+x69+x6,10 +x6,11+x6,12 (Shipping through Pump 3 [node 6])

Xij ≥ 0 for all i and j (Non negativity constraint)

b) The network diagram for this problem: -

Where W = well, P = pump and R = refinery

5.15

G

1.52 5.69

1.60 0 6.13

1.40 5.63

5.12

1.70 1.45 5.47

1.63 6.05

5.71 5.80

1.55 1.57

5.32 6.12

6.16

1.30 6.25

g 6.17

0

5.87

0