Assignment 3: Excel Functions and Linear Programming

Solution

Date Due: February 12, 2015 Instructor: Trani

Problem 1

Task 1

```
Public Function RailNoise(SELref, Ncars, S, V)
'Function used to estimate the noise generated by a rail vehicle

'Programmer: Moises Bobadilla
' Date: Februrary 10, 2015
'
' Inputs:
' SELref = equivalent noise level (dBA)
' Ncars = number of cars in the train
' S = train speed (mph)
' V = hourly average train volume (trains/hr)

RailNoise = SELref + 10 * (Log(Ncars) / Log(10)) + 20 * (Log(S / 50) / Log(10)) + 10 * (Log(V) / Log(10)) - 31.4


End Function
```

NOTE: Taking the natural log in VBA can be done using two methods: a) as shown in the solution to Task 1 (divide Log(x)/log(10)) or b) sing the Excel function (Application.WorksheetFunction.ln). This last statement used Excel to do the computation of ln.

Task 2

Inputs		
SELref	73	dBA
Ncars	8	# of cars
S	49	mph
V	28	cars/hr
Output		
Leq	64.9270	dBA

Task 3

Train Speed (mph)	Leq (dBA)
0	0
5	45.102
6	46.686
9	50.208
12	52.707
15	54.645
18	56.229
21	57.567
24	58.727
27	59.750
30	60.666
33	61.493
36	62.249
39	62.944
42	63.588
45	64.187
48	64.748
51	65.274
54	65.771
57	66.241
60	66.686
63	67.110
66	67.514
69	67.900

NOTE: Sanity check. The higher the train speed, the higher the noise.

Task 4

# of cars	Leq (dBA)
2	58.906
3	60.667
4	61.917
5	62.886
6	63.678
7	64.347
8	64.927

NOTE: Sanity check. The larger the train size (i.e., transit unit), the more noise is produced.

Problem 2

a) Formulate the problem as a Linear programming problem

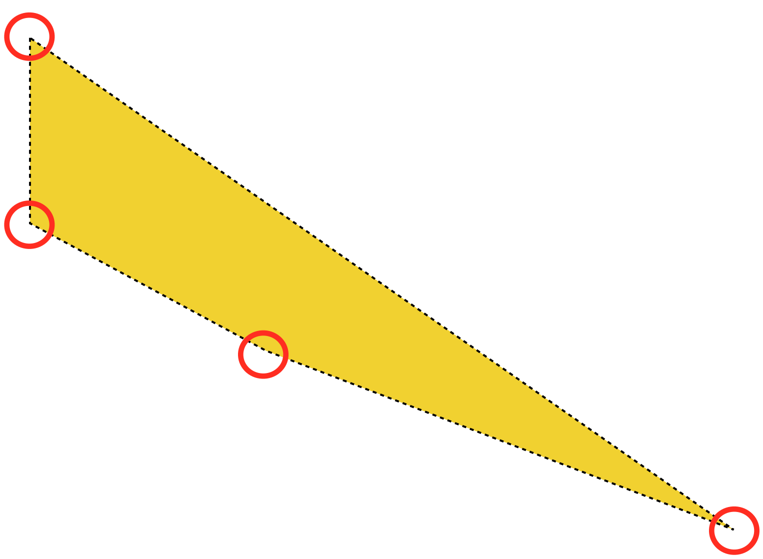
Decision variables:
x_1 = cubic meters of material from Site 1
x_2 = cubic meters of material from Site 2

Objective:

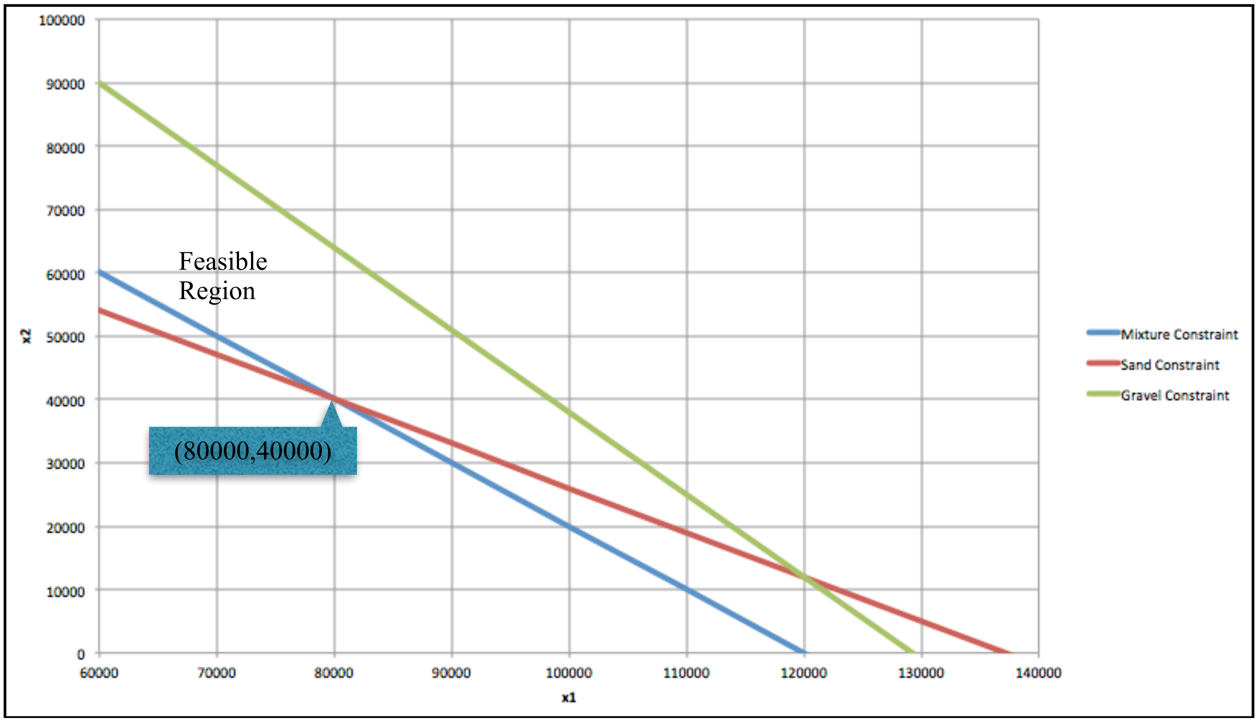
- "Minimize the cost of transporting/obtaining the material needed"
- Min $z = 350x_1 + 420x_2$

Constraints:

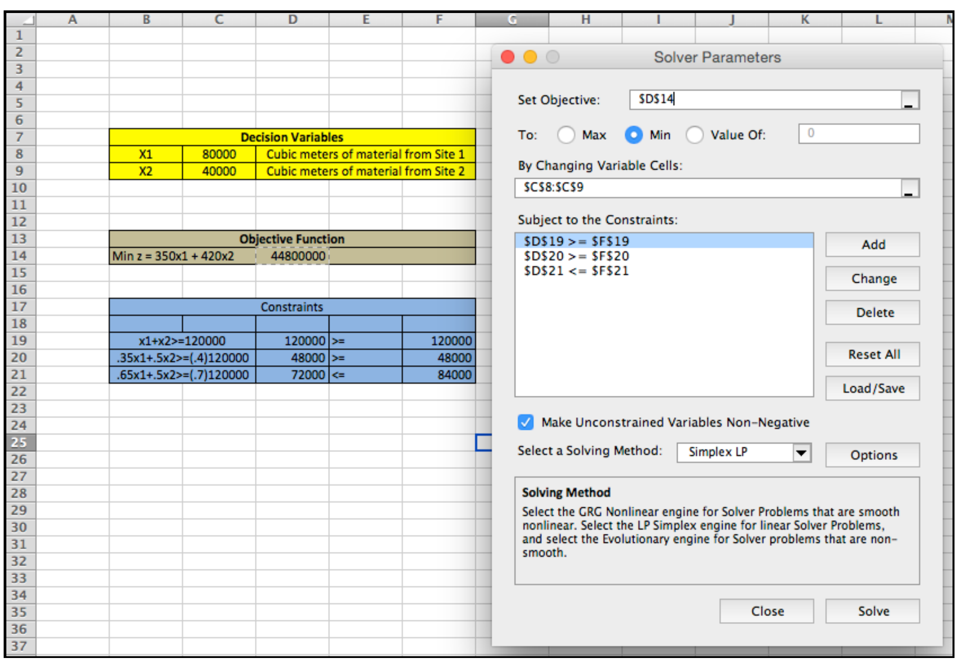
- *Mixture requirements (total)*
  $x_1 + x_2 >= 120{,}000$
- *Sand requirement constraint:*
  $(.35)x_1 + (.5)x_2 >= (0.4)*(120{,}000)$
- *Gravel requirement constraint:*
  $(.65)x_1 + (.5)x_2 <= (0.7)*(120{,}000)$
- *Non-negativity*



b) Solve the problem graphically



c) Solve the problem using Solver



d) Setup the first tableau of the Simplex procedure

1) Reformulate. Convert original constraints to equalities by adding surplus/slack variables (depending on > or <) and its respective M variables in the objective function:

Objective:

Max $-z = -350x_1 - 420x_2$

$\rightarrow$ Max $-z + 350x_1 + 420x_2 + Mx_4 + Mx_7 = 0$

Subject to:

$(.35)x_1 + (.5)x_2 - x_3 + x_4 = 48{,}000$

$(.65)x_1 + (.5)x_2 + x_5 = 84{,}000$

$x_1 + x_2 - x_6 + x_7 = 120{,}000$

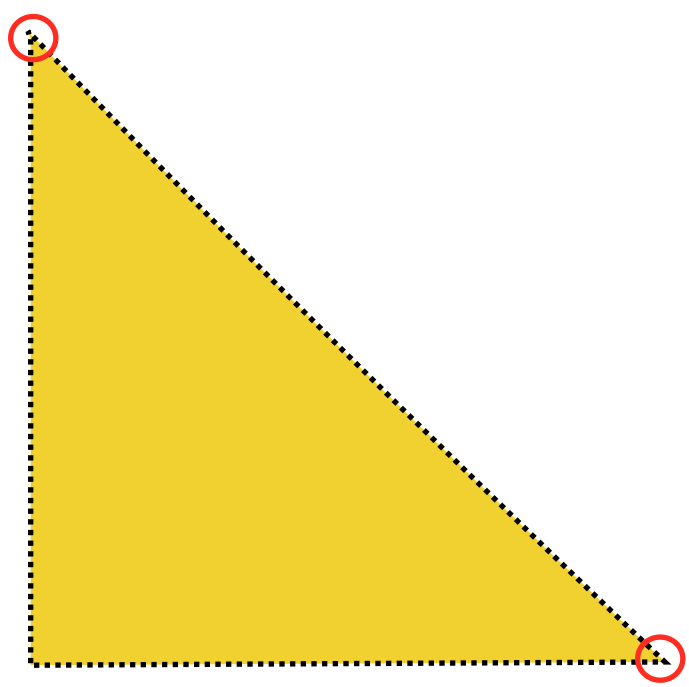
2) Convert to Standard Format. Only list artificial variables

		z	x_1	x_2	x_3	x_4	x_5	x_6	x_7	RHS
		-1	350	420	0	M	0	0	M	0
x_4 row	-M *	0	.35	.5	-1	1	0	0	0	48,000
x_7 row	-M *	0	1	1	0	0	0	-1	1	120,000
	z BV row	-1	-1.35M +350	-1.5M +420	M	0	0	M	0	-168,000M

3) Initial Tableau

BV	z	x_1	x_2	x_3	x_4	x_5	x_6	x_7	RHS
z	-1	-1.35M +350	-1.5M +420	M	0	0	M	0	-168,000M
x_4	0	.35	.50	-1	1	0	0	0	48,000
x_5	0	.65	.5	0	0	1	0	0	84,000
x_7	0	1	1	0	0	0	-1	1	120,000

Problem 3



a) Formulate the problem as a linear programming problem

Decision variables:

x_1 = Amount of product A produced/day

x_2 = Amount of product B produced/day

Objective:

- "Maximize revenue"
- Max $z = 120x_1 + 97x_2$

Constraints:

- *Individual production constraint*

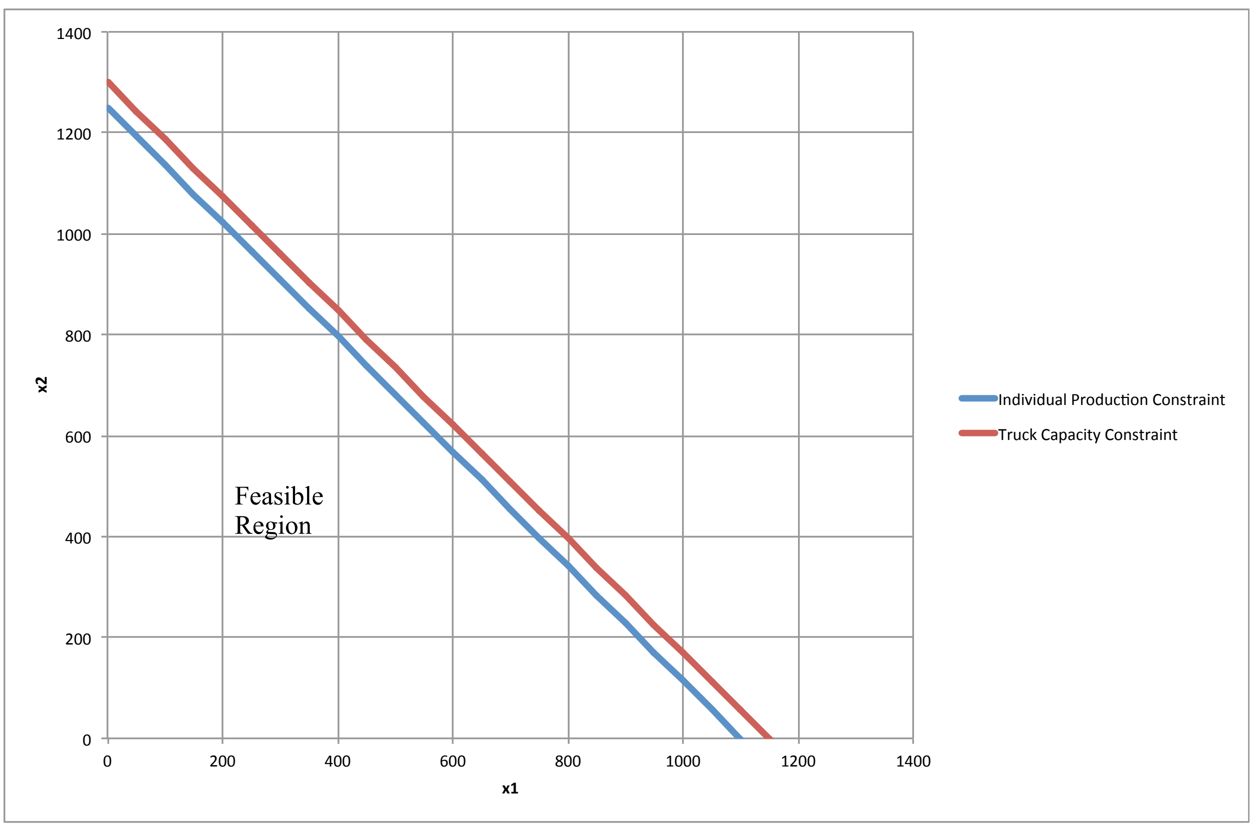
$$\frac{x_1}{1100} + \frac{x_2}{1250} \leq 1$$

- *Truck capacity constraint:*

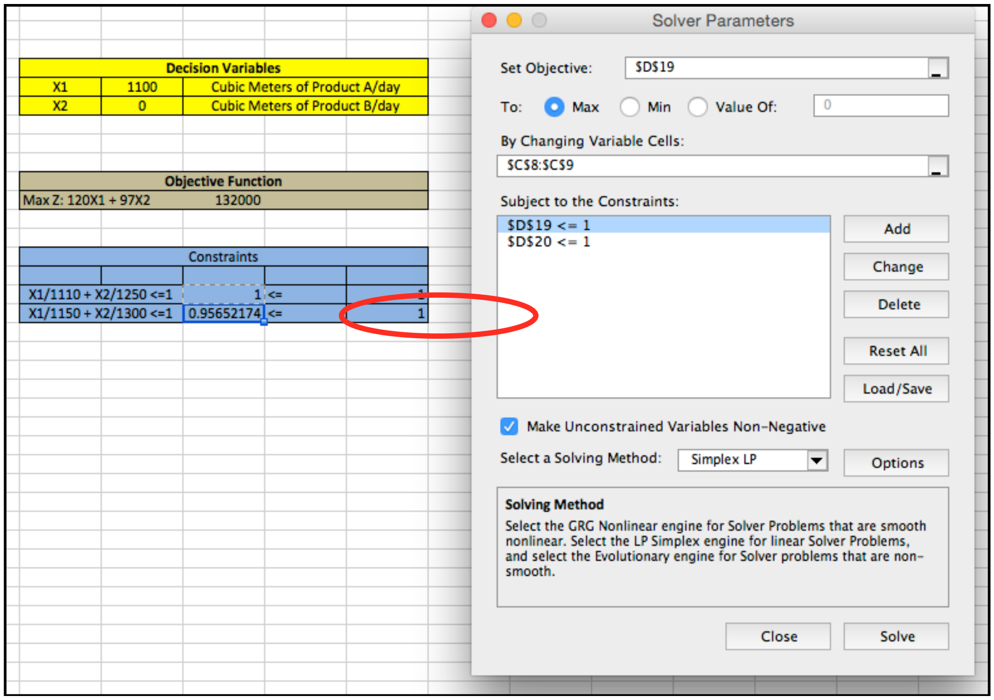
$$\frac{x_1}{1150} + \frac{x_2}{1300} \leq 1$$

- *Non-negativity*

b) Solve the problem graphically



c) Solve the problem using Solver



Problem 4

a) Formulate the problem as a linear programming problem

Problem 4

Decision variables:

x_1 = Amount of pollutants removed from Trinity River (kg)
x_2 = Amount of pollutants removed from Humbolt River (kg)
x_3 = Amount of pollutants removed from the city (kg)
x_4 = Amount of pollutants removed from the airport (kg)

Objective:

- "Minimize the cost of pollutant removal"
- Min z = $53x_1 + 51x_2 + 67x_3 + 56x_4$

Constraints:

- *40% Removal goal*

$$\sum_{i=1}^{4} x_i \leq [(0.40) * (15{,}8000 + 29{,}200 + 15{,}400 + 17{,}400)]$$

$$x_1 + x_2 + x_3 + x_4 \leq 31{,}120$$

- *Processing Plant ¼ removal constraint:*
  - Trinity River

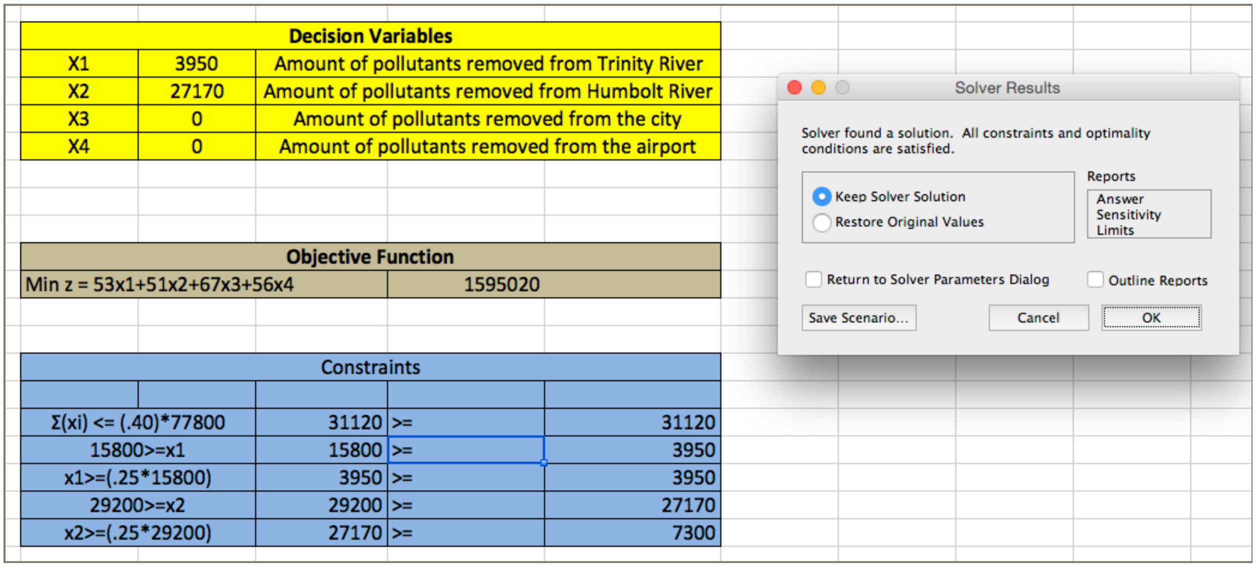
$$15{,}800 \geq x_1 \geq (.25) * (15{,}800)$$

  - Humbolt River

$$29{,}200 \geq x_2 \geq (.25) * (29{,}200)$$

- *Non-negativity*

b) Solve the problem using Excel Solver



Decision Variables		
X1	3950	Amount of pollutants removed from Trinity River
X2	27170	Amount of pollutants removed from Humbolt River
X3	0	Amount of pollutants removed from the city
X4	0	Amount of pollutants removed from the airport

Objective Function	
Min z = 53x1+51x2+67x3+56x4	1595020

Constraints			
Σ(xi) <= (.40)*77800	31120	>=	31120
15800>=x1	15800	>=	3950
x1>=(.25*15800)	3950	>=	3950
29200>=x2	29200	>=	27170
x2>=(.25*29200)	27170	>=	7300