#### **APPENDIX H**

## Procedure Using Excel Solver

### **1.1 Getting Started**

To begin using Excel, double-click on the Excel icon. Once Excel has loaded, enter the input data and construct relationships among data elements in a readable way.

When building this foundation for model, think ahead about the optimization model you will be developing. Ensure the cell in spreadsheet for each of the following:

- 1. quantity to maximize or minimize (target cell)
- 2. every decision variable (adjustable cell)
- 3. every quantity that might want to constrain(constrain cell)

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						/			
	U	V	3	Х	Y	Z	AA	AB	
1								1	
2								1	
3	Dm (M)	tv (s)	D (m)	L/D	Area D (m <sup>2</sup> )	Objective Function	Di (m)	Le(m	
4	[Di <sup>2</sup> + (Di+2*tcs) <sup>2</sup> /2] <sup>0.5</sup>	Le/(Qv/α*At)	Di+2*tc			min C =tcs*Fc*ps [pi*Dm*L + 2*Fa*Fh*Dm^2]			
5									
6	1.59	0.27	1.60	3.00	1.77	58893246.94		2	
7									
8									

# **1.2** Constructing an Optimization Model Using Solver

Once satisfied with the basic spreadsheet model have built, ready to

build an optimization model using Solver. To begin using Solver,

• click on "Data" and select "Solver".

Compatib	pility Mode] - Microsof	t Excel				x
					0 -	۳ x
Clear Reapply Advance	d Columns Duplicate	Data Consolidate What-If ss Validation * Analysis *	Group Ungroup Subto	Hide Detail	?⇒ Solver	
		Data Tools	Outline	e 6 (	Analysis	
				Solver		
	Y Z			What-if analysis tool t	hat finds t	he
				optimal value of a targ changing values in cel calculate the target ce	get cell by Ils used to II.	
	Area D (m <sup>2</sup> )	Objective Fun	ction	SOLVER		
	min C =tcs*Fc*ps [pi*Dm*L + 2*Fa*Fh*Dm^2]			Press F1 for more h	elp.	
	1.77		58893246.94	1	59	2.

		-	
X	Y	Z	AA
/D	Area D (m <sup>2</sup> )	Objective Function	Di (m)
		min C =tcs*Fc*ps [pi*Dm*L + 2*Fa*Fh*Dm^2]	
00	1. Solver Para	ameters	
	Equal To: By Chang \$AA\$6:\$ Subject to	Cell: 12552 1	Close Options
	\$AA\$5 < \$AA\$6 = \$AB\$6 < \$AB\$6 < \$E\$6 <= \$E\$6 <=	= \$U\$56   Add 1.5   \$656 = 1 \$V\$66 \$V\$66 \$U\$6	Reset All

1

2

## **1.3 Selecting the Cell to Optimize**

To select the cell wish to optimize, look at the "Set Cell" window within the dialogue box. Erase (or simply drag the cursor over) everything that is in that window. Then, either • type the address of the cell wish to optimize, or

• click on the cell wish to optimize.

• Choose either "Max" or "Min" depending on whether the objective is to maximize or minimize the target cell.

Z	AA	AB
1		
2		
3 Objective Function	Di (m)	Le(m)
4 min C =tcs*Fc*ps [pi*Dm*L + 2*Fa*Fh*Dn	m^2]	
5		
6 588932	46.94 1.59	2.3
7		
8 Solver Parameters		
9 Set Target Cell: 2246	Solve	
10 Equal To: Max @ Min _ Value of:	9	
11 By Changing Cells:	Close	
12 \$AA\$6:\$AB\$6	Guess	
13 Subject to the Constraints:		
14	Options	
15 \$AA\$6 = 1.5	Aga	
16 \$AB\$6 <= \$R\$6 \$AB\$6 >= 1	Change Reset All	
17 \$E\$6 <= \$H\$6 \$E\$6 <= \$I\$6	Delete	
18	Help	
19		
20		

# **1.4 Identifying Decision Variable Cells**

Move the cursor to the "By Changing Cells" window within the dialogue box. Again, erase anything that may be there (unless you put it there before and want to keep it). Must tell Excel which cells are decision variables—i.e., which cells Excel is allowed to change when trying to optimize. To do this:

• type the addresses of every cell wish to treat as a decision variable, separating them by commas, or

• drag the cursor across all cells wish to treat as decision variables



#### **1.5 Defining Constraints**

To begin entering constraints, click on the "Add" button to the right of the constraints window. A new dialogue box will appear. The cursor will be in the "Cell Reference" window within this dialogue box.

- · Type the cell address that contains the quantity ywant to constrain, or
- · click on the cell that contains the quantity want to constrain.

Again, if the dialogue box is in the way, can move it by dragging the bar at the top of the box. The default inequality that first appears for a constraint is "<=". To change this,

- click on the arrow beside the "<=" sign.
- · Select the inequality (or equality) you wish from the list provided.

(Notice that may also force a decision variable to be an integer using this window) After setting the inequality, move the cursor to the "Constraint" window.

· Type the number or the cell reference want to use as the constraining value

for that constraint, or

· click on the cell you want to use as the constraining value for that constraint.

After you are satisfied with that constraint,

- · click the "Add" button if you want to add another constraint, or
- · click the "OK" button if you want to go back to the original dialogue box.

3	Objective Function	Di (m)
4	min C =tcs*Fc*ps [pi*Dm*L + 2*Fa*Fh*Dm^2]	
5		
6	58893246.94	1.59
7		
8		
9		
10		
11	Add Constraint	
12	Cell References	
13		
14		(1000)
15	OK Cancel Add	Help
16		
17		

#### 1.6 To solve

Click **Solve** and do one of the following:

To keep the solution values on the worksheet, click **Keep Solver Solution** in the **Solver Results** dialog box. To restore the original data, click **Restore Original Values**.

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