

## Chapter 15: "What if" Thinking Helps: Advanced Spreadsheets for Planning

Fluency with Information Technology  
Third Edition

by  
Lawrence Snyder



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## Designing a Spreadsheet

- When a spreadsheet is used repeatedly, it becomes a tool of planning, analysis, and decision-making
- Must be well designed and flexible to be effective

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## The Trip

- Driving trip to the Arctic Circle from Chicago
- Make a spreadsheet to figure out how long it will take and how much it will cost

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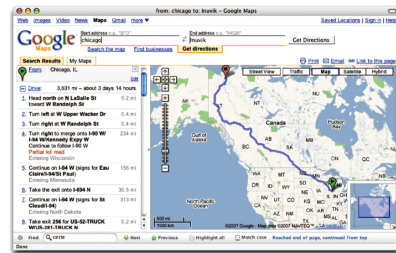


Figure 15.1 Google map directions for a trip from Chicago, Illinois (green pin), to Inuvik, Northwest Territories (red pin).

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## Design Guidelines

- Focus on Form
  - Make the form logical, the layout clean, and the entries clear and understandable
    - Descriptive info should be on the top and left
    - Summary info should be on the bottom and right
      - Use different fonts, colors, separate sheet for each table
- Explain Everything
  - It should be possible to know immediately what every cell means

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## Initial Spreadsheet: Applying the Rules

- Focus on Form:
  - title, authors, completion date, column headings, color, clean font, data aligned
- Explain Everything:
  - comments added to cells (*Insert > Comment*)

Trip to the Arctic Circle  
by Pat and Alex; completed 23.June.07

Segment	Time Est.	Miles	Fuel Price Report	Fuel Price
Chicago to Carrington ND	12:02	778 US	Chicago	\$3.59
Carrington to Battleford SK	11:06	620 US	Moosehead HI	\$2.96
Battleford to Fort St. John	11:26	648 CA	Moose Jaw SK	\$1.09
Fort St. John to Watson Lake YK	10:17	555 CA	Medicine Hat AB	\$1.01
Watson Lake to Dawson YK	11:55	601 CA	W. 54 AK Hwy	\$1.21
Dawson to Dawson via AC	14:00	484 CA	W. 54 AK Hwy	\$1.21

Figure 15.2 Initial spreadsheet for the Arctic Circle road trip.

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## Conditional Formatting

- **Cell Value Is Specifications**
  - *Format > Conditional Formatting...*
    - Change formatting in response to certain conditions
  - Can specify one or more conditions
  - Can use formulas in the comparison
    - Example: **bold** data greater than average of range

Trip to the Arctic Circle  
by Pat and Alex; completed 23.June.07

Segment	Time Est.	Miles	Fuel Price Report	Fuel Price
Chicago to Carrington ND	12:02	778 US Chicago		\$3.59
Carrington to Battleford SK	11:06	620 US Moorhead MN		\$2.96
Battleford to Fort St. John	11:26	648 CA Moose Jaw SK		\$1.09
Fort St. John to Watson Lake YK	10:17	555 CA Medicine Hat AB		\$1.01
Watson Lake to Dawson YK	11:55	601 CA MI 54 AK Hwy BC		\$1.21
Dawson to Dawson via AC	14:00	484 CA MI 54 AK Hwy BC		\$1.21

Figure 15.3 The Arctic Circle road trip spreadsheet with conditional formatting for "long days."

## Conditional Formatting (cont)

- **Formula Is Specifications**
  - Allows comparison with cells other than the one being formatted
  - A2 cell: `IF(B2>AVERAGE(B$2:B$7), TRUE, FALSE)`

Trip to the Arctic Circle  
by Pat and Alex; completed 23.June.07

Segment	Time Est.	Miles	Fuel Price Report	Fuel Price
Chicago to Carrington ND	12:02	778 US Chicago		\$3.59
Carrington to Battleford SK	11:06	620 US Moorhead MN		\$2.96
Battleford to Fort St. John	11:26	648 CA Moose Jaw SK		\$1.09
Fort St. John to Watson Lake YK	10:17	555 CA Medicine Hat AB		\$1.01
Watson Lake to Dawson YK	11:55	601 CA MI 54 AK Hwy BC		\$1.21
Dawson to Dawson via AC	14:00	484 CA MI 54 AK Hwy BC		\$1.21

Figure 15.4 Conditional formatting to highlight trip segments, whose Time Estimate is greater than average.

## Conditional Formatting (cont)

- **Distinguish Between the U.S. and Canada**
  - Italicize fuel cost if fuel price estimate is in Canadian dollars
  - E2 cell: `IF(Left(D2,2)="CA", TRUE, FALSE)`

Trip to the Arctic Circle  
by Pat and Alex; completed 23.June.07

Segment	Time Est.	Miles	Fuel Price Report	Fuel Price
Chicago to Carrington ND	12:02	778 US Chicago		\$3.59
Carrington to Battleford SK	11:06	620 US Moorhead MN		\$2.96
Battleford to Fort St. John	11:26	648 CA Moose Jaw SK		\$1.09
Fort St. John to Watson Lake YK	10:17	555 CA Medicine Hat AB		\$1.01
Watson Lake to Dawson YK	11:55	601 CA MI 54 AK Hwy BC		\$1.21
Dawson to Dawson via AC	14:00	484 CA MI 54 AK Hwy BC		\$1.21

Figure 15.4 Conditional formatting to highlight trip segments, whose Time Estimate is greater than average.

## Conditional Formulas

- **Computing with conditional factors**
- **Figuring the Amount Paid**
  - Miles per gallon (22) vs. miles per liter (5.8)
  - `=IF(LEFT(D2,2)="US", E2*C2/22, E2*C2/5.8)`

Trip to the Arctic Circle  
by Pat and Alex; completed 23.June.07

Segment	Miles	Fuel Price Report	Fuel Price	Amount Paid
Chicago to Carrington ND	778 US Chicago		\$3.59	\$126.96
Carrington to Battleford SK	620 US Moorhead MN		\$2.96	\$83.42
Battleford to Fort St. John	648 CA Moose Jaw SK		\$1.09	\$222.23
Fort St. John to Watson Lake YK	555 CA Medicine Hat AB		\$1.01	\$266.55
Watson Lake to Dawson YK	601 CA MI 54 AK Hwy BC		\$1.21	\$225.28
Dawson to Dawson via AC	484 CA MI 54 AK Hwy BC		\$1.21	\$100.89

Figure 15.5 Arctic Circle spreadsheet with Amount Paid column added. Notice that Time Estimate has been hidden, and that a comment noting the assumption of 22 mpg has been added to Amount Paid heading.

## Conditional Formulas (cont)

- **Cost in One Currency**
  - Canadian to US currency exchange rate (0.93)
  - `=IF(Left(D2,2)="CA", F2*0.93, F2)`

Trip to the Arctic Circle  
by Pat and Alex; completed 23.June.07

Segment	Miles	Fuel Price Report	Fuel Price	Amount Paid	Cost
Chicago to Carrington ND	778 US Chicago		\$3.59	\$126.96	\$126.96
Carrington to Battleford SK	620 US Moorhead MN		\$2.96	\$83.42	\$83.42
Battleford to Fort St. John BC	648 CA Moose Jaw SK		\$1.09	\$222.06	\$115.71
Fort St. John to Watson Lake YK	555 CA Medicine Hat AB		\$1.01	\$266.42	\$191.41
Watson Lake to Dawson YK	601 CA MI 54 AK Hwy BC		\$1.21	\$225.11	\$118.60
Dawson to Dawson via Arctic Cir	484 CA MI 54 AK Hwy BC		\$1.21	\$100.75	\$95.51
Dawson to Watson Lake YK	601 CA MI 54 AK Hwy BC		\$1.21	\$225.11	\$118.60
Watson Lake to Fort St. John BC	555 CA Medicine Hat AB		\$1.01	\$266.42	\$191.41
Fort St. John to Battleford SK	648 CA Moose Jaw SK		\$1.09	\$222.06	\$115.71
Battleford to Carrington ND	620 US Moorhead MN		\$2.96	\$83.42	\$83.42
Carrington to Chicago IL	778 US Chicago		\$3.59	\$126.96	\$126.96
			Total:	\$1,167.71	

Figure 15.6 Arctic Circle spreadsheet completed to the point of producing an estimate for fuel costs.

## Naming: Symbolic Reference

- Defining Names
  - Refer to cells *symbolically* by name rather than *literally* by explicit column/row position
  - A **name** is a word or phrase assigned to a cell or range of cells (no spaces)
    - Name used wherever cell references are used
    - Minimizes errors when columns/rows added later
    - *Insert > Name > Define*
    - *Insert > Name > Apply*

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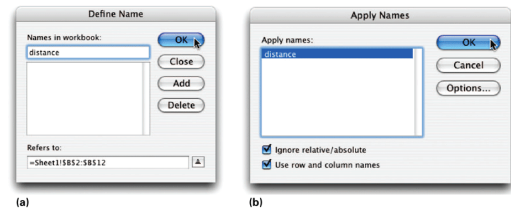


Figure 15.7 Name windows: (a) the Define Name window and (b) the Apply Names window.

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## Naming: Symbolic Reference (cont)

- Applying Names
  - =IF(LEFT(D2,2)="US", fuelPrice\*distance/22, fuelPrice\*distance/5.8)
  - Safer, easier to read and understand
- Make Assumptions Explicit
  - Assign instance-specific quantities that may change to cells, give them names, and use these names in the formulas
    - mpg, mpl, exchange rate, # of travelers
  - =IF(LEFT(priceSrc,2)="US", fuelPrice\*distance/mpg, fuelPrice\*distance/mpl)

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## "What If" Analysis

- Spreadsheets recalculate everything whenever a number is changed
- Ideal for speculating on the consequences of change
  - Make a change and notice what happens to the "bottom line"

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## "What If" Analysis (cont)

- Direct Experimentation
  - Potential risk of making permanent changes to data and formulas
- Scenarios
  - A named alternative to a spreadsheet based on different inputs
  - Aid to understanding changes in plans, like changes in gas mileage

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## Scenarios

- Tune-up Scenario
  - Select mpg cell, *Tools > Scenarios...*

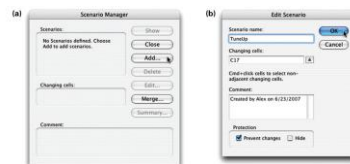


Figure 15.8 Dialog box sequence for adding a scenario to the Arctic Circle spreadsheet.

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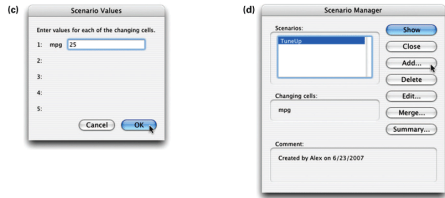


Figure 15.8 Dialog box sequence for adding a scenario to the Arctic Circle spreadsheet.

Scenario Summary		
	Current Values:	TuneUp
<b>Changing Cells:</b>		
mpg	22	25
<b>Result Cells:</b>		
FuelCost	\$1,167.71	\$1,027.59

Notes: Current Values column represents values of changing cells at time Scenario Summary Report was created. Changing cells for each scenario are highlighted in gray.

Figure 15.9 The Scenario Summary sheet showing the result of the TuneUp scenario.

## Scenarios (cont)

- Traveling Companions Scenario
  - Adding buddies in the car will drop the mpg but also the cost per person

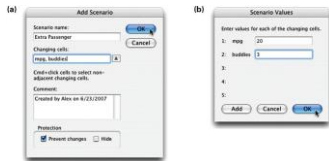


Figure 15.10 The Extra Passenger scenarios and their effect on ppFuel.

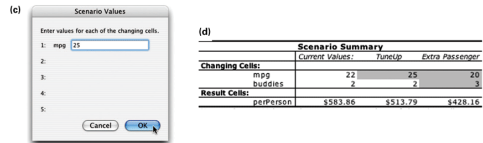


Figure 15.10 The Extra Passenger scenarios and their effect on ppFuel.

## Analyzing a Model

- Formulating a Model
  - Account for all foreseeable costs
- The Model
  - Table summarizing the per person expenses
- Reusing Scenarios
  - Rerun scenarios to see how the total cost changes as the number of travelers increases

Trip to the Arctic Circle						
by Fat and Alex, completed 23.June.07						
Lodging	Occupancy	Price	Lodging Expenses	Contin-gencies	Just In Case	
Campground	2	25	25			
Provincial Park	2	20	20	Tires	Base Cost	\$100.00
Provincial Park	2	20	20			\$160.00
Wilderness	2	0	0			
Hostel@820	1	20	40			
Hostel@820	1	20	40			
Wilderness	2	0	0			
Provincial Park	2	20	20			
Provincial Park	2	20	20			
Campground	2	25	25			
Total			\$210.00			\$260.00
Total Per Person			\$105.00			\$130.00
Camping	Yes					

Figure 15.11 The lodging and contingency data for the Arctic Circle road trip.

Trip to the Arctic Circle	
by Fat and Alex, completed 23.June.07	
Costs	Amount Per Person
Fuel	\$553.86
Lodging	\$105.00
Contingency	\$130.00
<b>Total</b>	<b>\$818.86</b>

Scenario Summary			
	Current Values:	1 Extra Traveler	2 Extra Travelers
<b>Changing Cells:</b>			
mpg	22	21	20
buddies	1	3	4
<b>Result Cells:</b>			
totalCost	\$818.86	\$399.24	\$491.11

## Analyzing a Model

- A Change in Plans
  - Stay in Hostels vs. camping

Scenario Summary				
	Current	1 Extra	2 Extra	Hostel Upgrade
Values:	Traveler	Travelers	Travelers	
<b>Changing Cells:</b>				
mpg	22	21	20	20
buddies	2	3	4	4
\$3s2	25	25	25	18
\$3s3	20	20	20	18
\$3s4	20	20	20	18
\$3s5	0	0	0	18
\$3s6	20	20	20	18
\$3s7	20	20	20	18
\$3s8	0	0	0	18
\$3s9	20	20	20	18
\$3s10	20	20	20	18
\$3s11	25	25	25	18
<b>Result Cells:</b>				
camping	Yes	Yes	Yes	No
estTotal	\$818.86	\$577.77	\$458.62	\$566.12

Figure 15.12 Scenario Summary table for the Arctic Circle road trip.

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## Analyzing Data Using Filtering

- Travel Log spreadsheet
  - Can use a *filter* to access subsets of information (selecting only certain rows from a list) to create a customized version of a spreadsheet
- Auto Filtering Technique
  - *Data > Filter > AutoFilter*
  - Options for filtering the list based on data in each column
  - Turn off AutoFilter by selecting it again (toggle)

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## Advanced Filtering Technique

- More refined analysis with precise filtering criteria
- Advanced Filtering Setup
  - Add a new column with the *same heading* as the column containing the date to be filtered
  - Enter a criterion to indicate that values in the other column by the same name should be filtered with that criterion

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## Advanced Filtering Technique (cont)

- Executing an Advanced Filter
  - Select a cell in the column to be filtered
  - *Data > Filtering > Advanced Search...*
    - *List range*: dimension of the list to be filtered
    - *Criteria range*: range covering the heading and the criterion of setup column
    - *Copy to*: specifies a new place on the spreadsheet to place the filtered result (optional)
  - Restore original table: *Data > Filtering > Show All*

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## Advanced Filtering Technique (cont)

- Filtering on Multiple Criteria
  - Define multiple setup columns with criteria
  - *Criteria range* in Advanced Filter window is enlarged to cover all criteria in the setup columns

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Road To Arctic Circle and Back: Stops  
Pat, Ann, Ch, Al

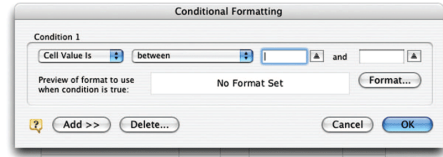
When	Seg	Who	Where	Reason	Rev	\$ Amt	MI	Remark
8/4/07 5:45	1	Al's house IL	Last pick-up	All tolls	X	0.00		We're Off!
8/4/07 6:40	1	Toll Booth IL	Area Furnaces			2.85		
8/4/07 8:05	1	DriveThru Joe IL	Espresso					Only driver
8/4/07 9:00	1	Beck's WI	Gas & Gro	Gas	A	34.50	241	
8/4/07 9:55	1	Hudson WI	Snacks					
8/4/07 12:05	1	St. Paul MN	Gas & Gro, Eat	Gas	P	28.95	191	Subway
8/4/07 14:45	1	St. Cloud MN	Stretch/Photo					Pretty Here
8/4/07 15:30	1	Sauk Center MN	Snacks					
8/4/07 16:55	1	Fergus Falls MN	Gas & Gro	Gas	P	29.22	205	
8/4/07 19:45	1	Fargo ND	Photo in ND					Pat's First
8/4/07 20:25	1	Valley City ND	Supper					Just Food
8/4/07 22:00	1	Carrington ND	Stay Night	Camp	C	21.45		Great Start
8/5/07 7:25	2	Carrington ND	Gas	Gas	A	37.42	252	
8/5/07 7:55	2	Steverson ND	Photo					Big Rip
8/5/07 10:05	2	Moorhead ND	Gas & Gro, Snk	Gas	X	19.64	135	Ice Cream
8/5/07 11:50	2	Frontal ND	Photo in CA					All Pets, 1st
8/5/07 12:25	2	Esteven SK	Lunch					
8/5/07 13:55	2	Weymouth SK	Gas & Gro, Eat	Gas	A	33.62	151	
8/5/07 15:45	2	Moose Jaw SK	Snacks					1 Scream!

Figure 15.13 Start of the Travel Log of the Arctic Circle road trip. Seg. # corresponds to a segment of the original plan (Sheet 1). \$ refers to who paid a shared expense, MI is distance traveled since last fuel.

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Chicago to Carrington, ND:	778 miles,	12 hrs, 2 minutes
Carrington to Battleford, SK:	620 miles,	11 hrs, 6 minutes
Battleford to Fort St. John, BC:	648 miles,	11 hrs, 26 minutes
Fort St. John to Watson Lake, BC:	555 miles,	10 hrs, 17 minutes
Watson Lake to Dawson, YK:	601 miles,	11 hrs, 55 minutes
Round-trip Dawson to Arctic Circle:	484 miles,	14 hours



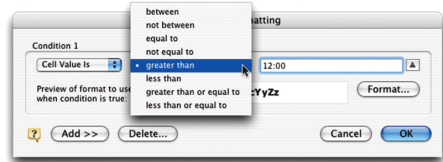
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Miles	Alex: Prices from gasbuddy.com	Fuel Price
778	US Chicago	\$3.59
620	US Moorehead MN	\$2.96

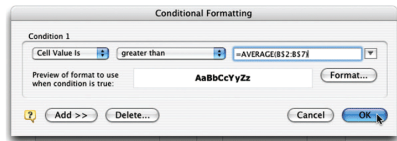


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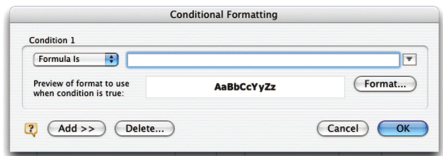
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Time Est.
12:02
11:06
11:26
10:17
11:55
14:00

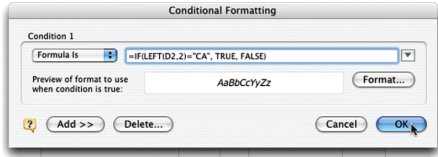


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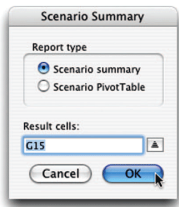
Assumptions:	
Miles per gallon:	22
Miles per liter:	5.81
US-Canadian Exchange Rate:	0.948
Travlers:	2

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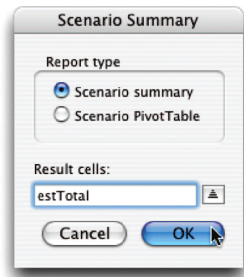
<b>Total:</b>	<b>\$1,167.71</b>
<b>Cost Each</b>	<b>\$583.86</b>

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Total			\$210.00
Total Per Person			\$105.00
Camping	Yes		

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When	Seq. No	Where	Reason	Buy	\$ Amt	MI	MI	Remark
8/4/07 5:45	1	All's house IL	Last pick-up		0.00			We're Off
8/4/07 6:40	1	Toll Booth IL	Alex Fumbles	All tolls	2.85			

When	Seq. No	Where	Reason	Buy	\$ Amt	MI	MI	Remark
8/4/07 5:45	1	All's house IL	Last pick-up		0.00			We're Off
8/4/07 6:40	1	Toll Booth IL	Alex Fumbles	All tolls	2.85			

Reason	Buy	\$ Amt	MI
Last pick-up		0.00	
Alex Fumbles	All tolls	2.85	
Gas & Go		1.50	
Snacks		1.95	
Gas & Go, East		3.22	
Snacks		3.22	
Gas & Go		3.22	
Photo in ND			

**Road to Arctic Circle and Back: Stops**

When	Seq. No	Where	Reason	Buy	\$ Amt	MI	MI	Remark
8/4/07 9:00	1	Beloit WI	Gas & Go	Gas	A	34.50	241	
8/4/07 12:05	1	St. Paul MN	Gas & Go, East	Gas	P	28.95	191	Subway
8/4/07 16:55	1	Fergus Falls MN	Gas & Go	Gas	A	29.22	205	
8/5/07 7:25	2	Carrington ND	Gas	Gas	A	37.42	252	
8/5/07 10:05	2	Minot ND	Gas & Go, Snx	Gas	X	19.64	135	Ice Cream
8/5/07 13:55	2	Weyburn SK	Gas & Go, East	Gas	A	33.82	151	

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When	Seq. No	Where	Reason	Buy	\$ Amt	MI	MI	Remark
8/5/07 10:05	2	Minot ND	Gas & Go, Snx	Gas	X	19.64	135	Ice Cream

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When	Seq. No	Where	Reason	Buy	\$ Amt	MI	MI	Remark
8/4/07 5:45	1	All's house IL	Last pick-up		0.00		>175	
8/4/07 6:40	1	Toll Booth IL	Alex Fumbles	All tolls	2.85			

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**Advanced Filter**

Action

Filter the list, in-place  
 Copy to another location

List range: SAS1:SJ520

Criteria range: SJ51:SJ52

Copy to: SAS127:SJ527

Unique records only

Cancel   **OK**

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When	Seq. No	Where	Reason	Buy	\$ Amt	MI	MI	Remark
8/4/07 9:00	1	Beloit WI	Gas & Go	Gas	A	34.50	241	
8/4/07 12:05	1	St. Paul MN	Gas & Go, East	Gas	P	28.95	191	
8/4/07 16:55	1	Fergus Falls MN	Gas & Go	Gas	P	29.22	205	
8/5/07 7:25	2	Carrington ND	Gas	Gas	A	37.42	252	

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When	Seq. No	Where	Reason	Buy	\$ Amt	MI	MI	MI	Remark
8/4/07 5:45	1	All's house IL	Last pick-up		0.00		>175	<225	

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When	Seg		Reason	Buy	\$ Amt	MI	MI	MI
	No.	Where						
8/4/07 12:05	1	St. Paul MN	Gas & Go, Eat	Gas	P 28.95	191		
8/4/07 16:55	1	Fergus Falls MN	Gas & Go	Gas	P 29.22	205		