Analytical Hierarchy Process (AHP) *for Fun and Profit*

ASHE Potomac Section

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Hal Forman – Expert Choice

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What is the Analytical Hierarchy Process (AHP)?

”A structured technique for organizing and analyzing complex decisions, using a pairwise comparison approach to allow a more accurate ordering of priorities for decision making.”

- Goal
- Criteria
- Alternatives

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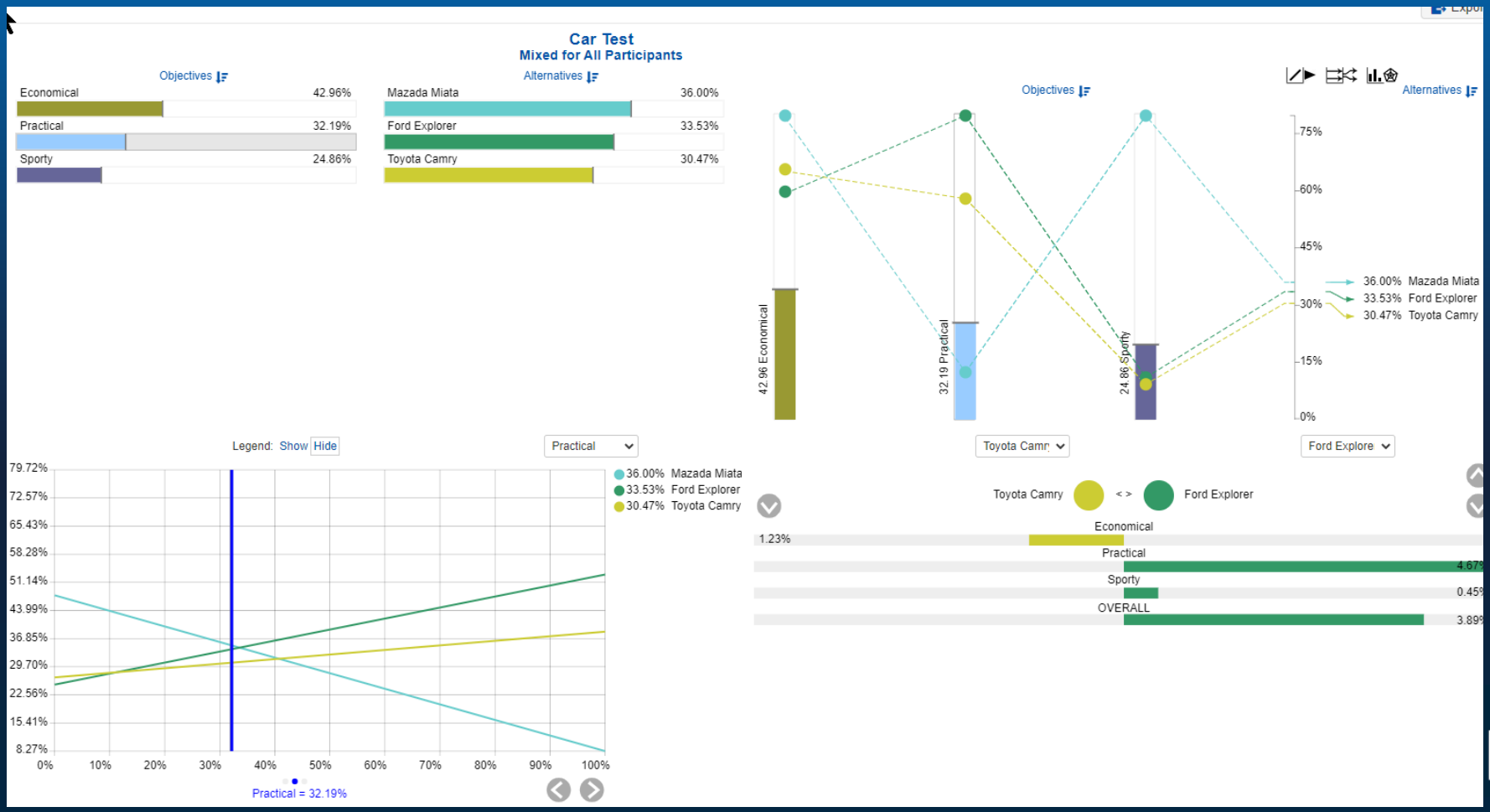
Example: Selecting a car

- Goal – Buy an affordable car that will be practical and impressive
- Criteria
  - Practical
  - Economical
  - Sporty
- Alternatives
  - Toyota Camry
  - Ford Explorer
  - Mazda Miata

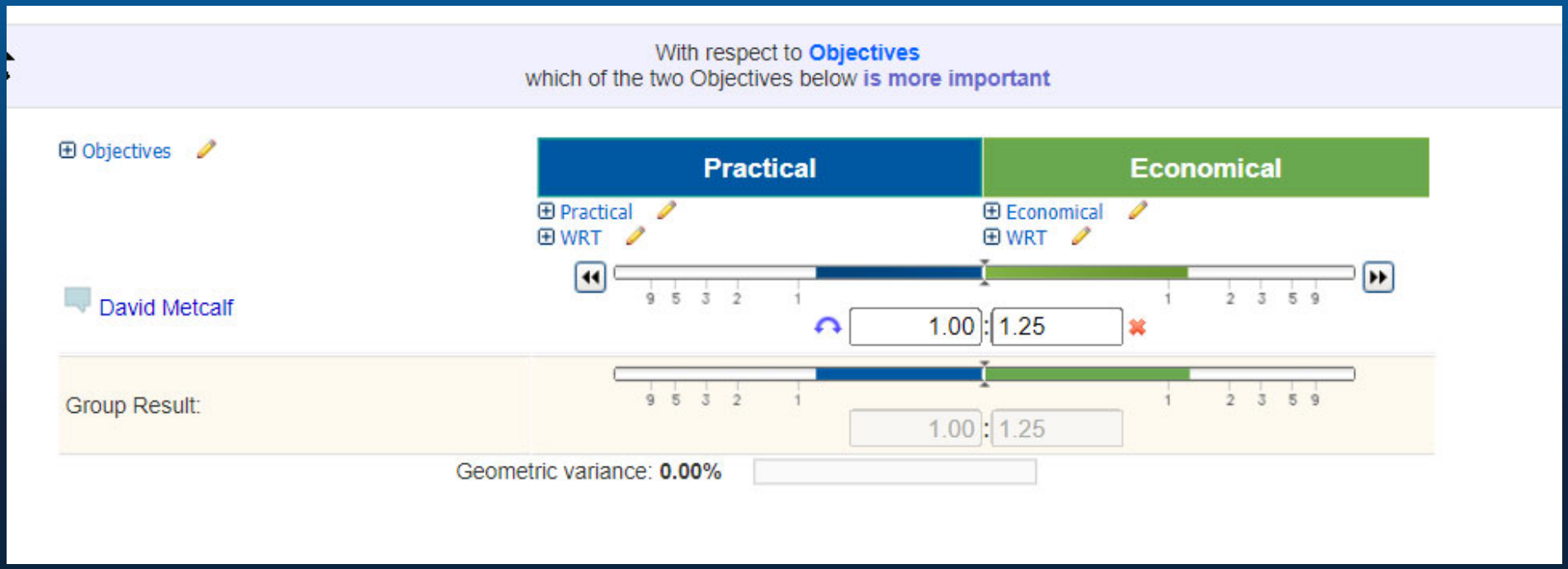
Simple Point Method (Not AHP)

	Camry	Explorer	Miata
Practical	6	7	3
Economy	6	5	4
Sporty	3	2	9
Total	15	14	16

AHP – Expert Choice Software



AHP – Criteria weighting



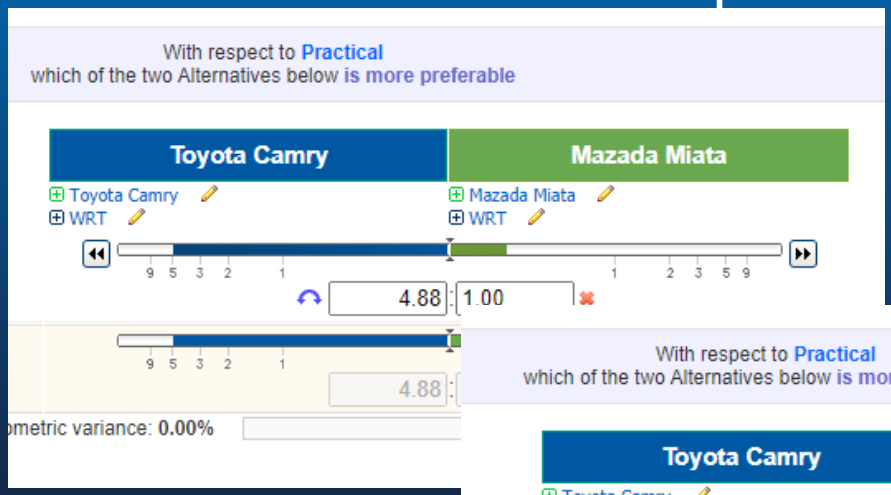
Car Example – AHP results

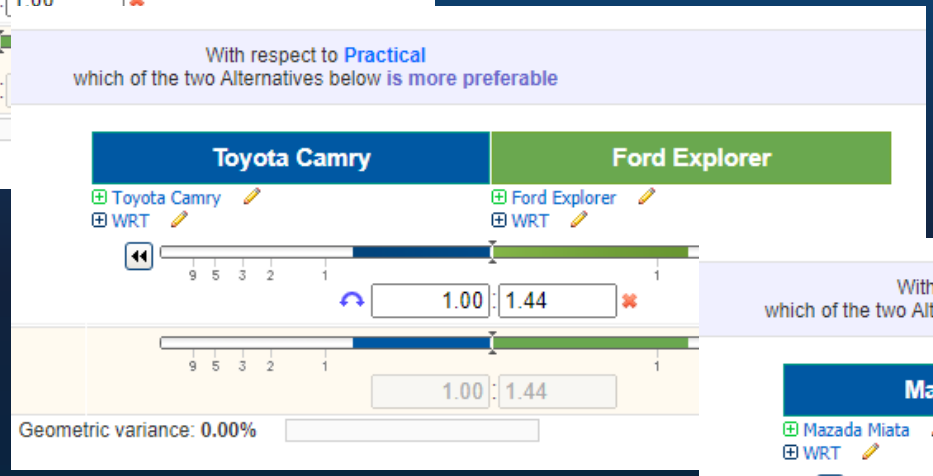
Priority of Objectives with respect to "Objectives"

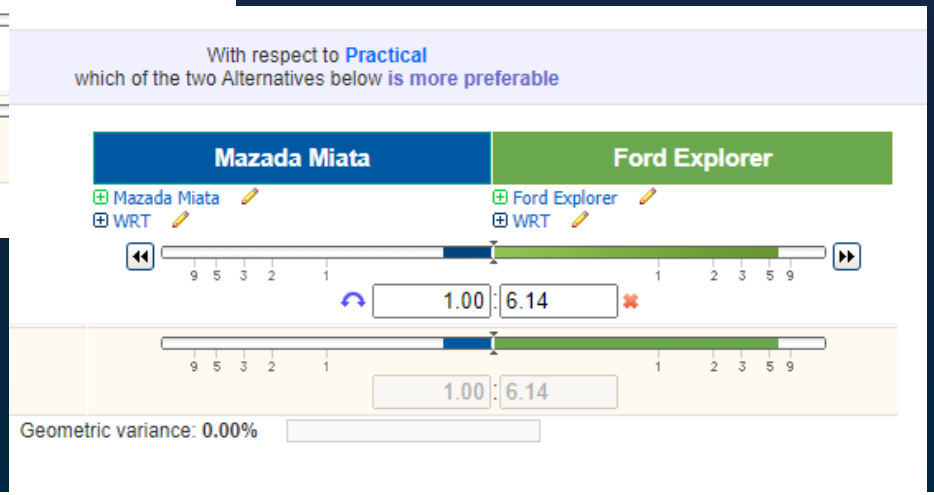
Name	Your Results	Bar Graph
Practical	31.23%	
Economical	46.43%	
Sporty	22.34%	

Inconsistency Ratio: 0.00

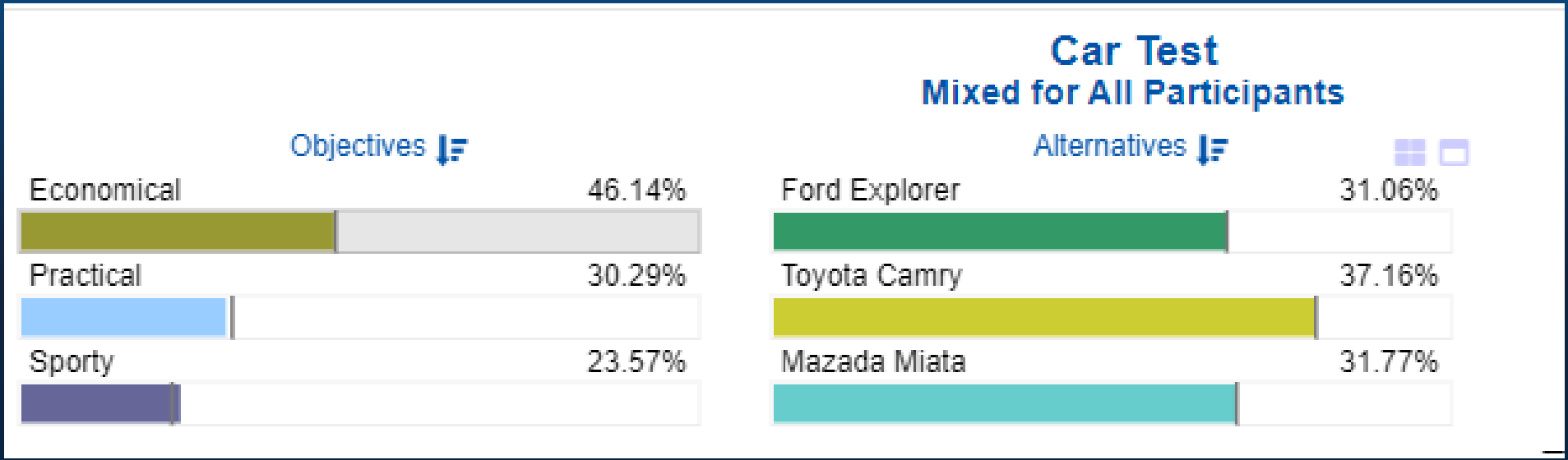
Alternatives Comparison wrt Practical



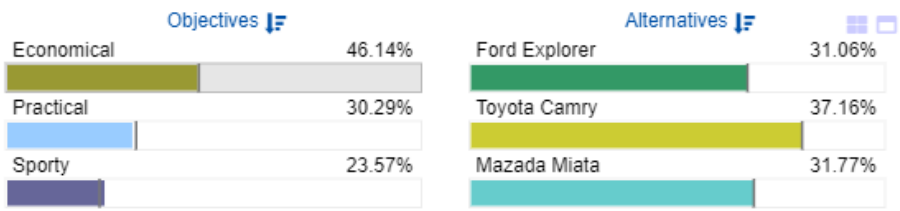


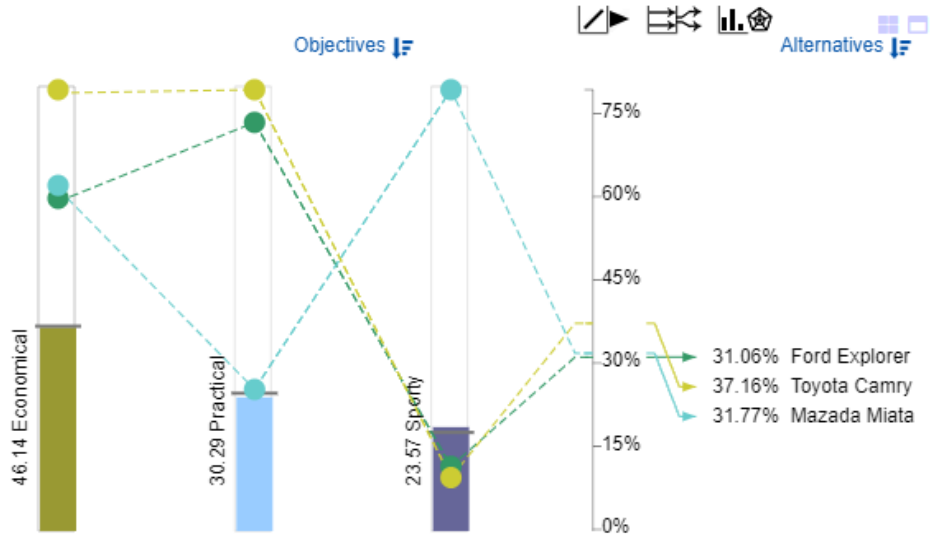


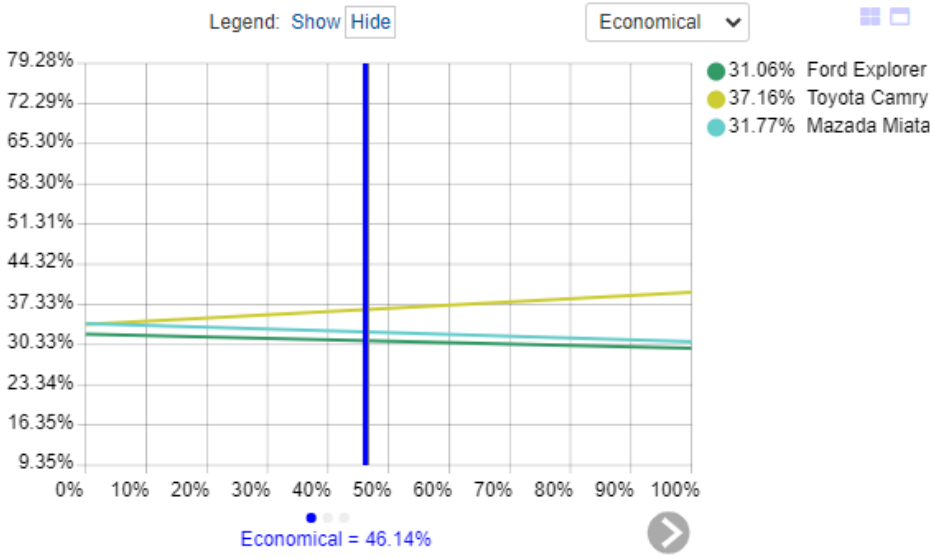
AHP Results

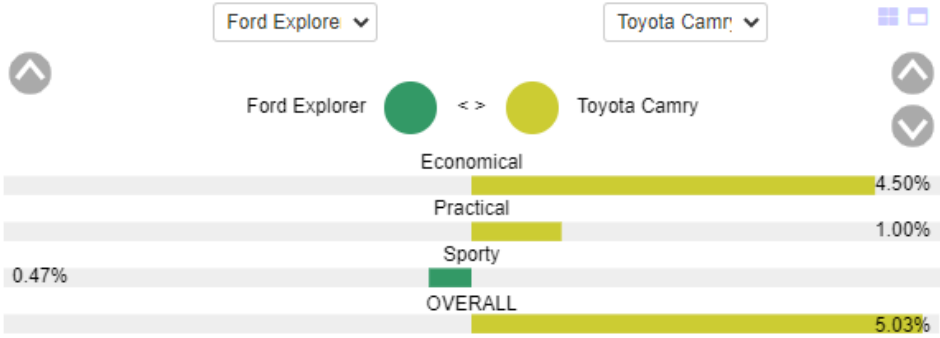

Car Test
Mixed for All Participants
Objectives
Economical 46.14%
Practical 30.29%
Sporty 23.57%
Alternatives
Ford Explorer 31.06%
Toyota Camry 37.16%
Mazada Miata 31.77%

Car Test
Mixed for All Participants









The Math Behind the Numbers

1 -9 Scale

Intensity of Importance	Definition
1	Equal Importance
3	Moderate Importance
5	Strong Importance
7	Very Strong Importance
9	Extreme Importance
2, 4, 6, 8	For compromises between the above
Reciprocals of above	In comparing elements i and j - if i is 3 compared to j - then j is 1/3 compared to i
Rationals	Force consistency Measured values available

Consistency And Weights

- • So consistent matrix for the car example would look like:

	P	M	G
P	1	3	5
M	1/3	1	5/3
G	1/5	3/5	1

– Note that matrix has Rank = 1
– That means that all rows are multiples of each other

- **Weights are easy to compute for this matrix**
  - **Use fact that rows are multiples of each other**
  - **Compute weights by normalizing any column**

$$w_P = \frac{15}{23} = 0.65, \quad w_M = \frac{5}{23} = 0.22, \quad w_G = \frac{3}{23} = 0.13$$

Transportation Engineering Applications

- Alternatives Analysis
  - Traffic Level of Service
  - Residential Impacts
  - Construction Costs
  - Impacts to Environmental Resources…;
- Establish Benefit – Cost ratios
- Population and Economic Projections

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Fun with AHP

- **Goal** – Select the Optimal Location for the Triple Curve Bypass
- Criteria
  - Crash Reduction
  - Neighborhood Impacts
  - Stream Impacts

Alt A1 – New location, skirts neighborhood, new crossing of stream

Alt B1 – Largely on existing alignment, design exception required.

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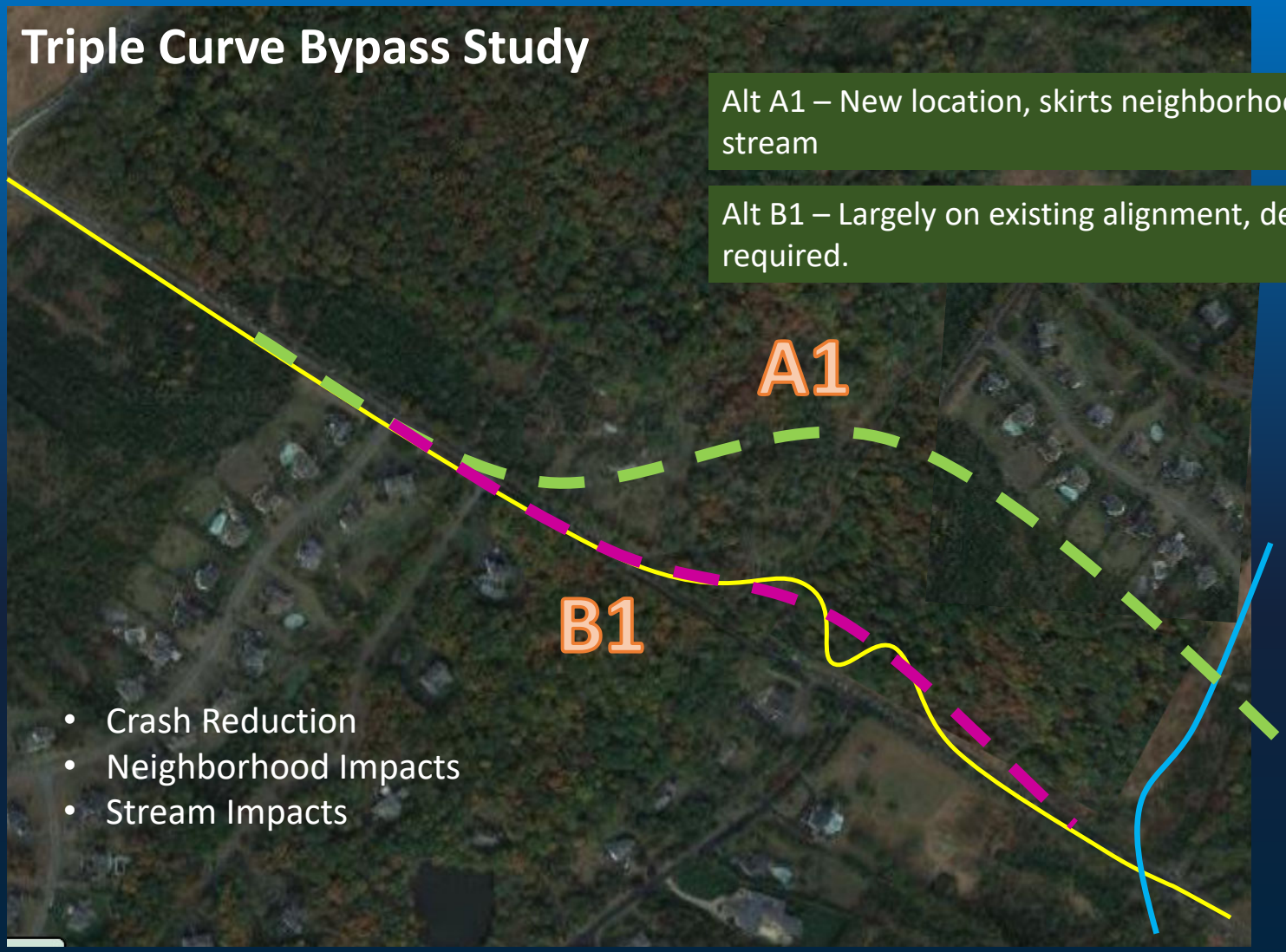
Triple Curve Bypass Study

Alt A1 – New location, skirts neighborhood, new crossing of stream

Alt B1 – Largely on existing alignment, design exception required.



- Crash Reduction
- Neighborhood Impacts
- Stream Impacts

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Thank You!

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