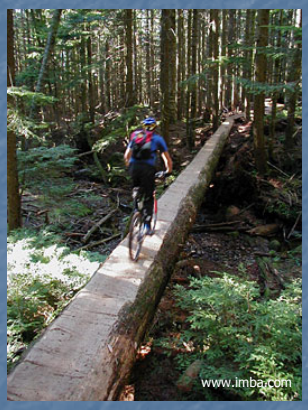
Location Analysis for Single-Use Mountain Bike Trail



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Proposal

- Find a location for a new single-track mountain bike trail
- Create a trail that is properly designed so it will require minimal maintenance
- Does not interfere with existing recreation opportunities, wildlife, or environment
- Trail that is challenging but can be used by all different skill levels of riders

Forest Park

- Located in NW Portland
- 5161 Acres
- Established in 1947
- Third largest Urban Park in the U.S.
- 70 miles of hiking trails
- 30 miles of bike paths
- No single-track mountain bike trails.

Current Trail System and the Need for More

- Keeps mountain bikers off hiking trails
- Prevents the construction of "commando" trails
- Provides recreational opportunities to more people

Trail Criteria

- Average slope less than 15%
- Maximum trail slope of 30%
- Ideal building hill slope 0-50%, Secondary 50-70%
- Does not interfere with existing hiking trails.
- Avoids drainage paths

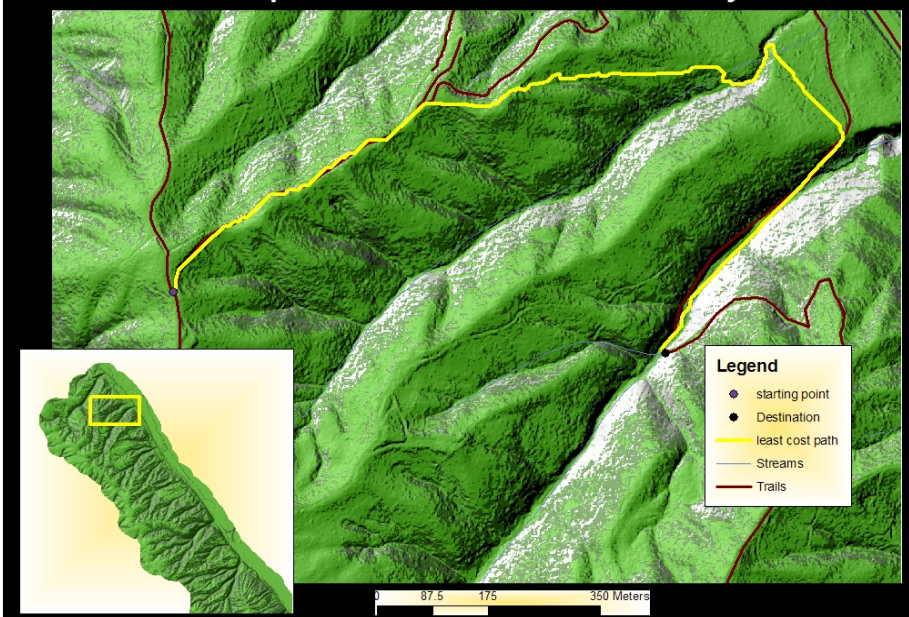
Trail building options

- Converting existing trails, opening them up to mountain bikes
- Non-GIS, drawing by hand and flagging- most commonly used.
- Least cost path analysis
- Alternative GIS design

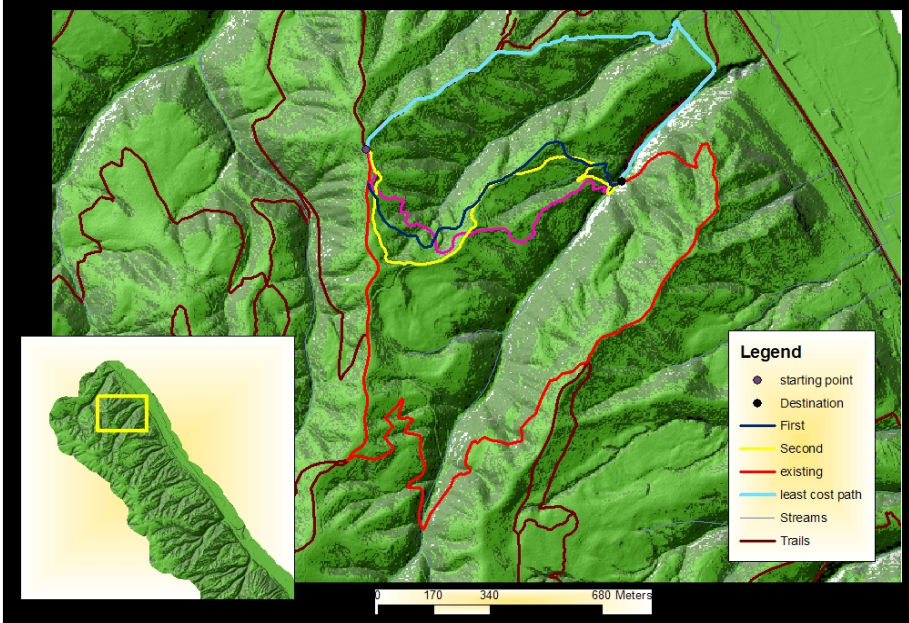
Data Used

- RLIS-contours, hill-shade, streets
- LiDAR Data-DEM, slope, hill-shade
- Portland Parks and Recreation-park boundary, trails

ArcMap, Least Cost Path Analysis



Initial Study Area

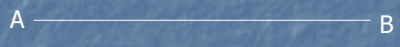


Trail Metrics

Finding ways to describe a polyline.

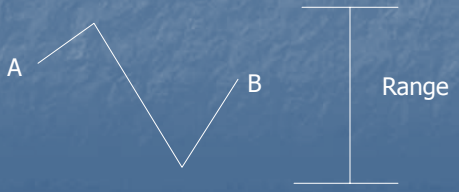
Metrics-Basics

- Length



- Elevation Change

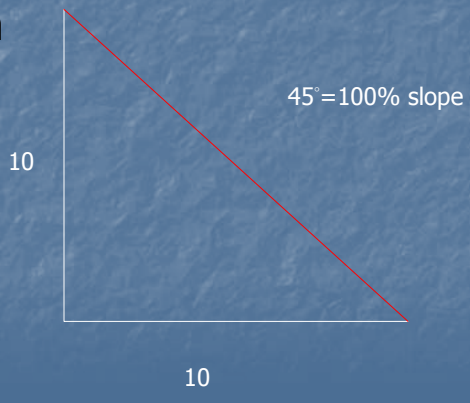
- Elevation Range



Metrics

Slope

Rise/Run



How Do You Get Slope?

Easy…

Get slope from a DEM in Spatial Analyst>Surface>slope.

Convert trail to raster (trail,1; else, no data) multiply trail raster against slope raster.

Raster attributes show min. max, std. dev, mean.

Slope

Hawth's tools (http://www.spatialecology.com/htools/tooldesc.php)

Has line overlay on raster tool, eliminates time and space of making rasters of lines.

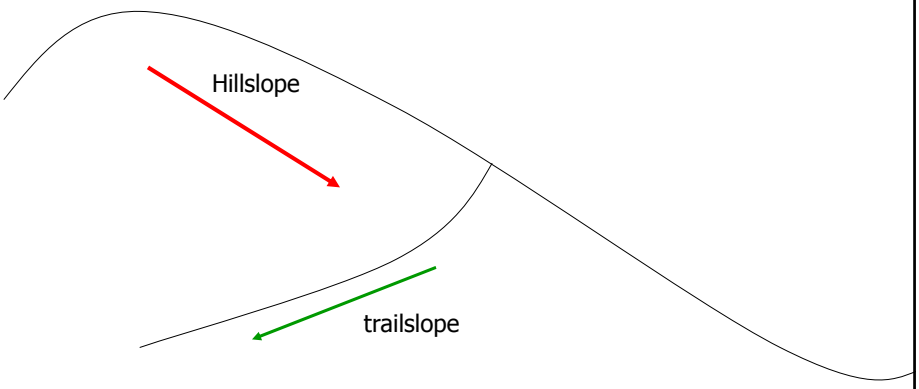
And it's FREE!

Slope Metrics

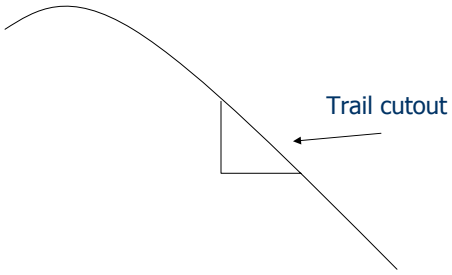
But…

Hillside Slope and *Trail* slope are different things

Slope Metrics



Slope Metrics



Hillslope determines if you can build a a trail or not- 0-50%,50-70%.
Trailslope determines is people can ride it.- 10% good, 15% max over 100'.

Trail Slope

- There is no tool for line slope.
- 3-D analyst can create a profile of a digitized line.
- Creates picture of ΔX, ΔY.
- Can only compare visually.

Determining Trail Slope

- Export data from 3-D Analyst into excel
- Equation:

=((abs(Y1-Y2))/(abs(X1-X2))*100)

- Gives cellular (cell by cell) percent slope of the line.

Determining Trail Slope

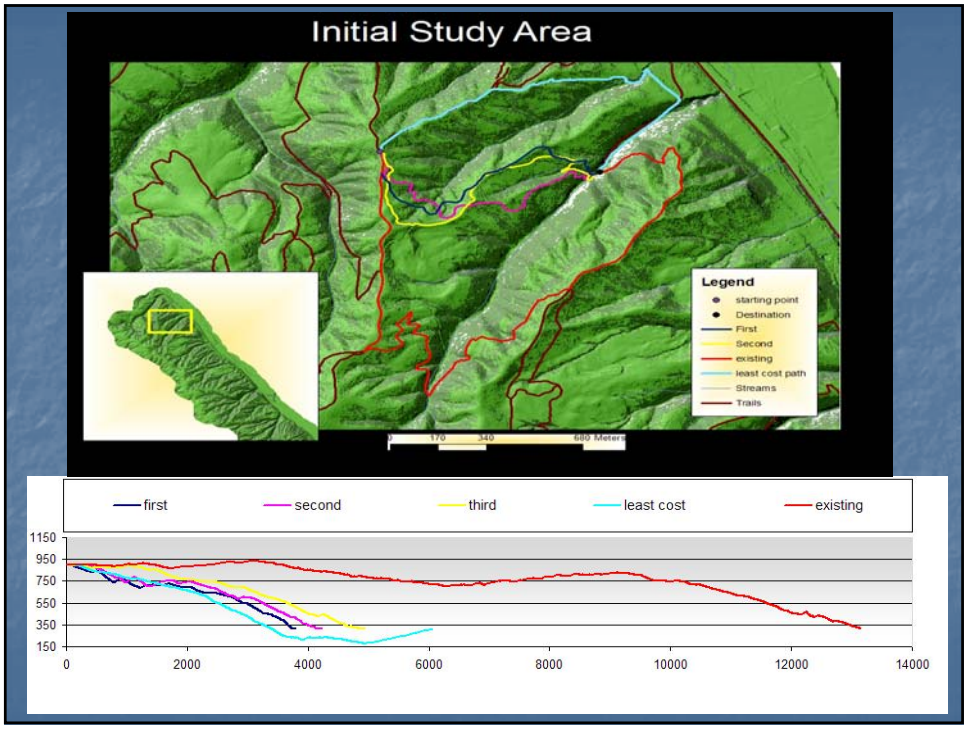
- Overcoming high trailslope is easy over 3’.
- A moving average over 33 cells gives average slope for a 99’ trail section.
- This tells us trail feasibility.

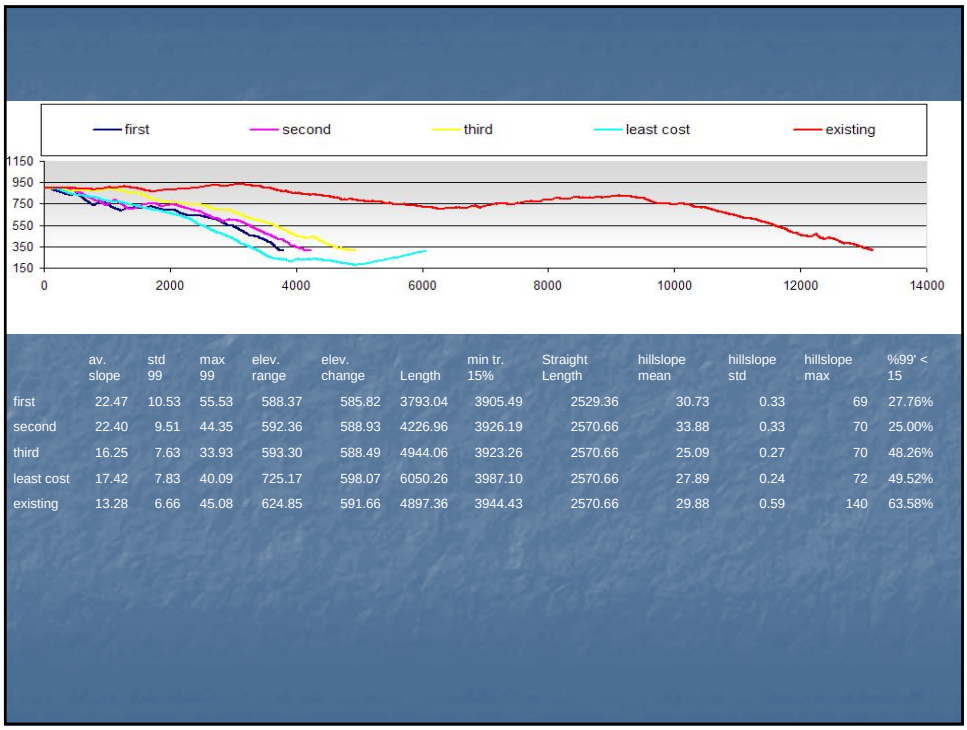
Metrics

- Standard Deviation tells us how varied the data are.
- If average slope is 10%, with std. dev. Of 1, 95% of the trail has an average between 8-12%

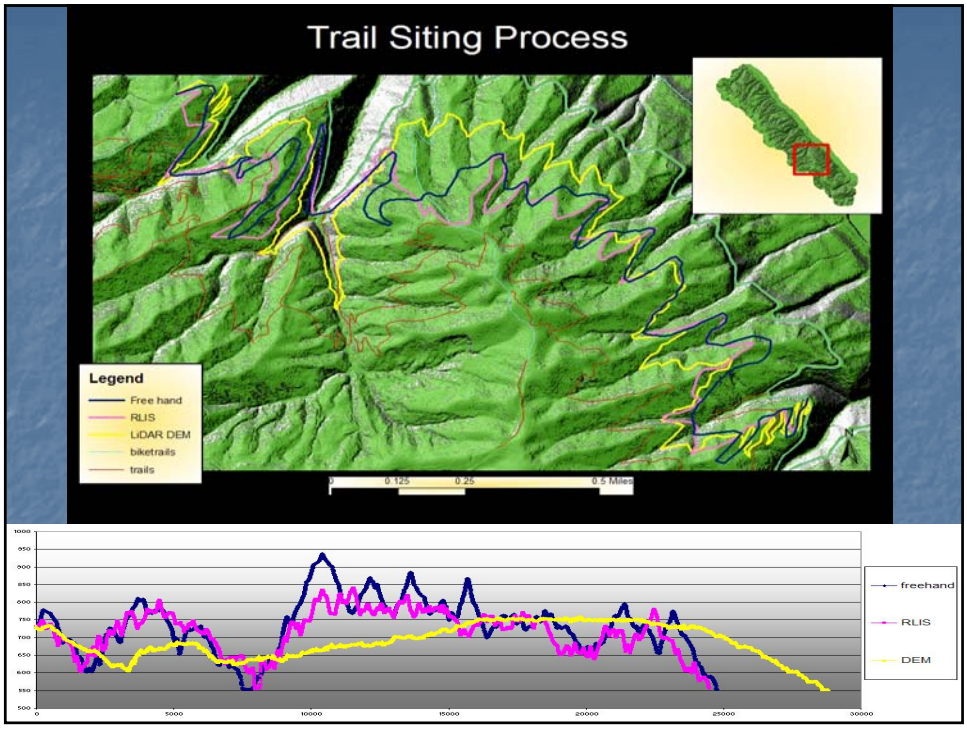
Metrics

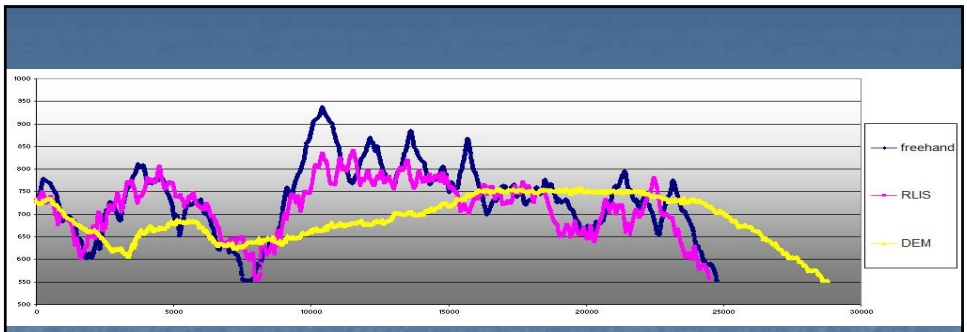
- Knowing elevation and desired slope can give a theoretical "zero variance" length.
- Comparing this to the actual straight line distance can show how feasible a trail would be in a specified area.





	av. slope	std 99	max 99	elev. range	elev. change	Length	min tr. 15%	Straight Length	hillslope mean	hillslope std	hillslope max	%99' < 15
first	22.47	10.53	55.53	588.37	585.82	3793.04	3905.49	2529.36	30.73	0.33	69	27.76%
second	22.40	9.51	44.35	592.36	588.93	4226.96	3926.19	2570.66	33.88	0.33	70	25.00%
third	16.25	7.63	33.93	593.30	588.49	4944.06	3923.26	2570.66	25.09	0.27	70	48.26%
least cost	17.42	7.83	40.09	725.17	598.07	6050.26	3987.10	2570.66	27.89	0.24	72	49.52%
existing	13.28	6.66	45.08	624.85	591.66	4897.36	3944.43	2570.66	29.88	0.59	140	63.58%

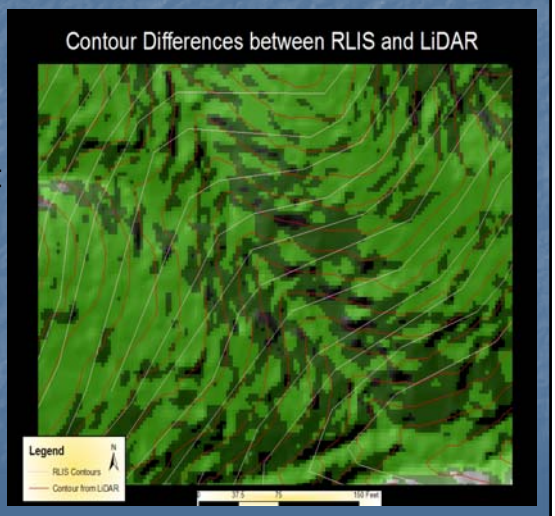




	av. slope	std 99	max 99	Elev. range	Elev. change	Length	min tr. 15%	str. Length	hillslope mean	hillslope std	hillslope max	% 99 < 15
freehand	18.67	7.97	44.74	385.60	179.27	24760.06	1195.11	7236.43	38.28	0.22	166	38.37%
RLIS	20.51	9.25	73.36	287.69	176.90	24483.19	1179.32	7236.43	38.28	0.22	166	38.37%
DEM	11.23	3.68	30.81	206.72	178.67	28807.42	1191.11	7236.43	49.64	0.18	152	85.32%

Issues (with data)

- RLIS contours significantly different from contours created from DEM
- Attempt with Least Cost Path plotted a trail that didn't adhere to IMBA standards
- Metrics of a fall line
  - On a cellular level
    - Where the trail starts
    - Where it ends
    - Trail angle in relation to aspect



Issues (with data cont.)

- Route optimization for a raster environment
- Underlying data doesn't necessarily dictate the trail location
  - Steep slopes can be conquered with switchbacks
  - Some obstacles are hidden even in LiDAR data

Issues (Data and Tools)

- Limitations of LiDAR
  - Highly accurate but contains data that may not make sense
    - Elevation anomalies exist where the "rise over run" can show a 400% slope (this indicates a 20′ rise over a 5′ run – 100% slope is 45° angle)
- Digitizing trails
  - 3D Analyst couldn't create a slope from an existing line
  - Trails had to be re-digitized to generate slope profiles
  - Digitizing in 3D Analyst is very unforgiving

Issues (in Forest Park)

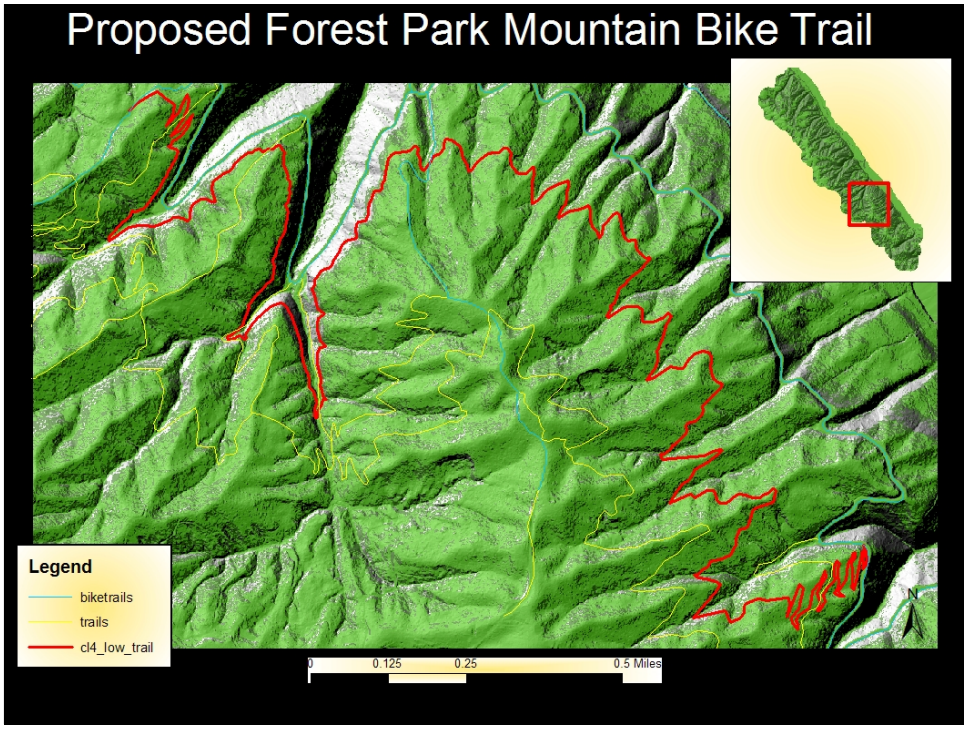
- Forest Park is a difficult place for siting a trail because of
  - Steep slopes
  - High existing trail densities
    - South Park density - 0.001045
    - Middle Park density – 0.001847
    - North Park density – 0.001055
  - Urban park with high user density
  - Conflicts between park users
- Actual park boundary
  - Boundary is different depending on who you talk to
    - Josh Darling – Portland Parks and Rec
    - Parts that are incorporated park are actually private property
    - Area considered to be Forest Park is somewhat "fuzzy"

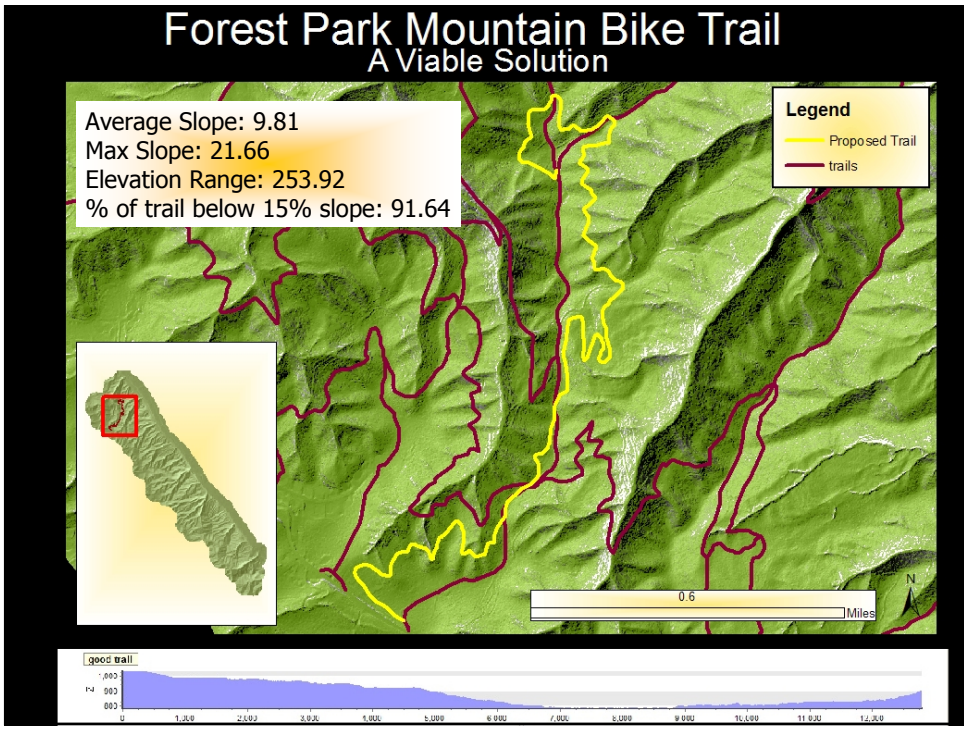
Conclusions

- A lot of factors to consider when choosing the location for a new trail
  - Trail that can be ridden both directions
  - Overall slope under 15%
  - Adequate space for trail
- Is this method of trail siting useful?
  - Accurate LiDAR data shows existing features that can be utilized in the new trail

Conclusions

- What would we do differently?
  - Study area choice
    - Forest Park has accurate data available
    - Terrain makes for difficult trail siting
    - Numerous existing trails, difficult to plot new trail without conflict
    - High user density in an urban park
  - Trail usage data
  - Actual park boundary


Proposed Forest Park Mountain Bike Trail
Legend
biketrails
trails
cl4_low_trail
0
0.125
0.25
0.5 Miles
N


Forest Park Mountain Bike Trail
A Viable Solution
Average Slope: 9.81
Max Slope: 21.66
Elevation Range: 253.92
% of trail below 15% slope: 91.64
Legend
Proposed Trail
trails
0.6
Miles
N
good trail

Conclusions

- Using LiDAR data of Forest Park
  - We were able to create two trails
    - One in the north western section of the park
    - A second crossing the middle section to the south eastern section
- Before a trail could be constructed
  - Ground truthing would be vital
  - Construction cost analysis

References

- Portland Parks and Recreation, www.portlandonline.com/parks
- Friends of Forest Park, www.friendsofforestpark.org/trails
- Chris Bernhardt, International Mountain Bike Association
- LiDAR Data; Kevin Martin, City of Portland
- Forest Park Data; Josh Darling, Portland Parks and Recreation
- RLIS Data, PSU; hill-shade, streets, contours
- Shimano American Corporation; *Planning and Managing Environmentally Friendly Mountain Bike Trails*. 2006