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18 August 2004

Zoning Commission of the District of Columbia
441 4th Street, N.W. -- Suite 200
Washington, D.C. 20001

SUBJECT: Forest Hills Tree and Slope Overlay District – ZC 02-19
Problems with OP's canopy estimates for Forest Hills

Dear Zoning Commissioners:

ANC 3F welcomes attempts to introduce and refine new concepts and analytical methods, but OP's macro-estimates of existing canopy coverage of each of 38 Squares in Forest Hills cannot be used to set uniform standards as OP suggested (25% for lots less than 7,500 sq. ft. and 36% for lots of 7,500 sq. ft. or more, as clarified by OP).

Our recent Memorandum ("Memo"; adopted July 19, filed July 21, 2004) noted that Applicant, Forest Hills Citizens Association (FHCA) questioned aspects of OP's methodologies. [Memo p. 5 and notes 4, 5. Our Attachment provided OP's estimates for each of 38 Squares, in square meters (to a "precision" of two decimal places) and estimated % canopy coverage).]

But we now know more. Accuracy of OP's estimated 38-Squares' data, not just OP's use of its estimates, now seems dubious. By summarizing flaws in OP estimation techniques and their application, we hope as much to facilitate (and encourage) correction the next time as to warn against uncritical acceptance this time. OP should refine these methods.

Square 2777

At the Zoning Commission's public hearing, on July 22, 2004, a witness challenged OP's estimate of tree canopy for one of those 38 squares.

- OP estimated a 6 percent tree canopy for Square 2777 (284.21 sq. m.).
- But FHCA witness Jim Urban (a prominent landscape architect and tree expert) said Square 2777 consists of a single lot which he landscaped for a client with an initial 23 percent tree canopy – which has grown bigger over the years.
- Could OP's methodology (or its application) shrink 23 percent to 6 percent?

OP analyzed photographs and prepared estimates without "ground-truthing" any of them. Could OP have overlooked trees in a photograph, leaving out their canopy area?

ZONING COMMISSION
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Case 02-19
Date 3/2

ZONING COMMISSION
District of Columbia
CASE NO.02-19
EXHIBIT NO.372

Two Lots in Square 2063

Last week we checked two of the lots in Square 2063, using an OP .pdf file photo map showing each square and the area that OP's analyst concluded was tree canopy.¹ We took OP's photo map to the Capital Memorial Church, where our ANC usually meets, and the Owl's Nest property (3031 Gates Road, one of the largest lots in the FH/TSP Overlay district [Memo note 5 at p. 5]), across from the Church.

- OP's analyst overlooked many mature trees on both properties:
 - *all* of the tree canopy on the south side of the Church.
 - *most* of the tree canopy on the west side of the Owl's Nest property.
- Indeed, to the west of the Owl's Nest historic landmark building OP's analyst detected a canopy cover of less than 25% where over 75% appears closer to the mark.
- How could these oversights occur?

Large, dark splotches appear on the Owl's Nest photo, which OP's analyst failed to identify as trees. Human error.

As to the Church, although splotches also appear (as pale green), the analyst may have identified them as trees *but excluded them anyhow*. How could that be?

OP's photo map says: *** Only trees located on private property were included in this analysis. Trees located on public property, such as "street trees" located within the street and alley rights-of-way, were not included.**

Now the south side of the Church is a steep bank, down to Brandywine Street. The bank belongs to the Church – "private property." Trees grow at the top and middle of the bank. But the analyst may have thought these were "street trees" along Brandywine Street, belonging to the City. He did not "ground-truth" his interpretation. He may or may not have realized that a steep bank existed.

Replicability? Literature Support?

We would like to try to replicate OP's methodologies, but cannot.

The OP "work papers" are only on its computer. There are no hard copies. (OP's green and red-lined "Forest Hills Tree Coverage Analysis" – July 7, 2004 – OPID0003434 – is a simplified summary, not the actual work paper.)

We asked for the written protocol given to OP's analyst. It was all oral.

We asked for the analyst's written reports, and his written comments on problems or issues he encountered. None exist. He simply furnished software-generated numbers.

We tried to find literature supporting a methodology to implement OP's peculiar direction that its analyst exclude all "street tree" canopy.

We have not found such literature and are waiting to learn whether OP knows of any (but we found the opposite, plenty on how to estimate canopy cover at the edge of pavement, with its own acronym: CCEP).

OP's direction to exclude all canopy contributed by "street trees" from its statistical analysis is all the more troubling given OP's recommendation that each individual lot receive credit for *just such excluded canopy*.

¹ Forest Hills Tree Coverage Analysis – OP – July 7, 2004 – OPID0003434 (Ex. ___ in this record) which we zoomed up and expanded for the properties in question.

Classification Errors and Biases

The principal report on which OP's July 12, 2004, Final Report relied [at note 2] warns of issues concerning accuracy, bias, suitability, and application in measuring or estimating tree canopy. Swiecki, T.J., Bernhardt, E.A. (2001), *Guidelines for Developing and Evaluating Tree Ordinances* [cited by OP to an internet website; we downloaded but have yet to locate a hard copy of that report]. For example:

“[A]erial photos generally cannot provide detailed data on individual trees. Ground survey techniques are preferred or should be used in conjunction with photointerpretation when detailed condition or species data about individual trees is necessary.

“Photointerpretation is also subject to **classification errors**, i.e., misinterpretation of the image. For example, tree shadows can be erroneously included as tree canopy or shrubs may be mistakenly classified as trees. Classification errors can lead to consistent overestimates or underestimates of canopy cover. Classification errors associated with image characteristics may be minimized by using the following types of images:

- color or false color images that provide clear distinctions between canopy and shadow
- high-resolution images under magnification
- stereoscopic image pairs

A person skilled in photointerpretation is also less likely to make classification errors than a neophyte photointerpreter. Some field checking of photogrammetric results is advisable, especially when training new personnel or when imagery is suboptimal.”

Swiecki & Bernhardt (2001), p. 2 of 6 (in section on “Photogrammetry and remote sensing techniques”) [emphasis in original].

“Digital image analysis techniques [upon which OP relied] have the potential to provide precise estimates of canopy cover, but photointerpretation errors can still result in **bias** due to misclassification.

Swiecki & Bernhardt (2001), p. 6 of 6 [emphasis in original].

Red-Line Methodology of OP Analyst Summarized in Appendix

We append our understanding of what OP's analyst did, using both GIS and non-GIS mapping (based on oral descriptions by others at OP). OP's methods seem rife with opportunity for bias and classification errors which tend to make such data unreliable.

Critically, OP's methodology is biased to underestimate actual canopy for present purposes: OP's 38 canopy estimates (for 38 Squares in the FH/TSP Overlay district) were not prepared for the purpose used in the July 12, 2004, Final Report. Rather, OP says, it set out to “test” conflicting contentions (a) that Forest Hills has a 70 percent tree canopy or (b) that 70% is an artifact of counting “street trees” and not true of trees on private property. Whether OP's methodology works for that purpose or not, it biases the results to understate canopy inside the

lots of each Square because its principal objective is to excise all actual canopy inside a private lot which “street trees” contributed (even though OP’s Alternative Proposal credits that excluded canopy as part of each lot’s canopy).

One cannot today rely on OP’s square-by-square estimates.

More on Use of These Questionable Data

Even if those estimates were accurate, the question would remain how to use them? [See our Memo p. 5.]

For example, we attach a table of OP’s estimates by square rearranged: OP estimates that squares adjacent to Rock Creek Park have a canopy on the average of 68 percent [i.e., 446,627.01 sq. m. of canopy divided by 655,768.18 sq. m. of total land in private lots]. But according to OP, canopy per square ranges from 23.0 percent to 93.8 percent. Somebody at OP (but not necessarily the analyst) believes the “correct” way of averaging is to add up the percentages per square and divide by the number of squares, necessarily giving more weight to small squares. Yet it is just those small squares for which OP’s “red-line” boundary methods may most bias results. [See Appendix.]

Finally, we are separately filing, in full, a thoughtful, seven-page text out of which OP’s July 12 Final Report quotes two sentences [at 5], so that the Zoning Commission may judge context for itself. National Association of Home Builders, *Tree Preservation Ordinances* (1991).

Sincerely,



Karen Lee Perry, Chair, ANC 3F

Attachment: Table: OP’s estimates of canopy for Squares adjoining RCP, etc. [1 page]

Appendix: Red-Line Methodologies of OP Analyst

OP’s methodology combines layers of GIS mapping with non-GIS mapping.

OP started with 2003, GIS aerial photographs by an OCTO contractor.

As a D.C. government agency, OP has access to this and other layers of OCTO data and to software for using the data.

The OCTO contractor photographed Forest Hills in June 2003. (Times of day uncertain.)

The contractor photographs from altitudes of 5,000 feet (“community level”) and 2,000 feet (“neighborhood level”). OP says it used images from 2,000 feet.

OP superimposed a layer of D.C. Squares covering almost all the area and all but a few of the lots it wanted to study. We assume their source is the D.C. Surveyor.

OP superimposed another layer of D.C. Tax and Revenue lot maps which still lack GIS true up. These maps have to be “stretched” to fit the aerial photos and, perhaps, Squares maps.

OP used only those lot boundaries bordering on public streets and alleys, with those boundaries marked in red on the computer.

OP now had aerial photos for each of the Squares it had identified and red-marked lines for each Square intended to show outside boundaries of all private lots. (The red lines took up a small amount of

space and, we believe, blocked part of the OP analyst's vision of the total picture. White-lines laid on top of street rights-of-way may have done something similar.)

OP used contractor software to estimate canopy (numerator in its canopy percentage calculations) but not to estimate total area within all the private lots of a Square (denominator).

OP simply copied Tax & Revenue data for each Square as the assumed total area *within OP's red lines* for each Square (rather than mapping that Square with the software used to map canopy).

OP did not check the mapping-and-measuring software, or its analyst's manipulation of the software, for accuracy by using it to estimate the total area within red lines for at least a few of the Squares and then comparing its results with the Tax & Revenue data for those same Squares.

OP thereby missed an opportunity to check both *accuracy* of its work and *consistency* between its sources for numerator and denominator in its estimates of percentage canopy coverage.

(Nor did OP measure or estimate the area outside the red lines, i.e., the streets and public alleys areas, as a cross check.)

OP's analyst examined photo images of areas within the red lines, identified what seemed to be trees to him, and used a cursor to surround by hand what he believed to be tree cover – excluding cover *inside the red lines* that “street trees” contributed to the private-property areas, as well as whatever portion of private-tree extended beyond the private property red line to the City-owned streets, sidewalks, parking strip areas. In other words, the cursor had to cut off canopy from private-property trees at the red line but exclude entirely any private-property canopy from “street trees.”

When OP's analyst moved the cursor by hand along the red lines, there was more opportunity for error in manipulating the cursor.

On the photos themselves, tree foliage appears to be pale green, or brown, or gray. But when the cursor surrounded an area (“polygon”), the software turned that area bright green (so that the analyst could tell whether he had already run the cursor around it and avoid double-counting) and the software also added up this tree canopy area in square meters (to the nearest hundredth of a square meter).

Swiecki and Bernhardt call this *technique* “heads-up” digitizing.²

OP's analyst did not visit any of the actual areas that had been photographed in order to “ground-truth” either the accuracy of the photos or the accuracy of his interpretation of them.

We do not know what previous training or experience (if any) OP's analyst had in photogrammetric assessment of tree canopy – macro or micro -- by any other method.

We do not know whether he used stereoscopic image pairs.

OP's analyst did not testify at the ZC's July 22 public hearing.

² Swiecki & Bernhardt (2001), p. 5 of 6: “**Digital image analysis methods**

“Any image you can view and store on a computer is referred to as a digital image. The word **digitize** generally refers to the process of converting images to a digital format, but it is also used to describe the conversion of raster-based images to vector-based format. **Raster** images are collections of pixels, which can be thought of as small squares in a very fine grid. Each pixel is associated with the information on color value and intensity for that portion of the grid. Images in **vector** format are in the form of points, lines, and closed figures called **polygons**. Points are described by coordinates and the positions, directions, and shapes of lines are described by geometric and mathematical relationships. Although GIS and CAD software work with both raster and vector data to varying degrees, vector data are used for most mapping applications.

“There are several ways to convert raster data, such as aerial photographs showing tree canopy, to vector data. Manual digitizing involves use of a handheld digitizer and digitizing tablet to trace tree outlines and directly produce tree canopy polygons. Alternatively, digital image can be displayed on a computer screen and tracing of the images is done on-screen using the computer mouse. This is referred to as “heads-up” digitizing. Specialized “interactive tracing” software can be used to facilitate the process further. The CITYgreen extension to ESRI ArcView GIS software uses a shortcut method that represents tree canopy as circles which are superimposed on the image through heads-up digitizing. Finally, some software uses image processing and pattern recognition techniques to automatically convert raster to vector data, especially printed material such as maps and plans. Once information such as tree canopy is represented as vector-based polygons, GIS and CAD programs can use these polygons directly to determine their total area, which can be used to calculate percent canopy cover.”

**OP CANOPY ESTIMATES
by SQUARE**

	A	B	C	D	E	F
1	Square Number	Area of Lots in SQ sq. meters	OP Estimate of Tree Cover sq. meters	OP % Coverage Estimate	How Much of SQ Area Comprises Lots > 9499 sq. ft.? A=all; B=most; C=<1/2; D=none	Comments
2		Squares immediately adjoining Rock Creek Park				
3	2282	121233.48	113674.00	93.8	B	* OP excludes from average; some GOV. Also adjoins Broad Branch.
4	2272	57476.14	25619.80	44.6	C	Also adjoins Broad Branch.
5	2258	102880.65	43880.80	42.7	B	Also adjoins Broad Branch and tributary to Broad Branch.
6	2250	33304.68	15222.00	45.7	B	Also adjoins Broad Branch.
7	2248	99030.00	76632.00	77.4	B	* OP excludes from average. Also adjoins Broad Branch and Soapstone Creek.
8	2245	102404.77	76153.50	74.4	A	* OP excludes from average. Also adjoins Broad Branch and Soapstone Creek.
9	2244	16876.23	10236.00	60.7	A	
10	2231	14534.93	3773.51	26.0	B	* OP excludes from average; one R-5-D lot
11	2232	108027.29	81435.40	75.4	A	* OP excludes from average; one R-5-D lot
12	Subtotal	655768.18	446627.01	68.1		Subtotal sums lines 3-11.
13						
14		"Linnean Playground" square -- unnamed tributary to Broad Branch				
15	2030	42089.84	28516.00	67.8	B	* OP excludes from average; some DC parkland; and tributary to Broad Branch.
16						
17		Largest square -- adjoins Soapstone Valley Park -- unnamed tributary to Soapstone Creek (in R-2 zone)				
18	2049	147359.83	45890.50	31.1	A	* OP excludes from average; estimate may be too low with Van Ness East R-5-D in total area denominator, instead of outside (since it is fully developed). Tributary to Soapstone Creek is in R-2 zone.
19						
20		Square consisting of Soapstone Valley Park -- including Soapstone Creek				
21	2046	102368.66	91890.90	89.8	A	* OP excludes from average; GOV. All in Soapstone Valley Park except for C-3-A lots (which are outside the study area) and comprises most of that Park.
22						
23		Additional squares immediately adjoining national parks				
24	2246	34948.67	23084.90	66.1	B	some GOV. Adjoins Soapstone Valley Park and Soapstone Creek.
25	2247	21186.72	14582.60	68.8	B	Adjoins Soapstone Valley Park and Soapstone Creek.
26	2041	25632.06	10296.70	40.2	B	Adjoins Soapstone Valley Park and Soapstone Creek.
27	2042	16610.02	8284.39	49.9	B	Adjoins Soapstone Valley Park and Soapstone Creek.
28	2043	35380.56	17839.80	50.4	B	Adjoins Soapstone Valley Park and Soapstone Creek.
29	2032	28344.04	13109.30	46.3	C	some GOV. Adjoins Broad Branch and includes its headwaters.
30	Subtotal	162102.08	87197.69	53.8		Subtotal sums lines 24-29 only.
31						
32		Additional squares east of Linnean Avenue				
33	2251	24135.78	6568.22	27.2	C	
34	2270	25740.97	6359.64	24.7	C	
35	2274	14657.89	5466.79	37.3	C	
36	2275	13056.83	3407.71	26.1	C	
37	Subtotal	77591.47	21802.36	28.1		Subtotal sums lines 33-36.
38						
39		Two squares betw. Linnean, Tilden, and Upton ["foot shape"]				
40	2238	31912.56	14367.70	45.0	B	Adjoins NPS holdings; Tilden median strip.
41	2239	24806.87	11393.90	45.9	B	
42	Subtotal	56719.43	25761.60	45.4		Subtotal sums lines 40 and 41.
43						
44	Lines 12+ 15+18+ 30+37+42	1141630.83	655795.16	57.4		N.B. This summation excludes Square 2046 (line 21, above) and sums the rest.
45						
46						
47		All other squares				
48	2031	11390.08	3270.70	28.7	C	
49	2033	38159.57	9094.27	23.8	B	some GOV; one hybrid R-1-A (80%) & R-5-D lot
50	2040	7230.70	1411.23	19.5	C	
51	2254	14359.70	5020.68	35.0	B	
52	2255	48719.04	23967.70	49.2	B	
53	2256	43242.68	15528.70	35.9	B	
54	2262	10115.68	3550.59	35.1	B	
55	2263	44995.96	10550.40	23.4	B	includes Owl's Nest
56	2266	2808.13	71.00	2.5	B	
57	2267	25573.61	7074.38	27.7	B	
58	2268	12045.73	4163.67	34.6	B	
59	2269	4013.08	936.91	23.3	C	
60	2276	11503.20	2006.97	17.4	A	
61	2277	4509.94	284.21	6.3	A	
62	Subtotal	278667.09	86931.41	31.9		
63						
64	38 SQs	1522666.58	834617.47	54.8		[Checks with OP's grand total.]
65	37 SQs	1420297.92	742726.57	53%		[Excludes SQ 2046 (line 21, above; includes all other SQs.)]