Noise Analysis for PW County Data Centers

Briefing to DCOAG & JMT

By John W. Lyver, IV, Ph.D.
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6/5/2024

What is Noise?

- From Merriam-Webster Dictionary:
  - ✓ "loud, confused, and usually inharmonious sound"
  - ✓ "any sound that is undesired or interferes with one's hearing of something"
- The human auditory system does NOT "sleep" at night like other bodily functions. From evolution, humans are most attuned to hear a few frequencies:
  - ✓ ~1,000 Hz: A baby's cry
  - ✓ ~ 600 Hz: Sound from a predator
  - ✓ ~ lower frequencies are felt and cannot be filtered out.

Data Center Noise

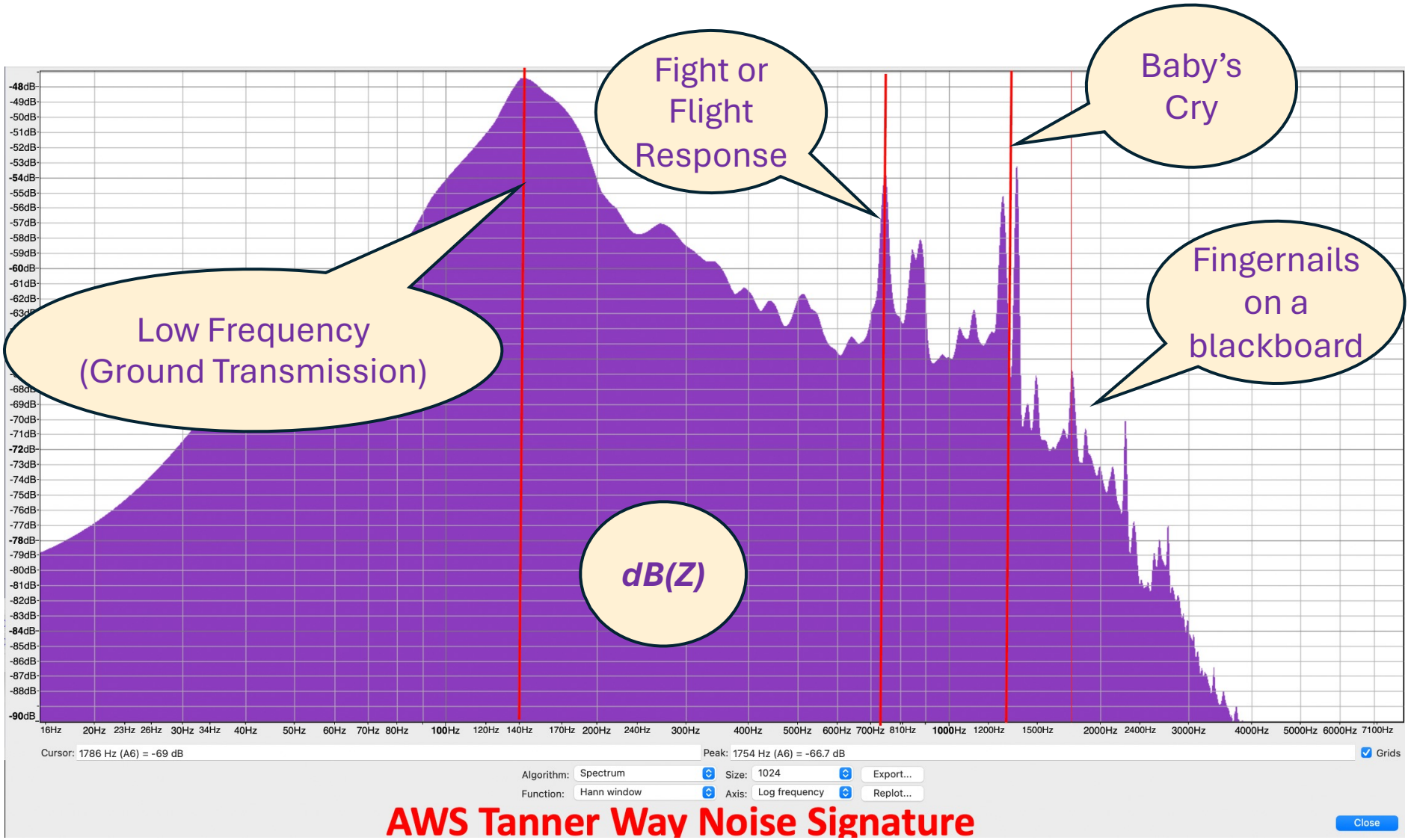
Tanner Way
1,200 Hz
730 Hz
140 Hz

Typical Noise Levels	
45-50 dBA	Quiet Suburb~ & Moderate Rainfall~
50-60 dBA	Modern Built in Dishwasher ~
55 dBA	Coffee percolator ~
59 dBA	2001 Volvo @ idle @ 5′ *
60 dBA	Restaurant with regular conversation ~ Modern garbage disposal @ 5′ * Sewing Machine @ 5′ ~
65-70 dBA	Restaurant which is too loud for conversation ~ Average 1990's Dishwasher ~
72 dBA	I-66 @ 300' * (to median strip)
74 dBA	Dyson Vacuum Cleaner @ 5′ *, Hairdryer @ 1′ ~ Battery powered Leaf Blower @ 5′ * *(Hearing damage begins)*
80 dBA	Food Blender ~, 1990's garbage disposal ~, Typical alarm clock~, coffee grinder ~
81 dBA	Push Gasoline Lawn Mower @ 5′ *
85 dBA	Train whistle @ 500' ~, Passing diesel semi-Truck ~

Noise "Intensity"

Note: *indicates measured noise and ~ indicates internet reference noise
Distance indicated is between generator and measurement

Tanner Way DC Noise
“Profile” or “Signature” or “Fingerprint”



Early 2024

Image courtesy of Dale Browne

Effects of Noise on People?

See the Medical Report in Sharepoint

From various American Heart Association publications

Persistent 24/7 Data Center Noise in the community can cause:

- **Chronic Sleep Deprivation**
- **Anxiety and Depression due to combination of noise and lack of control when residents realize this noise even permeates their homes.**
- **Difficulty with Concentration**
- **Increases stress related conditions such as:**
  - **gastrointestinal problems**
  - **auto-immune diseases**
  - **hypertension and cardiovascular disease**
- **Increased health risk as residents avoid outdoor exercise**

Chronic sleep deprivation affects both your brain and body and can cause:

- **Anxiety, depression, mood swings, suicidal thoughts**
- **Memory and concentration**
- **For children it can decrease growth hormones**
- **Vehicular and Workplace accidents**
- **Impacts insulin release and increases risk of diabetes.**
- **Less interest in exercise due to fatigue**
- **Hypertension, cardiovascular health, and stroke:**
  June 2022: American Heart Association updated the cardiovascular checklist by adding the importance of 7 – 9 hours sleep.

PERSISTENT 24/7 NOISE, AS WELL AS SLEEP DEPRIVATION DUE TO NOISE, CAN IMPACT MENTAL AND PHYSICAL HEALTH AND DRAMATICALLY LOWER QUALITY OF LIFE.

PW County Noise Ordinance (*Chapter 14 – dated Oct. 24, 1989*)

- **Sec. 14-2. - Violations of chapter**

  "Any person violating any provision of this chapter shall be guilty of a Class 2 misdemeanor."

  ✓ Limited by: VA Code § 15.2-980

  "Civil fines will not exceed $250 for the first offense and $500 for each subsequent offense."

- **Sec. *14*-4. - Maximum permissible sound levels**

  "Except as otherwise provided, any noise which emanates from any operation, activity or source, and which exceeds the maximum permissible sound levels established in this *section* below, is hereby prohibited. Such levels shall be measured at the property boundary of the sound source or at any point within any other property affected by the noise."

MAXIMUM PERMISSIBLE SOUND PRESSURE LEVELS

Zoning District Classification	Maximum dBA Daytime	Maximum dBA Nighttime
Residential	60	55

Noise Regulations and Enforcement

- Currently, PWC does not require Developer/Operator to perform **ANY** noise analyses
- No VA Code in Zoning or Building sections limit noise (other than aircraft noise)
- VA Code § 15.2-980. Civil penalties for violations of noise ordinances:

  *Any locality may, by ordinance, adopt a uniform schedule of civil penalties for violations of that locality's noise ordinance. This provision shall not apply to noise generated in connection with the business being performed on industrial property. Civil fines will not exceed **$250** for the first offense and **$500** for each subsequent offense. ...*

- Current PWC Noise Ordinance #14
  - ✓ Adopted in 1989 before industrial areas came near to residential areas (pre DCs)
  - ✓ Assumes **SINGLE** noise source without ambient noises – NOT holistic
  - ✓ **Only** requires compliance at property boundary
  - ✓ **Only** enforcement is after citizen complaint of excessive noise to PWC Police
    - PWC Police have **very limited** capability to investigate
- PWC does NOT have capability to:
  - ✓ Separate noises from multiple or dispersed sources
  - ✓ Measure dB(Z) noise levels
  - ✓ Know what nominal noise levels are from data centers (aka: noise fingerprint)
  - ✓ Perform continuous monitoring
  - ✓ Track noise complaints/investigations County-wide

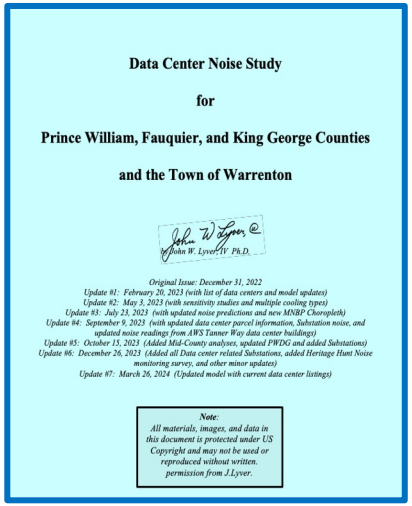
Noise Analysis/Predictions

Noise is not just a nuisance, it is a health risk

- **Points to consider:**
  - ✓ Noise is **additive**
  - ✓ Noise from Data Centers can be detected up to 3 miles away
  - ✓ Noise analyses MUST be **holistic** to include all noise sources, health effects, and economic impacts to be effective
  - ✓ PWC does not have the capability to do holistic noise analyses
  - ✓ **Onus should be on operators to control noise, not PWC/citizens**

- **Any noise monitoring/limitation/Ordinance should consider:**
  - ✓ The overall amount of noise energy/intensity at any 'occupied' location
  - ✓ The health effects of noise due to individual components in the noise
  - ✓ Enforcement/Control of noise limits

J.Lyver's Reports



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for

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and the Town of Warrenton

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Note:
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Prince William County

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March 26, 2024

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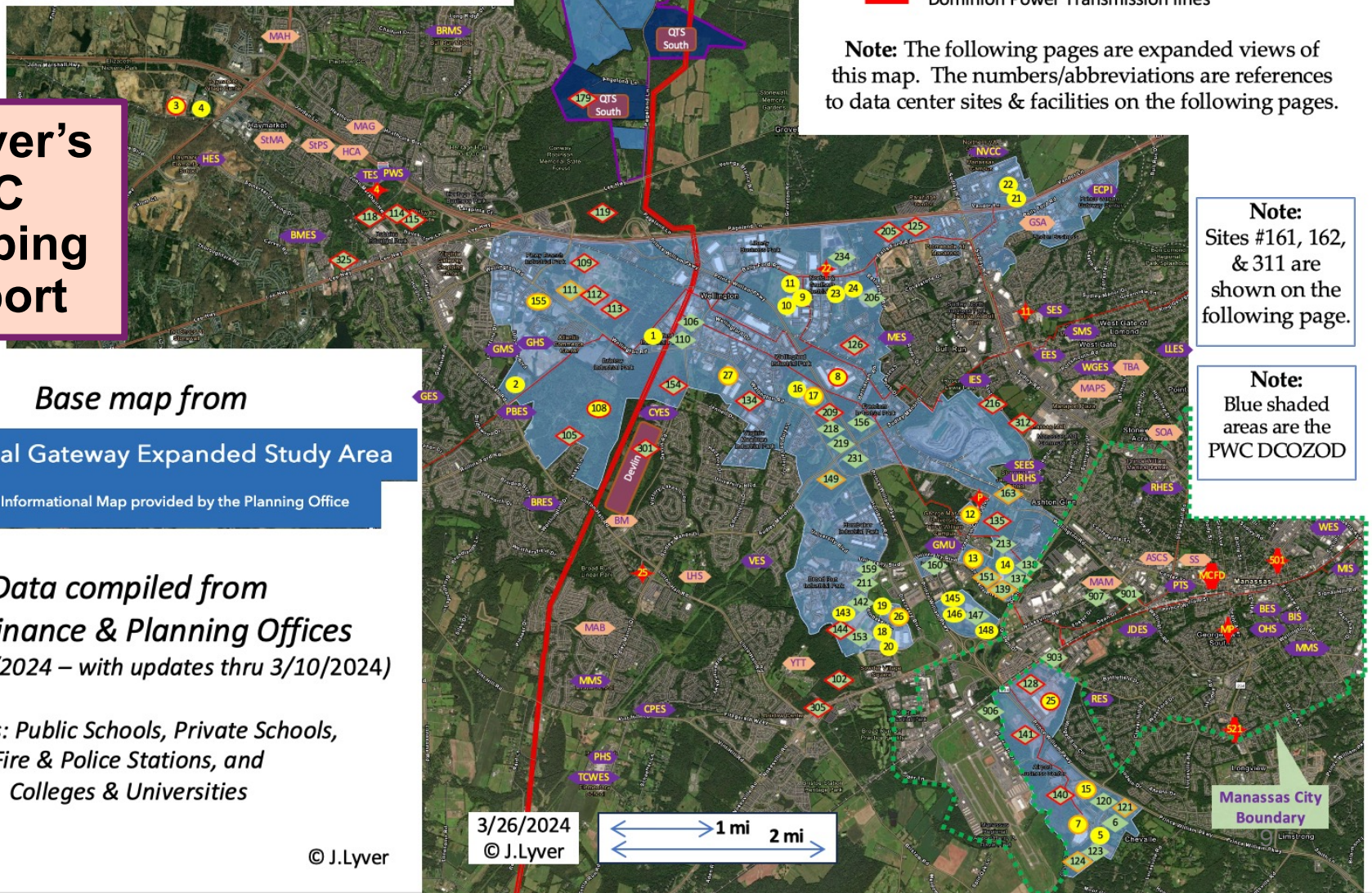
J.Lyver's DC Mapping Report

Prince William County & Manassas City

Operating DC:	**32** sites / **45** bldgs
Potential DC (est):	**over 150** more bldgs
Potential DC:	up to **55** planned new DC sites
Public K-12 schools < 1 mile from DC:	**13 & 8 more**
Private K-12 schools < 1 mile from DC:	**6 & 2 more**
Police/Fire < 1 mile from DC:	**3 & 3 more**

(Oper & Planed)



Note: The following pages are expanded views of this map. The numbers/abbreviations are references to data center sites & facilities on the following pages.

Note: Sites #161, 162, & 311 are shown on the following page.

Note: Blue shaded areas are the PWC DCOZOD

Base map from

PW Digital Gateway Expanded Study Area

An Interactive Informational Map provided by the Planning Office

Data compiled from
PWC Finance & Planning Offices
(dated 1/24/2024 – with updates thru 3/10/2024)

Includes: Public Schools, Private Schools, Fire & Police Stations, and Colleges & Universities

Data Centers and Substations in Prince William County

"O" Operational; "U" Under Construction; "A" Approved; "P" Applied for; "X" Unknown

Data Center Sq Ft -	85,803,833	211 Bldgs
Acreage Occupied by Data Centers -	5,857	
Acerage Occupied by DC Substations -	241	

http://pwc.publicaccessnow.com/AddressSearch.aspx (includes some parcels *outside* the overlay district #)

Total Estimated Power (MW) - 26,170

Data Centers and Substations - Inside Prince William County

Reference	<-- Status	GPIN	ST #	STREET NAME	CITY	ZIP	ACRES	SQ FT	# Bldg	USE CODE	OWNER	In/Out DCOZOD	DC or SS	Substations Supporting which DCs	Estimated Power in MW
1	O	7496-79-1270	8000	GAINSFORD CT	BRISTOW	20136	8.23	20,534	1	191	SES AMERICOM INC	in	DC		6
2	O	7496-07-8757	8217	LINTON HALL RD	BRISTOW	20136	31.91	227,465	1	191	PORPOISE VENTURES LLC (Digital Realty Trust)	in	DC		69
3.12	O	7298-41-4524	15435	JOHN MARSHALL HWY #	HAYMARKET	20169	38.50	311,795	3	191	AMAZON DATA SERVICES INC	out	DC		95
3.3	U	7298-41-4524	15435	JOHN MARSHALL HWY #	HAYMARKET	20169	38.50	141,379	1	191	AMAZON DATA SERVICES INC (second building under construction)	out	DC		43
4	O	7298-51-5907	15395	JOHN MARSHALL HWY #	HAYMARKET	20169	28.27	236,082	1	191	DC 11 DE LLC (Amazon)	out	DC		72
5	O	7694-95-7303	10900	AIRMAN AVE	MANASSAS	20112	9.78	139,000	1	191	MANUCHEHR VENTURES LLC, ATTN: GENERAL COUNSEL				
6	U	7694-96-2732	10849	AIRMAN AVE	MANASSAS	20110	16.56	250,144	1	191	UNICORN INTERESTS LLC,				
7	O	7694-85-3066	10880	AIRMAN AVE	MANASSAS	20112	27.60	394,593	1	191	ABTEEN VENTURES LLC, PROP INTEREST B1A (Cloud				
8	O	7596-58-8732	8170 (8180)	BETHLEHEM RD	MANASSAS	20109	62.13	719,742	4	191	COPT DC 19 LLC				
9	O	7597-42-1456	11800	BREWERS SPRING RD	MANASSAS	20109	7.85	123,534	1	191	AMAZON DATA SERVICE				
10	O	7597-42-2107	11801	BREWERS SPRING RD	MANASSAS	20109	10.05	115,600	1	191	AMAZON DATA SERVICES II PROPERTY TAX				
11	O	7597-42-1395	7600	DOANE DR	MANASSAS	20109	7.93	127,700	1	191	AMAZON DATA SERVICE				
12	O	7696-21-7764	9000 (9040)	FREEDOM CENTER BLVD	MANASSAS	20110	18.75	409,252	2	191	MANASSAS NCP LL				
13	O	7695-39-0644	9301	FREEDOM CENTER BLVD	MANASSAS	20110	22.72	305,510	1	191	QTS MANASSAS DC-5				
14	O	7695-48-1668	9400	GODWIN DR	MANASSAS	20110	12.4	127,000	1	191	QTS INVESTMENTS PROPERTIES LLC				
15	O	7694-87-3694	10100	HARRY J PARRISH BLVD	MANASSAS	20110	23.22	347,876	1	191	BOURZOU VENTURES LLC (C				
16	O	7596-47-5780	11680	HAYDEN RD	MANASSAS	20109	12	165,230	1	191	KH DATA CAPITAL BUILDIN C/O IRON MOUNTAIN GLOBAL				
17	O	7596-57-0222 (multiple GPINs)	11650	HAYDEN RD	MANASSAS	20109	53.20	325,918	1	191	KH DATA CAPITAL DEVELOPME C/O IRON MOUNTAIN GLOBAL				
18	O	7595-85-3339	9720	HORNBAKER RD	MANASSAS	20109	12.44	224,652	1	191	SI NVA02 LLC				
19	O	7595-96-0662	9651	HORNBAKER RD	MANASSAS	20109	19.50	247,608	1	191	POWERLOFT @ INNOVATI				
20	O	7595-85-6929	9750	HORNBAKER RD	MANASSAS	20109	12.57	241,249	1	191	SI NVA02 LLC				
21	O	7697-47-7005	7400	INFANTRY RIDGE RD	MANASSAS	20109	7.31	109,800	1	191	EQUINIX LLC				
22	O	7697-47-3772	7777	INFANTRY RIDGE RD	MANASSAS	20109	20.33	227,465	1	191	MCI COMMUNICATION SER VERIZON GLOBAL REAL E				
23	O	7597-62-3841	7510 (7610)	MASON KING CT	MANASSAS	20109	9.51	150,000	2	191	GI TC 7510 MASON KING CT LL				
24	O	7597-72-1867	7505	MASON KING CT	MANASSAS	20109	7.66	109,543	1	191	MANASSAS TECHNOLOGY PAR (Amazon)				
25	O	7695-62-8723	10201	TANNER WAY	MANASSAS	20110	82.58	795,191	4	191	AMAZON DATA SERVICI				
26	O	7595-95-6147	11120	THOMASSON BARN RD	MANASSAS	20109	21.14	352,030	2	191	COPT DC INNOVATION LLC ("Inn Building")				
27		7596-17-3979	7056	WELLINGTON RD	MANASSAS	20109	23.50	311,198	2	191	DC 12 14 DE LLC (Ama				

J.Lyver's DC Mapping Report

Count of DCs in Western Prince William County Region

CURRENTLY OPERATING DC - Inside Prince William County

Zip Code	Town	IN DCOZOD # Sites	Sq ft	# Bldg	Est MW	Outside DCOZOD # Sites	Sq ft	# Bldg	Est MW	Totals per Zip Code # Sites	Sq ft	#Bldg	Est MW
20109	Manassas	16	3,832,269	23	1,169	0	-	0	-	16	3,832,269	23	1,169
20110	Manassas	8	2,637,973	12	805	0	-	0	-	8	2,637,973	12	805
20112	Manassas	2	533,593	2	163	0	-	0	-	2	533,593	2	163
20136	Bristow	3	537,759	3	164	0	-	0	-	3	537,759	3	164
20143	Catharpin	0	-	0	-	0	-	0	-	0	-	0	-
20155	Gainesville	0	-	0	-	1	482,223	1	147	1	482,223	1	147
20156	Gainesville	0	-	0	-	0	-	0	-	0	-	0	-
20169	Haymarket	0	-	0	-	2	547,877	4	167	2	547,877	4	167
20181	Nokesville	0	-	0	-	0	-	0	-	0	-	0	-
22026	Dumfries	0	-	0	-	0	-	0	-	0	-	0	-
xx	other	0	-	0	-	0	-	0	-	0	-	0	-
	Total:	29	7,541,594	40	2,300	3	1,030,100	5	314	32	8,571,694	45	2,614
	Grand Totals (in & out)	32	8,571,694	45	2,614						Total Acres 962		

Note: 3rd Haymarket DC in Under Development Counts

PROPERTIES UNDER DEVELOPMENT - Inside Prince William County - INSIDE DCOZOD ONLY

Zip Code	Town	IN DCOZOD # Sites	Sq ft	#Bldg	Est MW	IN DCOZOD # Sites	Sq ft	#Bldg	Est MW	IN DCOZOD # Sites	Sq ft	#Bldg	Est MW	TOTALS IN DCOZOD # Sites	Sq ft	#Bldg	Est MW
		STATUS: UNDER CONSTRUCTION				STATUS: APPROVED				STATUS: APPLIED FOR				STATUS: ALL			
20109	Manassas	3	2,146,711	5	655	6	5,487,891	13	1,674	11	5,696,628	16	1,737	20	13,331,230	34	4,066
20110	Manassas	5	3,114,128	9	950	6	1,558,823	6	475	4	2,307,159	8	704	15	6,980,110	23	2,129
20112	Manassas	0	-	0	-	1	369,600	1	113	1	1,947,132	6	594	2	2,316,732	7	707
20136	Bristow	3	600,000	2	183	1	3,530,000	7	1,077	4	10,050,157	19	3,065	8	14,180,157	28	4,325
20143	Catharpin	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
20155	Gainesville	1	2,200,000	4	671	0	-	0	-	0	-	0	-	1	2,200,000	4	671
20156	Gainesville	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
20169	Haymarket	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
20181	Nokesville	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
22026	Dumfries	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
xx	other	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
	Total:	12	8,060,839	20	2,459	14	10,946,314	27	3,339	20	20,001,076	49	6,100	46	39,008,229	96	11,898
															Total Acres 2,488		

PROPERTIES UNDER DEVELOPMENT - Inside Prince William County - OUTSIDE DCOZOD ONLY

Zip Code	Town	OUTSIDE DCOZOD # Sites	Sq ft	#Bldg	Est MW	OUTSIDE DCOZOD # Sites	Sq ft	#Bldg	Est MW	OUTSIDE DCOZOD # Sites	Sq ft	#Bldg	Est MW	TOTALS OUTSIDE DCOZOD # Sites	Sq ft	#Bldg	Est MW
		STATUS: UNDER CONSTRUCTION				STATUS: APPROVED				STATUS: APPLIED FOR				STATUS: ALL			
20109	Manassas	0	-	0	-	0	-	0	-	1	1,062,000	3	324	1	1,062,000	3	324
20110	Manassas	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
20112	Manassas	0	-	0	-	0	-	0	-	2	1,513,200	4	462	2	1,513,200	4	462
20136	Bristow	0	-	0	-	0	-	0	-	3	4,519,282	9	1,378	3	4,519,282	9	1,378
20143	Catharpin	0	-	0	-	1	6,984,715	12	2,130	0	-	0	-	1	6,984,715	12	2,130
20155	Gainesville	3	6,445,823	14	1,966	2	15,275,403	23	4,659	1	1,787,266	3	545	6	23,508,492	40	7,170
20156	Gainesville	0	-	0	-	0	-	0	-	1	494,842	1	151	1	494,842	1	151
20169	Haymarket	1	141,379	1	43	0	-	0	-	0	-	0	-	1	141,379	1	43
20181	Nokesville	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
22026	Dumfries	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
xx	other	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
	Total:	4	6,587,202	15	2,009	3	22,260,118	35	6,789	8	9,376,590	20	2,860	15	38,223,910	70	11,658
															Total Acres 2,360		

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J.Lyver's DC Noise Study Report

Table of Contents

Modeling Noise

- Noise is:
  - ✓ An energy wave – can be modeled as energy spreading **AND**
  - ✓ A pressure wave – can be modeled as a wave spreading
- Noise energy is modeled as:
  - ✓ Pressure Wave: psi or energy in the wave
  - ✓ Energy Wave: Watts per Square Unit on the wave front
  - ✓ All modeling is done in base units, then reported in logarithmic units
- Noise energy intensity is reported as: Decibels – **dB**
  - **A-weighting [dB(A)]** – The A-weighted scale provides readings that conform to a notional human hearing response. (ANSI S1.4) 'A' Weighted is the most commonly used and is weighted to the human ear sensitivity from 20Hz to 20 kHz.
  - **Z-Weighting [dB(Z)]**– (*frequency-weighting*). Z-weighted scale is the flat frequency response of 8 Hz to 20,000 Hz . Reported in octaves or 1/3 octaves. Most common octave center frequencies: 52.5 Hz, 125 Hz, 250 Hz, 500 Hz, 1,000 Hz, 2,000 Hz, 4,000 Hz and 8,000 Hz.
    (Piano Middle "C" is 523Hz)

Computing Noise Methodology

Noise Emitted [*dB(A)*]

Noise Heard [*dB(A)*]

Convert to intensity [*watts/area*]

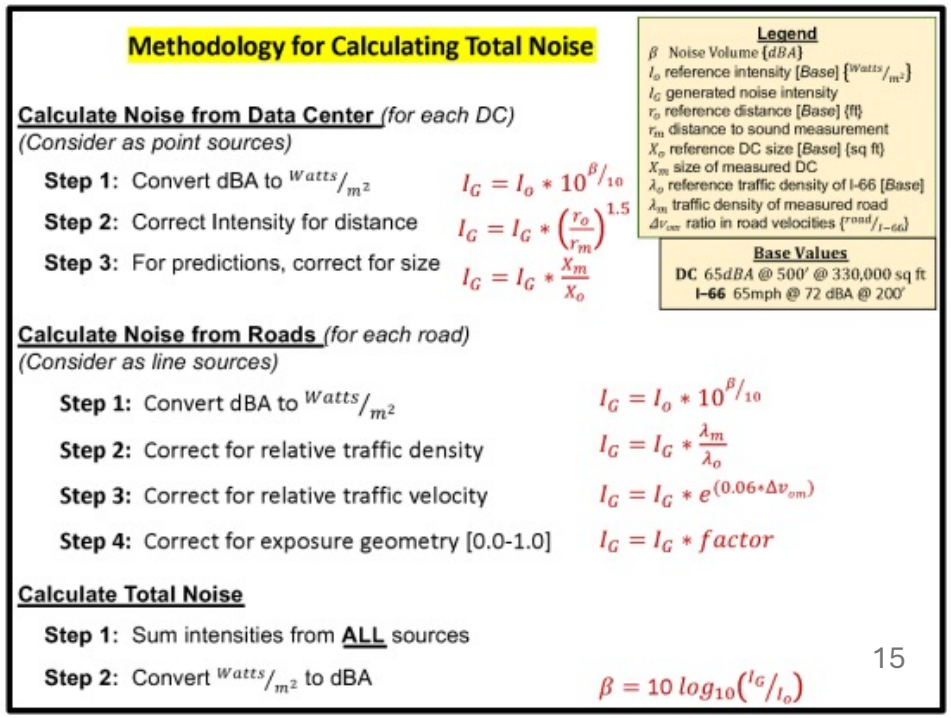
Attenuation [*distance ratio*]

Calculate intensity [*watts/area*]

J.Lyver's DC Noise Modeling

- Code authored/developed in MATLAB © and MS Excel © by J.Lyver.
- Report Chapter 1 details the basic Physics used to do the modeling.
  - ✓ Appendix III details the sensitivity studies performed to enhance the modeling
- Modeling based on a "Nominal Data Center"
  - ✓ 330,000 sq ft of floor space measured at 500' away from building
  - ✓ Building assumed to be circular with estimated floors/bldgs
  - ✓ Currently 5 noise levels/profiles used based on measurements
  - ✓ 189 DC Bldgs/sites individually modeled (100 DC sites & 217 bldgs)
- Substations modeled based on small or large size
- Modeling of 203 locations (neighborhoods, schools, police, and fire stations)

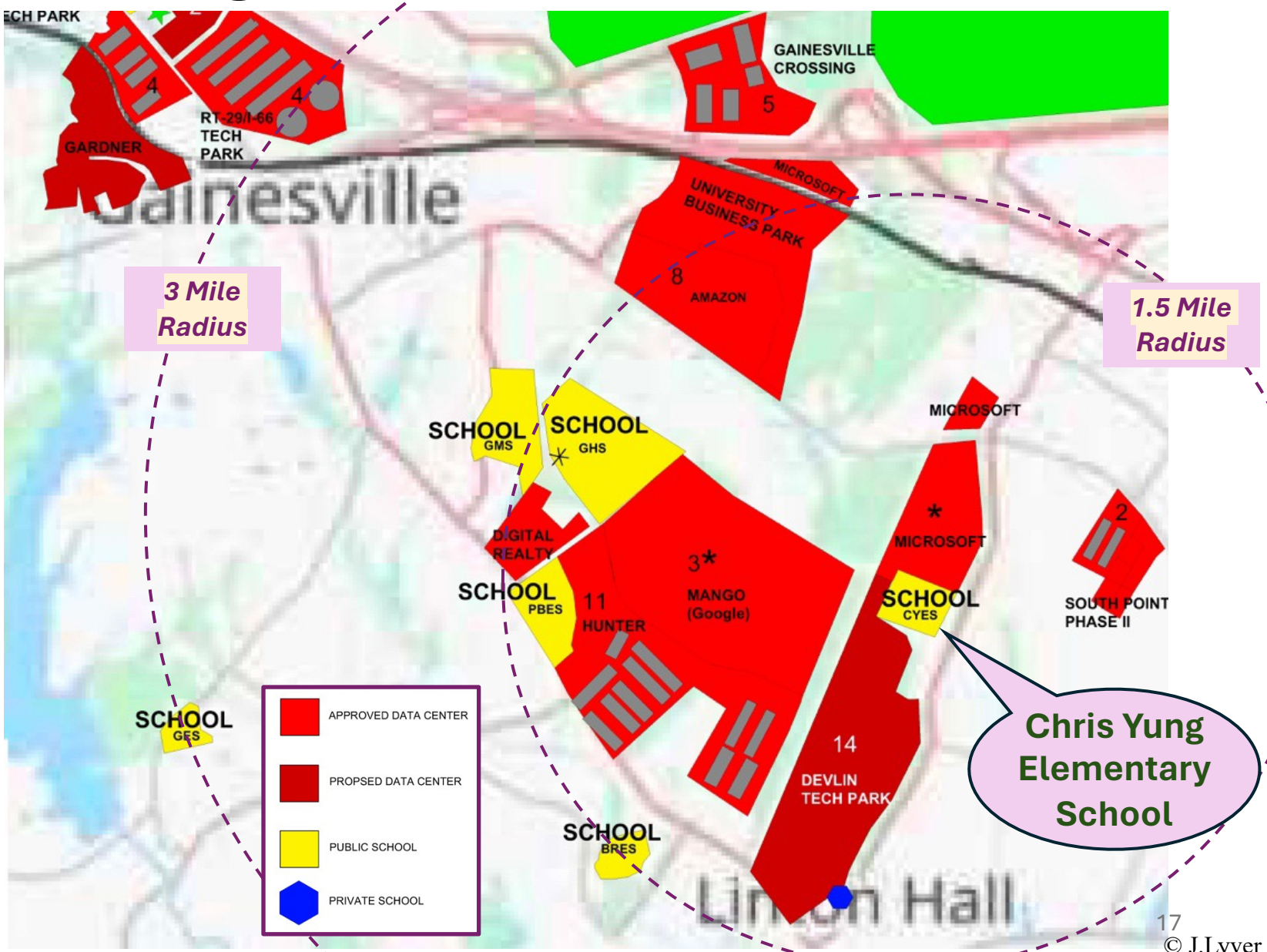
Note: Model's code is Copyright protected.



J.Lyver's DC Noise Study Analysis

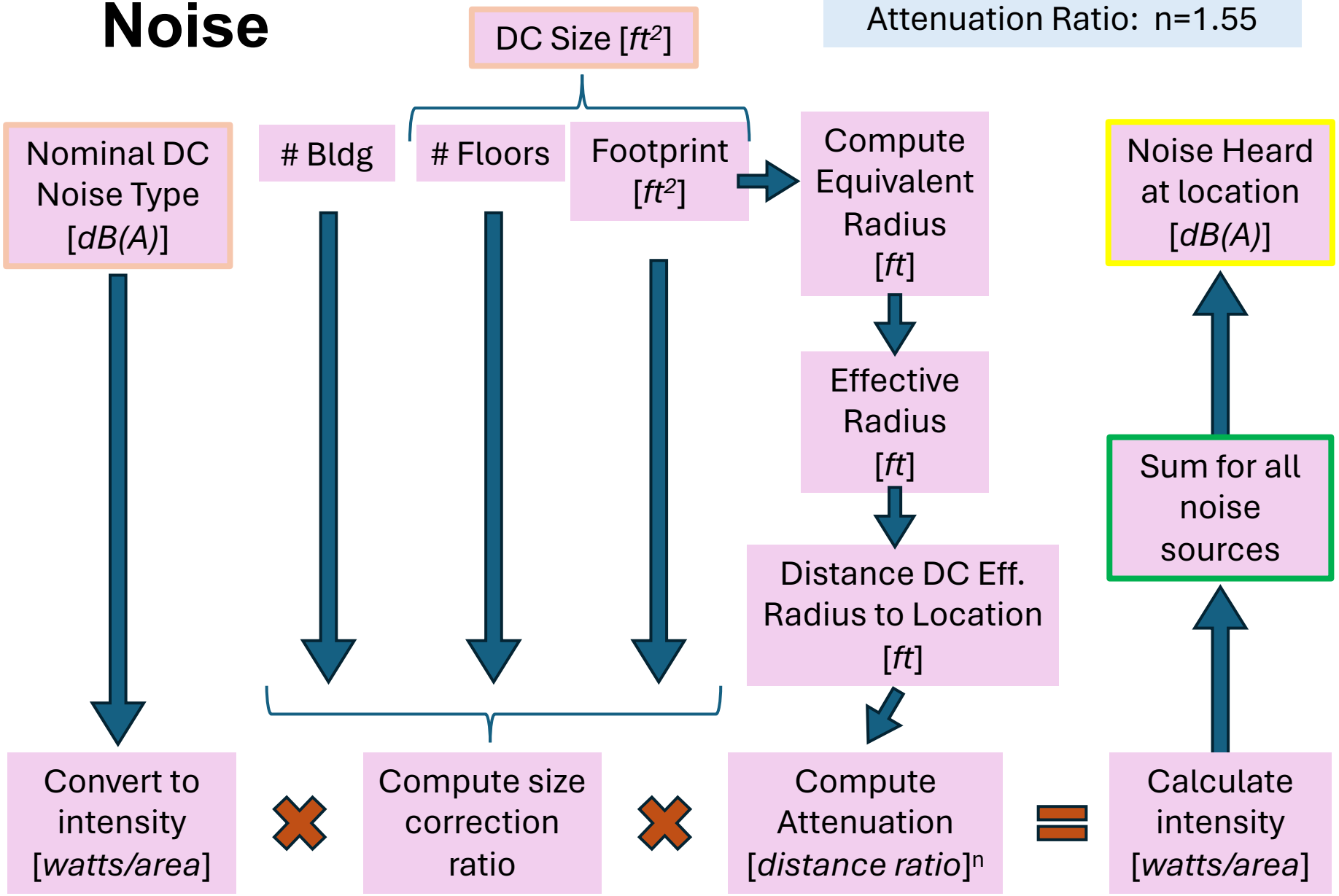
- Developed from scratch in MATLAB © and MS Excel © by J.Lyver.
- **Ambient Noise:**
  - ✓ **Projected Road Noise:**
    - Traffic Volumes: https://www.virginiadot.org/info/2021_traffic_data_by_jurisdiction.asp
    - Modeling developed from various internet sources and validated from readings taken along I-66.
    - Noise attenuation for roads modeled from above.
  - ✓ **Measured neighborhood Ambient Noise**
    - Detailed studies of 2 neighborhoods combined
    - Model Assumes: -1σ from average measurements (or actual readings)
  - **Warrenton Ambient Noise predictions verified through professionally done background readings [+/- <1 dB(A)]**
- **Projected Data Center noise:**
  - ✓ Normalized data applied as the average from 4 data center sites initially: *(AWS Tanner Way, QTS University Drive, facility south of Manassas Airport, and randomly selected data center along Loudoun County Parkway near US-50)*
  - ✓ Over time, added more data centers and substations. Currently model:
    - Air cooled data centers
    - Condenser / ADHU cooled data centers
    - Special modeling to reflect updated Tanner Way data centers
  - ✓ PWC predictions validated at Tanner Way through measurements **[+/- 1.5 dB(A)]**

Computing Noise



Computing Noise

Nominal DC Type:
x dB(A) for 330,000 ft² @ 500'
Attenuation Ratio: n=1.55



Computing Holistic Noise

Noise Emitted [*dB(A)*]

Noise Heard [*dB(A)*]

Convert to intensity [*watts/area*]

Attenuation [*distance ratio*]

Calculate NET intensity [*watts/area*]

Noise Emitter #2

Noise Emitter #3

and so on

Noise Emitter #n

J.Lyver's DC Noise Study Report - Outputs

Summarized Data

Table 14: MNBP Area Predicted Noise Intensities

Location		Current Noise dB(A)	Noise with all PWDG DCs dB(A)	Noise Energy Multiplier *	Closest Data Center (feet)
Conway-Robinson State Park	Entrance Loop	62.7	71.0	6.6	1,140
Stonewall Memorial Garden	North End Circle	58.4	66.2	6.0	> 1 mile
MNBP – HQ	Building	61.4	69.9	7.0	2,560
MNBP – Brawner Farm	Parking Center	57.8	67.8	10	2,640
MNBP – Matthew Hill Parking	Center	59.5	63.5	2.5	> 1 mile
MNBP – NY Monument	Monument	60.0	66.2	4.1	5,570
MNBP – Stone House	Building	60.3	63.2	2.0	> 1 mile
MNBP – Visitor Center	Front Parking	57.4	62.0	2.9	4,960
MNBP – Unfinished Railroad	Cross Featherbed	56.5	65.3	7.6	5,550
MNBP – Unfinished Railroad	Corner of Park	57.4	66.4	7.9	4,060
Sudley Road & Poplar Hill Rd	Intersection	59.3	64.8	3.5	> 1 mile
Sudley Road & Little Bull Run	Bridge	59.1	63.8	2.7	> 1 mile
Gen Trimble	SW Corner	55.4	67.5	16	2,640
Robin & Bluebird Lane	Intersection	54.1	65.1	12	2,890
Bobwhite Dr	Cul-de-Sac	54.1	69.3	35	1,250
Lolan St	North End	60.1	69.5	8.8	1,750
AVERAGE & CLOSEST for MNBP		**59.5**	**67.0**	**5.7**	**1,140**
AVERAGE & CLOSEST for area east of Pageland		**57.3**	**67.7**	**10.8**	**1,250**

*Note: See Table 6 Note (1) for explanation of * for the 'Noise Energy Multiplier' column.*

Small Area Maps

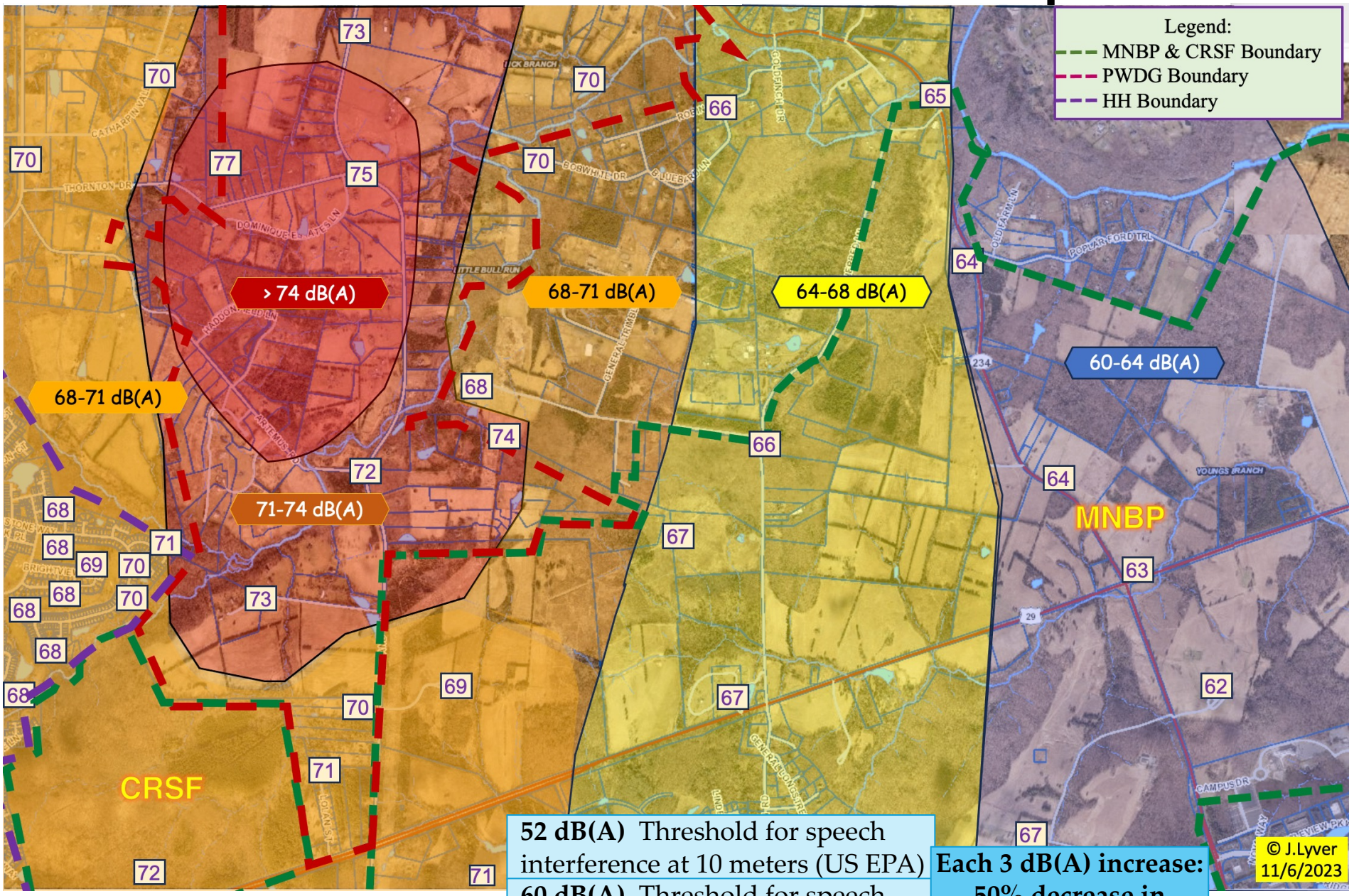
Figure 9: Great Oak HOA Predicted Noise Intensities

Raw Data

```
******      Neighborhood: MNBP                                  ******
      Location      (Ref #)     Bkrnd   0-1 mi   1-2 mi   2-3 mi    Total  NET   Multiplier
Conway Robinson SF - Entr        62.7     61.0     44.6     48.4     61.4
   N.Center         (#1501)                 68.2     63.4     60.4     69.9   71.2      7.0
                                counts:    1/22     3/33    12/32
                          Closest DC (feet):  Operating: 1150      Planned: 1956
MNBP - Brawner Farm              57.8      0.0     51.5     48.8     53.4
   House            (#1509)                59.4     65.2     60.0     67.1   67.8     10.0
                                counts:    0/7      5/40    15/33
                          Closest DC (feet):  Operating: 5854      Planned: 2638
MNBP - Brawner Farm              58.5      0.0     51.9     48.6     53.6
   Exhibit Bldg     (#1504)                62.0     65.1     60.0     67.6   68.3      9.6
                                counts:    0/9      4/38    14/34
                          Closest DC (feet):  Operating: 5310      Planned: 1708
MNBP - HQ                        61.4     55.2     47.8     49.3     56.8
   Building         (#1503)                66.1     63.8     62.4     69.1   70.0      7.2
                                counts:    1/17     7/27    10/56
                          Closest DC (feet):  Operating: 2735      Planned: 2526
MNBP - Matthew Hill Parking      59.5      0.0     29.1     43.5     43.7
   Center           (#1507)                0.0      54.8     60.7     61.7   63.8      2.7
                                counts:    0/0      2/9      6/35
                          Closest DC (feet):  Operating: 9691      Planned: 9682
MNBP - NY Monument               60.0      0.0     48.2     50.8     52.7
   Monument         (#1512)                0.0      60.3     62.6     64.6   66.1      4.1
                                counts:    0/0      8/21    10/58
                          Closest DC (feet):  Operating: 6276      Planned: 5538
MNBP - Poplar Hill Rd            59.3      0.0      0.0     38.2     38.2
   at VA-234        (#1508)                0.0      56.7     59.8     61.5   63.6      2.7
                                counts:    0/0      0/13     5/24
                          Closest DC (feet):  Operating: 12347     Planned: 8029
MNBP - Stone House               60.3      0.0     34.5     48.1     48.3
   Building         (#1506)                0.0      53.7     58.4     59.7   63.2      1.9
                                counts:    0/0      3/4     11/23
                          Closest DC (feet):  Operating: 6067      Planned: 6684
MNBP - Unfinished Railroad       57.4      0.0     47.5     48.4     51.0
   Trail Intsc E of QTS-S-LB D(#1510)                 54.6     63.6     60.7     65.7   66.5      8.1
                                counts:    0/4      2/30    16/37
                          Closest DC (feet):  Operating: 9969      Planned: 4063
MNBP - Unfinished Railroad       56.5      0.0      0.0     47.6     47.6
   RR intcs w/ Featherbed Rd(#1511)                   0.0      62.8     60.3     64.7   65.4      7.7
                                counts:    0/0      0/28     9/34
                          Closest DC (feet):  Operating: 11873     Planned: 5552
MNBP - Visitor Center            57.4     39.4     41.6     48.0     49.3
   Building         (#1505)                55.5     43.2     57.2     59.6   61.9      2.8
                                counts:    2/3      4/1      8/22
                          Closest DC (feet):  Operating: 3656      Planned: 4896
Stonewall Cemtry - Entr Circle   58.4      0.0     50.0     48.3     52.2
   North End        (#1502)                0.0      62.9     61.4     65.2   66.2      6.0
                                counts:    0/0      7/31    11/46
                          Closest DC (feet):  Operating: 7488      Planned: 5897

    ******  MNBP Average Noise:   *******
            Bkgrnd: 59.5  Operating DC: 54.0  Planned DC: 65.9  NET Noise: 67.0  Mult:  5.7
            Closest DC (feet):  Operating: 1150      Planned: 1708
```

Predicted Noise Levels in MNBP - Choropleth



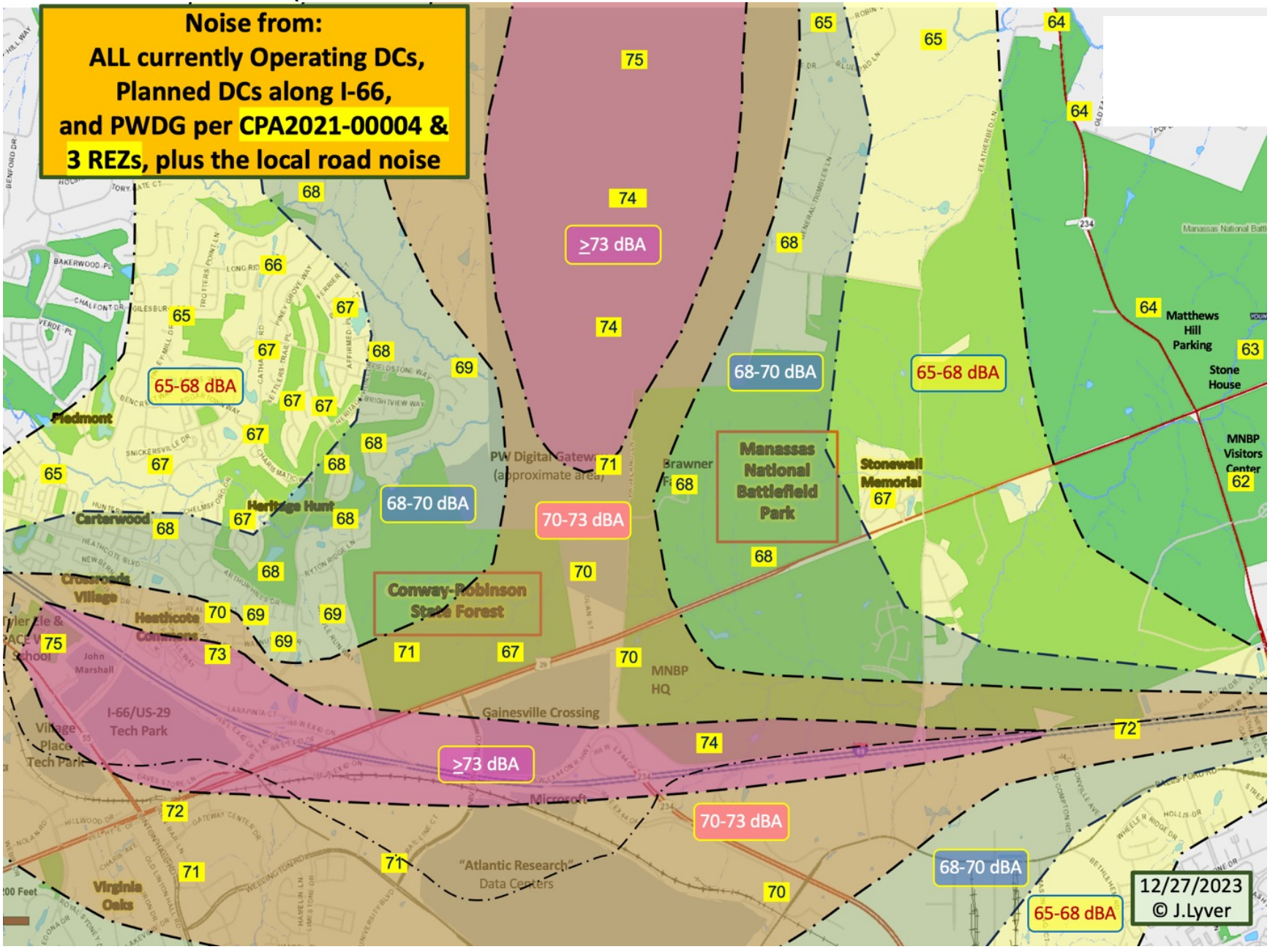
52 dB(A) Threshold for speech interference at 10 meters (US EPA)

60 dB(A) Threshold for speech interference at 1 meter (US EPA)

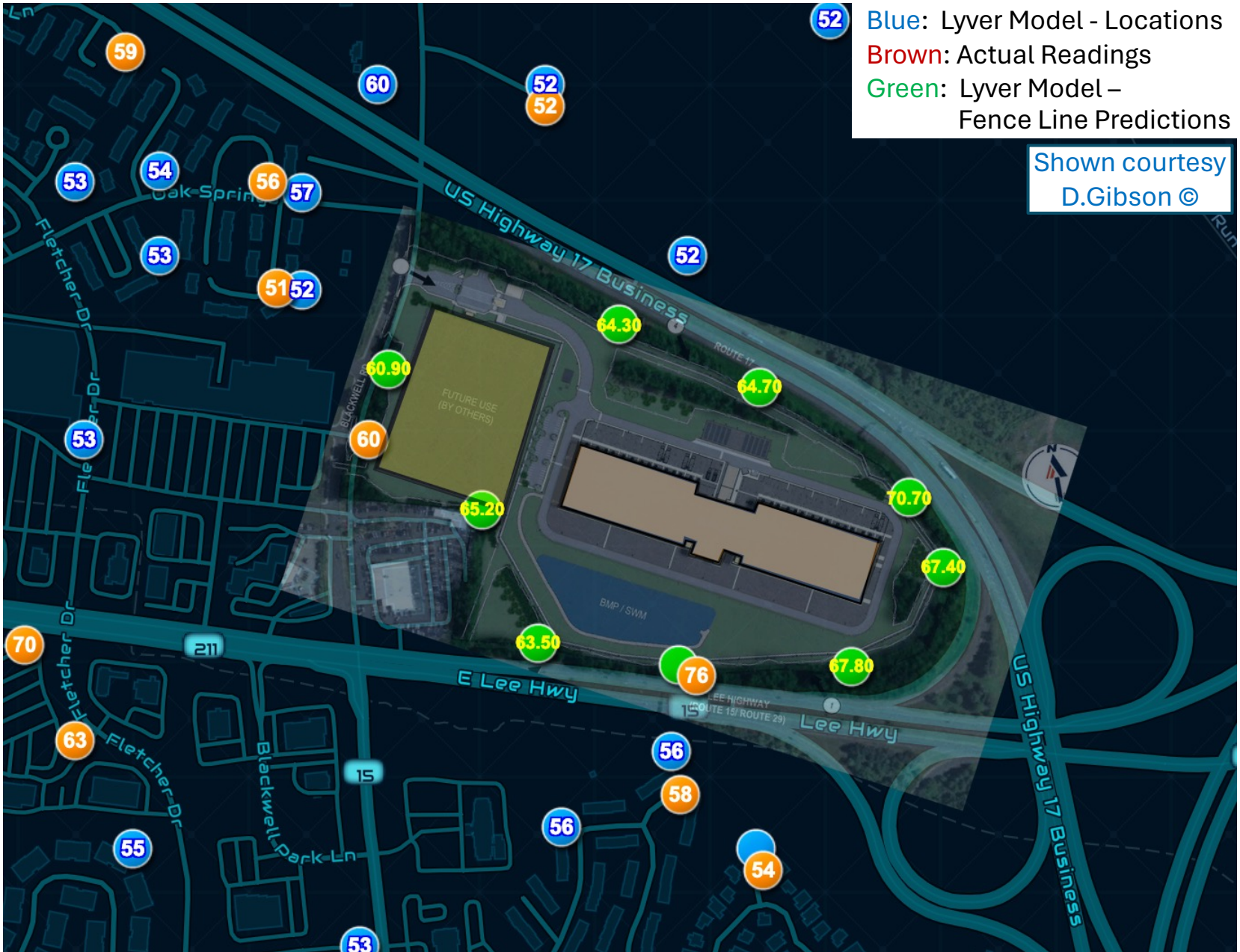
Each 3 dB(A) increase: 50% decrease in listening ability

Choropleth of Noise prediction for Future DCs in Gainesville Area

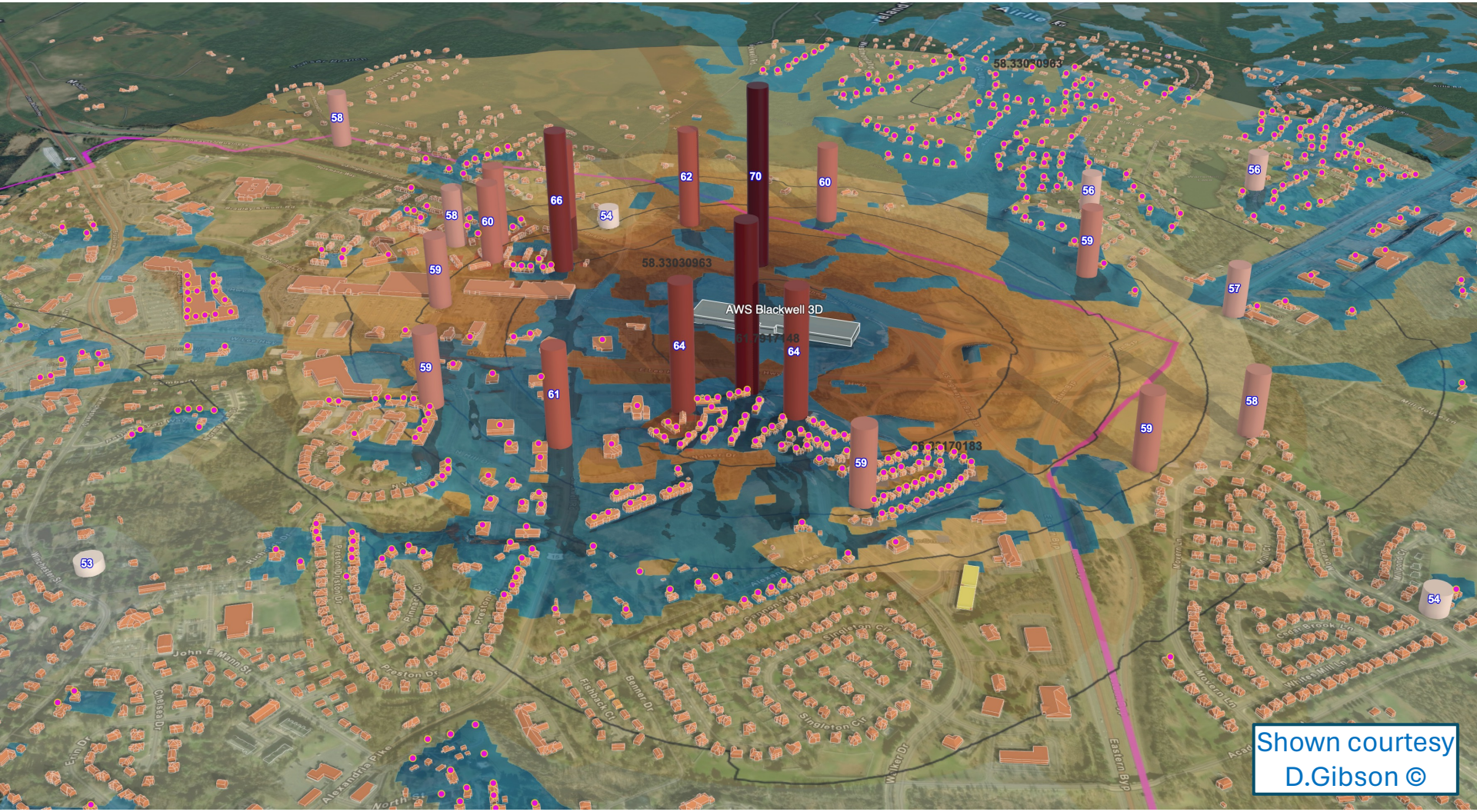
(*Interpretation and graphic done in MS PowerPoint)*



EXAMPLE: *ArcGIS™ display of* Warrenton DC Site showing noise intensity levels and 'Fence Line' Predictions above Ambient Noise



EXAMPLE: Noise Prediction display using ArcGIS™ for "Operational" Warrenton DC



Display shows location of DC, noise level predictions, interpolation of noise predictions, residences and schools

Understanding Data Center Noise Impacts on Schools

- Increases in ambient noise at schools will have several effects:
  - ✓ Learning decreases in classrooms (ANSI/ASA S12.60-2010) when noise increases above **35 dB(A)** *(PWC Schools does not currently use ANSI/ASA S12.60-2010)*
  - ✓ Unknown as to effects of irritating frequencies on learning [**dB(Z)**]
  - ✓ Outside Physical Education will suffer as noise increases
  - ✓ School children never escape the noise:
    - They wake up with the noise, travel to school in the noise, learn in the noise, play in the noise, go home in the noise and try to sleep in the noise
    - Adults go to work outside the noise areas
  - ✓ Understanding of nervous system effects on growing children is limited
  - ✓ Noise increases stress in children and adults

- PWC Public Schools do **NOT** have active mitigation programs for continuous noise. Currently there are:
  - ✓ Elementary Schools **7** <1 mile from a DC and will be **12** <1 mile in 2030
  - ✓ Middle Schools **1** <1 mile from a DC and will be **2** <1 mile in 2030
  - ✓ High Schools **2** <1 mile from a DC and will be **4** <1 mile in 2030
  - ✓ Non-Traditional Sch **1** <2 miles from a DC and will be **2** <1 mile in 2030
  - ✓ PWC PS HQs Will be < 1 mile from DCs in 2030

J.Lyver's DC Noise Study Report – Schools/Police/Fire

Table 40: Higher Education - Noise from Currently Operating DCs

School Name	Closest DC (feet)	Current dB(A)	# DCs <1 mile	# DCs <2 mile	Map Abbrev
NoVa Community College – Manassas Campus	1,810	51.2	2	5	NVCC
ECPI University	4,020	46.2	2	2	ECPI
George Mason University – SciTech Campus	770	65.5	8	19	GMU

Table 41: Higher Education – Additional Noise from Planned DCs

School Name	Closest DC (feet)	Planned dB(A) being Added	# DCs <1 mile	# DCs <2 miles	Map Abbrev
NoVa Community College – Manassas Campus	4,390	59.3	3	4	NVCC
ECPI University	< 2 miles	55.4	*	3	ECPI
George Mason University – SciTech Campus	710	68.8	22	55	GMU

Table 42: Higher Education – Total Noise from Operating and Planned DCs

School Name	Map Abbrev	Total DC Noise Intensity dB(A)	Multiplier
NoVa Community College - Manassas Campus	NVCC	60.2	20
ECPI University	ECPI	56.5	8.8
George Mason University - SciTech Campus	GMU	70.5	225

Table 43: Higher Education – Summary of Distances to Operating and Planned DC Buildings Less than 1 mile from the School

Facility	Inside or Outside the DCOZOD?	Nearby Data Center Sites
ECPI University	**INSIDE**	3/4 to 1 mile from 2 operating DC bldgs
NoVa Community College - Manassas Campus	Outside	1/2 mile from 2 operating DC bldgs 3/4 to 1 mile from 3 planned DC bldgs
George Mason University – SciTech Campus	Outside – Borders DCOZOD	< 1/4 mile from 3 operating and 2 planned DC bldg 1/4 to 1/3 mile from 3 planned DC bldg 1/3 to 1/2 mile from 1 operating and 2 planned DC bldgs 1/2 to 2/3 miles from 7 planned DC bldg 2/3 to 3/4 miles from 1 operating DC bldg 3/4 to 1 mile from 3 operating and 8 planned DC bldgs

Figure 23: School - Data Center Proximity - Gainesville Area

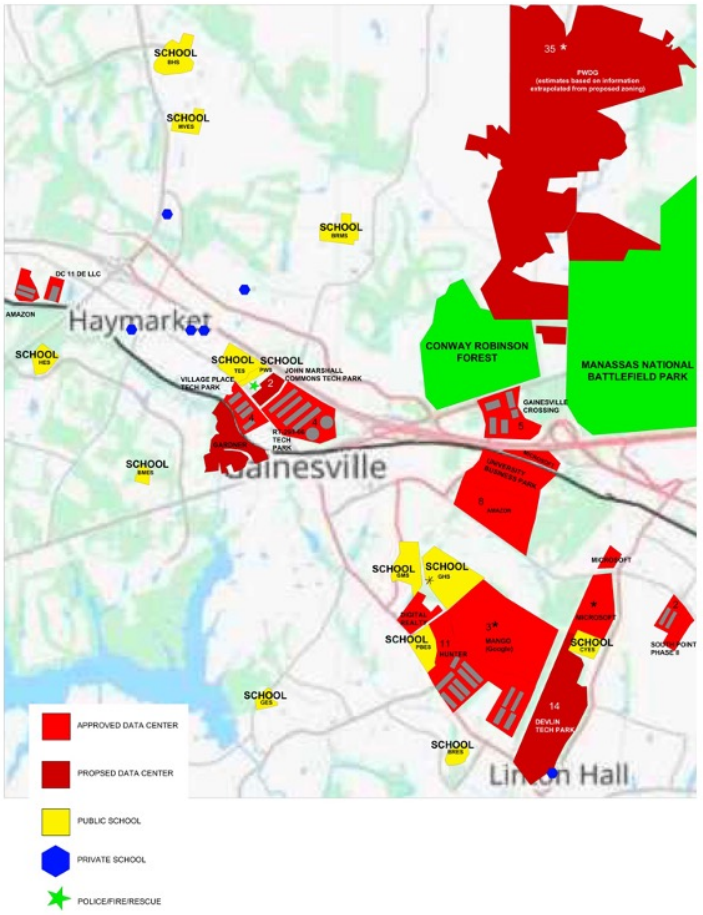


Image provided courtesy of Elspeth McCormick

Table 2: Predicted: Selected Public Schools with Excessive Noise

Grade Level	School	dB(A) after build-out of all DCs[1]
Elementary School	Bristow Run ES	68.4 dB(A)
	Chris Yung ES	72.0 dB(A)
	George P. Mullen ES	68.7 dB(A)
	Piney Branch ES	69.8 dB(A)
	Tyler ES	70.6 dB(A)
	George C. Round ES (Manassas City PS)	66.3 dB(A)
Middle School	Gainesville MS	68.2 dB(A)
High School	Gainesville HS	69.6 dB(A)
Non-Traditional	PACE West	81.2 dB(A)

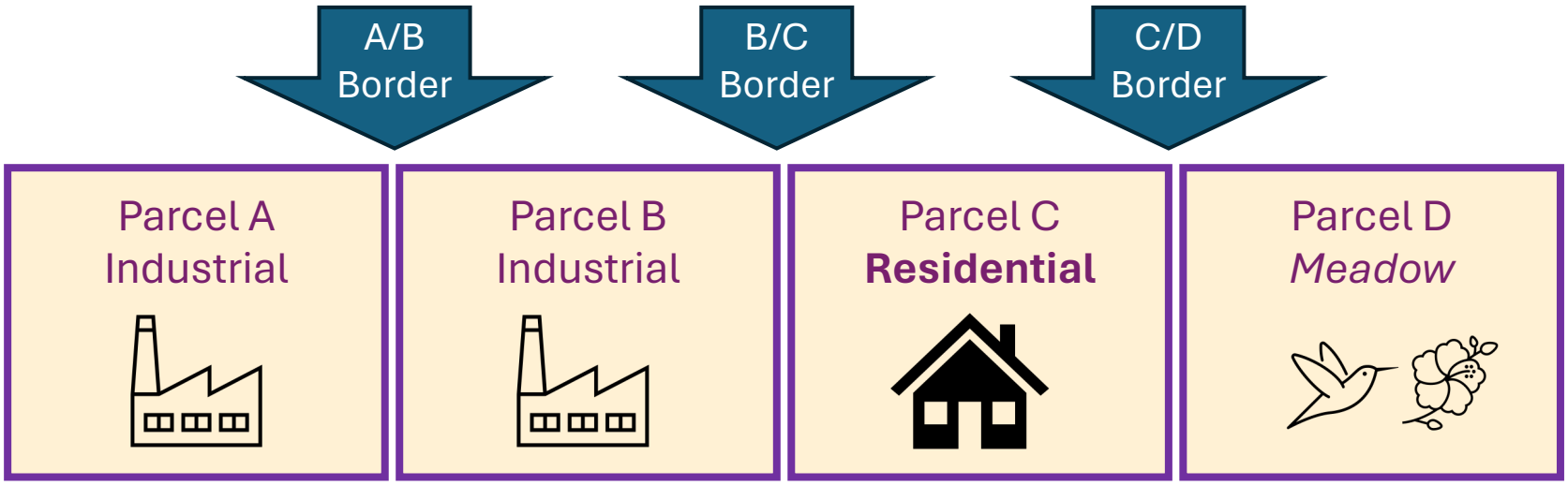
Summary of Base Reports

- Both reports are updated as:
  - ✓ DC status/approval/operational changes
  - ✓ Data is taken/verified for nominal DCs
  - ✓ Additional prediction locations are identified
- Special runs can be done with models upon request
- Special mapping can be done upon request

- PWC has NOT published noise/DC data - public information limited.
  - ✓ PWC needs to educate public on effects of noise and health effects
  - ✓ PWC needs to develop a means to make raw and processed DC location and modeling data to the public.
  - ✓ GIS systems like “PWC County Mapper” have the capability to make data available and to do interpretive displays.
  - ✓ I have made all of my reports available to whoever asks for them via personal Google Docs at:

QR Code to Reports

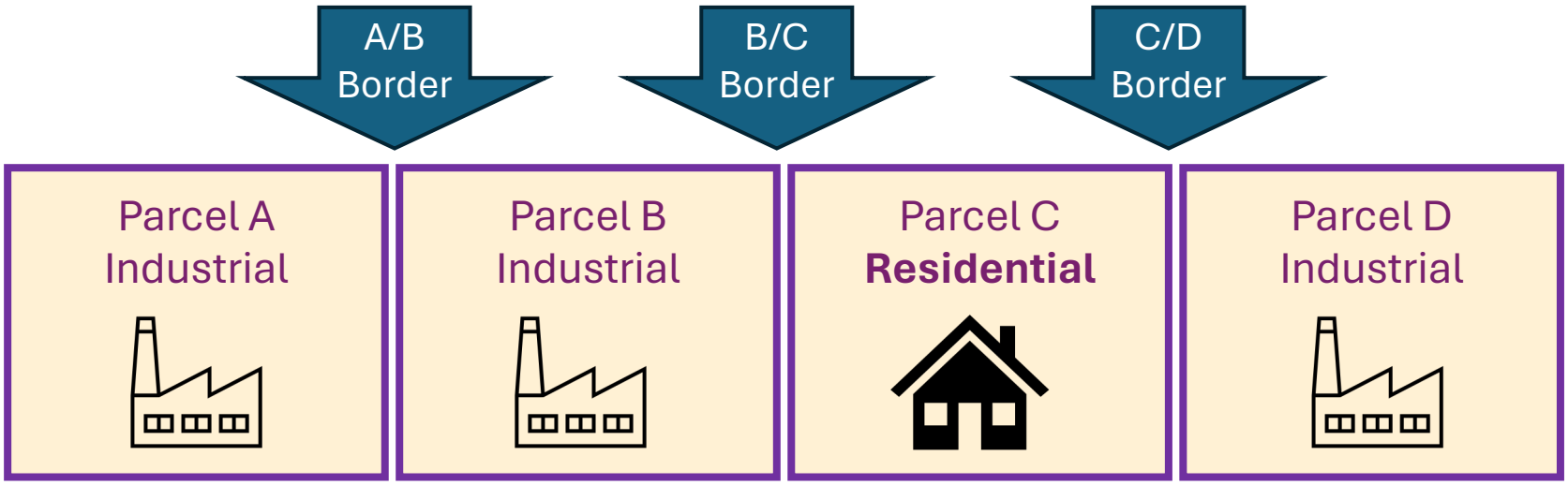
Scenario to consider #1 (Daytime):



Limit: 60 dB(A)

Middle "A"	A/B Border	Middle "B"	B/C Border	Middle "C"	C/D Border	Middle "D"
72 dB(A)	71 dB(A)	70 dB(A) *(due to A)*	68 dB(A)	65 dB(A)	50 dB(A)	40 dB(A)
		No new noise from "B"	**VIOLATION** who at fault	**VIOLATION**		

Scenario to consider #2 (Daytime):



Limit: 60 dB(A)

Middle "A"	A/B Border	Middle "B"	B/C Border	Middle "C"	C/D Border	Middle "D"
59 dB(A)	62 dB(A)	59 dB(A)	58 dB(A)	61 dB(A)	58 dB(A)	59 dB(A)
				VIOLATION who at fault		

Note: *58 dB(A) + 58 dB(A) = 61 dB(A)*

Summary of Actions needed for 'Noise Rules'

- An Updated PWC Noise Ordinance is **NOT** just a pen/ink update!
  - ✓ It may be a "Set" of document changes
    - ❖ Ordinance, Zoning, Application Review
    - ❖ May require changes to Commonwealth Laws/Ordinances
  - ✓ The Noise Ordinance must take into account:
    - ❖ Total Noise Intensity Energy levels where health can be affected **[dB(A)]**
    - ❖ Noise in individual 1/3 octaves that are especially irritating to humans **[dB(Z)]**
    - ❖ "Special" noise intensities to be controlled (Schools, Police/Fire, Medical)
    - ❖ That noise measurements can be taken anywhere on any parcel
    - ❖ Enforcement methods, investigation processes, prosecution processes, as well as levels of administrative, civil, & criminal actions
- PWC will need to improve:
  - ✓ Monitoring capabilities (Individual and continuous)
  - ✓ Health-Physics expertise
  - ✓ Complaint processing, investigation and record keeping
  - ✓ Public information
  - ✓ PWC Public School protection of our school children
- Noise Modeling and facility noise signatures WILL be needed for enforcement to separate and identify noise sources

THANK YOU!

Any Questions?

For further questions:

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