Slide 1

How many people were at the inauguration?

Prof. Dr. G. Keith Still FIMA FICPEM SFIIRSM MEWI FIPM
Capt. Marcel Altenburg MA PGCert

February 2017

Manchester Metropolitan University

Slide 2

Prof. Dr. G. Keith Still FIMA FICPEM SFIIRSM MEWI FIPM

PhD interdisciplinary mathematics/psychology
25 years consulting experience (small, medium, large events)

UK Cabinet Office Emergency Planning College (EPC)
15 years of teaching the principles of crowd safety for major events
International consultant
UK, USA, Australia, Netherlands, Singapore, Hong Kong, Saudi Arabia

Expert witness (USA and Europe)
Washington (Senate House Committee testimony), New York State (personal injury), Overcrowding (licensing), Duisburg/Germany (mass fatalities), London Underground, Lava and Ignite (fatalities), JLS Birmingham, Hillsborough Inquiry (mass fatalities), Concert London (personal injury), Chicago Arena (personal Injury)

City wide event planning experience
Makkah/Hajj (Saudi Arabia), Liverpool (LIMF and Matthews Street), Austin SXSW (USA), Lincoln Christmas Market, 2011 UK Royal Wedding, Brighton Pride, Manchester City Victory Parades, Leicester Caribbean Carnival, Notting Hill Carnival, Kendal Torchlight Carnival, Commonwealth Games (UK)

Slide 3

Capt. Marcel Altenburg MA PGCert

Captain and Unit Commander in the German Federal Armed Forces
12 years leading and training ground combat troops

Leading role in control rooms in the worlds biggest marathons
Berlin (since 2012), New York City, Chicago

MA in Human Science
Hamburg University and Helmut-Schmidt-University, Germany (2008-2012)

MSc Student in Crowd Safety and Risk Analysis
Manchester Metropolitan University (since 2015)

Enterprise Delivery Fellow at MMU
4 days before Donald Trump started his job

Slide 4

Crowd dynamics and crowd behaviour

Focus on anticipating problems, preparing safety plans and preventing accidents and incidents
Crowd dynamics anticipate, prepare, prevent

Introduction to Crowd Safety and Risk Analysis (short course)
Bridging course from industry to academia

MSc (Level 7)
Crowd Safety and Risk Analysis

Short courses (on-line)
Identity validation, Introduction to crowd safety, Writing a crowd management plan, crowd risk analysis, behavioural based safety, CCTV operators, site and event modelling

Introduction to Crowd Science
G. Keith Still
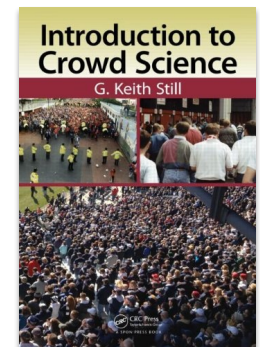
Crowded - definitions

Packed, congested, crushed, cramped, overcrowded, full, filled to capacity, full to bursting, overfull, overflowing, teeming, swarming, thronged, populous, overpopulated, over-peopled, busy, mobbed, stuffed, jam-packed, chock-a-block, chock-full, bursting at the seams, bulging at the seams, full to the gunwales, wall-to-wall, like Piccadilly Circus, chocker.

Different people use different words to describe crowded spaces
- Highly subjective and emotive. For example, crushed could mean imminent death is likely

Described as a "packed" High Street

Described as a "filled" High Street

Parade Area Civic Center Park during Show (29.595m²/318.560ft²)

Denver Broncos Super Bowl Victory Parade 2016

13
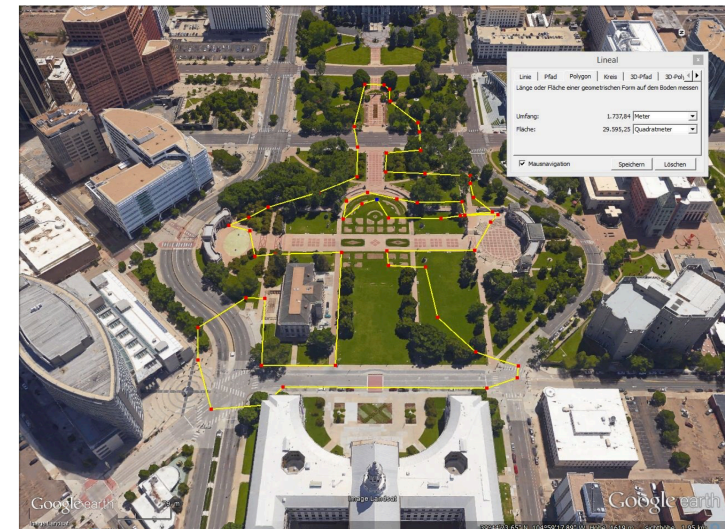
Impressions – Parade

Photo credit: The Denver Post/Joe Amon http://photos.denverpost.com/2016/02/09/broncos-super-bowl-50-victory-parade-and-rally-photos/#165

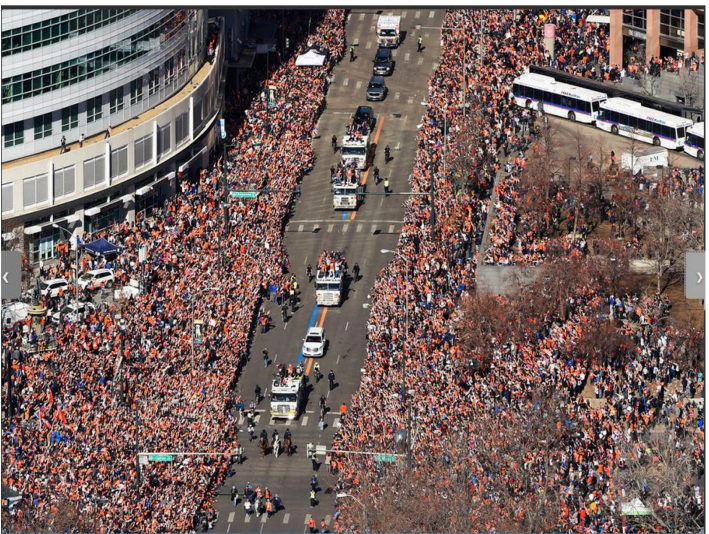Denver Broncos Super Bowl Victory Parade 2016

17

Impressions – Parade

Photo credit: The Denver Post/Kathryn Scott Osler http://photos.denverpost.com/2016/02/09/broncos-super-bowl-50-victory-parade-and-rally-photos/#142

Denver Broncos Super Bowl Victory Parade 2016

19

Impressions – Parade

Photo credit: The Denver Post/RJ Sangosti http://photos.denverpost.com/2016/02/09/broncos-super-bowl-50-victory-parade-and-rally-photos/#3

Denver Broncos Super Bowl Victory Parade 2016

21

Impressions – Civic Center Park

Photo credit: The Denver Post/RJ Sangosti http://photos.denverpost.com/2016/02/09/broncos-super-bowl-50-victory-parade-and-rally-photos/#85

Denver Broncos Super Bowl Victory Parade 2016

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Crowd density

Estimate the crowd density in the following images

(number of people per square metre)

Image 1

Image 2

Image 3

Image 4

Image 5

Image 6

Image 7

Density experiment (1m²)

1 person per square metre

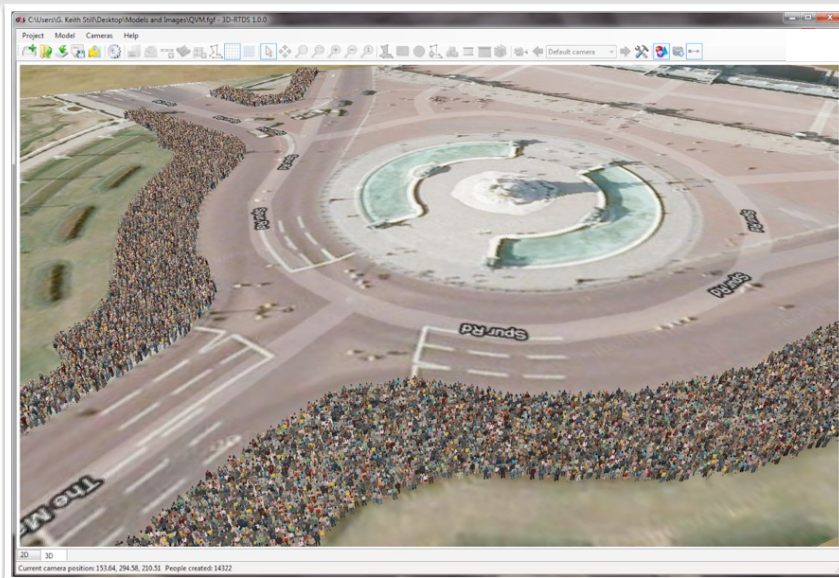# 2 people per square metre

3 people per square metre

4 people per square metre

5 people per square metre

Royal Wedding - capacity and density

2.5 people per square metre
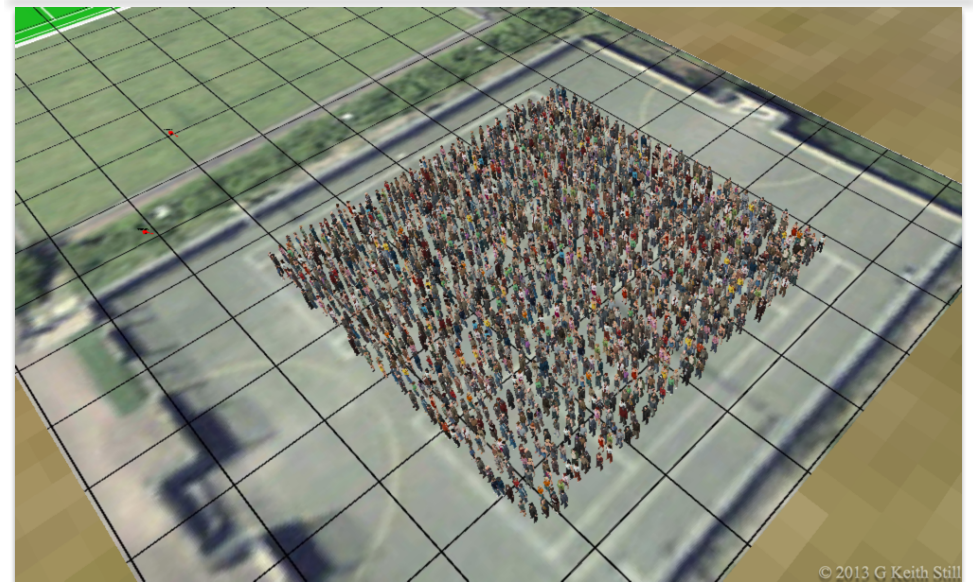
2.5 people per square metre

2.5 people per square metre

2.5 people per square metre

2.5 people per square metre

2.5 people per square metre

Male body shapes

Female body shapes

Hourglass   Inverted Triangle   Rectangle   Triangle   Diamond   Oval

Buggies, children, backpacks, esky's

Moving crowds

A moving crowd needs more space than a standing crowd

How much more?

2 people per square metre - unimpeded

3 people per square metre - unimpeded

4 people per square metre - impeded

5 people per square metre

5 marching in step

6 people per square metre

Crowd density versus crowd flow rate
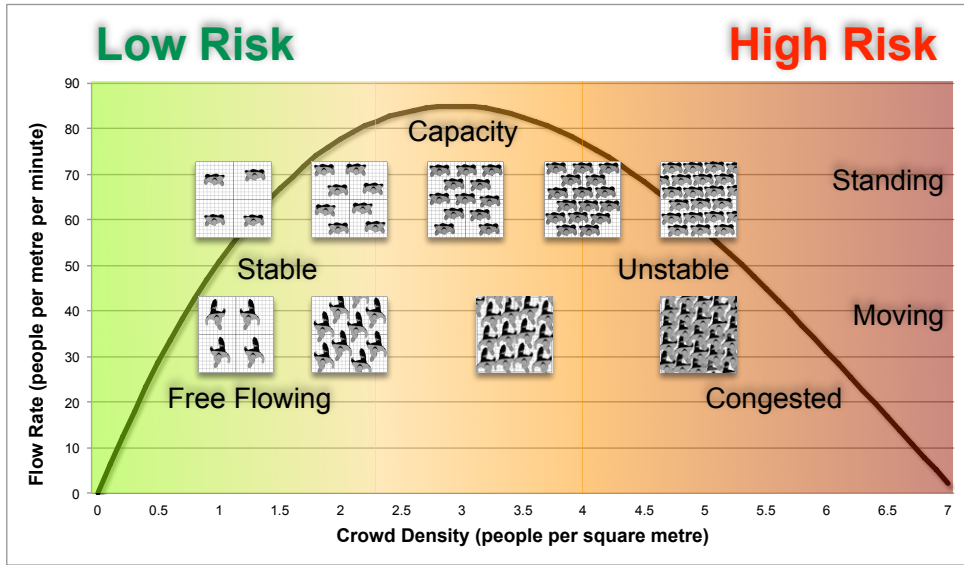
Glastonbury 175,000 people (3,626,000 m^2)

Woodstock 400,000 people (2,400,000 m^2)
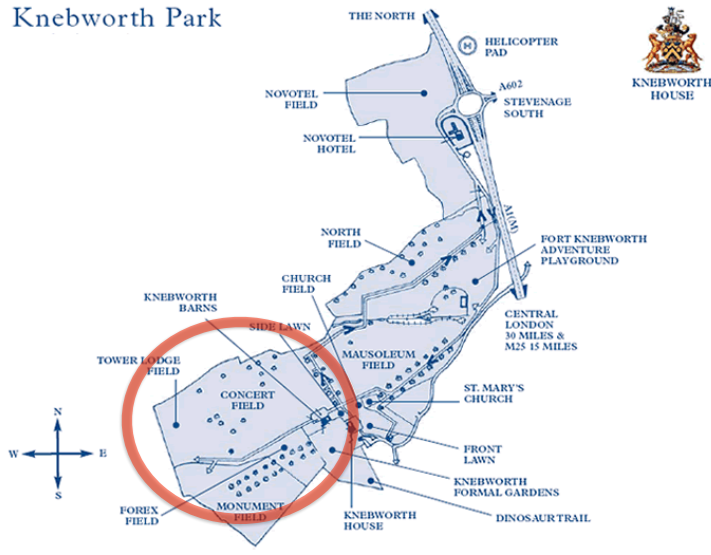
View of 400,000 people - Woodstock (1969)

Concert field 35 acres (141,640 m^2)

Robbie Williams, 125,000 people (141,640 m^2)

Concert 5 - 6 pm^2

Large Screens 2.5 pm^2

Using models for decision support

Modelling work for the Sydney Olympics
Site analysis, crowd management plan
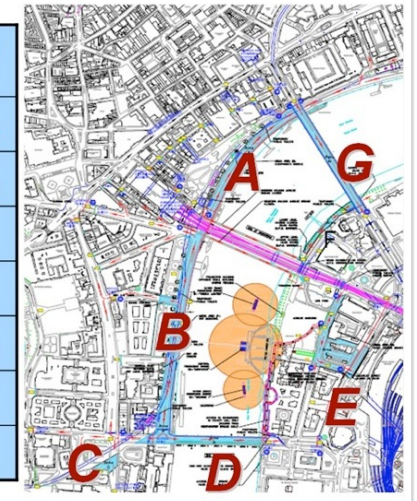
Control room systems

Crowd Condition Monitor

Modelling New Year (London 2006 - 2016)

Areas (see image)	Area (m2)
A – Waterloo to Embankment Station	11,955
B – Embankment to Westminster Station	23,304
C – Parliament Square	2,092
D – Westminster Bridge	4,138
E – Belvedere Road	11,241
F – Royal Festival Hall	3,000
G – Waterloo Bridge	9,143

Slide 57

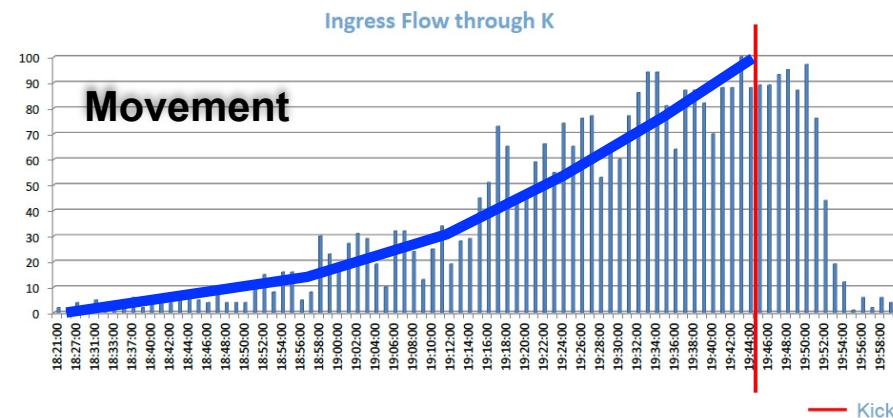# Modelling system – spreadsheet analysis

Flow Estimator

Density per metre square	Area Name	Area	Total Capacity		Exponetial Time to Fail	11:15:59 PM		Arrival Profile		Use Street Counts	
4	B	23304	93216		Linear Time To Fail	11:54:47 PM		Default	+ 15 Mins	Street Counts Update	

Time Period	2100-2115	2115-2130	2130-2145	2145-2200	2200-2215	2215-2230	2230-2245	2245-2300	2300-2315	2315-2330	2330-2345	2345-0000
Arrival Profile	30%	30%	30%	30%	30%	40%	45%	50%	60%	70%	80%	100%
Desired Flow For Period	4700	4700	4700	4700	4700	6267	7050	7833	9400	10967	12533	15667
Desired Aggregate Flow	4700	9400	14100	18800	23500	29766	36816	44650	54050	65016	77549	93216
Overall Street Count	8000	0	0	0	0	0	0	0	0	0	0	0
Predicted Flow Exponential	8000	8000	8000	8000	8000	10667	12000	13333	16000	18667	21333	26667
Aggregate Flow Exponential	8000	16000	24000	32000	40000	50667	62667	76000	92000	110667	132000	158667
Predicted Flow Linear	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000
Aggregate Flow Linear	8000	16000	24000	32000	40000	48000	56000	64000	72000	80000	88000	96000

Legend:
- Desired Capacity
- Actual Capacity Exponentiall Function
- Actual Capacity Linear Function
- Max Safe Capacity

Slide (top right)
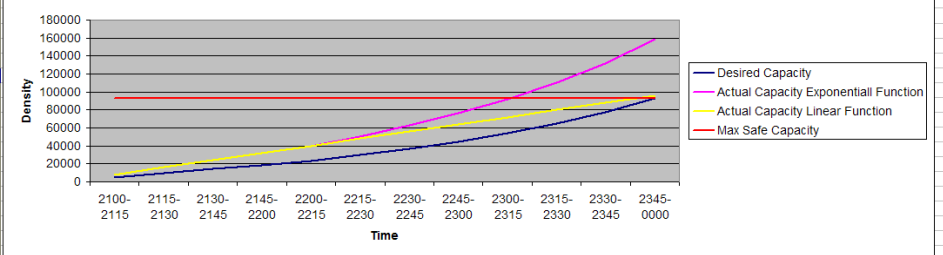
Manchester City v West Ham: 8/01/2014, 7.45pm

- Sales = 30,381
- Attendance = 29,853
- Max Flow = 760
- Total entries through K = 3485
- Max Flow through K = 100

Ingress Flow through K

Movement

Kick Off

Slide 60

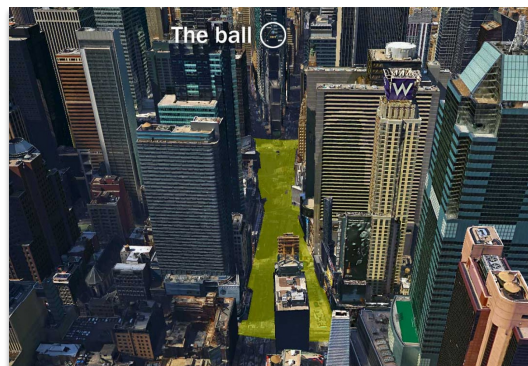# The Washington Post

Ignoring safety, what's the maximum number of people that can fit in Times Square?

By **Philip Bump** December 31, 2016

31st Dec 2016
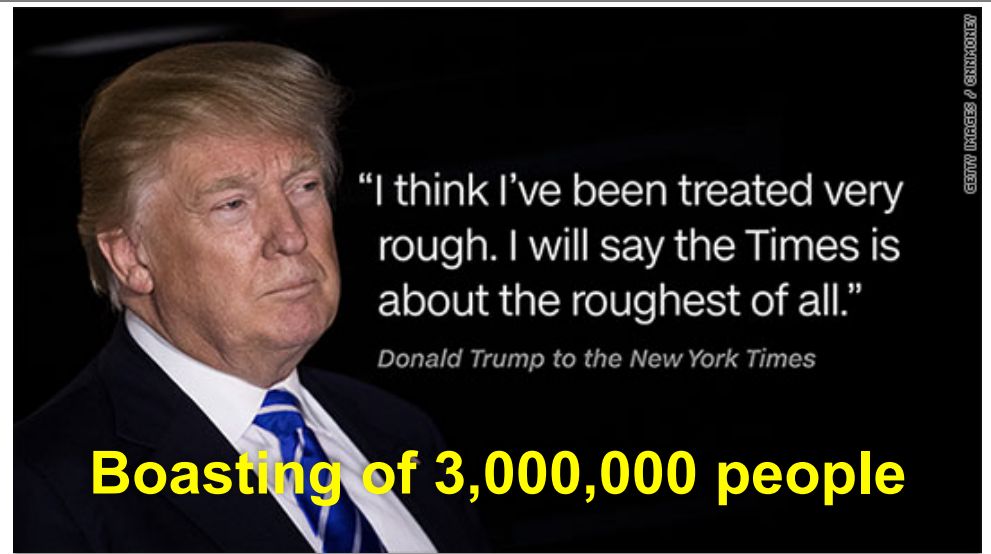

The ball

Slide (bottom left)

Counting crowds at the inauguration (2017)

Prof. Dr. G. Keith Still FIMA FICPEM SFIIRSM MEWI FIPM

Capt. Marcel Altenburg MA PGCert

Manchester Metropolitan University

The New York Times

From Lincoln to Obama, How Crowds
at the Capitol Have Been Counted

By TIM WALLACE   JAN. 18, 2017

"I think I've been treated very rough. I will say the Times is about the roughest of all."

Donald Trump to the New York Times

Boasting of 3,000,000 people

"Can you guys do this LIVE?"

Manchester Metropolitan University

Common open event questions (RAMP)

We don't know how many people may come to the event…

…what is the best way to plan for a major event?

What direction will crowds approach and depart the area?

Route question (transportation hubs to and from event site)

What is your event capacity?

How much area do you have? How will the area be used?

How quickly will these spaces fill?

What crowd movements do we expect?

Over what period of time?

What type of crowd are we expecting?

Demographics, families?

Routes for the inauguration 2017
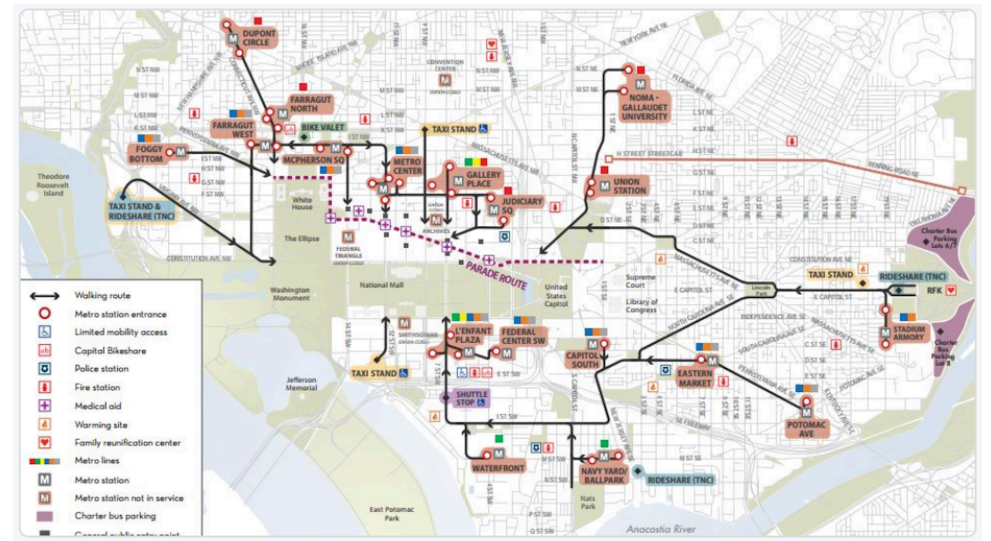
Area for the inauguration 2017

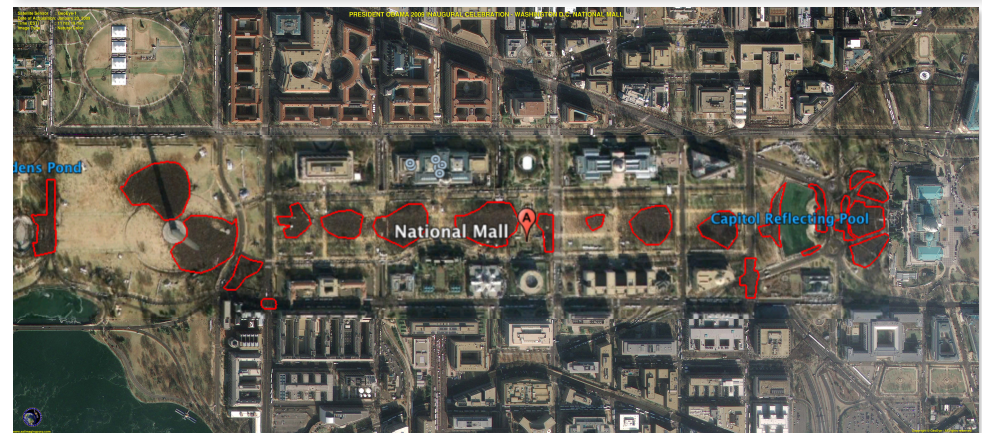

What areas do we have available?
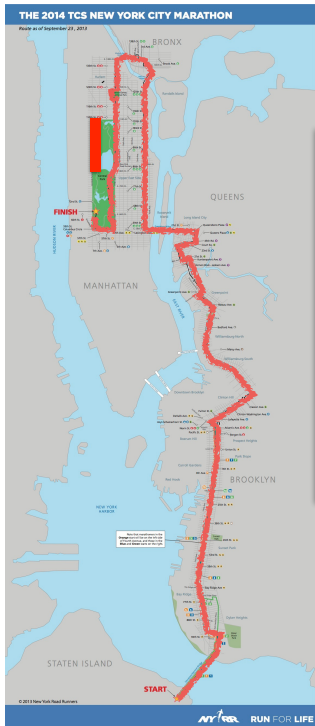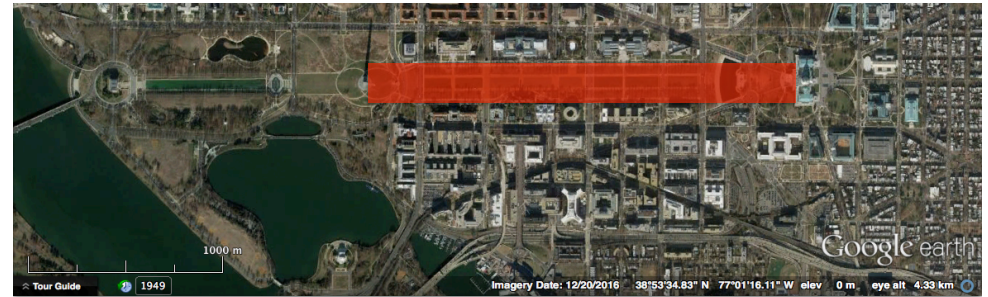
New York Marathon 42.195km

Obama = 1.8 Million

Let's evaluate 42 km x 2 sides = 84,000m
x 2 (people per metre) = 168,000 people
x 11 deep (both sides) = 1,848,000 people

Obama (2009) 175,000m^2 occupied space

Estimated 1.8 million people (would require 720,000 square metres)

Obama 2009 = 175,000 m^2 so 400,000 - 500,000 people (@ 2.5 pm^2)

Inauguration Ceremonies

MAP AND GUIDELINES
January 20, 2017
The Capitol of the United States of America
City of Washington
MAP OF GATE LOCATIONS AND GUEST SECTIONS FOR TICKET HOLDERS
Please bring this Map and Guidelines and your ticket to the Inauguration
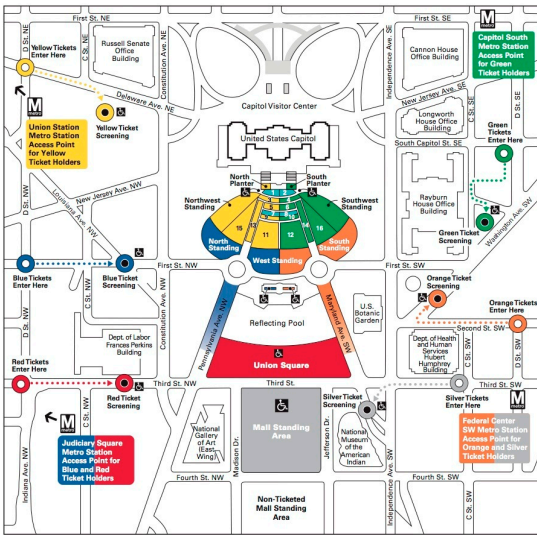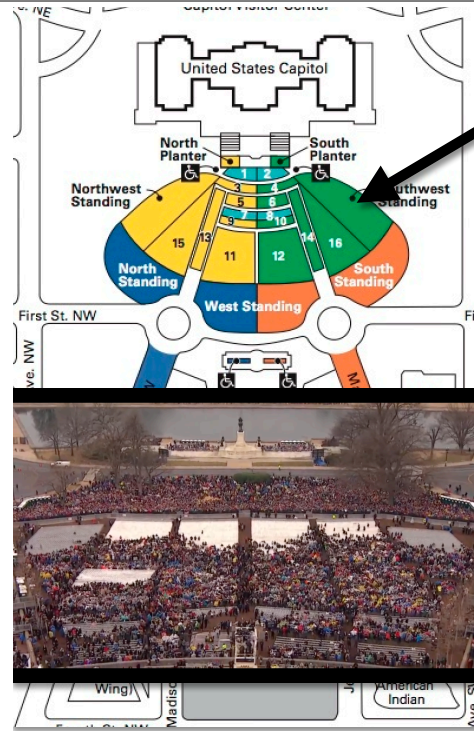
From the White House website we had the area allocations

We can map these areas using Google Earth Pro

Measure the space
Evaluate the capacity
Evaluate the routes
Evaluate the transport and parking capacity

Then monitor the crowd build up on the day
How the space is filling over time

Crowd Dynamics

Bowl = 39,346 m²
-10% for spaces

35,000 m² of seating
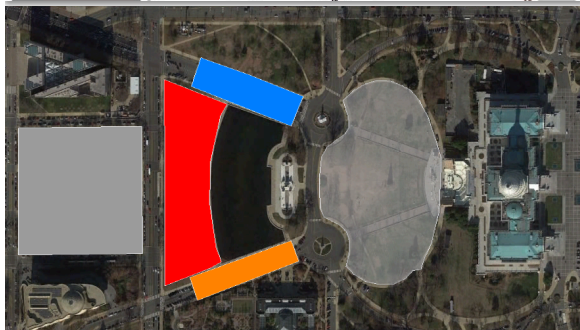All seated 2 people per square metres
70,000 people (approx)
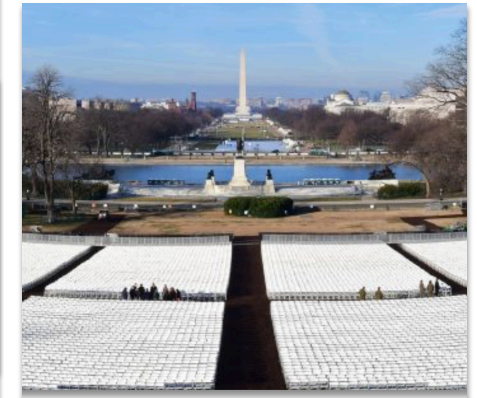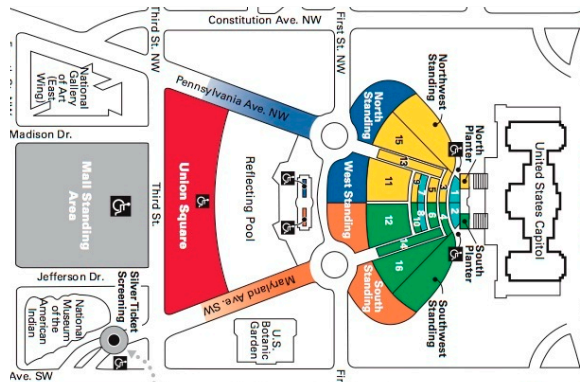
Penn Avenue = 7,300m²
Union Square = 20,000m²
Maryland Ave. = 5,300m²
Mall Standing = 33,200m²
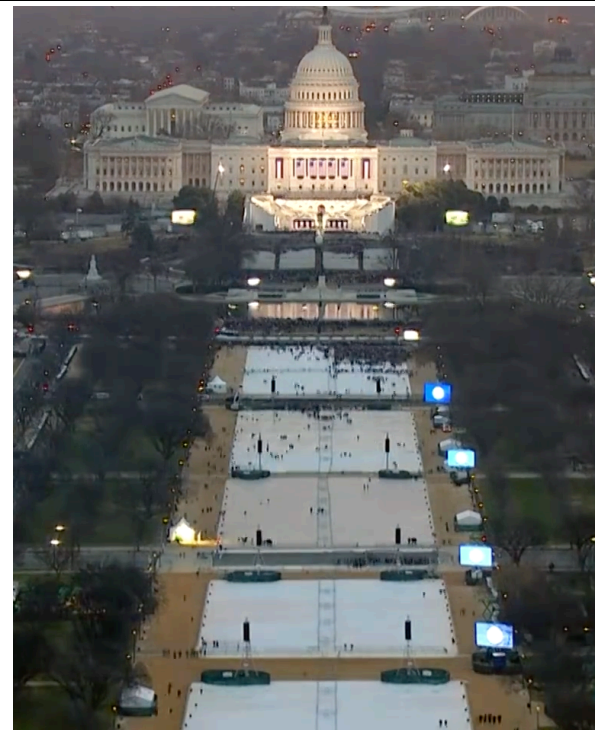Total area = 65,800m²
At 2pm² = 131,600
At 3pm² = 197,400

The Bowl
70,000 people

Between 200,000 and 267,400 people

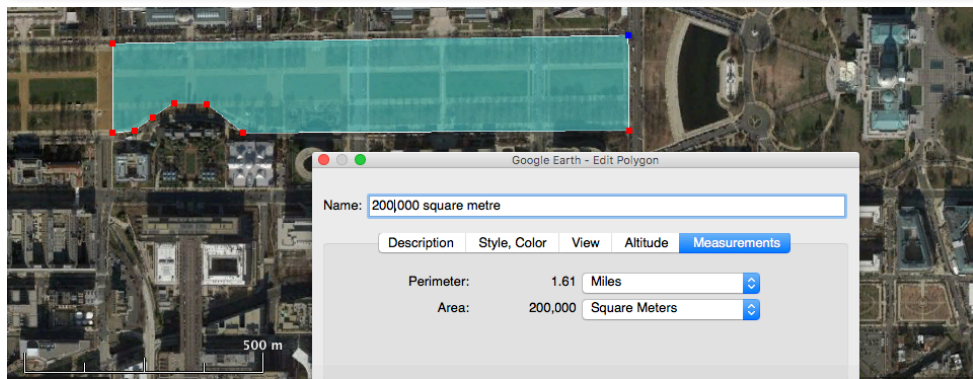If 100% occupied space
250,000 tickets

We can see the white flooring (used in 2013) is not over the whole area
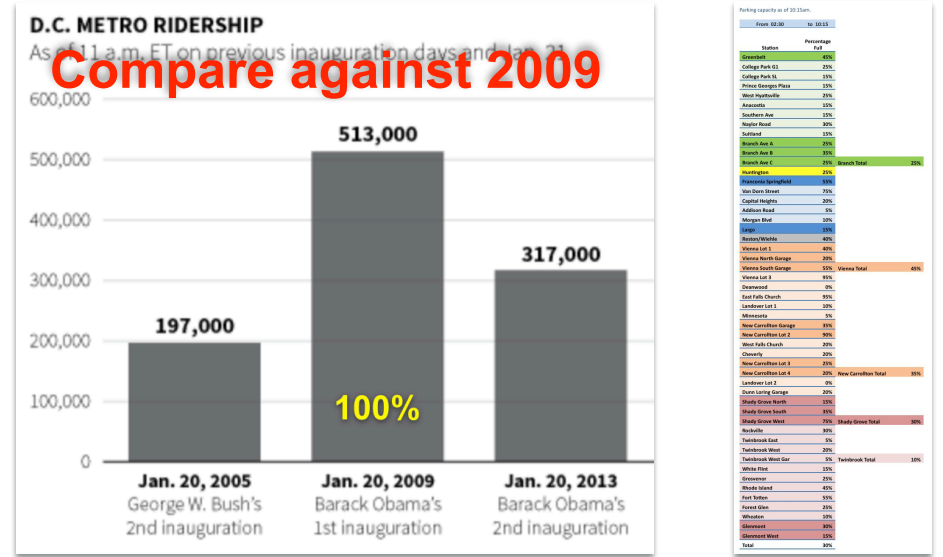
The Mall area was smaller 200,000 m²

It could hold 500,000 people (@ 2.5 pm²)
    If fully occupied

For safety, the sections are divided
    Barriers and the media tent

Movement (metro and parking - live)

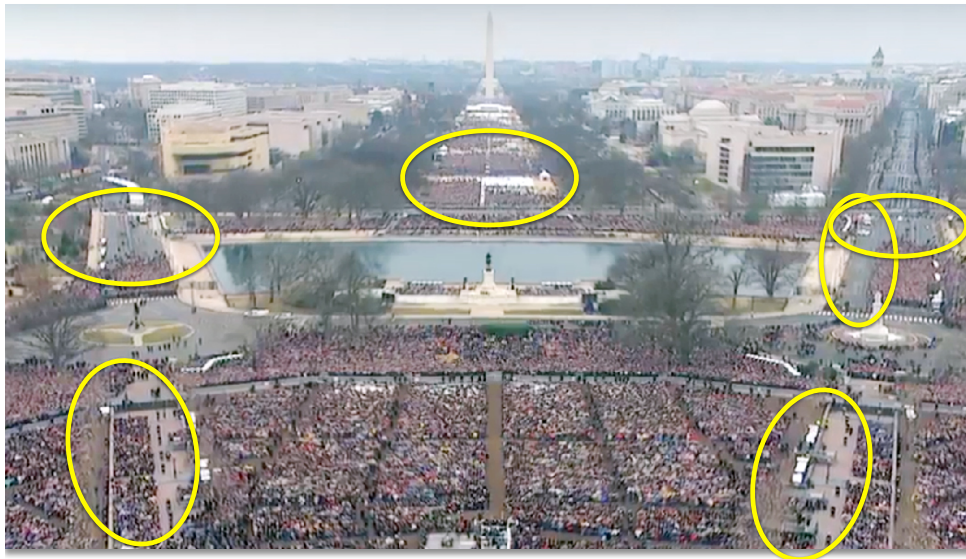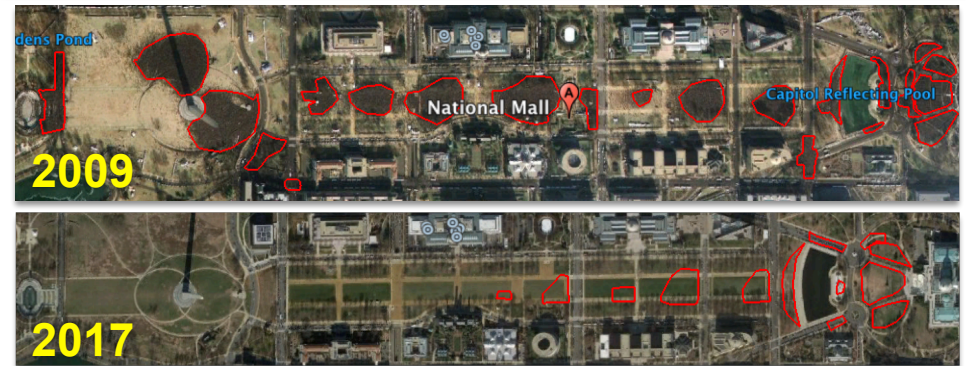**Compare against 2009**

Time lapse of the 2017 inauguration

Large empty areas

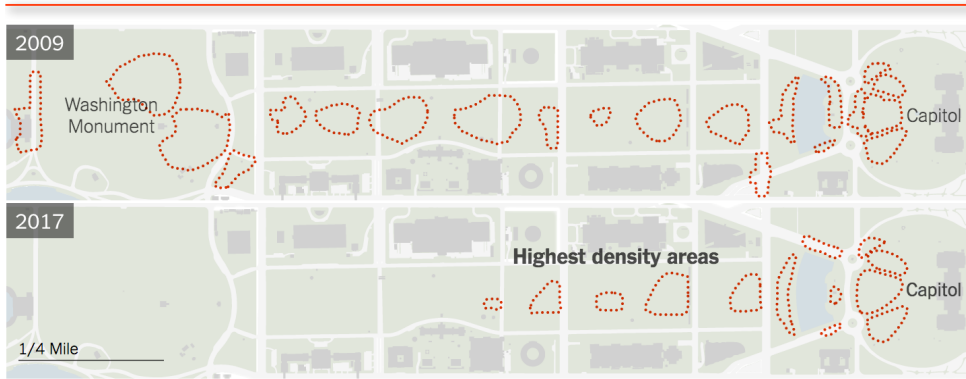# Measuring the satellite images

2009

2017

From the 2009 satellite images we can measure the high density areas

The front 1/3rd (beyond the reflecting pool) was full in both events

The back 2/3rd's were empty for 2017

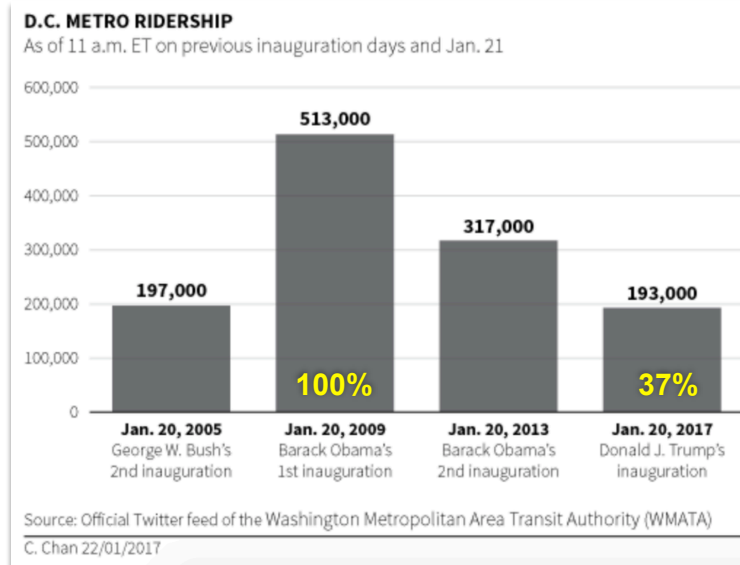# The high density areas were 1/3rd of 2009

The New York Times published the article, using the above graphics

We had confirmation in the visuals, the area analysis, the crowd build up over time and the metro data.

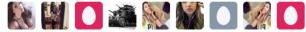All point to 1/3rd the Obama crowd

At 11am 193,000 trips (2017)

D.C. METRO RIDERSHIP
As of 11 a.m. ET on previous inauguration days and Jan. 21

197,000	513,000	317,000	193,000
	100%		**37%**
Jan. 20, 2005 George W. Bush's 2nd inauguration	Jan. 20, 2009 Barack Obama's 1st inauguration	Jan. 20, 2013 Barack Obama's 2nd inauguration	Jan. 20, 2017 Donald J. Trump's inauguration

Source: Official Twitter feed of the Washington Metropolitan Area Transit Authority (WMATA)

C. Chan 22/01/2017

The New York Times ✔
@nytimes

Following ⌄

Comparing the crowds at Donald Trump's and Barack Obama's inaugurations nyti.ms/2j3yaDE

2009 Obama inauguration

2017 Trump inauguration

11:15 - we had the meme

Left: Getty Images; right: 58th Presidential Inaugural Committee

RETWEETS 12,571 LIKES 14,922

8:57 PM - 20 Jan 2017

↩ 865   ♻ 13K   ♥ 15K

0100 our job was complete
13 hours of live analysis

21st Jan - the next day

New York Times (21st Jan 2017)

WOMEN'S MARCH —ON WASHINGTON—

Great job guys, could you count the Women's March today?
    We had a slight problem - it was my wife's birthday

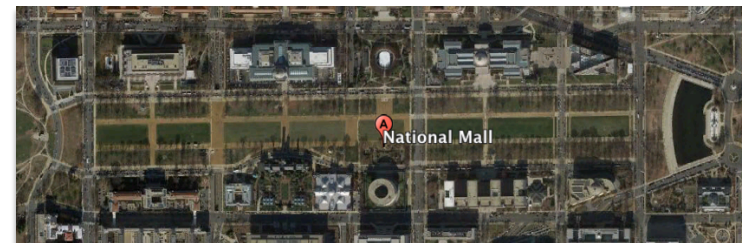We needed a strategy, some subterfuge, a plan

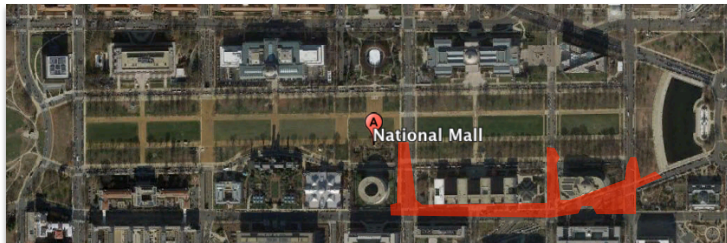# Routes, Areas, Movement, Profile (packing)
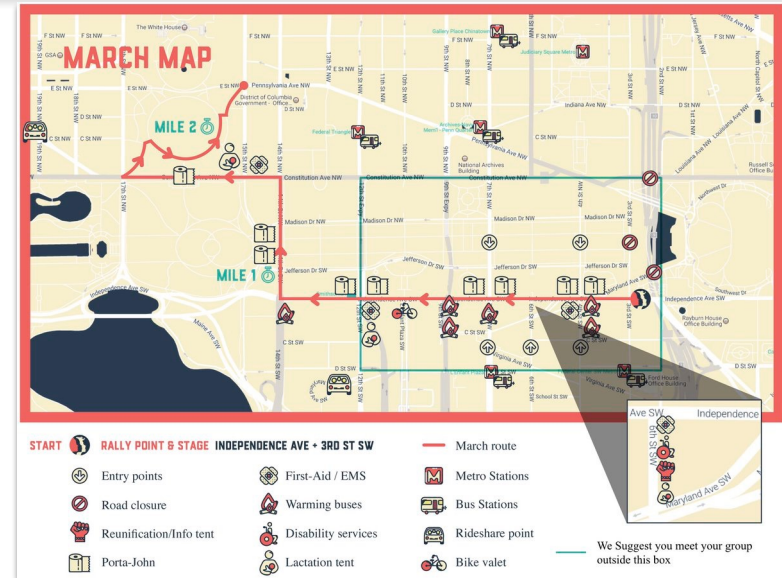
How big would this crowd be?

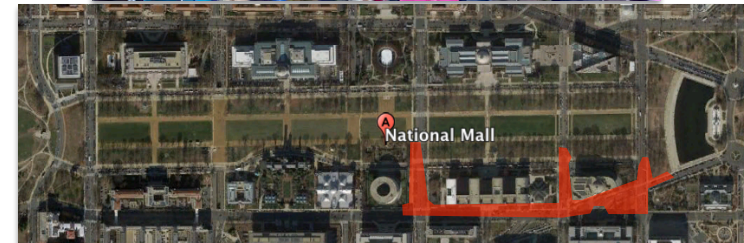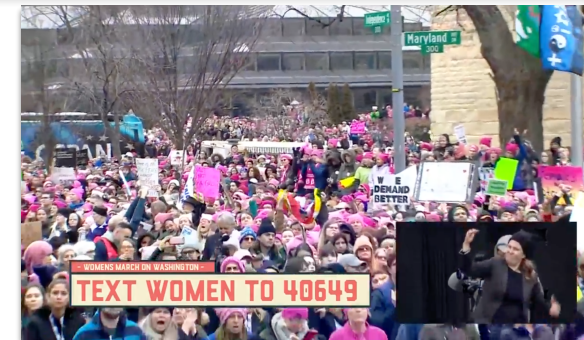**Will this become a story?**

Step 1 - Areas and crowd shapes (noon)
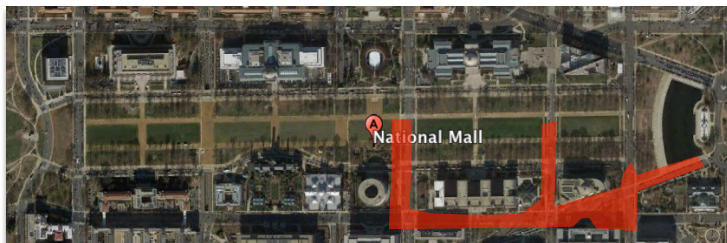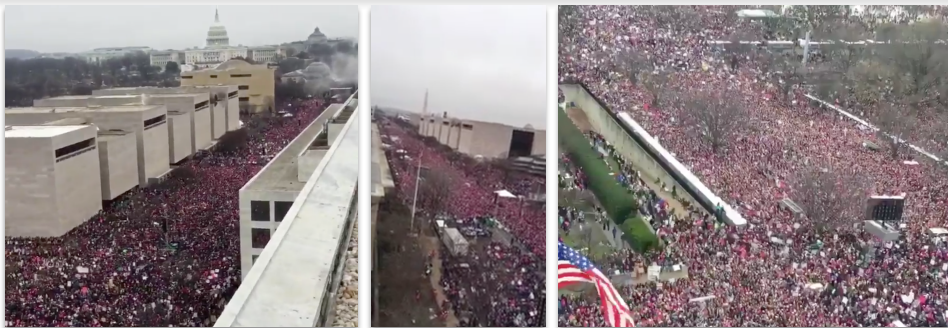
Step 1 - Areas and crowd shapes (noon)

Step 2 - Crowd density (packing - noon)

62%

Women's March - the gathering

81%

Inauguration   Women´s March

???

145%

97

295%

98
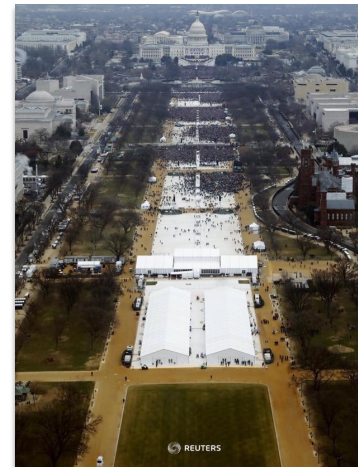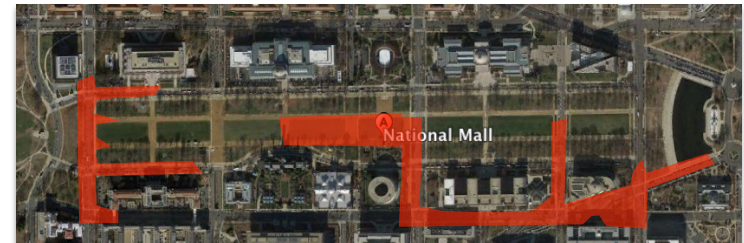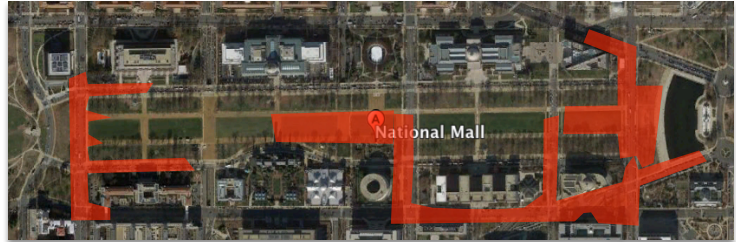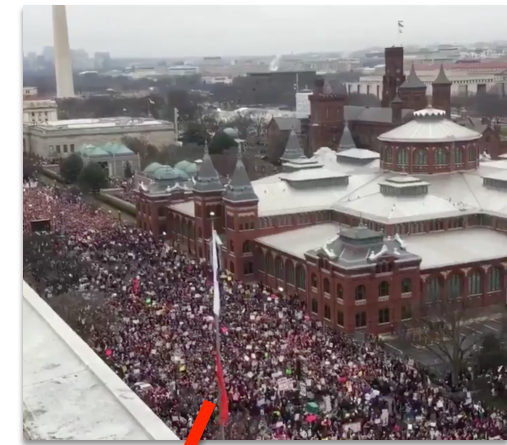
Women's March
180,000 m²

295%

Inauguration
61,000 m²

99

New Year Times - Graphics Department

2009 Obama

Highest density areas

Washington Monument

Capitol

2017 Trump

Women's march

1/4 Mile

100
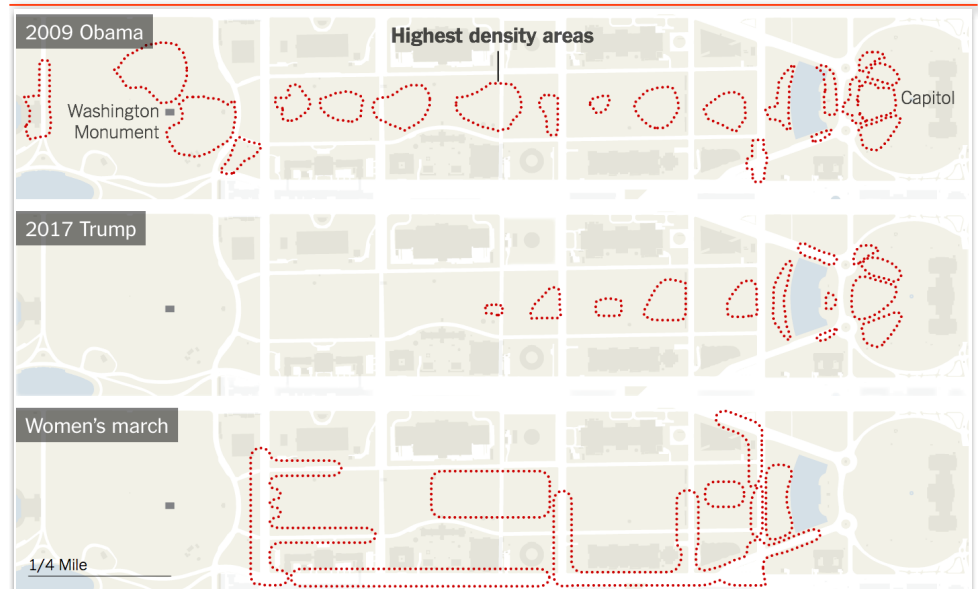
2:00pm

2:30pm

Washington metro ridership

Saturday's march in Washington overwhelmed the city's Metro subway system, with enormous crowds reported and some stations temporarily forced to turn away riders.

D.C. METRO RIDERSHIP
As of 11 a.m. ET on previous inauguration days and Jan. 21

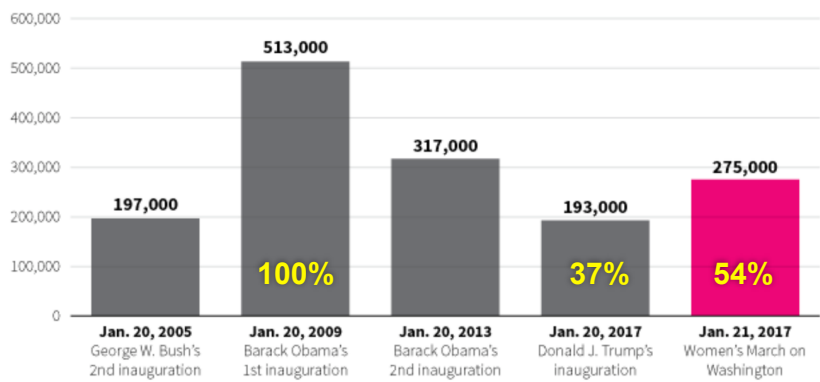|				
197,000	513,000	317,000	193,000	275,000
	100%		**37%**	**54%**
Jan. 20, 2005	Jan. 20, 2009	Jan. 20, 2013	Jan. 20, 2017	Jan. 21, 2017
George W. Bush's 2nd inauguration	Barack Obama's 1st inauguration	Barack Obama's 2nd inauguration	Donald J. Trump's inauguration	Women's March on Washington

Source: Official Twitter feed of the Washington Metropolitan Area Transit Authority (WMATA)

C. Chan 22/01/2017

REUTERS

Metro @wmata · Jan 21

Metro Ridership as of 11am: 275k. For comparison, that's more than 8x a normal Sat & even busier than most weekdays. #wmata #womensmarch

↩ 46   ⟲ 2.0K   ♡ 2.2K

Metro @wmata · Jan 21

Metro Parking Update: Many end-of-line garages and lots now at/near capacity. Detail ⬇ #wmata #WomensMarch

Morgan Blvd	15%
Largo	25%
Reston/Wiehle	60%
Vienna Lot 1	85%
Vienna North Garage	40%
Vienna South Garage	90%
Vienna Total	70%
Vienna Lot 3	100%
Deanwood	0%
East Falls Church	100%

Marcel gets call from the CIA building (2130)
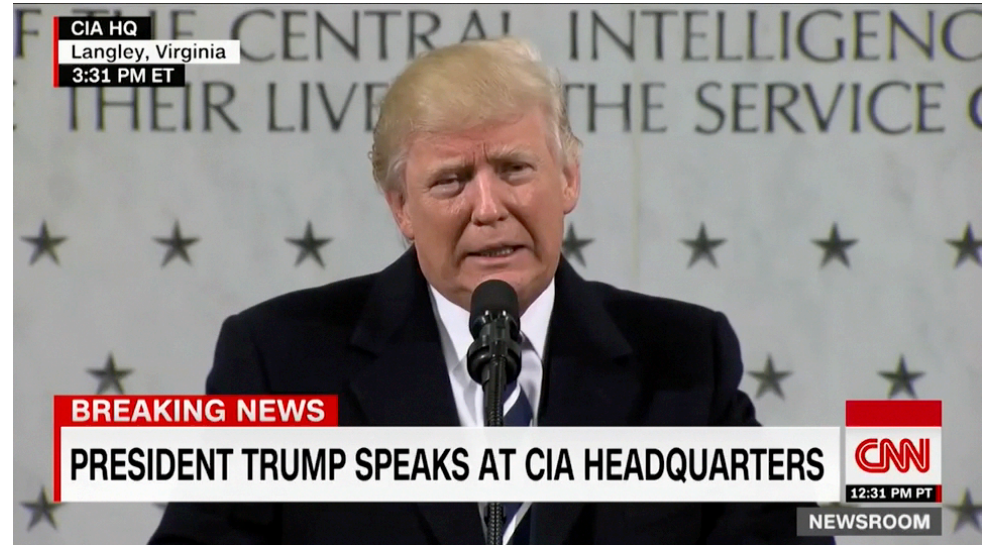
"Something is happening here - you need to see this"

Manchester Metropolitan University

Slide 1 (top-left)

Colleague - earthquake - rescue

Slide 2 (top-right)

"I made a speech, I looked out.."

CIA HQ
Langley, Virginia
3:31 PM ET

BREAKING NEWS
PRESIDENT TRUMP SPEAKS AT CIA HEADQUARTERS CNN
12:31 PM PT
NEWSROOM

Slide 3 (bottom-left)

Saturday 21ˢᵗ Jan 2017

Slide 4 (bottom-right)

Claims that these were NOT the same time

We can see Obama and Trump on the screens !

Kellyanne Conway - Counsellor to the President

"You know the very powerful and the very stupid have one thing in common. They don't alter their views to fit the facts. They alter the facts to fit the views. Which can be uncomfortable if you happen to be one of the facts that needs altering."

-The Doctor
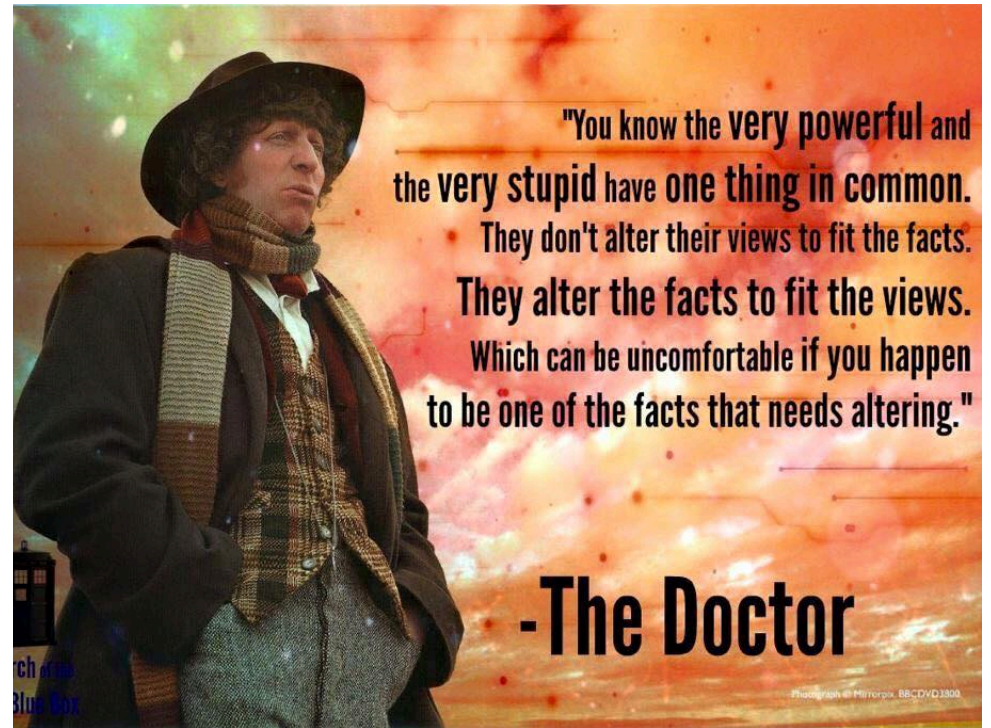
"I will not allow you, or anyone else…"

IF YOU FIND YOURSELF IN A HOLE, THE FIRST THING TO DO IS STOP DIGGING.
- WILL ROGERS

rawforbeauty.com
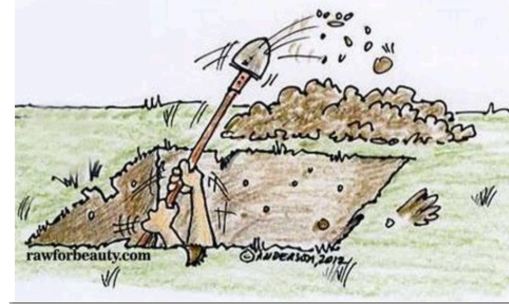
"The press was trying to make it seem like we were ignoring the facts ... you look at a situation ... in the same way you can look at a weather report," Mr Spicer said.

"One weather report comes out and says it's going to be cloudy and the next one says there's going to be light rain. No one lied to you."

We may disagree with the weather forecast for tomorrow, but not with the weather we had yesterday!

As we elevate the image

We can see the spaces

Super Bowl 51 - Attendance 70,807

48.8m by 109.7m = 5,353.36 m^2
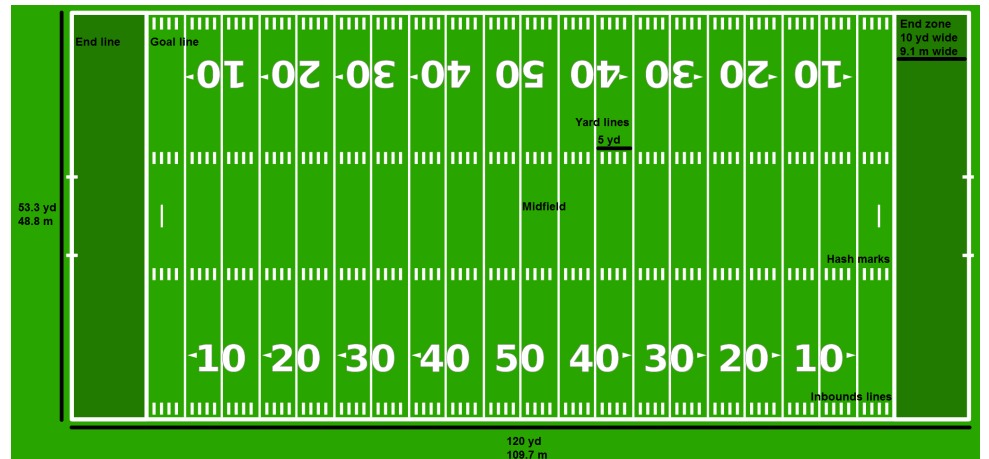
Pitch full = 13,383 people

MEDIA

INTERNET

TELEVISION

RADIO

MAGAZINES

NEWSPAPERS
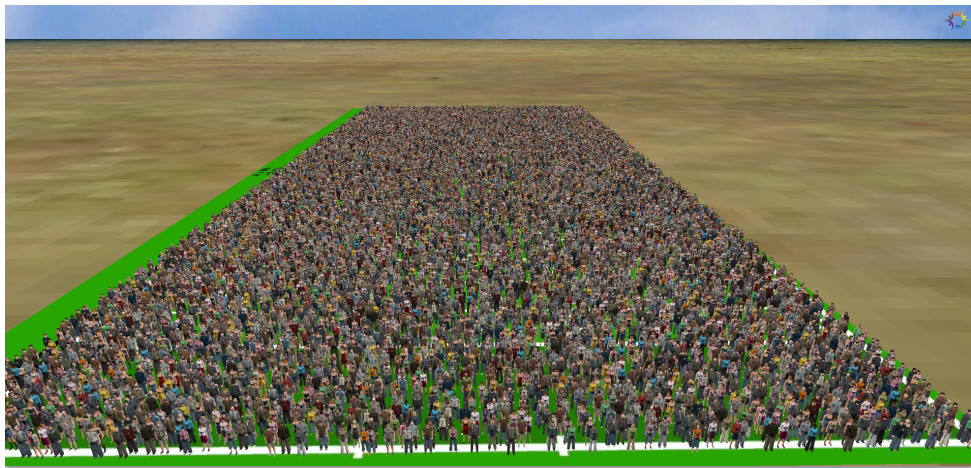
Round the clock for 4 days

GREGGS

Our disguises needed some work

BBC RADIO CUMBRIA Kendal Studio

Any questions?

NOW A MAJOR FILM

The Boys from MMU who

KICKED the HORNETS' NEST

Tony Schwartz

Sir Anthony Hopkins as
Prof. Dr. G. Keith Still

Michael Fassbender as
Capt. Marcel Altenburg