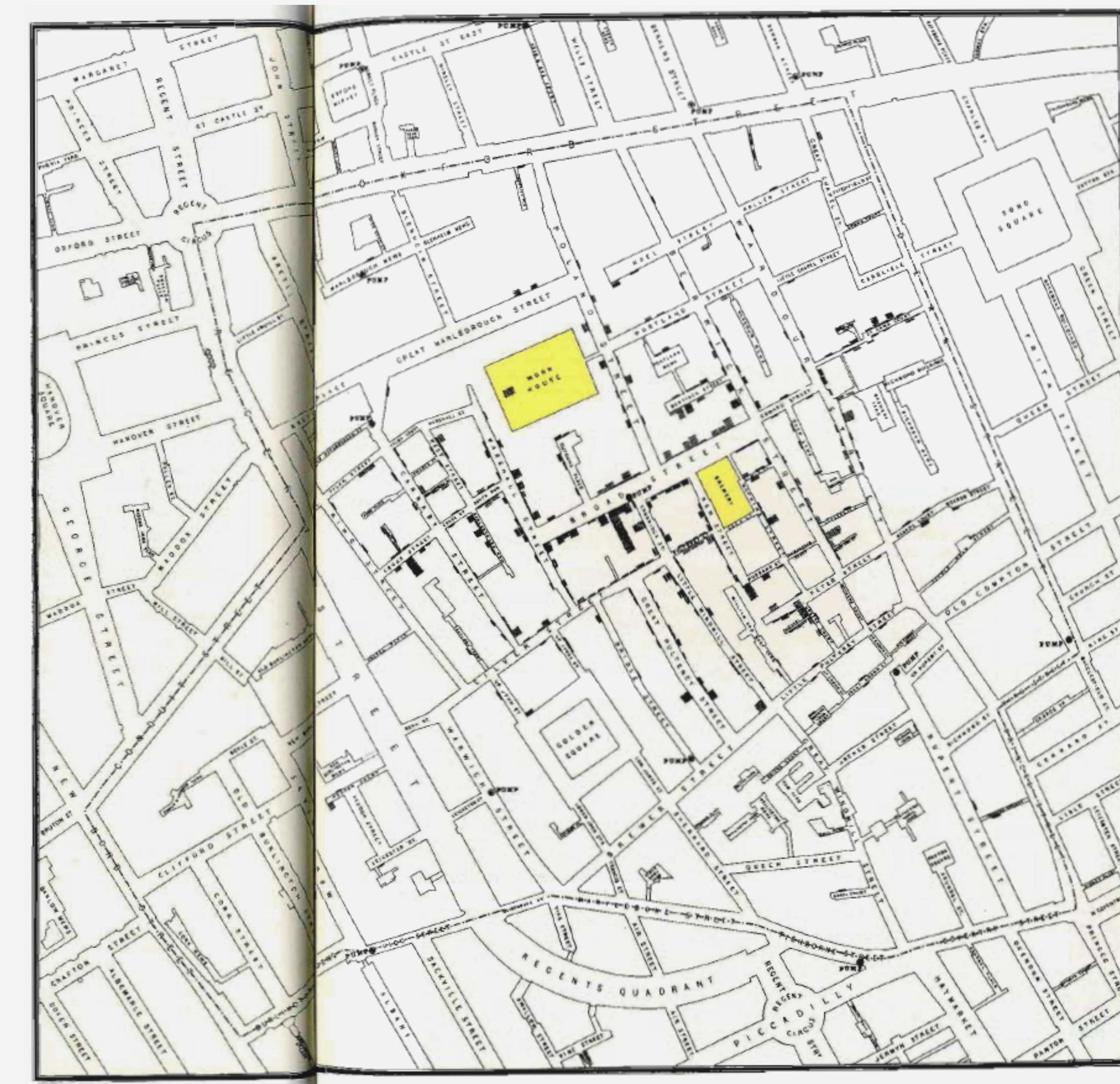
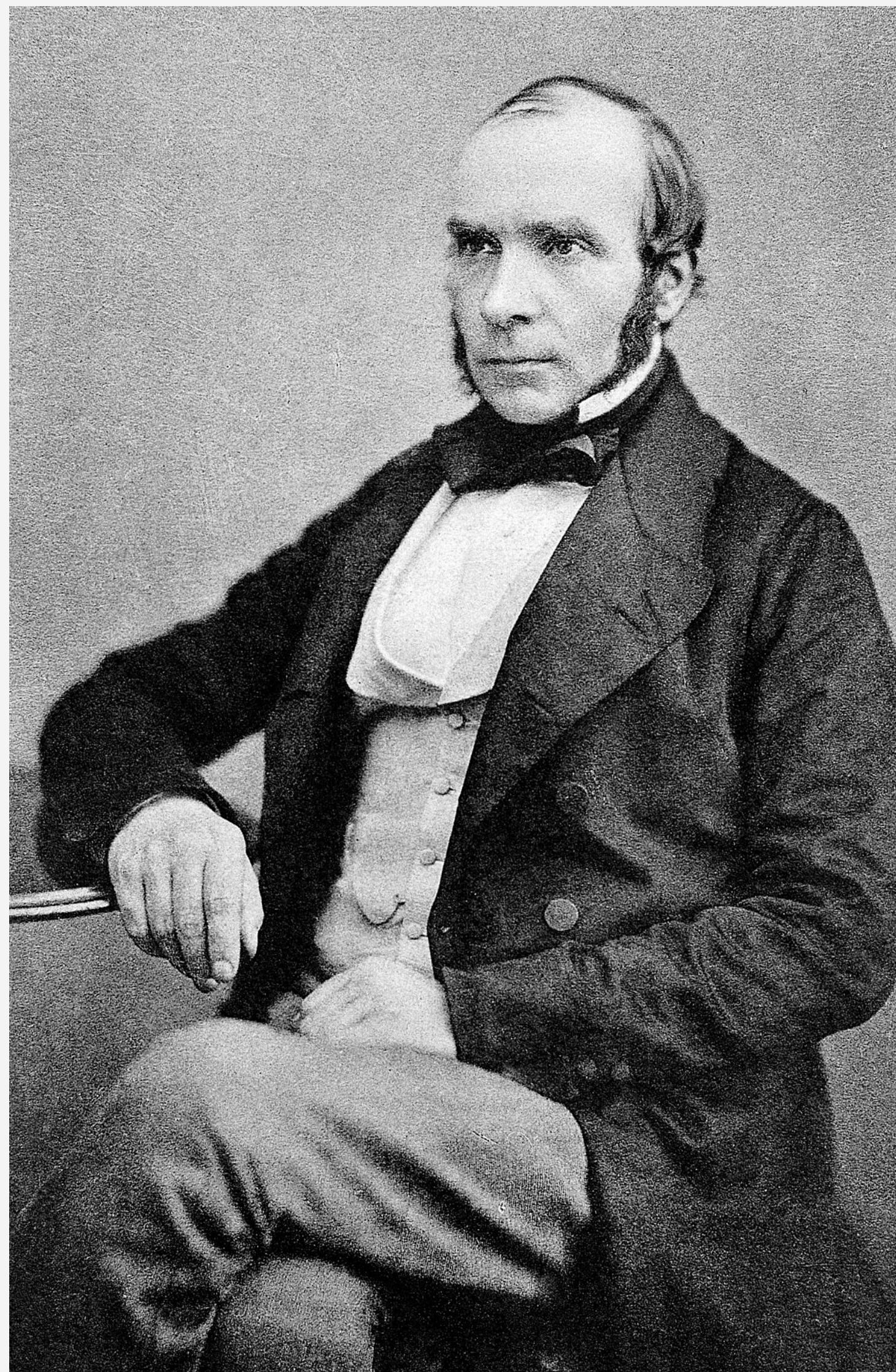


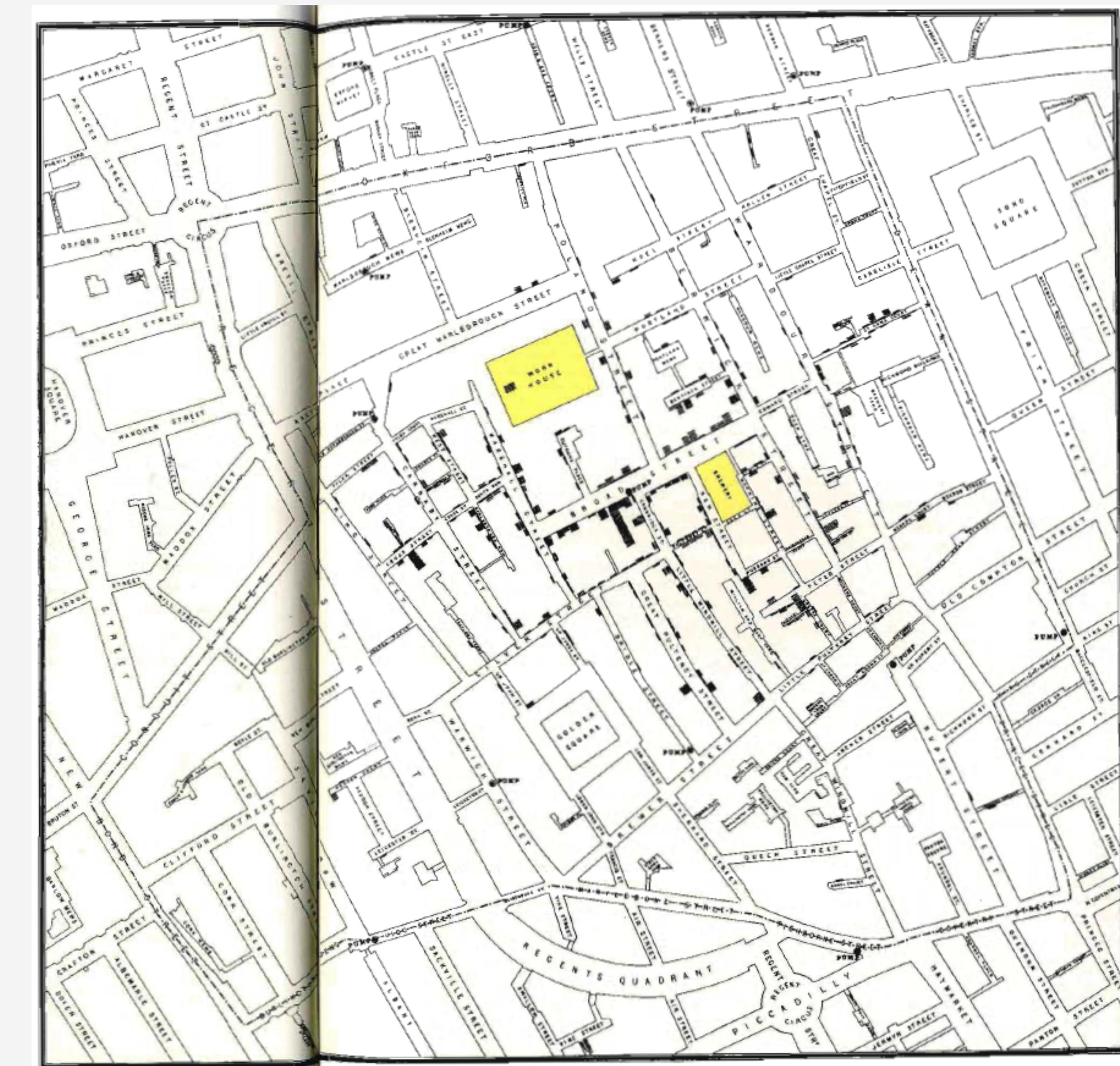
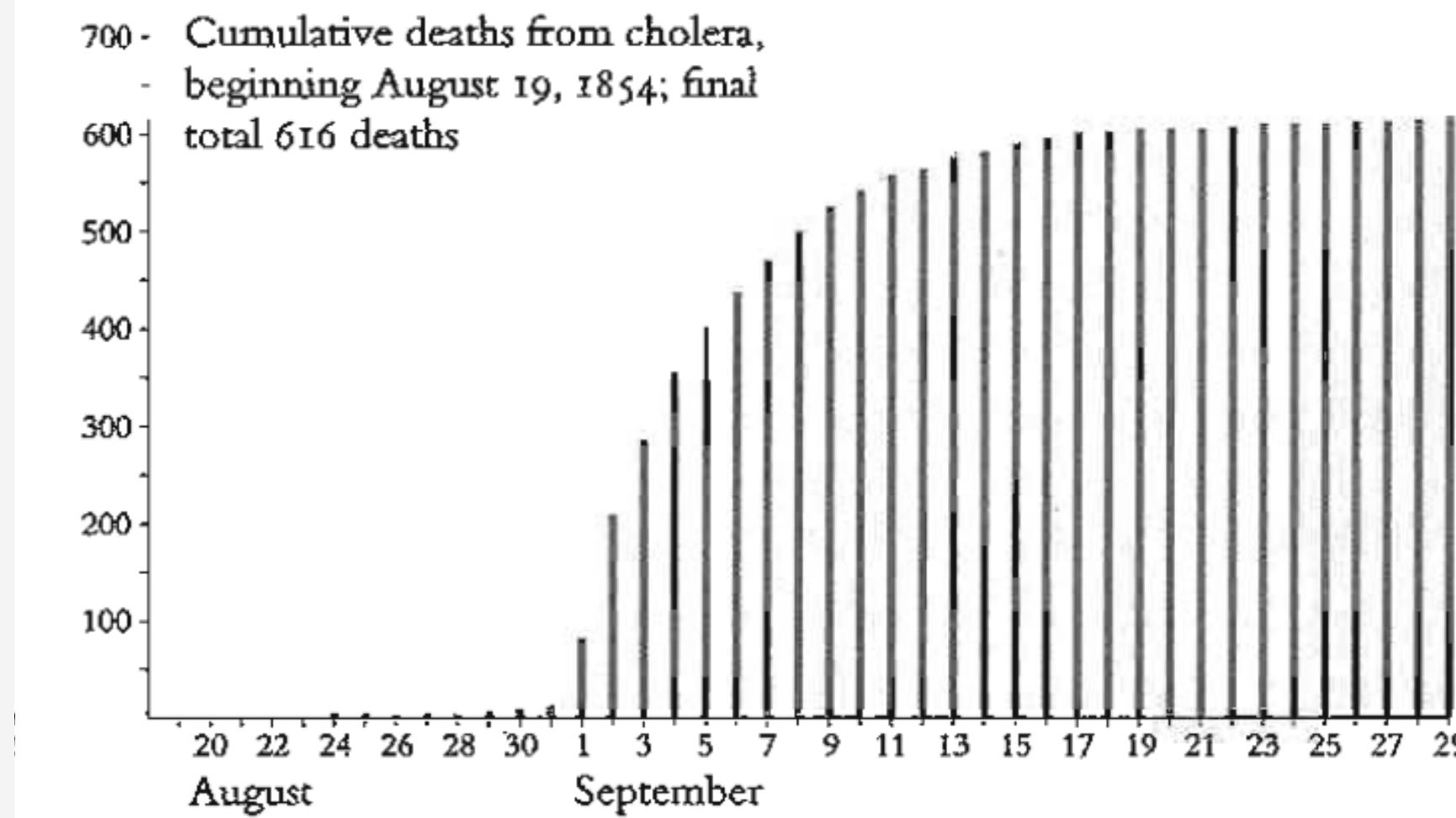
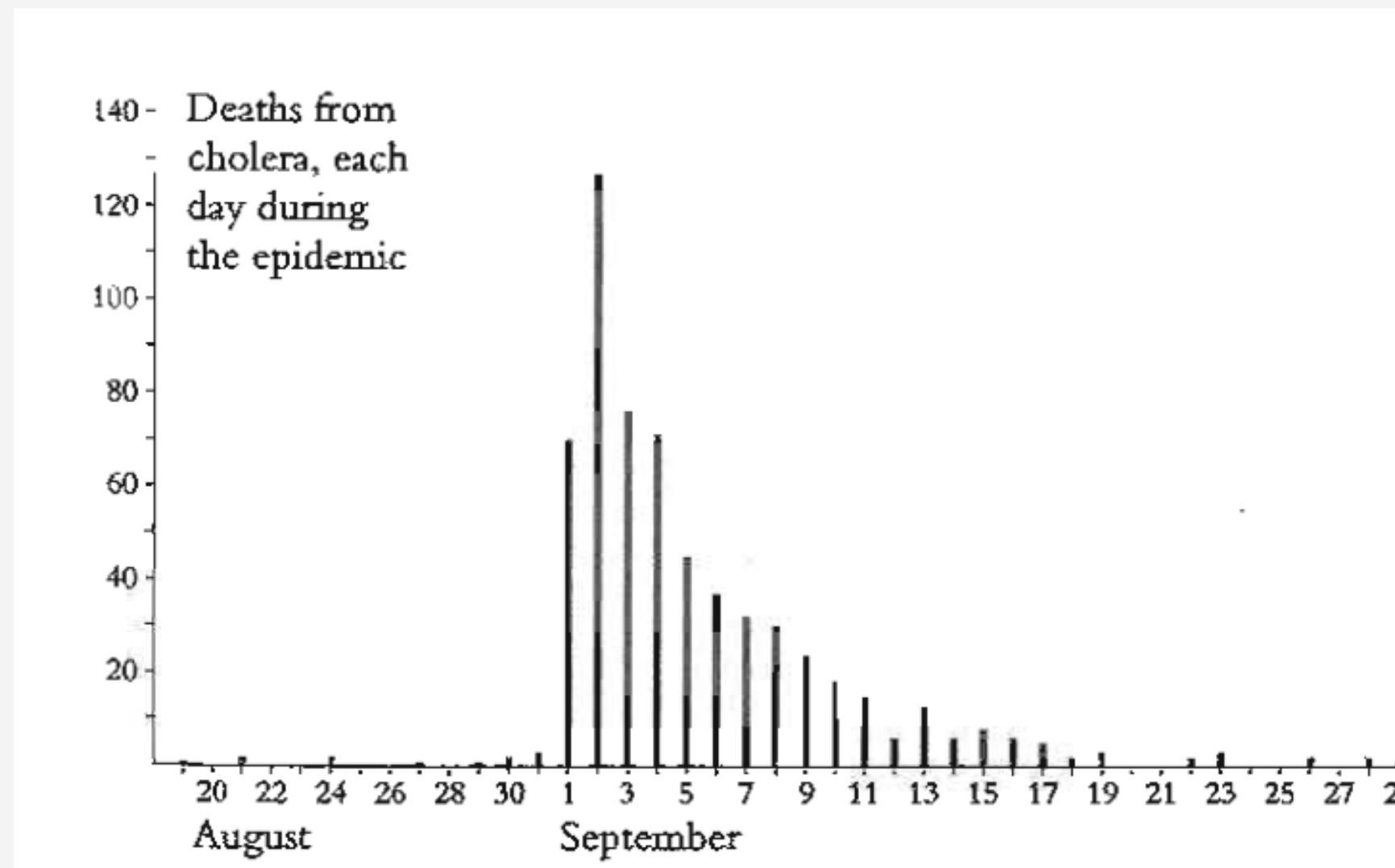
Ch. 2

//Visual and Statistical Thinking:
Displays of Evidence for Making Decisions

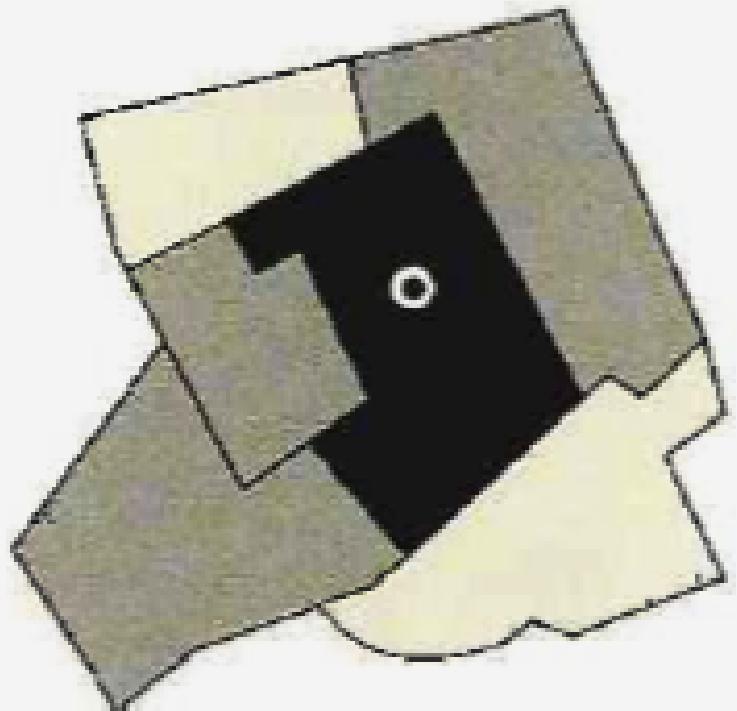
//John Snow



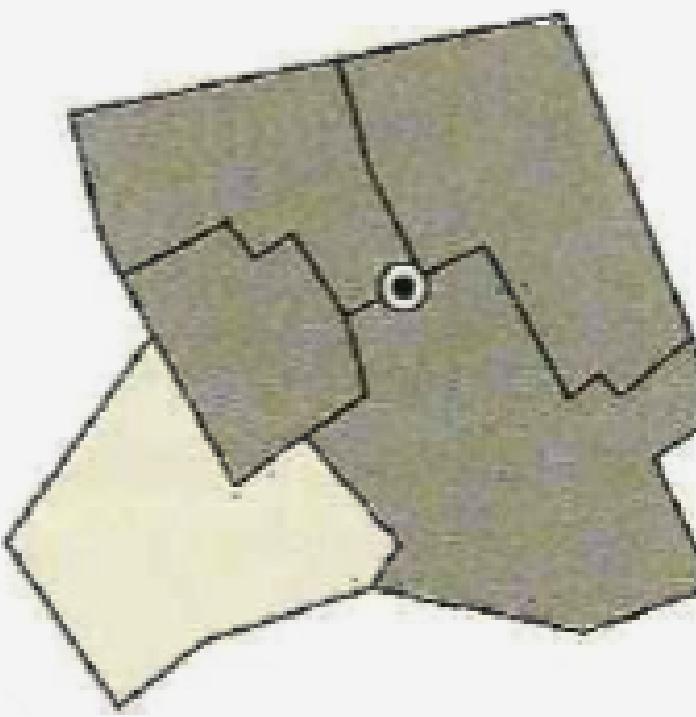
//Snow' s Data



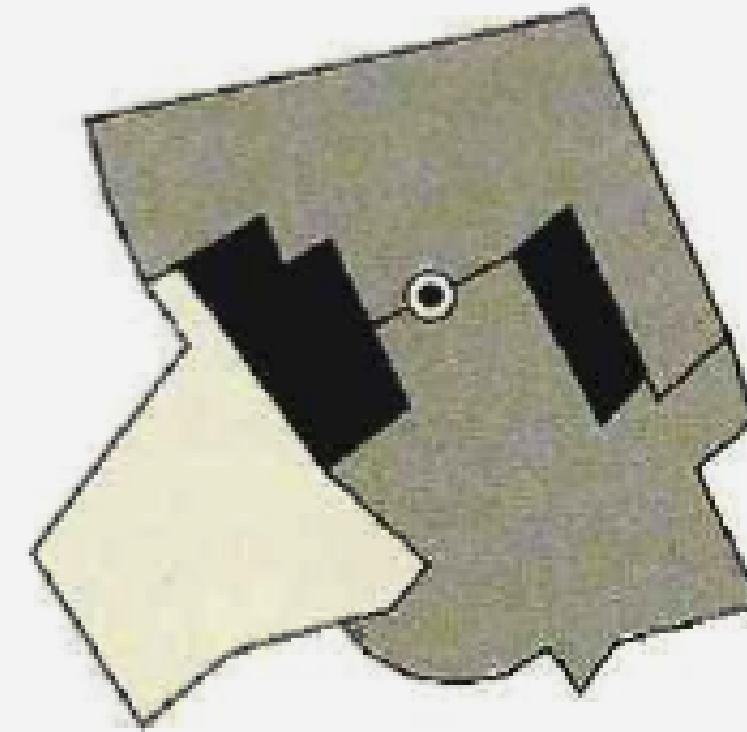
//Mark Monmonier



In this aggregation of individual deaths into six areas, the greatest number is concentrated at the Broad Street pump.

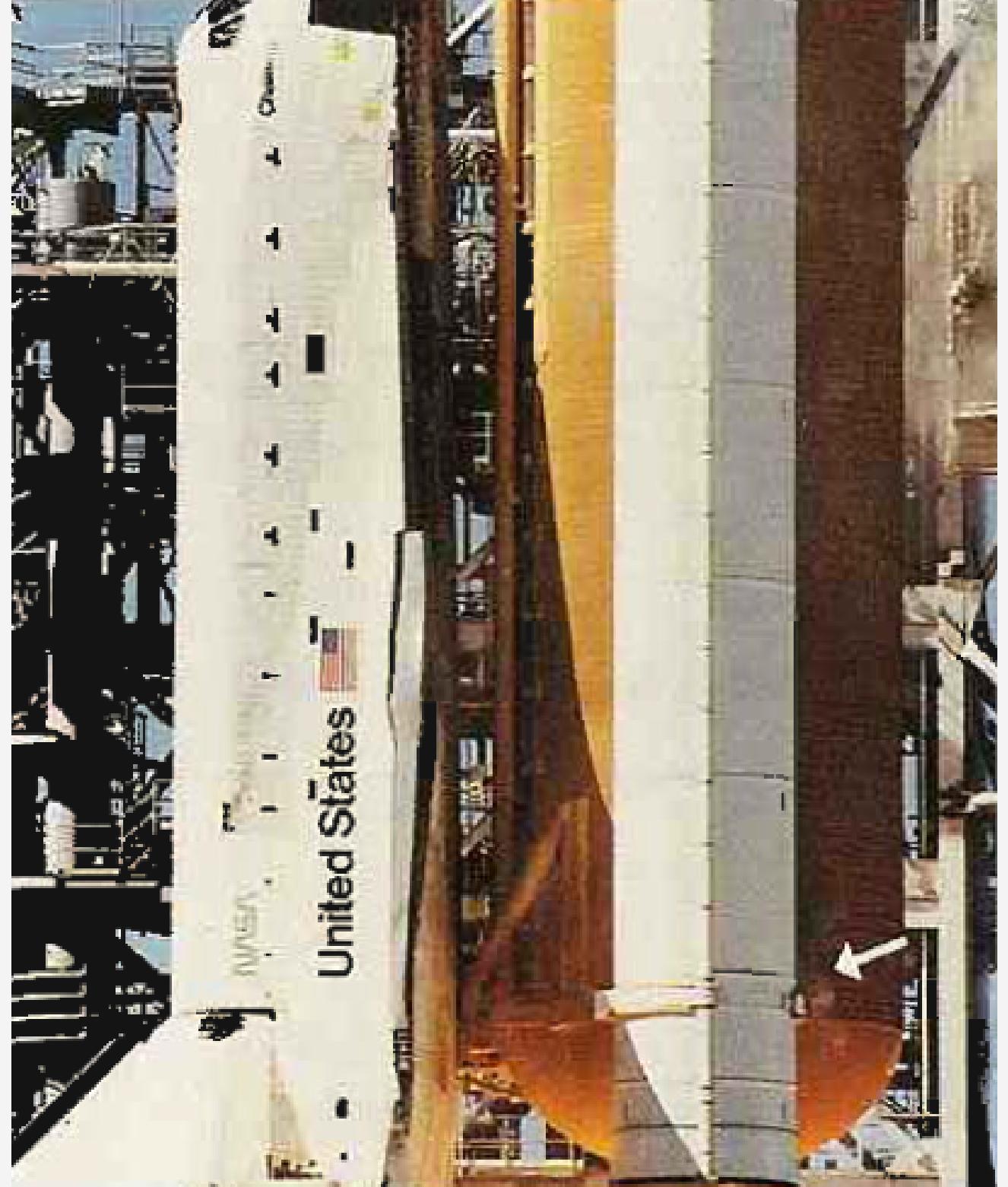


Using different geographic subdivisions, the cholera numbers are nearly the same in four of the five areas.

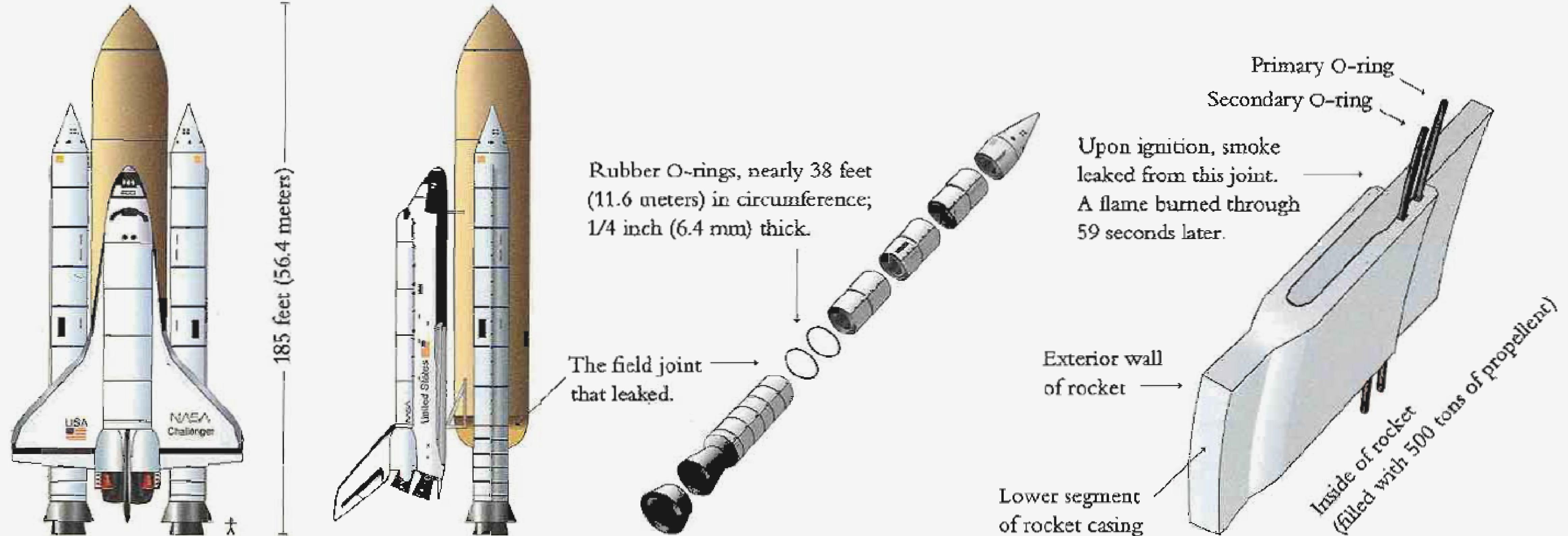


In this aggregation of the deaths, the two areas with the most deaths do not even include the infected pump!

//Challenger Incident



//O-rings



//No Name?

TEMPERATURE Concern on

SRM JONES

27 Jan 1986

//Chart 2

HISTORY OF O-RING DAMAGE ON SRM FIELD JOINTS

Date	APT		SRM No.	Cross Sectional View			Top View		Clocking Location (deg)
				Erosion Depth (in.)	Perimeter Affected (deg)	Nominal Dia. (in.)	Length Of Max Erosion (in.)	Total Heat Affected Length (in.)	
Oct 30, 1985		{ 61A LH Center Field**	22A	None	None	0.280	None	None	36°--66°
		{ 61A LH CENTER FIELD**	22A	NONE	NONE	0.280	NONE	NONE	338°-18°
Y		{ 51C LH Forward Field**	15A	0.010	154.0	0.280	4.25	5.25	163
		{ 51C RH Center Field (prim)***	15B	0.038	130.0	0.280	12.50	58.75	354
		{ 51C RH Center Field (sec)***	15B	None	45.0	0.280	None	29.50	354
		41D RH Forward Field	138	0.028	110.0	0.280	3.00	None	275
		41C LH Aft Field*	11A	None	None	0.280	None	None	--
		41B LH Forward Field	10A	0.040	217.0	0.280	3.00	14.50	351
JUL		STS-2 RH Aft Field	28	0.053	116.0	0.280	--	--	90

*Hot gas path detected in putty. Indication of heat on O-ring, but no damage.

**Soot behind primary O-ring.

***Soot behind primary O-ring, heat affected secondary O-ring.

Clocking location of leak check port - 0 deg.

OTHER SRM-15 FIELD JOINTS HAD NO BLOWHOLES IN PUTTY AND NO SOOT NEAR OR BEYOND THE PRIMARY O-RING.

SRM-22 FORWARD FIELD JOINT HAD PUTTY PATH TO PRIMARY O-RING, BUT NO O-RING EROSION AND NO SOOT BLOWBY. OTHER SRM-22 FIELD JOINTS HAD NO BLOWHOLES IN PUTTY.

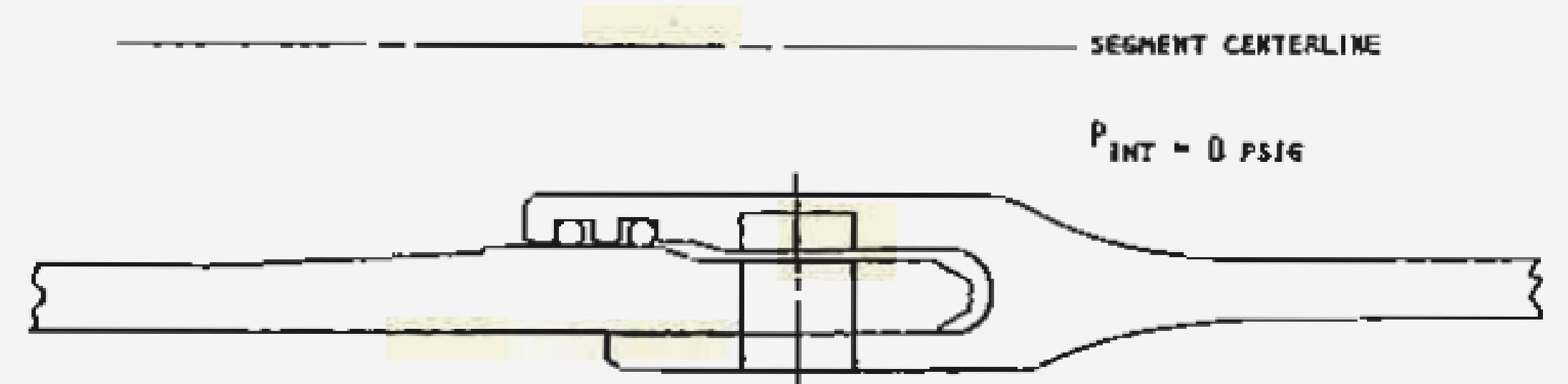
//Chart 3

PRIMARY CONCERNS -

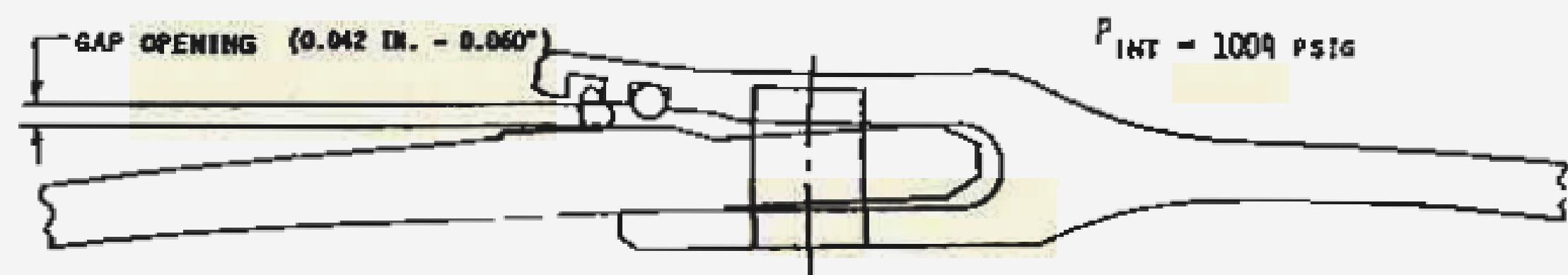
FIELD JOINT - HIGHEST CONCERN

- o EROSION PENETRATION OF PRIMARY SEAL REQUIRES RELIABLE SECONDARY SEAL FOR PRESSURE INTEGRITY
 - o IGNITION TRANSIENT - (0-600 MS)
 - o (0-170 MS) HIGH PROBABILITY OF RELIABLE SECONDARY SEAL
 - o (170-330 MS) REDUCED PROBABILITY OF RELIABLE SECONDARY SEAL
 - o (330-600 MS) HIGH PROBABILITY OF NO SECONDARY SEAL CAPABILITY
 - o STEADY STATE - (600 MS - 2 MINUTES)
 - o IF EROSION PENETRATES PRIMARY O-RING SEAL - HIGH PROBABILITY OF NO SECONDARY SEAL CAPABILITY
 - o BENCH TESTING SHOWED O-RING NOT CAPABLE OF MAINTAINING CONTACT WITH METAL PARTS GAP OPENING RATE TO MEOP
 - o BENCH TESTING SHOWED CAPABILITY TO MAINTAIN O-RING CONTACT DURING INITIAL PHASE (0-170 MS) OF TRANSIENT

PRIMARY CONCERNS - CONT



UNPRESSURIZED JOINT - NO ROTATION



PRESSURIZED JOINT - ROTATION EFFECT (EXAGGERATED)

//Blow-By Charts

Blow By HISTORY

SRM-15 WORST BLOW-BY
 • 2 CASE JOINTS (80° , 110°) ARC
 • MUCH WORSE VISUALLY THAN SRM-22

SRM-22 BLOW-BY

- 2 CASE JOINTS ($30-40^\circ$)

SRM-13A, 15, 16A, 18, 23A 24A

- NOZZLE Blow-By

HISTORY OF O-RING TEMPERATURES (DEGREES - F)

MOTOR	MBT	AMB	O-RING	WIND
DM-4	68	36	47	10 MPH
DM-2	76	45	52	10 MPH
QM-3	72.5	40	48	10 MPH
QM-4	76	48	51	10 MPH
SRM-15	52	64	53	10 MPH
SRM-22	77	78	75	10 MPH
SRM-25	55	26	29 27	10 MPH 25 MPH

MOTOR O-RING

DM-4 47

DM-2 52

QM-3 48

QM-4 51

SRM-15 53

SRM-22 75

SRM-25 29

27

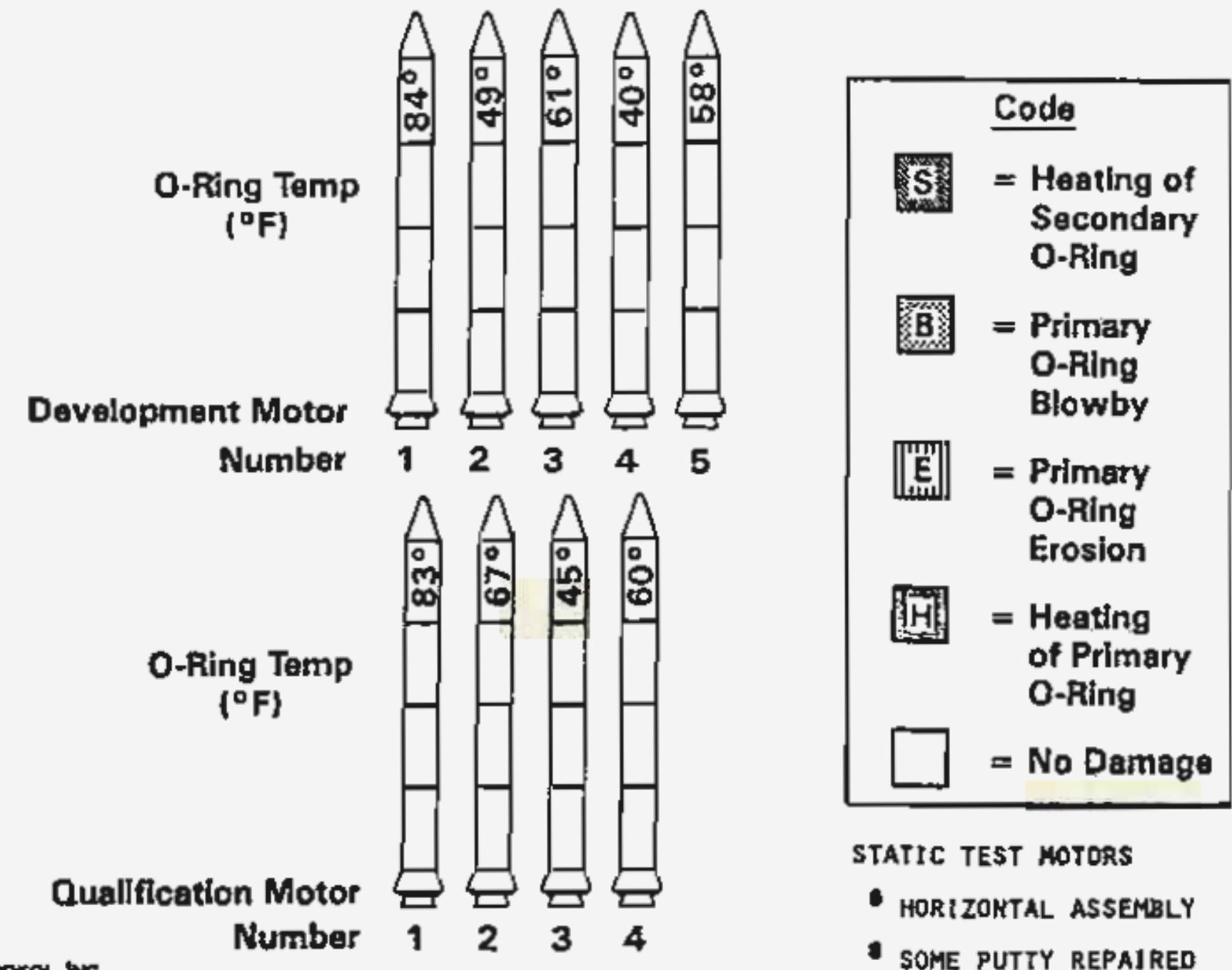
Test rockets ignited on fixed horizontal platforms in Utah.

The only 2 shuttle launches (of 24) for which temperatures were shown in the 13 Challenger charts.

Forecasted O-ring temperatures for the Challenger.

//Charts After Incident

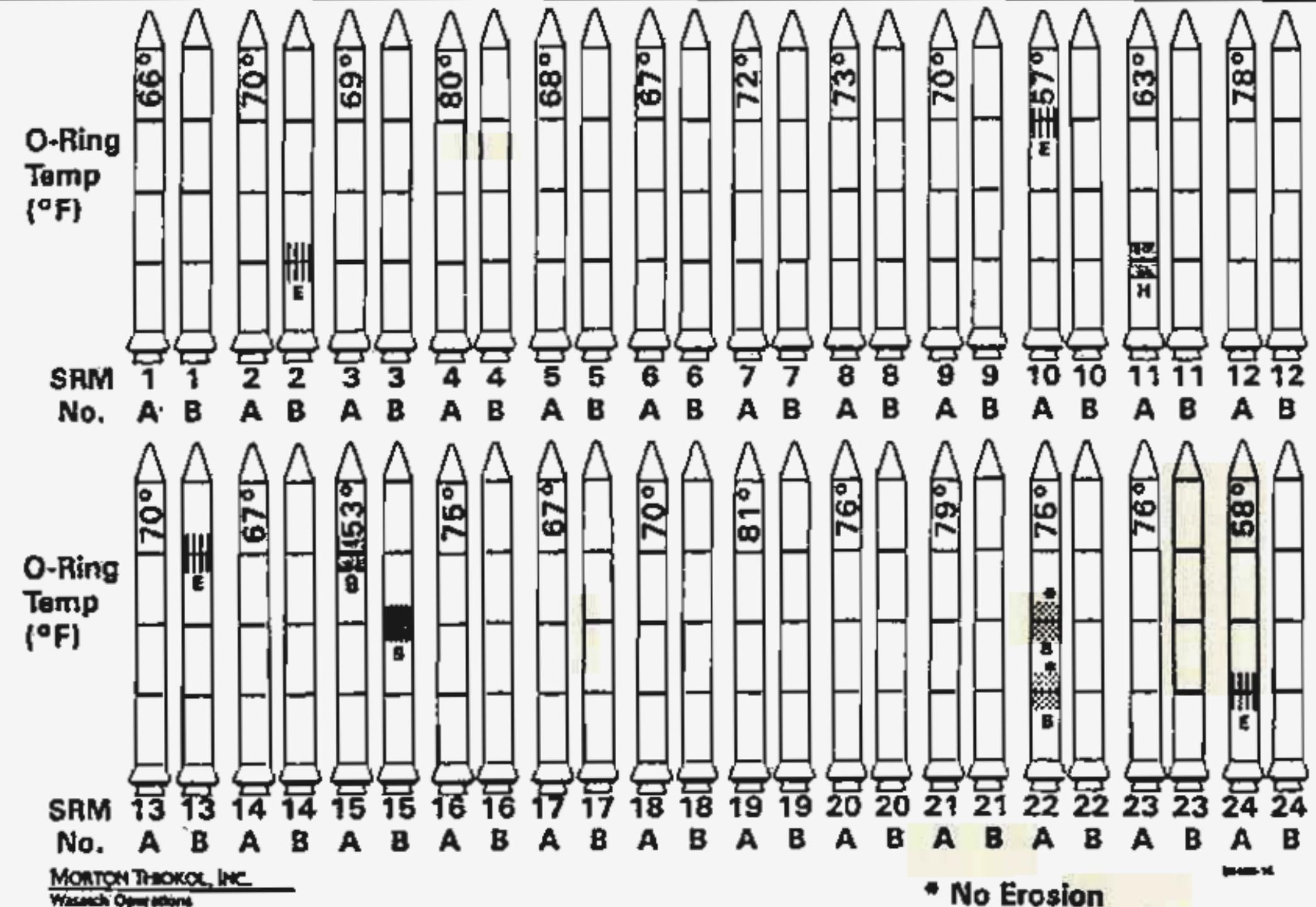
History of O-Ring Damage in Field Joints



MORTON THOKOL, INC.
Wasatch Operations

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AND CANNOT BE CONSIDERED COMPLETE WITHOUT THE ORAL DISCUSSION

History of O-Ring Damage in Field Joints (Cont)



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Fin

//Thank you!

