Ambient Air Monitoring Following Natural Disasters and Industrial Accidents

TOXICOLOGY, RISK ASSESSMENT, & RESEARCH DIVISION

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Outline

- Background, purpose, and goals
- Data sources and analysis method
- Findings of analysis:
  - Emissions
  - Stationary Monitoring
  - Mobile Monitoring
  - Handheld Monitoring
  - EPA ASPECT Data
- Summary and Conclusions

Background

- Natural disasters and industrial accidents have the potential to lead to the release of excess emissions of chemicals into the air.
- For natural disasters, these emissions can be caused by facility shutdown, facility startup, or by damage to the facility.
- These chemical emissions have the potential to affect air quality in a way that could adversely affect human health or could lead to nuisance odor conditions.
- Because of the potential effects on air quality, the TCEQ closely monitors air quality after natural disasters and industrial accidents to ensure protection of public health and the environment.

Purpose and Goal

- **Goal**: To evaluate air monitoring data collected during and after natural and industrial events, to understand how the emissions caused by those events negatively impacted air quality.
- **Purpose**: To aid in the discussion on when, where, and how long to best deploy agency resources after natural disasters, to inform TCEQ's responses to future events.
- The following data were used to conduct this analysis:
  - Emissions
  - Stationary monitoring
  - Mobile monitoring
  - Handheld monitoring
  - Airborne Spectral Photometric Environmental Collection Technology (ASPECT) flyovers

Natural and Industrial Events

Natural Events

- Primary focus of this analysis
- Provide insight into air quality impacts from mass startup of facilities after shutdown in an affected area

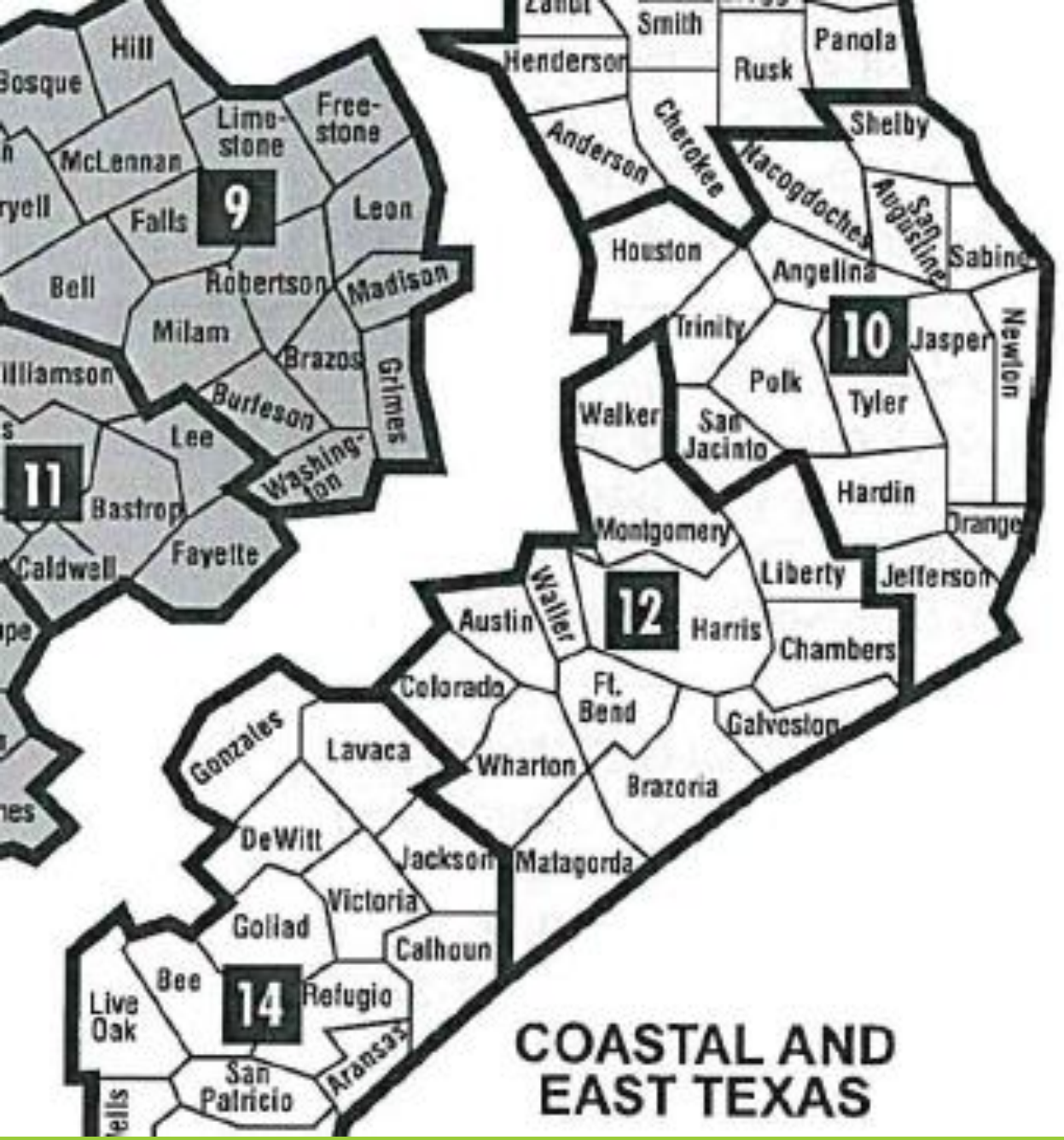
Industrial Events

- Included as a comparison for the natural events, where there is a known (often uncontrolled) release of chemical emissions in a specific area following large-scale industrial accidents

Events and Date Ranges

Events	Event Type	Event Start Date	Date Range for Evaluation	TCEQ Region(s) Affected/ Evaluated
Hurricane Harvey	Natural	August 25, 2017	August 21, 2017 – September 30, 2017	10, 12, 14
ITC Fire	Industrial	March 17, 2019	March 15, 2019 – June 11, 2019	12
TPC Fire	Industrial	November 27, 2019	November 25, 2019 – January 13, 2020	10
Hurricane Laura	Natural	August 27, 2020	August 25, 2020 – September 19, 2020	10, 12
Hurricane Delta	Natural	October 9, 2020	October 7, 2020 – October 12, 2020	10
Winter Storm Uri	Natural	February 13, 2021	February 11, 2021 – March 31, 2021	10, 12, 14

Region 10: Beaumont Region 12: Houston Region 14: Corpus Christi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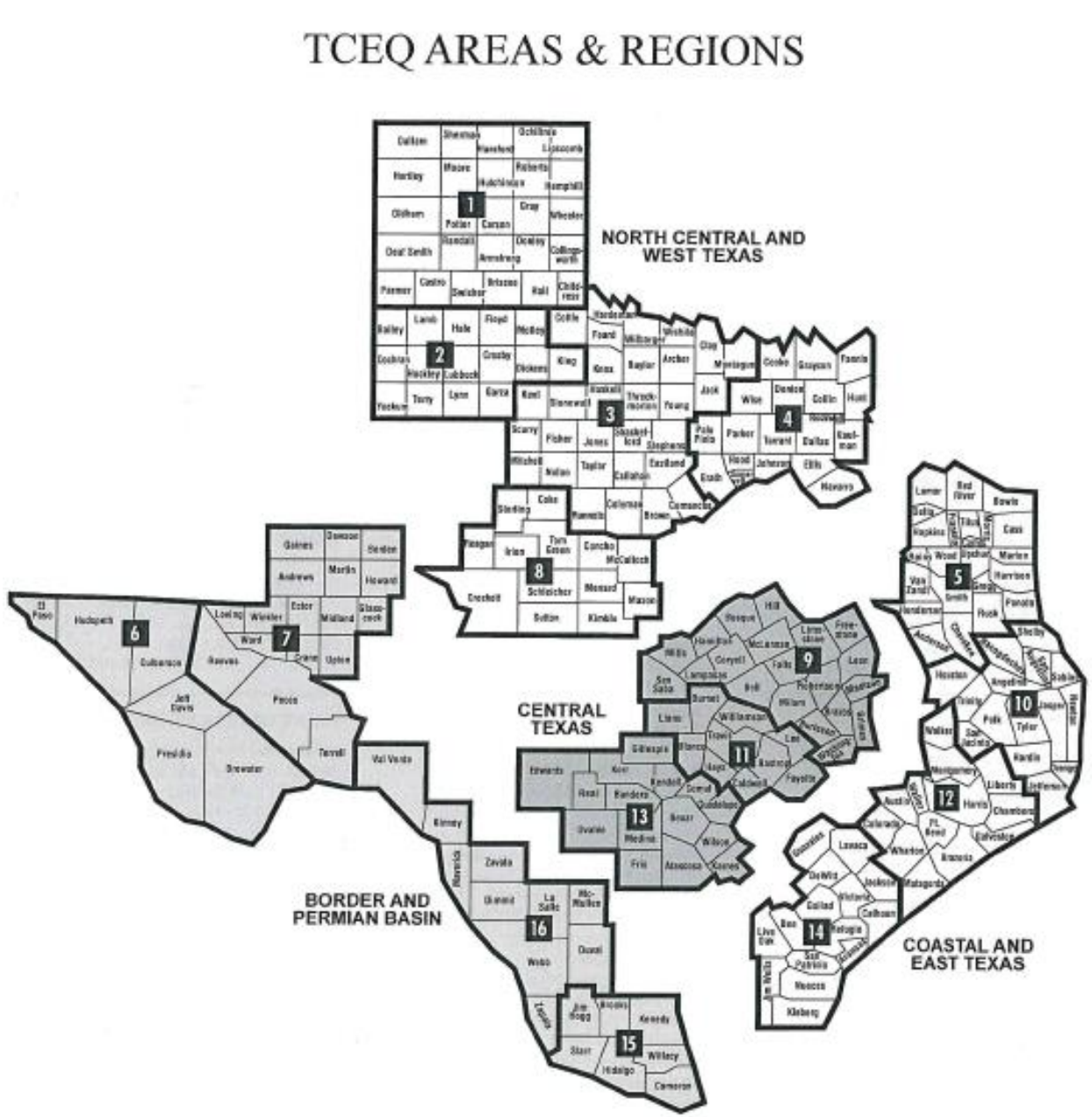
TCEQ AREAS & REGIONS
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TEXAS
BORDER AND
PERMIAN BASIN
COASTAL AND
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Available Data by Event

Event	Emissions Data	Stationary Data	Mobile Data	Handheld Data	ASPECT Data
Hurricane Harvey	Yes	Yes	--	--	Yes
Hurricane Laura	Yes	Yes	Yes	Yes	Yes
Hurricane Delta	Yes	Yes	Yes	Yes	--
Winter Storm Uri	Yes	Yes	Yes	Yes	Yes
ITC Fire	Yes	Yes	Yes	Yes	Yes
TPC Fire	Yes	Yes	--	Yes	--

Evaluation of Emissions and Air Monitoring Data

- Emissions and monitoring data were collected (as available).
- Measured concentrations of chemicals were compared to various benchmark comparison values to determine the number of monitored chemical exceedances associated with each dataset.
- Total amounts of emissions, number of monitoring samples, and number of exceedances were tabulated for each event.
- For winter storm Uri, the timing of reported emissions, monitoring sample collection, and monitored exceedances of comparison values were evaluated.

Evaluation of Air Monitoring Data

Data Stream	Averaging Time	Comparison Value (CV)	Notes
Stationary Data	1 hour	• TCEQ short-term AMCVs (VOCs) • EPA NAAQS levels ($PM_{2.5}$, CO, NO_2, SO_2)	
Mobile Data	1 - 6 seconds; 30 minutes*	• TCEQ short-term AMCVs (VOCs) • EPA NAAQS levels (NO_2, SO_2, O_3) • State standards (H_2S)	Conservative comparison: health conclusions cannot be drawn based on a single instantaneous concentration exceeding a short-term CV
Handheld Data	~ 1 second	• TCEQ short-term AMCVs (VOCs) • EPA NAAQS levels (CO, SO_2) • State standards (H_2S) • Background levels (total VOCs)	Conservative comparison: health conclusions cannot be drawn based on a single instantaneous concentration exceeding a short-term CV
ASPECT		None	ASPECT data are not comparable with ground-level CVs

*30-minute samples for ITC fire mobile monitoring only

AMCVs – Air Monitoring Comparison Values. Short-term AMCVs are developed for comparison to 1-hour air monitoring data.

NAAQS – National Ambient Air Quality Standards. NAAQS are promulgated by EPA for compliance purposes, but their levels were used unofficially as a CV

14 Common Analytes

- 1,3-Butadiene
- 1-Butene (1-butylene)
- Acetylene
- Benzene
- Cyclohexane
- Ethylbenzene
- Isobutane
- m/p-Xylene
- n-Hexane (hexane)
- n-Octane (octane)
- o-Xylene
- Propylene
- Styrene
- Toluene

Some or all of these common compounds were monitored across the data streams (i.e., emissions reports, stationary autoGC data, mobile monitoring data, handheld data, and ASPECT surveillance data).

Emissions Data

Emissions in excess of permitted amounts are required to be reported to TCEQ, and are captured in the State of Texas Environmental Electronic Reporting System (STEERS) database

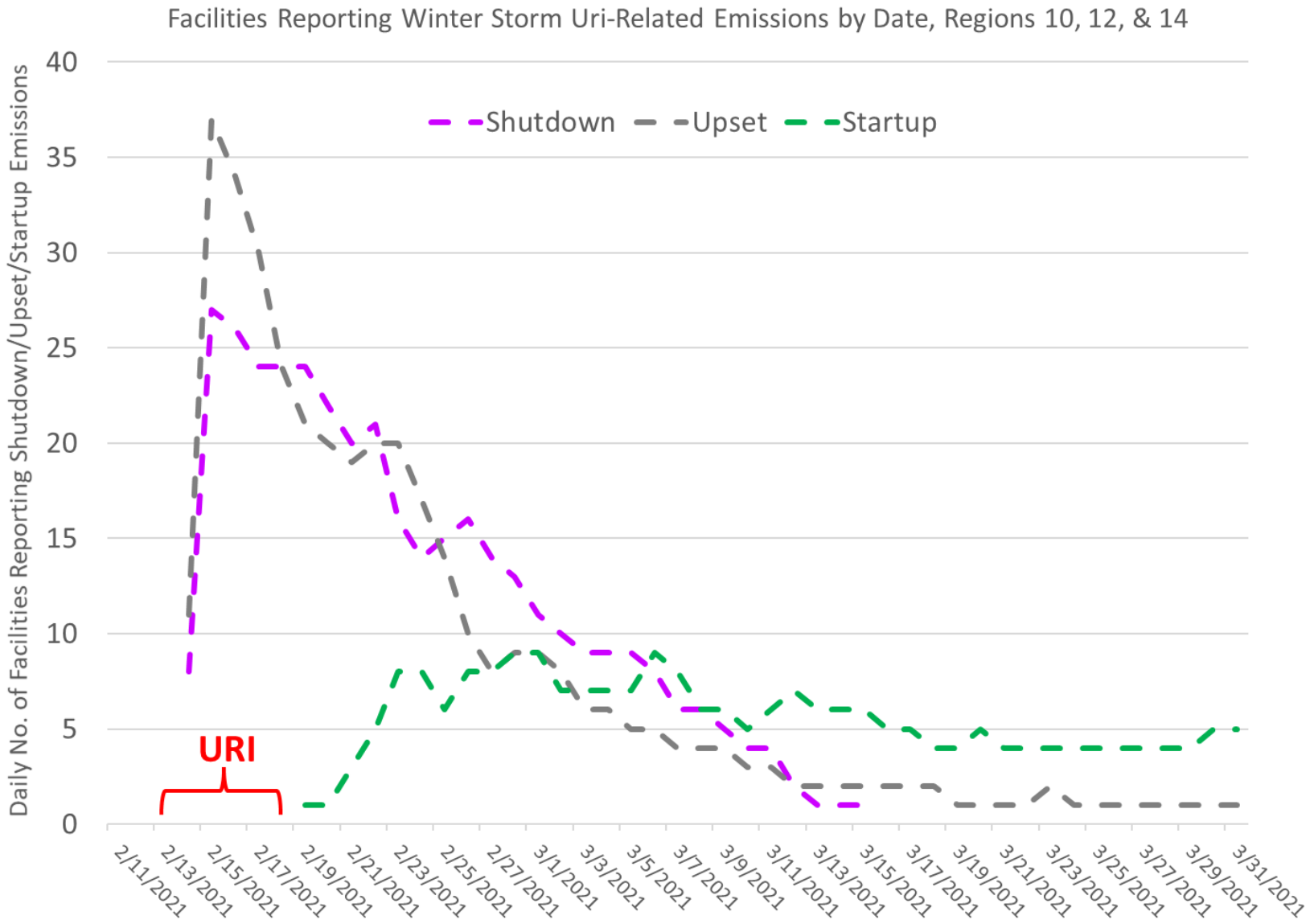
Event-Attributable Emissions

Event	Total Reportable Emissions (lbs)	Benzene	1,3-Butadiene	Carbon Monoxide*	Sulfur Dioxide*	Nitrogen Oxides*
Hurricane Harvey	14,225,386	34,424	37,140	2,954,375	4,437,028	1,748,334
Hurricane Laura	607,396	537	1,161	345,779	37,755	29,245
Hurricane Delta	480,211	4,127	488	254,331	19,448	29,220
Winter Storm Uri[#]	4,714,693	40,078	37,471	1,592,817	1,114,528	358,142
Natural Event Total	**20,027,686**	**79,166**	**76,260**	**5,147,302**	**5,608,759**	**2,164,941**
ITC Fire	16,471,095	652,773	5,551	1,789,685	29,054	44,132
TPC Fire	1,214,586	166	257,640	207,260	13,160	16,300
Industrial Event Total	**17,685,681**	**652,939**	**263,191**	**1,996,945**	**42,214**	**60,432**

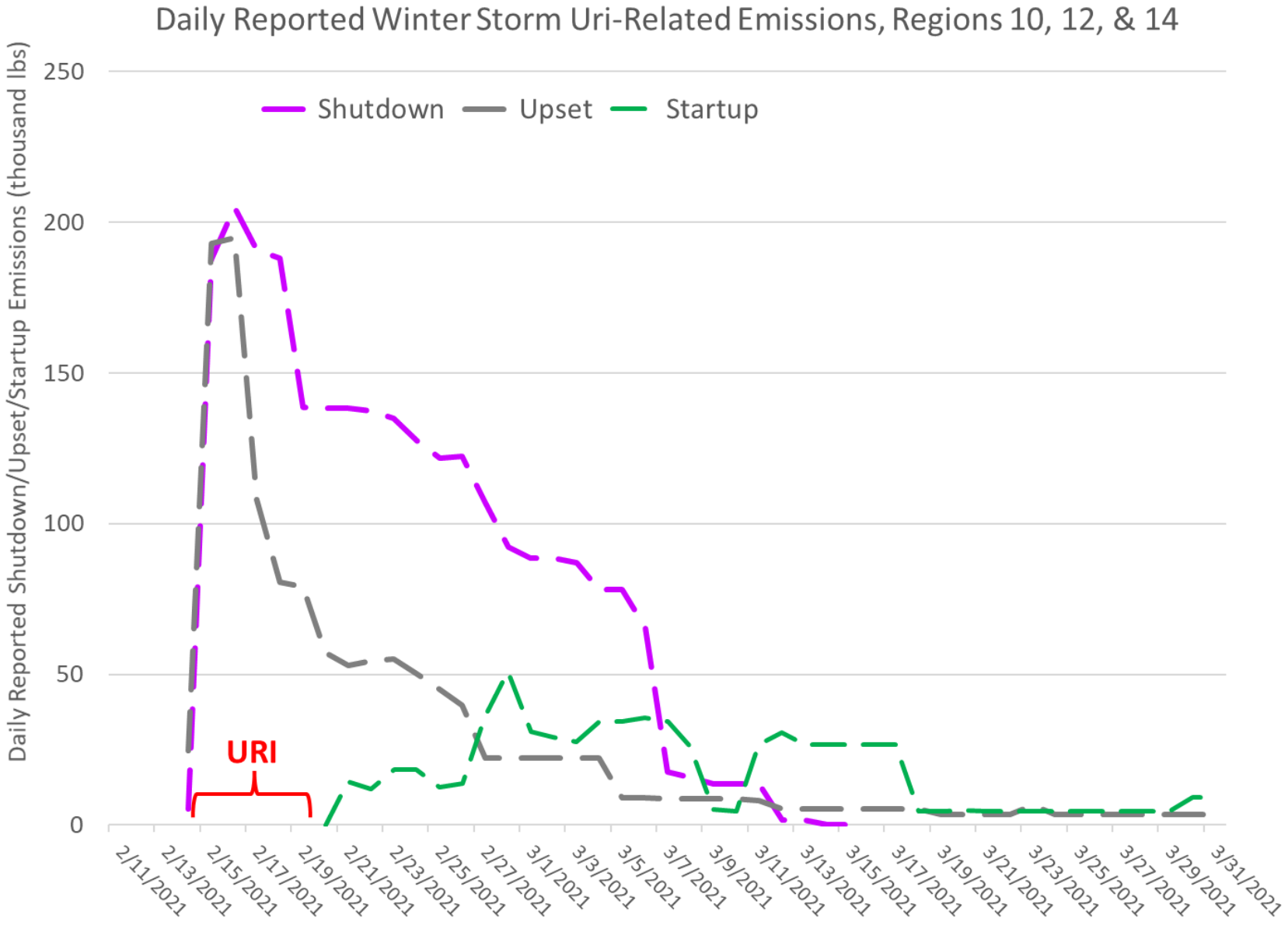
***Carbon Monoxide, Sulfur Dioxide, and Nitrogen Oxides are contaminants that are commonly responsible for large amounts of reportable emissions for individual events.**

[#]Emissions totals for Winter Storm Uri include only those reported for Beaumont, Houston, and Corpus Christi regions, because those were the regions evaluated in this report.

Facilities Reporting Emissions During/After Winter Storm Uri



Pounds of Facility Emissions During/After Winter Storm Uri



Stationary Monitoring Data

Continuous $PM_{2.5}$ by Event

Event	Days Covered	# Samples	# Exceed	Notes on Exceedances
ITC Fire	5	537	0	5 continuous $PM_{2.5}$ monitors: Date range March 17-21, 2019; 1 continuous $PM_{2.5}$ monitor: Date range March 20-21, 2019
TPC Fire	5	480	0	4 continuous $PM_{2.5}$ monitors: Date range November 27-December 1, 2019
Industrial Event Total	**10**	**1,017**	**0**	

$PM_{2.5}$ – Particulate matter less than or equal to 2.5 µm in diameter
All 24-hr average concentrations of $PM_{2.5}$ were well below the level of the 24-hour NAAQS (35 µg/m³).

Continuous CO, NO_2, and SO_2 by Event

Event	Days Covered	# Samples	# Exceed	Notes on Exceedances
Hurricane Harvey	41	42,082	1	SO_2 (R12 - Houston)
Hurricane Laura	23	23,381	0	
Hurricane Delta	6	1,396	0	
Winter Storm Uri	49	46,388	2	SO_2 (R10 - Beaumont)
Natural Event Total	**119**	**113,247**	**3**	**0.0026% Exceeded**
ITC Fire	89	72,426	0	
TPC Fire	50	16,251	1	NO_2
Industrial Event Total	**139**	**88,677**	**1**	**0.0011% Exceeded**

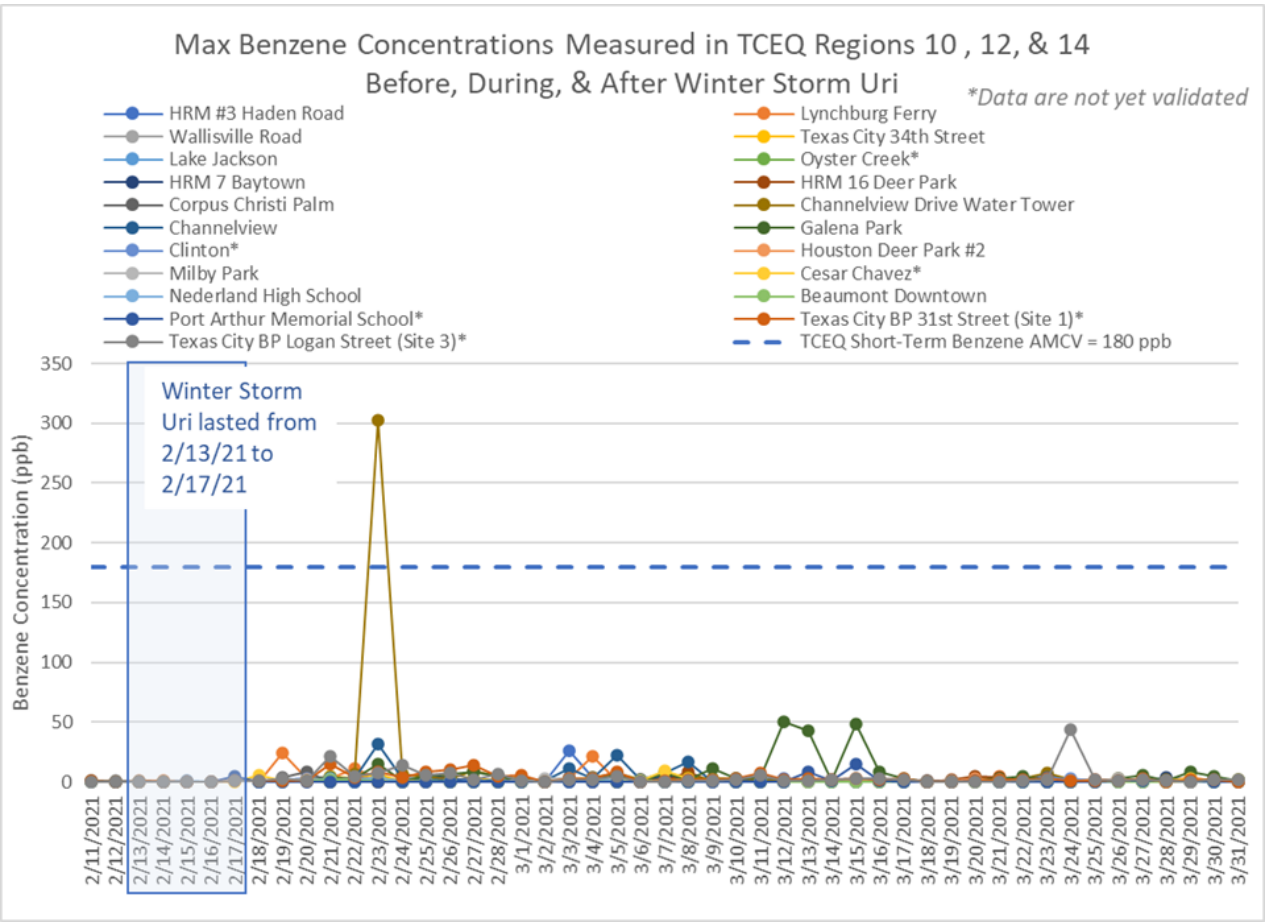
Stationary VOC Monitoring by Event

Event	Days Covered	# Samples (all VOCs)	# Exceed	# Health Exceed	# Odor Exceed	Notes on Exceedances
Hurricane Harvey	41	385,545	1	0	1	Isoprene odor
Hurricane Laura	23	265,243	0	0	0	
Hurricane Delta	6	11,271	0	0	0	
Winter Storm Uri	49	737,262	8	1	7	1 Benzene Health; 3 Styrene Odor; 4 Isoprene Odor
Natural Event Total	**119**	**1,399,321**	**9**	**1**	**8**	**0.00064% Exceeded**
ITC Fire	89	1,059,800	3	2	1	2 Benzene Health; 1 Styrene Odor
TPC Fire	50	93,530	0	0	0	
Industrial Event Total	**139**	**1,153,330**	**3**	**2**	**1**	**0.00026% Exceeded**

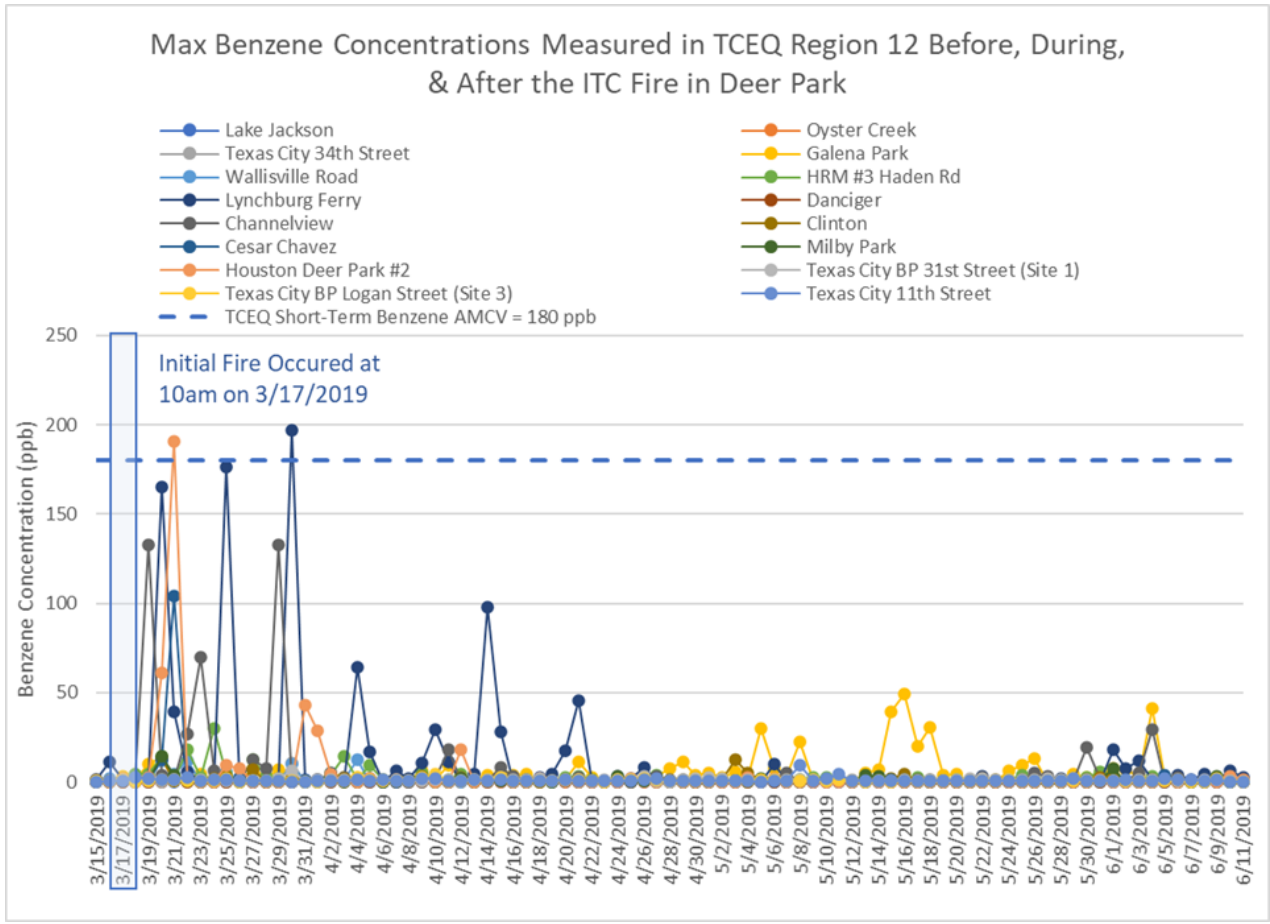
VOC – Volatile organic compound

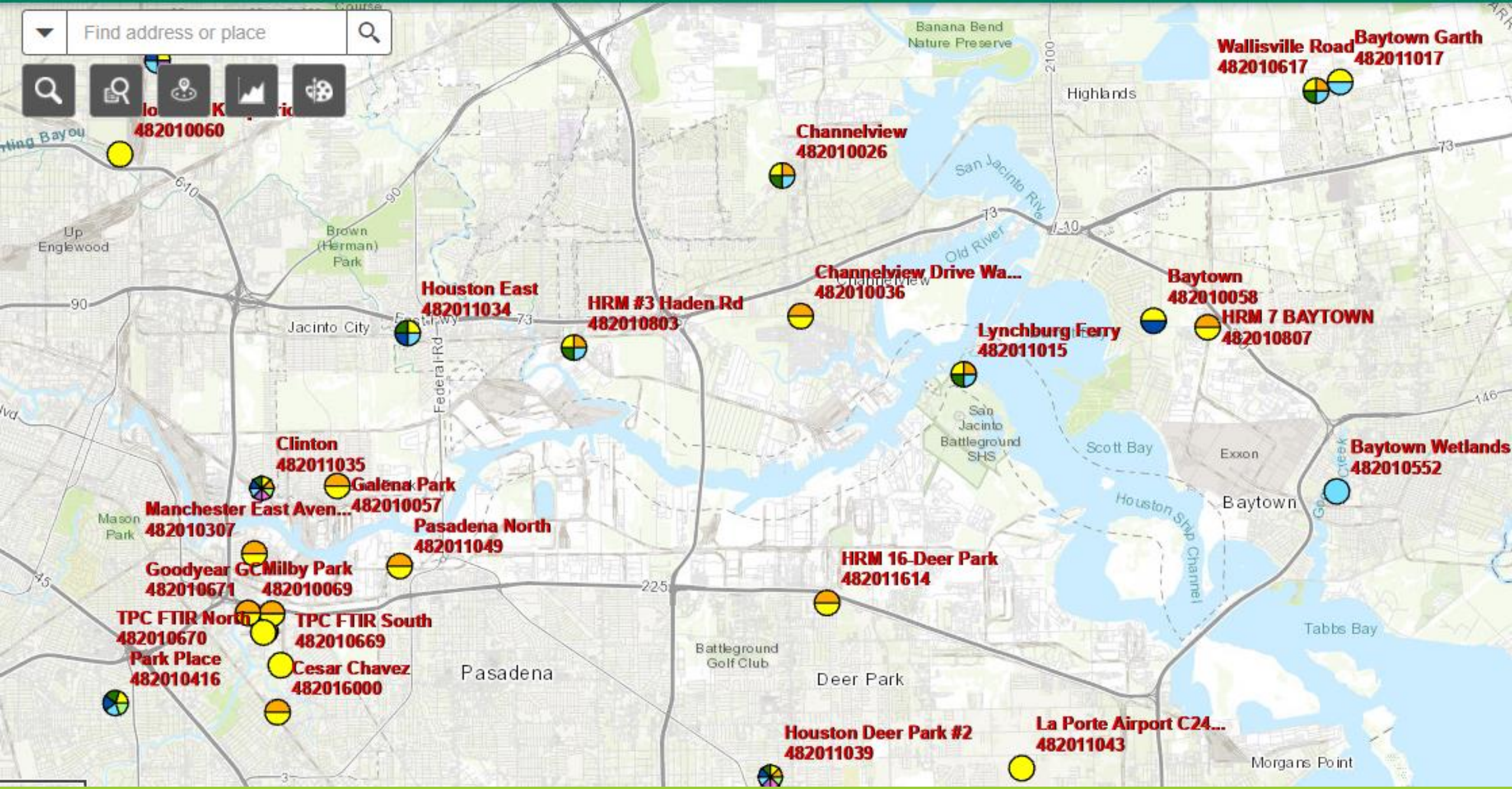
Daily Max Benzene Concentrations

Winter Storm Uri: Benzene



ITC Fire: Benzene

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San Jacinto Battleground SHS
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Tabbs Bay
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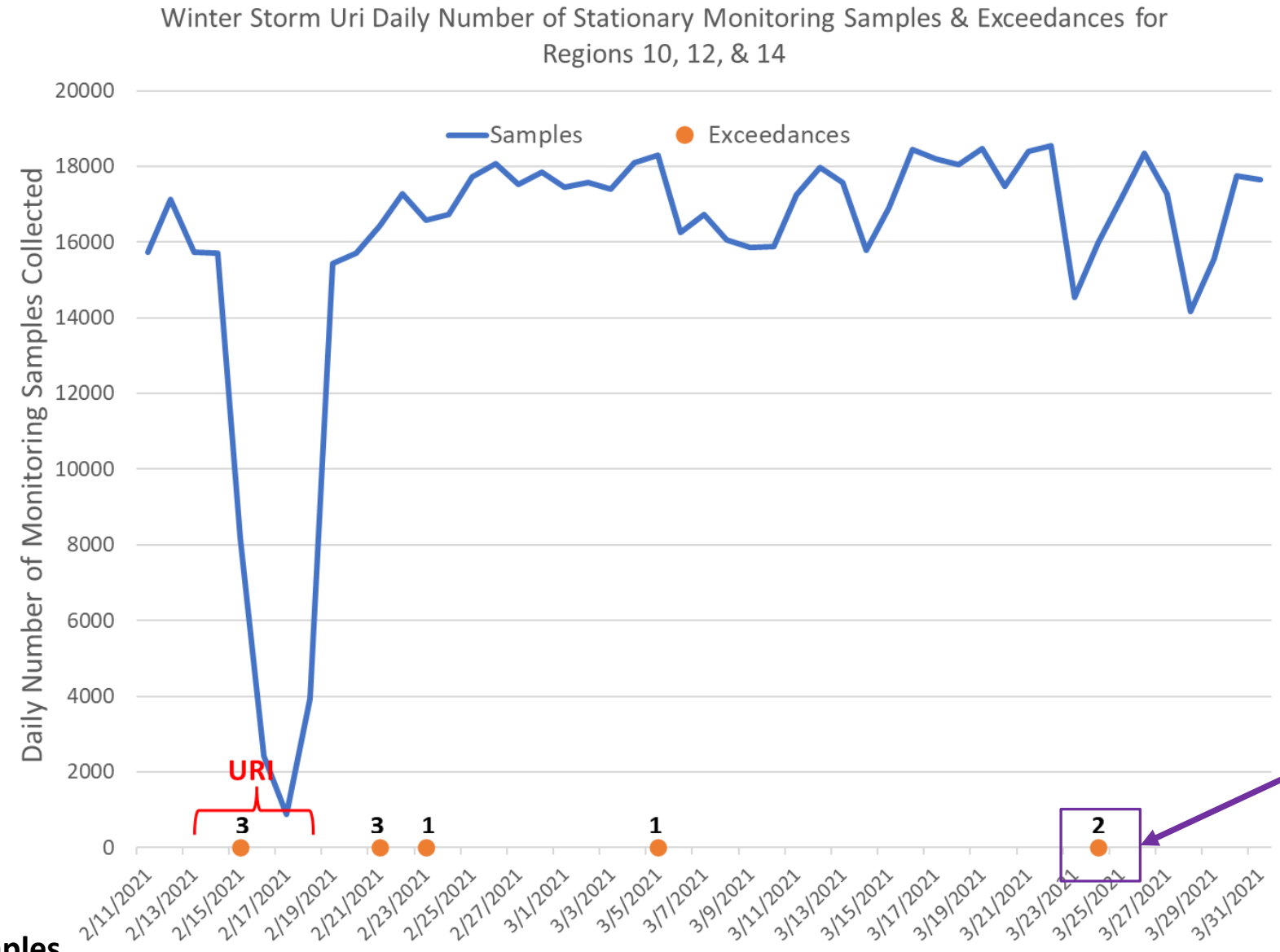
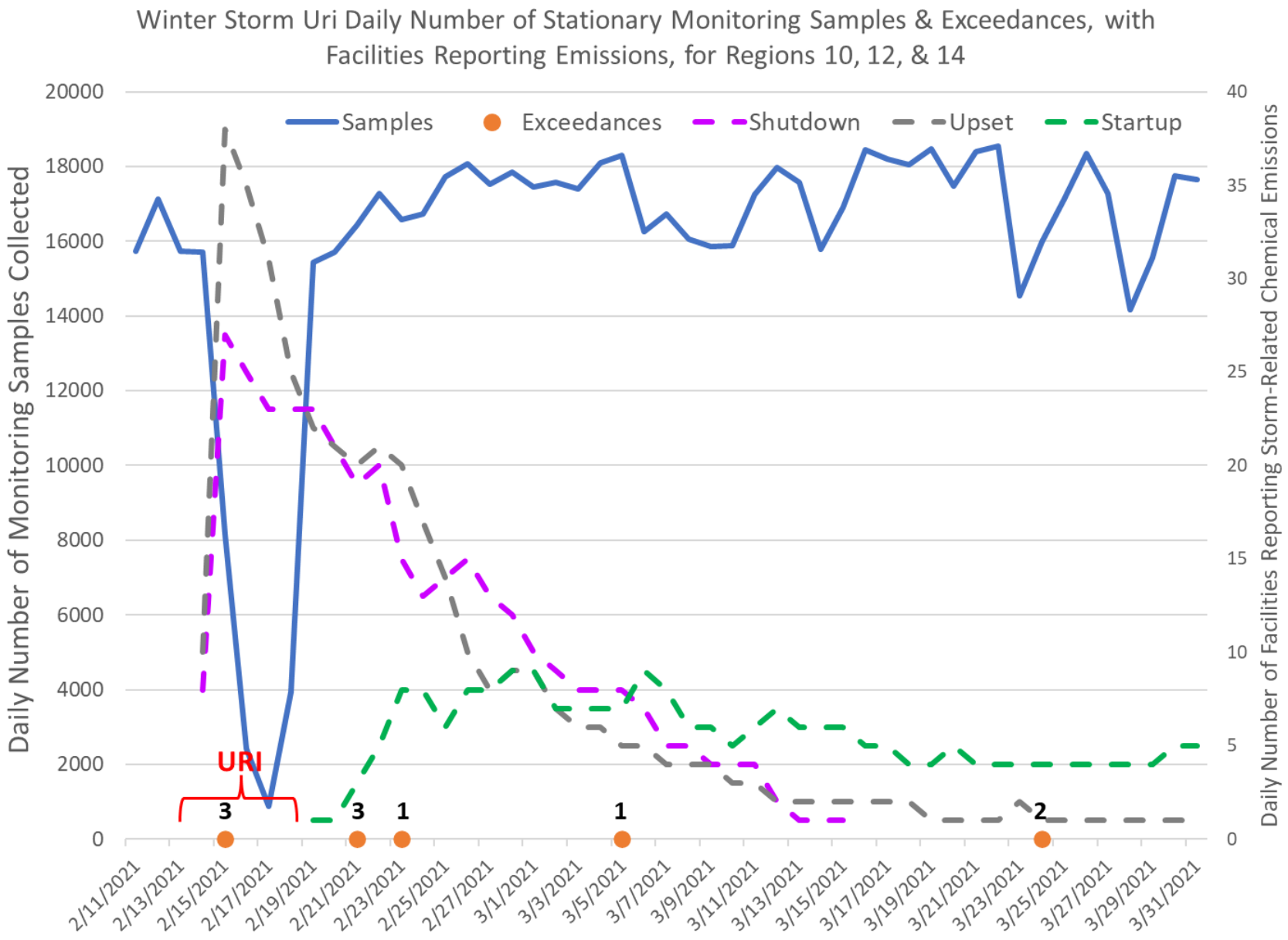
Mason Park

Uri: Timing of Stationary Monitoring and Exceedances



Percent of total samples with exceedances that day:

Uri: Timing of Stationary Monitoring, Exceedances, and Emissions



Solids Lines & Dots: Monitoring Data

Dashed Lines: Emissions

Mobile Monitoring Data

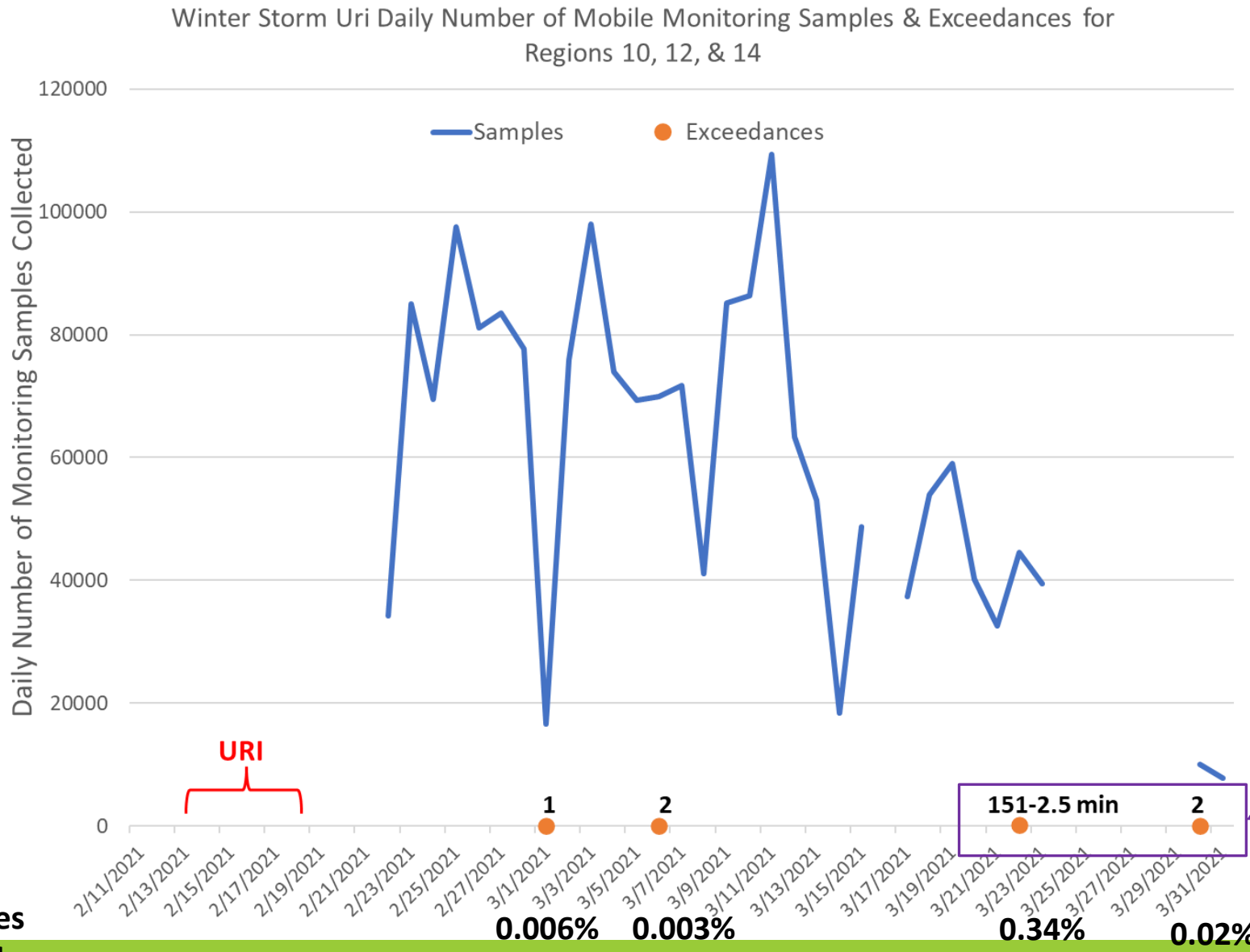
These are 1-6 second samples and were conservatively compared to short-term Comparison Values (CVs) – health conclusions cannot be drawn based on a single instantaneous concentration exceeding a short-term CV.

Mobile Monitoring by Event

Event	# Days of Sampling	# Samples	# Exceed	# Health Exceed	# Odor Exceed	Notes on Exceedances
Hurricane Laura	9	213,475	110	0	110	36 & 72 sec > styrene odor AMCV*; 12 sec (2 samples) > 1,3-butadiene odor AMCV
Hurricane Delta	3	57,037	0	0	0	
Winter Storm Uri	31	1,831,468	156	0	154	~2.5 min > styrene odor AMCV; 2 x 6 sec > ethane + ethylene vegetation AMCV
Natural Event Total	**43**	**2,101,980**	**266**	**0**	**264**	**0.013% Exceeded (on 6 occasions, 1-sec data)**
ITC Fire	50	266,940	9	7	2	7 x 20-30 min > benzene health AMCV; 2 x 20-30 min > styrene odor AMCV
Industrial Event Total	**50**	**266,940**	**9**	**7**	**2**	**0.0034% Exceeded (30-min data)**

***Styrene exceedances were only marginally higher than the odor AMCV, in the presence of high instrument baseline**

Uri: Timing of Mobile Monitoring and Exceedances

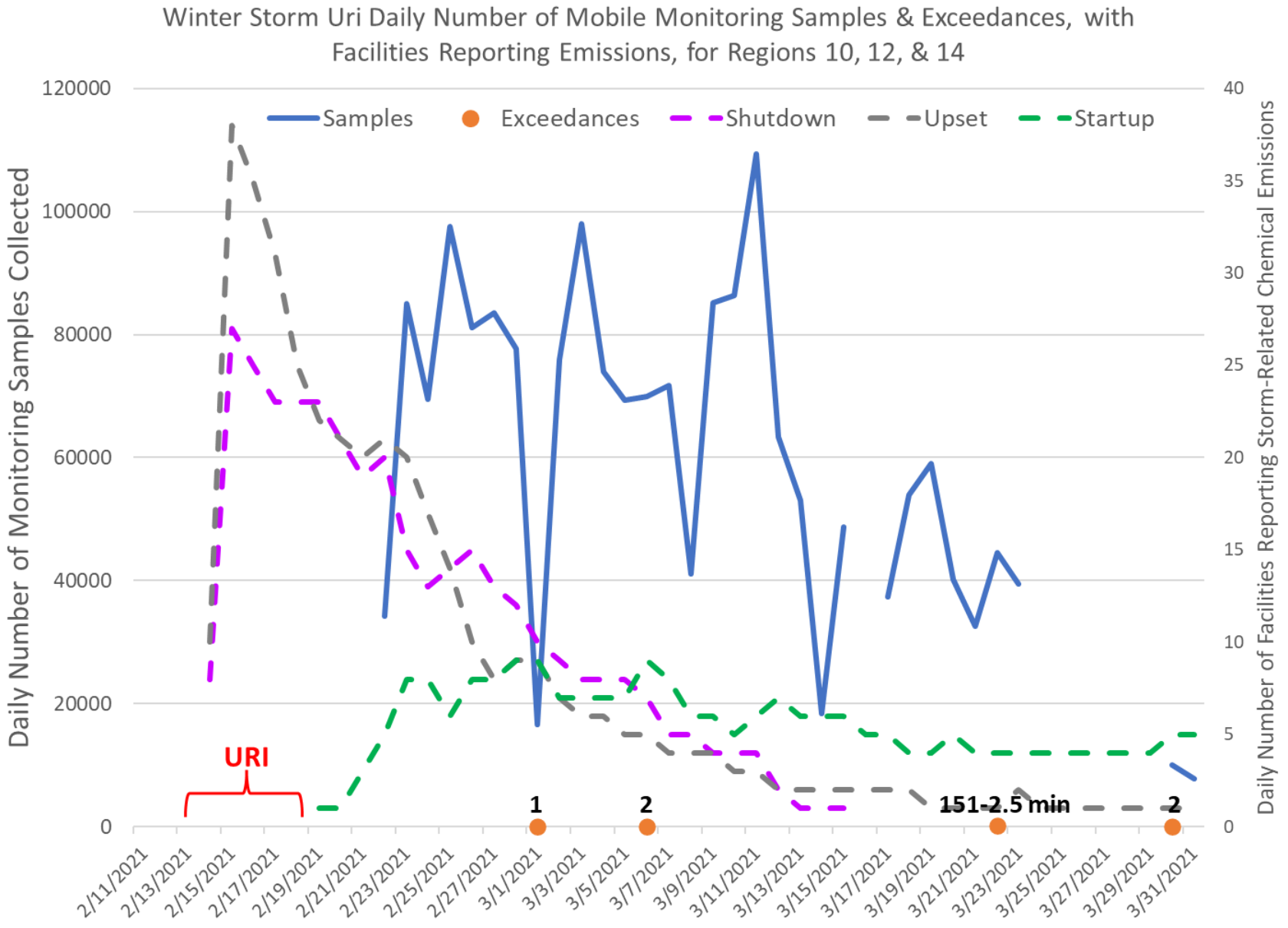


These are 1-6 second samples and were conservatively compared to short-term Comparison Values (CVs) – health conclusions cannot be drawn based on a single instantaneous concentration exceeding a short-term CV.

No storm-related emission events in vicinity of these exceedances

Percent of total samples with exceedances that day:

Uri: Timing of Mobile Monitoring, Exceedances, and Emissions



Solids Lines & Dots: Monitoring Data

Dashed Lines: Emissions

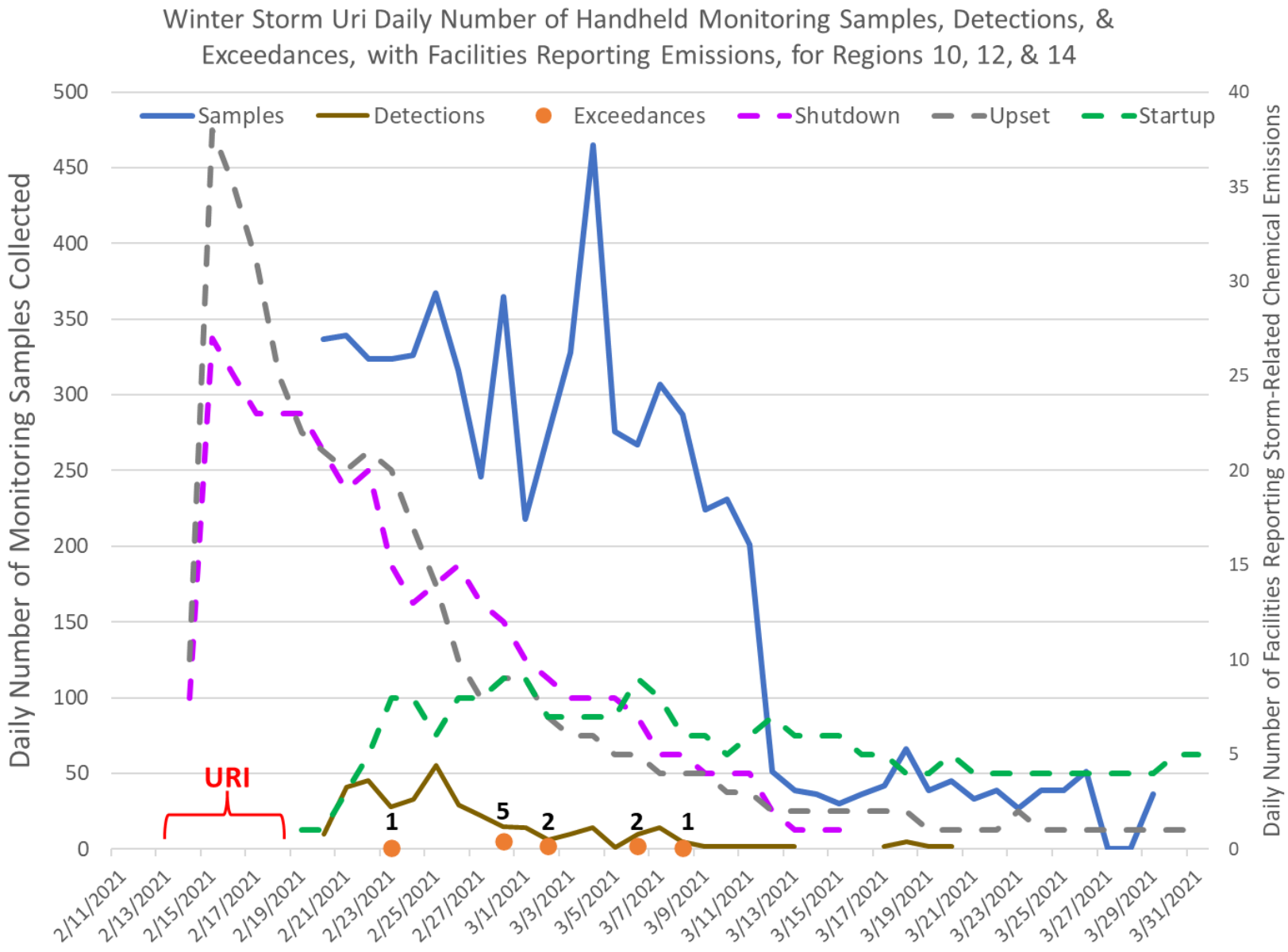
Handheld Monitoring Data

These are 1-second samples and were conservatively compared to short-term Comparison Values (CVs) – health conclusions cannot be drawn based on a single instantaneous concentration exceeding a short-term CV.

Handheld Sampling by Event

Event	# Days of Sampling	# Samples	# Exceed	# Health Exceed	# Odor Exceed	# Background Exceed	Notes on Exceedances
Hurricane Laura	20	7,129	25	14	10	1	H_2S (10 state std); HCN (14 health); VOC (1 background)
Hurricane Delta	3	285	0	0	0	0	
Winter Storm Uri	36	6,669	11	5	6	0	CO (1 health); HCN (3 health); H_2S (6 state std); NH_3 (1 health)
Natural Event Total	**59**	**14,083**	**36**	**19**	**16**	**1**	**0.26% Exceeded**
ITC Fire	87	56,859	358	161	0	197	VOC (197 background); Benzene (56 health); CO (2 health); SO_2 (25 health); Cl_2 (78 health)
TPC Fire	48	15,089	107	44	40	23	VOC (23 background); H_2S (1 state std); SO_2 (1 health); 1,3-butadiene (10 health & 39 odor); HCN (33 health)
Industrial Event Total	**135**	**71,948**	**465**	**205**	**40**	**220**	**0.65% Exceeded**

Uri: Timing of Handheld Monitoring, Exceedances, and Emissions



Solids Lines & Dots: Monitoring Data

Dashed Lines: Emissions

Summary and Conclusions

Summary: Exceedances after Natural & Industrial Events

- Natural Events:
  - Out of approximately 3.6 million data points, only 311 (0.0086%) were above health- or odor-based comparison values.
  - Most exceedances were odorous (288 out of 311), which may help explain odor complaints in media coverage.
  - Health exceedances were typically marginally higher than the comparison value and transient in nature: exposure would not be expected to result in adverse health effects

- Industrial Events:
  - Approximately 1.6 million data points, with 215 health-based, 43 odor-based, and 220 background VOC exceedances.

Summary: Timing of Emissions and Exceedances after Winter Storm Uri

- Most monitored exceedances of comparison values occurred within the first few weeks after the storm event. Later exceedances were rarely in a location that had a reported storm-related excess emission event.
- No clear correlation between the number of facilities with storm-related startup/shutdown/upset emissions and the number of monitored exceedances of comparison values.
- The number of facilities reporting startup excess emissions was fairly constant for several weeks after the storm. Therefore, there was no clear clustering of startup-related emissions at a particular time.

Conclusions and Final Notes

- Monitored exceedances after natural events are very rare and are typically above odor levels, not health levels. They occur in the first few weeks after the natural event.
- Monitored exceedances after industrial events are more likely to be above health-based levels, but shelters-in-place decrease exposure.

- Important Notes:
  - The 1-6 second mobile and handheld samples were conservatively compared to short-term comparison values – health conclusions cannot be drawn based on a single instantaneous concentration exceedance.
  - Regardless of whether chemical concentrations in an area exceeded CVs, if a facility reports an emission of a chemical in excess of permitted amounts, the TCEQ will investigate and take enforcement action when appropriate.

Acknowledgements

- Hundreds of TCEQ staff gathered data and conducted investigative work to generate the information that was used in this analysis. This included monitoring data collection, data validation, quality assurance, and investigative review of emissions reports.
- A team of 6 toxicologists compiled and analyzed the data:
  - Janet Hamilton, PhD
  - Sabine Lange, PhD
  - Stony Lo, PhD
  - Darrell McCant, MPH
  - Tracie Phillips, PhD
  - Swati Rawat, PhD