Major Stationary Source Precursor Demonstration for NOx, SOx, VOC, and NH_3 in the Salt Lake City 24-hour $PM_{2.5}$ Serious Nonattainment Area

Final Report

Prepared for:
Utah Petroleum Association
10714 S. Jordan Gateway
Suite 160
South Jordan, UT 84095

Prepared by:
Chris Emery, Sue Kemball-Cook, Michele Jimenez,
Ross Beardsley, Tejas Shah

Ramboll Environment and Health
773 San Marin Drive, Suite 2115
Novato, California, 94998
www.ramboll.com
P-415-899-0700
F-415-899-0707

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EXECUTIVE SUMMARY

This report documents a major stationary source precursor demonstration (MSSPD) for the Salt Lake City (SLC) 24-hour Fine Particulate ($PM_{2.5}$) Serious Nonattainment Area (NAA). The demonstration addresses four emitted compounds known to contribute to secondary formation of ambient $PM_{2.5}$: nitrogen oxides (NOx), sulfur oxides (SOx), volatile organic compounds (VOC), and ammonia (NH_3). The approach follows the US Environmental Protection Agency's (EPA) draft precursor demonstration guidance (EPA, 2016b) for both contribution-based and sensitivity-based analyses. The demonstration employs the current Utah Division of Air Quality's (UDAQ) January 2011 photochemical modeling platform supporting the development of the SLC NAA State Implementation Plan (SIP)[1], and so this demonstration is directly relevant and parallel to UDAQ's technical analyses. We have adopted EPA's recommended threshold of 1.5 $\mu g/m^3$ for assessing whether a contribution is significant.[2]

EPA defines stationary facility sources in Serious $PM_{2.5}$ Nonattainment Areas as "major" if direct $PM_{2.5}$ or any precursor emissions equal or exceed 70 tons per year (TPY) based on their permitted "potential to emit" (PTE) rates (40 CFR 51.1000 Definitions). We cross-referenced stationary sources in the UDAQ point source inventory to their permitted PTE rates, and identified 19 facilities within the SLC NAA that may emit at least 70 TPY of $PM_{2.5}$ or any precursor emissions as major stationary sources for this demonstration (Section 2.1).

The photochemical modeling platform provided by UDAQ included a 2014 "base year" emissions scenario and a 2019 "future year" scenario. Initial MSSPD analyses for NOx and SOx were conducted using the 2014 scenario (Appendix B) and are not discussed further here. Based on discussions with UDAQ, final MSSPD analyses for NOx, SOx, VOC and NH_3 were conducted using the 2019 scenario, as described below (Sections 3-6). UDAQ had not completed their 2019 point source projections at the time Ramboll received the 2019 emission files, so we carried forward the 2014 point source emissions to the 2019 scenario while including SOx reductions at three refineries to account for emission controls implemented since 2014, and a correction to reported NH_3 emissions at one refinery (Section 2.2). Our model results show that the refinery SOx adjustments result in $PM_{2.5}$ reductions of up to 3.6 $\mu g/m^3$ at the limiting SLC monitoring site (Hawthorne) during peak episode days.

For the 2019 MSSPD analyses, we zeroed-out NOx, SOx, VOC and NH_3 precursor emissions from major stationary sources to determine $PM_{2.5}$ contribution. Additionally, we reduced SO_2 emissions from major stationary sources by 30, 50 and 70% to determine $PM_{2.5}$ sensitivity to that precursor. We made no modifications to emissions of any other species or sectors. We

[1] The UDAQ photochemical model is run for an exceedance $PM_{2.5}$ episode that occurred during the cold air pool event of January 1-10, 2011. See Appendix A for more information.

[2] Draft EPA (2016b) guidance recommended 1.3 $\mu g/m^3$ for the $PM_{2.5}$ 24-hour NAAQS as the appropriate threshold "for identifying an air quality change that is 'insignificant' and thus does not 'contribute' to $PM_{2.5}$ concentrations subject to the current $PM_{2.5}$ NAAQS." This was based on the initial EPA (2016a) technical basis analysis. More recently, however, EPA (2018) updated and finalized their technical basis document, which now recommends a threshold for identifying significance of 1.5 $\mu g/m^3$.

ran the model for the entirety of the January 2011 modeling episode with the 2019 emissions inventory, and compared the resulting concentration fields of total 24-hour $PM_{2.5}$ to output from model runs using the zeroed-out point source NOx, SOx, VOC, and NH_3 emissions, and the 30, 50, and 70% SO_2 emission reductions. Following EPA guidance, concentration differences calculated at each monitoring site within the SLC NAA and for all days encompassed by the 2011 modeling episode determined major stationary source contributions and sensitivity.

Estimated 2019 NOx contributions (via zero-out) to daily 24-hour $PM_{2.5}$ at each monitoring site fell well below the significance threshold of 1.5 $\mu g/m^3$. Estimated 2019 SOx contributions from major stationary sources approached the 1.5 $\mu g/m^3$ threshold on a single episode day at one site, but remained less than the threshold over all sites and days. We also performed SOx sensitivity reductions of 30 to 70% for major stationary sources, which showed $PM_{2.5}$ sensitivity well below the threshold. Estimated 2019 VOC contributions from major stationary sources also resulted in $PM_{2.5}$ impacts orders of magnitude smaller than the threshold. Finally, the model also indicated no 2019 NH_3 contributions from major stationary sources above the threshold.

From this major stationary source precursor modeling demonstration, we conclude that the model shows contributions from major stationary source NOx, SOx, VOC and NH_3 precursor emissions to 24-hour $PM_{2.5}$ concentrations within the SLC NAA that are below EPA's 1.5 $\mu g/m^3$ threshold for significance. Although NH_3 emissions from major stationary sources are well-quantified, two factors complicate understanding their contributions to $PM_{2.5}$:

(1) A poor understanding of non-point NH_3 emission sources in the region;
(2) UDAQ's artificial "injection" of additional NH_3 emissions into the model to address an underestimate of NH_3 in their inventory, which UDAQ diagnosed through comparison of modeled and measured ammonium.

UDAQ's adjustment may influence the stationary source NH_3 contributions reported here.

1.0 INTRODUCTION

The US Environmental Protection Agency (EPA) designated the Salt Lake City (SLC) Nonattainment Area (NAA) as Serious for the 24-hour fine particulate ($PM_{2.5}$) National Ambient Air Quality Standard (NAAQS) (Federal Register, 2017). The $PM_{2.5}$ State Implementation Plan (SIP) Requirements Rule issued by EPA in August 2016 for Serious Areas (Federal Register, 2016) requires SIP revisions that include an attainment demonstration of the $PM_{2.5}$ NAAQS. To provide the technical underpinnings of the SLC Serious Area $PM_{2.5}$ SIP, the Utah Division of Air Quality (UDAQ) has developed a photochemical modeling platform that simulates conditions during a January 2011 persistent cold air pool (PCAP) event that resulted in exceedances of the $PM_{2.5}$ NAAQS over multiple days in SLC. The UDAQ photochemical modeling platform is based on the Comprehensive Air quality Model with extensions (CAMx; Ramboll, 2018). UDAQ has prepared emission inventories for this modeling platform that represent the years 2014, 2016 and 2019, from which the model will project future-year 24-hour $PM_{2.5}$ Design Values (DV). Besides accounting for economic and population projections in the region, the 2019 emission inventory must reflect local emission reductions for area and industrial point sources, as well as federal programs affecting on-road and non-road mobile sources, that will result in the SLC NAA attaining the $PM_{2.5}$ NAAQS.

The $PM_{2.5}$ SIP Requirements Rule identifies nitrogen oxides (NOx), sulfur oxides (SOx), volatile organic compounds (VOC) and ammonia (NH_3) as the $PM_{2.5}$ precursors that must presumptively be evaluated for potential control measures. The rule allows this presumption to be overcome on a precursor-specific basis as long as it can be demonstrated that any one of these precursors emitted within the nonattainment area does not significantly contribute to NAAQS levels. It also allows for a similar analysis for Nonattainment New Source Review (NNSR) programs, which is not considered here. The scope of such precursor demonstrations may extend comprehensively to all sources (a "comprehensive precursor demonstration") or may be limited to major sources (a "major stationary source precursor demonstration") depending on the extent of the demonstration. If a precursor demonstration is approved by the EPA, the state will not be required to control emissions of the relevant precursor for sources consistent with the scope of the demonstration.

The $PM_{2.5}$ SIP Requirements Rule outlines a two-step analysis[3] applicable to both comprehensive and major source demonstrations. The first step determines whether all emissions of a precursor from the sources being evaluated contribute significantly to $PM_{2.5}$ levels. Analyses may be based on air quality monitoring data in the area or on air quality modeling. If the first step does not support a finding of insignificant contribution, a second step may be performed, referred to as a "sensitivity-based" analysis, which evaluates the effect of reducing emissions of a precursor on $PM_{2.5}$ levels in the area. $PM_{2.5}$ precursor demonstration guidance from EPA (2016b) recommends an emission reduction range of 30 to 70% for sensitivity analyses.

[3] 40 CFR 51.1006(a)(1) and 40 CFR 51.1006(a)(2)

This report documents a major stationary source precursor demonstration (MSSPD) performed for NOx, SOx, VOC, and NH_3 in the SLC NAA. The approach is consistent with EPA's draft precursor demonstration guidance (EPA, 2016b). The demonstration employs the UDAQ 2011 photochemical modeling platform that will support the development of the SLC NAA SIP, and so this demonstration is directly relevant and parallel to UDAQ's technical analyses[4]. Appendix A details UDAQ's delivery of modeling datasets to Ramboll and which versions of their modeling platform were used in the analyses documented here. A determination of significance was based on EPA's recommended threshold of 1.5 $\mu g/m^3$ EPA (2018)[5].

Section 2 describes the UDAQ 2014 base and 2019 future emission inventories employed in this analysis, along with adjusted SOx and NH_3 emissions for certain refinery point sources to better reflect their emissions in 2019. Sections 3 through 6 report results from the MSSPD analyses conducted for NOx, SOx, VOC and NH3, respectively, using the UDAQ 2019 future year emissions inventory along with the updated point source inventory. Section 7 provides a brief summary of results. Appendix B describes preliminary MSSPD analyses for NOx and SOx using the UDAQ 2014 base year emissions inventory. The author's biographical summaries are presented in Appendix C.

[4] The UDAQ photochemical model is run for a $PM_{2.5}$ exceedance episode that occurred during the cold air pool event of January 1-10, 2011. See Appendix A for more information.

[5] The initial EPA (2016a) technical basis analysis concluded, and the draft EPA (2016b) demonstration guidance recommended, 1.3 $\mu g/m^3$ for the $PM_{2.5}$ 24-hour NAAQS as the appropriate threshold "for identifying an air quality change that is 'insignificant' and thus does not 'contribute' to $PM_{2.5}$ concentrations subject to the current $PM_{2.5}$ NAAQS." More recently, however, EPA (2018) updated and finalized their technical basis document, which now recommends a threshold for identifying significance of 1.5 $\mu g/m^3$.

2.0 EMISSION INVENTORIES FOR THE DEMONSTRATION

We assessed major stationary source contributions to 24-hour $PM_{2.5}$ using the UDAQ January 2011 photochemical modeling platform. In February 2018, UDAQ provided their extensive modeling dataset to Ramboll, and we conducted an initial simulation of the UDAQ 2014 "base year" modeling scenario to ensure that we could replicate UDAQ-provided output files. Appendix A provides details on the versions of the modeling datasets provided by UDAQ and the dates when Ramboll received them. We then conducted preliminary MSSPD assessments for NOx and SOx using the 2014 base year emissions, as described in Appendix B. In early May 2018, we obtained an initial version of UDAQ's 2019 future year model-ready emission files. As described below and in Sections 3 through 6, all final MSSPD assessments were conducted using this version of UDAQ's 2019 future year emission inventory subject to certain adjustments.[6]

2.1 UDAQ 2014 Base Year Modeling Inventory

EPA defines stationary facility sources in Serious $PM_{2.5}$ Nonattainment Areas as "major" if direct $PM_{2.5}$ or any precursor emissions equal or exceed 70 tons per year (TPY) based on their permitted "potential to emit" (PTE) rates (40 CFR 51.1000 Definitions). We cross-referenced stationary sources in the UDAQ 2014 base year point source inventory to their permitted PTE rates, and identified those facilities within the SLC NAA that may emit at least 70 TPY of $PM_{2.5}$ or any precursor emissions as major stationary sources for this demonstration. Table 1 lists the major stationary facility sources in the SLC NAA. We then zeroed-out specific precursor emissions from these facilities in the raw stationary inventory file provided by UDAQ, and processed this file through the Sparse Matrix Operator Kernel Emissions (SMOKE) system using UDAQ's scripts and supporting files to generate new, model-ready, low-level and elevated point source inputs for the CAMx model. We performed this separately for precursor species NOx, SOx, VOC, and NH_3 resulting in four different sets of zero-out emission input files. All other emission species and sectors were unmodified.

2.2 UDAQ 2019 Future Year Modeling Inventory

On May 9, 2018, UDAQ provided model-ready emission files representing their projected 2019 emission inventory for on-road mobile, non-road mobile, and area source sectors. At that time, UDAQ had not completed their 2019 point source projections. To conduct a MSSPD for the 2019 future year projection, we carried forward the 2014 point source emissions to the 2019 inventory. However, the UDAQ 2014 point source emission inventory does not account for SOx

[6] We understand that UDAQ has since updated their 2019 future year inventory. It was necessary to "lock-in" the 2019 inventory we received in May so that we could complete the MSSPD modeling analyses reported here before the end of the SIP public comment period. It is not anticipated that the updates made to the inventory would affect the conclusions of insignificant contribution.

Table 1. List of "major" stationary facility sources within the SLC NAA and their 2014 primary $PM_{2.5}$ and precursor emissions (TPY). Table from UDAQ web site[7].

Source: UDAQ 11/14/17			2014 Baseline Emissions				
County	Site ID	Site Name	$PM_{2.5}$ (tons/yr)	SO_X (tons/yr)	NO_X (tons/yr)	VOC (tons/yr)	NH_3 (tons/yr)
Salt Lake Non-Attainment Area							
Box Elder	10008	Nucor Steel- Nucor Steel	37.5	135.0	156.8	31.7	1.9
Box Elder	10009	ATK Launch Systems - Promontory	19.1	1.9	51.0	31.2	0.4
Box Elder	10028	Vulcraft - Division of Nucor Corporation- Steel Products Manufacturing	9.3	0.4	5.8	38.1	0.0
Box Elder	14107	Procter and Gamble-Paper Manufacturing Plant	38.9	0.3	27.2	18.6	0.2
Davis	10119	Chevron Products Co - Salt Lake Refinery	32.9	23.9	375.6	298.1	8.9
Davis	10121	Hill Air Force Base - Main Base	8.5	4.0	151.4	126.4	1.5
Davis	10122	Big West Oil - Flying J Refinery	45.9	57.1	92.3	307.4	117.4
Davis	10123	Holly Corp- HRMC and HEP Woods Cross Operations	12.7	102.3	168.4	155.3	17.6
Davis	10129	Wasatch Integrated Waste Mgt District- County Landfill & Energy Recovery Facility (DCERF)	9.8	17.2	236.4	23.2	0.0
Salt Lake	10335	Tesoro Refining & Marketing Company LLC	89.1	708.3	358.1	250.4	3.8
Salt Lake	10346	Kennecott Utah Copper LLC- Smelter & Refinery	420.0	704.4	160.0	10.4	5.6
Salt Lake	10354	University of Utah- University of Utah facilities	14.4	0.7	72.2	9.8	3.0
Salt Lake	10355	Pacificorp Energy- Gadsby Power Plant	16.9	1.5	117.4	9.6	13.1
Salt Lake	10571	Kennecott Utah Copper LLC- Mine & Copperton Concentrator **	105.4	0.0	5.6	4.7	1.8
Salt Lake	10572	Kennecott Utah Copper LLC- Power Plant Lab Tailings Impoundment	71.8	1500.3	1322.5	8.2	0.2
Salt Lake	11386	Hexcel Corporation- Salt Lake Operations	72.0	27.9	145.8	160.6	79.4
Salt Lake	12495	UAMPS - West Valley Power Plant	3.9	0.4	8.6	1.3	0.0
Tooele	10707	Lhoist North America - Grantsville Plant	0.2	0.0	0.2	0.1	0.0
Weber	10917	Compass Minerals Ogden Inc. - Production Plant	28.2	8.7	134.6	16.4	3.1

** The original table from UDAQ included non-road equipment tailpipe emissions operating within the Kennecott mine facility. The definition of a "major" stationary source does not include tail pipe emissions, so the non-road emissions were removed to show just stationary source emissions at the Kennecott mine facility. Non-tailpipe, mechanically generated particulate emissions associated with the non-road equipment's operation (for example, road dust) remain in the inventory.

reductions implemented since 2014 at some of the major stationary facilities. Figure 1 shows that SLC petroleum refineries have reduced SOx emissions by more than 80% since 2014, which translates to about a 40% decrease over all major point sources[8]. Based on data supplied by the petroleum refinery operators, we reduced refinery SOx emissions at three facilities to derive an adjusted 2014 point source inventory (Figure 1):

(1) Tesoro from 708 TPY to 58 TPY[9];
(2) Big West Oil from 57 to 33 TPY[10];
(3) Holly Frontier from 102 to 43 TPY[11].

This resulted in a reduction in total refinery emissions from 891 TPY to 160 TPY (82%). Additionally, we corrected NH_3 emissions from the Big West Oil facility from 117.4 TPY to 6.7 TPY[10]. All other emission species and sectors were unmodified. We processed the adjusted

[7] https://deq.utah.gov/legacy/pollutants/p/particulate-matter/pm25/serious-area-state-implementation-plans/posted-inventories.htm.
[8] SOx emissions of 1500 TPY listed for the Kennecott Power Plant facility in Table 1 are not applicable to the winter season, as the current SIP and permit requirements require that facility to switch from coal to natural gas during winter; this is properly reflected in the UDAQ 2014 emission modeling files.
[9] Based on 2017 emissions inventory submittal adjusted for wet gas scrubber startup in January 2018.
[10] Based on 2017 emissions inventory submission for Big West refinery.
[11] Based on 2017 emissions inventory submission for HollyFrontier refinery.

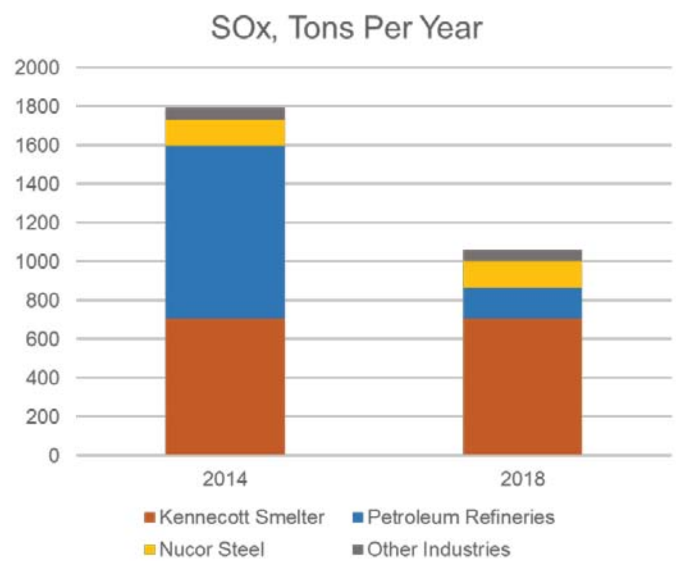

Figure 1. Comparison of 2014 and 2018 major point source SOx emissions (TPY).

point source inventory through the SMOKE system to generate 2019 model-ready, low-level and elevated point source inputs for the CAMx model. Tables 2(a) and 2(b) compare 2014 and 2019 model-ready daily emission totals (tons per day, TPD) by major source sector for each of the criteria air pollutants and chlorides (Cl_2 and HCl). Note that these values represent emissions for a single day of the modeling episode, the peak $PM_{2.5}$ day of January 7, and are summed over the entire 1.33-km modeling domain. Table 2(b) reflects the point source SOx and NH_3 adjustments described above.

Table 2(a). 2014 UDAQ model-ready daily emission totals (TPD) for the January 7 episode day over the entire 1.33-km modeling domain.

Sector	CO	NOx	VOC	NH_3	SO_2	$PM_{2.5}$	Cl_2	HCl
Area	61.90	23.36	88.23	81.01	0.35	10.66	0.00	0.13
Nonroad	161.10	39.01	25.25	0.03	0.36	2.33	0.00	0.00
Mobile	596.03	110.83	59.56	2.19	0.61	5.31	0.00	0.01
Points	11.75	14.60	16.05	1.33	5.84	4.67	3.77	2.08
Total	830.78	187.80	189.09	84.57	7.16	22.96	3.77	2.22

Table 2(b). 2019 model-ready daily emission totals (TPD) for the January 7 episode day over the entire 1.33-km modeling domain, used for the 2019 MSSPD. Note that point source emissions are held constant at 2014 rates, except that SOx emissions at three refineries, and NH_3 emissions at Big West Oil, have been updated as described in the text.

Sector	CO	NOx	VOC	NH_3	SO_2	$PM_{2.5}$	Cl_2	HCl
2019 Area	60.61	20.13	79.92	80.66	0.91	10.93	0.00	0.14
2019 Nonroad	152.72	33.22	19.83	0.03	0.36	1.83	0.00	0.00
2019 Mobile	443.42	78.02	41.92	1.95	0.66	4.08	0.00	0.00
Adjusted 2014 Points	11.75	14.60	16.05	1.02	3.80	4.67	3.77	2.08
Total	668.50	145.97	157.71	83.66	5.73	21.51	3.77	2.23

2.3 Comparison of total $PM_{2.5}$ Predictions Among 2014 and 2019 Inventories

We ran CAMx for the January 2011 modeling episode with the 2014 base and the 2019 future year model-ready emission inventories described above. Additionally, we ran a third case with the 2014 base emissions, but with the adjusted SOx point source emissions described in Section 2.2 to isolate the effect on $PM_{2.5}$ concentrations from the refinery SOx emissions reductions (i.e., not including the Big West NH_3 reduction). For each of these three cases, resulting hourly gridded concentrations of all $PM_{2.5}$ components (sulfate, nitrate, ammonia, elemental and organic carbon, sodium, chloride, and primary $PM_{2.5}$) were summed to total $PM_{2.5}$ mass concentrations, and averaged each day (midnight-midnight) to derive 24-hour $PM_{2.5}$. We tabulated resulting 24-hour $PM_{2.5}$ concentrations for each day and at each monitoring site within the SLC NAA, as shown in Tables 3(a)-(c). Comparing Tables 3(a) and (b), simulated changes in $PM_{2.5}$ from 2014 to 2019 range from -4.4 to +2.0 µg/m^3, with an average change over all sites and days of -1.3 µg/m^3. The episode-average reductions at Hawthorne and Rose Park monitors, the limiting DV sites in the SLC NAA, are similar at about -1.5 µg/m^3. Comparing Tables 3(a) and 3(c), simulated changes in $PM_{2.5}$ resulting from the 80% refinery SOx reductions since 2014 account for $PM_{2.5}$ reductions of up to 3.6 µg/m^3 and 2.6 µg/m^3 at Hawthorne and Rose Park monitors on January 6, respectively, and reductions of 3.0 µg/m^3 and 2.4 µg/m^3 on the January 7 peak day, respectively.

Table 3(a). Total 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the 2014 base year case.

Base Case			24-Hour $PM_{2.5}$ (µg/m^3)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	9.9	6.8	4.3	12.8	19.1	8.6	13.7	34.7	33.1	10.6	9.7
Tooele	490450003	Tooele	9.5	8.2	12.5	20.6	19.1	13.5	23.2	36.3	31.7	10.7	9.0
Cottonwood	490350003	Cottonwood West	14.0	11.8	14.4	33.0	33.3	26.6	38.9	50.8	43.7	14.2	13.2
Erda	490450004	Erda	10.2	8.3	11.8	21.3	17.8	14.2	24.9	30.5	29.2	11.5	8.4
Hawthorne	490353006	Salt Lake City	16.0	12.7	19.4	28.9	33.7	23.4	43.7	53.1	51.0	16.6	13.7
Magna	490351001	Magna	9.6	8.4	13.0	23.3	24.1	19.8	27.7	40.4	42.7	9.7	12.5
Rose Park	490353010	Salt Lake City	16.6	13.9	14.3	32.5	33.9	25.9	42.3	50.0	46.8	15.2	16.3
Bountiful Viewmont	490110004	Bountiful	11.2	7.1	9.5	26.9	23.1	15.0	35.6	40.2	43.0	9.3	10.7
Ogden	490570002	Ogden	11.7	8.0	8.4	13.8	22.3	14.6	34.5	35.9	35.0	9.2	12.0
Harrisville	490571003	Harrisville	11.7	8.0	7.3	10.7	20.2	12.6	24.3	35.5	29.2	9.7	9.3
Brigham City	490030003	Brigham City	9.2	9.3	7.8	8.7	13.0	13.8	18.7	29.0	26.8	6.8	9.4

Table 3(b). Total 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the 2019 future year case.

Future Year 2019			24-Hour $PM_{2.5}$ (µg/m^3)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	9.7	6.6	4.2	12.1	17.6	8.2	13.3	34.9	30.9	10.3	8.8
Tooele	490450003	Tooele	9.4	7.9	11.7	18.7	17.2	12.7	21.5	33.0	28.3	10.2	8.6
Cottonwood	490350003	Cottonwood West	13.7	11.4	14.3	31.9	31.8	25.6	38.1	51.8	43.1	13.1	12.4
Erda	490450004	Erda	10.0	8.0	11.1	18.9	15.9	13.3	23.3	26.5	25.3	11.0	7.8
Hawthorne	490353006	Salt Lake City	15.7	12.3	19.0	27.8	31.9	22.1	39.2	51.1	49.7	15.3	12.8
Magna	490351001	Magna	9.5	8.2	12.0	21.2	21.6	18.3	26.9	38.0	40.8	9.3	11.8
ROSE PARK	490353010	Salt Lake City	16.3	13.5	13.9	30.5	31.8	24.7	39.1	46.4	45.0	14.2	15.3
Bountiful Viewmont	490110004	Bountiful	11.0	7.0	9.1	25.1	21.4	14.0	37.7	37.1	40.4	8.9	9.9
Ogden	490570002	Ogden	11.4	7.6	7.9	12.4	19.9	13.3	32.7	32.0	31.6	8.7	10.8
Harrisville	490571003	Harrisville	11.4	7.7	6.8	9.7	17.9	11.5	22.0	31.2	25.7	9.1	8.5
Brigham City	490030003	Brigham City	9.1	8.8	7.2	7.9	11.3	12.6	16.6	24.8	23.0	6.5	8.3

Table 3(c). Total 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the 2014 base year case using the adjusted point source inventory for SOx.

Adjusted Base Case $PM_{2.5}$			24-Hour $PM_{2.5}$ (µg/m³)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	9.9	6.8	4.3	12.7	19.0	8.6	13.7	34.4	32.9	10.6	9.7
Tooele	490450003	Tooele	9.5	8.2	12.5	20.6	19.1	13.5	23.1	36.1	31.6	10.7	9.0
Cottonwood	490350003	Cottonwood West	14.0	11.8	14.4	32.5	33.0	26.6	38.4	49.3	43.4	13.8	13.1
Erda	490450004	Erda	10.2	8.3	11.8	21.2	17.7	14.1	24.9	30.3	29.0	11.5	8.4
Hawthorne	490353006	Salt Lake City	16.0	12.7	19.1	28.5	33.1	23.4	40.1	50.1	50.7	15.9	13.6
Magna	490351001	Magna	9.6	8.4	13.0	23.3	23.9	19.7	27.5	40.0	42.5	9.7	12.5
ROSE PARK	490353010	Salt Lake City	16.6	13.9	14.2	31.5	33.3	25.8	39.7	47.5	46.5	14.8	16.2
Bountiful Viewmont	490110004	Bountiful	11.2	7.1	9.5	26.2	22.7	14.8	34.5	39.3	42.6	9.2	10.6
Ogden	490570002	Ogden	11.7	8.0	8.4	13.8	21.9	14.6	33.9	35.5	34.7	9.2	11.9
Harrisville	490571003	Harrisville	11.7	8.0	7.3	10.7	20.0	12.5	24.1	35.1	28.9	9.7	9.2
Brigham City	490030003	Brigham City	9.2	9.3	7.8	8.7	13.0	13.7	18.6	28.7	26.5	6.8	9.3

3.0 MAJOR STATIONARY SOURCE PRECURSOR DEMONSTRATION FOR NOX

3.1 Precursor Demonstration for NOx Contribution

We ran CAMx for the entirety of the January 2011 modeling episode with the 2019 emission scenario in which major stationary source NOx emissions were zeroed out. Resulting hourly gridded concentrations of all $PM_{2.5}$ components (sulfate, nitrate, ammonia, elemental and organic carbon, sodium, chloride, and primary $PM_{2.5}$) were summed to form total $PM_{2.5}$ mass concentrations, and averaged each day (midnight-midnight) to derive 24-hour $PM_{2.5}$. Following EPA guidance, we calculated 24-hour $PM_{2.5}$ concentration differences between the 2019 future year case (Table 3(b)) and NOx zero-out run (Table 4(a)) for each day and at each monitoring site within the SLC NAA to determine major stationary source NOx precursor contributions; results are shown in Table 4(b). Figure 2 shows the locations of permitted stationary sources in the region and the SLC NAA monitoring sites.

Table 4(a). 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the 2019 major stationary source NOx zero-out case.

NOx Control $PM_{2.5}$			24-Hour $PM_{2.5}$ (µg/m³)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	9.7	6.6	4.2	12.1	17.3	8.1	13.3	34.9	30.7	10.2	8.7
Tooele	490450003	Tooele	9.4	7.9	11.7	18.6	16.9	12.6	21.4	32.7	28.0	10.2	8.6
Cottonwood	490350003	Cottonwood West	13.6	11.4	14.3	31.9	31.5	25.6	38.2	52.3	43.1	13.0	12.3
Erda	490450004	Erda	10.0	8.0	11.0	18.6	15.7	13.2	23.2	26.1	24.9	11.0	7.8
Hawthorne	490353006	Salt Lake City	15.6	12.3	19.1	27.8	31.6	22.1	39.7	51.8	49.6	15.2	12.8
Magna	490351001	Magna	9.5	8.2	11.9	20.8	21.2	18.2	26.9	37.7	40.5	9.2	11.7
ROSE PARK	490353010	Salt Lake City	16.2	13.5	14.0	30.4	31.4	24.7	39.7	46.7	44.8	14.0	15.2
Bountiful Viewmont	490110004	Bountiful	10.9	7.0	9.2	25.0	21.0	14.0	39.2	37.0	39.8	8.8	9.7
Ogden	490570002	Ogden	11.3	7.6	7.8	12.3	19.3	13.2	32.6	31.2	31.0	8.6	10.7
Harrisville	490571003	Harrisville	11.4	7.7	6.8	9.6	17.5	11.4	21.7	30.4	25.1	9.0	8.4
Brigham City	490030003	Brigham City	9.1	8.7	7.2	7.8	11.1	12.4	16.2	23.9	22.1	6.5	8.2

Table 4(b). Change in total 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the 2019 major stationary source NOx zero-out case. Green shade indicates impacts below the 1.5 µg/m³ threshold for significant contributions.

(Future Year 2019 - NOx Control $PM_{2.5}$)			24-Hour $PM_{2.5}$ (µg/m³)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	0.02	0.00	0.00	0.04	0.22	0.02	0.00	-0.07	0.20	0.06	0.05
Tooele	490450003	Tooele	0.01	0.00	0.02	0.15	0.26	0.04	0.11	0.28	0.29	0.05	0.02
Cottonwood	490350003	Cottonwood West	0.03	0.00	-0.02	0.04	0.28	0.00	-0.19	-0.57	-0.01	0.13	0.06
Erda	490450004	Erda	0.01	0.00	0.02	0.26	0.22	0.05	0.12	0.44	0.40	0.04	0.02
Hawthorne	490353006	Salt Lake City	0.04	0.00	-0.08	0.04	0.33	0.04	-0.42	-0.72	0.13	0.13	0.07
Magna	490351001	Magna	0.01	0.00	0.05	0.35	0.43	0.12	0.04	0.32	0.23	0.07	0.08
ROSE PARK	490353010	Salt Lake City	0.05	0.01	-0.11	0.14	0.40	0.03	-0.59	-0.31	0.21	0.14	0.07
Bountiful Viewmont	490110004	Bountiful	0.05	0.01	-0.01	0.06	0.44	-0.05	-1.50	0.14	0.56	0.07	0.17
Ogden	490570002	Ogden	0.04	0.02	0.01	0.12	0.55	0.12	0.08	0.80	0.61	0.06	0.15
Harrisville	490571003	Harrisville	0.03	0.03	0.01	0.07	0.37	0.11	0.34	0.77	0.64	0.05	0.09
Brigham City	490030003	Brigham City	0.01	0.08	0.05	0.08	0.24	0.18	0.40	0.86	0.83	0.02	0.10

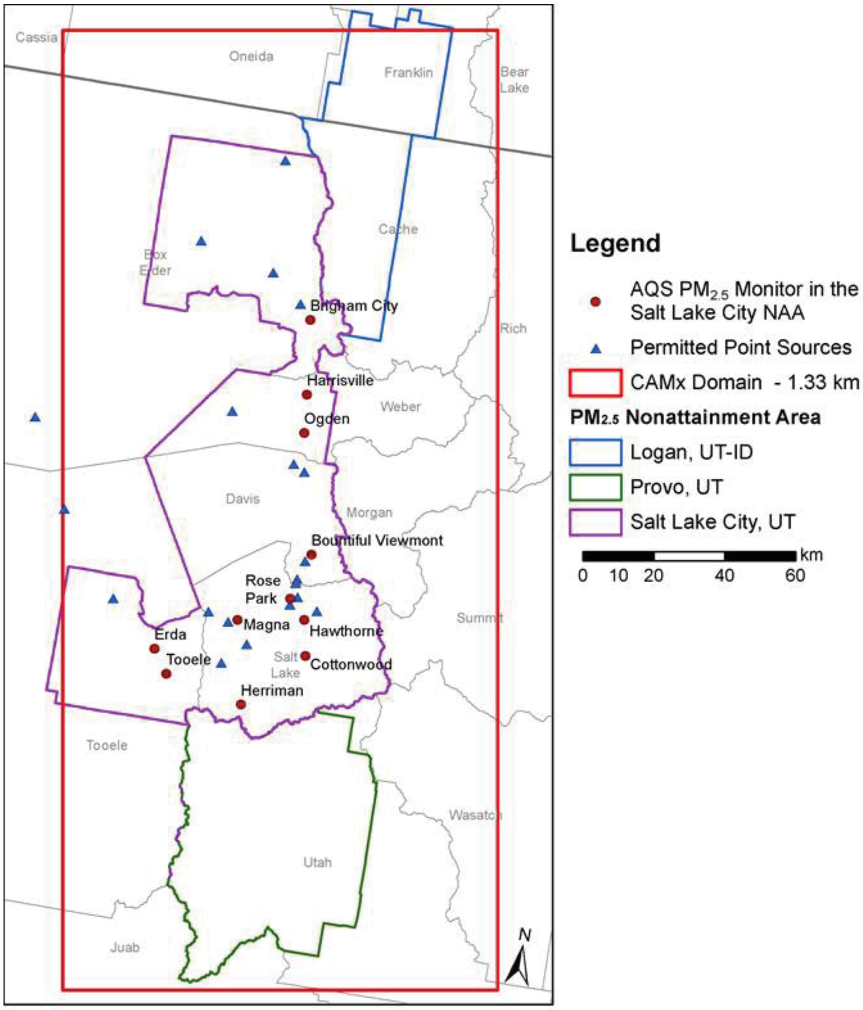

Figure 2. Locations of permitted stationary sources (blue triangles) and UDAQ monitoring sites (red circles) located within the SLC NAA (purple outline). Neighboring $PM_{2.5}$ nonattainment areas and county boundaries are also depicted. The UDAQ CAMx modeling domain is shown by the red rectangular boundary.

Values in Table 4(b) shaded green indicate NOx contributions below the significance threshold of 1.5 µg/m^3. The modeled NOx contributions are always well below the threshold. In fact, NOx reductions occasionally result in small increases in $PM_{2.5}$ on some days and at certain monitors, shown as negative numbers in Table 4, the result of subtracting a higher $PM_{2.5}$ value in the NOx zero-out case from a lower corresponding $PM_{2.5}$ value in the 2019 future year case.

Higher $PM_{2.5}$ in the zero-out case may occur for nitrate, sulfate and/or ammonium because of non-linear gas and PM chemistry. This is a common characteristic of areas with high NOx and related nitrate concentrations, and is parallel to so-called "NOx-disbenefit" and "weekend-weekday" effects seen with ozone. Appendix B shows similar results for major stationary source NOx precursor contributions calculated from the 2014 base year scenario.

4.0 MAJOR STATIONARY SOURCE PRECURSOR DEMONSTRATION FOR SOX

4.1 Precursor Demonstration for SOx Contribution

Following the same methodology for NOx, we ran CAMx for the January 2011 modeling episode with the 2019 emission scenario in which major stationary source SOx emissions were zeroed out. We calculated $PM_{2.5}$ concentration differences between the 2019 future year case (Table 3(b)) and SOx zero-out run (Table 5(a)) for each day and at each monitoring site within the SLC NAA; results are shown in Table 5(b). Values shaded green indicate SOx contributions below the significance threshold of 1.5 μg/m^3. Note that no $PM_{2.5}$ increases occur with the SOx removal. According to the model, there are no contributions greater than the significance threshold of 1.5 μg/m^3.

Table 5(a). 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the 2019 major stationary source SOx zero-out case.

SOx Control $PM_{2.5}$			24-Hour $PM_{2.5}$ (μg/m³)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	9.7	6.6	4.2	12.0	17.3	8.1	13.3	34.3	30.5	9.8	8.7
Tooele	490450003	Tooele	9.4	7.9	11.7	18.5	16.8	12.6	21.1	32.4	27.8	10.1	8.6
Cottonwood	490350003	Cottonwood West	13.7	11.4	14.3	31.7	31.3	25.5	37.8	51.1	42.9	13.0	12.3
Erda	490450004	Erda	10.0	8.0	11.1	18.7	15.7	13.1	23.1	25.6	24.6	11.0	7.7
Hawthorne	490353006	Salt Lake City	15.7	12.3	18.9	27.7	31.3	22.1	38.4	50.1	49.4	15.1	12.7
Magna	490351001	Magna	9.5	8.2	12.0	21.1	20.4	18.1	26.7	36.5	40.0	9.1	11.4
ROSE PARK	490353010	Salt Lake City	16.2	13.5	13.9	30.2	31.1	24.7	38.5	45.2	44.6	14.0	15.1
Bountiful Viewmont	490110004	Bountiful	11.0	7.0	9.1	24.9	21.0	13.9	37.3	36.5	40.0	8.7	9.8
Ogden	490570002	Ogden	11.4	7.6	7.9	12.4	19.5	13.2	32.4	31.5	31.2	8.6	10.7
Harrisville	490571003	Harrisville	11.4	7.7	6.8	9.6	17.7	11.4	21.9	30.9	25.4	9.0	8.4
Brigham City	490030003	Brigham City	9.1	8.8	7.2	7.8	11.2	12.5	16.5	24.5	22.6	6.5	8.3

Table 5(b). Change in total 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the 2019 major stationary source SOx zero-out case. Green shade indicates impacts below the 1.5 μg/m^3 threshold for significant contributions.

(2019 Base Case $PM_{2.5}$ - SOx Control $PM_{2.5}$)			24-Hour $PM_{2.5}$ (μg/m³)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	0.02	0.00	0.00	0.13	0.26	0.02	0.01	0.53	0.43	0.43	0.11
Tooele	490450003	Tooele	0.00	0.00	0.00	0.20	0.37	0.05	0.37	0.65	0.51	0.10	0.03
Cottonwood	490350003	Cottonwood West	0.01	0.00	0.01	0.19	0.47	0.08	0.26	0.63	0.18	0.15	0.09
Erda	490450004	Erda	0.00	0.00	0.00	0.16	0.28	0.11	0.26	0.88	0.75	0.07	0.05
Hawthorne	490353006	Salt Lake City	0.01	0.01	0.05	0.14	0.58	0.07	0.84	0.99	0.27	0.23	0.10
Magna	490351001	Magna	0.00	0.00	0.00	0.06	1.20	0.16	0.23	1.47	0.80	0.25	0.40
ROSE PARK	490353010	Salt Lake City	0.01	0.01	0.03	0.30	0.68	0.06	0.56	1.21	0.34	0.18	0.11
Bountiful Viewmont	490110004	Bountiful	0.01	0.01	0.00	0.26	0.45	0.13	0.33	0.60	0.41	0.13	0.13
Ogden	490570002	Ogden	0.00	0.01	0.01	0.06	0.33	0.11	0.29	0.45	0.36	0.07	0.13
Harrisville	490571003	Harrisville	0.00	0.01	0.00	0.05	0.21	0.10	0.12	0.30	0.32	0.07	0.11
Brigham City	490030003	Brigham City	0.00	0.03	0.01	0.05	0.12	0.11	0.09	0.29	0.39	0.04	0.09

Appendix B shows similar, yet slightly larger major stationary source SOx precursor contributions calculated from the 2014 base year scenario.

4.2 Precursor Demonstration for SOx Sensitivity

Although the zero-out (100% reduction) analysis was below the significance threshold, we conducted an additional sensitivity-based analysis in order to provide an additional basis for demonstrating the insignificant contribution associated with major stationary source SO_2 emissions.

Page 30 of the draft EPA (2016b) precursor demonstration guidance states:

> "…the EPA recommends comparing the estimated impacts of precursor emissions on $PM_{2.5}$ mass from sensitivity modeling to the contribution thresholds for the annual average and 24-hour NAAQS, as appropriate, identified in Section 2.2. The EPA generally expects that if modeling demonstrates that reductions in the 30-70% range produce an air quality impact below these thresholds, then it would approve such a demonstration as adequate to show that the precursor is insignificant."

For the SOx precursor sensitivity demonstration, we reduced SOx emissions from the major stationary source facilities by 30%, 50%, and 70% from the adjusted 2014 levels described in Section 2.2, and compared the impact of this reduction on modeled $PM_{2.5}$ to the 1.5 µg/m^3 significance threshold. We processed the new inventory file through SMOKE system to generate new, model-ready, low-level and elevated point source inputs for the CAMx model. All other emission species and sectors were unmodified. We ran CAMx for the January 2011 modeling episode with the 30%, 50% and 70% SOx reductions and calculated the 24-hour $PM_{2.5}$ concentration differences between the 2019 future year case (Table 3(b)) and each SOx reduction case (Tables 6(a)-(c)) for all days and at each monitoring site within the SLC NAA. Tables 7(a)-(c) list total $PM_{2.5}$ sensitivity to the major stationary source SOx reductions on each day and at each monitor. According to the model, all SOx reduction sensitivity cases result in 24-hour $PM_{2.5}$ impacts of less than 1.5 µg/m^3 at all sites and for all days.

Table 6(a)-(c). 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the 2019 major stationary source SOx 30%, 50% and 70% SOx reduction cases.

SOx 30% Control $PM_{2.5}$			24-Hour $PM_{2.5}$ (µg/m^3)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	9.7	6.6	4.2	12.1	17.5	8.2	13.3	34.7	30.8	10.2	8.8
Tooele	490450003	Tooele	9.4	7.9	11.7	18.7	17.1	12.7	21.4	32.8	28.1	10.2	8.6
Cottonwood	490350003	Cottonwood West	13.7	11.4	14.3	31.9	31.7	25.6	38.0	51.6	43.0	13.1	12.4
Erda	490450004	Erda	10.0	8.0	11.1	18.8	15.8	13.2	23.2	26.3	25.1	11.0	7.8
Hawthorne	490353006	Salt Lake City	15.7	12.3	19.0	27.8	31.7	22.1	39.0	50.8	49.6	15.2	12.8
Magna	490351001	Magna	9.5	8.2	12.0	21.1	21.3	18.2	26.8	37.7	40.6	9.2	11.7
ROSE PARK	490353010	Salt Lake City	16.3	13.5	13.9	30.4	31.6	24.7	38.9	46.1	44.9	14.1	15.2
Bountiful Viewmont	490110004	Bountiful	11.0	7.0	9.1	25.0	21.3	14.0	37.6	36.9	40.3	8.8	9.9
Ogden	490570002	Ogden	11.4	7.6	7.9	12.4	19.8	13.3	32.6	31.8	31.5	8.6	10.8
Harrisville	490571003	Harrisville	11.4	7.7	6.8	9.7	17.8	11.5	22.0	31.1	25.6	9.1	8.4
Brigham City	490030003	Brigham City	9.1	8.8	7.2	7.8	11.3	12.5	16.5	24.7	22.9	6.5	8.3

SOx 50% Control $PM_{2.5}$			24-Hour $PM_{2.5}$ (μg/m³)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	9.7	6.6	4.2	12.1	17.4	8.1	13.3	34.6	30.7	10.1	8.7
Tooele	490450003	Tooele	9.4	7.9	11.7	18.6	17.0	12.7	21.3	32.7	28.0	10.2	8.6
Cottonwood	490350003	Cottonwood West	13.7	11.4	14.3	31.8	31.6	25.6	37.9	51.5	43.0	13.1	12.3
Erda	490450004	Erda	10.0	8.0	11.1	18.8	15.8	13.2	23.2	26.1	24.9	11.0	7.8
Hawthorne	490353006	Salt Lake City	15.7	12.3	19.0	27.7	31.6	22.1	38.8	50.6	49.6	15.2	12.8
Magna	490351001	Magna	9.5	8.2	12.0	21.1	21.1	18.2	26.8	37.4	40.4	9.2	11.6
ROSE PARK	490353010	Salt Lake City	16.3	13.5	13.9	30.4	31.5	24.7	38.8	45.9	44.8	14.1	15.2
Bountiful Viewmont	490110004	Bountiful	11.0	7.0	9.1	25.0	21.2	13.9	37.5	36.8	40.2	8.8	9.8
Ogden	490570002	Ogden	11.4	7.6	7.9	12.4	19.7	13.2	32.6	31.8	31.4	8.6	10.7
Harrisville	490571003	Harrisville	11.4	7.7	6.8	9.7	17.8	11.5	22.0	31.0	25.6	9.0	8.4
Brigham City	490030003	Brigham City	9.1	8.8	7.2	7.8	11.3	12.5	16.5	24.6	22.8	6.5	8.3

SOx 70% Control $PM_{2.5}$			24-Hour $PM_{2.5}$ (μg/m³)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	9.7	6.6	4.2	12.0	17.4	8.1	13.3	34.5	30.6	10.0	8.7
Tooele	490450003	Tooele	9.4	7.9	11.7	18.6	16.9	12.7	21.2	32.6	27.9	10.1	8.6
Cottonwood	490350003	Cottonwood West	13.7	11.4	14.3	31.8	31.5	25.5	37.9	51.4	43.0	13.0	12.3
Erda	490450004	Erda	10.0	8.0	11.1	18.8	15.7	13.2	23.1	25.9	24.8	11.0	7.8
Hawthorne	490353006	Salt Lake City	15.7	12.3	18.9	27.7	31.5	22.1	38.7	50.4	49.5	15.1	12.8
Magna	490351001	Magna	9.5	8.2	12.0	21.1	20.8	18.2	26.8	37.1	40.2	9.1	11.5
ROSE PARK	490353010	Salt Lake City	16.3	13.5	13.9	30.3	31.3	24.7	38.7	45.6	44.7	14.0	15.2
Bountiful Viewmont	490110004	Bountiful	11.0	7.0	9.1	24.9	21.1	13.9	37.4	36.7	40.1	8.8	9.8
Ogden	490570002	Ogden	11.4	7.6	7.9	12.4	19.6	13.2	32.5	31.7	31.3	8.6	10.7
Harrisville	490571003	Harrisville	11.4	7.7	6.8	9.7	17.7	11.5	22.0	31.0	25.5	9.0	8.4
Brigham City	490030003	Brigham City	9.1	8.8	7.2	7.8	11.2	12.5	16.5	24.6	22.7	6.5	8.3

Table 7(a)-(c). Change in total 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the 2019 30%, 50% and 70% SOx reduction cases. Green shade indicates impacts below the 1.5 μg/m³ threshold for significant contributions.

(2019 Base Case $PM_{2.5}$ - SOx 30% Control $PM_{2.5}$)			24-Hour $PM_{2.5}$ (μg/m³)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	0.01	0.00	0.00	0.04	0.07	0.00	0.00	0.15	0.12	0.11	0.03
Tooele	490450003	Tooele	0.00	0.00	0.00	0.06	0.11	0.01	0.11	0.19	0.15	0.03	0.01
Cottonwood	490350003	Cottonwood West	0.00	0.00	0.00	0.06	0.13	0.02	0.08	0.17	0.05	0.04	0.03
Erda	490450004	Erda	0.00	0.00	0.00	0.05	0.08	0.03	0.08	0.26	0.22	0.02	0.01
Hawthorne	490353006	Salt Lake City	0.00	0.00	0.02	0.03	0.16	0.02	0.25	0.25	0.07	0.07	0.03
Magna	490351001	Magna	0.00	0.00	0.00	0.02	0.32	0.04	0.07	0.35	0.20	0.07	0.08
ROSE PARK	490353010	Salt Lake City	0.00	0.00	0.01	0.09	0.20	0.02	0.17	0.28	0.09	0.05	0.03
Bountiful Viewmont	490110004	Bountiful	0.00	0.00	0.00	0.08	0.12	0.04	0.10	0.17	0.11	0.04	0.04
Ogden	490570002	Ogden	0.00	0.00	0.00	0.02	0.10	0.03	0.09	0.13	0.11	0.02	0.04
Harrisville	490571003	Harrisville	0.00	0.00	0.00	0.01	0.06	0.03	0.03	0.09	0.09	0.02	0.03
Brigham City	490030003	Brigham City	0.00	0.01	0.00	0.01	0.04	0.03	0.03	0.09	0.12	0.01	0.03

(2019 Base Case $PM_{2.5}$ - SOx 50% Control $PM_{2.5}$)			24-Hour $PM_{2.5}$ (μg/m³)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	0.01	0.00	0.00	0.06	0.13	0.01	0.01	0.26	0.21	0.19	0.05
Tooele	490450003	Tooele	0.00	0.00	0.00	0.10	0.18	0.02	0.19	0.32	0.25	0.05	0.01
Cottonwood	490350003	Cottonwood West	0.01	0.00	0.00	0.09	0.22	0.04	0.13	0.29	0.08	0.07	0.04
Erda	490450004	Erda	0.00	0.00	0.00	0.08	0.14	0.06	0.13	0.43	0.37	0.03	0.02
Hawthorne	490353006	Salt Lake City	0.00	0.00	0.03	0.06	0.28	0.03	0.42	0.44	0.12	0.11	0.05
Magna	490351001	Magna	0.00	0.00	0.00	0.03	0.55	0.07	0.11	0.62	0.34	0.12	0.15
ROSE PARK	490353010	Salt Lake City	0.00	0.00	0.01	0.14	0.33	0.03	0.28	0.50	0.15	0.09	0.06
Bountiful Viewmont	490110004	Bountiful	0.00	0.00	0.00	0.13	0.21	0.07	0.16	0.28	0.19	0.06	0.06
Ogden	490570002	Ogden	0.00	0.00	0.00	0.03	0.16	0.05	0.14	0.22	0.18	0.03	0.06
Harrisville	490571003	Harrisville	0.00	0.01	0.00	0.02	0.10	0.05	0.06	0.15	0.16	0.03	0.05
Brigham City	490030003	Brigham City	0.00	0.01	0.00	0.02	0.06	0.06	0.05	0.15	0.19	0.02	0.04

(2019 Base Case $PM_{2.5}$ - SOx 70% Control $PM_{2.5}$)			24-Hour $PM_{2.5}$ (µg/m³)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	0.01	0.00	0.00	0.09	0.18	0.01	0.01	0.36	0.29	0.28	0.08
Tooele	490450003	Tooele	0.00	0.00	0.00	0.14	0.25	0.03	0.26	0.45	0.36	0.07	0.02
Cottonwood	490350003	Cottonwood West	0.01	0.00	0.00	0.13	0.32	0.06	0.18	0.42	0.12	0.10	0.06
Erda	490450004	Erda	0.00	0.00	0.00	0.11	0.19	0.08	0.18	0.61	0.52	0.05	0.03
Hawthorne	490353006	Salt Lake City	0.00	0.00	0.04	0.09	0.39	0.05	0.59	0.64	0.18	0.16	0.07
Magna	490351001	Magna	0.00	0.00	0.00	0.04	0.80	0.10	0.16	0.94	0.51	0.17	0.23
ROSE PARK	490353010	Salt Lake City	0.00	0.00	0.02	0.20	0.47	0.04	0.39	0.75	0.22	0.13	0.08
Bountiful Viewmont	490110004	Bountiful	0.01	0.00	0.00	0.19	0.30	0.09	0.23	0.41	0.27	0.09	0.09
Ogden	490570002	Ogden	0.00	0.01	0.00	0.04	0.23	0.08	0.20	0.31	0.25	0.05	0.09
Harrisville	490571003	Harrisville	0.00	0.01	0.00	0.04	0.14	0.07	0.08	0.21	0.22	0.05	0.07
Brigham City	490030003	Brigham City	0.00	0.02	0.00	0.03	0.08	0.08	0.06	0.20	0.27	0.03	0.06

Appendix B shows similar results for major stationary source SOx precursor sensitivity calculated from the 2014 base year and SOx-adjusted 2014 scenarios.

5.0 PRECURSOR DEMONSTRATION FOR VOC CONTRIBUTION

We ran CAMx for the entirety of the January 2011 modeling episode for the 2019 emission scenario in which major stationary source VOC emissions were zeroed. We calculated $PM_{2.5}$ concentration differences between the 2019 future year case (Table 3(b)) and the VOC zero-out run (Table 8(a)) for each day and at each monitoring site within the SLC NAA; results are shown in Table 8(b). Values shaded green indicate VOC contributions below the significance threshold of 1.5 µg/m^3. VOC contributions are always well below the threshold.

Table 8(a). 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the 2019 major stationary source VOC zero-out case.

VOC Control $PM_{2.5}$			24-Hour $PM_{2.5}$ (µg/m³)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	9.7	6.6	4.2	12.1	17.5	8.2	13.3	34.7	30.8	10.3	8.8
Tooele	490450003	Tooele	9.4	7.9	11.7	18.7	17.2	12.7	21.5	33.0	28.3	10.2	8.6
Cottonwood	490350003	Cottonwood West	13.7	11.4	14.3	31.8	31.7	25.6	37.9	51.3	42.9	13.1	12.4
Erda	490450004	Erda	10.0	8.0	11.1	18.9	15.9	13.3	23.3	26.5	25.3	11.0	7.8
Hawthorne	490353006	Salt Lake City	15.7	12.3	19.0	27.7	31.8	22.1	39.1	50.6	49.5	15.3	12.8
Magna	490351001	Magna	9.5	8.2	11.9	21.1	21.6	18.3	26.9	37.9	40.6	9.3	11.8
ROSE PARK	490353010	Salt Lake City	16.2	13.5	13.9	30.4	31.7	24.7	38.8	46.1	44.8	14.1	15.3
Bountiful Viewmont	490110004	Bountiful	10.9	7.0	9.1	24.9	21.3	13.8	37.1	36.9	40.3	8.8	9.9
Ogden	490570002	Ogden	11.3	7.6	7.8	12.4	19.8	13.2	32.5	31.9	31.5	8.6	10.8
Harrisville	490571003	Harrisville	11.4	7.7	6.8	9.7	17.9	11.5	21.9	31.1	25.7	9.1	8.4
Brigham City	490030003	Brigham City	9.1	8.8	7.2	7.9	11.3	12.5	16.5	24.8	23.0	6.5	8.3

Table 8(b). Change in total 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the 2019 major stationary source VOC zero-out case. Green shade indicates impacts below the 1.5 µg/m^3 threshold for significant contributions.

(Base Case $PM_{2.5}$ - VOC Control $PM_{2.5}$)			24-Hour $PM_{2.5}$ (µg/m³)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	0.00	0.00	0.00	0.03	0.02	0.00	0.01	0.18	0.08	0.00	0.00
Tooele	490450003	Tooele	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.02	0.01	0.00	0.00
Cottonwood	490350003	Cottonwood West	0.00	0.00	0.01	0.11	0.08	0.04	0.13	0.46	0.19	0.01	0.00
Erda	490450004	Erda	0.00	0.00	0.01	0.02	0.00	0.00	0.02	0.01	0.01	0.00	0.00
Hawthorne	490353006	Salt Lake City	0.01	0.00	0.01	0.13	0.09	0.02	0.20	0.50	0.20	0.02	0.00
Magna	490351001	Magna	0.00	0.00	0.02	0.04	0.02	0.02	0.06	0.10	0.13	0.00	0.00
ROSE PARK	490353010	Salt Lake City	0.02	0.00	0.03	0.13	0.09	0.03	0.24	0.29	0.17	0.02	0.00
Bountiful Viewmont	490110004	Bountiful	0.04	0.00	0.07	0.17	0.07	0.16	0.58	0.21	0.13	0.06	0.02
Ogden	490570002	Ogden	0.02	0.01	0.01	0.02	0.05	0.05	0.23	0.11	0.07	0.02	0.03
Harrisville	490571003	Harrisville	0.02	0.00	0.01	0.01	0.02	0.02	0.11	0.09	0.04	0.01	0.02
Brigham City	490030003	Brigham City	0.00	0.01	0.01	0.01	0.01	0.02	0.05	0.04	0.02	0.00	0.01

6.0 PRECURSOR DEMONSTRATION FOR NH_3 CONTRIBUTION

We ran CAMx for the entirety of the January 2011 modeling episode for the 2019 emission scenario in which major stationary source NH_3 emissions were zeroed. We calculated $PM_{2.5}$ concentration differences between the 2019 future year case (Table 3(b)) and NH_3 zero-out run (Table 9(a)) for each day and at each monitoring site within the SLC NAA; results are shown in Table 9(b). Values shaded green indicate NH_3 contributions below the significance threshold of 1.5 µg/m^3. According to the model, NH_3 contributions are always below the threshold, although NH_3 contributions increase later in the episode. The results in Table 9 are consistent with finding from the Utah Winter Fine Particulate Study (UWFPS; Baasandorj et al., 2018), which indicate that fine particulate ammonium nitrate within SLC may be near a balance between nitrate-limited and NH_3-limited conditions, with a tendency towards NH_3-limited conditions later during cold air pool events.

Table 9(a). 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the 2019 major stationary source NH_3 zero-out case.

NH_3 Control $PM_{2.5}$			24-Hour $PM_{2.5}$ (µg/m³)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	9.7	6.6	4.2	12.1	17.5	8.2	13.3	34.6	30.8	10.3	8.8
Tooele	490450003	Tooele	9.4	7.9	11.7	18.7	17.2	12.7	21.5	33.0	28.3	10.2	8.6
Cottonwood	490350003	Cottonwood West	13.7	11.4	14.3	31.9	31.6	25.6	38.1	51.2	42.8	13.1	12.4
Erda	490450004	Erda	10.0	8.0	11.1	18.9	15.9	13.3	23.3	26.5	25.3	11.0	7.8
Hawthorne	490353006	Salt Lake City	15.7	12.3	19.0	27.7	31.8	22.1	39.2	50.5	49.3	15.3	12.8
Magna	490351001	Magna	9.5	8.2	12.0	21.1	21.6	18.3	26.9	37.6	39.9	9.3	11.7
ROSE PARK	490353010	Salt Lake City	16.3	13.5	13.9	30.5	31.7	24.7	39.1	45.3	44.4	14.2	15.3
Bountiful Viewmont	490110004	Bountiful	11.0	7.0	9.1	25.1	21.0	14.0	37.6	36.8	39.6	8.8	9.9
Ogden	490570002	Ogden	11.4	7.6	7.9	12.4	19.8	13.3	32.7	32.0	31.4	8.7	10.8
Harrisville	490571003	Harrisville	11.4	7.7	6.8	9.7	17.9	11.5	22.0	31.2	25.6	9.1	8.5
Brigham City	490030003	Brigham City	9.1	8.8	7.2	7.9	11.3	12.6	16.6	24.8	22.9	6.5	8.3

Table 9(b). Change in total 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the 2019 major stationary source NH_3 zero-out case. Green shade indicates impacts below the 1.5 µg/m^3 threshold for significant contributions.

(Base Case $PM_{2.5}$ - NH3 Control $PM_{2.5}$)			24-Hour $PM_{2.5}$ (µg/m³)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	0.00	0.00	0.00	0.01	0.03	0.00	0.00	0.28	0.12	0.01	0.00
Tooele	490450003	Tooele	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.02	0.00	0.00
Cottonwood	490350003	Cottonwood West	0.00	0.00	0.00	0.02	0.17	0.00	0.00	0.61	0.31	0.02	0.00
Erda	490450004	Erda	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.02	0.00	0.00
Hawthorne	490353006	Salt Lake City	0.00	0.00	0.00	0.06	0.13	0.00	0.01	0.62	0.41	0.01	0.00
Magna	490351001	Magna	0.00	0.00	0.00	0.09	0.03	0.00	0.00	0.41	0.85	0.00	0.02
ROSE PARK	490353010	Salt Lake City	0.00	0.00	0.00	0.03	0.12	0.00	0.01	1.06	0.54	0.01	0.00
Bountiful Viewmont	490110004	Bountiful	0.00	0.01	0.00	0.05	0.43	0.01	0.01	0.28	0.78	0.01	0.00
Ogden	490570002	Ogden	0.00	0.00	0.00	0.00	0.04	0.01	0.01	0.02	0.16	0.00	0.00
Harrisville	490571003	Harrisville	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.01	0.09	0.00	0.00
Brigham City	490030003	Brigham City	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.03	0.00	0.00

7.0 SUMMARY

Table 10 summarizes maximum modeled 24-hour $PM_{2.5}$ contributions from major stationary source NOx, SOx, VOC and NH_3 emissions, and maximum modeled 24-hour $PM_{2.5}$ sensitivity to major stationary source SOx reductions of 30%, 50%, and 70%, over all days of the January 2011 modeling episode and over all monitoring sites. Table 10 also shows the impacts specifically at Hawthorne and Rose Park monitoring sites, the two SLC NAA monitoring sites with the highest design values.

Table 10. Summary of maximum 24-hour $PM_{2.5}$ contributions ($\mu g/m^3$) from major stationary source NOx, SOx, VOC and NH_3 emissions, and maximum $PM_{2.5}$ sensitivity ($\mu g/m^3$) to major stationary source SOx reductions of 30%, 50%, and 70%, over all days and sites; results at Hawthorne and Rose Park are also shown.

Demonstration Case	Hawthorne	Rose Park	Maximum (Site)
NOx Contribution	0.33	0.40	0.86 (Brigham City)
VOC Contribution	0.50	0.29	0.58 (Bountiful)
NH3 Contribution	0.62	1.06	1.06 (Rose Park)
SOx Contribution	0.99	1.21	1.47 (Magna)
SOx 30% Sensitivity	0.25	0.28	0.35 (Magna)
SOx 50% Sensitivity	0.44	0.50	0.62 (Magna)
SOx 70% Sensitivity	0.64	0.75	0.92 (Magna)

8.0 REFERENCES

Baasandorj, M., et al., 2018. 2017 Utah Winter Fine Particulate Study Final Report. Prepared for the Utah Division of Air Quality (UDAQ), March 16, 2018. https://documents.deq.utah.gov/air-quality/planning/technical-analysis/research/northern-utah-airpollution/utah-winter-fine-particulate-study/DAQ-2018-004037.pdf.

Federal Register, 2016. Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements; Final Rule (40 CFR Parts 50, 51, and 93), Vol. 81, No. 164 (8/24/2016), https://www.gpo.gov/fdsys/pkg/FR-2016-08-24/pdf/2016-18768.pdf.

Federal Register, 2017. Determinations of Attainment by the Attainment Date, Determinations of Failure To Attain by the Attainment Date and Reclassification for Certain Nonattainment Areas for the 2006 24-Hour Fine Particulate Matter National Ambient Air Quality Standards (40 CFR 52 and 81), Vol. 82, No. 89 (5/10/2017), https://www.gpo.gov/fdsys/pkg/FR-2017-05-10/pdf/2017-09391.pdf.

Ramboll, 2018. User's Guide: Comprehensive Air quality Model with extensions (CAMx), version 6.50. www.camx.com.

US EPA, 2016a. "Technical Basis for the EPA's Development of the Significant Impact Thresholds for $PM_{2.5}$ and Ozone", Draft for Public Review & Comment (August 1, 2016). U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Air

Quality Assessment Division, Research Triangle Park, NC. https://19january2017snapshot.epa.gov/sites/production/files/2016-08/documents/pm2_5_sils_and_ozone_technical_basis_document.pdf.

US EPA, 2016b. "Draft $PM_{2.5}$ Precursor Demonstration Guidance", Stephen D. Page to Regional Air Division Directors (November 17, 2016). https://www.epa.gov/pm-pollution/draft-pm25-precursor-demonstration-guidance.

US EPA, 2018. "Technical Basis for the EPA's Development of the Significant Impact Thresholds for $PM_{2.5}$ and Ozone (EPA-454/R-18-001)." U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Air Quality Assessment Division, Research Triangle Park, NC (April 2018). https://www.epa.gov/sites/production/files/2018-04/documents/ozone_pm2.5_sils_technical_document_final_4-17-18.pdf.

APPENDIX A

Timeline for Data Acquisition and MSSPD Analysis

Appendix A Timeline for Data Acquisition and MSSPD Analyses

The UDAQ photochemical model is run for a $PM_{2.5}$ episode that occurred during the cold air pool event of January 1-10, 2011 and included multiple exceedance days. UDAQ has developed two "base" emission scenarios representing the years 2014 and 2016, and a "future" emission scenario representing the year 2019. The analyses reported here were performed prior to the availability of the 2016 base year emissions.

Below we outline the steps in obtaining the UDAQ photochemical modeling database for the 2014 base and 2019 future years, and the process of running the model for the 2014 and 2019 MSSPD analyses. The process was iterative and included on-going dialogue between Ramboll and UDAQ staff. Therefore, the analyses documented in this report are based on the same modeling tools and inputs (with appropriate adjustments as noted in Section 2.2) as UDAQ is relying on for its air quality analyses.

On February 6, 2018, UDAQ sent the entire 2014 base year modeling platform to Ramboll via hard disk drive. The data contents included[12]:

- All 2014 emissions in both sector-based (pre-merged) and model-ready (merged) files;
- All meteorological input files;
- All initial/boundary condition files;
- All photolysis rate and ozone column input files;
- CAMx v6.30 source code and run scripts;
- 2014 CAMx output generated by UDAQ;
- The entire 2014 SMOKE emissions processing system, including raw 2014 inventory files for all sectors, run scripts and supporting speciation and temporal profiles, spatial allocation files, and related cross-reference files.

Ramboll conducted an initial simulation of the UDAQ 2014 "base year" to ensure that we could replicate UDAQ-provided output files. Once confirmed, we used the 2014 modeling database to conduct a preliminary NOx and SOx MSSPD analyses by identifying point sources as "major" if their 2014 actual emissions (as opposed to PTE) reported in the UDAQ emission inventory exceeded 70 TPY for direct $PM_{2.5}$ or any precursor species (Appendix B, Table B-1). Ramboll also conducted major source SOx contribution and sensitivity analyses using a SOx-adjusted 2014 point source inventory (Section 2.2 and Appendix B). The ammonia emissions adjustment for Big West Oil had not yet been implemented at this time.

On May 9, 2018, UDAQ provided 2019 future year emission projections for mobile, area and point sources. This was in response to an e-mail request from Chris Emery, Ramboll, on May 9,

[12] Data contents were specifically outlined in the December 15, 2017 e-mail from Marise Textor, Andeavor, and confirmed in the UDAQ response letter from Bryce Bird to Marise Textor dated January 19, 2019 (DAQP-002-18).

2018, and a prior phone call between Emery and UDAQ on May 8. At that point UDAQ had not completed their 2019 point source projections. The 2019 emission files were provided as both pre-merged and merged surface gridded files in model-ready format. This data transfer was conducted electronically from a guest account set up by UDAQ on a University of Utah FTP server.

In the final 2019 MSSPD analyses for NOx, SOx, VOC, and NH_3, Ramboll used the SOx- and NH_3-adjusted 2014 point source inventory (Section 2.2) in place of the UDAQ's initial 2019 point source inventory. In these analyses, we identified point sources as "major" if their permitted PTE emission exceeded 70 TPY for direct $PM_{2.5}$ or any precursor species (Section 2.1). This added five additional point sources (Table 1, Section 2.1) relative to the 2014 MSSPD analyses described in Appendix B. The 2019 MSSPD analyses were run with all other UDAQ 2019 emission inputs. Although UDAQ has since updated their 2019 future year inventory, it was necessary to "lock-in" the 2019 inventory we received in early May so that we could complete the MSSPD modeling analyses reported here before the end of the SIP public comment period.

APPENDIX B

Preliminary Major Stationary Source Precursor Demonstrations for NOx and SOx Based on the 2014 UDAQ Emission Inventory

Appendix B Preliminary Major Stationary Source Precursor Demonstrations for NOx and SOx Based on the 2014 UDAQ Emission Inventory

B.1 UDAQ 2014 Base Year Modeling Inventory

EPA defines stationary facility sources in Serious $PM_{2.5}$ Nonattainment Areas as "major" if direct $PM_{2.5}$ or any precursor emissions equal or exceed 70 tons per year (TPY) based on their permitted "potential to emit" (PTE) rates (40 CFR 51.1000 Definitions). In our preliminary MSSPD analyses using the 2014 UDAQ emission inventory, we cross-referenced stationary sources to their 2014 actual rates (as opposed to permitted PTE rates), and identified those facilities within the SLC NAA that emitted at least 70 TPY of $PM_{2.5}$ or any precursor emissions as major stationary sources for this demonstration. Table B-1 lists the major stationary facility sources in the SLC NAA that were used in the 2014 MSSPD analyses (note that these differ from the corrected set of major stationary sources based on PTE used in the 2019 MSSPD analyses described in the main report). We then zeroed-out specific precursor emissions from these facilities in the raw stationary inventory file provided by UDAQ, and processed this file through the Sparse Matrix Operator Kernel Emissions (SMOKE) system using UDAQ's scripts and supporting files to generate new, model-ready, low-level and elevated point source inputs for the CAMx model. We performed this separately for precursor species NOx and SOx resulting in two different zero-out emission input files. All other emission species and sectors were unmodified.

B.2 2014 Precursor Demonstration for NOx Contribution

We ran CAMx for the entirety of the January 2011 modeling episode with the major stationary source NOx emissions in the 2014 UDAQ inventory zeroed out. We performed the same simulation for the 2014 CAMx base year replication run (using the unaltered emission inventory). Resulting hourly gridded concentrations of all $PM_{2.5}$ components (sulfate, nitrate, ammonia, elemental and organic carbon, sodium, chloride, and primary $PM_{2.5}$) were summed to total $PM_{2.5}$ mass concentrations, and averaged each day (midnight-midnight) to derive 24-hour $PM_{2.5}$. Following EPA guidance, we calculated 24-hour $PM_{2.5}$ concentration differences between the 2014 base year (Table B-2(a)) and NOx zero-out runs (Table B-2(b)) for all days and at each monitoring site within the SLC NAA to determine major stationary source NOx precursor contributions.

Table B-2(c) lists the major stationary source NOx contributions on total $PM_{2.5}$ on each day and at each monitor. Values shaded green indicate NOx contributions below the significance threshold of 1.5 $\mu g/m^3$. The model shows NOx contributions were always well below the threshold.

Table B-1. List of “major” stationary facility sources within the SLC NAA and their 2014 primary $PM_{2.5}$ and precursor emissions (TPY). Those facilities highlighted in color are considered “major” according to actual 2014 emissions greater than 70 TPY (as opposed to PTE). Table from UDAQ web site[13].

Source: UDAQ 11/14/17				2014 Baseline Emissions				
	County	Site ID	Site Name	$PM_{2.5}$ (tons/yr)	SO_X (tons/yr)	NO_X (tons/yr)	VOC (tons/yr)	NH_3 (tons/yr)
Salt Lake Non-Attainment Area								
	Box Elder	10008	Nucor Steel- Nucor Steel	37.5	135.0	156.8	31.7	1.9
	Box Elder	10009	ATK Launch Systems - Promontory	19.1	1.9	51.0	31.2	0.4
	Box Elder	10028	Vulcraft - Division of Nucor Corporation- Steel Products Manufacturing	9.3	0.4	5.8	38.1	0.0
	Box Elder	14107	Procter and Gamble-Paper Manufacturing Plant	38.9	0.3	27.2	18.6	0.2
	Davis	10119	Chevron Products Co - Salt Lake Refinery	32.9	23.9	375.6	298.1	8.9
	Davis	10121	Hill Air Force Base - Main Base	8.5	4.0	151.4	126.4	1.5
	Davis	10122	Big West Oil - Flying J Refinery	45.9	57.1	92.3	307.4	117.4
	Davis	10123	Holly Corp- HRMC and HEP Woods Cross Operations	12.7	102.3	168.4	155.3	17.6
	Davis	10129	Wasatch Integrated Waste Mgt District- County Landfill & Energy Recovery Facility (DCERF)	9.8	17.2	236.4	23.2	0.0
	Salt Lake	10335	Tesoro Refining & Marketing Company LLC	89.1	708.3	358.1	250.4	3.8
	Salt Lake	10346	Kennecott Utah Copper LLC- Smelter & Refinery	420.0	704.4	160.0	10.4	5.6
	Salt Lake	10354	University of Utah- University of Utah facilities	14.4	0.7	72.2	9.8	3.0
	Salt Lake	10355	Pacificorp Energy- Gadsby Power Plant	16.9	1.5	117.4	9.6	13.1
	Salt Lake	10571	Kennecott Utah Copper LLC- Mine & Copperton Concentrator **	105.4	0.0	5.6	4.7	1.8
	Salt Lake	10572	Kennecott Utah Copper LLC- Power Plant Lab Tailings Impoundment	71.8	1500.3	1322.5	8.2	0.2
	Salt Lake	11386	Hexcel Corporation- Salt Lake Operations	72.0	27.9	145.8	160.6	79.4
	Salt Lake	12495	UAMPS - West Valley Power Plant	3.9	0.4	8.6	1.3	0.0
	Tooele	10707	Lhoist North America - Grantsville Plant	0.2	0.0	0.2	0.1	0.0
	Tooele	10726	Morton Salt Inc.	14.9	3.3	38.3	2.8	0.4
	Weber	10917	Compass Minerals Ogden Inc. - Production Plant	28.2	8.7	134.6	16.4	3.1

** The original table from UDAQ included non-road equipment tailpipe emissions operating within the Kennecott mine facility. The definition of a “major” stationary source does not include tail pipe emissions, so the non-road emissions were removed to show just stationary source emissions at the Kennecott mine facility. Non-tailpipe, mechanically generated particulate emissions associated with the non-road equipment’s operation (for example, road dust) remains in the inventory.

Table B-2(a). Total 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the 2014 base year case.

Base Case			24-Hour $PM_{2.5}$ ($\mu g/m^3$)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	9.9	6.8	4.3	12.8	19.1	8.6	13.7	34.7	33.1	10.6	9.7
Tooele	490450003	Tooele	9.5	8.2	12.5	20.6	19.1	13.5	23.2	36.3	31.7	10.7	9.0
Cottonwood	490350003	Cottonwood West	14.0	11.8	14.4	33.0	33.3	26.6	38.9	50.8	43.7	14.2	13.2
Erda	490450004	Erda	10.2	8.3	11.8	21.3	17.8	14.2	24.9	30.5	29.2	11.5	8.4
Hawthorne	490353006	Salt Lake City	16.0	12.7	19.4	28.9	33.7	23.4	43.7	53.1	51.0	16.6	13.7
Magna	490351001	Magna	9.6	8.4	13.0	23.3	24.1	19.8	27.7	40.4	42.7	9.7	12.5
Rose Park	490353010	Salt Lake City	16.6	13.9	14.3	32.5	33.9	25.9	42.3	50.0	46.8	15.2	16.3
Bountiful Viewmont	490110004	Bountiful	11.2	7.1	9.5	26.9	23.1	15.0	35.6	40.2	43.0	9.3	10.7
Ogden	490570002	Ogden	11.7	8.0	8.4	13.8	22.3	14.6	34.5	35.9	35.0	9.2	12.0
Harrisville	490571003	Harrisville	11.7	8.0	7.3	10.7	20.2	12.6	24.3	35.5	29.2	9.7	9.3
Brigham City	490030003	Brigham City	9.2	9.3	7.8	8.7	13.0	13.8	18.7	29.0	26.8	6.8	9.4

[13] https://deq.utah.gov/legacy/pollutants/p/particulate-matter/pm25/serious-area-state-implementation-plans/posted-inventories.htm.

Table B-2(b). 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the 2014 major stationary source NOx zero-out case.

NOx Control $PM_{2.5}$			24-Hour $PM_{2.5}$ (µg/m³)										
Site Name	**AQS ID**	**City**	**12/31/2010**	**1/1/2011**	**1/2/2011**	**1/3/2011**	**1/4/2011**	**1/5/2011**	**1/6/2011**	**1/7/2011**	**1/8/2011**	**1/9/2011**	**1/10/2011**
Herriman	490353013	Herriman	9.9	6.8	4.3	12.8	18.9	8.6	13.7	34.9	33.1	10.6	9.6
Tooele	490450003	Tooele	9.5	8.2	12.5	20.5	18.9	13.5	23.1	36.0	31.4	10.7	9.0
Cottonwood	490350003	Cottonwood West	14.0	11.8	14.4	33.1	33.3	26.6	39.1	51.6	44.1	14.1	13.2
Erda	490450004	Erda	10.1	8.3	11.8	21.1	17.6	14.1	24.9	30.2	28.9	11.5	8.4
Hawthorne	490353006	Salt Lake City	16.0	12.7	19.5	29.1	33.7	23.4	43.9	53.9	51.4	16.5	13.7
Magna	490351001	Magna	9.6	8.4	13.0	23.1	23.8	19.7	27.8	40.3	42.8	9.6	12.4
Rose Park	490353010	Salt Lake City	16.6	13.9	14.5	32.7	33.8	25.8	42.6	50.3	47.0	15.1	16.2
Bountiful Viewmont	490110004	Bountiful	11.1	7.1	9.6	27.4	23.0	15.0	37.2	40.3	42.8	9.3	10.6
Ogden	490570002	Ogden	11.7	8.0	8.4	13.8	22.0	14.6	34.8	35.6	34.7	9.2	11.9
Harrisville	490571003	Harrisville	11.7	8.0	7.2	10.7	20.0	12.5	24.2	35.1	28.7	9.7	9.2
Brigham City	490030003	Brigham City	9.2	9.3	7.8	8.7	12.9	13.7	18.4	28.4	26.2	6.8	9.3

Table B-2(c). Change in total 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the 2014 major stationary source NOx zero-out case. Green shade indicates impacts below the 1.5 µg/m³ threshold for significant contributions.

(Base Case $PM_{2.5}$ - NOx Control $PM_{2.5}$)			24-Hour $PM_{2.5}$ (µg/m³)										
Site Name	**AQS ID**	**City**	**12/31/2010**	**1/1/2011**	**1/2/2011**	**1/3/2011**	**1/4/2011**	**1/5/2011**	**1/6/2011**	**1/7/2011**	**1/8/2011**	**1/9/2011**	**1/10/2011**
Herriman	490353013	Herriman	0.01	0.00	0.00	0.01	0.15	0.02	0.00	-0.20	0.03	0.04	0.04
Tooele	490450003	Tooele	0.00	0.00	0.02	0.11	0.23	0.03	0.07	0.21	0.23	0.04	0.01
Cottonwood	490350003	Cottonwood West	0.02	0.00	-0.02	-0.18	0.00	0.01	-0.19	-0.77	-0.40	0.08	0.05
Erda	490450004	Erda	0.01	0.00	0.02	0.19	0.20	0.04	0.06	0.34	0.31	0.03	0.02
Hawthorne	490353006	Salt Lake City	0.03	0.00	-0.06	-0.12	0.01	0.03	-0.25	-0.81	-0.40	0.08	0.07
Magna	490351001	Magna	0.01	0.00	0.03	0.17	0.32	0.09	-0.08	0.09	-0.05	0.06	0.07
Rose Park	490353010	Salt Lake City	0.04	0.00	-0.13	-0.19	0.08	0.02	-0.37	-0.34	-0.24	0.11	0.07
Bountiful Viewmont	490110004	Bountiful	0.04	0.01	-0.04	-0.47	0.15	-0.04	-1.54	-0.07	0.15	0.04	0.14
Ogden	490570002	Ogden	0.03	0.02	0.01	0.05	0.26	0.09	-0.29	0.33	0.35	0.05	0.13
Harrisville	490571003	Harrisville	0.02	0.03	0.01	0.06	0.21	0.09	0.10	0.42	0.44	0.04	0.08
Brigham City	490030003	Brigham City	0.00	0.06	0.04	0.06	0.17	0.13	0.29	0.59	0.61	0.02	0.08

B.3 2014 Precursor Demonstration for SOx Contribution

Following the same methodology for NOx, we ran CAMx for the January 2011 modeling episode with the major stationary source SOx emissions zeroed out. We calculated $PM_{2.5}$ concentration differences between the 2014 base year (Table B-2(a)) and SOx zero-out run (Table B-3(a)) for all days and at each monitoring site within the SLC NAA, as shown in Table B-3(b). Values shaded green indicate SOx contributions below the significance threshold of 1.5 µg/m³; values shaded in red indicate SOx contribution above that threshold. Note that no $PM_{2.5}$ increases occur with the SOx removal. According to the model, contributions greater than the threshold occur for several locations and dates, with maxima of 4.5 and 4.4 µg/m³ at Hawthorn and Rose Park, respectively, on January 7 (the peak observed exceedance day).

Table B-3(a). 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the 2014 major stationary source SOx zero-out case.

SOx Control $PM_{2.5}$			24-Hour $PM_{2.5}$ (µg/m³)										
Site Name	**AQS ID**	**City**	**12/31/2010**	**1/1/2011**	**1/2/2011**	**1/3/2011**	**1/4/2011**	**1/5/2011**	**1/6/2011**	**1/7/2011**	**1/8/2011**	**1/9/2011**	**1/10/2011**
Herriman	490353013	Herriman	9.9	6.8	4.3	12.6	18.7	8.6	13.7	33.9	32.5	10.2	9.6
Tooele	490450003	Tooele	9.5	8.2	12.5	20.4	18.7	13.5	22.7	35.5	31.1	10.6	9.0
Cottonwood	490350003	Cottonwood West	14.0	11.8	14.4	32.3	32.6	26.5	38.1	48.1	43.2	13.6	13.1
Erda	490450004	Erda	10.2	8.3	11.8	21.1	17.4	14.0	24.6	29.5	28.3	11.4	8.3
Hawthorne	490353006	Salt Lake City	16.0	12.7	19.1	28.4	32.6	23.3	39.2	48.6	50.4	15.7	13.5
Magna	490351001	Magna	9.6	8.4	13.0	23.2	22.9	19.6	27.3	38.9	41.8	9.4	12.1
Rose Park	490353010	Salt Lake City	16.6	13.9	14.2	31.2	32.6	25.8	39.1	45.6	46.2	14.6	16.1
Bountiful Viewmont	490110004	Bountiful	11.2	7.1	9.5	25.9	22.3	14.7	34.2	38.7	42.2	9.1	10.5
Ogden	490570002	Ogden	11.7	8.0	8.4	13.7	21.6	14.5	33.6	35.1	34.4	9.1	11.8
Harrisville	490571003	Harrisville	11.7	8.0	7.2	10.6	19.8	12.4	24.0	34.8	28.6	9.6	9.1
Brigham City	490030003	Brigham City	9.2	9.3	7.8	8.7	12.8	13.6	18.5	28.4	26.2	6.7	9.2

Table B-3(b). Change in total 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the 2014 major stationary source SOx zero-out case. Green shade indicates impacts below the 1.5 µg/m³ threshold for significant contributions; red shade indicates impacts above that threshold.

(Base Case $PM_{2.5}$ - SOx Control $PM_{2.5}$)			24-Hour $PM_{2.5}$ (µg/m³)										
Site Name	**AQS ID**	**City**	**12/31/2010**	**1/1/2011**	**1/2/2011**	**1/3/2011**	**1/4/2011**	**1/5/2011**	**1/6/2011**	**1/7/2011**	**1/8/2011**	**1/9/2011**	**1/10/2011**
Herriman	490353013	Herriman	0.02	0.00	0.00	0.18	0.30	0.02	0.01	0.81	0.61	0.44	0.13
Tooele	490450003	Tooele	0.00	0.00	0.00	0.22	0.41	0.05	0.42	0.73	0.58	0.11	0.03
Cottonwood	490350003	Cottonwood West	0.04	0.00	0.03	0.68	0.68	0.10	0.85	2.69	0.52	0.58	0.15
Erda	490450004	Erda	0.00	0.00	0.00	0.20	0.32	0.12	0.31	0.99	0.83	0.08	0.05
Hawthorne	490353006	Salt Lake City	0.02	0.01	0.36	0.57	1.11	0.08	4.46	4.49	0.64	0.90	0.17
Magna	490351001	Magna	0.00	0.00	0.01	0.10	1.19	0.17	0.39	1.53	0.92	0.26	0.40
Rose Park	490353010	Salt Lake City	0.01	0.01	0.16	1.26	1.23	0.08	3.14	4.37	0.63	0.59	0.18
Bountiful Viewmont	490110004	Bountiful	0.02	0.01	0.01	1.02	0.84	0.28	1.47	1.48	0.78	0.28	0.28
Ogden	490570002	Ogden	0.01	0.01	0.01	0.08	0.65	0.13	0.91	0.83	0.66	0.10	0.22
Harrisville	490571003	Harrisville	0.01	0.02	0.01	0.07	0.37	0.11	0.30	0.74	0.60	0.09	0.17
Brigham City	490030003	Brigham City	0.00	0.05	0.02	0.06	0.19	0.15	0.15	0.55	0.65	0.04	0.15

B.4. 2014 Adjusted Precursor Demonstration for SOx Contribution

We ran CAMx for the January 2011 modeling episode with the SOx-adjusted 2014 point source emissions (Section 2.2) and calculated $PM_{2.5}$ concentration differences between the SOx-adjusted case (Table B-4(a)) and the SOx zero-out run described previously (Table B-3(a)) for all days and at each monitoring site within the SLC NAA; results are shown in Table B-4(b). Note that at the time this case was run, we had not yet made the NH_3 adjustment to the Big West facility, as described in Section 2.2. According to the model, SOx contributions remain slightly greater than the 1.5 µg/m³ significance threshold on January 7 at Hawthorne and Rose Park.

Table B-4(a). 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the 2014 base year case using the adjusted point source inventory for SOx.

Adjusted Base Case $PM_{2.5}$			24-Hour $PM_{2.5}$ (µg/m³)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	9.9	6.8	4.3	12.7	19.0	8.6	13.7	34.4	32.9	10.6	9.7
Tooele	490450003	Tooele	9.5	8.2	12.5	20.6	19.1	13.5	23.1	36.1	31.6	10.7	9.0
Cottonwood	490350003	Cottonwood West	14.0	11.8	14.4	32.5	33.0	26.6	38.4	49.3	43.4	13.8	13.1
Erda	490450004	Erda	10.2	8.3	11.8	21.2	17.7	14.1	24.9	30.3	29.0	11.5	8.4
Hawthorne	490353006	Salt Lake City	16.0	12.7	19.1	28.5	33.1	23.4	40.1	50.1	50.7	15.9	13.6
Magna	490351001	Magna	9.6	8.4	13.0	23.3	23.9	19.7	27.5	40.0	42.5	9.7	12.5
ROSE PARK	490353010	Salt Lake City	16.6	13.9	14.2	31.5	33.3	25.8	39.7	47.5	46.5	14.8	16.2
Bountiful Viewmont	490110004	Bountiful	11.2	7.1	9.5	26.2	22.7	14.8	34.5	39.3	42.6	9.2	10.6
Ogden	490570002	Ogden	11.7	8.0	8.4	13.8	21.9	14.6	33.9	35.5	34.7	9.2	11.9
Harrisville	490571003	Harrisville	11.7	8.0	7.3	10.7	20.0	12.5	24.1	35.1	28.9	9.7	9.2
Brigham City	490030003	Brigham City	9.2	9.3	7.8	8.7	13.0	13.7	18.6	28.7	26.5	6.8	9.3

Table B-4(b). Change in total 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the SOx-adjusted 2014 case and the major stationary source SOx zero-out case. Green shade indicates impacts below the 1.5 µg/m³ threshold for significant contributions; red shade indicates impacts above that threshold.

(Adjusted Base Case $PM_{2.5}$ - SOx Control $PM_{2.5}$)			24-Hour $PM_{2.5}$ (µg/m³)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	0.02	0.00	0.00	0.13	0.22	0.01	0.01	0.52	0.41	0.42	0.11
Tooele	490450003	Tooele	0.00	0.00	0.00	0.18	0.35	0.05	0.37	0.62	0.48	0.10	0.03
Cottonwood	490350003	Cottonwood West	0.01	0.00	0.01	0.19	0.41	0.08	0.27	1.12	0.21	0.14	0.09
Erda	490450004	Erda	0.00	0.00	0.00	0.15	0.27	0.11	0.25	0.84	0.70	0.07	0.05
Hawthorne	490353006	Salt Lake City	0.01	0.01	0.05	0.17	0.54	0.06	0.84	1.54	0.30	0.22	0.10
Magna	490351001	Magna	0.00	0.00	0.00	0.06	1.04	0.14	0.22	1.18	0.70	0.25	0.37
Rose Park	490353010	Salt Lake City	0.01	0.01	0.03	0.31	0.66	0.06	0.56	1.93	0.34	0.18	0.11
Bountiful Viewmont	490110004	Bountiful	0.01	0.01	0.00	0.26	0.41	0.12	0.34	0.58	0.45	0.13	0.12
Ogden	490570002	Ogden	0.00	0.01	0.01	0.06	0.28	0.10	0.30	0.41	0.31	0.06	0.12
Harrisville	490571003	Harrisville	0.00	0.01	0.00	0.05	0.19	0.08	0.11	0.30	0.28	0.06	0.10
Brigham City	490030003	Brigham City	0.00	0.02	0.01	0.05	0.11	0.10	0.08	0.29	0.34	0.04	0.09

B.5 2014 Adjusted Precursor Demonstration for SOx Sensitivity

For the SOx precursor sensitivity demonstration, we reduced major stationary source SOx emissions by 30% from the SOx-adjusted 2014 case, and compared the impact of this reduction on modeled $PM_{2.5}$ to the 1.5 µg/m³ significance threshold. We processed the new inventory file through SMOKE system to generate new, model-ready, low-level and elevated point source inputs for the CAMx model. All other emission species and sectors were unmodified. We ran CAMx for the January 2011 modeling episode with the 30% SOx reduction point source inputs and calculated the $PM_{2.5}$ concentration differences between the SOx-adjusted 2014 case (Table B-4(a)) and SOx 30% reduction case (Table B-5(a)) for all days and at each monitoring site within the SLC NAA; results are shown in Table B-5(b). According to the model, $PM_{2.5}$ sensitivity in this case always falls below the 1.5 µg/m³ significance threshold.

Table B-5(a). 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the 2014 major stationary source SOx 30% reduction case.

SOx 30% Control $PM_{2.5}$			24-Hour $PM_{2.5}$ ($\mu g/m^3$)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	9.9	6.8	4.3	12.7	18.9	8.6	13.7	34.3	32.8	10.5	9.6
Tooele	490450003	Tooele	9.5	8.2	12.5	20.5	19.0	13.5	23.0	36.0	31.4	10.7	9.0
Cottonwood	490350003	Cottonwood West	14.0	11.8	14.4	32.4	32.9	26.6	38.3	49.0	43.3	13.7	13.1
Erda	490450004	Erda	10.2	8.3	11.8	21.2	17.6	14.1	24.8	30.1	28.8	11.5	8.4
Hawthorne	490353006	Salt Lake City	16.0	12.7	19.1	28.5	33.0	23.4	39.8	49.7	50.6	15.9	13.6
Magna	490351001	Magna	9.6	8.4	13.0	23.2	23.7	19.7	27.5	39.7	42.4	9.6	12.4
ROSE PARK	490353010	Salt Lake City	16.6	13.9	14.2	31.4	33.1	25.8	39.5	47.0	46.4	14.8	16.2
Bountiful Viewmont	490110004	Bountiful	11.2	7.1	9.5	26.1	22.6	14.8	34.4	39.1	42.5	9.2	10.5
Ogden	490570002	Ogden	11.7	8.0	8.4	13.8	21.8	14.6	33.8	35.3	34.6	9.2	11.8
Harrisville	490571003	Harrisville	11.7	8.0	7.3	10.7	19.9	12.5	24.1	35.0	28.8	9.7	9.2
Brigham City	490030003	Brigham City	9.2	9.3	7.8	8.7	12.9	13.7	18.6	28.6	26.4	6.8	9.3

Table B-5(b). Change in total 24-hour $PM_{2.5}$ concentrations on each modeled day of the January 2011 episode and at each monitor in the SLC NAA, as simulated in the 30% SOx reduction case. Green shade indicates sensitivity below the 1.5 $\mu g/m^3$ threshold for significant contributions.

(Adjusted Base Case $PM_{2.5}$ - SOx 30% Control $PM_{2.5}$)			24-Hour $PM_{2.5}$ ($\mu g/m^3$)										
Site Name	AQS ID	City	12/31/2010	1/1/2011	1/2/2011	1/3/2011	1/4/2011	1/5/2011	1/6/2011	1/7/2011	1/8/2011	1/9/2011	1/10/2011
Herriman	490353013	Herriman	0.01	0.00	0.00	0.04	0.06	0.00	0.00	0.15	0.12	0.11	0.03
Tooele	490450003	Tooele	0.00	0.00	0.00	0.05	0.10	0.01	0.11	0.18	0.14	0.03	0.01
Cottonwood	490350003	Cottonwood West	0.00	0.00	0.00	0.06	0.11	0.02	0.08	0.31	0.06	0.04	0.03
Erda	490450004	Erda	0.00	0.00	0.00	0.04	0.08	0.03	0.08	0.25	0.21	0.02	0.01
Hawthorne	490353006	Salt Lake City	0.00	0.00	0.02	0.05	0.15	0.02	0.25	0.43	0.08	0.07	0.03
Magna	490351001	Magna	0.00	0.00	0.00	0.02	0.27	0.03	0.07	0.30	0.18	0.07	0.07
ROSE PARK	490353010	Salt Lake City	0.00	0.00	0.01	0.09	0.19	0.02	0.17	0.52	0.09	0.05	0.03
Bountiful Viewmont	490110004	Bountiful	0.00	0.00	0.00	0.08	0.11	0.03	0.10	0.16	0.12	0.04	0.03
Ogden	490570002	Ogden	0.00	0.00	0.00	0.02	0.08	0.03	0.09	0.12	0.09	0.02	0.03
Harrisville	490571003	Harrisville	0.00	0.00	0.00	0.01	0.06	0.02	0.03	0.09	0.08	0.02	0.03
Brigham City	490030003	Brigham City	0.00	0.01	0.00	0.01	0.03	0.03	0.02	0.08	0.10	0.01	0.03

APPENDIX C

Author Biographies

Appendix C Author Biographies

Chris Emery has 27 years of experience in numerical modeling and analysis of urban and regional air pollution and meteorology. His expertise includes design, development and application of air quality modeling systems. Chris co-authors the Comprehensive Air Quality Model with extensions (CAMx)—a regional nested grid photochemical model with Plume-in-Grid and Probing Tool extensions. He also prepares the CAMx User's Guide, and manages public distributions of CAMx and support programs. He has delivered CAMx training for numerous US and international clients including private, governmental, and academic institutions for over fifteen years. He has applied a variety of models for private and public clients, in both local and regional regulatory arenas, throughout the US and abroad. His projects have included ozone, particulate matter (PM_{10} and $PM_{2.5}$) and carbon monoxide modeling to support regulatory planning; determining effects of alternative and innovative air quality management strategies; analyzing source contributions and emission sensitivity; modeling fate of toxic air pollutants; studying prospective and retrospective air quality trends; estimating North American background ozone; and simulating source impacts on national parks and wilderness areas. Chris has applied and evaluated meteorological models and global chemical transport models to develop inputs needed by regional photochemical modeling applications. He has served as a member of the American Meteorological Society's Board of the Urban Environment.

Susan Kemball-Cook, PhD has over 20 years of experience in atmospheric physics and model development and application. Her expertise includes photochemical modeling, emission inventory development, global and regional climate modeling, and climate change risk assessment. Sue is the Ramboll Service Line Coordinator for Climate Model Downscaling. Sue has managed projects assisting several Texas Ozone Near Nonattainment Areas in staying in attainment of the National Ambient Air Quality Standard for ozone. These projects have included quantifying ozone transport, emission inventory evaluation using satellite data, exceptional event analysis, control strategy evaluation, and conceptual model development. She has led numerous CAMx modeling projects, including the first evaluation of CAMx performance in the upper troposphere/lower stratosphere against aircraft data and the development of a capability to more accurately model the stratospheric contribution to background ozone. Sue has worked on air quality impact assessments for Texas shale gas development and has managed air quality and air quality related values (AQRVs) impact assessments for numerous National Environmental Policy Act (NEPA) studies for proposed oil and gas developments in the western U.S. She has extensive experience in application and evaluation of CAMx, CMAQ and WRF in NEPA studies and in oil and gas emission inventory development.

Michele Jimenez has extensive experience in emission inventory modeling and the development of software tools to support such efforts. She has directed the development of regional emission inventories in the United States which include emissions modeling for the multi-state regional RPO nested modeling grid. In addition, Michele has experience in data base management systems, scientific software design and implementation, graphics software development, and PC applications.

Ross Beardsley, PhD is experienced in both the development and use of air quality models. He has advanced knowledge of atmospheric processes, as well as environmental monitoring and data analysis. Ross has developed new atmospheric modeling tools and utilized such regional and global models as CAMx, CMAQ, and GEOS-Chem. Ross was the primary developer of a comprehensive secondary organic aerosol (SOA) model that predicts the chemical and physical transformation of volatile organic compounds (VOCs) in the atmosphere. He also co-developed the fully automated Florida Air Quality Modeling System (http://data.as.essie.ufl.edu/faqms/) that generates three-day forecasts of Florida's air quality using WRF for meteorology and CMAQ for air quality. A strong technical programmer, Ross is proficient in Fortran, Linux/Unix, Shell Script, Python, R, and VBA.

Tejas Shah has more than ten years of experience with air pollution analyses. His expertise includes emission modeling, air quality modeling, emission inventory development, spatial analysis with GIS, database tool development, control-measure evaluation and economic impact analysis. Additionally, he has extensive experience using the RPOs emissions inventory, the USEPA's national emissions inventory (NEI) and the Environment Canada national inventory. Tejas' work at Ramboll Environ includes Sparse Matrix Operator Kernel Emissions (SMOKE) processing of regional and project-level emission inventories for various oil and gas EIS projects in the Intermountain West; preparing gridding surrogates and speciation profiles for the SMOKE model input; augmenting SPECIATE—a repository of speciation profiles; spatial analyses and preparing landuse/landcover files for the Comprehensive Air Quality Model with extensions (CAMx) and MEGAN models using GIS; and developing database tools.