Appendix SIR-1

Modeling Report

Dixie and Fishlake National Forests

Oil & Gas Leasing Environmental Impact Statements
Air Quality Modeling Report

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Abbreviations

AP-42	US EPA Guidance document on air pollution emission factors
AQRV	Air Quality Related Value (as defined in FLAG guidance)
b_{ext}	Beta extinction; a measure of the propensity for air to scatter light
EIS	US Environmental Impact Statement
EPA	United States Environmental Protection Agency
FLAG	Federal Land Managers' Air Group
FLM	Federal Land Manager
ISCST3	US EPA Industrial Source Complex air quality model, version 3
IWAQM	Interagency Workgroup on Air Quality Models
lbs/hr	Pounds per hour
MMbtu	Million British Thermal Units (btu); units of heat measurement
Mscf	Million standard cubic feet; measurement unit for gas volume
NOx	Oxides of nitrogen
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NF	National Forest
NWS	National Weather Service
O&G	Oil and Gas
$PM_{2.5}$	Particulate matter less than 2.5 microns in diameter
PM_{10}	Particulate matter less than 10 microns in diameter
ROI	Radius of Impact
SO_2	Sulfur dioxide
UDAQ	Utah Division of Air Quality
UDEQ	Utah Department of Environmental Quality
$\mu g/m^3$	Micrograms per meter cubed
USGS	United States Geological Survey
USFS	United States Forest Service
VOCs	Volatile Organic Compounds
WRAP	Western Regional Air Partnership

1.0 PURPOSE

This modeling report describes an air quality modeling analysis prepared in support of Oil & Gas (O&G) Leasing Environmental Impact Statements (EIS) for the Dixie and Fishlake National Forests (NF). The report uses emission factors required for newer tiered engines as recommended by the U.S. Environmental Protection Agency (EPA) and was performed in a manner consistent with a Modeling Protocol reviewed and commented upon by federal and State of Utah representatives A screening methodology to quickly estimate potential impacts of O&G development emissions at the leasing/exploration stage was prepared and its conservatism verified. This screening methodology will help Forest Service staff in their planning by identifying whether impacts from potential future development scenarios will safely be below impact thresholds, or if further analysis will be required before air quality impacts can be shown to be within acceptable ranges.

The analyses described in this report will support the EIS process by preparing a simple screening tool that land managers may use to estimate air quality impacts associated with potential development. The analyses are based upon conservative estimates of emissions from potential Oil & Gas activity and the atmospheric dispersion of those emissions. As a result of this conservatism, projects shown by this screening method to have impacts within acceptable ranges would clearly meet air quality impact limits in a site specific impact analysis. For all other potential future development of O&G activities identified in the leasing EISs, project specific air quality analyses would be required using appropriate project and site specific information in order to more closely identify potential impacts. While the screening method provides a efficient tool for land managers making leasing decisions it does not represent a full regulatory air quality impact analyses that may be required to permit future, individual O&G activities under existing state and federal air quality regulations.

The modeling analyses described in this report will not address two air quality issues: ozone and secondary particulate formation. Ozone and secondary particulates are pollutants that are not emitted directly but formed through atmospheric processes and the emissions of precursors. Although these issues are a regional concern, an assessment of their impact is beyond the scope of an analysis at the leasing/exploration stage. UDAQ and the Utah Governor's Office recommend a region-wide cooperative approach would be more appropriate to assess impact risks associated with secondary pollutant precursor emissions, which include sulfates, nitrates, and volatile organic compounds (VOCs).

2.0 BACKGROUND / OVERVIEW

2.1 Oil & Gas Leasing Activity

The Dixie and Fishlake NFs are evaluating O&G leasing across their domains in EISs under development. The proposed actions and alternatives in these EISs will be structured to conservatively evaluate potential impacts from a range of O&G activities the United States Forest Service (USFS) considers reasonably foreseeable, and not any project specific development. The EIS for each forest will provide specific definitions of proposed actions and/or alternatives. The analyses in this modeling report will support the EIS reviews of potential air quality impacts and provide a method of estimating the potential impact of any potential exploration or subsequent development scenario. If the conservative analyses in this

modeling report clearly document impacts within acceptable ranges set by air quality regulations, Federal Land Manager's Air Group (FLAG) guidance, or a leasing EIS, then additional modeling or impact assessments may not be needed. If a future development scenario is proposed which cannot be shown by the screening tables to meet those acceptable impact thresholds, then the proposed development could not be justified by these screening analyses. Instead, any such development would require a follow-up NEPA analysis and refined air quality analyses that would include project and site specific information in order to further identify potential impacts.

2.2 Initial Screening Model Analysis

The initial aspect of the dispersion modeling analyses described here was to prepare a representative screening analysis that can be used by the USFS personnel to quantifiably estimate potential impacts of O&G exploration planning and leasing. The potential emissions associated with Oil & Gas exploration and possibly subsequent development of those resources are conservatively estimated. The dispersion of those emissions is also conservatively estimated using worst-case meteorological data. The result is a screening analysis that shows maximum potential impacts associated with a given level of Oil & Gas activity. The maximum potential impact estimates from the screening analyses can be compared to benchmark ambient air standards, increments, and thresholds in order to determine if the conservative screening analyses shows that the action being considered meets state and federal impact limits. Because the screening analysis is based upon conservative assumptions, a site specific analysis of impacts associated with a specific proposal could show lower impacts than those conservatively estimated in the screening analyses presented here.

The results of these analyses are normalized sets of conversion factors in tables for various source / receptor elevation differences at 22 graduated source / receptor distances. The tables indicate the predicted impacts in $\mu g/m^3$ for each 1 lb/hr of emissions. The details of the conversion factor tables were described in the modeling protocol for this project after refinement with USFS Air Program Manager, Bud Rolofson. The screening values can be applied to subsequent O&G development scenarios by estimating the air emissions (in lbs/hr) anticipated from those scenarios and multiplying them by the table screening values to determine a screening estimate of potential ambient air quality impacts. Those impacts can be compared against applicable air quality standards, increments, and thresholds to provide an initial estimate of a range of management options based upon air quality impacts. Ambient air potential impact information will allow land managers to estimate the potential for air quality impacts for subsequent levels of O&G development projects.

2.3 Three Oil & Gas Development Scenarios for Evaluation of Initial Screening Table

After initial development of the screening model runs, the reasonableness of the screening tables were confirmed with site specific analyses of USFS identified potential development scenarios to ensure their reasonableness for development scenarios consistent with forest service (FS) expectations. The three potential development scenarios recommended to be considered are:

1. Scenario 1 -- Individual exploratory wells: over the next 15 years, 60 wells are estimated on the Dixie NF and 45 wells on the Fishlake NF. Each scenario spans a period of three weeks for construction, three months of drilling activity, and two weeks of reclamation,

2. Scenario 2 -- A conventional 20-well oil field development featuring 20 well pads and associated oil extraction and processing operations over an area estimated at 3.5 square miles, and
3. Scenario 3 -- A 10 to 15-well directional drilling development (primarily on the Fishlake NF) which features two to three well pads

The USFS notes that primary energy development is expected to be for crude oil, however, natural gas could likely be found as well. The USFS has surmised gas will not be found in volumes that would support commercial development. Gas might be flared onsite or produced in quantities to either fuel onsite engines or support limited development, storage, and transport via trucks.

Air quality modeling was performed for each of these development scenarios to assess potential criteria air quality pollutant (PM_{10}, NO_x, and SO_2) concentrations and air quality related values (AQRV) as defined in FLAG guidance. That information was used to confirm the representativeness, conservatism, and accuracy of the screening modeling analyses. Those specific development scenario model analyses confirmed the conservative nature of the screening runs by showing that predicted air quality impacts from actual development scenarios were lower than the conservative estimates from the screening tables prepared in this analysis. Therefore, impact estimates from the screening tables can be considered as conservative estimates based upon that level of activity as long as the activity occurs consistent with the assumptions included in the screening analyses. The EIS plans to ensure that consistency and/or require a project specific analysis for any development it supports. The screening table impact estimates are conservative (likely to overestimate actual impacts). Therefore, activities whose impacts estimated from the screening tables are within applicable impact limits can be safely assumed to have no adverse impacts in a site and development specific impact analysis.

Emission inventories were also compiled using estimates of VOC emissions and offsite particulate emissions from each development scenario. However, no modeling or quantitative assessments were made of ambient air quality impacts associated with those emissions.

3.0 MODELING METHODOLOGY

3.1 Brief Description of CALPUFF and ISCST3 Modeling Programs

The EPA-approved CALPUFF model was used in the screening mode for the long-range transport, deposition, and visibility analyses. The ISCST3 model utilized by UDAQ to assess impacts for minor sources was used to conservatively estimate impacts in the near field (within 50 kilometers of the activity being modeled). CALPUFF modeling results were analyzed to assess long-range transport (beyond 50 kilometer) pollutant concentrations and impacts on air quality and air quality related values including deposition of nitrates, deposition of sulfates, and visibility.

The ISCST3 modeling does not include any air chemistry analyses; it simply tracks emissions without chemical transformations during transport in the near field based upon meteorological data from local observation stations.

The CALPUFF model allows for chemical reaction. The modeling performed for this analysis utilized the MESOPUFF II chemical transformation process recommended for screening

modeling by model developer Joseph Scire of Enviro-Tech, with relevant environmental parameters consistent with those proposed in the modeling protocol. Minor adjustments to initial land surface and land use parameters were made based upon UDAQ comments on the modeling protocol. CALPUFF model algorithms can account for the effects of changes in terrain from the meteorological data stations, which in the project area are generally located in valley bottoms, to receptors which could be at any elevation from valley bottom to mountain top.

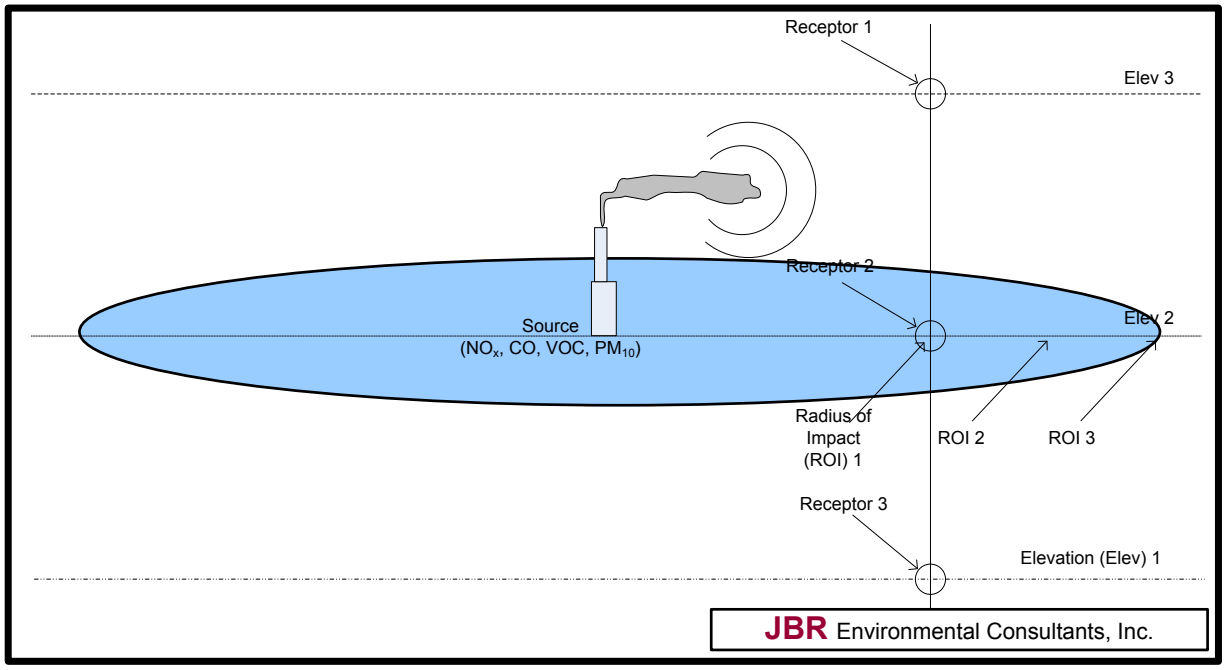
3.2 General Approach for this Analysis

Figure 3.2-1 on the following page visually depicts the modeling approach for the ISCST3 runs. The CALPUFF dispersion model is more refined in that it tracks emissions as a continuous series of puffs (numerical representations of emissions over a short period of time), which can expand or change transport direction as meteorological conditions change.

Impacts for each pollutant and AQRV were evaluated at a set of predetermined elevations in relation to the source and radius of impact (ROI, circles of increasing radius centered around the source). In the screening table runs, seven elevation scenarios were considered - one more than proposed in the project's modeling protocol based upon comments received from UDAQ. The 22 ROI utilized were unchanged from those proposed in the modeling protocol. At the intersection of each of the seven elevations and the 22 ROIs, a receptor is identified. Receptors are defined as the locations where quantitative air quality impacts are predicted.

Various types of receptor grids can be used by defining points on a polar coordinate system (see Figure 6.0-1), a Cartesian (x-y) coordinate system, or a combination of both systems. The receptor locations are documented in the receptor network section below. Maximum model predicted impact values on each radius from the source were reported and included in the screening tables (see Appendix A). All US airsheds are defined as Class I (pristine areas deserving special regulatory protection), Class II (typical airsheds, including most of the US), and Class III (a rarely used classification for industrial zones allowing higher air quality impacts). The model predicted maximum impacts can be compared against applicable Class I or Class II impact limits, or any other applicable impact limits, including FLAG guidelines on acceptable AQRV impact limits for planning purposes or EIS specific impact thresholds.

Figure 3.2-1 Modeling Methodology (for ISCST3)



3.3 Testing Applicability of Initial Screening Table

To evaluate applicability of the screening table results, ISCST3 and CALPUFF modeling was also performed for the specific development scenarios defined in Section 2.0 of this report. Those specific development scenarios were modeled at locations the Dixie and Fishlake NFs identified as conceivable for O&G development.

The emission sources and emission rates for these runs were identified based upon expectations for future development provided by the Dixie and Fishlake NFs. The section below provides more detail on model emission sources. The model emissions were distributed across the development area consistent with USFS descriptions of the development scenarios.

4.0 MODEL SOURCE DATA

4.1 Equipment Considerations for Preparing Emission Inventories

Assessments of equipment needed to support oil exploration and/or oil field development with some possibility of gas resources were prepared generally, and also specifically, for the three development scenarios. An inventory of emissions from all emission sources identified to support the potential oil (and possibly gas) development was prepared. Conservative assumptions were made of the type, size, and number of pieces for each equipment type, consistent with guidance from the USFS and the US EPA. Although natural gas was not expected to be found in economical quantities, a heated oil/gas/water separator, a compressor to move developable gas, and a gas flare were assumed in each oil field development scenario.

As recommended by the U.S. EPA, emissions from mobile and stationery combustion sources assume that engines associated with the potential development meet emission standards from recent EPA tiered emission limits. Generally, equipment was assumed to meet the minimum tiered emission requirements from approximately the last five years, allowing flexibility to the operator because of the comparatively small size of potential development activity anticipated. EPA reviewed and approved the engine emission estimates before the modeling analyses were performed. EPA indicated that more recent engines would likely be required for resource development larger in scale or concentration than the scenarios considered in this analysis.

Emission estimates assume that all vehicular travel is on unpaved surfaces, and that there is no electrical power service onsite, so all major equipment onsite is fossil fuel fired.

In the screening modeling analyses, all model sources were assumed to be collected at a central point, with grid origin with relative coordinates (0,0). That gridding allowed the screening model results to be used to estimate impacts from a variety of development options, from simple projects like an individual exploratory well to more complicated ones like expansive well field developments.

Table 4.1-1 below documents the types of equipment associated with air emissions under the screening model scenario. The emission data from the screening modeling analyses includes the total onsite emissions associated with potential development normalized at 1.0 pound per hour.[1] These emissions are allocated proportionally among equipment and emission stacks as point sources (stacks) or area sources (areas from which non-stack fugitive emissions like dust occur) consistent with regional development scenarios. To be conservative, the emissions profile shown here assumes oil extraction efforts for each scenario, with a small component consistent with gas flaring or processing. The screening model emissions were allocated in model emissions sources listed in Table 4.1-1 with associated stack parameters. The emissions values found in Table 4.1-1 represent the normalized screening emission rates. They represent the proportion of overall emissions of the pollutant from that source in the screening model, not the actual total emissions calculated for each piece of equipment.

[1] In the screening model, the emissions entry for each source represents the percentage of the emissions of that pollutant for that source. The sum of the normalized emissions for the entire development is 100%, or 1.00 lb/hr.

Table 4.1-1 Screening Model Sources and Source Parameters

Point Source ID	Source Description	Easting (X)	Northing (Y)	Stack Height	Temp	Exit Velocity	Stack Diam.	PM_{10}	NOx	SO_2	CO
		(m)	(m)	(ft)	(°F)	(fps)	(ft)	(lb/hr)	(lb/hr)	(lb/hr)	(lb/hr)
Reciprocating Internal Combustion Engines (RICE) / Turbines											
DRE	Drill Rig Engine	0.0	0.0	15.0	950.0	75.0	1	0.1122	0.2950	0.0024	0.0982
WP1	Well Pump	0.0	0.0	10.0	775.0	45.0	0.667	0.4112	0.4610	0.9954	0.3494
RICE / Turbine emission totals								0.5234	0.7561	0.9978	0.4476
Use or flare NG											
Flare	Exploration Flare	0.0	0.0	85.0	1000.0	51.0	1.5	0.0000	0.0384	0.0000	0.1284
Flare	Production Flare	0.0	0.0	85.0	1000.0	51.0	1.5	0.0000	0.0852	0.0000	0.2850
HT1	Heater Treater	0.0	0.0	20.0	180.0	15.0	0.67	0.0307	0.0332	0.0014	0.0171
Use or Flare NG emission totals								0.0307	0.1568	0.0014	0.4305
NG development											
DHY1	Dehydrator	0.0	0.0	30.0	200.0	8.0	1	0.0031	0.0033	0.0001	0.0017
CM1	Compressor Engine	0.0	0.0	25.0	760.0	95.0	1	0.0189	0.0768	0.0007	0.0944
NG development emission totals								0.0220	0.0802	0.0008	0.0962
Dust: Ground dist, vehicles, etc …				Release Height	Radius of Circle	Number of Vertices	Vertical Dimension				
Area Circle Source ID				(ft)	(ft)		(ft)				
	Fugitives	0.0	0.0	10.0	300.0		20	0.4239	0.0070	0.0000	0.0257
TOTAL EMISSIONS								**1.000**	**1.000**	**1.000**	**1.000**

- The uppermost shaded **table section** includes **stack emissions from reciprocating engines or turbines**. This emission category includes well pumps needed to extract oil as well as onsite well drilling rigs with diesel powered drilling engines. Consistent with emissions from regional oil development fields, the total onsite emissions from this source category represented the majority of emissions in the normalized screening model analysis. The emissions of SO_2 from the well pumps, approved by EPA reviewers, are conservative because they are from EPA's AP-42 emission factor guidance document from before recent efforts to reduce diesel fuel sulfur content. This is unlike the AP-42 emission factors for the larger well drilling engine which accounted for the low sulfur fuel that will be required during the project's operational phase.

- The first unhighlighted section includes **emissions associated with processing or using natural gas** expected to be found at least in small quantities in oil development fields. The total onsite emissions from this category make up about 10 percent of total emissions for most pollutants, though flaring could make up a larger percentage of emissions of sulfur dioxide and related compounds.

- The second shaded **section** includes **emissions** that would be expected with **low volumes of natural gas development**. Because developable natural gas is not expected in any appreciable volume, this category represents no more than two percent of the normalized 1.0 lb/hr emissions in this screening analysis.

- The lowest unhighlighted **table section represents onsite fugitive emissions** not vented through a stationary stack. This category includes fugitive dust emissions from vehicular exhaust and road dust, wind erosion from disturbed ground surfaces, and emissions including valve and tank leakage from handling resources and supplies. This category represents the major component for particulate emissions, but includes lower percentages of emissions from the other criteria pollutants studied (NO_x, SO_2, and CO).

- The **bold red Total Emissions** in the highlighted bottom section under each pollutant's column show that cumulative screening model emissions for each pollutant were 1.0 pound per hour.

4.2 Evaluating Applicability of Model Results Screening

To evaluate applicability of the results from the screening modeling analyses, model source data sets were prepared for the specific well field development scenarios described as reasonable by local USFS personnel. The Dixie NF development scenario described and modeled is understood to be based upon the only active energy development activity occurring on that NF. Similarly, the development scenario proposed by the Fishlake NF and modeled for this analysis is understood to be based upon the one existing energy field development there.

For the specific development scenario modeling analyses, model sources were identified and their emissions estimated based upon expected operating scenarios. They were allocated across the development field consistent with descriptions of each scenario provided by the respective NFs. Each of the well field development scenarios were assumed to cover three to three and a half square miles, include specified numbers of wells footprints, and be operated consistent with scenario information provided by each NF. Each scenario included the volume of vehicular traffic expected to be needed to support those efforts.

4.3 References

References utilized in preparing the emission inventory included Utah State Government's "Analysis of Emissions from Oil and Gas Wells in Utah," the Oil & Gas Emission Inventory Workbook for the Uinta Basin Study, similar data from the Four Corners Oil & Gas Development Study, information from existing oil field development on the Dixie and Fishlake NF, and regional and national O&G field emission analyses and emission factors.

The Uinta Basin Study was especially helpful in supplying county-wide cumulative inventories of air emissions from recent development of O&G field development in Uinta and Duchesne Counties, Utah. That data, similar information from a Four Corners area study, and information about existing O&G field developments on the Dixie and Fishlake NFs provided the main basis for allocating the PM_{10}, NOx, and SO_2 emissions among source types and categories in the model. This information was also used in the screening model runs to allocate the normalized 1 lb/hr of emissions proportionally among a variety of emissions sources, each with representative stack parameters and model emissions scenarios. This also helped in the quality assurance reviews of emissions inventories for the specific development scenario modeling analyses. It ensured that the model emissions were allocated among likely sources consistent with emission inventories from existing regional and local O&G developments.

Vehicle traffic volume estimates were prepared consistent with the "Highway Freight Traffic Associated with Development of Oil and Gas Wells" document prepared in 2006 by Daniel Kuhn of the Utah Department of Transportation.

4.4 Dixie National Forest Development Scenario Modeling (Scenario 2)

The Dixie NF development scenario was prescribed to be one conventional 20-well oil field. Each well would be on a separate pad with ground disturbance per pad of 5.9 acres. The total new actual ground disturbance including original discovery well, production well pads, new roads, reconstruction of existing roads, central production facility, water disposal well, overhead power line and substation, field pipeline/power line corridors, and truck loading area is estimated at 263 acres. The general area within the perimeter of the field including pads, pad access roads, and interior pipelines and power lines, and undisturbed areas between, is estimated at approximately 3.5 square miles. Well spacing of 160 acres around each well was used for this special estimate as recommend by Dixie NF.

Table 4.4-1 on the following page documents the model emission sources used to simulate emissions from the 20- well field development scenario. Note that the emission sources are distributed over 3.5 square miles in a manner consistent with the spread of the well field scenario at a typical location within the Dixie NF, with variations in elevations across the development field and across the receptor network. This was performed to check the representativeness of the screening table results on actual field type development conditions. Figures 5.1-1 and 5.1-2 of this document provide a visual representation of their layout.

Table 4.4-1 Dixie National Forest 20-Well Oil Field Development Scenario Model Sources and Source Parameters

Source ID	Source Description	Easting (X)	Northing (Y)	Base Elev	Stk Ht	Temp	Exit Vel	Stk Diam.	PM_{10}	NOx	SO_2
POINT SOURCES		(m)	(m)	(ft)	(ft)	(°F)	(fps)	(ft)	(lb/hr)	(lb/hr)	(lb/hr)
DRE	Drill Rig Engine	427831	4209861	9448	15	950.0	75	1.0	0.26	8.47	0.01
FLARE	Production Flare	427781	4209911	9480	100	1000.0	55	1.5	0.00	3.55	0.00
CM1	Compressor Engine	427831	4209961	9455	25	760.0	95	1.0	0.04	2.20	0.00
HT1	Heater Treater	426936	4208986	9472	20	180.0	15	0.7	0.004	0.05	0.00
HT2	Heater Treater	427489	4208796	9416	20	180.0	15	0.7	0.004	0.05	0.00
HT3	Heater Treater	428269	4208686	9431	20	180.0	15	0.7	0.004	0.05	0.00
HT4	Heater Treater	428861	4208911	9486	20	180.0	15	0.7	0.004	0.05	0.00
HT5	Heater Treater	429086	4209503	9524	20	180.0	15	0.7	0.004	0.05	0.00
HT6	Heater Treater	429086	4210319	9462	20	180.0	15	0.7	0.004	0.05	0.00
HT7	Heater Treater	428861	4210911	9542	20	180.0	15	0.7	0.004	0.05	0.00
HT8	Heater Treater	428269	4211136	9472	20	180.0	15	0.7	0.004	0.05	0.00
HT9	Heater Treater	427453	4211136	9538	20	180.0	15	0.7	0.004	0.05	0.00
HT10	Heater Treater	426861	4210911	9425	20	180.0	15	0.7	0.004	0.05	0.00
HT11	Heater Treater	426636	4210319	9409	20	180.0	15	0.7	0.004	0.05	0.00
HT12	Heater Treater	426636	4209508	9381	20	180.0	15	0.7	0.004	0.05	0.00
HT13	Heater Treater	427236	4209286	9383	20	180.0	15	0.7	0.004	0.05	0.00
HT14	Heater Treater	428486	4209286	9440	20	180.0	15	0.7	0.004	0.05	0.00
HT15	Heater Treater	428486	4210536	9527	20	180.0	15	0.7	0.004	0.05	0.00
HT16	Heater Treater	427236	4210536	9447	20	180.0	15	0.7	0.004	0.05	0.00
HT17	Heater Treater	427161	4209911	9373	20	180.0	15	0.7	0.004	0.05	0.00
HT18	Heater Treater	427861	4209211	9386	20	180.0	15	0.7	0.004	0.05	0.00
HT19	Heater Treater	428561	4209911	9464	20	180.0	15	0.7	0.004	0.05	0.00
HT20	Heater Treater	427861	4210611	9554	20	180.0	15	0.7	0.004	0.05	0.00
DHY1	Dehydrator	426906	4208956	9482	30	200.0	8	1.0	0.004	0.05	0.00
DHY4	Dehydrator	428831	4208881	9488	30	200.0	8	1.0	0.004	0.05	0.00
DHY7	Dehydrator	428831	4210881	9507	30	200.0	8	1.0	0.004	0.05	0.00
DHY10	Dehydrator	426831	4210881	9420	30	200.0	8	1.0	0.004	0.05	0.00
WP1	Well Pump	426906	4209016	9472	10	775.0	45	0.7	0.05	0.66	0.21
WP2	Well Pump	427459	4208826	9418	10	775.0	45	0.7	0.05	0.66	0.21
WP3	Well Pump	428239	4208716	9426	10	775.0	45	0.7	0.05	0.66	0.21
WP4	Well Pump	428831	4208941	9482	10	775.0	45	0.7	0.05	0.66	0.21
WP5	Well Pump	429056	4209533	9524	10	775.0	45	0.7	0.05	0.66	0.21
WP6	Well Pump	429056	4210349	9462	10	775.0	45	0.7	0.05	0.66	0.21
WP7	Well Pump	428831	4210941	9544	10	775.0	45	0.7	0.05	0.66	0.21
WP8	Well Pump	428239	4211166	9471	10	775.0	45	0.7	0.05	0.66	0.21
WP9	Well Pump	427423	4211166	9533	10	775.0	45	0.7	0.05	0.66	0.21

Source ID	Source Description	Easting (X)	Northing (Y)	Base Elev	Stk Ht	Temp	Exit Vel	Stk Diam.	PM_{10}	NOx	SO_2
POINT SOURCES		(m)	(m)	(ft)	(ft)	(°F)	(fps)	(ft)	(lb/hr)	(lb/hr)	(lb/hr)
WP10	Well Pump	426831	4210941	9422	10	775.0	45	0.7	0.05	0.66	0.21
WP11	Well Pump	426606	4210349	9409	10	775.0	45	0.7	0.05	0.66	0.21
WP12	Well Pump	426606	4209538	9380	10	775.0	45	0.7	0.05	0.66	0.21
WP13	Well Pump	427206	4209316	9380	10	775.0	45	0.7	0.05	0.66	0.21
WP14	Well Pump	428456	4209316	9440	10	775.0	45	0.7	0.05	0.66	0.21
WP15	Well Pump	428456	4210566	9524	10	775.0	45	0.7	0.05	0.66	0.21
WP16	Well Pump	427206	4210566	9447	10	775.0	45	0.7	0.05	0.66	0.21
WP17	Well Pump	427131	4209941	9372	10	775.0	45	0.7	0.05	0.66	0.21
WP18	Well Pump	427831	4209241	9390	10	775.0	45	0.7	0.05	0.66	0.21
WP19	Well Pump	428531	4209941	9459	10	775.0	45	0.7	0.05	0.66	0.21
WP20	Well Pump	427831	4210641	9551	10	775.0	45	0.7	0.05	0.66	0.21

Source ID	Source Description	Easting (X)	Northing (Y)	Base Elev	Release Height	Horz. Dim.	Vert. Dim.	PM_{10}	NOx	SO_2
VOLUME SOURCES		(m)	(m)	(ft)	(ft)	(ft)	(ft)	(lb/hr)	(lb/hr)	(lb/hr)
ORD1	outer road	427831	4208536	9414	2.0	100	6.0	0.04	0.01	
ORD2	outer road	427183	4208891	9445	2.0	75	6.0	0.04	0.01	
ORD3	outer road	426719	4209207	9476	2.0	75	6.0	0.04	0.01	
ORD4	outer road	426456	4209911	9427	2.0	100	6.0	0.04	0.01	
ORD5	outer road	426719	4210615	9413	2.0	75	6.0	0.04	0.01	
ORD6	outer road	427127	4211024	9483	2.0	75	6.0	0.04	0.01	
ORD7	outer road	427831	4211286	9477	2.0	100	6.0	0.04	0.01	
ORD8	outer road	428535	4211024	9469	2.0	75	6.0	0.04	0.01	
ORD9	outer road	428944	4210615	9469	2.0	75	6.0	0.04	0.01	
ORD10	outer road	429206	4209911	9471	2.0	100	6.0	0.04	0.01	
ORD11	outer road	428944	4209207	9495	2.0	75	6.0	0.04	0.01	
ORD12	outer road	428535	4208799	9460	2.0	75	6.0	0.04	0.01	
IRD1	inner road	427519	4209249	9391	2.0	75	6.0	0.04	0.01	
IRD2	inner road	427169	4209599	9367	2.0	75	6.0	0.04	0.01	
IRD3	inner road	427169	4210224	9392	2.0	75	6.0	0.04	0.01	
IRD4	inner road	427519	4210574	9511	2.0	75	6.0	0.04	0.01	
IRD5	inner road	428144	4210574	9567	2.0	75	6.0	0.04	0.01	
IRD6	inner road	428494	4210224	9521	2.0	75	6.0	0.04	0.01	
IRD7	inner road	428494	4209599	9452	2.0	75	6.0	0.04	0.01	
IRD8	inner road	428144	4209249	9393	2.0	75	6.0	0.04	0.01	

Source ID	Source Description	Easting (X)	Northing (Y)	Base Elev	Rel Ht	Radius of Circle	Vert. Dim	PM_{10}	NOx	SO_2
CIRCULAR AREA SOURCES		(m)	(m)	(ft)	(ft)	(ft)	(ft)	(lb/hr)	(lb/hr)	(lb/hr)
WELPAD1	Disturbed area - well pad	426831	4208911	9491	0.0	282.7	2.00	0.015		
WELPAD2	Disturbed area - well pad	427423	4208686	9430	0.0	282.7	2.00	0.015		
WELPAD3	Disturbed area - well pad	428239	4208686	9428	0.0	282.7	2.00	0.015		
WELPAD4	Disturbed area - well pad	428831	4208911	9485	0.0	282.7	2.00	0.015		
WELPAD5	Disturbed area - well pad	429056	4209503	9524	0.0	282.7	2.00	0.015		
WELPAD6	Disturbed area - well pad	429056	4210319	9462	0.0	282.7	2.00	0.015		
WELPAD7	Disturbed area - well pad	428831	4210911	9526	0.0	282.7	2.00	0.015		
WELPAD8	Disturbed area - well pad	428239	4211136	9474	0.0	282.7	2.00	0.015		
WELPAD9	Disturbed area - well pad	427423	4211136	9533	0.0	282.7	2.00	0.015		
WELPAD10	Disturbed area - well pad	426831	4210911	9422	0.0	282.7	2.00	0.015		
WELPAD11	Disturbed area - well pad	426606	4210319	9409	0.0	282.7	2.00	0.015		
WELPAD12	Disturbed area - well pad	426606	4209508	9385	0.0	282.7	2.00	0.015		
WELPAD13	Disturbed area - well pad	427206	4209286	9385	0.0	282.7	2.00	0.015		
WELPAD14	Disturbed area - well pad	428456	4209286	9437	0.0	282.7	2.00	0.015		
WELPAD15	Disturbed area - well pad	428456	4210536	9532	0.0	282.7	2.00	0.015		
WELPAD16	Disturbed area - well pad	427206	4210536	9442	0.0	282.7	2.00	0.015		
WELPAD17	Disturbed area - well pad	427131	4209911	9372	0.0	282.7	2.00	0.015		
WELPAD18	Disturbed area - well pad	427831	4209211	9386	0.0	282.7	2.00	0.015		
WELPAD19	Disturbed area - well pad	428531	4209911	9458	0.0	282.7	2.00	0.015		
WELPAD20	Disturbed area - well pad	427831	4210611	9550	0.0	282.7	2.00	0.015		
CENTPROC	50 acres dist center proc	427831	4209911	9453	0.0	832.6	2.00	0.1		

4.5 Fishlake National Forest Development Scenario Modeling (Scenario 3)

The Fishlake NF development scenario model consisted of one, 10 to 15-well field on the Fishlake NF using directional drilling technology. The scenario described two or three production pads with each pad hosting up to five wells each, using directional drilling technology and an offset distance of one-half mile. The modeled scenario included 12 wells on three pads. Total actual ground disturbance including the discovery well, central production facilities pad, production pads, water disposal well, new access roads, reconstruction of existing roads, pipelines and power lines, and a truck loading facility is estimated at 122-acres. The area within the perimeter of the field including pads, pad access roads, and interior pipelines and power lines, and undisturbed areas between could vary, but is estimated at approximately 3.0 square miles using a well spacing of 160 acres (or ½ mile distance between down-hole well termini (directional drilling).

Table 4.5-1 on the following page documents the model emissions sources used to simulate emissions from this well field development scenario. As with the Dixie NF development scenario modeling analysis, on the ground considerations were added by distributing the model emission sources over three square miles. The sources were distributed in a manner consistent with the anticipated spread of the well field scenario at a conceivable location in the Fishlake

NF, with variations in elevations across the development field and across the receptor network based upon actual topography in the modeled location. Figures in the next section of this document will provide a visual representation of their layout.

Table 4.5-1 Fishlake National Forest Directional Drilling Oil Field Development Scenario Model Sources and Source Parameters

Source ID	Source Description	Easting (X)	Northing (Y)	Base Elev	Stack Height	Temp	Exit Velocity	Stk Diam	PM_{10}	NOx	SO_2
POINT SOURCES		(m)	(m)	(ft)	(ft)	(°F)	(fps)	(ft)	(lb/hr)	(lb/hr)	(lb/hr)
DRE	Drill Rig Engine	381262	4277427	8200	15	950	75	1.00	0.26	8.47	0.01
PFLAR	Production Flare	381212	4277417	8184	100	1000	55	1.50	0.00	3.55	0.00
COMPR	Compressor Engine	381312	4277417	8222	25	760	95	1.00	0.04	2.20	0.00
HT1	Heater Treater	380332	4276797	8081	20	180	15	0.67	0.004	0.05	0.00
HT2	Heater Treater	380392	4276797	8081	20	180	15	0.67	0.004	0.05	0.00
HT3	Heater Treater	380392	4276737	8081	20	180	15	0.67	0.004	0.05	0.00
HT4	Heater Treater	380332	4276737	8081	20	180	15	0.67	0.004	0.05	0.00
HT5	Heater Treater	382332	4277497	8521	20	180	15	0.67	0.004	0.05	0.00
HT6	Heater Treater	382392	4277497	8483	20	180	15	0.67	0.004	0.05	0.00
HT7	Heater Treater	382392	4277437	8481	20	180	15	0.67	0.004	0.05	0.00
HT8	Heater Treater	382332	4277437	8519	20	180	15	0.67	0.004	0.05	0.00
HT9	Heater Treater	381032	4278147	8162	20	180	15	0.67	0.004	0.05	0.00
HT10	Heater Treater	381092	4278147	8151	20	180	15	0.67	0.004	0.05	0.00
HT11	Heater Treater	381092	4278087	8163	20	180	15	0.67	0.004	0.05	0.00
HT12	Heater Treater	381032	4278087	8166	20	180	15	0.67	0.004	0.05	0.00
DHY1	Dehydrator	381262	4277467	8213	30	200	8	1.00	0.004	0.05	0.00
DHY2	Dehydrator	381262	4277367	8203	30	200	8	1.00	0.004	0.05	0.00
WP1	Well Pump	380312	4276817	8081	10	775	45	0.67	0.05	0.66	0.21
WP2	Well Pump	380412	4276817	8082	10	775	45	0.67	0.05	0.66	0.21
WP3	Well Pump	380412	4276717	8081	10	775	45	0.67	0.05	0.66	0.21
WP4	Well Pump	380312	4276717	8081	10	775	45	0.67	0.05	0.66	0.21
WP5	Well Pump	382312	4277517	8531	10	775	45	0.67	0.05	0.66	0.21
WP6	Well Pump	382412	4277517	8481	10	775	45	0.67	0.05	0.66	0.21
WP7	Well Pump	382412	4277417	8472	10	775	45	0.67	0.05	0.66	0.21
WP8	Well Pump	382312	4277417	8525	10	775	45	0.67	0.05	0.66	0.21
WP9	Well Pump	381012	4278167	8164	10	775	45	0.67	0.05	0.66	0.21
WP10	Well Pump	381112	4278167	8151	10	775	45	0.67	0.05	0.66	0.21
WP11	Well Pump	381112	4278067	8166	10	775	45	0.67	0.05	0.66	0.21
WP12	Well Pump	381012	4278067	8172	10	775	45	0.67	0.05	0.66	0.21

Source ID	Source Description	Easting (X)	Northing (Y)	Base Elevation	Release Height	Horiz Dim	Vert Dim	PM_{10}	NOx	SO_2
VOLUME SOURCES		(m)	(m)	(ft)	(ft)	(ft)	(ft)	(lb/hr)	(lb/hr)	(lb/hr)
ORD1	outer road	381262	4276042	8116	2.0	100	6.0	0.04	0.075	
ORD2	outer road	380558	4276305	8097	2.0	75	6.0	0.04	0.075	
ORD3	outer road	380150	4276713	8072	2.0	75	6.0	0.04	0.075	
ORD4	outer road	379887	4277417	8052	2.0	100	6.0	0.04	0.075	
ORD5	outer road	380150	4278121	8283	2.0	75	6.0	0.04	0.075	
ORD6	outer road	380558	4278530	7977	2.0	75	6.0	0.04	0.075	
ORD7	outer road	381262	4278792	8219	2.0	100	6.0	0.04	0.075	
ORD8	outer road	381966	4278530	8318	2.0	75	6.0	0.04	0.075	
ORD9	outer road	382375	4278121	8527	2.0	75	6.0	0.04	0.075	
ORD10	outer road	382637	4277417	8468	2.0	100	6.0	0.04	0.075	
ORD11	outer road	382375	4276713	8450	2.0	75	6.0	0.04	0.075	
ORD12	outer road	381966	4276305	8200	2.0	75	6.0	0.04	0.075	
IRD1	inner road	380950	4276755	8184	2.0	75	6.0	0.04	0.075	
IRD2	inner road	380600	4277105	8144	2.0	75	6.0	0.04	0.075	
IRD3	inner road	380600	4277730	8225	2.0	75	6.0	0.04	0.075	
IRD4	inner road	380950	4278080	8194	2.0	75	6.0	0.04	0.075	
IRD5	inner road	381575	4278080	8334	2.0	75	6.0	0.04	0.075	
IRD6	inner road	381925	4277730	8439	2.0	75	6.0	0.04	0.075	
IRD7	inner road	381925	4277105	8321	2.0	75	6.0	0.04	0.075	
IRD8	inner road	381575	4276755	8249	2.0	75	6.0	0.04	0.075	

Source ID	Source Description	Easting (X)	Northing (Y)	Base Elev	Rel Ht	Radius of Circle	Vert Dim	PM_{10}	NOx	SO_2
		(m)	(m)	(ft)	(ft)	(ft)	(ft)	(lb/hr)	(lb/hr)	(lb/hr)
WELPAD1	Disturbed area - well pad	380362	4276767	8081	0	282.7	2.0	0.033		
WELPAD2	Disturbed area - well pad	382362	4277467	8498	0	282.7	2.0	0.033		
WELPAD3	Disturbed area - well pad	381062	4278117	8156	0	282.7	2.0	0.033		
CENTPROC	50 acres dist center proc	381262	4277417	8199	0	832.6	2.0	0.1		

4.6 Fugitive Emissions in the Development Scenario Modeling

Actual development scenarios would include fugitive sources of VOCs and particulates; only particulates can be modeled. The development scenario model runs include area and/or volume sources to assess the impacts of particulate emissions from ground disturbance and criteria pollutant emissions from vehicular traffic. The onsite emissions were evenly distributed around the facility in the model, with concentrations relatively even across the area. This is considered conservative in this analysis, where the nearest receptors are 0.25 kilometers (0.155 miles) away, closer to the center of activity than some of the wells. The percentages of overall traffic emissions that occur within the project boundary, as opposed to outside that boundary,

were estimated high. Road and disturbed area emissions occurring outside the identified project area are included in the emissions inventory, but their impacts were not modeled.

5.0 MODEL FACILITY AND SOURCE LAYOUT

The emissions scenarios for the screening table runs included eight model emission sources: seven point sources, and a fugitive area source. These runs were scaled to be representative of actual emissions from anticipated O&G development.

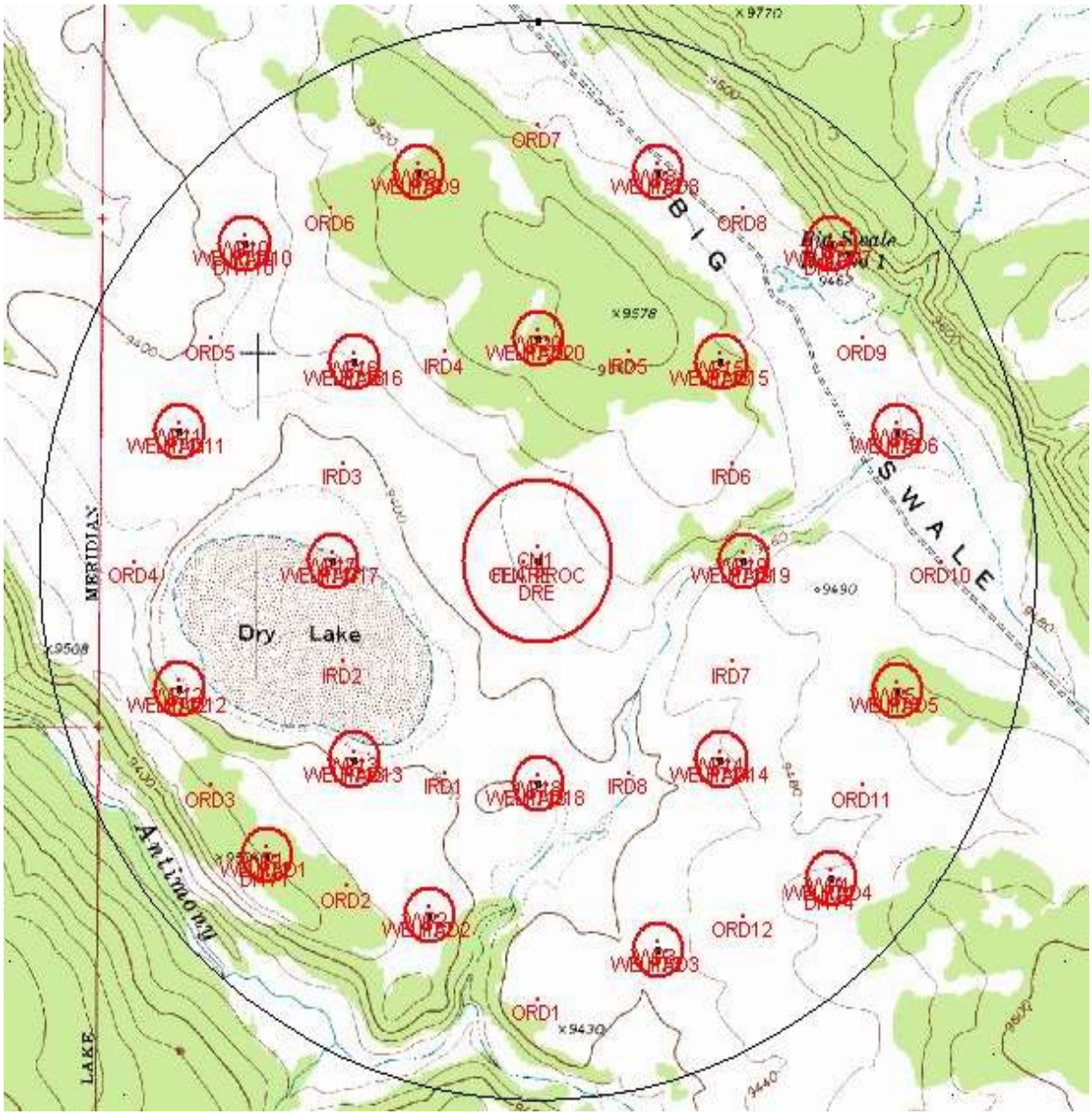
The screening tables prepared from the screening runs were checked for accuracy. The results were compared to the development scenario runs with model emissions laid out using on the ground locations in the Dixie and Fishlake NFs. Those model scenarios were based upon development scenarios determined by the USFS. The methodology for setting up and laying out these specific development scenario model runs is described below. These runs also assisted in defining model source data for the screening table runs.

Building downwash was not considered because the nearest receptors were well beyond all building or structure cavities. While actual locations within the respective NF, both sites selected were chosen at random, with a relatively flat area to locate the well field being the only criteria.

5.1 Dixie National Forest Well Field Layout

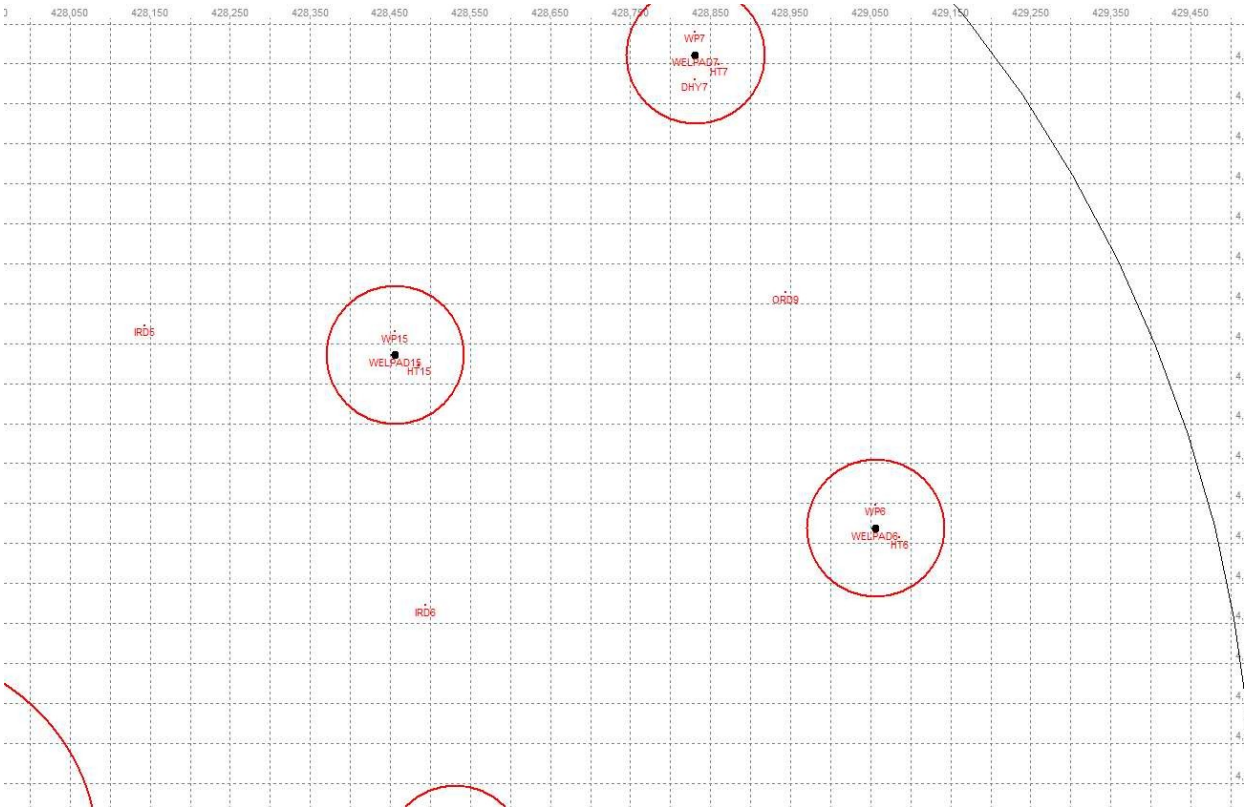
Figure 5.1-1 shows the representative ISCST3 model layout for the Dixie NF 20-well field that is used as one of the three specific development scenarios modeled. The black circle represents a 3.5 square mile area boundary anticipated by the USFS. The underlying topographic map shows the hypothetical location modeled at Big Swale on the Pollywog Lake United States Geological Survey (USGS) topographic map, approximately twelve miles ESE of Antimony, Utah. Model emission sources are shown and labeled in red. The layout shows 20 well pads located around a central processing area. The central processing area includes one gas flare, storage tanks, one well drilling rig, and the potential gas compressor engine. The fugitive emissions from roads and disturbed areas, other than well pads and the central processing area, were included in the model by a series of 20 area or volume sources distributed between the well pads. They are shown as red dots labeled “ORDx” or “IRDx” (for inner or outer roads).

Figure 5.1-1 ISCST3 Model: Dixie National Forest 20-Well Oil Field Scenario Facility Layout



For a representative set of well pads, Figure 5.1-2 shows details of what is located near each well pad. Heater / treater separators for natural gas are included with some wells, but are assumed to operate at very low volumes. Figure 5.1-2 shows the inner ring depicting the central processing area to the lower left and the outer ring showing the extent of the well field to the upper right. Between the well pads, representative model inner and outer road sources seen in red are used to depict emissions conservatively estimated from onsite vehicular traffic.

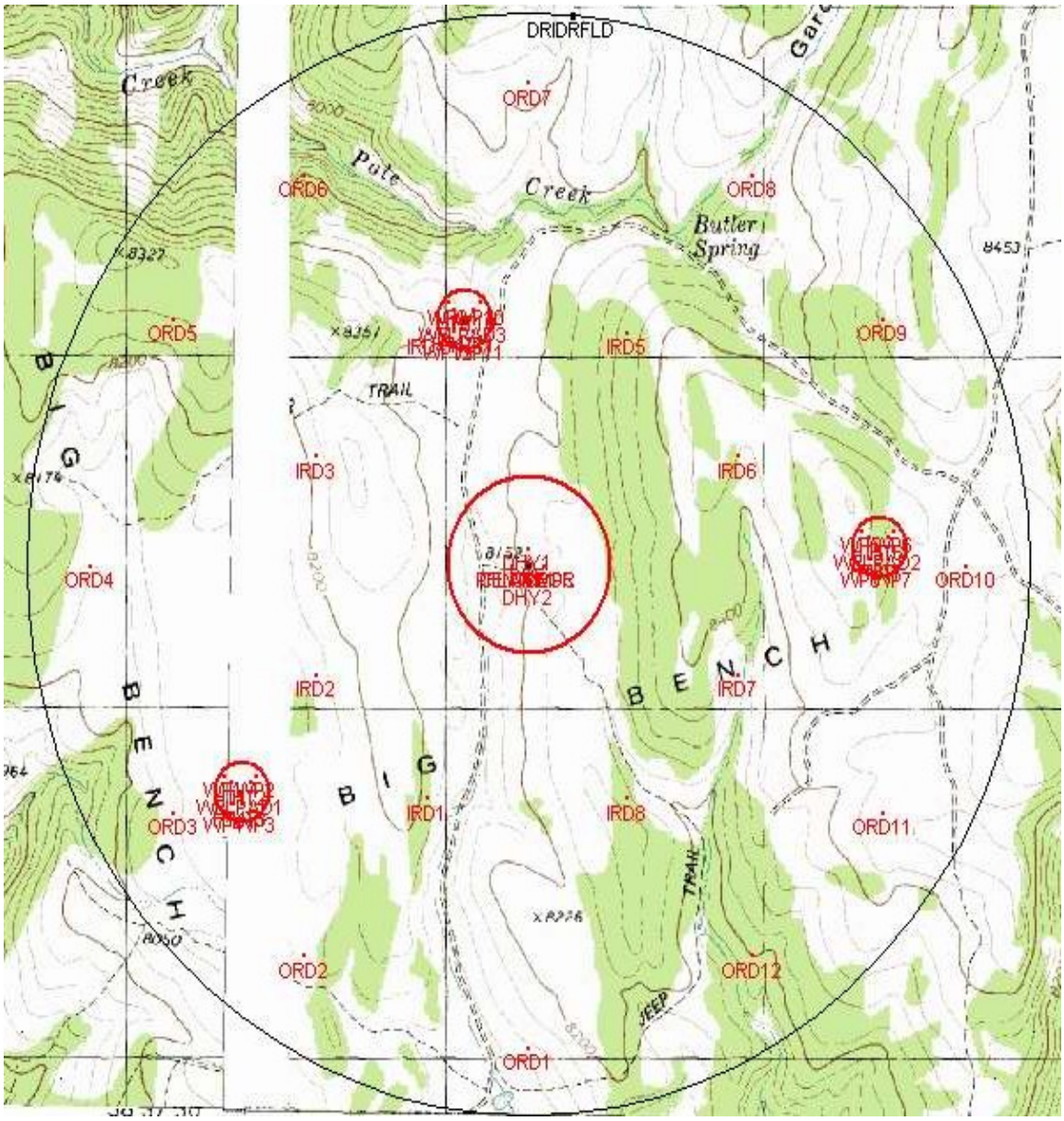
Figure 5.1-2 ISCST3 Model Source Layout: Each Well Field, Either Oil Field Scenario



5.2 Fishlake National Forest Well Field Layout

Based on USFS development expectations, the 10 to 15 well Fishlake NF directional drilling oil field development model scenario featured fewer well pads over a slightly smaller area than the Dixie NF well field, with potentially more concentrated activity in the vicinity of each well. Figure 5.2-1 shows the representative ISCST3 model layout for the hypothetical 12-well directional drilling oil field that was used as one of the specific development scenarios. The black circle represents a 3-square mile area boundary for the entire field. The underlying topographic map shows the hypothetical location modeled at Big Bench on the Joseph Peak USGS topographic map, approximately eight miles WSW of Joseph, Utah in the Fillmore District.

Figure 5.2-1 ISCST3 Model: FNF 12-Well Directional, Drilling Field Scenario Facility Layout



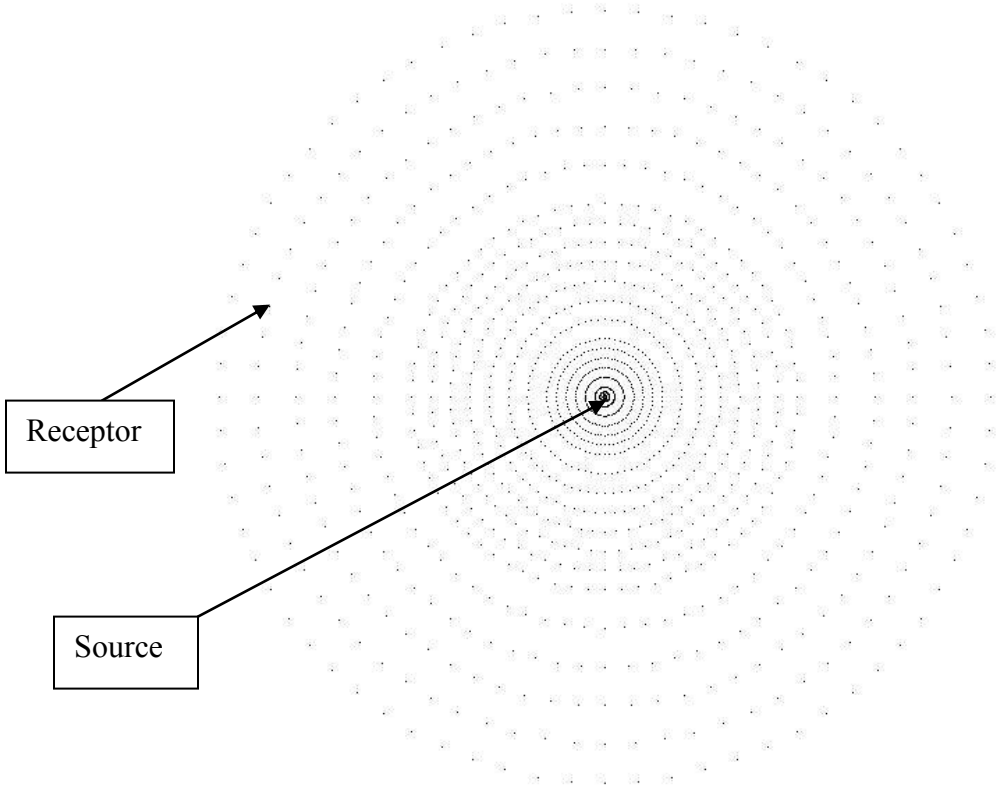
5.3 Exploratory Well Development Scenario (Scenario 1) Layout

The exploration development scenario model includes all emissions within an area consisting of a 5.9 acre pad with 9 to 10.7 acres of road and other surface disturbances around or atop the pad. Given that the nearest receptor was 250-meters away, the screening scenario with all sources collocated was assumed to be representative of an isolated exploratory oil well.

6.0 MODEL DOMAIN, MAPPING, AND RECEPTOR NETWORK

The model receptor network extends to 200 kilometers (km) from the area of activity. The receptor network for the analyses includes rings of receptors around the activity area at distances of 0.25, 0.5, 1, 2.5, 5, 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100, 120, 140, 160, 180, and 200 km (Figure 6.0-1). Receptors were placed at 10 degree intervals around the receptor rings within 50 km and at 5 degree intervals around the long range transport receptor rings. The expanded receptor network at longer distances cut down the distance receptors at these larger outer rings. The figure below shows the model receptor network. The model domain was set conservatively beyond the furthest extent of the receptor network.

Figure 6.0-1 Model Receptor Network



The ISCST3 model was used for pollutant concentrations within 50 km (approximately 31 miles) of the activity area and the CALPUFF model beyond that distance, consistent with EPA long-range transport and UDAQ air quality modeling guidance. All deposition and visibility AQRV impact modeling was also performed using CALPUFF and its CALPOST post processing system (version 6.12). For the short term, 3-hour and 24-hour average standard, CALPUFF analyses were used to supplement ISCST3 analyses of SO_2 dispersion in the near field. ISCST3 analyses extrapolated short term effects of low overnight inversion mixing heights from valley observation sites questionably representative of anticipated development sites and/or unlikely to persist for the duration ISCST3 applied them. CALPUFF's enhanced boundary layer data and model calculations allowed a more realistic estimate of dispersion of the SO_2 emissions, which were primarily from well pumps.

6.1 Receptor Network

The receptor network for the screening modeling included seven source/receptor elevation differences. Separate model runs for each elevation difference scenario were performed with receptors at 2500, 1000, 500, and 100 feet above the source elevation, at the same elevation as the source, and at 1,000 and 2,500 feet below the source. These elevation difference scenarios include the five described in the modeling protocol, plus two more with receptors 500 feet and 100 feet above the model sources. Those added receptor elevations were based upon UDAQ comment that this elevation can often have highest impacts due to close proximity to the mean plume height. The base elevation for the emission sources in the model was set at 6,000 feet, which is considered a reasonable approximation of likely development sites within the two NFs. This receptor network was used for both the ISCST3 and CALPUFF screening modeling runs for criteria pollutant impact, AQRV's and deposition impacts.

In the case of the ISCST3 and CALPUFF specific development scenario model runs, receptors were set at actual elevations corresponding to the distance rings described for the screening runs. The elevations of those receptors were calculated from USGS digital elevation model (DEM) data for receptors at each receptor ring distance, every 10 degrees around the inner rings and every 5 degrees around the outer rings (see Figure 6.0-1).

The ambient air boundary (point beyond which the public has access) for the specific development scenario model runs in the June 2008 version of this modeling report was the edge of the activity area, the 3-square mile area for the Fishlake NF directional drilling scenario and the 3.5 square mile area for the Dixie NF conventional drilling scenario. Based on agency comments, the analysis conducted in this current version of this modeling report refined the receptor network to begin at the fence surrounding the central processing area, assuming that the public could have access to areas beyond there including around the well pads.

6.2 Visibility and Deposition Analyses

The CALPUFF visibility and wet deposition analyses required extended hourly surface meteorological data sets including relative humidity. The only site near the study area with EPA-approved surface meteorological data was Cedar City. Therefore, Cedar City meteorological data prepared from SAMSON data sets with extended ISCST3 parameters was used for the visibility and deposition analyses. Specific development scenario model runs for air pollutant concentrations for potential development scenarios on the two NFs utilized multiple meteorological data files for added conservatism. The details of meteorological data used in specific development scenario model runs are described in Section 7.0.

Light is scattered by particles in the air. In clear weather, visibility decreases as light scattering increases. The amount of light scattering is a function of the quantity and size of particulates in the air. Light extinction is quantified as beta extinction (B_{ext}). Visibility model results calculated the visibility degradation measured by increases in B_{ext}. The predicted increase in B_{ext} was calculated and interpreted for each scenario to conservatively estimate visibility degradation in the form of number of days with visibility degradation exceeding 0.5 and 1.0 deciviews (defined as a 5% or 10% increase in B_{ext} respectively). A 0.5 deciview visibility impact in Class I airsheds is defined by FLAG as a level of concern above which a cumulative visibility impact analysis is recommended if occurring with any frequency. A 1 deciview or higher impact in Class I areas is set as the FLAG threshold at which Class I area land managers would be inclined to oppose the impacting project. For conservatism, a background concentration of 15.6 mm^{-1} was assumed.

This is consistent with the most pristine background visibility in regional Class I airsheds, thus minimizing the impact that would result in the percentage change thresholds being triggered.

7.0 METEOROLOGICAL DATA

The normalized model analyses used to prepare the screening tables utilized ISCST3-based screening meteorological data files and/or regional ISCST3 meteorological data files. The ISCST3 data files with extended meteorological data were needed for AQRV analyses (visibility and deposition) consistent with FLAG guidance. The screening meteorological data file utilizes each dispersion scenario considered in the EPA dispersion model known as "SCREEN3," blowing from each of 36 directions (every 10 degrees around the compass). Those wind directions match the directions to the model receptors.

For the near-field ISCST3 Dixie 20-well development scenario analyses used to evaluate the screening tables, Cedar City National Weather Service data was used along with one year of UDAQ-provided data during 2001 from the Sigurd Power Plant near Sigurd, as per the recommendation of UDAQ. For the Fishlake 12-well directional drilling scenario analyses, the same Sigurd meteorological data was used along with five years of UDAQ-provided and recommended data between 1997 to 2002 from PacifiCorp's Hunter Power Plant (Hunter) located outside Castle Dale. A discontinuity was found in the Hunter data set that limited the usable Hunter meteorological data files to three years and nine months from 1997 through late November of 2000. The Cedar City surface data was retrieved in SAMSON format along with associated upper air data and processed through the EPA PCRAMMET program consistent with UDAQ and EPA guidance.

Cedar City National Weather Service (NWS) data, the only data available in the project area with the extended parameters needed for visibility and/or deposition analyses, was used for all long-range transport analyses except the criteria pollutant concentration screening analyses and all AQRV analyses. Three years of Cedar City meteorological data, from 1988 to 1990, were used consistent with FLAG guidance. National Weather Service upper air meteorological data from Salt Lake City, the nearest and most representative site with available data, was used to complete the Cedar City modeling meteorological data files.

8.0 LAND USE CLASSIFICATION AND AREA PHYSICAL CHARACTERISTICS

Rural dispersion coefficients are assumed to be appropriate for all locations where project development is anticipated. Landforms across the CALPUFF modeling domain were judged to include primarily forested or barren land. Upon the recommendation of UDAQ, barren land parameters were used in CALPUFF, with slight adjustments in roughness, length, albedo (reflectiveness) and leaf index toward forested land to account for the vegetation in the higher elevations. CALPUFF plume elements were modeled as puffs. CALPUFF screening was prepared consistent with the "Guide for Applying the EPA Class 1 Screening Methodology with the CALPUFF Modeling System" prepared in 2001 by Joseph Scire of Earth-Tech, the developer of the CALPUFF modeling system. Mr. Scire and David Strimaitis, his current TRC Companies, Inc. partner and contributor to the development of the CALPUFF modeling system, provided comments and guidance on the CALPUFF modeling applications. No boundary influx was included in the CALPUFF analysis. The mean background ozone and ammonia

concentrations used were specifically suggested by UDAQ and were consistent with recommend default values.

In other areas not discussed, ISCST3 defaults, including regulatory default options, were used, except for allowing for missing hours in non-NWS meteorological data files. CALPUFF Screening defaults recommended by FLAG and Interagency Workgroup on Air Quality Models (IWAQM) guidance or Mr. Scire or Strimaitis and/or incorporated in the ISC2PUFF translation program for ISCST3 input files were employed. Table 8.0-1 documents the values used in the modeling, post-processing, or data preparation.

Table 8.0-1 Proposed Physical Parameters for the Project Area

Parameter	Value
Min. Obukhov length (m)	10.0
Roughness length (m), met-data site	1.0
Roughness length (m), receptor network	0.20
Noon time albedo	0.30
Bowen ratio	5.0
Anthropogenic heat flux (W/m^2)	3.0
Fraction net radiation absorbed by ground	0.160
Mean monthly / annual ozone concentration (ppb)	80
Mean monthly / annual ammonia concentration (ppb)	10
Land use (CALPUFF)	Barren Land, with leaf index and roughness length adjusted slightly toward Forest Land
Leaf index	0.3
RURAL / URBAN	RURAL

9.0 MODELING RESULTS

9.1 Screening Modeling

The results of the screening modeling analyses were translated into a set of screening tables as described in the modeling protocol. The pollutant concentration screening runs were prepared using a screening meteorological data file. One-hour average maximum model predicted impacts were reported because the hourly data in those meteorological files was hypothetical; consecutive hours did not represent an actual time series. Therefore, processing the results of the screening air concentration modeling runs consisted of taking model predicted maximum one-hour average impacts and applying UDAQ recommended persistence factors to estimate model predicted impacts at averaging periods consistent with ambient air quality standards, increments and thresholds. Model output values from the CALPOST post-processing program associated with CALPUFF in that modeling system were copied directly into the screening and specific development scenario impact tables. The resulting screening tables conservatively estimate the maximum impact per pound per hour of emissions of criteria air pollutants at a variety of distances from the proposed activity and elevations differences between the activity area and receptor.

AQRV analyses (visibility impact and nitrogen and sulfur deposition) were performed with two or three years of measured met-data for each development scenario. Visibility impact analyses provided a quantative estimate of the increase of beta extinction for the specific development proposed, and site specific deposition analyses provide estimates of deposition rates. Site specific AQRV impact analyses confirm the reasonableness of deposition estimates from the screening analyses. The resulting AQRV impact predictions for each development scenario should represent a conservative estimate of the magnitude of impacts.

Model results from the specific development scenario runs were used to perform quality assurance checks on the screening table initially prepared from screening modeling results. As a result of those quality assurance checks, specific recommendations were made for applying the screening table entries for near field short term SO_2 concentrations (the reasoning behind those refinements is discussed in Section 9.1 of this report).

The intention in preparing these criteria pollutant impact screening table and AQRV analyses is to conservatively estimate the potential impact and confirm, through the specific development scenario model analyses, that the screening process would not underestimate the actual impacts. With that verification, the screening table results and AQRV impact analyses can be used to make an initial check on compliance with applicable impact limits. If screening impact estimates from a development action show compliance with applicable impact limits for all receptors, as long as that development action was planned consistent with the assumptions included in the screening analysis, it would not be expected to show any air quality impact concerns with a site and development specific air quality impact analysis. If screening impact estimates from a development action do not show compliance with applicable impact limits for all receptors, that development action cannot be justified by the screening analysis. That development action might require stronger emission control or mitigation conditions, or might be justified by a site and development specific air quality impact analysis (which would remove some of the conservatism inherent in the screening analysis).

Screening tables are presented in Appendix A for each parameter modeled: PM_{10}, NOx, SO_2, and visibility. The details of the specific development scenario model runs, analyses of results, and refinements made to the original screening tables as a result of those specific development scenario model runs are described below.

Each Appendix A table shows maximum predicted impacts at each receptor ring distance for each source / receptor elevation difference scenario. The impacts included in the tables are normalized, based upon one pound per hour emissions. The normalized impacts can be used to estimate the potential impact of various O&G development scenarios considered in either NF. Using the pound per hour emissions rate from any proposed project, the screening impact can be estimated by multiplying the screening table impact in Appendix A (in $\mu g/m^3$ per pound per hour emission) by the projected emission rate (in pounds per hour) for the project under consideration. The documentation clarifies that this is a screening tool for planning, leasing, and exploration estimates and conveys what level of development will require subsequent NEPA and/or air permitting action.

9.2 Specific Development Scenario Model Runs

As noted earlier, after the screening model runs, three potential development scenarios described by the Dixie and Fishlake NFs were modeled to assess concentrations of NOx, SO_2, and PM_{10}. The activity was set at arbitrarily chosen, conceivably developable locations on each NF. The locations were chosen based upon their O&G production potential, where such information was available; otherwise they were selected by air quality scientists as topographically representative sites where development could occur.

Receptors were placed in 22 rings around each of these development scenarios, at intervals consistent with the screening modeling receptors. Receptor elevations in the specific development scenario modeling used actual elevations from USGS digital elevation models. The primary goal was to estimate modeled impacts from the identified potential development scenario laid out in an area where it could conceivably occur. Another goal was to check if modeled impacts, at receptors set at actual locations in rings surrounding that development, were consistent with those predicted at those locations by the screening tables developed. As noted under the Model Receptor discussion, receptors were set assuming the outer edge of the developed area would be the ambient air boundary (the nearest location to which the public has access), which began at the fence of the central processing area.

Figures 5.1-1, 5.1-2, and 5.2-1 above show the layout of the model for the multi-well scenarios, and show the actual locations used for the specific development scenario modeling run analyses. Tables 4.4-1 and 4.5-1 above show the model source parameters used to simulate emissions from each scenario.

As noted under the meteorological data description, the specific development scenario model runs were made for the Dixie NF 20-well development scenario with one year of meteorological data from Sigurd (NW of the site monitored) and five years of data from Cedar City (representative of the central Dixie NF). The analytical verifications were performed by comparing the maximum model predicted impact at each receptor ring distance in the specific development scenario model analyses with maximum impacts predicted for that ring and receptor elevation from the screening tables developed for this project.

Similarly, verifications for the Fishlake NF 12-well drilling scenario were performed using one year of meteorological data from Sigurd (located in the south-central area of the Fishlake NF in the Sevier River canyon that channels flow locally) and the useable three years and nine months of data from the Hunter Power Plant (representative of the northeastern areas of the Fishlake NF).

For the above comparisons, the second maximum modeled impact from each meteorological data set was compared to the screening table result (see Appendix A) for the short term averaging periods (one day or less). The highest second maximum value in any year is the one compared against NAAQS standards for regulatory impact analyses. Model maximum impacts over the duration of the period modeled were used to verify longer term average impacts. This approach is conservative for the multi-year meteorological data files because the second maximum concentration over the duration of the period modeled would likely be higher than the second highest concentration in any individual year.

In regulatory air quality impact analyses, the first maximum impact, or increase in impacts, can be the value compared against incremental limit thresholds for major new sources or sources potentially affecting Class 1 airsheds. Because model receptors in the specific development scenario analyses were placed at actual elevations for the distance and orientation from the well field development scenario, the specific development scenario model runs results provided an opportunity to check the reasonableness of the values on the screening table.

These specific development scenario modeling runs were considered as a realistic test of potential maximum impacts from the scenarios modeled, even if the local wind patterns were not consistent with one of the meteorological data sets, since the results represent the conservative model predicted impacts from a variety of different wind flow patterns.

The goal of the verification process was to ensure that the screening tables produced conservative estimates of potential impacts (that they did not under predict impacts, which could result in problems if they were used for planning purposes), and that they were reasonable enough in estimating possible impacts to be potentially valuable planning tools.

“Model predicted maximum impacts” for each development scenario were prepared through the specific development scenario model runs described. For each meteorological data set modeled, the maximum impact for each pollutant and each regulatory averaging period was calculated at each receptor distance up to 40 kilometers. The actual elevations of the receptors where the maximum model predicted impact occurred were documented and the source / receptor elevation difference calculated. Those maximum predicted impacts at each receptor ring were compared to the impact value estimated from the screening tables for the source / receptor elevation difference. Mean source elevations were used for each development scenario, which included real world considerations of elevation variation across the well field. This data set provided quality assurance checks for a good percentage of the values on the screening table. Receptors lower than the source elevation showed up a little more than those with higher elevations than the source during the screening table verification process, mostly because the locations chosen for the specific development scenario model analyses had comparatively high elevations. There were still sufficient results to provide direct checks to almost half of the screening table results for receptors higher than the source elevation.

A representative section of the comparisons of the specific development scenario results with screening table results is included in Appendix B. Those verification analyses showed that the

results from the screening table were quite conservative (overestimated values from specific development scenario analyses) for the closer receptors (especially those less than five miles from the development activity), for long range transport (receptors more than 30 kilometers from the development activity), and for the longer averaging periods. In the near field, this is because the screening runs had all emissions in one location, while actual field development spread the emissions (and hence impacts) over a larger footprint. This effect was minimized by starting the receptor network at the central processing area, and including the well fields in ambient air (accessible to public access). The screening scenario assumed very concentrated emissions that resulted in higher potential maximum impact predictions than those predicted from a well field scenario that spread activity over a few square miles. That concentration of emissions in the assumed model runs supporting the screening table would seem to be appropriate for individual wells, as in an isolated exploratory well. Nonetheless, it is potentially conservative when considering emissions spread over a well field.

UDAQ recommended an annual average persistence factor (conversion factor to estimate long term average impacts from short term maximum impacts) of 0.08 for simple terrain and 0.03 for complex terrain (multipliers of maximum predicted one hour average impact). The annual average impact persistence factor was set at 0.08 in these screening table results to be conservative. The use of a lower persistence factor for converting screening model predicted maximum one hour average model results (to estimate maximum annual average impacts) is probably justified for much of the Dixie NF because of the complex terrain, even though it is not used in this report.

9.3 Specific Development Scenario Model Results and Verification against Screening Table Estimates

Results for the 20-well conventional drilling and 12-well directional drilling development scenario runs indicated that impacts within 2½ miles of the well field perimeter and annual average impact predictions at all receptors rarely exceeded 30 percent of those predicted by the screening tables. Screening table results for those analyses proved conservative because they were never exceeded by development scenario analysis results. If the UDAQ recommended annual persistence factor of 0.03 for complex terrain were substituted for the 0.08 used in the tables, the screening table results would be lowered by 62.5%. Specific development scenario model runs would still show that the screening tables would be conservative even for the lower persistence factor UDAQ recommends for complex terrain.

As a result, we recommend that the distance from the source be measured only from the central fenced area where access is controlled, not the furthest extent of the well field development. We also recommend that some added conservatism could be removed by lowering the screening table annual average impact predictions by 62.5% in complex terrain.

The specific development scenario model run comparisons against screening table predicted impacts for more distant receptors, and for PM_{10} short term 24-hour averaging period at all receptors, showed the screening table values to be conservative (never under-predicting).

For SO_2 short term average impacts, verification efforts showed conservatism in the screening tables for receptors within five kilometers and beyond 50 kilometers. In the intermediate 5 – 50 km range, for receptors well above or well below the mean source elevation, a concern related to the concentration of the SO_2 emissions in a few sets of stack parameters in the screening model runs led to less conservative estimates from the screening tables. In a few cases,

receptors well above or well below the model mean source base elevation had higher SO_2 impacts in the specific development scenario analyses than those estimated from the screening tables.

Diesel emissions, primarily from well pumps, represented the vast majority of SO_2 emissions. SO_2 was potentially exaggerated because the EPA AP-42 emission factor guidance for large diesel engines (including the drill rig engine) took into account lower sulfur content in available diesel fuel during the project operational phase, but the AP-42 emission factors for small diesel engines (used for the well pumps) did not (assuming 1996 fuel sulfur content). Because model SO_2 emissions were 99.5% concentrated in one set of model sources (the well pumps), the screening model results were dominated by the impacts of the well pumps.

Although screening model runs assume that all emissions occur at the same elevation, this rarely occurs in actual field locations in areas like the National Forests studied. As a result, the projections of the screening tables showed a plume narrowly concentrated with significant concentrations at nearby elevations but limited impacts at other elevations. Verification showed that the screening tables were conservative when applied using the elevation difference between the receptor and the well site with the closest elevation rather than the mean well field elevation. That method accounts for the actual difference between the receptor elevation and the elevation of a well pump plume. Therefore, to ensure conservatism (to make sure the screening table does not underestimate actual impacts), it is recommended that for short term SO_2, the elevation difference to reference in the screening tables should be the difference in elevation between the receptor and well nearest in elevation (rather than the mean well field elevation recommended for all other screening table applications).

Calculated statistics (shown in Appendix B) indicated that specific development scenario analysis SO_2 short term predictions for receptors at elevations higher or lower than the mean source elevation were, for three 3-hour averages and one 24-hour average, slightly higher than maximum impacts calculated from the screening tables. When the table was reinterpreted using the minimum elevation difference between the receptor and any project well pump instead of elevation difference between the receptor and the mean well field elevation, the screening table estimates of predicted impact never underestimated any impacts predicted in the specific development scenario analyses. Therefore, it is recommended to use the minimum elevation difference between the receptor and any project well rather than the elevation difference between the receptor and the mean well field elevation for short term SO_2 averaging period applications to ensure conservatism in applying the screening tables.

Further quality assurance identified inconsistencies in some variables across the transition from the near-field analyses prepared primarily using ISCST3 and the long-range transport analyses prepared using the CALPUFF model. Reviewers verified that there were inconsistencies across the 50km distance from the source where the recommended model changes from ISCST3 to CALPUFF. Those inconsistencies are more likely an indication of differences of model internal calculation methodology between ISCST3 and CALPUFF than anything likely to be noticed in the field. However, no adjustments were made to the initial screening results for this condition. While the inconsistencies in model predicted concentration trends noted are not likely to be observed in the field, the inconsistencies could occur when performing regulatory modeling, since they are a function of internal methodologies in the models that a permit applicant would be required to use during the regulatory process.

9.4 Screening Model Results Interpreted for US Forest Service Identified Potential Development Scenario Impacts

For each of the three potential development scenarios described in Section 2.0, the equipment assumed to be operating to support the scenario development is described here. Also, the screening table data is interpreted consistent with emissions from that equipment at anticipated operational levels to estimate maximum potential impacts. Those impact projections are conservative because they are based upon conservative emission source layout and dispersion conditions. The long term average impact projections are conservative because they are based upon short term emission rates that would likely be higher than those anticipated on an annual basis.

The visibility impact projections are considered to be conservative because the normalized runs featured low emission rates. Low rate normalized runs do not account for the depletion of ammonia or competition between nitrates and sulfates for ammonia that occur with higher emission rates. These scenarios represent the high end of potential impacts found in a refined air quality impact analysis, which are required for most development actions beyond initial exploration.

9.4.1 Scenario 1: Exploratory Drilling (Dixie and Fishlake National Forests)

This scenario is assumed to include the following activities that affect air quality:

- Construction of 5.5-acre drilling locations.
- A diesel fuel fired drill rig engine with emissions based upon 13.5 tons NOx per well reported in the Western Regional Air Partnership (WRAP) Oil & Gas Emission Inventory prepared in December 2005 by Environ and the 2005 Wyoming field survey from which that data was developed, with actual emissions adjusted downward to be compliant with recent tiered engine requirements, and SO_2 emissions consistent with AP-42 assuming the 15ppm sulfur content in diesel scheduled to be required during the operational phase.
    - The WRAP study indicated the mean drilling time is approximately 90 days per well, continuously around the clock except for maintenance. Therefore, the longer term average impact predictions effectively assume four wells drilled back to back in relatively close proximity to each other.
- Construction of 1.1 miles of new access roads.
- Support traffic to supply, maintain, and staff the drilling effort.
- A low volume of flaring of natural gas during exploration, equal to 100 Mscf per year.

Table 9.4-1 below documents the predicted criteria pollutant NO_2, SO_2, and PM_{10} concentration, nitrate and sulfate deposition, and visibility impairment impacts at a variety of distances for three elevation difference scenarios. A more complete set of tables featuring more elevation differences and more receptor rings are included in Appendix A.

Table 9.4-1 Screening Impacts Predicted with the Exploratory Drilling Scenario

Distance from Operating Area to Receptor (km)														
		1 (km)	2.5 (km)	5 (km)	10 (km)	15 (km)	20 (km)	30 (km)	40 (km)	50 (km)	70 (km)	100 (km)	140 (km)	200 (km)
Receptors 2500 feet above source														
NO_2	annual	4.42	1.11	0.38	0.13	0.07	0.04	0.03	0.02	0.05	0.01	0.01	0.01	0.01
SO_2	3 hour	0.07	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	24 hour	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	annual	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PM-10	24 hour	8.18	3.41	1.48	0.61	0.36	0.26	0.16	0.11	0.46	0.11	0.10	0.07	0.01
	annual	2.05	0.85	0.37	0.15	0.09	0.06	0.04	0.03	0.11	0.03	0.02	0.05	0.00
N Dep	kg/hect/yr	0.0356	0.0127	0.0056	0.0022	0.0012	0.0008	0.0004	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000
S Dep	kg/hect/yr	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Visibility	Days Δdv >0.5	6	3	2	2	2	1	0	0	0	0	0	0	0
	Days Δdv >1.0	0	0	0	0	0	0	0	0	0	0	0	0	0
Receptors 500 feet above source														
NO_2	annual	7.59	2.27	0.90	0.35	0.20	0.14	0.08	0.06	0.05	0.01	0.01	0.00	0.00
SO_2	3 hour	0.08	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	24 hour		0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	annual	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PM-10	24 hour	10.44	4.06	1.73	0.71	0.42	0.30	0.18	0.13	0.46	0.21	0.10	0.07	0.01
	annual	2.61	1.01	0.43	0.18	0.10	0.07	0.05	0.03	0.11	0.05	0.02	0.02	0.00
N Dep	kg/hect/yr	0.0356	0.0127	0.0056	0.0022	0.0012	0.0008	0.0004	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000
S Dep	kg/hect/yr	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Visibility	Days Δdv >0.5	6	3	2	2	2	1	0	0	0	0	0	0	0
	Days Δdv >1.0	0	0	0	0	0	0	0	0	0	0	0	0	0
Receptors at same elevation as source														
NO_2	annual	10.10	6.51	3.39	1.63	1.04	0.77	0.50	0.37	0.05	0.01	0.01	0.00	0.00
SO_2	3 hour	0.16	0.10	0.05	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	24 hour	0.07	0.05	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	annual	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PM-10	24 hour	12.35	6.00	2.77	1.20	0.73	0.53	0.33	0.24	0.31	0.07	0.06	0.04	0.00
	annual	3.09	1.50	0.69	0.30	0.18	0.13	0.08	0.06	0.08	0.02	0.02	0.01	0.00
N Dep	kg/hect/yr	0.0262	0.0107	0.0050	0.0020	0.0011	0.0007	0.0003	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000
S Dep	kg/hect/yr	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Visibility	Days Δdv >0.5	4	1	1	1	1	1	0	0	0	0	0	0	0
	Days Δdv >1.0	0	0	0	0	0	0	0	0	0	0	0	0	0

Receptors 1000 feet below source														
NO_2	annual	0.51	0.30	0.23	0.13	0.09	0.08	0.07	0.06	0.01	0.00	0.00	0.00	0.00
SO_2	3 hour	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	24 hour	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	annual	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PM-10	24 hour	8.18	3.41	1.48	0.61	0.36	0.26	0.16	0.11	0.01	0.00	0.00	0.00	0.00
	annual	2.05	0.85	0.37	0.15	0.09	0.06	0.04	0.03	0.00	0.00	0.00	0.00	0.00
N Dep	kg/hect/yr	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
S Dep	kg/hect/yr	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Visibility	Days Δdv >0.5	0	0	0	0	0	0	0	0	0	0	0	0	0
	Days Δdv >1.0	0	0	0	0	0	0	0	0	0	0	0	0	0

Units for NOx, SO_2, and PM_{10} concentrations are $\mu g/m^3$

Screening table and model results show air quality impacts concentrated in the near proximity of an isolated exploratory well drilling operation. Visibility impacts potentially reach the FLAG 5% degradation level of concern out to 20 kilometers (12.4 miles) above which a cumulative impact analysis could be requested, and never reach the 10% visibility degradation FLAG recommends and Federal Land Managers (FLM) would likely oppose. Air concentrations of all pollutants fall below EPA defined significant impact levels by five kilometers (3.1 miles). Screening tables show that compliance with NAAQS would be assured with the background concentrations expected in potential development areas.

9.4.2 Scenario 2: 20-Well Conventional Drilling Development Consistent with the Dixie National Forest Development Scenario

This scenario is assumed to include the following activities that affect air quality:

- Construction of twenty 5.5-acre drilling locations.
- One diesel fuel fired drill rig engine with emissions based upon the 13.5 tons NOx per well reported in the WRAP Oil & Gas Emission Inventory prepared by Environ and the 2005 Wyoming field survey from which that data was developed, with actual emissions adjusted downward to be compliant with recent tiered engine requirements. SO_2 emissions are consistent with AP-42 assuming the 15ppm sulfur content in diesel scheduled to be required during the operational phase.
    - The WRAP study indicated the mean drilling time is approximately 90 days per well, continuously around the clock except for maintenance. Therefore, the longer term average impact predictions effectively assume four wells drilled back to back in relatively close proximity.
- Construction of eight miles of new access roads.
- Support traffic to supply, maintain, and staff the drilling and pumping effort.
- Twenty 0.5 MMbtu/hr heater / treater separators, two at each well pad.
- Twenty diesel powered 100 hp well pumps to extract oil, one for each well.
- One 1.0 MMbtu dehydrator and one 500 HP compressor processing a low volume of natural gas at partial capacity.

Diesel well pumps are assumed because the development sites are expected to be remote from the electric power grid. Though a slight amount of natural gas production is included, producible natural gas is not likely assumed by the USFS and is not anticipated in sufficient quantity to power the well pumps.

Table 9.4-2 documents the predicted criteria pollutant NO_2, SO_2, and PM_{10} concentration, nitrate and sulfate deposition, and visibility impairment impacts at a variety of distances for three elevation difference scenarios.

Table 9.4-2 Screening Impacts Predicted with the 20-Well Conventional Drilling Scenario

Distance From Operating Area to receptor (km)														
		1 (km)	2.5 (km)	5 (km)	10 (km)	15 (km)	20 (km)	30 (km)	40 (km)	50 (km)	70 (km)	100 (km)	140 (km)	200 (km)
Receptors 2500 feet above source														
NO_2	annual	13.04	3.28	1.12	0.38	0.20	0.13	0.07	0.05	0.15	0.04	0.02	0.01	0.00
SO_2	3 hour	27.62	6.41	2.12	0.70	0.37	0.24	0.14	0.10	0.19	0.04	0.02	0.01	0.00
	24 hour	12.28	9.38	4.88	2.17	1.33	0.95	0.60	0.48	0.11	0.02	0.01	0.01	0.00
	annual	3.07	0.71	0.24	0.08	0.04	0.03	0.02	0.01	0.03	0.01	0.00	0.00	0.00
PM-10	24 hour	16.57	6.90	3.00	1.24	0.74	0.52	0.32	0.23	0.92	0.43	0.20	0.14	0.00
	annual	4.14	1.73	0.75	0.31	0.18	0.13	0.08	0.06	0.23	0.11	0.05	0.03	0.00
N Dep	kg/hect/yr	0.1051	0.0375	0.0167	0.0065	0.0036	0.0023	0.0011	0.0006	0.0004	0.0002	0.0001	0.0000	0.0000
S Dep	kg/hect/yr	0.0383	0.0150	0.0059	0.0029	0.0017	0.0011	0.0005	0.0003	0.0002	0.0001	0.0000	0.0000	0.0000
Visibility	Days Δdv >0.5	82	75	73	60	49	40	27	15	10	4	2	1	0
	Days Δdv >1.0	49	43	40	31	25	18	6	3	2	0	0	0	0
Receptors 500 feet above source														
NO_2	annual	22.41	6.71	2.65	1.04	0.60	0.41	0.25	0.17	0.15	0.04	0.02	0.01	0.00
SO_2	3 hour	34.08	9.49	3.57	1.35	0.77	0.53	0.31	0.22	0.18	0.04	0.02	0.01	0.00
	24 hour	15.15	4.22	1.59	0.60	0.34	0.23	0.14	0.10	0.10	0.02	0.01	0.01	0.00
	annual	3.79	1.05	0.40	0.15	0.09	0.06	0.03	0.02	0.03	0.01	0.00	0.00	0.00
PM-10	24 hour	21.15	8.22	3.50	1.43	0.85	0.60	0.37	0.26	0.92	0.43	0.20	0.14	0.03
	annual	5.29	2.05	0.88	0.36	0.21	0.15	0.09	0.07	0.23	0.11	0.05	0.03	0.01
N Dep	kg/hect/yr	0.1051	0.0375	0.0167	0.0065	0.0036	0.0023	0.0011	0.0006	0.0004	0.0002	0.0001	0.0000	0.0000
S Dep	kg/hect/yr	0.0383	0.0150	0.0059	0.0029	0.0017	0.0011	0.0005	0.0003	0.0002	0.0001	0.0000	0.0000	0.0000
Visibility	Days Δdv >0.5	82	75	73	60	49	40	27	15	10	4	2	1	0
	Days Δdv >1.0	49	43	40	31	25	18	6	3	2	0	0	0	0

Receptors at same elevation as source														
NO_2	annual	29.83	19.21	10.01	4.80	3.08	2.27	1.47	1.09	0.14	0.04	0.02	0.01	0.00
SO_2	3 hour	67.92	44.37	22.15	10.03	6.19	4.46	2.80	2.03	0.18	0.04	0.02	0.01	0.00
	24 hour	30.19	19.72	9.84	4.46	2.75	1.98	1.24	0.90	0.10	0.02	0.01	0.01	0.00
	annual	7.55	4.93	2.46	1.11	0.69	0.50	0.31	0.23	0.03	0.01	0.00	0.00	0.00
PM-10	24 hour	25.01	12.16	5.62	2.44	1.49	1.06	0.67	0.48	0.62	0.15	0.13	0.09	0.03
	annual	6.25	3.04	1.40	0.61	0.37	0.27	0.17	0.12	0.16	0.04	0.03	0.02	0.01
N Dep	kg/hect/yr	0.0774	0.0315	0.0148	0.0059	0.0033	0.0022	0.0010	0.0006	0.0004	0.0001	0.0001	0.0000	0.0000
S Dep	kg/hect/yr	0.0314	0.0135	0.0055	0.0027	0.0016	0.0011	0.0004	0.0003	0.0002	0.0000	0.0000	0.0000	0.0000
Visibility	Days Δdv >0.5	77	69	70	57	47	38	25	14	9	3	2	1	0
	Days Δdv >1.0	46	39	37	31	23	17	5	2	1	0	0	0	0

Receptors 1000 feet below source														
NO_2	annual	1.50	0.88	0.67	0.38	0.27	0.23	0.20	0.16	0.02	0.01	0.01	0.01	0.00
SO_2	3 hour	2.78	1.62	1.23	0.71	0.49	0.41	0.37	0.30	0.05	0.01	0.01	0.01	0.00
	24 hour	1.24	0.72	0.55	0.31	0.22	0.18	0.16	0.14	0.03	0.01	0.00	0.00	0.00
	annual	0.31	0.18	0.14	0.08	0.05	0.05	0.04	0.03	0.01	0.00	0.00	0.00	0.00
PM-10	24 hour	16.57	6.90	3.00	1.24	0.74	0.52	0.32	0.23	0.02	0.01	0.01	0.00	0.00
	annual	4.14	1.73	0.75	0.31	0.18	0.13	0.08	0.06	0.00	0.00	0.00	0.00	0.00
N Dep	kg/hect/yr	0.0003	0.0005	0.0004	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000
S Dep	kg/hect/yr	0.0004	0.0003	0.0002	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
Visibility	Days Δdv >0.5	5	6	5	6	4	5	3	3	2	2	2	0	0
	Days Δdv >1.0	1	1	1	1	1	1	1	0	0	0	0	0	0

Units for NOx, SO_2, and PM_{10} concentrations are $\mu g/m^3$

The results show potential increases in b_{ext} over the FLAG limit for Class I areas threshold of 10 percent out to almost 55 kilometers (34.2 miles), and over the FLAG level of concern of 0.5 deciviews (5% increase in b_{ext}) above which FLMs could request a cumulative visibility impact analysis out to 100 kilometers (62 miles). Potential deposition rates drop below FLAG screening thresholds of 0.005 kg/hect/year within 45 km (27.9 miles).

Criteria pollutant impacts conservatively estimated from the screening table are shown to approach but not exceed the NAAQS with anticipated background concentrations added in the immediate vicinity of development activity. Criteria pollutants are well below NAAQS within a few hundred kilometers and everywhere beyond. Air pollutant impacts are predicted to drop off to levels defined as insignificant in Class II areas within 41.5 km (25.8 miles) for NOx and in less than 13 km (8.1 miles) for all other pollutants. Compared against Class I area impact limits, criteria pollutant impacts are predicted to be insignificant within 60 kilometers (37.3 miles) for all pollutants. When predicted impacts are below Class I impact limits, cumulative incremental degradation impact analyses are not likely necessary. Therefore, this screening analysis cannot rule out the need to perform a cumulative impact analysis for criteria pollutants if Class I areas exist within 60 km (37.3 miles) of this type of development activity.

The conservatism in the screening tables is shown by the results of the verifications prepared from modeling runs for potential development operational scenarios. Specific development scenario modeling analyses with realistic layout of equipment in potentially sensible locations and representative meteorological data indicate low probability of exceeding NAAQS,

increments and/or thresholds nearby, and show distances to those impact thresholds two to three times lower than predicted by the screening modeling. Using our assumed layout of equipment, locations, and regional meteorological data, the results indicate a low probability of exceeding ambient air quality standards, increments and/or thresholds.

The emission inventory for this analysis was conservative in that it assumed one new well was being drilled while the full field is operating, and also assumed that diesel pumps would be used at each well head. Predicted impacts would decrease by up to 20 percent if either no well drilling occurred simultaneously with the operation of the wells, or if enough natural gas was recovered onsite to fuel the well pumps. NOx, SO_2, and visibility impacts would be lowered significantly (SO_2 by 90 percent or more) if electric power lines brought power onsite and no fuel was needed to operate the well pumps.

9.4.3 Scenario 3: 12-Well Directional Drilling Development Consistent with the Fishlake National Forest Development Scenario

This scenario is assumed to include the following activities that affect air quality:

- Construction of three 5.5-acre drilling locations.
- One diesel fuel fired drill rig engine with emissions based upon the 13.5 tons NOx per well reported in the WRAP Oil & Gas Emission Inventory prepared by Environ and the 2005 Wyoming field survey from which that data was developed, with actual emissions adjusted downward to be compliant with recent tiered engine requirements, and SO_2 emissions consistent with AP-42 assuming the 15ppm sulfur content in diesel scheduled to be required during the project's operational phase.
    - The WRAP study indicated the mean drilling time is approximately 90 days per well, continuously around the clock except for maintenance. Therefore, the longer term average impact predictions effectively assume four wells drilled back to back in relatively close proximity.
- Construction of five miles of new access roads.
- Support traffic to supply, maintain, and staff the drilling and pumping effort.
- Six 1.0 MMbtu/hr heater / treater separators, two at each well pad.
- Twelve diesel powered 100 hp well pumps to extract oil, one for each well.
- One 0.5 MMbtu/hr dehydrator and one 500 HP compressor processing a low volume of natural gas at partial capacity.

Diesel well pumps are assumed because the development sites are expected to be remote from the electric power grid. Though a slight amount of natural gas production is included, producible natural gas is not routinely expected and is not anticipated in sufficient quantity to power the well pumps.

Table 9.4-3 on the following page documents the predicted criteria pollutant NO_2, SO_2, and PM_{10} concentration, nitrate and sulfate deposition, and visibility impairment impacts at a variety of distances for three elevation difference scenarios.

Table 9.4-3 Screening Impacts Predicted with the 12-Well Directional Drilling Scenario

		Distance From Operating Area to receptor (km)												
		1 (km)	2.5 (km)	5 (km)	10 (km)	15 (km)	20 (km)	30 (km)	40 (km)	50 (km)	70 (km)	100 (km)	140 (km)	200 (km)
Receptors 2500 feet above source														
NO_2	annual	10.29	2.59	0.88	0.30	0.16	0.10	0.06	0.04	0.12	0.03	0.02	0.01	0.00
SO_2	3 hour	16.60	3.85	1.27	0.42	0.22	0.14	0.08	0.06	0.11	0.02	0.01	0.01	0.00
	24 hour	7.38	5.63	2.93	1.30	0.80	0.57	0.36	0.29	0.07	0.01	0.01	0.00	0.00
	annual	1.84	0.43	0.14	0.05	0.02	0.02	0.01	0.01	0.02	0.00	0.00	0.00	0.00
PM-10	24 hour	12.76	5.31	2.31	0.95	0.57	0.40	0.25	0.18	0.71	0.33	0.15	0.10	0.00
	annual	3.19	1.33	0.58	0.24	0.14	0.10	0.06	0.04	0.18	0.08	0.04	0.03	0.00
N Dep	kg/hect/yr	0.0829	0.0296	0.0132	0.0051	0.0028	0.0018	0.0009	0.0005	0.0003	0.0001	0.0001	0.0000	0.0000
S Dep	kg/hect/yr	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Visibility	Days Δdv >0.5	24	21	23	26	23	17	11	7	3	1	0	0	0
	Days Δdv >1.0	6	6	7	8	7	4	1	0	0	0	0	0	0
Receptors 500 feet above source														
NO_2	annual	17.68	5.30	2.09	0.82	0.47	0.33	0.19	0.14	0.12	0.03	0.02	0.01	0.00
SO_2	3 hour	20.48	5.70	2.15	0.81	0.46	0.32	0.19	0.13	0.11	0.02	0.01	0.01	0.00
	24 hour	9.10	2.53	0.95	0.36	0.21	0.14	0.08	0.06	0.06	0.01	0.01	0.00	0.00
	annual	2.28	0.63	0.24	0.09	0.05	0.04	0.02	0.01	0.02	0.00	0.00	0.00	0.00
PM-10	24 hour	16.29	6.33	2.70	1.10	0.65	0.46	0.28	0.20	0.71	0.33	0.15	0.10	0.02
	annual	4.07	1.58	0.67	0.28	0.16	0.12	0.07	0.05	0.18	0.08	0.04	0.03	0.01
N Dep	kg/hect/yr	0.0829	0.0296	0.0132	0.0051	0.0028	0.0018	0.0009	0.0005	0.0003	0.0001	0.0001	0.0000	0.0000
S Dep	kg/hect/yr	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Visibility	Days Δdv >0.5	24	21	23	26	23	17	11	7	3	1	0	0	0
	Days Δdv >1.0	6	6	7	8	7	4	1	0	0	0	0	0	0
Receptors at same elevation as source														
NO_2	annual	23.54	15.16	7.90	3.79	2.43	1.79	1.16	0.86	0.11	0.03	0.01	0.01	0.00
SO_2	3 hour	40.81	26.66	13.31	6.02	3.72	2.68	1.68	1.22	0.11	0.02	0.01	0.01	0.00
	24 hour	18.14	11.85	5.91	2.68	1.65	1.19	0.75	0.54	0.06	0.01	0.01	0.00	0.00
	annual	4.53	2.96	1.48	0.67	0.41	0.30	0.19	0.14	0.02	0.00	0.00	0.00	0.00
PM-10	24 hour	19.26	9.37	4.32	1.88	1.14	0.82	0.51	0.37	0.48	0.11	0.10	0.07	0.00
	annual	4.81	2.34	1.08	0.47	0.29	0.21	0.13	0.09	0.12	0.03	0.03	0.02	0.00
N Dep	kg/hect/yr	0.0610	0.0248	0.0116	0.0047	0.0026	0.0017	0.0008	0.0005	0.0003	0.0001	0.0001	0.0000	0.0000
S Dep	kg/hect/yr	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Visibility	Days Δdv >0.5	23	20	22	23	20	16	9	6	2	1	0	0	0
	Days Δdv >1.0	6	6	7	7	6	4	1	0	0	0	0	0	0

Receptors 1000 feet below source														
NO_2	annual	1.19	0.69	0.52	0.30	0.21	0.18	0.16	0.13	0.02	0.01	0.01	0.00	0.00
SO_2	3 hour	1.67	0.97	0.74	0.43	0.30	0.25	0.22	0.18	0.03	0.01	0.00	0.00	0.00
	24 hour	0.74	0.43	0.33	0.19	0.13	0.11	0.10	0.08	0.02	0.00	0.00	0.00	0.00
	annual	0.19	0.11	0.08	0.05	0.03	0.03	0.02	0.02	0.00	0.00	0.00	0.00	0.00
PM-10	24 hour	12.76	5.31	2.31	0.95	0.57	0.40	0.25	0.18	0.01	0.01	0.00	0.00	0.00
	annual	3.19	1.33	0.58	0.24	0.14	0.10	0.06	0.04	0.00	0.00	0.00	0.00	0.00
N Dep	kg/hect/yr	0.0002	0.0004	0.0003	0.0002	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
S Dep	kg/hect/yr	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Visibility	Days Δdv >0.5	1	1	1	2	1	2	1	0	0	0	0	0	0
	Days Δdv >1.0	0	0	0	0	0	0	0	0	0	0	0	0	0

Units for NOx, SO_2, and PM_{10} concentrations are $\mu g/m^3$

The screening results show visibility degradation potentially reaching the FLAG level of concern of 0.5 deciviews (5% increase in b_{ext}) potentially requiring a cumulative visibility impact analysis out to 50 kilometers (31 miles), and reaching the FLAG suggested 1 deciview impact limit (10% increase in b_{ext}) out to 30 kilometers (18.6 miles). Deposition rates drop below FLAG screening thresholds of 0.005 kg/hect/year within 35 km (21.7 miles).

Criteria pollutant (NOx, SO_2, and PM_{10}) impacts conservatively estimated from the screening table are shown to approach but not exceed the NAAQS with anticipated background concentrations added in the immediate vicinity of development activity. However, impacts are estimated by screening to be well within NAAQS standards within a few hundred kilometers and everywhere beyond. Air pollutant impacts are predicted to drop off to levels defined as insignificant in Class II areas within 10 km (6.2 miles) for NOx and in less than 4 km (2.5 miles) for all other pollutants. Criteria pollutant impacts are conservatively predicted by screening to be insignificant compared against Class I area significance levels within 55 kilometers (34.1) miles) for NOx and 50 kilometers (31 miles) for all other pollutants. When predicted impacts are below Class I impact limits, impact analyses for cumulative incremental degradation are not likely necessary. Therefore, this screening analysis cannot rule out the need to perform a cumulative impact analysis for criteria pollutants if Class I areas exist within 55 km (34.1 miles).

The conservatism in the screening tables is shown by the results of the verifications prepared from modeling runs for potential development operational scenarios. Specific development scenario modeling analyses with realistic layout of equipment in potentially sensible locations and representative meteorological data indicate low probability of exceeding NAAQS, increments and/or thresholds nearby, and show distances to those impact thresholds two to three times lower than predicted by the screening modeling. These results assume reasonable dust control consistent with anticipated dust control efforts and requirements. The larger percentage differences from screening modeling estimates were generally for long term averaging periods and for the visibility analyses, where the screening assumptions were especially conservative. Specific development scenario modeling results show that actual development scenarios that do not pass the screening tests could be shown to have air quality impacts within acceptable limits with refined air quality modeling. The specific development scenario model analyses give only an indication of the extent to which impacts from refined modeling could be lower than those estimated from the screening tables.

The emission inventory for this analysis was conservative in that it assumed one new well was being drilled while the full field is operating, and also assumed that diesel pumps would be used

at each well head. NOx, SO_2, and visibility impacts would decrease by approximately 20 percent if either no well drilling occurred simultaneously with the operation of 12-wells, or if enough natural gas was recovered onsite to fuel the well pumps. NOx, SO_2, and visibility impacts would be approximately 90 percent lower if electric power lines brought power onsite, and no fuel was needed to operate the well pumps.

9.5 Screening Table Summary

These estimates of potential impacts are based upon emission profiles consistent with the recommendations of the affected NFs, the US EPA, and the UDEQ, and with the NEPA analysis and associated requirements or mitigation measures defined in the EIS. These predicted distances to regulatory threshold impact limits are only for gauging if a more detailed analysis or a cumulative impact analysis should be considered. The model and screening tables can be used as in the examples given in Tables 9.4-2 and 9.4-3 to gauge the need for cumulative impact analysis.

9.5.1 Screening Table Values Do Not Under Predict Full Modeling values

In summary, the verification process described above and documented in Appendix B resulted in demonstrating that the results in the screening tables were conservative.

These analyses reveal that screening tables can be used to prepare conservative assessment of impacts of any specific action or alternative consistent with the assumptions included. Specific development scenario analyses confirm that when applied to representative potential development scenarios (consistent with the assumptions documented for the screening analysis), the screening tables do not under predict impacts predicted by site and project impact analyses

9.5.2 Elevation Difference for Sulfur Dioxide

There is, however, one caveat for short term average SO_2 impact estimates. For receptors at a distance of between 5 and 40 kilometers from the source, the elevation difference between the receptor and the source used in applying the screening tables should be based upon the elevation difference between the receptor and the well nearest in elevation to it rather than between the receptor location and the mean well field elevation.

9.5.3 Class I Cumulative Impact Analyses

The screening analysis for a single exploration well (Scenario 1), shows the need to perform a cumulative impact analysis for criteria pollutants if Class I areas exist within 3.1 miles of the drilling location.

The screening analysis for the Dixie NF “typical 20-well field” scenario (Scenario 2), using a set of reasonable assumptions, shows the need to perform a cumulative impact analysis for criteria pollutants if Class I areas exist within 37.3 miles

The screening analysis for the Fishlake NF “typical 12-well field” scenario (Scenario 3), using a set of reasonable assumptions, shows the need to perform a cumulative impact analysis for criteria pollutants if Class I areas exist within 34.1 miles.

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9.5.4 Visibility Analysis

The visibility analyses for the three development scenarios showed that isolated exploratory wells were not likely to have any significant impact. However, the development scenarios could have visibility impacts potentially reaching the FLAG limit of 1 deciview impact out to 35 kilometers (21.7 miles) for the Fishlake well development scenario and up to 55 kilometers (34.1 miles) for the Dixie NF well development scenario. Those analyses also indicate that the FLMs could request a cumulative visibility impact analysis for receptors out to 50 kilometers (31 miles) from the location for the Fishlake well development scenario and of 100 kilometers (62 miles) for the Dixie well development scenario.

Similarly, EPA FLAG recommended deposition impact thresholds for Class 1 areas could be reached out to from 21.7 kilometers (13.5 miles) for the Fishlake well development scenario and to 45 kilometers (27.9 miles) for the Dixie NF well development scenario. Those estimates are driven by the assumption of diesel well pumps. If natural gas could be recovered in sufficient quantity to power the well pumps, the extent of potential visibility and deposition impacts would drop, probably by at least one third, mainly due to sulfur deposition. If electric power was available, emissions of pollutants affecting visibility impacts would be considerably lower than those used for the visibility impact analyses reported here. Comparably lower deposition impacts could be estimated using the screening tables.

APPENDIX SIR-1A

Dixie and Fishlake National Forests

Screening Tables for Prompt Initial Estimates of

Likely Impacts from Oil and& Gas Development

Receptor Elevation (ft) compared to Source Elevation

PM-10	Distance from Operations to Receptor (km)										
	0.25	0.5	1	2.5	5	10	15	20	25	30	40
2500											
24hr ave (ug/m3)	20.129536	10.73376	7.024516	2.925596	1.2699	0.525316	0.312892	0.221672	0.169608	0.136356	0.09814
annual ave (ug/m3)	5.032384	2.68344	1.756129	0.731399	0.317475	0.131329	0.078223	0.055418	0.042402	0.034089	0.024535
1000											
24hr ave (ug/m3)	20.119304	12.759264	7.920324	3.18526	1.370592	0.564332	0.335312	0.237116	0.181164	0.145472	0.104492
annual ave (ug/m3)	5.029826	3.189816	1.980081	0.796315	0.342648	0.141083	0.083828	0.059279	0.045291	0.036368	0.026123
500											
24hr ave (ug/m3)	22.348028	15.1355	8.965812	3.483172	1.484748	0.60816	0.360388	0.254356	0.194048	0.155624	0.111556
annual ave (ug/m3)	5.587007	3.783875	2.241453	0.870793	0.371187	0.15204	0.090097	0.063589	0.048512	0.038906	0.027889
100											
24hr ave (ug/m3)	24.439884	16.322632	9.476412	3.644388	1.56142	0.648152	0.388748	0.276632	0.212532	0.17148	0.12396
annual ave (ug/m3)	6.109971	4.080658	2.369103	0.911097	0.390355	0.162038	0.097187	0.069158	0.053133	0.04287	0.03099
0											
24hr ave (ug/m3)	16.670336	12.944948	10.601604	5.155588	2.380732	1.03302	0.629584	0.45146	0.348652	0.282336	0.205104
annual ave (ug/m3)	4.167584	3.236237	2.650401	1.288897	0.595183	0.258255	0.157396	0.112865	0.087163	0.070584	0.051276
-1000											
24hr ave (ug/m3)	14.004428	10.73376	7.024516	2.925596	1.2699	0.525316	0.312892	0.221672	0.169608	0.13636	0.098148
annual ave (ug/m3)	3.501107	2.68344	1.756129	0.731399	0.317475	0.131329	0.078223	0.055418	0.042402	0.03409	0.024537
-2500											
24hr ave (ug/m3)	14.004428	10.733732	7.024516	2.925596	1.2699	0.525316	0.312892	0.221672	0.169608	0.136356	0.09814
annual ave (ug/m3)	3.501107	2.683433	1.756129	0.731399	0.317475	0.131329	0.078223	0.055418	0.042402	0.034089	0.024535

Receptor Elevation (ft) compared to Source Elevation

PM-10	Distance from Operations to Receptor (km)										
	50	60	70	80	90	100	120	140	160	180	200
2500											
24hr ave (ug/m3)	0.390744	0.24864	0.180752	0.12906	0.11452	0.082772	0.066248	0.0572493	0.0330896	0.0015281	0.0011024
annual ave (ug/m3)	0.097686	0.06216	0.045188	0.032265	0.02863	0.020693	0.016562	0.0143123	0.0082724	0.000382	0.0002756
1000											
24hr ave (ug/m3)	0.390744	0.24864	0.180752	0.12906	0.11452	0.082772	0.066248	0.0572493	0.0330896	0.0015281	0.0110244
annual ave (ug/m3)	0.097686	0.06216	0.045188	0.032265	0.02863	0.020693	0.016562	0.0143123	0.0082724	0.000382	0.0027561
500											
24hr ave (ug/m3)	0.390744	0.24864	0.180752	0.12906	0.11452	0.082772	0.066248	0.0572493	0.0330896	0.0015281	0.0110244
annual ave (ug/m3)	0.097686	0.06216	0.045188	0.032265	0.02863	0.020693	0.016562	0.0143123	0.0082724	0.000382	0.0027561
100											
24hr ave (ug/m3)	0.390744	0.24864	0.180752	0.12906	0.11452	0.082772	0.066248	0.0572493	0.0330896	0.0015281	0.0110244
annual ave (ug/m3)	0.097686	0.06216	0.045188	0.032265	0.02863	0.020693	0.016562	0.0143123	0.0082724	0.000382	0.0027561
0											
24hr ave (ug/m3)	0.263264	0.167346	0.061536	0.086492	0.076632	0.055548	0.044306	0.0382787	0.0224308	0.0015277	0.0005234
annual ave (ug/m3)	0.065816	0.0418365	0.015384	0.021623	0.019158	0.013887	0.0110765	0.0095697	0.0056077	0.0003819	0.0001309
-1000											
24hr ave (ug/m3)	0.0064456	0.0055926	0.004234	0.0031652	0.0027644	0.0023777	0.0020894	0.001735	0.0025569	0.0013503	0.0012872
annual ave (ug/m3)	0.0016114	0.0013982	0.0010585	0.0007913	0.0006911	0.0005944	0.0005224	0.0004338	0.0006392	0.0003376	0.0003218
-2500											
24hr ave (ug/m3)	0.0064456	0.0054036	0.004234	0.0021736	0.001529	0.0012026	0.0013525	0.001556	0.0012819	0.0007228	0.0007328
annual ave (ug/m3)	0.0016114	0.0013509	0.0010585	0.0005434	0.0003822	0.0003006	0.0003381	0.000389	0.0003205	0.0001807	0.0001832

SO2

Distance from Operations to Receptor (km)

Receptor Elevation (ft) compared to Source Elevation	0.25	0.5	1	2.5	5	10	15	20	25	30	40
2500											
3hr ave (ug/m3)	52.429194	20.720880	6.706620	1.555578	0.513783	0.169767	0.090243	0.058140	0.042048	0.032859	0.023265
24hr ave (ug/m3)	23.301864	9.209280	2.980720	2.276573	1.185994	0.525834	0.322890	0.231814	0.179296	0.145424	0.116706
annual ave (ug/m3)	5.825466	2.302320	0.745180	0.172842	0.057087	0.018863	0.010027	0.006460	0.004672	0.003651	0.002585
dep(kg/hect/yr)	0.015008	0.015008	0.010123	0.005446	0.003082	0.001736	0.001280	0.000922	0.000719	0.000557	0.000375
1000											
3hr ave (ug/m3)	52.428699	20.720880	6.706620	1.555578	0.513783	0.169767	0.090243	0.058140	0.042345	0.033309	0.023265
24hr ave (ug/m3)	23.301644	9.209280	2.980720	0.691368	0.228348	0.075452	0.040108	0.025840	0.018820	0.014804	0.010340
annual ave (ug/m3)	5.825411	2.302320	0.745180	0.172842	0.057087	0.018863	0.010027	0.006460	0.004705	0.003701	0.002585
dep(kg/hect/yr)	0.015008	0.015008	0.010123	0.005446	0.003082	0.001736	0.001280	0.000922	0.000719	0.000557	0.000375
500											
3hr ave (ug/m3)	52.425153	20.720880	8.274897	2.303379	0.867852	0.328689	0.186921	0.128124	0.095544	0.075159	0.052209
24hr ave (ug/m3)	23.300068	9.209280	3.677732	1.023724	0.385712	0.146084	0.083076	0.056944	0.042464	0.033404	0.023204
annual ave (ug/m3)	5.825017	2.302320	0.919433	0.255931	0.096428	0.036521	0.020769	0.014236	0.010616	0.008351	0.005801
dep(kg/hect/yr)	0.015008	0.015008	0.010123	0.005446	0.003082	0.001736	0.001280	0.000922	0.000719	0.000557	0.000375
100											
3hr ave (ug/m3)	55.371627	27.454923	14.815665	6.133050	2.589858	1.047834	0.617418	0.423072	0.321336	0.256644	0.180027
24hr ave (ug/m3)	24.609612	12.202188	6.584740	2.725800	1.151048	0.465704	0.274408	0.188032	0.142816	0.114064	0.080012
annual ave (ug/m3)	6.152403	3.050547	1.646185	0.681450	0.287762	0.116426	0.068602	0.047008	0.035704	0.028516	0.020003
dep(kg/hect/yr)	0.015008	0.015008	0.010123	0.005446	0.003082	0.001736	0.001280	0.000922	0.000719	0.000557	0.000375
0											
3hr ave (ug/m3)	46.060353	28.021581	16.490871	10.772271	5.377005	2.434743	1.502847	1.082088	0.837414	0.678672	0.493056
24hr ave (ug/m3)	20.471268	12.454036	7.329276	4.787676	2.389780	1.082108	0.667932	0.480928	0.372184	0.301632	0.219136
annual ave (ug/m3)	5.117817	3.113509	1.832319	1.196919	0.597445	0.270527	0.166983	0.120232	0.093046	0.075408	0.054784
dep(kg/hect/yr)	0.015008	0.011088	0.006974	0.004178	0.002537	0.001359	0.001050	0.000785	0.000623	0.000493	0.000340
-1000											
3hr ave (ug/m3)	0.000333	1.172295	0.675477	0.393912	0.298530	0.171963	0.120024	0.099513	0.095958	0.088920	0.073872
24hr ave (ug/m3)	0.000148	0.521020	0.300212	0.175072	0.132680	0.076428	0.053344	0.044228	0.042648	0.039520	0.032832
annual ave (ug/m3)	0.000037	0.130255	0.075053	0.043768	0.033170	0.019107	0.013336	0.011057	0.010662	0.009880	0.008208
dep(kg/hect/yr)	0.015008	0.000081	0.000141	0.000189	0.000226	0.000160	0.000127	0.000112	0.000103	0.000098	0.000089
-2500											
3hr ave (ug/m3)	0.012672	1.172295	0.871812	0.582219	0.322758	0.203184	0.136800	0.100881	0.079659	0.065880	0.050751
24hr ave (ug/m3)	0.005632	0.521020	0.387472	0.258764	0.143448	0.090304	0.060800	0.044836	0.035404	0.029280	0.022556
annual ave (ug/m3)	0.001408	0.130255	0.096868	0.064691	0.035862	0.022576	0.015200	0.011209	0.008851	0.007320	0.005639
dep(kg/hect/yr)	0.015008	0.000052	0.000063	0.000079	0.000100	0.000100	0.000088	0.000074	0.000062	0.000054	0.000047

SO2		Distance from Operations to Receptor (km)										
		50	60	70	80	90	100	120	140	160	180	200
Receptor Elevation (ft) compared to Source Elevation	**2500**											
	3hr ave (ug/m3)	0.046282	0.018480	0.009997	0.008388	0.007515	0.004701	0.003426	0.002699	0.002356	0.001184	0.001097
	24hr ave (ug/m3)	0.026447	0.010560	0.005712	0.004793	0.004294	0.002686	0.001958	0.001542	0.001346	0.000676	0.000627
	annual ave (ug/m3)	0.006612	0.002640	0.001428	0.001198	0.001074	0.000672	0.000489	0.000386	0.000337	0.000169	0.000157
	dep(kg/hect/yr)	0.000238	0.000173	0.000126	0.000094	0.000074	0.000063	0.000050	0.000041	0.000034	0.000029	0.000025
	1000											
	3hr ave (ug/m3)	0.046282	0.018480	0.009997	0.008388	0.007515	0.004701	0.003426	0.002699	0.002356	0.001184	0.001097
	24hr ave (ug/m3)	0.026447	0.010560	0.005712	0.004793	0.004294	0.002686	0.001958	0.001542	0.001346	0.000676	0.000627
	annual ave (ug/m3)	0.006612	0.002640	0.001428	0.001198	0.001074	0.000672	0.000489	0.000386	0.000337	0.000169	0.000157
	dep(kg/hect/yr)	0.000259	0.000186	0.000135	0.000099	0.000075	0.000064	0.000050	0.000041	0.000035	0.000030	0.000026
	500											
	3hr ave (ug/m3)	0.043664	0.018360	0.009705	0.008217	0.007269	0.004607	0.003337	0.002657	0.002125	0.001165	0.001097
	24hr ave (ug/m3)	0.024951	0.010491	0.005546	0.004696	0.004154	0.002632	0.001907	0.001518	0.001214	0.000666	0.000584
	annual ave (ug/m3)	0.006238	0.002623	0.001386	0.001174	0.001038	0.000658	0.000477	0.000380	0.000304	0.000166	0.000161
	dep(kg/hect/yr)	0.000259	0.000186	0.000135	0.000099	0.000075	0.000064	0.000050	0.000041	0.000035	0.000030	0.000026
	100											
	3hr ave (ug/m3)	0.043664	0.018360	0.009705	0.008217	0.007269	0.004607	0.003337	0.002657	0.002125	0.001165	0.001097
	24hr ave (ug/m3)	0.024951	0.010491	0.005546	0.004696	0.004154	0.002632	0.001907	0.001518	0.001214	0.000666	0.000584
	annual ave (ug/m3)	0.006238	0.002623	0.001386	0.001174	0.001038	0.000658	0.000477	0.000380	0.000304	0.000166	0.000161
	dep(kg/hect/yr)	0.000259	0.000186	0.000135	0.000099	0.000075	0.000064	0.000050	0.000041	0.000035	0.000030	0.000026
	0											
	3hr ave (ug/m3)	0.043664	0.018360	0.009705	0.008217	0.007269	0.004607	0.003337	0.002657	0.002125	0.001165	0.001097
	24hr ave (ug/m3)	0.024951	0.010491	0.005546	0.004696	0.004154	0.002632	0.001907	0.001518	0.001214	0.000666	0.000584
	annual ave (ug/m3)	0.006238	0.002623	0.001386	0.001174	0.001038	0.000658	0.000477	0.000380	0.000304	0.000166	0.000161
	dep(kg/hect/yr)	0.000259	0.000186	0.000135	0.000099	0.000075	0.000064	0.000050	0.000041	0.000035	0.000030	0.000026
	-1000											
	3hr ave (ug/m3)	0.011974	0.005435	0.003292	0.002451	0.002050	0.001762	0.001563	0.001311	0.001857	0.001021	0.000977
	24hr ave (ug/m3)	0.006842	0.003106	0.001881	0.001401	0.001171	0.001007	0.000893	0.000749	0.001061	0.000584	0.000558
	annual ave (ug/m3)	0.001711	0.000776	0.000470	0.000350	0.000293	0.000252	0.000223	0.000187	0.000265	0.000146	0.000140
	dep(kg/hect/yr)	0.000079	0.000069	0.000062	0.000056	0.000050	0.000046	0.000039	0.000033	0.000029	0.000026	0.000023
	-2500											
	3hr ave (ug/m3)	0.004921	0.005435	0.003292	0.001776	0.001156	0.000935	0.001025	0.001179	0.000927	0.000541	0.000550
	24hr ave (ug/m3)	0.002812	0.003106	0.001881	0.001015	0.000660	0.000534	0.000586	0.000673	0.000530	0.000309	0.000314
	annual ave (ug/m3)	0.000703	0.000776	0.000470	0.000254	0.000165	0.000134	0.000146	0.000168	0.000132	0.000077	0.000079
	dep(kg/hect/yr)	0.000041	0.000037	0.000034	0.000032	0.000030	0.000028	0.000024	0.000021	0.000019	0.000018	0.000017

Receptor Elevation (ft) compared to Source Elevation

NOx	Distance from Operations to Receptor (km)										
	0.25	0.5	1	2.5	5	10	15	20	25	30	40
2500											
annual ave (ug/m3)	3.172979	1.289185	0.45462	0.114293	0.038994	0.013104	0.007007	0.004531	0.003285	0.002573	0.001825
dep(kg/hect/yr)	0.000017	0.090955	0.044116224	0.015461231	0.00672431	0.00237311	0.0012384	0.00078234	0.00051307	0.00036363	0.00020592
1000											
annual ave (ug/m3)	3.166254	1.289185	0.45462	0.120546	0.048103	0.019008	0.011025	0.007639	0.005741	0.004544	0.003184
dep(kg/hect/yr)	0.000017	0.09095493	0.044116224	0.015461231	0.00672431	0.00237311	0.0012384	0.00078234	0.000513	0.00036363	0.00020592
500											
annual ave (ug/m3)	3.486917	1.741156	0.781069	0.233967	0.09222	0.036134	0.020872	0.014424	0.01082	0.00855	0.005976
dep(kg/hect/yr)	0.000017	0.09095493	0.044116224	0.015461231	0.00672431	0.00237311	0.0012384	0.00078234	0.000513	0.00036363	0.00020592
100											
annual ave (ug/m3)	3.284705	1.747867	0.922212	0.408719	0.18475	0.080894	0.049954	0.035355	0.027371	0.022589	0.016917
dep(kg/hect/yr)	0.000017	0.09095493	0.044116224	0.015461231	0.00672431	0.00237311	0.0012384	0.00078234	0.000513	0.00036363	0.00020592
0											
annual ave (ug/m3)	2.67054	1.663214	1.039713	0.669593	0.348906	0.167308	0.107256	0.079021	0.062297	0.051275	0.038034
dep(kg/hect/yr)	0.000017	0.07579314	0.035281596	0.013872326	0.00626266	0.00225979	0.00118749	0.00075328	0.00049476	0.00035174	0.0001998
-1000											
annual ave (ug/m3)	0.057815	0.044312	0.052369	0.030632	0.023185	0.013284	0.009272	0.007863	0.007468	0.006871	0.005679
dep(kg/hect/yr)	0.000017	4.46443E-05	0.000117996	0.000218785	0.00014951	0.000085	0.000071	0.000067	0.000061	0.000055	0.000045
-2500											
annual ave (ug/m3)	0.057815	0.079422	0.060759	0.045244	0.0248	0.019429	0.014012	0.010856	0.008891	0.00756	0.005868
dep(kg/hect/yr)	0.000017	0.000017	0.000033	0.000037	0.000050	0.000036	0.000029	0.000024	0.000022	0.000021	0.000019

Receptor Elevation (ft) compared to Source Elevation

NOx	Distance from Operations to Receptor (km)										
	50	60	70	80	90	100	120	140	160	180	200
2500											
annual ave (ug/m3)	0.0051342	0.0029421	0.0012732	0.0011128	0.00093333	0.00072414	0.00065569	0.00040637	0.0002535	0.00016235	0.00010215
dep(kg/hect/yr)	0.000124886	0.000079	0.000052	0.000036	0.000030	0.000026	0.000020	0.000016	0.000013	0.000011	0.000010
1000											
annual ave (ug/m3)	0.0051342	0.0029421	0.0012732	0.0011128	0.00093333	0.00072414	0.00065569	0.00040637	0.0002535	0.00016235	0.00010215
dep(kg/hect/yr)	0.000124886	0.000079	0.000052	0.000036	0.000030	0.000026	0.000020	0.000016	0.000013	0.000011	0.000010
500											
annual ave (ug/m3)	0.0051342	0.0029421	0.0012732	0.0011128	0.00093333	0.00072414	0.00065569	0.00040637	0.0002535	0.00016235	0.00010215
dep(kg/hect/yr)	0.000124886	0.000079	0.000052	0.000036	0.000030	0.000026	0.000020	0.000016	0.000013	0.000011	0.000010
100											
annual ave (ug/m3)	0.0051342	0.0029421	0.0012732	0.0011128	0.00093333	0.00072414	0.00065569	0.00040637	0.0002535	0.00016235	0.00010215
dep(kg/hect/yr)	0.000124886	0.000079	0.000052	0.000036	0.000030	0.000026	0.000020	0.000016	0.000013	0.000011	0.000010
0											
annual ave (ug/m3)	0.0048582	0.0025029	0.0012482	0.0010898	0.00091722	0.00060981	0.00046478	0.00028405	0.00024689	0.00016209	0.00015462
dep(kg/hect/yr)	0.000121	0.000077	0.000051	0.000036	0.000030	0.000025	0.000019	0.000016	0.000013	0.000011	0.000009
-1000											
annual ave (ug/m3)	0.0006946	0.00066168	0.00049089	0.00033354	0.00026393	0.00023069	0.00020763	0.000179	0.00018261	0.00013937	0.00013397
dep(kg/hect/yr)	0.000038	0.000032	0.000028	0.000025	0.000022	0.000020	0.000016	0.000014	0.000012	0.000010	0.000009
-2500											
annual ave (ug/m3)	0.0006946	0.00066168	0.00049089	0.00033354	0.00021519	0.00017726	0.00014484	0.00015269	0.00012695	8.9795E-05	7.3072E-05
dep(kg/hect/yr)	0.000017	0.000016	0.000014	0.000012	0.000011	0.000011	0.000010	0.000009	0.000008	0.000007	0.000007

APPENDIX SIR-1B

Dixie and Fishlake National Forests

Statistics Comparing Verification Run Results

With Initial Screening Table Results

Dixie NF 20 Well Drilling Scenario

NO2 Verification Annual Average: Refined Modeling Results vs. Screening Table

Cedar City met. data	2nd max over 5 years	NO2 annual average refined model predicted impact ug/m3	A pred impact per lb/hr emission /lb/hr	elev	source receptor elev diff del ht	B scr table results for src/red ht diff Scr table	(A-B)/B % dif
	0.25	9.8431	0.343084699	9566.9	146.9	3.284705	-89.6%
	0.5	10.58238	0.368852562	9567.9	147.9	1.747867	-78.9%
	1	6.76497	0.235795399	9490.2	70.2	0.922212	-74.4%
	2.5	1.94944	0.067948414	9560.4	140.4	0.408719	-83.4%
	5	0.84572	0.029477867	9511.8	91.8	0.18475	-84.0%
	10	0.25096	0.008747299	9482.9	62.9	0.080894	-89.2%
	15	0.10233	0.003566748	9331.0	-89.0	0.049954	-92.9%
	20	0.07949	0.002770652	9342.8	-77.2	0.079021	-96.5%
	25	0.07265	0.002532241	9399.6	-20.4	0.062297	-95.9%
	30	0.05862	0.002043221	9697.2	277.2	0.022589	-91.0%
	40	0.00966	0.000336703	7982.6	-1437.4	0.005679	-94.1%
Sigurd met. data	2nd max over 1 year	**ug/m3**	**/lb/hr**	**elev**	**del ht**	**Scr Tab**	**%diff**
	0.25	16.96058	0.591166957	9545.3	125.3	3.284705	-82.0%
	0.5	13.33981	0.46496375	9567.9	147.9	1.747867	-73.4%
	1	12.21057	0.425603695	9531.2	111.2	0.922212	-53.8%
	2.5	3.76716	0.131305681	9684.4	264.4	0.408719	-67.9%
	5	1.77419	0.061840014	9562.3	142.3	0.18475	-66.5%
	10	0.82065	0.028604043	9482.9	62.9	0.080894	-64.6%
	15	0.33588	0.011707215	9610.9	190.9	0.049954	-76.6%
	20	0.20432	0.007121645	9533.8	113.8	0.035355	-79.9%
	25	0.11849	0.00413001	9445.5	25.5	0.062297	-93.4%
	30	0.16216	0.005652144	9528.9	108.9	0.022589	-75.0%
	40	0.02505	0.000873127	9190.9	-229.1	0.038034	-97.7%

negative % diff shows screening tables predictions are conservatively high as compared to verification analyses

Dixie NF 20 Well Drilling Scenario

PM-10 24 hour Average Verification: Refined Modeling Results vs. Screening Table

Cedar City met. data	2nd max over 5 years	PM-10 24 hour average					
		refined model predicted impact	**A** pred impact per lb/hr emission		source receptor elev diff	**B** scr table results for src/red ht diff	(A-B)/B
		ug/m3	**/lb/hr**	**elev**	**del ht**	**Scr Tab**	**%diff**
	0.25	3.22152	1.365050847	9508.2	88.2	24.43988	-94.4%
	0.5	2.62721	1.113224576	9567.9	147.9	16.32263	-93.2%
	1	1.92472	0.815559322	9531.2	111.2	9.476412	-91.4%
	2.5	0.74613	0.31615678	9487.9	67.9	3.644388	-91.3%
	5	0.40585	0.171970339	9447.2	27.2	2.380732	-92.8%
	10	0.17673	0.074885593	9482.9	62.9	0.648152	-88.4%
	15	0.10558	0.044737288	9331.0	-89.0	0.629584	-92.9%
	20	0.09035	0.038283898	9342.8	-77.2	0.45146	-91.5%
	25	0.07044	0.029847458	6437.0	-2983.0	0.169608	-82.4%
	30	0.0622	0.026355932	7654.9	-1765.1	0.136356	-80.7%
	40	0.04966	0.021042373	7851.4	-1568.6	0.098148	-78.6%

Sigurd met. data	2nd max over 1 year	ug/m3	/lb/hr	elev	del ht	Scr Tab	%diff
	0.25	5.25581	2.227038136	9564.6	144.6	24.43988	-90.9%
	0.5	3.88428	1.645881356	9567.9	147.9	16.32263	-89.9%
	1	3.52142	1.492127119	9531.2	111.2	9.476412	-84.3%
	2.5	1.21486	0.514771186	9668.3	248.3	3.644388	-85.9%
	5	0.66231	0.280639831	9511.8	91.8	1.56142	-82.0%
	10	0.34464	0.146033898	9320.9	-99.1	1.03302	-85.9%
	15	0.25026	0.106042373	9122.0	-298.0	0.629584	-83.2%
	20	0.1824	0.077288136	8871.7	-548.3	0.221672	-65.1%
	25	0.14563	0.061707627	8363.5	-1056.5	0.169608	-63.6%
	30	0.12743	0.053995763	7857.3	-1562.7	0.13636	-60.4%
	40	0.09531	0.040385593	6952.4	-2467.6	0.09814	-58.8%

negative % diff shows screening tables predictions are conservatively high as compared to verification analyses

Dixie NF 20 Well Drilling Scenario

PM-10 Annual Average Verification: Refined Modeling Results vs. Screening Table

Cedar City met. data	2nd max over 5 years	PM-10 annual average					
		refined model predicted impact	**A** pred impact per lb/hr emission		source receptor elev diff	**B** scr table results for src/red ht diff	(A-B)/B
		ug/m3	**/lb/hr**	**elev**	**del ht**	**Scr Tab**	**%diff**
	0.25						
	0.5	2.71	1.148305085	9586.7	166.7	5.389365	-78.7%
	1	1.81	0.766949153	9636.2	216.2	3.500076	-78.1%
	2.5	0.82991	0.35165678	9490.2	70.2	1.450883	-75.8%
	5	0.39448	0.167152542	9475.4	55.4	0.629172	-73.4%
	10	0.19076	0.080830508	9396.0	-24	0.260148	-68.9%
	15	0.0784	0.033220339	9310.4	-109.6	0.154907	-78.6%
	20	0.0559	0.023686441	9299.2	-120.8	0.109719	-78.4%
	25	0.05772	0.024457627	9555.1	135.1	0.083933	-70.9%
	30	0.04682	0.019838983	9523.0	103	0.067466	-70.6%
	40	0.03537	0.014987288	9821.5	401.5	0.049028	-69.4%

Sigurd met. data	2nd max over 1 year	**ug/m3**	**/lb/hr**	**elev**	**del ht**	**Scr Tab**	**%diff**
	0.25	1.96332	0.831915254	9564.6	144.6	5.389365	-84.6%
	0.5	1.68205	0.712733051	9567.9	147.9	3.500076	-79.6%
	1	1.2175	0.515889831	9531.2	111.2	1.450883	-64.4%
	2.5	0.34604	0.146627119	9684.4	264.4	0.629172	-76.7%
	5	0.15586	0.066042373	9613.8	193.8	1.56142	-95.8%
	10	0.06891	0.029199153	9482.9	62.9	0.648152	-95.5%
	15	0.0319	0.013516949	9415.0	-5.0	0.629584	-97.9%
	20	0.01713	0.007258475	9411.7	-8.3	0.45146	-98.4%
	25	0.01113	0.004716102	9445.5	25.5	0.348652	-98.6%
	30	0.01293	0.005478814	9528.9	108.9	0.17148	-96.8%
	40	0.00366	0.001550847	6952.4	-2467.6	0.09814	-98.4%

negative % diff shows screening tables predictions are conservatively high as compared to verification analyses

Dixe NF 20 Well Drilling Scenario

SO2 3 hour Average Verification: Refined Modeling Results vs. Screening Table

Cedar City met. data	2nd max over 5 years	SO2 3 hour average					
		refined model predicted impact	**A** pred impact per lb/hr emission		source receptor elev diff	**B** scr table results for src/red ht diff	(A-B)/B
		ug/m3	**/lb/hr**	**elev**	**del ht**	**Scr Tab**	**%diff**
	0.25	16.45	3.992718447	9398.0	-22.0	46.060353	-91.3%
	0.5	16.673	4.04684466	9564.0	144.0	27.4549	-85.3%
	1	16.211	3.934708738	9531.2	111.2	14.8157	-73.4%
	2.5	4.9243	1.195218447	9682.1	262.1	2.3034	-48.1%
	5	3.182	0.772330097	10206.4	786.4	0.867852	-11.0%
	10	1.7232	0.418252427	10257.2	837.2	0.3287	27.2%
	15	0.9838	0.238786408	9948.5	528.5	0.1869	27.7%
	20	0.63558	0.15426699	9342.8	-77.2	1.0821	-85.7%
	25	0.42098	0.102179612	9399.6	-20.4	0.837414	-87.8%
	30	0.29997	0.072808252	9697.2	277.2	0.2566	-71.6%
	40	0.16323	0.039618932	7365.2	-2054.8	0.0508	-21.9%
Sigurd met. data	2nd max over 1 year	**ug/m3**	**/lb/hr**	**elev**	**del ht**	**Scr Tab**	**%diff**
	0.25	16.059	3.897815534	9386.2	-33.8	46.060353	-91.5%
	0.5	18.793	4.561407767	9564.0	144.0	27.4549	-83.4%
	1	19.243	4.670631068	9531.2	111.2	14.8157	-68.5%
	2.5	7.5264	1.826796117	9760.2	340.2	2.3034	-20.7%
	5	4.9081	1.191286408	9697.2	277.2	2.5899	-54.0%
	10	3.2921	0.799053398	9676.2	256.2	1.0478	-23.7%
	15	1.7188	0.417184466	9415.0	-5.0	1.5028	-72.2%
	20	1.1983	0.290849515	9411.7	-8.3	1.0821	-73.1%
	25	0.43614	0.105859223	7302.5	-2117.5	0.0797	32.9%
	30	0.43194	0.104839806	9528.9	108.9	0.2566	-59.1%
	40	0.22018	0.053441748	7769.7	-1650.3	0.0739	-27.7%

negative % diff shows screening tables predictions are conservatively high as compared to verification analyses

Dixe NF 20 Well Drilling Scenario

SO2 24 hour Average Verification: Refined Modeling Results vs. Screening Table

Cedar City met. data	2nd max over 5 years	SO2 24 hour average					
		refined model predicted impact	**A** pred impact per lb/hr emission		source receptor elev diff	**B** scr table results for src/red ht diff	(A-B)/B
		ug/m3	**/lb/hr**	**elev**	**del ht**	**Scr Tab**	**%diff**
	0.25	5.18	1.257281553	9387.5	-32.5	20.47127	-93.9%
	0.5	5.3597	1.300898058	9567.9	147.9	12.202188	-89.3%
	1	6.1717	1.497985437	9531.2	111.2	6.58474	-77.3%
	2.5	1.2352	0.299805825	9560.4	140.4	2.7258	-89.0%
	5	0.81505	0.19782767	9447.2	27.2	2.38978	-91.7%
	10	0.35351	0.085803398	9806.4	386.4	0.146084	-41.3%
	15	0.20126	0.048849515	10245.1	825.1	0.040108	21.8%
	20	0.1367	0.033179612	9342.8	-77.2	0.480928	-93.1%
	25	0.086177	0.020916748	9399.6	-20.4	0.372184	-94.4%
	30	0.073134	0.017750971	9697.2	277.2	0.114064	-84.4%
	40	0.03772	0.00915534	7056.1	-2363.9	0.022556	-59.4%
Sigurd met. data	2nd max over 1 year	**ug/m3**	**/lb/hr**	**elev**	**del ht**	**Scr Tab**	**%diff**
	0.25	4.7554	1.154223301	9386.2	-33.8	20.47127	-94.4%
	0.5	6.4729	1.571092233	9567.9	147.9	12.202188	-87.1%
	1	6.1576	1.494563107	9531.2	111.2	6.58474	-77.3%
	2.5	2.5361	0.615558252	9668.3	248.3	2.7258	-77.4%
	5	1.3122	0.318495146	9613.5	193.5	1.151048	-72.3%
	10	0.65085	0.157973301	9482.9	62.9	0.465704	-66.1%
	15	0.39608	0.096135922	9610.9	190.9	0.274408	-65.0%
	20	0.1816	0.04407767	9411.7	-8.3	0.480928	-90.8%
	25	0.11062	0.026849515	7473.4	-1946.6	0.05268	-49.0%
	30	0.081532	0.01978932	9528.9	108.9	0.114064	-82.7%
	40	0.062753	0.015231311	7591.2	-1828.8	0.022556	-32.5%

negative % diff shows screening tables predictions are conservatively high as compared to verification analyses

Dixe NF 20 Well Drilling Scenario

SO2 Annual Average Verification: Refined Modeling Results vs. Screening Table

Cedar City met. data	2nd max over 5 years	SO2 annual average					
		refined model predicted impact	**A** pred impact per lb/hr emission		source receptor elev diff	**B** scr table results for src/red ht diff	(A-B)/B
		ug/m3	**/lb/hr**	**elev**	**del ht**	**Scr Tab**	**%diff**
	0.25	1.36203	0.330589806	9386.2	-33.8	5.117817	-93.5%
	0.5	1.95213	0.473817961	9567.9	147.9	3.050547	-84.5%
	1	1.30358	0.316402913	9490.2	70.2	1.646185	-80.8%
	2.5	0.33406	0.081082524	9560.4	140.4	0.68145	-88.1%
	5	0.12932	0.03138835	9511.8	91.8	0.287762	-89.1%
	10	0.03607	0.008754854	9482.9	62.9	0.116426	-92.5%
	15	0.01785	0.004332524	9331.0	-89.0	0.166983	-97.4%
	20	0.01356	0.003291262	9342.8	-77.2	0.120232	-97.3%
	25	0.01253	0.003041262	9399.6	-20.4	0.093046	-96.7%
	30	0.00892	0.002165049	9697.2	277.2	0.028516	-92.4%
	40	0.00163	0.000395631	7982.6	-1437.4	0.008208	-95.2%
Sigurd met. data	2nd max over 1 year	**ug/m3**	**/lb/hr**	**elev**	**del ht**	**Scr Tab**	**%diff**
	0.25						
	0.5	1.36	0.330097087	9719.2	299.2	2.079332	-84.1%
	1	0.97159	0.235822816	9742.1	322.1	0.880569	-73.2%
	2.5	0.58605	0.142245146	9608.3	188.3	4.344336	-96.7%
	5	0.34898	0.084703883	9536.6	116.6	0.541491	-84.4%
	10	0.14926	0.036228155	9536.4	116.4	0.245899	-85.3%
	15	0.07499	0.018201456	9599.4	179.4	0.152399	-88.1%
	20	0.03263	0.007919903	9482.9	62.9	0.110078	-92.8%
	25	0.02219	0.005385922	9555.1	135.1	0.085433	-93.7%
	30	0.01805	0.004381068	9523.0	103.0	0.069418	-93.7%
	40	0.00846	0.002053398	9962.6	542.6	0.005807	-64.6%

negative % diff shows screening tables predictions are conservatively high as compared to verification analyses

Fishlake NF 12 Well Drilling Scenario

NO2 Annual Average Verification: Refined Modeling Results vs. Screening Table

Hunter met. data	2nd max over 5 years	refined model predicted impact **ug/m3**	**A** pred impact per lb/hr emission **/lb/hr**	**NO2** **elev**	source receptor elev diff **del ht**	**B** scr table results for src/red ht diff **Scr table**	(A-B)/B **% dif**
	0.5	3.74457	0.165417444	8232.3	33.2	1.663214	-90.1%
	1	1.35899	0.06003377	8175.7	-23.4	1.039713	-94.2%
	2.5	0.73904	0.032647302	8146.6	-52.5	0.669593	-95.1%
	5	0.31294	0.013824213	8119.6	-79.5	0.348906	-96.0%
	10	0.08239	0.003639602	7889.3	-309.8	0.167308	-97.8%
	15	0.16516	0.00729599	8482.3	283.2	0.049954	-85.4%
	20	0.11555	0.005104454	8367.9	168.8	0.035355	-85.6%
	25	0.08655	0.003823371	7969.9	-229.2	0.062297	-93.9%
	30	0.07715	0.003408123	7750.4	-448.7	0.051275	-93.4%
	40	0.06694	0.002957094	7808.4	-390.7	0.038034	-92.2%
Sigurd met. data	2nd max over 1 year	**ug/m3**	**/lb/hr**	**elev**	**del ht**	**Scr Tab**	**%diff**
	0.5	4.78104	0.211203801	8251.6	52.5	1.747867	-87.9%
	1	3.6615	0.161747803	8284.9	85.8	0.922212	-82.5%
	2.5	1.78453	0.07883212	8345.1	146	0.408719	-80.7%
	5	0.79307	0.035034093	8473.1	274	0.18475	-81.0%
	10	0.17741	0.007837137	8064	-135.1	0.167308	-95.3%
	15	0.26046	0.011505895	7951	-248.1	0.107256	-89.3%
	20	0.25778	0.011387505	8015.2	-183.9	0.079021	-85.6%
	25	0.14316	0.006324134	8503.6	304.5	0.01082	-41.6%
	30	0.09354	0.004132156	8070.9	-128.2	0.051275	-91.9%
	40	0.09609	0.004244803	8467.6	268.5	0.016917	-74.9%

negative % diff shows screening tables predictions are conservatively high as compared to verification analyses

Fishlake NF 12 Well Drilling Scenario

PM-10 24 hour Average Verification: Refined Modeling Results vs. Screening Table

Hunter met. data	2nd max over 5 years	**PM-10 24 hour average** refined model predicted impact **ug/m3**	**A** pred impact per lb/hr emission **/lb/hr**	**elev**	source receptor elev diff **del ht**	**B** scr table results for src/red ht diff **Scr Tab**	(A-B)/B **%diff**
	0.5	1.49482	0.604096648	8326.8	127.7	16.322632	-96.3%
	1	1.01863	0.411655563	8141.1	-58	10.601604	-96.1%
	2.5	0.57499	0.232368801	8216	16.9	5.155588	-95.5%
	5	0.36337	0.146847513	8074.7	-124.4	2.380732	-93.8%
	10	0.29139	0.117758474	7889.3	-309.8	1.03302	-88.6%
	15	0.26289	0.106240864	8482.3	283.2	0.388748	-72.7%
	20	0.20166	0.081496187	8367.9	168.8	0.276632	-70.5%
	25	0.19624	0.07930582	8408.5	209.4	0.212532	-62.7%
	30	0.15954	0.064474371	7750.4	-448.7	0.282336	-77.2%
	40	0.13123	0.053033545	7808.4	-390.7	0.205104	-74.1%
Sigurd met. data	2nd max over 1 year	**ug/m3**	**/lb/hr**	**elev**	**del ht**	**Scr Tab**	**%diff**
	0.5	1.58985	0.642500807	8699.8	500.7	15.1355	-95.8%
	1	1.04858	0.423759157	8296.9	97.8	9.476412	-95.5%
	2.5	0.65056	0.262908655	8345.1	146	3.644388	-92.8%
	5	0.40528	0.163784462	8473.1	274	1.56142	-89.5%
	10	0.27389	0.110686257	8130.8	-68.3	1.03302	-89.3%
	15	0.16665	0.067347712	8004.2	-194.9	0.629584	-89.3%
	20	0.13258	0.053579116	8015.2	-183.9	0.45146	-88.1%
	25	0.12409	0.05014808	7914.5	-284.6	0.348652	-85.6%
	30	0.10305	0.041645255	7818.3	-380.8	0.282336	-85.2%
	40	0.07306	0.029525495	7933.3	-265.8	0.205104	-85.6%

negative % diff shows screening tables predictions are conservatively high as compared to verification analyses

Fishlake NF 12 Well Drilling Scenario

PM-10 Annual Average Verification: Refined Modeling Results vs. Screening Table

Hunter met. data	2nd max over 5 years	**PM-10 annual average** refined model predicted impact **ug/m3**	**A** pred impact per lb/hr emission **/lb/hr**	**elev**	source receptor elev diff **del ht**	**B** scr table results for src/red ht diff **Scr Tab**	(A-B)/B **%diff**
	0.5	0.37387	0.151090843	8326.8	127.7	4.080658	-0.96297
	1	0.18559	0.075001871	8141.1	-58	2.650401	-97.2%
	2.5	0.06265	0.025318537	8216	16.9	1.288897	-98.0%
	5	0.02977	0.012030851	8074.7	-124.4	0.595183	-98.0%
	10	0.00822	0.003321921	7889.3	-309.8	0.258255	-98.7%
	15	0.01569	0.006340748	8482.3	283.2	0.097187	-93.5%
	20	0.01076	0.004348403	8367.9	168.8	0.069158	-93.7%
	25	0.00869	0.003511861	8408.5	209.4	0.053133	-93.4%
	30	0.00732	0.002958207	7750.4	-448.7	0.070584	-95.8%
	40	0.00629	0.002541957	7808.4	-390.7	0.051276	-95.0%
Sigurd met. data	2nd max over 1 year	**ug/m3**	**/lb/hr**	**elev**	**del ht**	**Scr Tab**	**%diff**
	0.5	0.43787	0.176954951	8298	98.9	4.080658	-95.7%
	1	0.33231	0.134295338	8284.9	85.8	2.369103	-94.3%
	2.5	0.17052	0.068911682	8345.1	146	0.911097	-92.4%
	5	0.07605	0.030733834	8473.1	274	0.390355	-92.1%
	10	0.02087	0.008434124	8064	-135.1	0.258255	-96.7%
	15	0.02364	0.009553555	7951	-248.1	0.157396	-93.9%
	20	0.01941	0.007844099	8015.2	-183.9	0.112865	-93.1%
	25	0.01189	0.004805066	8503.6	304.5	0.048512	-90.1%
	30	0.00884	0.00357248	8070.9	-128.2	0.070584	-94.9%
	40	0.0081	0.003273426	7933.3	-265.8	0.051276	-93.6%

negative % diff shows screening tables predictions are conservatively high as compared to verification analyses

Fishlake NF 12 Well Drilling Scenario

SO2 3 hour Average Verification: Refined Modeling Results vs. Screening Table

Hunter met. data	2nd max over 5 years	**SO2 3 hour average** refined model predicted impact	**A** pred impact per lb/hr emission		source receptor elev diff	**B** scr table results for src/red ht diff	(A-B)/B
		ug/m3	**/lb/hr**	**elev**	**del ht**	**Scr Tab**	**%diff**
	0.5	9.41507	3.80488101	8325.9	126.8	27.454923	-86.1%
	1	6.10321	2.466470013	8175.7	-23.4	16.490871	-85.0%
	2.5	3.92929	1.587930934	7898.6	-300.5	10.772271	-85.3%
	5	2.26171	0.91401736	7882.4	-316.7	5.377005	-83.0%
	10	1.75134	0.707763225	7792.5	-406.6	2.434743	-70.9%
	15	1.38627	0.560228697	7456.2	-742.9	1.502847	-62.7%
	20	1.17354	0.474258828	8157.5	-41.6	1.082088	-56.2%
	25	1.00662	0.406802002	7750.2	-448.9	0.837414	-51.4%
	30	0.88059	0.355869916	7799.4	-399.7	0.678672	-47.6%
	40	0.70485	0.284848693	7618.3	-580.8	0.073872	285.6%
Sigurd met. data	2nd max over 1 year	**ug/m3**	**/lb/hr**	**elev**	**del ht**	**Scr Tab**	**%diff**
	0.5	8.79908	3.555943014	8305.8	106.7	27.454923	-87.0%
	1	6.93435	2.802355865	8310.4	111.3	14.815665	-81.1%
	2.5	3.81426	1.541444242	8204	4.9	10.772271	-85.7%
	5	2.19613	0.887514732	8273.7	74.6	2.589858	-65.7%
	10	1.14014	0.460760996	8115.4	-83.7	2.434743	-81.1%
	15	1.05792	0.427533701	7951	-248.1	1.502847	-71.6%
	20	0.638	0.257832824	7274.1	-925	0.099513	159.1%
	25	0.71547	0.289140518	8120.9	-78.2	0.837414	-65.5%
	30	0.59722	0.241352538	8112.2	-86.9	0.678672	-64.4%
	40	0.39028	0.157722562	7470.5	-728.6	0.073872	113.5%

negative % diff shows screening tables predictions are conservatively high as compared to verification analyses

Fishlake NF 12 Well Drilling Scenario

SO2 24 hour Average Verification: Refined Modeling Results vs. Screening Table

Hunter met. data	2nd max over 5 years	**SO2 24 hour average** refined model predicted impact	**A** pred impact per lb/hr emission		source receptor elev diff	**B** scr table results for src/red ht diff	(A-B)/B
		ug/m3	**/lb/hr**	**elev**	**del ht**	**Scr Tab**	**%diff**
	0.5	2.16975	0.876853871	8326.8	127.7	12.202188	-92.8%
	1	1.2319	0.497843661	8185.8	-13.3	7.329276	-93.2%
	2.5	0.59774	0.241562684	7813.1	-386	4.787676	-95.0%
	5	0.39002	0.157617489	7867.9	-331.2	2.38978	-93.4%
	10	0.25199	0.101835883	7748.6	-450.5	1.082108	-90.6%
	15	0.18794	0.075951569	8187.8	-11.3	0.667932	-88.6%
	20	0.14669	0.059281343	8157.5	-41.6	0.480928	-87.7%
	25	0.13305	0.053769055	8153.5	-45.6	0.372184	-85.6%
	30	0.11007	0.044482224	7799.4	-399.7	0.301632	-85.3%
	40	0.08811	0.035607602	7618.3	-580.8	0.032832	8.5%
Sigurd met. data	2nd max over 1 year	**ug/m3**	**/lb/hr**	**elev**	**del ht**	**Scr Tab**	**%diff**
	0.5	2.12579	0.859088462	8237.6	38.5	12.454036	-93.1%
	1	1.71395	0.692652928	8310.4	111.3	6.58474	-89.5%
	2.5	0.78418	0.316908062	8091	-108.1	4.787676	-93.4%
	5	0.43967	0.177682379	8199.1	0	2.38978	-92.6%
	10	0.22266	0.089982847	8115.4	-83.7	1.082108	-91.7%
	15	0.20174	0.081528517	7951	-248.1	0.667932	-87.8%
	20	0.12162	0.049149887	8165.4	-33.7	0.480928	-89.8%
	25	0.1504	0.060780653	8120.9	-78.2	0.372184	-83.7%
	30	0.13183	0.053276021	8112.2	-86.9	0.301632	-82.3%
	40	0.08507	0.034379057	8193.4	-5.7	0.219136	-84.3%

negative % diff shows screening tables predictions are conservatively high as compared to verification analyses

Fishlake NF 12 Well Drilling Scenario

SO2 Annual Average Verification: Refined Modeling Results vs. Screening Table

		SO2 annual average					
Hunter met. data	2nd max over 5 years	refined model predicted impact	**A** pred impact per lb/hr emission		source receptor elev diff	**B** scr table results for src/red ht diff	(A-B)/B
		ug/m3	**/lb/hr**	**elev**	**del ht**	**Scr Tab**	**%diff**
	0.5	0.52496	0.212150344	8326.8	127.7	3.050547	-93.0%
	1	0.25114	0.101492375	8141.1	-58	1.832319	-94.5%
	2.5	0.07642	0.030883361	8216	16.9	1.196919	-97.4%
	5	0.03784	0.015292154	8074.7	-124.4	0.597445	-97.4%
	10	0.01147	0.004635333	7889.3	-309.8	0.270527	-98.3%
	15	0.01902	0.00768649	8482.3	283.2	0.068602	-88.8%
	20	0.01187	0.004796984	8367.9	168.8	0.047008	-89.8%
	25	0.00936	0.003782626	8408.5	209.4	0.035704	-89.4%
	30	0.00838	0.003386582	7750.4	-448.7	0.075408	-95.5%
	40	0.0077	0.003111775	7808.4	-390.7	0.054784	-94.3%
Sigurd met. data	2nd max over 1 year	**ug/m3**	**/lb/hr**	**elev**	**del ht**	**Scr Tab**	**%diff**
	0.5	0.48265	0.195051744	8316.1	117	3.050547	-93.6%
	1	0.37982	0.153495397	8349	149.9	1.646185	-90.7%
	2.5	0.22143	0.089485771	8294.5	95.4	0.68145	-86.9%
	5	0.09927	0.040117656	8473.1	274	0.287762	-86.1%
	10	0.02298	0.009286831	8064	-135.1	0.270527	-96.6%
	15	0.03047	0.01231374	7951	-248.1	0.166983	-92.6%
	20	0.02068	0.00835734	8015.2	-183.9	0.120232	-93.0%
	25	0.01353	0.005467834	8503.6	304.5	0.035704	-84.7%
	30	0.01086	0.004388816	8070.9	-128.2	0.075408	-94.2%
	40	0.01062	0.004291825	7933.3	-265.8	0.054784	-92.2%

negative % diff shows screening tables predictions are conservatively high as compared to verification analyses