MATTHEW H. MEAD
GOVERNOR

THE STATE OF WYOMING

STATE CAPITOL
CHEYENNE, WY 82002

Office of the Governor

October 27, 2015

Shaun McGrath
Administrator Region 8
U.S. Environmental Protection Agency
1595 Wynkoop Street
Denver, CO 80202-1129

Re: Wyoming Department of Environmental Quality Designation Recommendation for Carbon County, Wyoming

Dear Administrator McGrath,

This letter responds to Janet McCabe's (U. S. Environmental Protection Agency (EPA) Acting Assistant Administrator) March 20, 2015 letter to Director Todd Parfitt (Wyoming Department of Environmental Quality (DEQ)) regarding attainment designations for the 2010 1-hour sulfur dioxide (SO_2) National Ambient Air Quality Standard. This recommendation meets the extended due date of November 2, 2015.

The March 2, 2015 court order directs attainment in three rounds: round one completion date July 2, 2016; round two completion date December 31, 2017; and round three completion date December 31, 2020. Sinclair Wyoming Refining Company's (SWRC) SO_2 air quality monitor recorded a violation of the 2010 SO_2 NAAQS between calendar years 2012 and 2014 in Carbon County. This resulted in Carbon County's inclusion as an area subject to round one designation.

The DEQ's Air Quality Division (AQD) has conducted extensive evaluations of the SWRC SO_2 air quality monitor (AQS ID number 56-007-0852) and surrounding areas. These evaluations are the basis of this designation recommendation. The DEQ-AQD also received modeling from SWRC to assist with the decision. SWRC's modeling was not conducted in accordance with the SO_2 Modeling Technical Assistance Document and was not considered by the DEQ-AQD (supporting document attached).

The DEQ-AQD considered the information in the technical support document and determined available information was inconclusive (due to location of the SWRC SO_2 air quality monitor and the dispersion modeling evaluation). The DEQ-AQD recommends that Carbon County remain unclassified at this time.

PHONE: (307) 777-7434

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The DEQ-AQD will work with the EPA (in accordance with 40 CFR 51.1200) to identify SWRC as a stationary source subject to further air quality characterization (SO_2 Data Requirements Rule). The DEQ-AQD has decided to include SWRC in round three of designations – requiring SWRC to conduct additional ambient SO_2 monitoring. This additional monitoring data will be used for the final designation due December 31, 2020.

The DEQ-AQD is pursuing an enforcement action for violation of permit conditions related to ambient air monitors against SWRC. The proposed order will require Sinclair to modify its permitted ambient boundary and to install a monitor in the Town of Sinclair. The DEQ-AQD will coordinate with the EPA and SWRC on a monitoring network in anticipation of the December 31, 2020 designation.

I look forward to working with the EPA finalize an attainment designation for Carbon County, Wyoming.

Sincerely,

Matthew H. Mead
Governor

MHM:ts

Encl.

1. Wyoming Department of Environmental Quality, Air Quality Division: Final Air Dispersion Modeling Report in Support of the 2010 1-Hour Sulfur Dioxide NAAQS Designation Recommendation, October 20, 2015
2. Technical Support Document for Carbon County, Wyoming 1-Hour SO2 Designation

cc: Todd Parfitt, Director, Wyoming Department of Environmental Quality global environmental solutions

Wyoming Department of Environmental Quality
Air Quality Division

Final Air Dispersion Modeling Report in Support of the 2010 1-Hour Sulfur Dioxide NAAQS Designation Recommendation

SLR Ref: 118.01467.00001

October 20, 2015

Final Air Dispersion Modeling Report in Support of the 2010 1-Hour Sulfur Dioxide NAAQS Designation Recommendation

Prepared for:

Wyoming Department of Environmental Quality - Air Quality Division
200 West 17th Street
Cheyenne, WY 82002

This document has been prepared by SLR International Corp. The material and data in this report were prepared under the supervision and direction of the undersigned.

Prepared By:
Patrick McKean, CCM, Senior Scientist

Reviewed by:
Jason Reed, CCM, Senior Scientist

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ACRONYMS

AERMAP	AERMOD terrain processor
AERMET	AERMOD meteorological processor
AERMINUTE	1-minute ASOS wind data processor
AERMOD	American Meteorological Society/EPA Regulatory Model
AERSURFACE	AERMET surface characteristics processor
acf/hr	actual cubic feet per hour
AIG	AERMOD Implementation Guide
AQD	Air Quality Division
AQS	EPA Air Quality System
ASOS	Automated Surface Observing System
B_0	Bowen Ratio
BPIPPRM	Building Profile Input Program for Plume Rise Model Enhancements
CEMS	Continuous Emission Monitoring System
CoCoRaHS	Community Collaborative Rain, Hail & Snow Network
dscf/hr	dry standard cubic feet per hour
EPA	United States Environmental Protection Agency
EU	emission unit
FCCU	Fluid Catalytic Cracking Unit
FSL	Forecast Systems Laboratory
g/s	grams per second
GEP	Good Engineering Practice
GHCN	Global Historical Climatology Network
GMT	Greenwich Mean Time
K	Kelvin
km	kilometer
lb/hr	pound per hour
m	meter
m/s	meters per second
mb	millibar
MST	Mountain Standard Time
NAAQS	National Ambient Air Quality Standard
NCDC	National Climatic Data Center
NED	National Elevation Dataset
NLCD92	National Land Cover Data 1992
NAD83	North American Datum 1983
NWS	National Weather Service
O_2	oxygen
ppb	parts per billion
ppm	parts per million
ppmvd	parts per million by volume on a dry basis

r	albedo
RCFA	Root Cause Failure Analysis
SLR	SLR International Corporation
SO_2	sulfur dioxide
SRU	sulfur recover unit
SWRC	Sinclair Wyoming Refining Company
TGTU	Tail Gas Treating Unit
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
WDEQ	Wyoming Department of Environmental Quality
$\mu g/m^3$	micrograms per cubic meter
z_0	surface roughness length
σ_w	vertical wind speed standard deviation
σ_θ	wind direction standard deviation

1. INTRODUCTION

This air dispersion modeling report was prepared in support of the Wyoming Department of Environmental Quality (WDEQ), Air Quality Division's (AQD) full evaluation performed to determine an appropriate designation for Carbon County, Wyoming for the 2010 1-hour sulfur dioxide (SO_2) National Ambient Air Quality Standard (NAAQS). This evaluation was prepared in response to Acting Assistant United States Environmental Protection Agency (EPA) Administrator Janet McCabe's letter dated March 20, 2015 to WDEQ Director Todd Parfitt. The WDEQ-AQD conducted this modeling evaluation to inform the designation recommendation.

The WDEQ-AQD contracted with SLR International Corporation (SLR) to conduct the modeling and prepare this report. The modeling methodology was developed in consultation with the WDEQ-AQD to capture the actual Sinclair Wyoming Refining Company (SWRC) operating conditions during the period from 2012 to 2014, to the extent possible, based on available information and data. The air quality modeling was conducted in accordance with guidance provided by the EPA as outlined in the following documents:

- SO_2 NAAQS Designations Modeling Technical Assistance Document (Modeling TAD; EPA 2013).
- Guideline on Air Quality Models [published as 40 CFR 51, Appendix W] (Modeling Guideline; EPA 2005).

SLR used the EPA- and WDEQ-AQD-approved dispersion model and methods described in the above reference documents to perform the modeling analysis.

1.1 DOCUMENT ORGANIZATION

This document is organized into four chapters. Chapter 2 provides an overview of the dispersion modeling procedures and inputs. Chapter 3 presents the results and conclusions of the dispersion modeling analysis. Chapter 4 contains a list of references.

2. DISPERSION MODELING PROCEDURES AND INPUTS

2.1 MODEL SELECTION

Selection of the appropriate dispersion model for use in the analysis was based on the available meteorological input data, the physical characteristics of the sources that are to be simulated, the land use designation in the vicinity of the facility, the complexity of the nearby terrain, and applicable EPA guidance to be used for the 2010 1-hour SO_2 NAAQS designations.

SLR used the current version of the EPA-approved American Meteorological Society/EPA Regulatory Model (AERMOD) modeling system in accordance with the Modeling TAD and the Modeling Guideline. AERMOD is recommended for use in 2010 1-hour SO_2 NAAQS designations when modeling multi-source emissions, and can account for plume downwash, stack tip downwash, and point, area, and volume sources (EPA 2015a; 2013; 2005; and 2004).

Current version numbers of the AERMOD model and pre-processors that were used include:

- AERMAP Version 11103;
- AERSURFACE Version 13016;
- AERMINUTE Version 14337;
- AERMET Version 15181; and
- AERMOD Version 15181.

2.2 MODEL INPUT OPTIONS

Model input options were set to their regulatory default values.

2.3 PLUME DOWNWASH

The effects of plume downwash were considered for all SWRC sources. Direction-specific building dimensions were calculated using the current version of the EPA-approved Building Profile Input Program (BPIPPRM Version 04274). Building dimensions were obtained from a BPIPPRM input provided by the WDEQ-AQD used in SWRC's 2014 minor source permit action MD-15648. At the direction of and in consultation with the WDEQ-AQD, additional structures were digitized and included in the downwash analysis in the vicinity of the #3 Tail Gas Treating Unit (TGTU) and #4 TGTU. The additional structures were deemed necessary by the WDEQ-AQD to better characterize plume downwash in the vicinity of these sources.

Actual SWRC stack heights, as provided by the WDEQ-AQD from previous permit modeling, were used for the modeling analysis. The base elevations of all SWRC structures and stacks were obtained from digital elevation data. A description of the digital elevation dataset data is provided in Section 2.8. A simplified plot plan of the SWRC facility, showing the location of all structures and emission units (EUs) used in the plume downwash calculations, is provided in Figure 2-1.

The effects of plume downwash were not considered for off-site sources because of the very low emissions [≤0.1 pound per hour (lb/hr) of SO_2 at each off-site facility] and the relatively large distance from SWRC [between 9.3 and 12 kilometers (km) from SWRC]. Emissions from the off-site sources are not expected to cause a significant impact, regardless of whether or not there is downwash included in the modeling.

2.4 METEOROLOGICAL DATA PROCESSING

Hourly meteorological data used for air quality modeling must be spatially and climatologically representative of the area of interest. For attainment designation purposes, the Modeling TAD requires a three year dataset of representative meteorological data, preferably concurrent with actual emissions data. Required surface meteorological data inputs to the AERMOD meteorological processor (AERMET) include, at minimum, hourly observations of wind speed, wind direction, temperature, lateral turbulence, and cloud cover (or solar radiation and low-level vertical temperature difference data in lieu of cloud cover). The meteorological processor also requires morning upper air sounding data from a representative NWS station.

The hourly meteorological data used for the air quality modeling analysis was generated from the following input datasets for calendar years 2012 through 2014:

- The site-specific, 30-m meteorological tower located at the SWRC facility;
- The 1-minute Automated Surface Observing System (ASOS) wind speed and wind direction data reported at the Rawlins airport; and
- The upper air sounding meteorological data collected at Riverton, Wyoming.

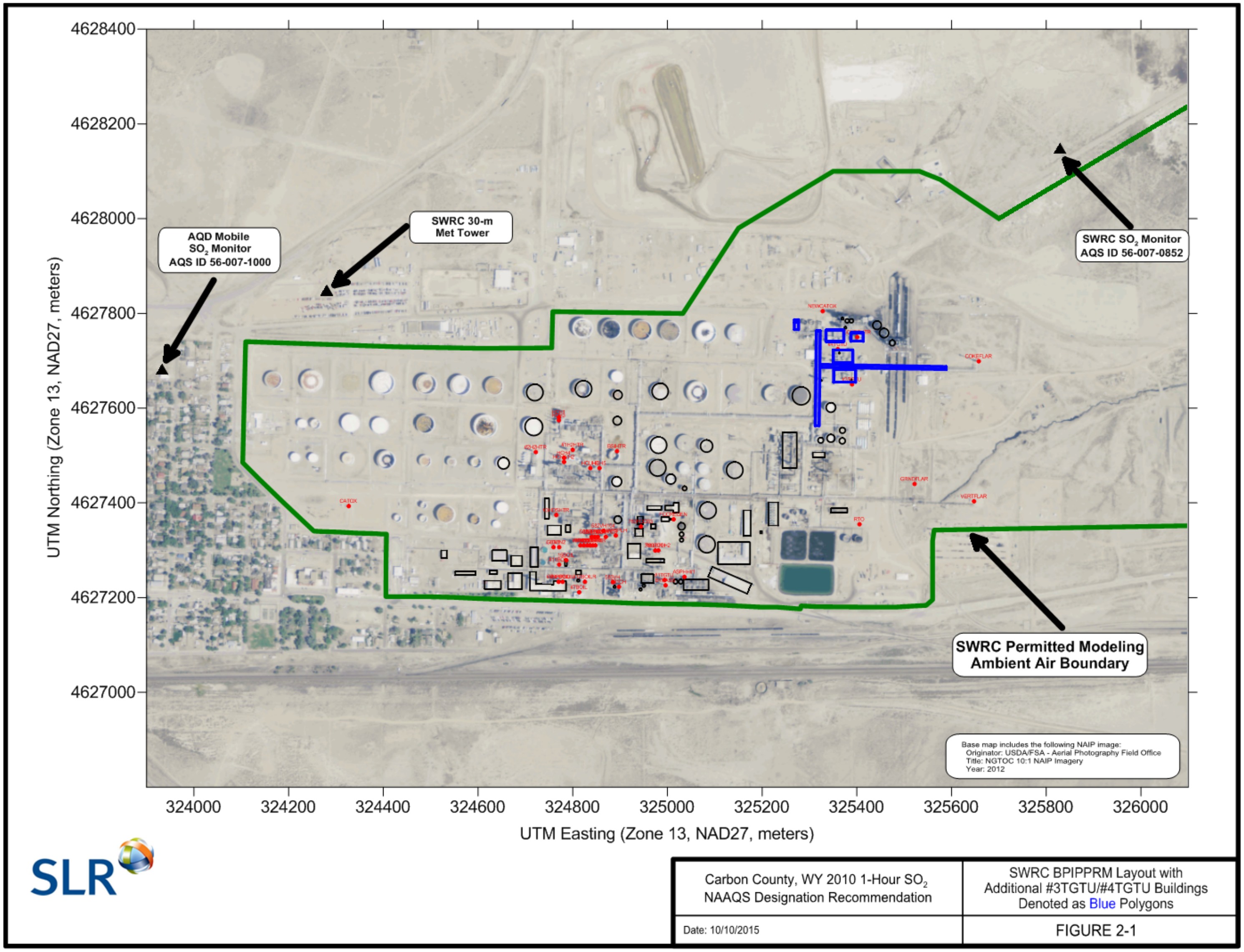
2.4.1 SWRC SITE-SPECIFIC DATA

SWRC operates a site-specific, 30-m meteorological monitoring tower located on the northwest corner of the SWRC property. The site-specific data has been used in air quality impact assessments to support construction permit applications using the AERMOD dispersion model. The data are well-suited for AERMOD simulations using concurrent hourly emissions data, which are described later in this report.

The meteorological parameters that were processed for use in the dispersion modeling analysis are:

- 10- and 30-m horizontal meter wind speed, wind direction, and wind direction standard deviation (σ_θ);

Figure 2-1 SWRC Structures and Stacks Used in the Downwash Analysis



- 10- and 30-m vertical wind speed standard deviation (σ_w);
- 2-, 10-, and 30-m ambient temperature;
- 10-2 m ambient temperature difference;
- Total solar radiation; and
- Barometric pressure.

The validated meteorological data were provided by the WQEQ-AQD in Excel format. The validated data were prepared for input to AERMET as follows:

- Original missing data flags (-6999) in the Excel file were set to the AERMET default missing data flags for each parameter; and
- Vertical wind speed standard deviation values less than 0.1 m/s were set to missing[1].

The quarterly valid data capture for each meteorological parameter (prior to setting σ_w values less than 0.1 m/s to missing) was greater than 98 percent for the three-year period, with the majority of the parameters exceeding 99 percent by quarter.

Figure 2-2 and Figure 2-3 show wind roses for the SWRC 10- and 30-m levels, respectively, for the 2012-2014 period. Both wind roses show predominant winds from the west-southwesterly direction, with secondary maxima from the westerly and southwesterly directions.

Validated SWRC meteorological monitoring data were exported from Excel for use in AERMET. The AERMET processing procedure is described in detail below. A copy of the validated SWRC meteorological dataset that was used for the modeling analysis, along with data processing spreadsheets and meteorological preprocessor input/output files are provided in Appendix A.

2.4.2 NATIONAL WEATHER SERVICE (NWS) SURFACE DATA

Per the WDEQ-AQD's request, 1-minute ASOS wind data from the Rawlins NWS airport site was used to substitute any missing wind data from the SWRC site-specific dataset. The data was obtained from the National Climatic Data Center's (NCDC) FTP site for the years 2012-2014[2]. The 1-minute ASOS data capture at Rawlins was generally good, except data from June through December 2013 was unavailable.

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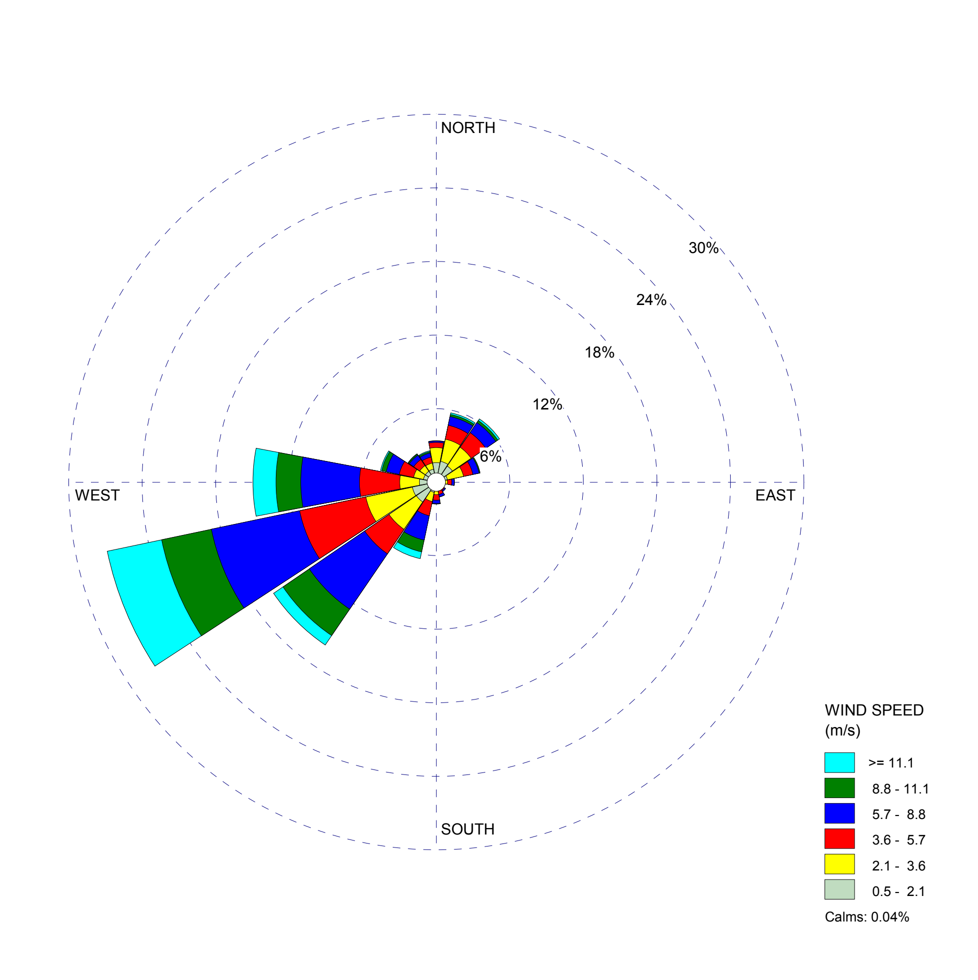
[1] According to information provided by EPA's AERMOD Implementation Group (Roger Brode), in the absence of observed sigma-w data, the sigma-w profile is calculated in AERMOD based on the boundary-layer parameters, w* and u*. A problem can occur if there is an inconsistent observed sigma-w value that causes an inconsistency between the observed sigma-w values and the calculated w* value. Such an inconsistency between w* and observed sigma-w can result in extremely large and unrealistic values of the skewness in convective conditions, which is proportional to $(w^*/\text{sigma-w})^3$. This can lead to anomalous plume height and sigma-z values for the updraft and downdraft portions of the direct plume in AERMOD. According to Brode, there is no simple solution to the problem without incorporating a feedback loop between the measured sigma-w and the calculation of w*, which is not part of the current AERMOD model. He suggests that users should avoid inputs of anomalously low (especially below instrument threshold) input values of sigma-w to AERMOD. Setting input values of tower sigma-w less than 0.1 m/s to missing is consistent with that advice. (E-mail from Roger Brode of PES to Bob Paine of ENSR Regarding the Use of Concurrent Meteorological Observations for AERMET Processing [Modeling Protocol for the Granite Fox Power Project, Submitted by ENSR to the Nevada Division of Environmental Protection Bureau of Air Pollution Control]. September 1, 2005).

[2] ftp://ftp.ncdc.noaa.gov/pub/data/asos-onemin/

Figure 2-2 10-meter SWRC Wind Rose

WIND ROSE PLOT:
Sinclair Wyoming Refining Company
10-m Winds

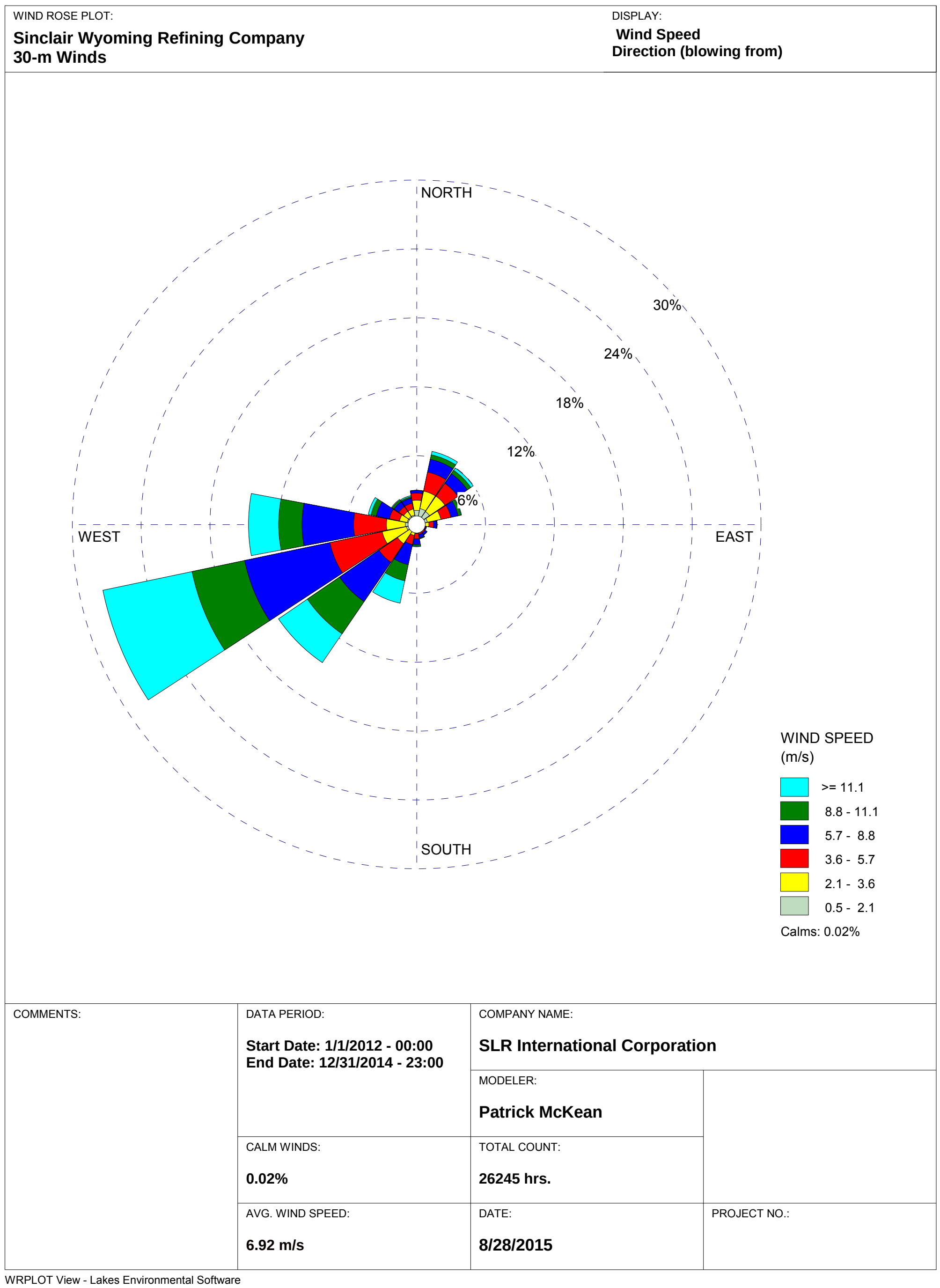
DISPLAY:
Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD: **Start Date: 1/1/2012 - 00:00** **End Date: 12/31/2014 - 23:00**	COMPANY NAME: **SLR International Corporation**	
		MODELER: **Patrick McKean**	
	CALM WINDS: **0.04%**	TOTAL COUNT: **26245 hrs.**	
	AVG. WIND SPEED: **5.83 m/s**	DATE: **8/28/2015**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

Figure 2-3 30-meter SWRC Wind Rose



The 1-minute ASOS data was processed using the AERMINUTE program to create a file of hourly averages of wind speed and wind direction for the Rawlins data set. Figure 2-4 shows the wind rose for the hourly averaged AERMINUTE output, which generally matches the wind roses for the SWRC site-specific data.

Missing SWRC wind data was substituted with the AERMINUTE output in stage 2 of the AERMET processing. The SWRC wind data was substituted with Rawlins wind data by AERMET as summarized below:

- 22 times in year 2012;
- 10 times in year 2013; and
- 38 times in year 2014.

2.4.3 NWS UPPER AIR DATA

The temperature structure of the atmosphere prior to sunrise is required by AERMET to estimate the growth of the convective boundary layer for the day. AERMET uses the 1200 Greenwich Mean Time (GMT) upper air sounding from the nearest NWS upper air observing station for this purpose. Without the 12Z sounding, AERMET will set the daytime convective boundary layer parameters to missing for that day, and AERMOD will flag these hours as missing and not perform dispersion calculations. The nearest upper air site to the SWRC facility is located in Riverton, Wyoming, approximately 181 km northwest of SWRC. The upper air data for this site were obtained from the Forecast Systems Laboratory (FSL)/NCDC Radiosonde Data Archive[3] and provided as input to AERMET.

During the AERMET processing, it was determined that thirteen 12Z soundings were missing during the three-year period of interest: nine were missing in 2012; two were missing in 2013, and two were missing in 2014. At the direction of the WDEQ-AQD, and in order to construct the most complete dataset possible and retain valid site-specific surface meteorological data in the modeling analysis, the missing soundings were filled using either the prior day's sounding or the subsequent day's sounding from Riverton.

Since AERMET uses the vertical temperature data from the sounding up to 5,000 m above ground level, an analysis of archived 500 millibar (mb) weather maps[4] was conducted to find the most appropriate day to use for the substitution. Since the vertical temperature profile is the parameter used by AERMET, the analysis focused on the 1,000-500 mb thicknesses[5], but also qualitatively considered wind flow, wind speed, and proximity of low/high pressure systems. It is recognized that the selection of the appropriate day to use as a substitute is subjective; therefore an additional analysis was conducted in which AERMET/AERMOD were run two ways for a single day on January 27, 2012: 1) using the 12Z sounding from the day prior to the missing day, and 2) using the 12Z sounding from the day after the missing day. Between the two runs, the AERMET surface files do have somewhat different

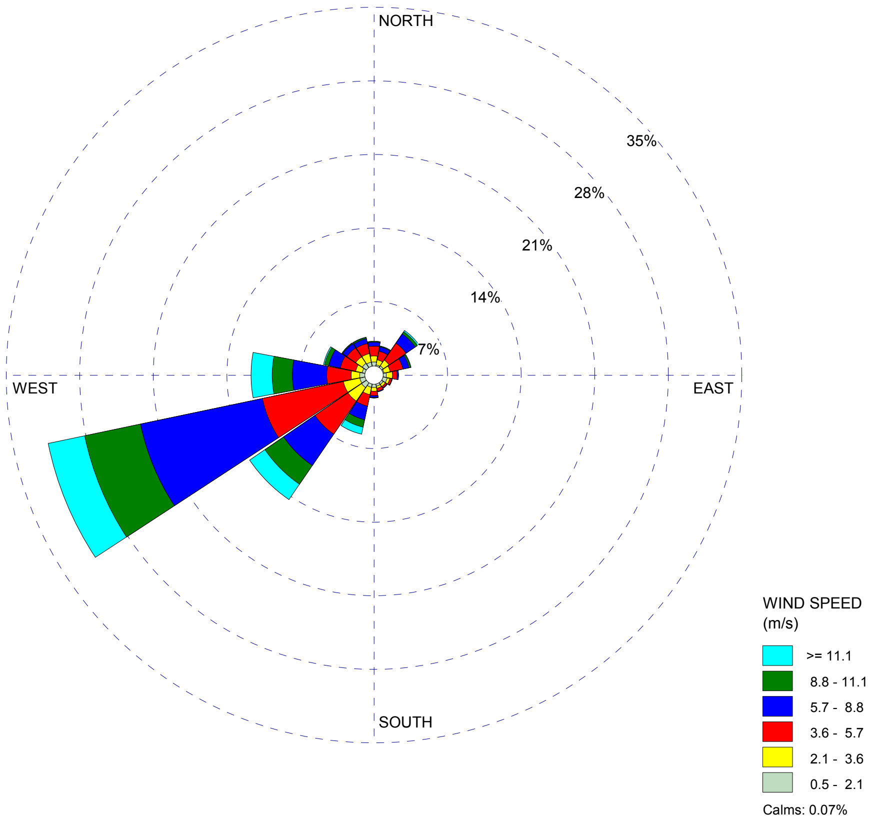
[3] http://www.esrl.noaa.gov/raobs/

[4] http://archive.atmos.colostate.edu/data/misc/QHTA11/

[5] The 1000-500 mb thickness is directly related to the temperature of the column.

Figure 2-4 10-meter Rawlins Wind Rose Generated from 1-Minute ASOS Data

WIND ROSE PLOT:	DISPLAY:
Rawlins Airport **10-m Winds**	**Wind Speed** **Direction (blowing from)**



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	Start Date: 1/1/2012 - 00:00 **End Date: 12/31/2014 - 23:00**	**SLR International Corporation**	
		MODELER: **Patrick McKean**	
	CALM WINDS: **0.07%**	TOTAL COUNT: **20407 hrs.**	
	AVG. WIND SPEED: **5.78 m/s**	DATE: **8/31/2015**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software convective parameters; however the resulting maximum hourly concentrations for the two runs were identical[6]. A brief discussion of the selected substitution days along with the archived maps are provided in Appendix B.

2.4.4 SURFACE CHARACTERISTICS

Processing of the meteorological data requires assigning appropriate surface characteristics including surface roughness length (z_0), Bowen Ratio (B_0), and albedo (r). Surface characteristics were assigned following guidance provided in the current version of the AERMOD Implementation Guide (AIG; EPA 2015b).

The AIG recommends that the surface characteristics be determined based on digitized land cover data. The EPA has developed the AERSURFACE processor that can be used to determine site characteristics based on digitized land cover data in accordance with the recommendations from the AIG. AERSURFACE incorporates look-up tables of representative surface characteristic values by land cover category and seasonal category.

The AERSURFACE processor was used to obtain the surface characteristics for input to stage 3 of AERMET. The current version of AERSURFACE was used with land cover data from the United States Geological Survey (USGS) National Land Cover Data 1992 archives (NLCD92). The NLCD92 archive provides data at a spatial resolution of 30 m based on a 21-category classification scheme applied over the continental United States.

AERSURFACE was used to calculate surface characteristics for twelve 30-degree sectors for two meteorological sites: the SWRC site-specific tower and Rawlins airport.

The latitude and longitude[7] of these stations are:

- SWRC tower: 41.78491 north latitude, 107.1152 west longitude; and
- Rawlins tower: 41.7994 north latitude, 107.2064 west longitude.

2.4.4.1 Seasonal Classification

In AERSURFACE, the various land cover categories are linked to a set of seasonal surface characteristics for each land cover category. As such, AERSURFACE requires specification of the seasonal category for each month of the year. The following five seasonal categories are offered by AERSURFACE:

- Late autumn after frost and harvest, or winter with no snow (with default months: December, January and February);
- Winter with continuous snow on ground (with default months: December, January and February);

[6] AERMOD was run for 24 hours using the modeling files WDEQ-AQD provided from minor source permit action MD-15648. When paired in space and time, the top 20 1-hour impacts between the two runs were identical.

[7] Coordinates in North American Datum 1983 (NAD83).

- Transitional spring with partial green coverage or short annuals (with default months: March, April and May);
- Midsummer with lush vegetation (with default months: June, July and August); and
- Autumn with un-harvested cropland; (with default months: September, October and November).

Following WDEQ-AQD guidance, each month was assigned to its default season unless evidence of snow cover would change the default season to winter with snow. In addition, in some years the transition months of November and March may have continuous snow cover and would be classified as winter with snow. For each winter month and the adjacent transitional months, snow cover was evaluated to determine if the month should be classified as winter with snow or winter with no snow.

The availability of snow cover data from nearby stations listed in the Global Historical Climatology Network (GHCN)[8] was evaluated. Only one site, Sinclair 0.1 N (WY-CR-9), which is a Community Collaborative Rain, Hail & Snow Network (CoCoRaHS) station, had consistent data capture for the snow depth field for the years 2012-2014. The Rawlins airport has an archive of daily snow depth based on approximately 50 years of data[9], but data collection ceased in the year 2000. Analysis of this archive shows that the Rawlins airport (approximately 8 km west-northwest of SWRC) typically has snow depth greater than 1 inch from November 20 through March 12.

Using these data sets, each month was evaluated to determine if greater than 50 percent of the days within that month had snow depth more than 1 inch. A month that had greater than 50 percent of the days with snow depth more than 1 inch was classified as winter with snow; otherwise it was classified as winter with no snow (i.e., for the months December, January, or February) or its default season (e.g., for the transitional months of November or March).

Since the CoCoRaHS program is supported by volunteers, there may be periods of missing data. Therefore, the following procedure was implemented to evaluate all winter and transition months:

1. If the WY-CR-9 site had data capture such that >50 percent of the days in a month have snow depth ≥1 inch, classify that month as winter with snow.
2. If the WY-CR-9 site had data capture such that >50 percent of the days in a month do not have snow depth ≥1 inch, classify that month as winter with no snow or the default season.
3. If the WY-CR-9 site did not have 50 percent data capture (i.e., less than half the month had any observations), then classify winter months as winter with snow based on Rawlins snow depth climatology, and classify all other months as their default season.

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[8] ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/daily/by_year/

[9] http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?wy7533

For the period of interest, this procedure results in all December, January, and February months to be classified as winter with snow except for January 2012, which had enough observations to support winter with no snow. All transition months were classified as their default seasons. The monthly seasonal determinations for each year are provided in Table 2-1 through Table 2-3.

2.4.4.2 Surface Moisture Determination

The surface moisture condition (average, dry, or wet) for each month was determined by comparing the observed precipitation for each month within the period of interest (years 2012-2014) to the 30 year climatological record for that month. "Wet" conditions were selected if monthly precipitation was in the upper 30^{th} percentile of the climate record, "dry" conditions if precipitation was in the lower 30^{th} percentile of the climate record, and "average" conditions if precipitation was in the middle 40^{th} percentile of the climate record. The 30 year climatological record for each month was based on the Rawlins airport data from 1980-2010. The observed precipitation for the 2012-2014 period was also obtained from the Rawlins airport. The monthly surface moisture determinations for each year are provided in Table 2-1 through Table 2-3.

2.4.4.3 AERSURFACE Processing

The AERSURFACE processor was run for both the SWRC and Rawlins meteorological tower locations using the above inputs and seasonal definitions. Due to limitations in the code, only one moisture classification, and one arid or non-arid classification, per year can be input to AERSURFACE. Therefore, AERSURFACE was run six separate times with the following settings: 1) arid and dry moisture; 2) arid and wet moisture; 3) arid and average moisture; 4) non-arid and dry moisture; 5) non-arid and wet moisture; and 6) non-arid and average moisture. All winter with snow months were run as non-arid (based on the AERSURFACE definition) and all months with no snow were run as arid (based on an annual precipitation total of around 9 inches, and per the WDEQ-AQD's direction). Based on the monthly seasonal and moisture classifications listed in Table 2-1 through Table 2-3, the appropriate geophysical parameters were used for each month of the 2012-2014 period as input into stage 3 of AERMET.

Figure 2-5 illustrates the NLCD92 cover data overlaid with the AERSURFACE land cover output for the Bowen ratio and albedo domains. The domain for the surface roughness (1-km radius surrounding each meteorological tower) is contained within the larger Bowen ratio and albedo domains. Review of this figure indicates the input/output land cover is properly matched, aligned, and consistent with expectations.

Table 2-1 Year 2012 Seasonal and Moisture Determinations

Month	Maximum snow depth [1] (in)	Average snow depth [1] (in)	Days with Snow on Ground [1,2]	Days with Missing Snow Data	Seasonal Classification [2]	Justification for Seasonal Classification	Soil Moisture Classification [3]	Aridity Classification
Jan	1.0	0.3	8	1	Winter, no snow	Adequate data capture: Less than 50% of month covered with snow	Dry	Arid
Feb	3.0	1.0	17	7	Winter, snow	Adequate data capture: Snow-covered ground	Wet	Nonarid
Mar	0.5	0.0	0	19	Spring	Default classification	Dry	Arid
Apr	1.0	0.1	1	27	Spring	Default classification	Average	Arid
May	0.0	0.0	0	31	Spring	Default classification	Dry	Arid
Jun	0.0	0.0	0	30	Summer	Default classification	Dry	Arid
Jul	0.0	0.0	0	31	Summer	Default classification	Average	Arid
Aug	0.0	0.0	0	31	Summer	Default classification	Dry	Arid
Sep	0.0	0.0	0	30	Autumn	Default classification	Dry	Arid
Oct	0.0	0.0	0	29	Autumn	Default classification	Dry	Arid
Nov	1.0	0.0	1	27	Autumn	Default classification	Average	Arid
Dec	2.0	0.4	7	17	Winter, snow	Inadequate data capture: Use climatology	Average	Nonarid

[1] Source: GHCN: US1WYCR0009 WY SINCLAIR 0.1 N

[2] A day is considered snow-covered if the reported snow depth was at least 1 inch.
A month is considered snow-covered if at least half the days in the month were snow-covered.

[3] Based on AERSURFACE requirements from the monthly average precipitation (inches) compared to 30 year climatology at Rawlins FAA

Table 2-2 Year 2013 Seasonal and Moisture Determinations

Month	Maximum snow depth[1] (in)	Average snow depth[1] (in)	Days with Snow on Ground[1,2]	Days with Missing Snow Data	Seasonal Classification[2]	Justification for Seasonal Classification	Soil Moisture Classification[3]	Aridity Classification
Jan	2.5	0.8	12	8	Winter, snow	Inadequate data capture: Use climatology	Average	Nonarid
Feb	3.5	1.4	20	1	Winter, snow	Adequate data capture: Snow-covered ground	Average	Nonarid
Mar	1.0	0.1	1	4	Spring	Default classification	Dry	Arid
Apr	6.0	2.6	9	16	Spring	Default classification	Average	Arid
May	0.0	0.0	0	31	Spring	Default classification	Dry	Arid
Jun	0.0	0.0	0	30	Summer	Default classification	Dry	Arid
Jul	0.0	0.0	0	31	Summer	Default classification	Average	Arid
Aug	0.0	0.0	0	31	Summer	Default classification	Dry	Arid
Sep	0.0	0.0	0	30	Autumn	Default classification	Wet	Arid
Oct	4.5	1.8	2	26	Autumn	Default classification	Wet	Arid
Nov	2.0	1.3	7	22	Autumn	Default classification	Dry	Arid
Dec	5.0	2.1	25	3	Winter, snow	Adequate data capture: Snow-covered ground	Wet	Nonarid

[1] Source: GHCN: US1WYCR0009 WY SINCLAIR 0.1 N

[2] A day is considered snow-covered if the reported snow depth was at least 1 inch.
A month is considered snow-covered if at least half the days in the month were snow-covered.

[3] Based on AERSURFACE requirements from the monthly average precipitation (inches) compared to 30 year climatology at Rawlins FAA

Table 2-3 Year 2014 Seasonal and Moisture Determinations

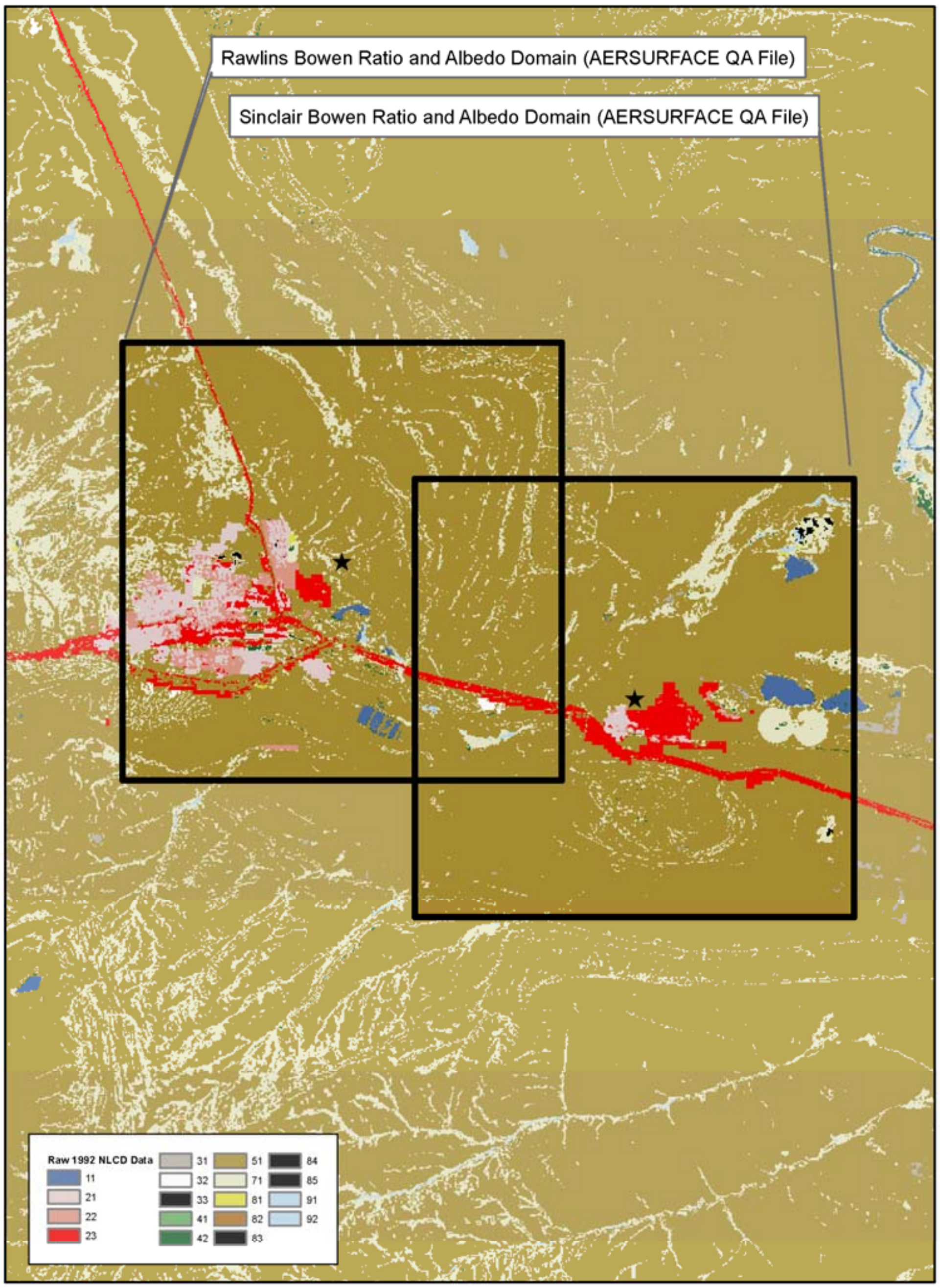
Month	Maximum snow depth [2] (in)	Average snow depth [2] (in)	Days with Snow on Ground [2,3]	Days with Missing Snow Data	Seasonal Classification [3]	Justification for Seasonal Classification	Soil Moisture Classification [4]	Aridity Classification
Jan	2.5	0.8	16	3	Winter, snow	Adequate data capture: Snow-covered ground	Average	Nonarid
Feb	2.0	0.6	6	9	Winter, snow	Inadequate data capture: Use climatology	Average	Nonarid
Mar	4.0	0.6	2	22	Spring	Default classification	Average	Arid
Apr	1.0	0.3	1	25	Spring	Default classification	Dry	Arid
May	8.5	3.6	5	26	Spring	Default classification	Dry	Arid
Jun	0.0	0.0	0	30	Summer	Default classification	Dry	Arid
Jul	0.0	0.0	0	31	Summer	Default classification	Dry	Arid
Aug	0.0	0.0	0	31	Summer	Default classification	Wet	Arid
Sep	0.0	0.0	0	30	Autumn	Default classification	Wet	Arid
Oct	0.0	0.0	0	31	Autumn	Default classification	Dry	Arid
Nov	2.5	1.0	8	17	Autumn	Default classification	Wet	Arid
Dec	5.0	3.3	19	12	Winter, snow	Adequate data capture: Snow-covered ground	Wet	Nonarid

[1] Source: GHCN: US1WYCR0009 WY SINCLAIR 0.1 N

[2] A day is considered snow-covered if the reported snow depth was at least 1 inch.
A month is considered snow-covered if at least half the days in the month were snow-covered.

[3] Based on AERSURFACE requirements from the monthly average precipitation (inches) compared to 30 year climatology at Rawlins FAA

Figure 2-5 NLCD92 Land Cover Data (Map Extents) and AERSURFACE Domain Resulting Land Cover Data (10X10 km Boxes)



2.4.5 AERMET PROCESSING

The SWRC site-specific surface meteorological data (as supplemented with 1-minute ASOS wind data from Rawlins where needed), Riverton upper air data, and surface characteristics were processed using the latest version of the AERMET processor to generate AERMOD-ready surface and profile files. Stage 3 of AERMET was run for each individual year to retain the seasonal and moisture determinations for each year. The individual AERMET generated files were combined into single surface and profile files to allow the AERMOD dispersion model to output the appropriate modeled design value of the 1-hour SO_2 concentrations for comparison against the 1-hour SO_2 NAAQS.

2.5 MODELED EMISSION INVENTORY

2.5.1 SWRC EMISSION UNITS

The SWRC modeled emission inventory was developed using several sources of information and data to capture the SWRC operating conditions during the period from 2012 to 2014. The modeled inventory was developed from the following:

- The primary sources of hourly actual SO_2 emissions data were obtained from SWRC's continuous emission monitoring systems (CEMS) for specific emission units (EU) described later in this section;
- Root Cause Failure Analysis (RCFA) reports that were prepared as required by the May 8, 2008 Consent Decree (Consent Decree) between the United States of America and SWRC for specific EUs described later in this section;
- Annual emission inventory reports submitted to the WDEQ-AQD required by SWRC's Operating Permit; and
- Emission rates and stack parameters from the modeling files associated with SWRC's 2014 minor source permit action MD-15648, which generally reflect Federally-enforceable permit limits for the EUs.

During the period from 2012 through 2014, SWRC EUs experienced upset conditions that were documented in RCFA reports submitted to the EPA, which included information for the following EUs: North Flare, South Flare, Emergency Ground Flare, #1 TGTU Bypass Stack[10], #3 TGTU, and the #4 TGTU. For these reported events, SWRC provided emission estimates based on event-specific information that they considered more accurate than the CEMS data during the upset events. Specifically, SWRC provided a statement in the TGTU RCFA reports, that SWRC's engineering calculations were reported "…in lieu of the CEMS reading, which was inaccurate…[11]".

Sulfur dioxide concentrations from the CEMS during upset conditions may or may not have exceeded the upper range of the CEMS. Therefore, in order to characterize the actual hourly SO_2 emissions from the sources with CEMS/RCFA data for upset conditions, SLR

[10] The #1 TGTU bypass is a bypass to the #1 TGTU stack. This bypass also serves the #1 sulfur recover unit (SRU) and #2 SRU.
[11] This statement was included in Attachment 2 of each TGTU RCFA report.

substituted the CEMS hourly emissions data with the RCFA report hourly emissions data when RCFA data were available. An overview of this substitution procedure and CEMS code handling is provided in this section.

Emission units that did not have CEMS or RCFA report data were modeled at their permitted allowable emission rates and source release parameters shown in Appendix C. The permitted information was also used for specific EUs during periods where there was no CEMS/RCFA data available for those EUs, as described in this section.

2.5.1.1 TGTU CEMS Code Data Processing

Hourly actual emissions were prepared for the following sources that have a CEMS:

- North Flare;
- South Flare;
- #1 TGTU;
- #1 TGTU Bypass Stack;
- #3 TGTU;
- #4 TGTU; and
- Fluid Catalytic Cracking Unit (FCCU).

The CEMS data required filtering and processing prior to being used to generate the AERMOD hourly emission files described later in this section. The steps taken to prepare the CEMS data for input to AERMOD are summarized below.

#1 TGTU From 1/1/12 – 9/30/12 (SWRC's Perillon CEM System):

There were no codes available in the Perillon CEMS output provided by SWRC. Therefore, for hours with available SO_2 concentrations, SLR calculated the lb/hr SO_2 emission rates, in consultation with the WDEQ-AQD. For hours with valid CEMS flow rates, SLR calculated the actual flow rate [actual cubic feet per hour (acf/hr)] using the CEMS dry standard flow rate, previously modeled exhaust temperature (because there is no temperature data in this CEMS data), and pressure/moisture provided in the "readme" tab of the CEMS spreadsheet provided by SWRC.

The CEMS time stamps were in Mountain Standard Time (MST) and Mountain Daylight Savings Time, which required special processing to convert all times to MST for input to the AERMOD hourly emission files. The hours were assumed to be hour beginning (e.g., hour 0100 is the average from 0100 – 0159). There were significant periods of missing records from March 12, 2012 through April 4, 2012, and from August 8, 2012 through September 30, 2012. These missing hours were assumed to have no SO_2 emissions.

All TGTUs and FCCU (SWRC's CeDAR CEM System):

SWRC provided hourly SO_2 concentrations, SO_2 lb/hr emission rates, and exhaust flow rates and temperatures for the #1 TGTU (starting on October 1, 2012) and #3 TGTU, #4 TGTU, and FCCU. All of the time stamps were assumed to be in MST and were assumed to be hour beginning. The following steps were taken to process the CeDAR CEMS data for these units.

The SO_2 concentrations [in parts per million by volume on a dry basis (ppmvd)] and flow rate [in dry standard cubic feet per hour (dscf/hr)] CEMS codes were evaluated to determine if the EU was down (and therefore assumed not to be emitting SO_2), or if the CEM system alone was down or otherwise reporting invalid readings. According to the "readme" tab in the CEMS spreadsheet provided by SWRC, the codes that identify the EU as being down were <13> and <29>. Each hour was coded by SLR as either "DOWN" (i.e., if codes <13> or <29> were found, the EU was not operating, and therefore emitting 0 lb/hr of SO_2), or "ND" (indicating no data) if the CEMS data was flagged with a code where no valid data is recorded, in which case, the EU was assumed to be operating but was not monitoring valid emissions or flow rates.

For periods coded as "DOWN", an emission rate of 0 lb/hr of SO_2 was used in the AERMOD hourly emission files. For periods coded with "ND", the previous permitted emission rates and stack parameters were used in the AERMOD hourly emission files.

If RCFA report data were available for a given EU, then the CEMS emission rate was substituted with the total lb/hr SO_2 emission rate calculated by SLR from information contained in each RCFA report as described below. Appendix D contains summaries of the RCFA report data that were included in the modeling.

2.5.1.2 CEMS/RCFA Report Emission Substitutions for TGTUs

The following information in each TGTU RCFA report was reviewed for purposes of preparing hourly emission rates that were used as replacements for the CEMS data:

- The stack from which excess emissions were reported, along with the total pounds of excess SO_2 emitted for the event, both of which are noted on the first page of each report's cover letter.
- The total SO_2 concentrations (in ppmvd) at 0 percent oxygen (O_2)] provided in Attachment 2 of each RCFA report.

SWRC included lb/hr SO_2 emission rates in the RCFA reports; however, these lb/hr rates represented only the excess SO_2 emissions greater than 250 parts per million (ppm). The emissions required for the modeling analysis is the total SO_2 lb/hr emission rate. The total SO_2 concentration, along with the flow rate and percent oxygen, for each hour in the RCFA reports was used to calculate the total SO_2 lb/hr emission rates.

For times when RCFA emissions data were available for a given TGTU, the calculated RCFA total lb/hr SO_2 emission rate was used in place of that TGTU's CEMS data for the corresponding hours, regardless of the codes that were present in the CEMS data.

2.5.1.3 CEMS/RCFA Report Emission Substitutions for Flares

The following information in each flare RCFA report was reviewed for purposes of preparing hourly emission rates that were used as replacements for the CEMS data:

- Start/end times for each event;
- The average pound per hour (lb/hr) SO_2 emission rate during each event;
- The total SO_2 lb/event emissions; and
- The average flare gas flow rate during each event.

For times when RCFA emissions data were available for a given flare, the reported lb/hr SO_2 emission rate was used in place of that flare's CEMS data for the corresponding hours. If a flaring event lasted less than one hour, then the reported lb/event value was used for the hour in which the emissions occurred.

This procedure was followed for the two candlestick flares (North and South flares). During one of the flaring events (February 4 through February 13, 2014), there were three days (February 6 through February 8) when refinery gases were assumed to be released from the Emergency Ground Flare, based on the event description in the RCFA report. This flare does not have a CEMS and is only used for emergency purposes; therefore, the RCFA emissions from the ground flare were used during February 6 through February 8, with zero emissions occurring for all other days in the 2012-2014 period.

2.5.1.4 AERMOD Hourly Emission File Development

The AERMOD hourly emission files were developed using the available CEMS and RCFA report data, along with emission rates and stack parameters from the modeling files associated with SWRC's 2014 minor source permit action MD-15648. Hourly emission files are used in AERMOD for varying emission rates, stack temperatures, and velocities. Other stack information such as the Universal Transverse Mercator (UTM) locations, base elevations, and diameters are "fixed" in the model and were obtained from the previous modeling files, with updates where appropriate in coordination with the WDEQ-AQD.

The hourly emission files were developed by adding the following information to SWRC's CEMS spreadsheets.

<u>TGTUs and FCCU:</u>

- The required AERMOD keywords, model times (hours converted to hour-ending to be consistent with the meteorological data), and the modeled stack ID.

- If RCFA report information was available, the total lb/hr SO_2 emission rates from the RCFA report was input to the hourly emission file, in units of grams per second (g/s). In these cases, the CEMS emission rates were not used.
- If the CEMS data were coded as “DOWN”, then 0 g/s was input to the hourly emission file. If the CEMS data coded as “ND”, the permitted emission rate was input to the hourly emission file, along with the previous permitted stack parameters.
- For hours with valid CEMS emissions data that were not substituted with RCFA data, the CEMS emission rates and exhaust temperatures were input to the hourly emission file.
- For hours with valid CEMS emissions and flow rates, SLR used the CEMS actual flow rate (acf/hr) and previous modeled stack diameter to calculate the stack velocity in the hourly emission file. If CEMS emissions or flow rate was coded as “ND”, then the previous permitted stack velocity was input to the hourly emission file.

North and South Flares:

- The required AERMOD keywords, model times (hours converted to hour-ending to be consistent with the meteorological data), and the modeled stack ID.
- If RCFA report information was available, the total lb/hr SO_2 emission rates from the RCFA report was input to the hourly emission file, in units of g/s. In these cases, the CEMS emission rates were not used.
- Since the effective release height and diameter cannot be varied in the AERMOD hourly emission files, these parameters were calculated following EPA’s screening procedures (EPA 1995) using each flare’s physical stack height and average flare gas heat content obtained from the 2012, 2013, and 2014 annual emission reports. The gas heat contents for each year were applied to the flare gas flow rates during events for each year. The calculated 3-year average effective release heights and diameters were used in the AERMOD input file for the stack height and diameter.
- The flare exhaust temperature and velocity were set to the EPA (1995) default values of 1,273 Kelvin (K) and 20 meters per second (m/s), respectively.

The Emergency Ground Flare was characterized in AERMOD as a volume source, in consultation with the WDEQ-AQD. Since the Emergency Ground Flare only had emissions from February 6 through February 8, 2014, the AERMOD hourly emission file contained RCFA report emissions for this period with zero emissions occurring for all other days in the 2012-2014 period.

2.5.2 OFF-SITE SOURCES

Off-site sources were obtained from SWRC’s 2014 minor source permit action MD-15648. The following off-site sources were included in the AERMOD model runs:

- Rostad Mortuary Crematory; and
- Wyoming Department of Corrections

Emissions from these facilities consisted of combustion sources. Figure 2-6 shows the locations of these facilities in relation to the SWRC refinery.

2.6 URBAN SOURCE CLASSIFICATION

An Auer land-use analysis, as described in the Modeling Guideline was conducted to determine the appropriate dispersion coefficients to use in the AERMOD model. Given limited development around the SWRC facility, a qualitative land-use analysis was performed utilizing aerial imagery from Google Earth. Less than 50 percent of the area within a 3 km radius of the SWRC facility could be classified as land use types I1, I2, C1, R2, or R3 [heavy industrial, light/moderate industrial, commercial, compact residential (single family), or compact residential (multi-family), respectively]. Therefore, the URBANOPT keyword in AERMOD was not used.

2.7 AMBIENT AIR BOUNDARY

SWRC's currently permitted modeling ambient boundary was used. A drawing showing the modeled ambient air boundary is provided in Figure 2-7.

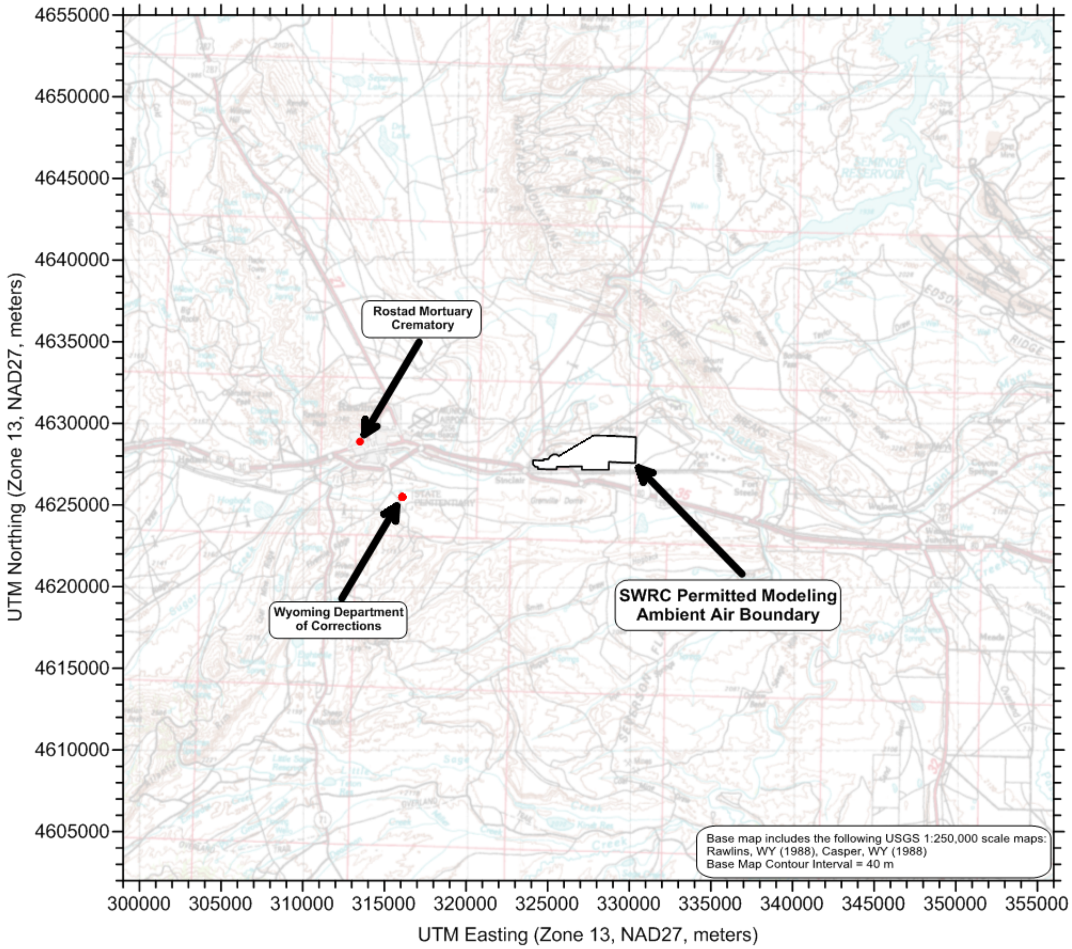
2.8 RECEPTOR NETWORK

The receptor grid that was used in SWRC's 2012 PSD major modification permit action MD-12620 was used in the modeling analysis, which was provided by the WDEQ-AQD. Cartesian receptor grids were defined in UTM Zone 13 NAD27 coordinates. The grids were determined to adequately resolve the highest predicted pollutant impacts while at the same time allowing for reasonable execution time. Several nested receptor grids of varying resolution were placed at:

- 50-m resolution along the ambient air boundary.
- 100-m resolution extending to 1 km from the ambient air boundary.
- 250-m resolution from the edge of the 100-m grid extending to 3 km from the ambient air boundary.
- 500-m resolution from the edge of the 250-m grid extending to 10 km from the ambient air boundary.
- 1,000-m resolution extending from the edge of the 500-m grid to 25 km from the ambient air boundary.

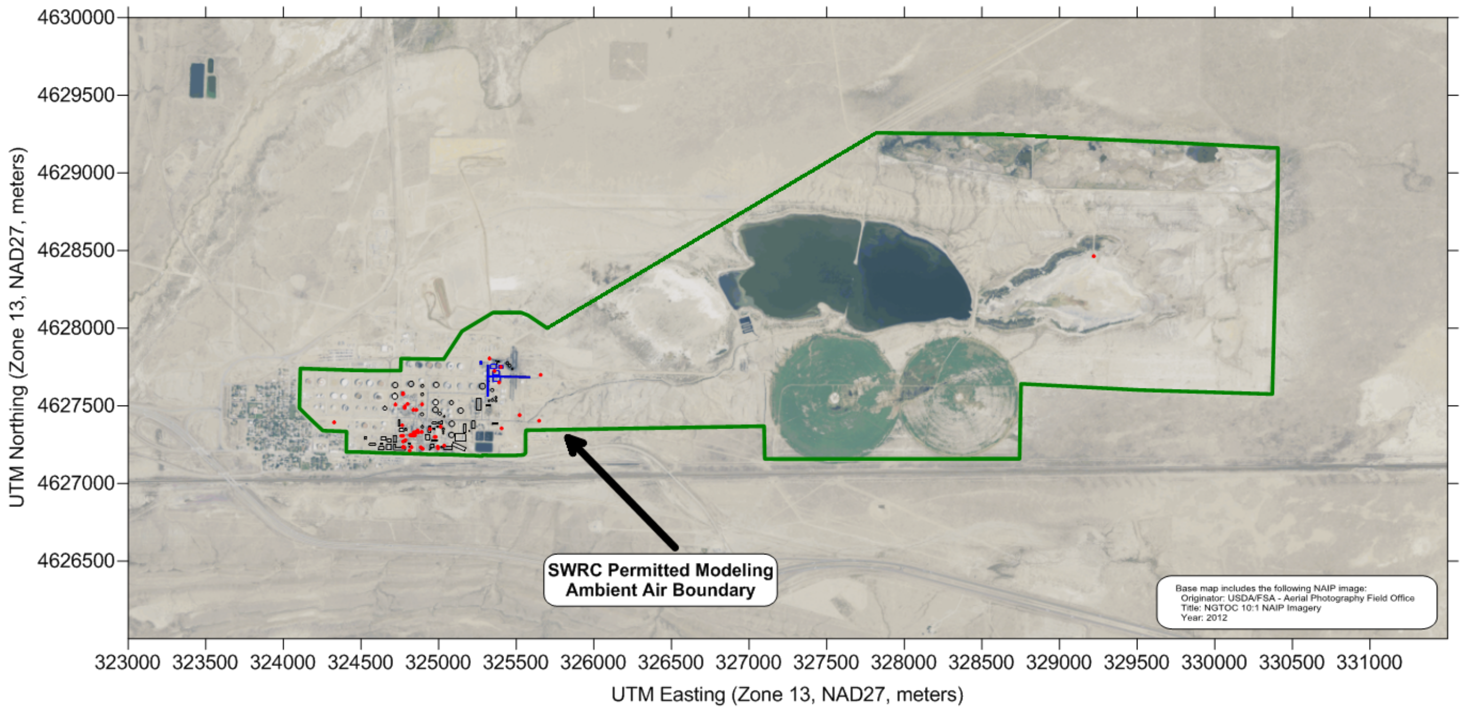
Receptor elevation and scale heights were obtained using the AERMAP terrain processor. The digital elevation dataset provided as input to AERMAP was National Elevation Dataset (NED) data at 1/3 arc-second resolution, which is equivalent to approximately 10 m in the project area.

Figure 2-6 Modeled Off-Site Source Locations



Carbon County, WY 2010 1-Hour SO_2 NAAQS Designation Recommendation	Modeled Off-Site Source Locations
Date: 10/10/2015	FIGURE 2-6

Figure 2-7 Modeled Ambient Air Boundary



SLR

Carbon County, WY 2010 1-Hour SO_2 NAAQS Designation Recommendation	Modeled Ambient Air Boundary
Date: 10/10/2015	FIGURE 2-7

To obtain the correct hill height scale for each receptor, the digital terrain data file provided to AERMAP included a buffer of approximately 10 km beyond the receptor grid area. In addition, 1:24,000 and 1:250,000 scale maps of the project area were examined to make sure that all significant terrain features at or above a 10 percent slope from each receptor were included in the digital terrain data file(s) provided to AERMAP.

Drawings showing the receptor grids, and contoured receptor elevations overlaid onto topographic maps, are provided in Figure 2-8 through Figure 2-11.

2.9 BACKGROUND CONCENTRATIONS

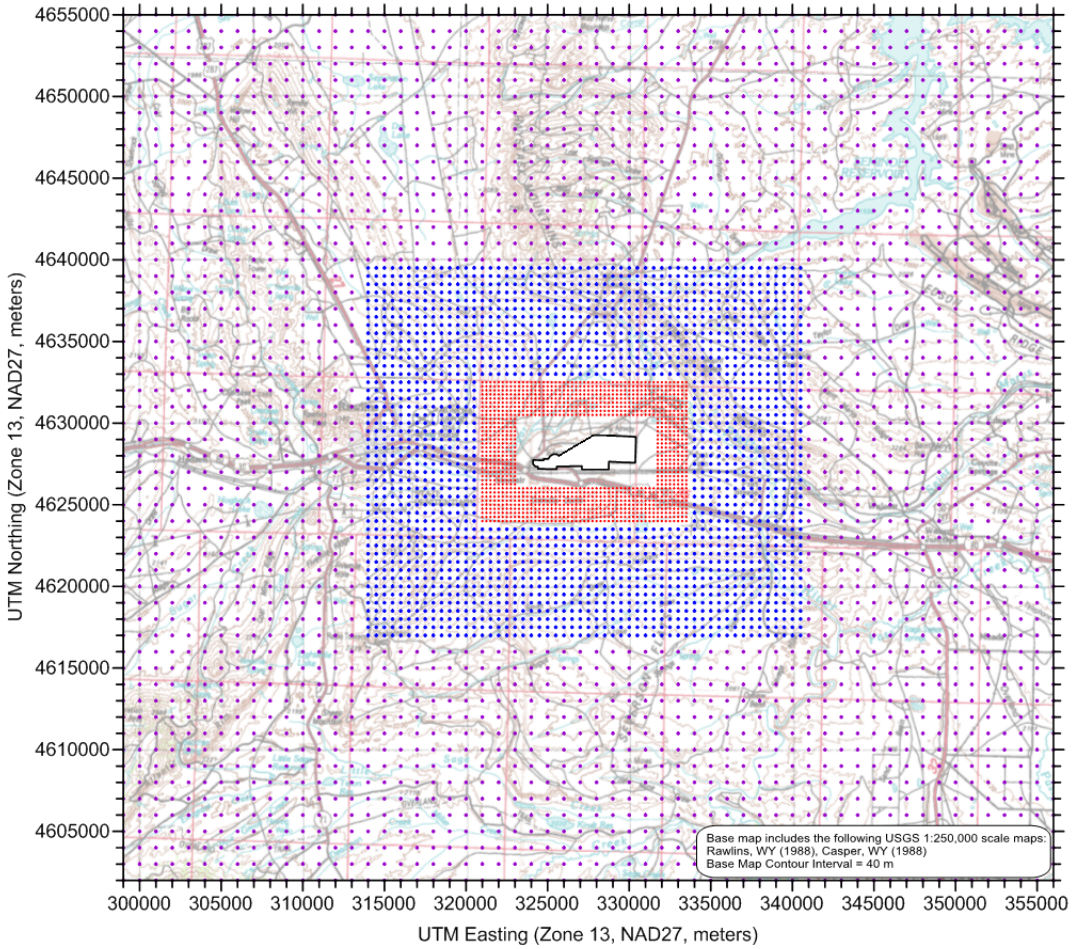
In addition to including off-site emissions, hourly background concentrations were included in the AERMOD model simulations. Per Section 8.1 of the Modeling TAD, and at the direction of the WDEQ-AQD, background SO_2 concentrations were processed for the WDEQ-AQD's Sinclair Mobile monitor located in the Town of Sinclair [EPA Air Quality System (AQS) ID number 56-007-1000]. The hourly ambient SO_2 concentrations from this monitor were processed in Excel to develop temporally and seasonally-varying background values, excluding periods when emissions from SWRC are expected to impact the monitor (i.e., excluding times when the winds are blowing from SWRC).

While the Modeling Guideline Section 8.2.2b recommends that a 90 degree sector downwind of the emission source may be used to determine the area of impact of that source on a monitor, this recommendation is interpreted to be intended for specific individual point sources of emissions. For this air quality impact assessment, due to the proximity of the ambient monitor to the numerous SWRC emission sources located immediately west of the monitor, arcs were drawn from the location of the ambient monitor for use in determining the wind directions that would be impacted by SWRC emissions.

Figure 2-12 is a map showing these arcs and areas that were considered when developing the background concentrations (i.e., the unshaded areas were considered to not be impacted by SWRC emissions). The wind directions that were included were from 150 degrees through 70 degrees, with all other wind directions (i.e., winds bellowing from SWRC) excluded from the data processing. This approach was directed by the WDEQ-AQD to minimize influences from SWRC on the background concentrations used in AERMOD.

The modeling TAD states that the background can take the form of the NAAQS for the temporally/seasonally-varying processing (i.e., the 3-year average of the 99th percentile of the daily maximum 1-hour values). The WDEQ-AQD reviewed the Modeling TAD's recommendation for 3-years of monitored data for background and the use of the 3-year average of the 99th percentile values. Since the Sinclair Mobile Monitor has one full year of data, the WDEQ-AQD indicated that using the 2nd highest concentrations from the monitor was appropriate.

Figure 2-8 Far-Field Receptor Grid



Carbon County, WY 2010 1-Hour SO_2 NAAQS Designation Recommendation	Far-Field Receptor Grid
Date: 10/10/2015	FIGURE 2-8

Figure 2-9 Far-Field Receptor AERMAP Elevations

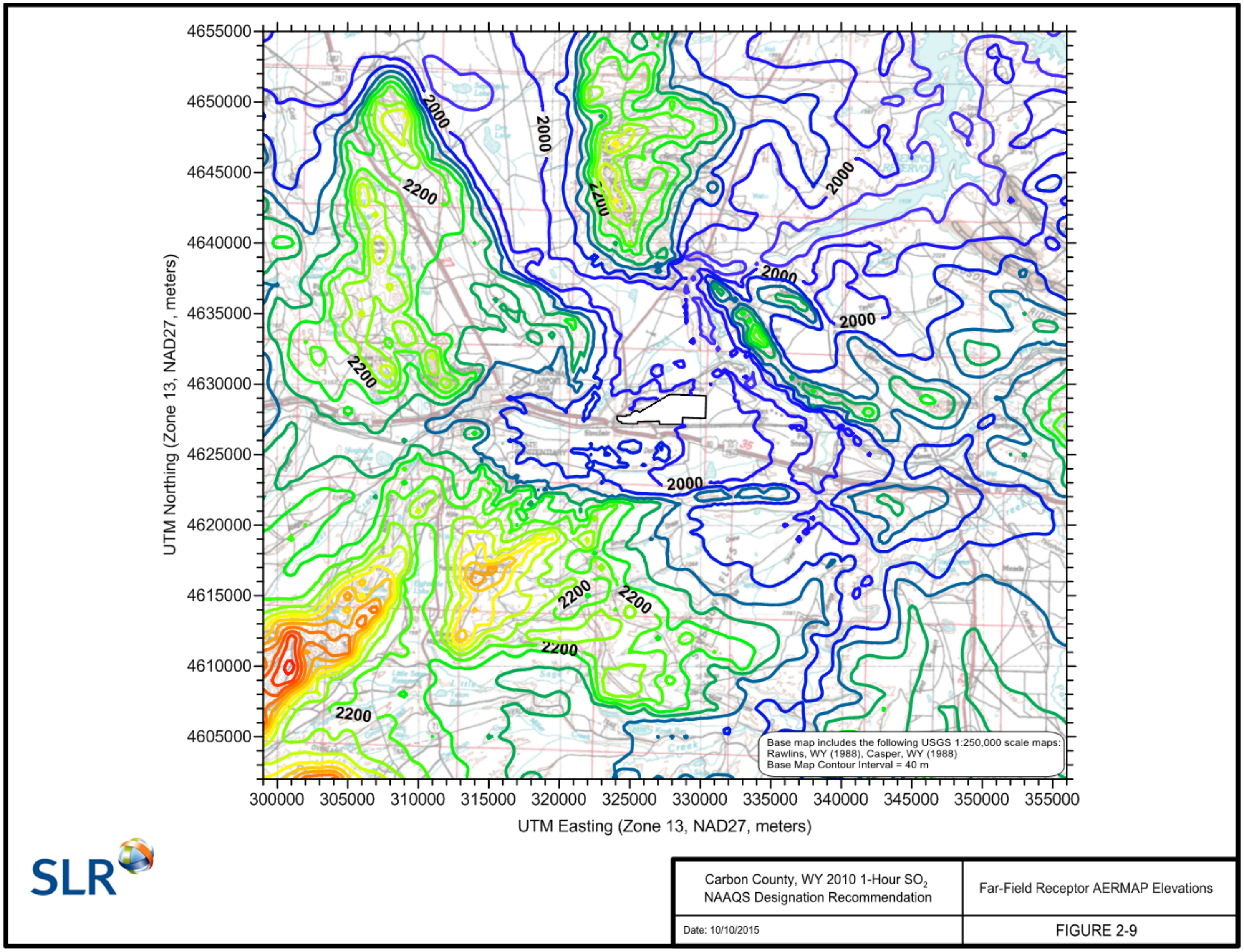
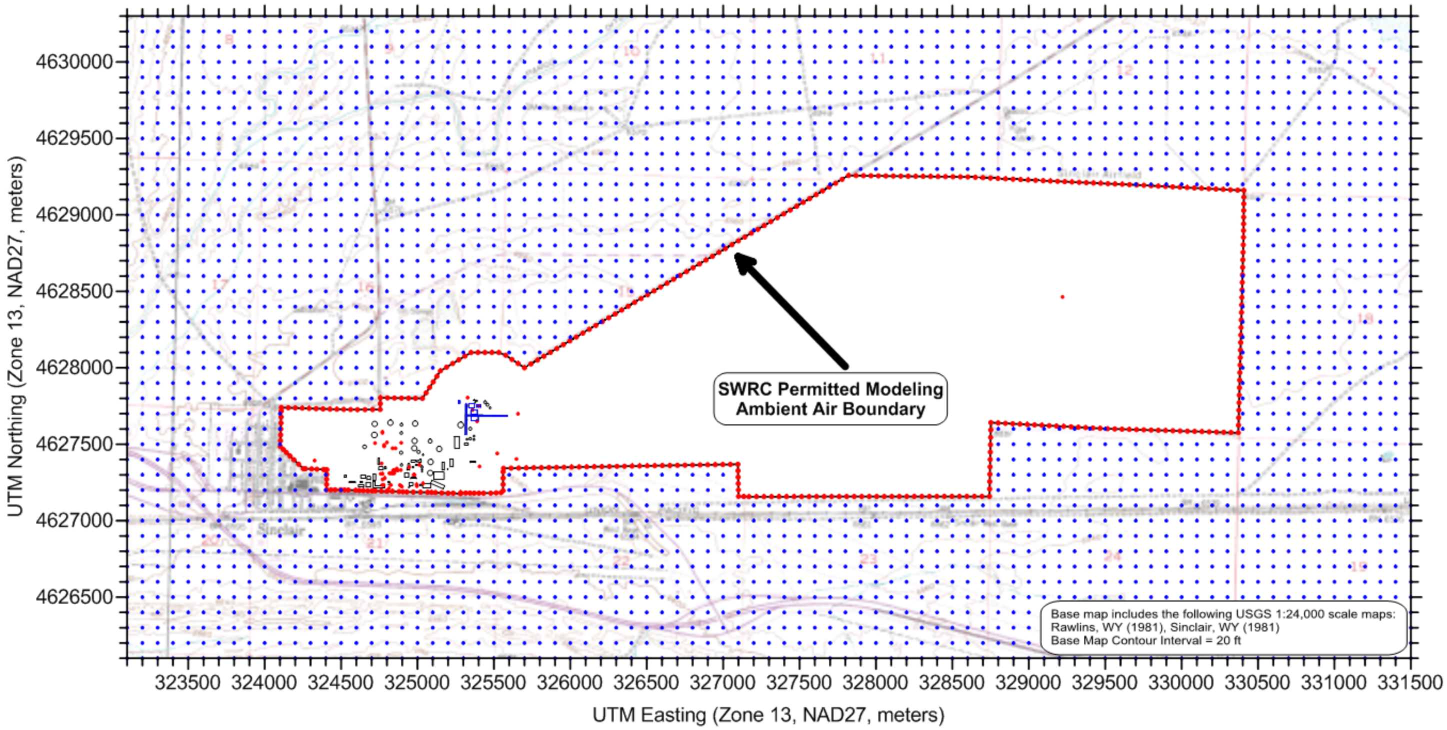
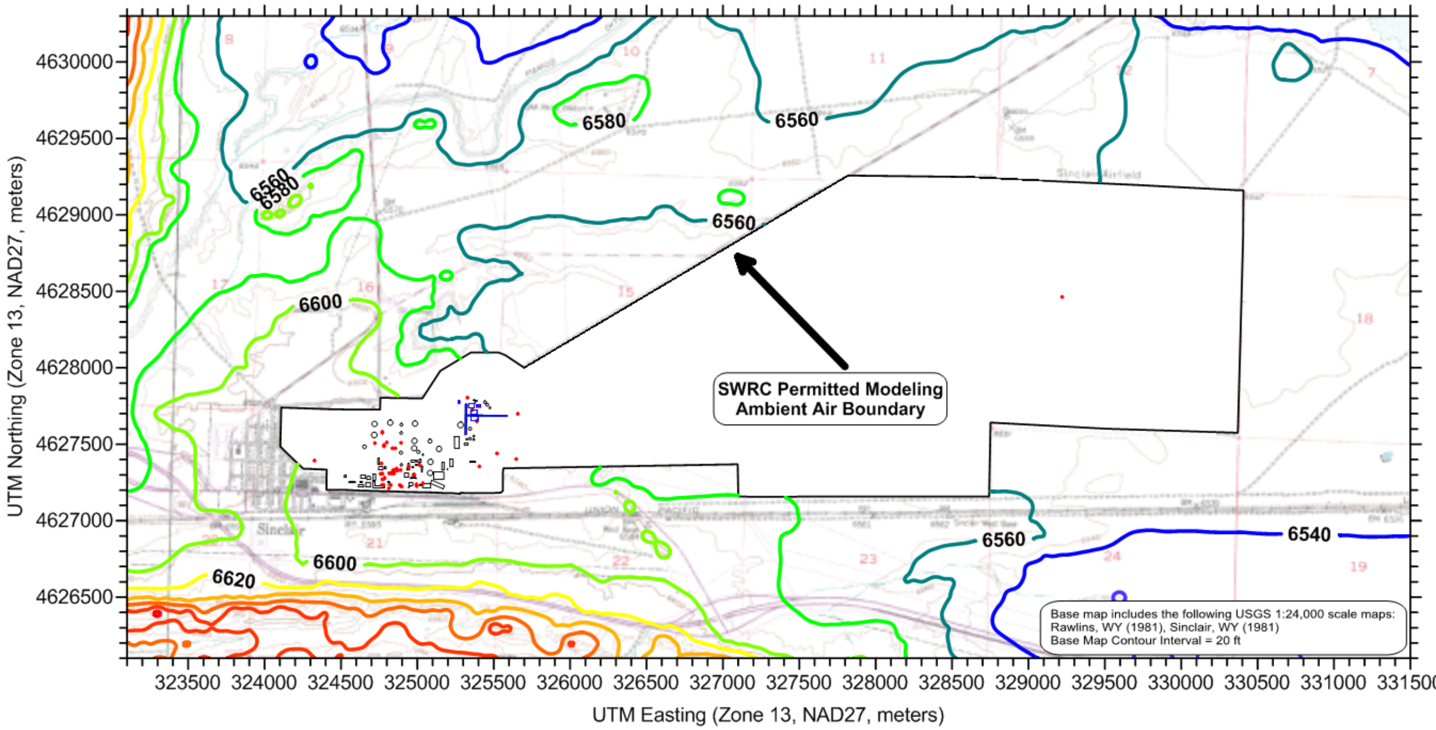


Figure 2-10 Near-Field Receptor Grid



Carbon County, WY 2010 1-Hour SO_2 NAAQS Designation Recommendation	Near-Field Receptor Grid
Date: 10/10/2015	FIGURE 2-10

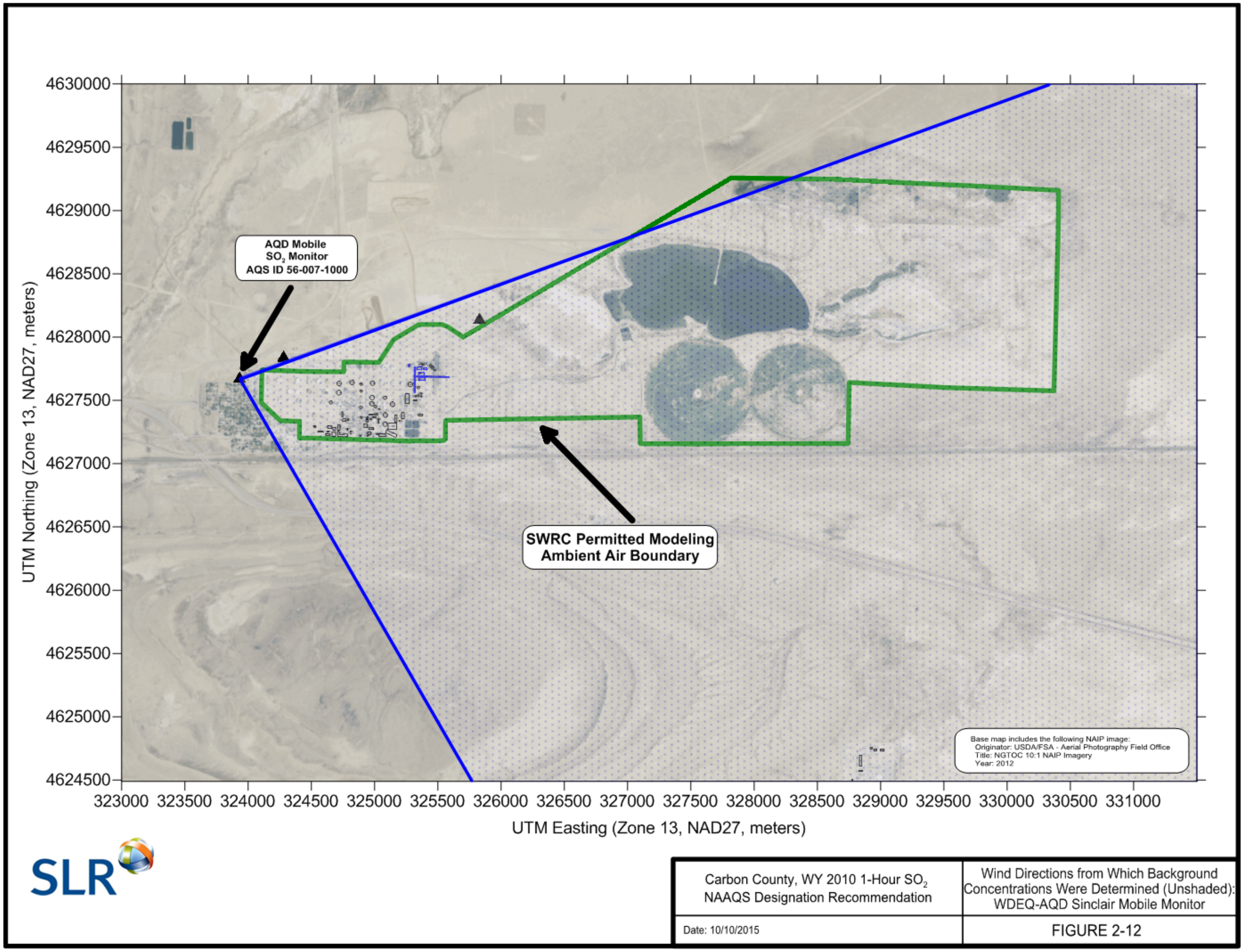
Figure 2-11 Near-Field Receptor AERMAP Elevations



SLR

Carbon County, WY 2010 1-Hour SO_2 NAAQS Designation Recommendation	Near-Field Receptor AERMAP Elevations
Date: 10/10/2015	FIGURE 2-11

Figure 2-12 Wind Directions Considered for Developing Background SO_2 Concentrations



Based on SLR's review of the WDEQ-AQD's gridded 4-km resolution SO_2 emission inventory, the background concentrations developed for this impact analysis is considered representative of both distant and local, diffuse emission sources in the area. The temporally and seasonally-varying background concentrations used in the AERMOD simulations are provided in Appendix E.

3. DISPERSION MODELING RESULTS AND CONCLUSIONS

The results of the modeling analysis indicated that there were no modeled violations of the 1-hour SO_2 NAAQS within the receptor grid developed for areas on and outside of the SWRC permitted modeling ambient air boundary. The maximum modeled 1-hour SO_2 design value concentration predicted by AERMOD was 62.1 parts per billion (ppb) [162.6 micrograms per cubic meter ($\mu g/m^3$)] compared to the NAAQS of 75 ppb (196 $\mu g/m^3$). Isopleth maps of the modeled 1-hour SO_2 design value concentrations are provided in Figure 3-1 through Figure 3-3.

Review of Figure 3-1 and Figure 3-2 indicates that the maximum modeled design values occur in the vicinity of SWRC with no elevated design value impacts in the near or far-field of the modeling domain. Figure 3-3 provides a near-field isopleth map of the modeled 1-hour SO_2 design value concentrations in the immediate vicinity of the SWRC stationary source and SWRC SO_2 air quality monitor (AQS ID 56-007-0852). This figure shows a strong SO_2 concentration gradient to the north and northeast of SWRC emission units, and in the area around the SWRC SO_2 air quality monitor.

Based on the refined dispersion modeling results and a comparison of those results to available air quality monitoring data for the same time period, the WDEQ-AQD determined that the modeling evaluation was inconclusive for making an attainment or nonattainment designation for the 2010 1-hour SO_2 NAAQS. As such, the WDEQ-AQD recommends that Carbon County remains designated as unclassifiable at this time.

Copies of all terrain and meteorological processing files, BPIPPRM input and output files, hourly emission and background SO_2 files, and AERMOD model input and output files can be found on the CD-ROM in Appendix A.

Figure 3-1 Modeled 1-hour SO_2 Design Value Concentrations: Far-Field

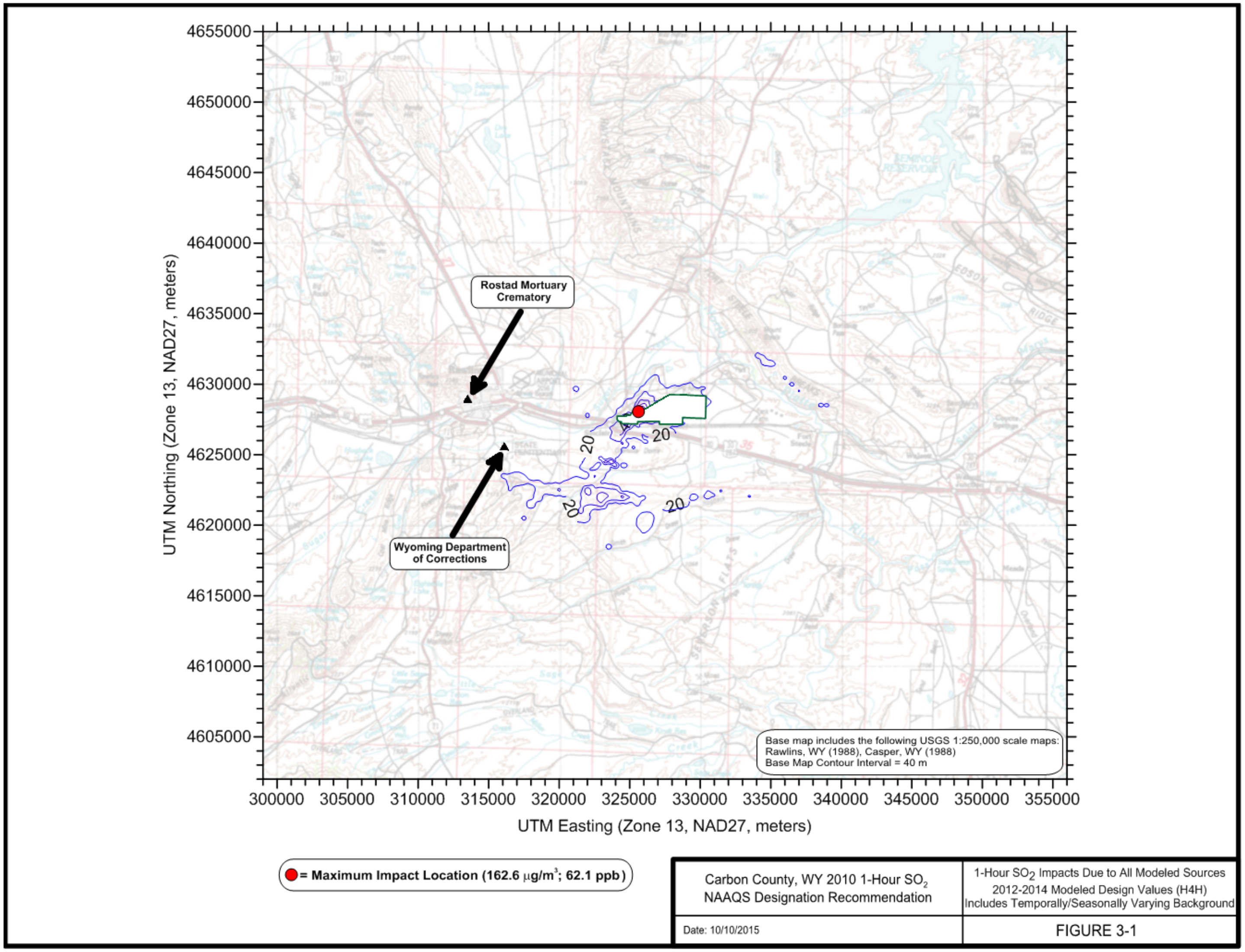


Figure 3-2 Modeled 1-hour SO_2 Design Value Concentrations: Mid-Field

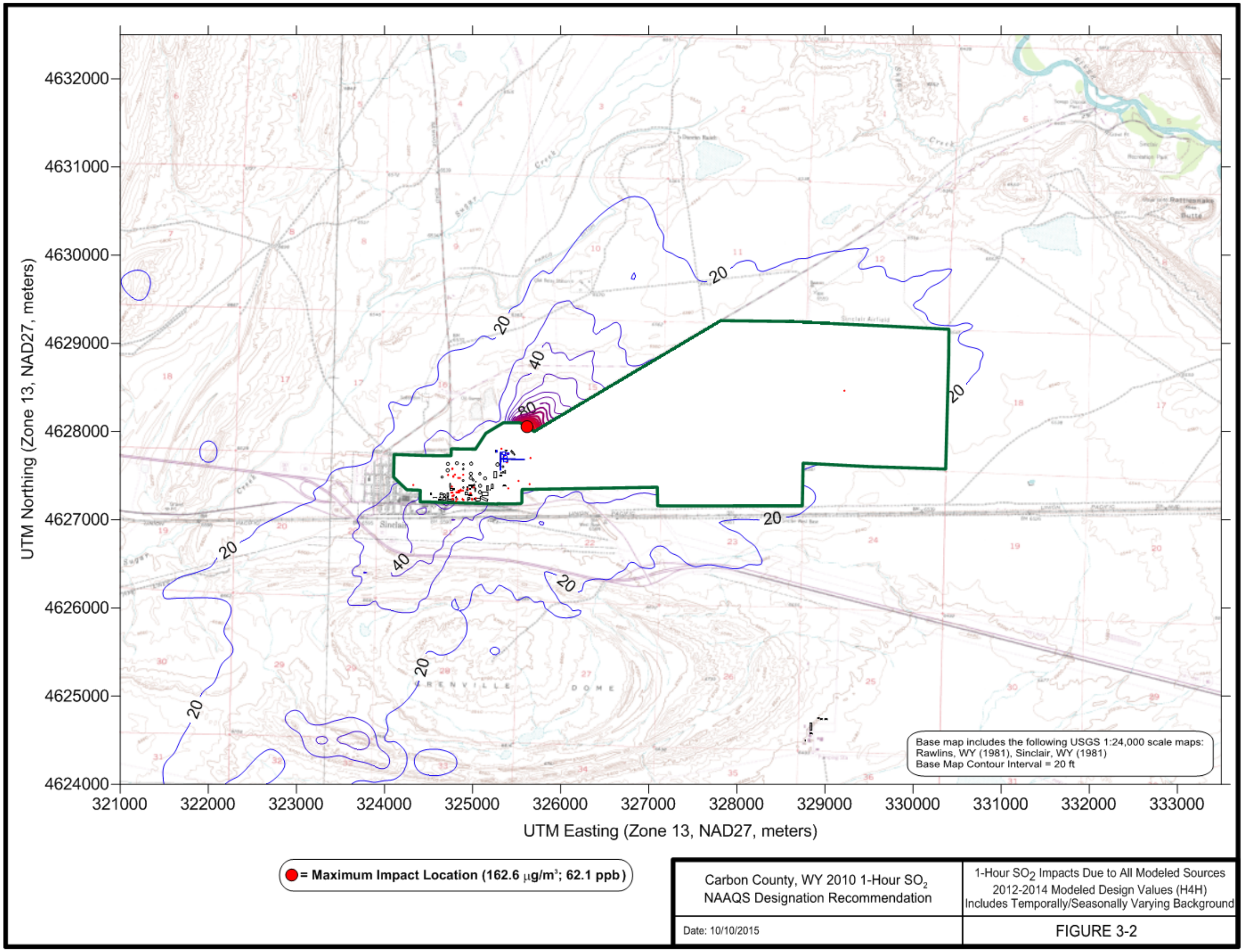
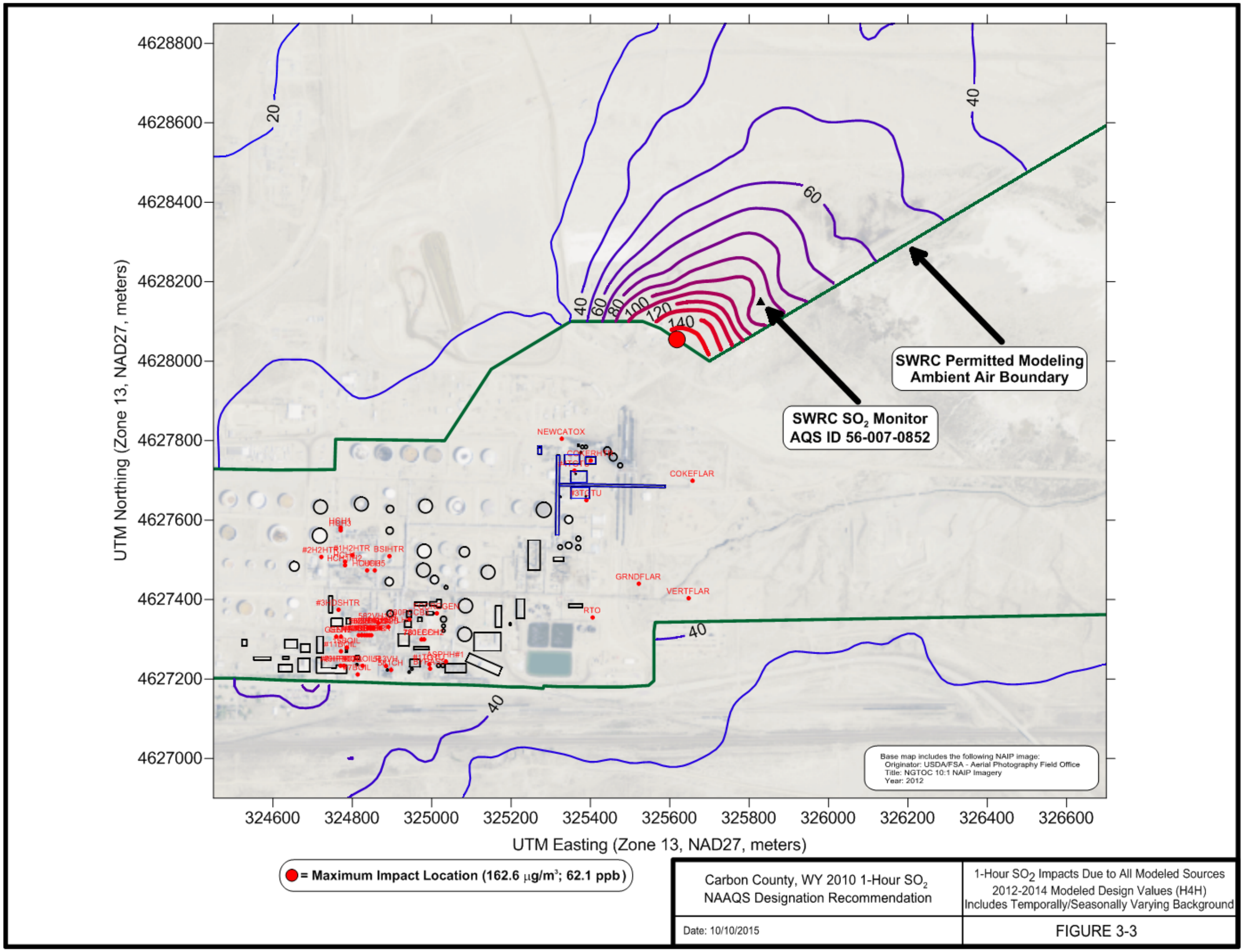


Figure 3-3 Modeled 1-hour SO_2 Design Value Concentrations: Near-Field



4. REFERENCES

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_____. 1995. SCREEN3 Model User's Guide (EPA-454/B-95-004). Office of Air Quality Planning and Standards. September 1995.

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APPENDIX A

CD-ROM with All Processing and Model I/O Files

Final Air Dispersion Modeling Report in Support of the 2010 1-Hour Sulfur Dioxide NAAQS Designation Recommendation

Wyoming Department of Environmental Quality - Air Quality Division
200 West 17th Street
Cheyenne, WY 82002

October 20, 2015

This DVD contains model input/output files, and associated inputs and processing data, used in the dispersion modeling to support the WDEQ-AQD's 2010 1-hour sulfur dioxide NAAQS designation recommendation for Carbon County, WY.

The individual file contents for each directory are described below:

EXECUTABLES

General Description

This folder contains model and processor PC executables. There are subfolders for each model/processor.

AERMAP

General Description

This folder contains input/output files for all AERMAP runs. The first level subfolder (e.g., 100m_grid, stacks, etc.) indicates the receptor grid and buildings/sources that were processed. All file names are identical for each subfolder and are described below, as applicable for the receptor/building/source processing.

File Name	File Contents
*.inp	AERMAP input file
*.out	AERMAP output file
*.rec	Receptor elevations and height scales extracted by AERMAP
*.sou	Building or source elevations extracted by AERMAP
*.tif	NED terrain data file

BPIP

General Description

This folder contains BPIP input and output files.

File Name	File Contents
*.inp	BPIP input file
*.out	BPIP output file
*.sum	BPIP summary output file

AERSURFACE

General Description

This folder contains input/output files for the 2012-2014 AERSURFACE runs. The years are separated into their own folders. The ‘NLCD’ folder contains the 1992 NLCD land cover data that was used.

File Name	File Contents
rawl*.inp	6 AERSURFACE input files for the Rawlins site for 6 moisture/aridity classifications (arid/dry; arid/average; arid/wet; not arid/dry; not arid/average; not arid/wet)
rawl_stage3.inp	The hand-edited file that combined the AERSURFACE Rawlins output from the above runs, by month and classification, into the input for stage3 AERMET processing
raw*.dat	AERSURFACE output files for each of the 6 classifications for the Rawlins site
raw*.log	AERSURFACE log files for each of the 6 classifications for the Rawlins site
sinc*.inp	6 AERSURFACE input files for the Sinclair site for 6 moisture/aridity classifications (arid/dry; arid/average; arid/wet; not arid/dry; not arid/average; not arid/wet)
sinc_stage3.inp	The hand-edited file that combined the AERSURFACE Sinclair output from the above runs, by month and classification, into the input for stage3 AERMET processing
sin*.dat	AERSURFACE output files for each of the 6 classifications for the Sinclair site
sin*.log	AERSURFACE log files for each of the 6 classifications for the Sinclair site

AERMINUTE

General Description

This folder contains AERMINUTE input and output files.

File Name	File Contents
*.dat	Various input/output AERMINUTE files
*.inp	AERMINUTE input file
*.log	AERMINUTE log file

AERMET

General Description

This folder contains input/output files for the 2012-2014 AERMET runs. Subfolders indicate folders containing upper air data and Sinclair site-specific data. Files not listed below are various output files for the different AERMET stages.

File Name	File Contents
*.inp	AERMET input file
*.err	AERMET output error file
*.rpt	AERMET output report file
*.pfl	AERMET output profile file
*.sfc	AERMET output surface file

AERMOD

General Description

This folder contains input/output files for the AERMOD model run. .

File Name	File Contents
*.inp	AERMOD input file
*.out	AERMOD output file
*.plt	Plot files. File name indicates the source group and averaging period
*.dat	AERMOD error file
*.prn	Hourly emission and background SO_2 files

APPENDIX B

Upper Air Sounding Substitution Discussion and Archived 500 mb Maps

Final Air Dispersion Modeling Report in Support of the 2010 1-Hour Sulfur Dioxide NAAQS Designation Recommendation

Wyoming Department of Environmental Quality - Air Quality Division
200 West 17th Street
Cheyenne, WY 82002

October 20, 2015

An analysis was performed to select the most appropriate day to use as a substitute for the days with missing 12Z upper air soundings at Riverton. The table on the nest page lists the following information:

- each day with a missing 12Z sounding for the 2012-2014 period;
- the day selected to use a substitute for the missing day;
- the approximate thickness values for the area of interest; and
- a qualitative discussion about the winds at 500-mb for the days of interest.

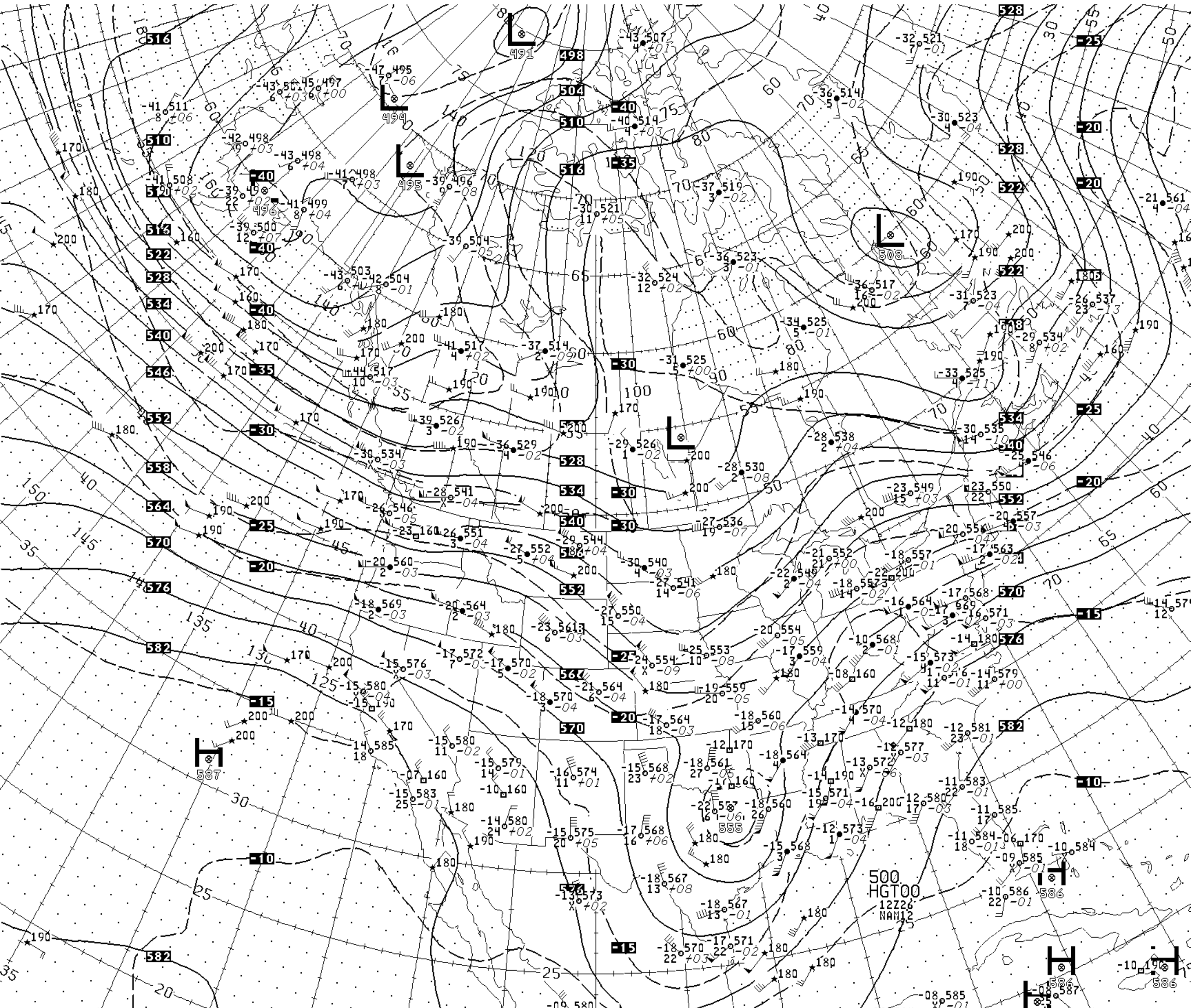
The cells highlighted in green indicate that the day was selected to use as a substitute. The cells highlighted in red indicate that the sounding data for that day is missing at Riverton. The graphics following the table are the 500-mb maps used for the analysis.

Missing Day			Substituted With		Map Analysis: 1000-500 mb Thickness (dm)			Map Analysis: Winds
Year	Month	Day	Month	Day	Day Prior	Missing Day	Day After	
12	1	27	1	28	558 -564	546 -552	552 -558	Somewhat similar northwest flow; on back side of the same low pressure in Canada
12	3	4	3	5	546	564	564 -570	Flow is weaker, but similar thickness as missing day
12	3	27	3	28	564	558	564	Similar weak, zonal or southwesterly flow to missing day
12	4	30	5	1	558	564 -570	564	Similar weak, zonal or southwesterly flow to missing day
12	6	11	6	12	564	576	576 - 582	Similar weak, zonal flow to missing day
12	9	8	9	10	582	588	588	Since 9/9 is missing, use 9/10 because of similar weak, zonal flow
12	9	9	9	10	588	588	582	Similar weak, zonal flow to missing day
12	9	14	9	15	582 - 588	588	588	Similar weak, zonal flow to missing day
12	10	17	10	18	570 - 576	552 -558	564 -570	Similar strong, northwesterly flow to missing day; on backside of same low pressure
13	1	19	1	20	564 -570	564 -570	564 - 570	Similar strong, northwesterly flow to missing day
13	2	28	2	27	552	552 - 558	564	Similar weak, northwesterly flow to missing day
14	2	5	2	7	540	540	540	Since 2/6 is missing, use 2/7 because of similar zonal flow
14	2	6	2	7	540	540	540- 546	Similar zonal flow to missing day

Selected sounding for missing day

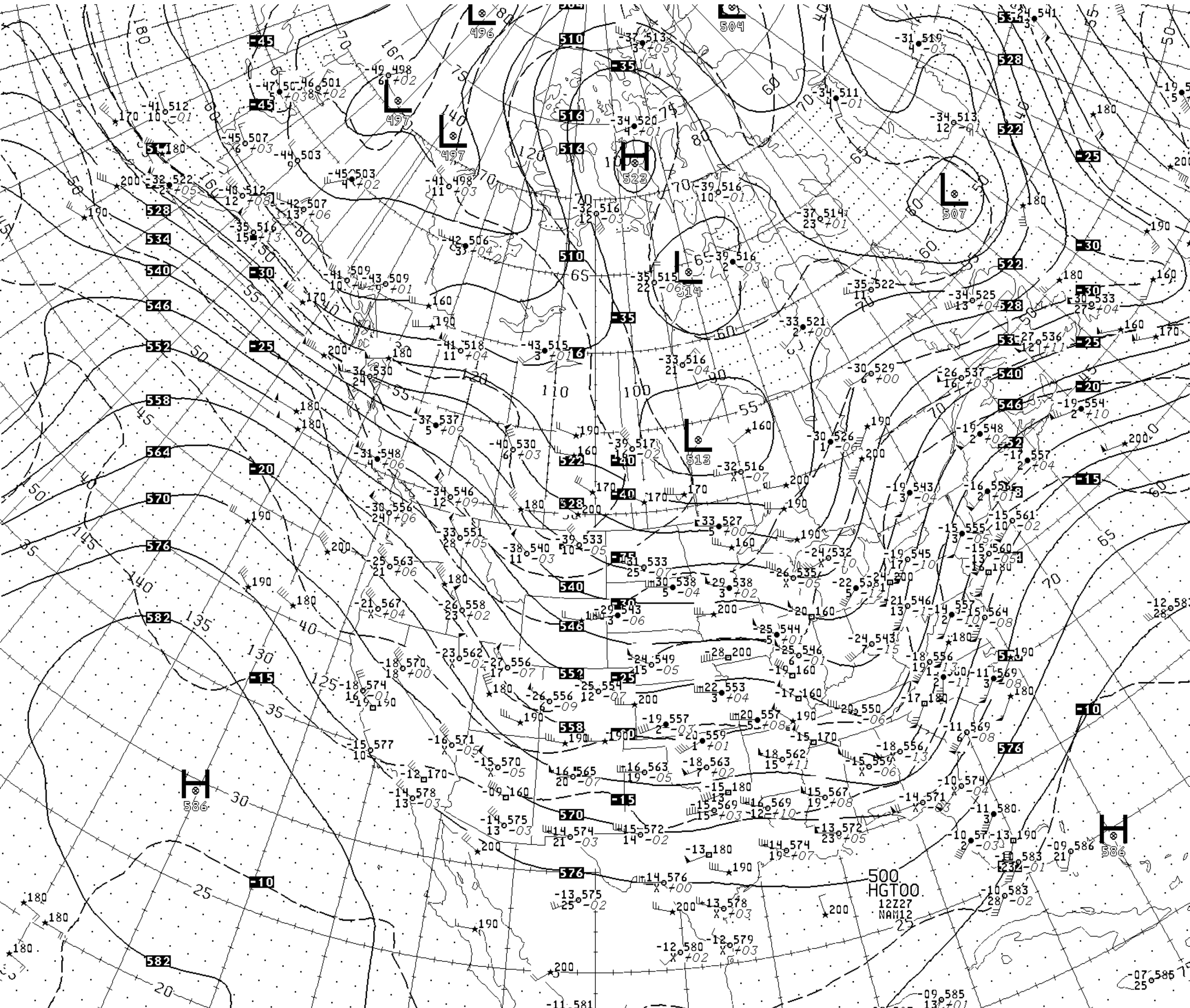
Missing sounding data for this day (12Z)

500 mb Maps



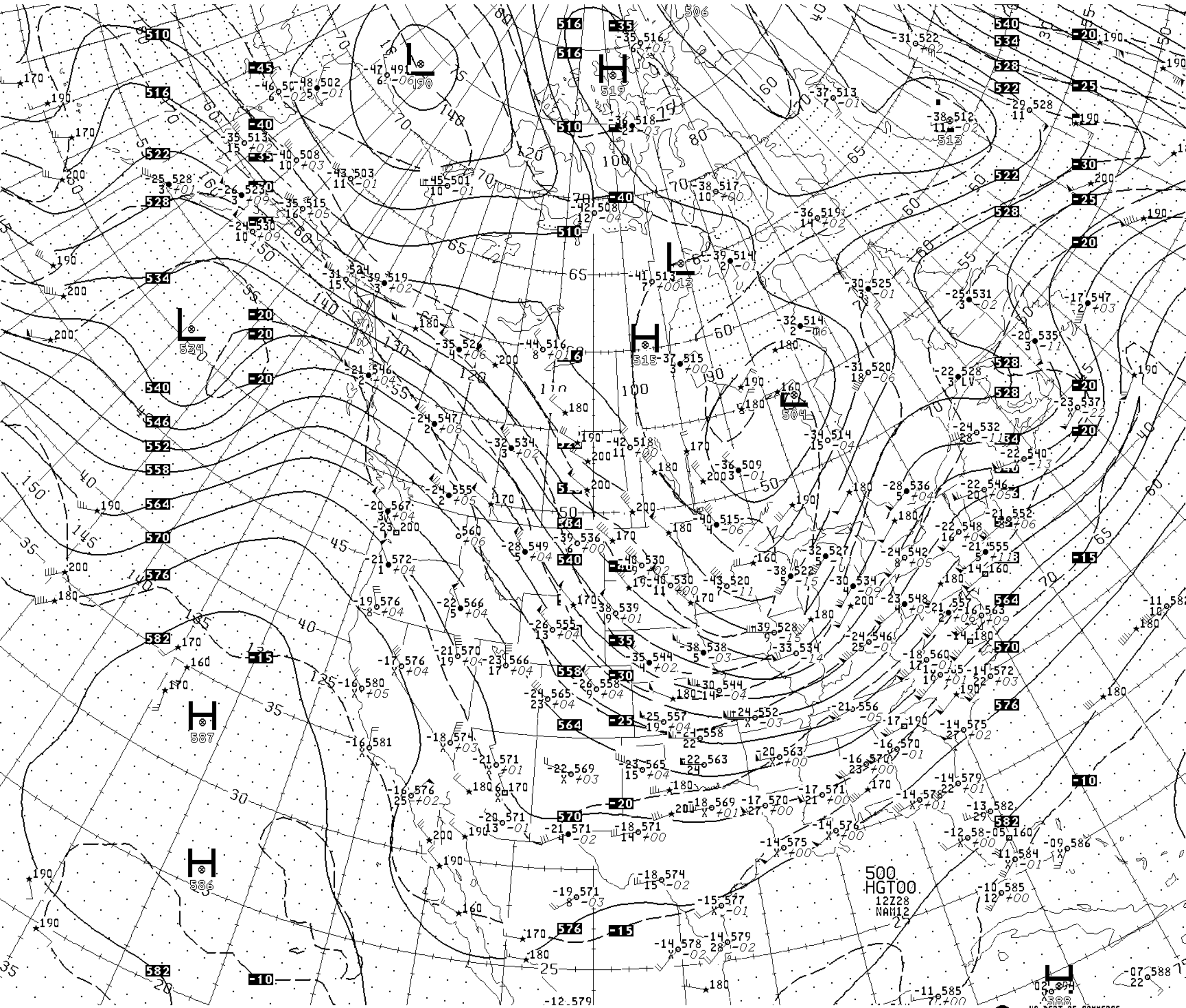
D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z THU 26 JAN 2012

US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



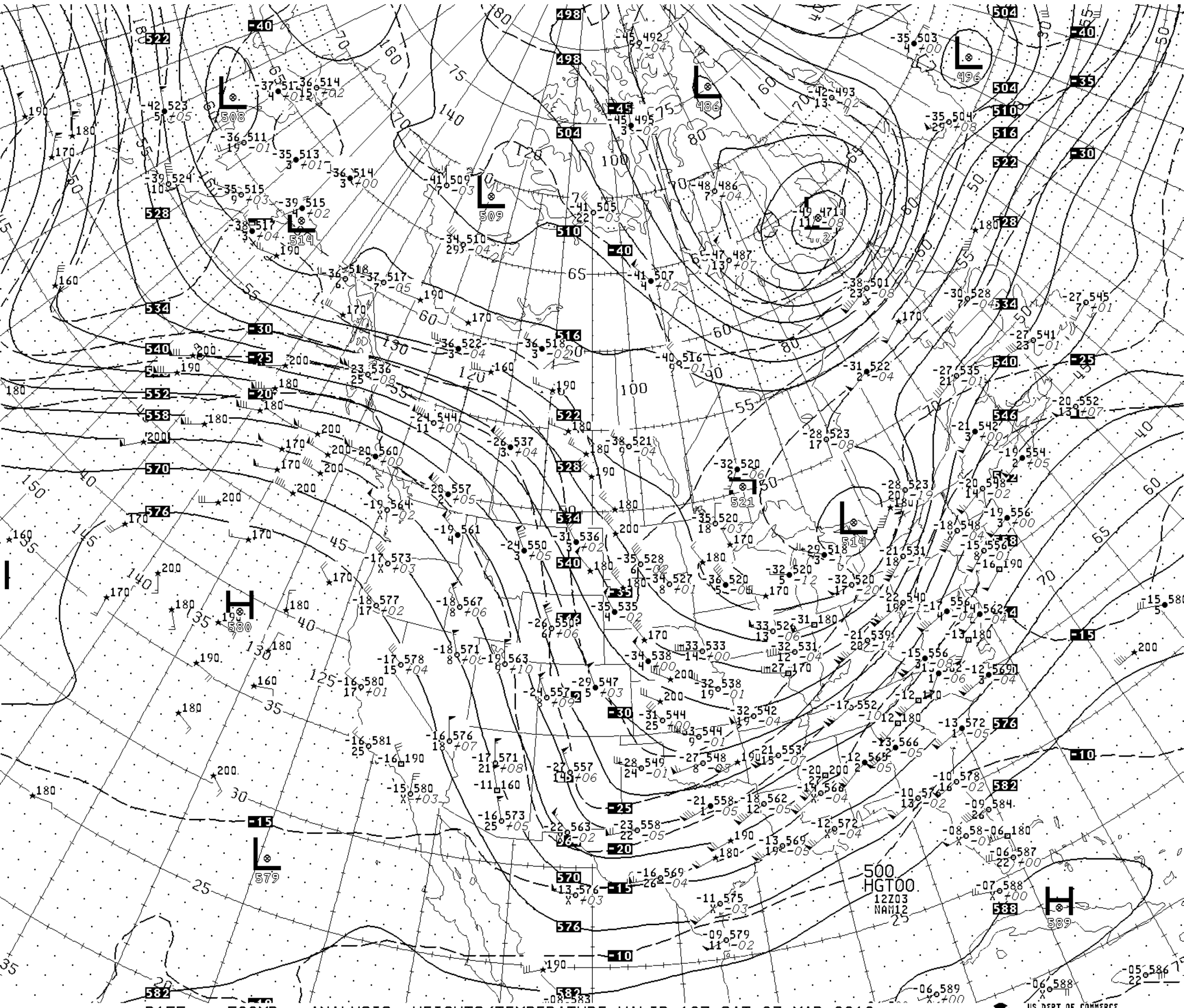
D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z FRI 27 JAN 2012

US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



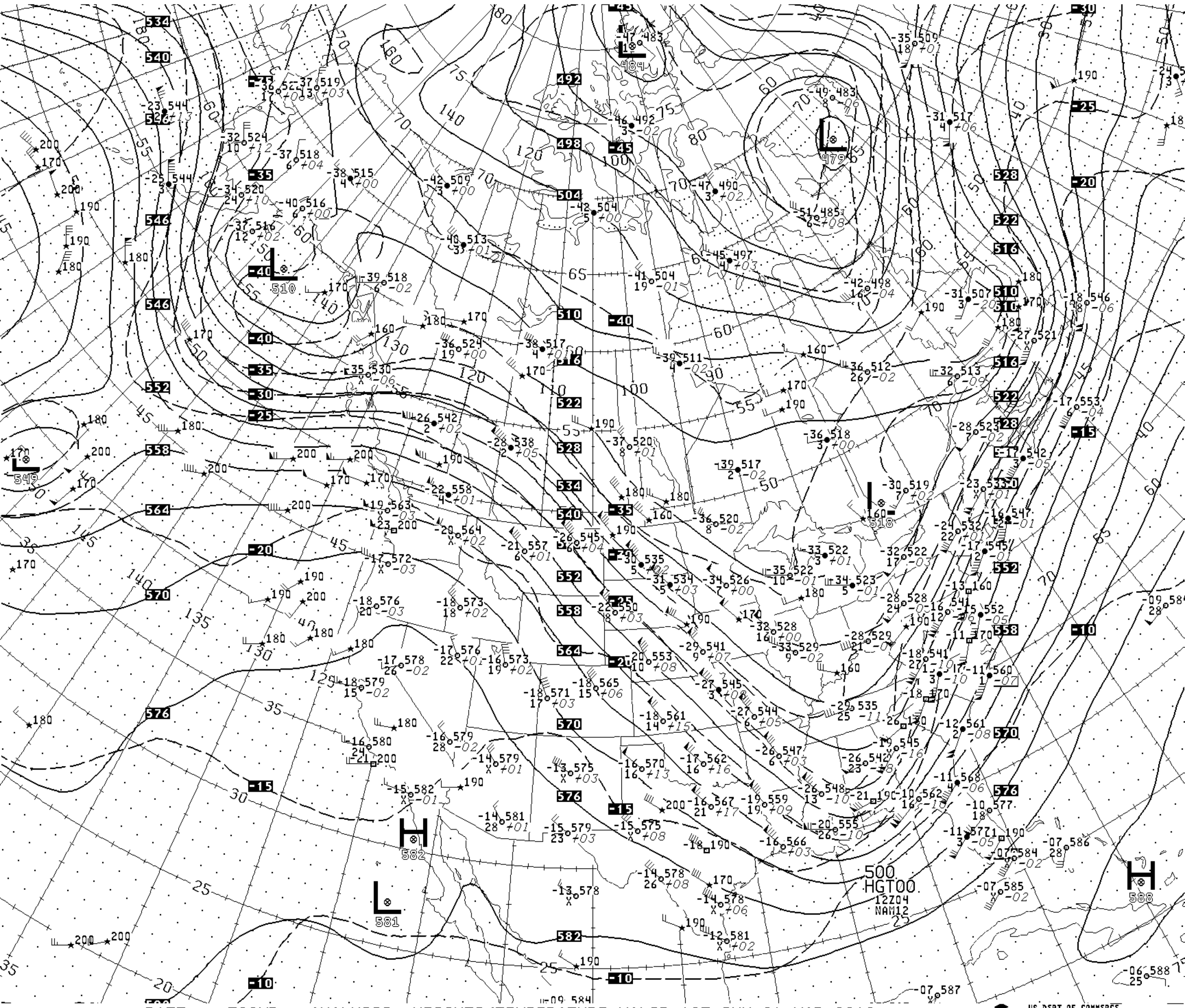
D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z SAT 28 JAN 2012

US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



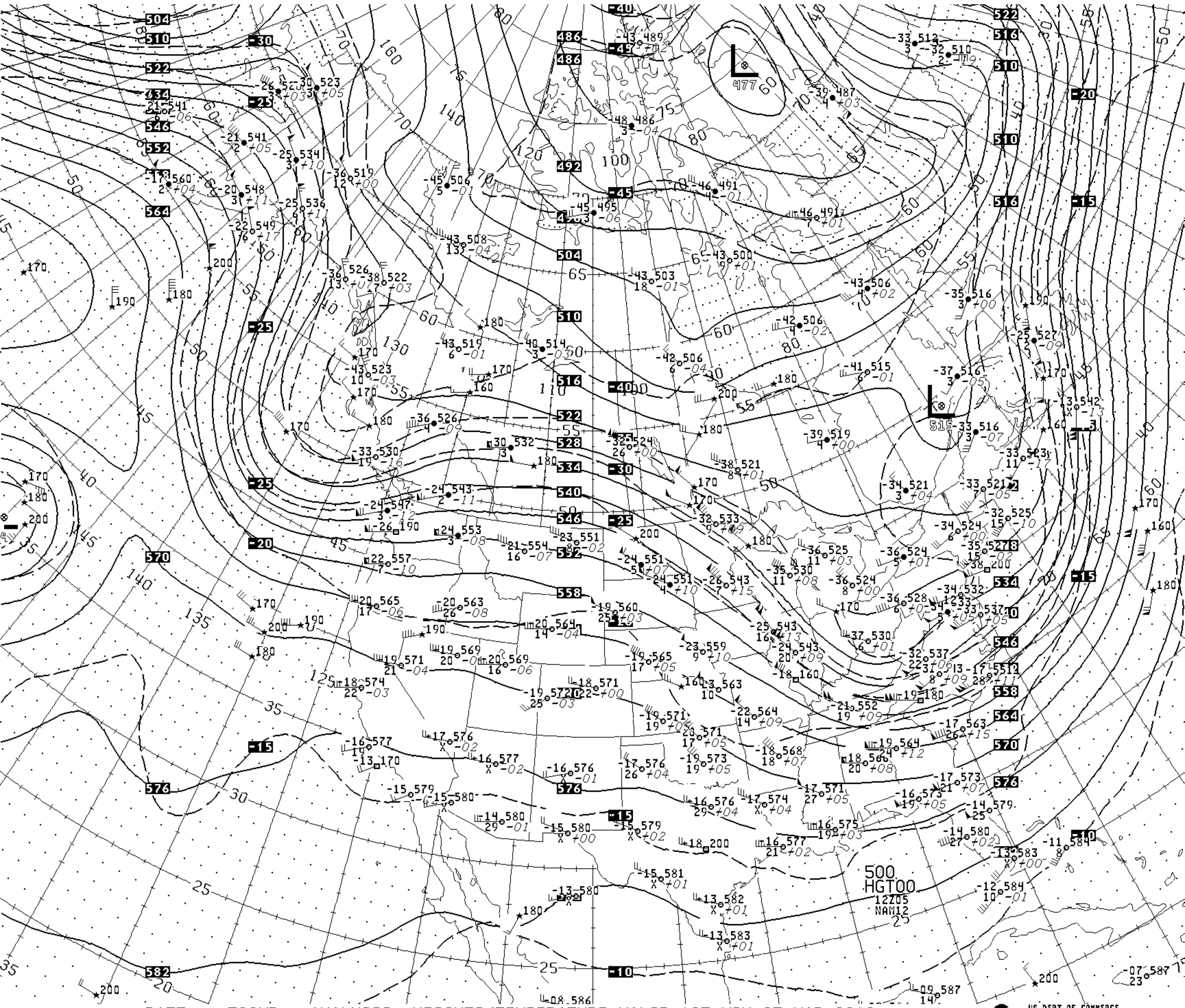
D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z SAT 03 MAR 2012

US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



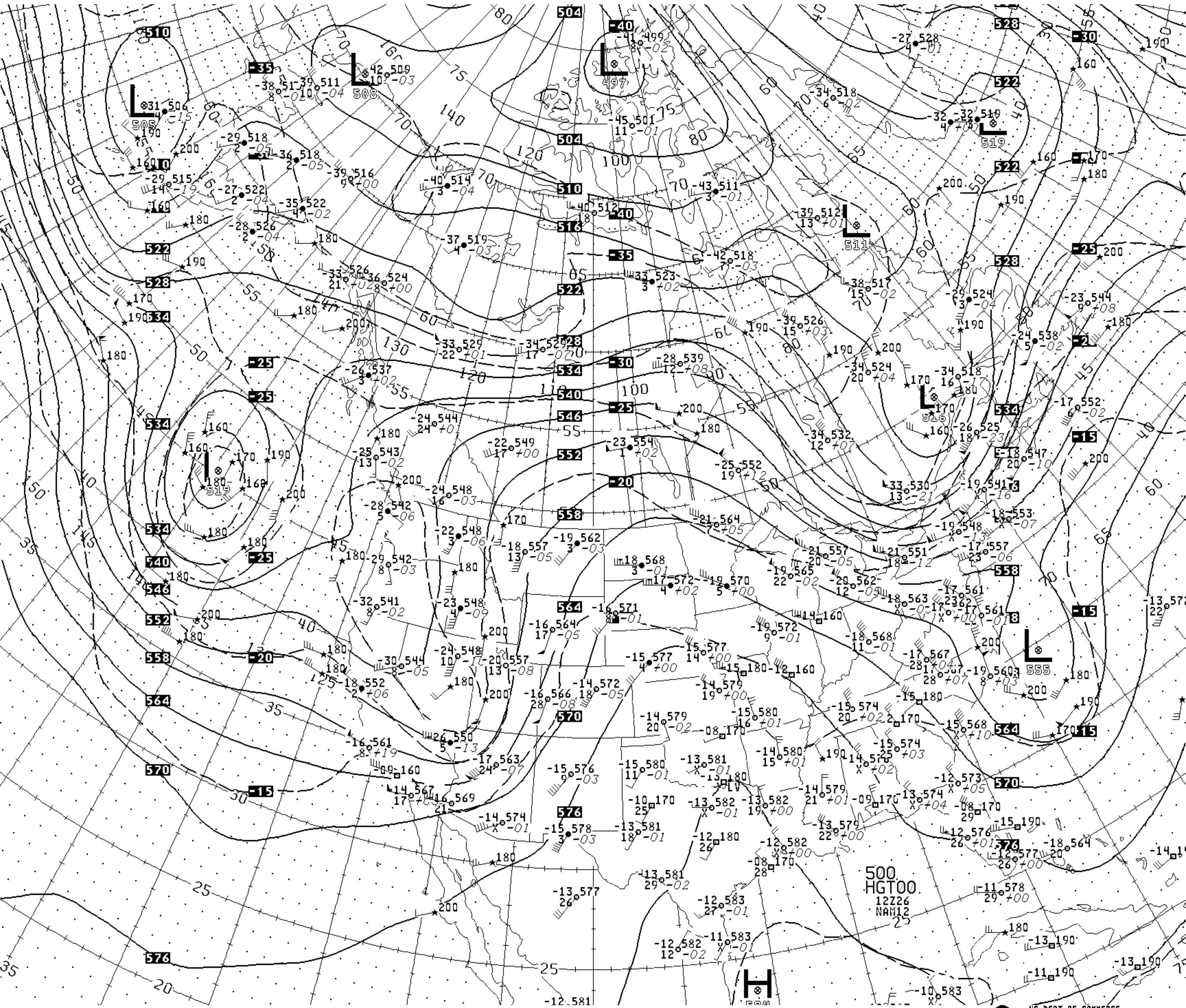
D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z SUN 04 MAR 2012

US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



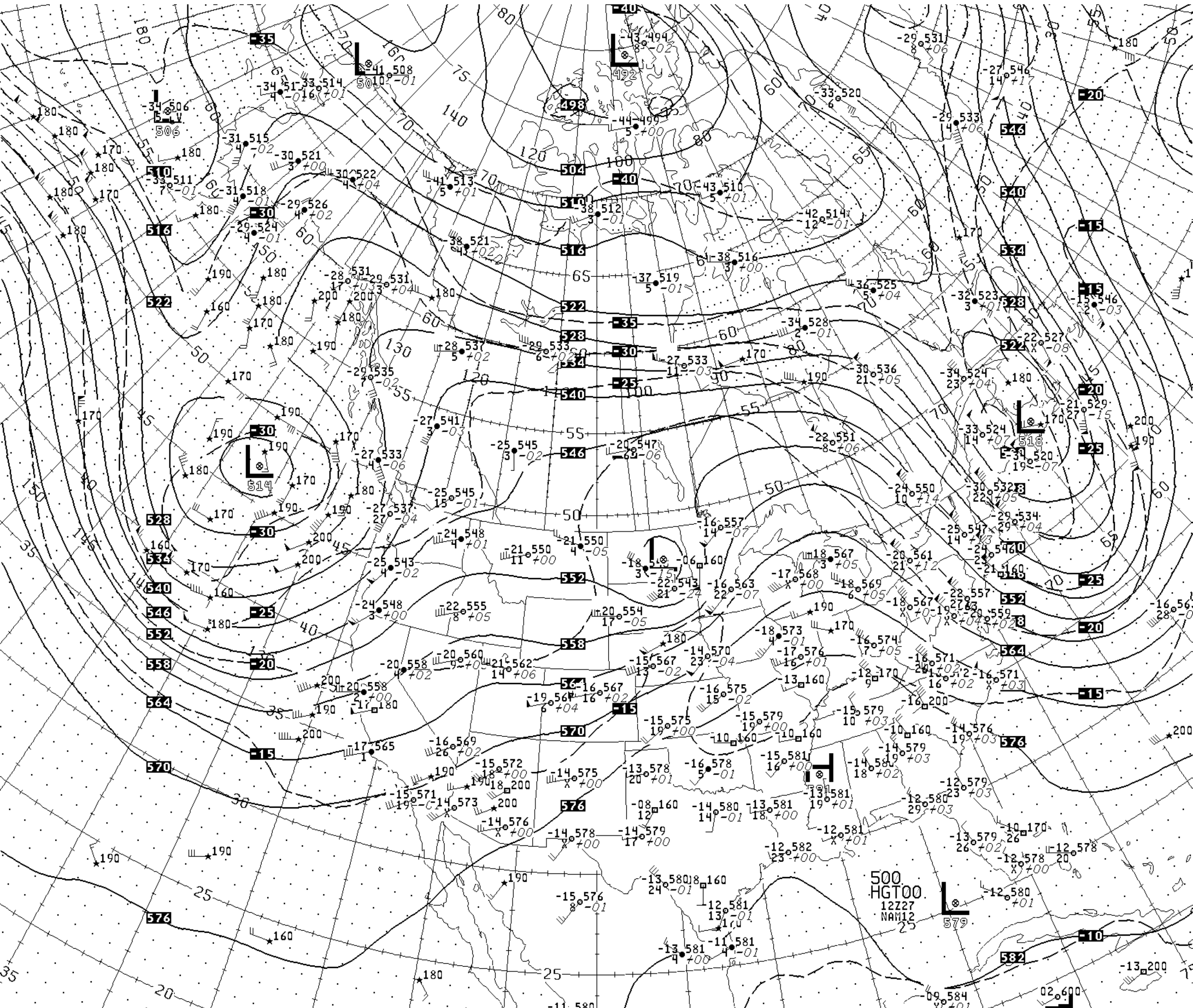
D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z MON 05 MAR 2012

US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



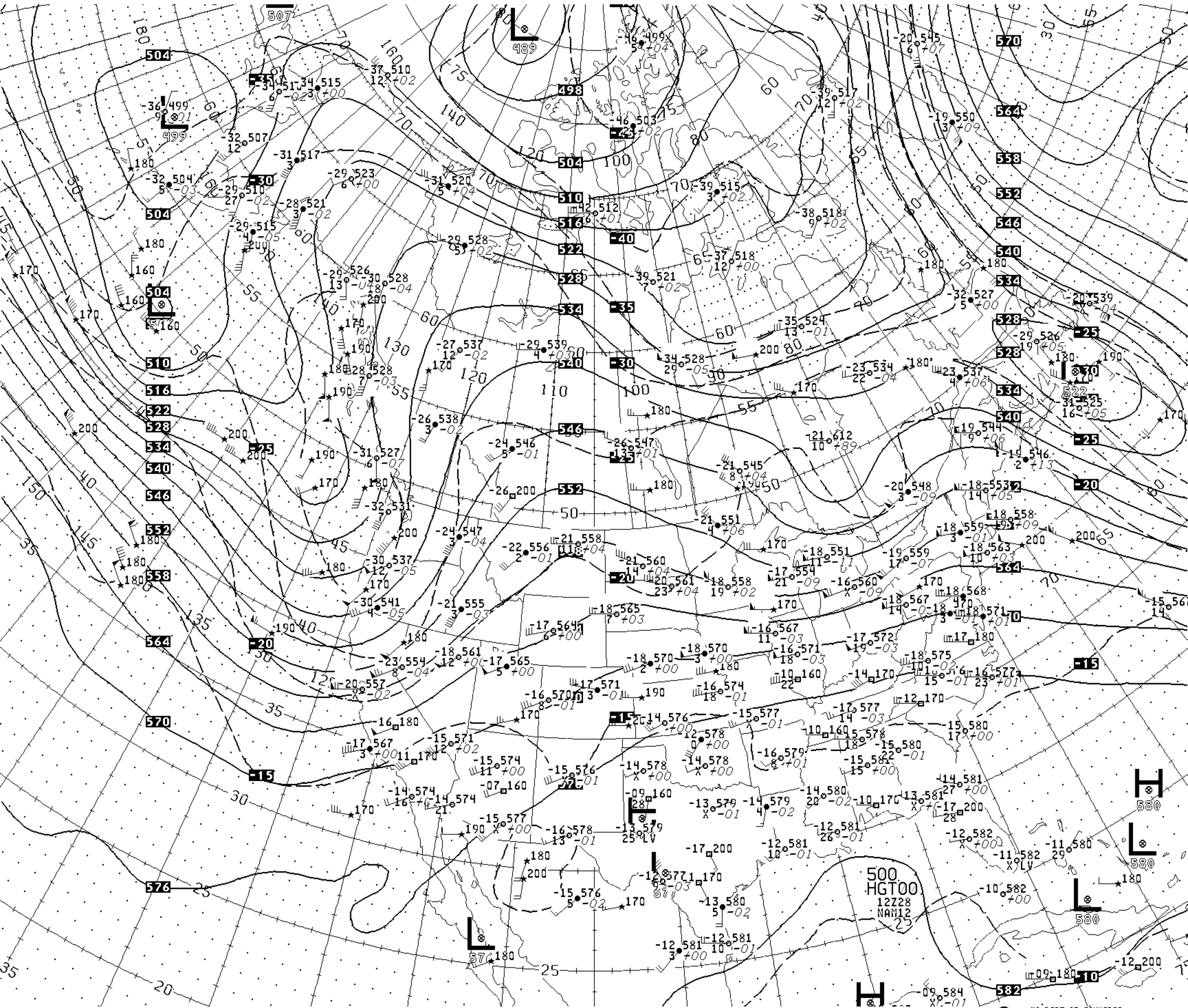
D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z MON 26 MAR 2012

US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



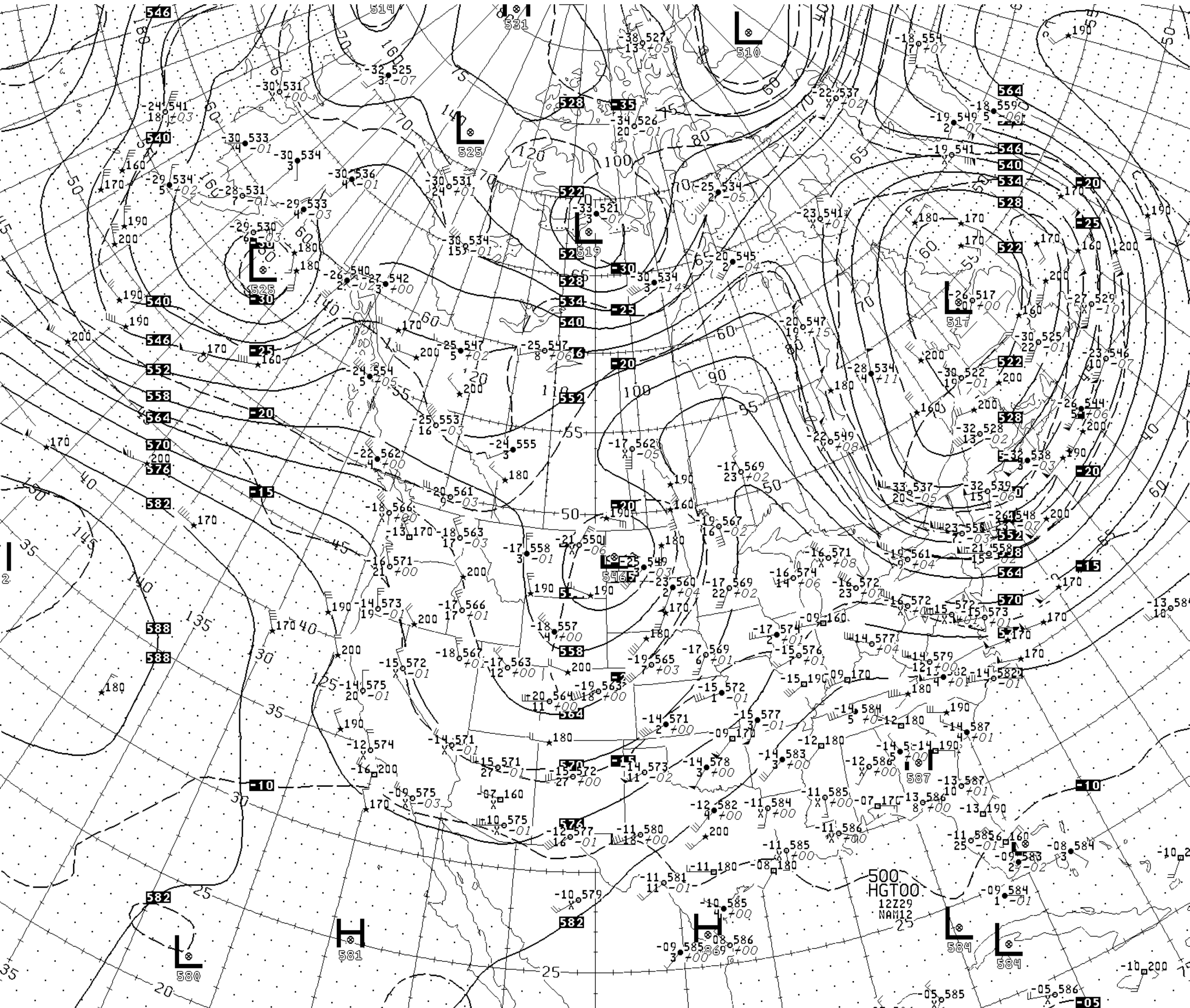
D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z TUE 27 MAR 2012

US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON

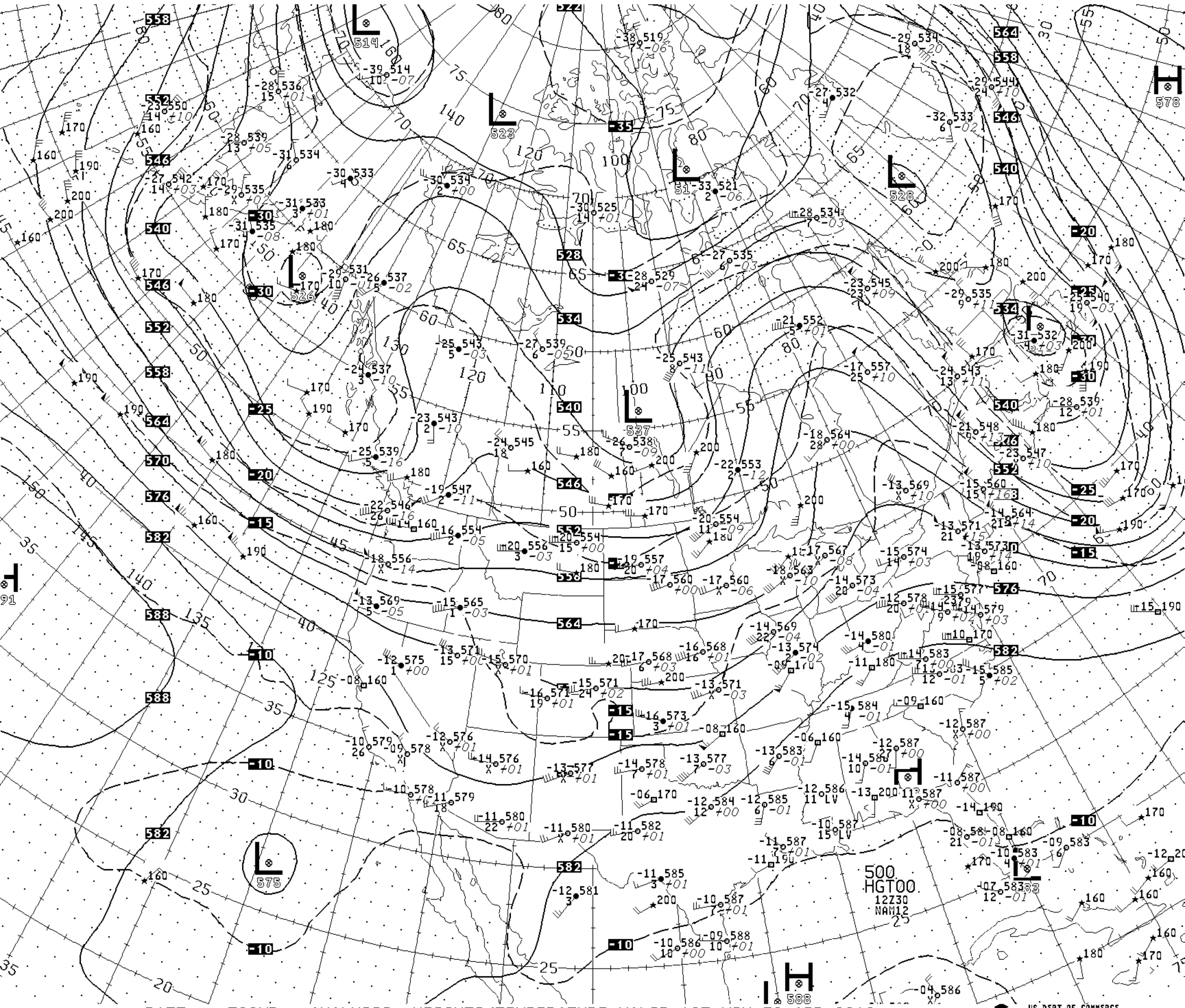


D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z WED 28 MAR 2012

US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON

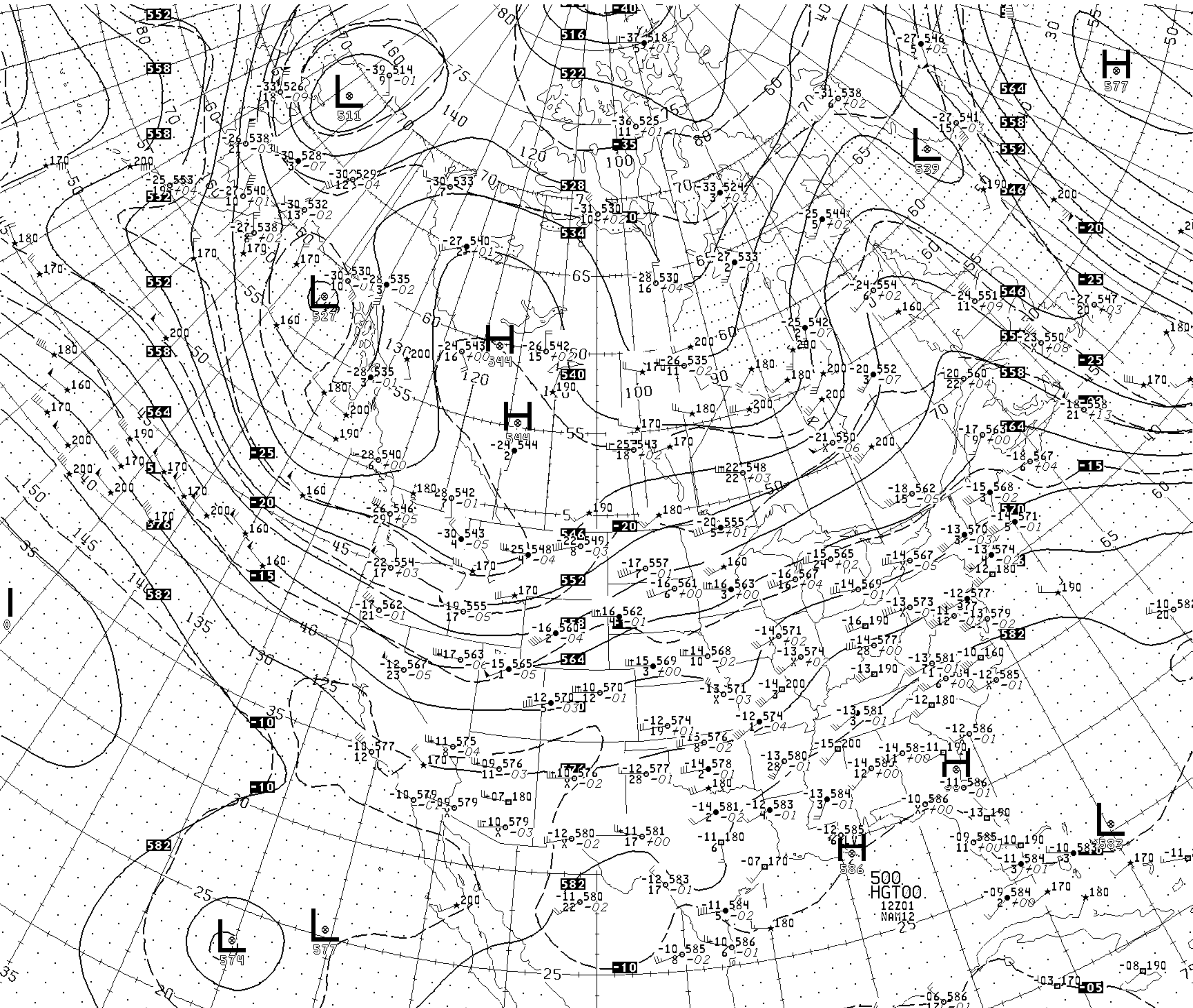


D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z SUN 29 APR 2012



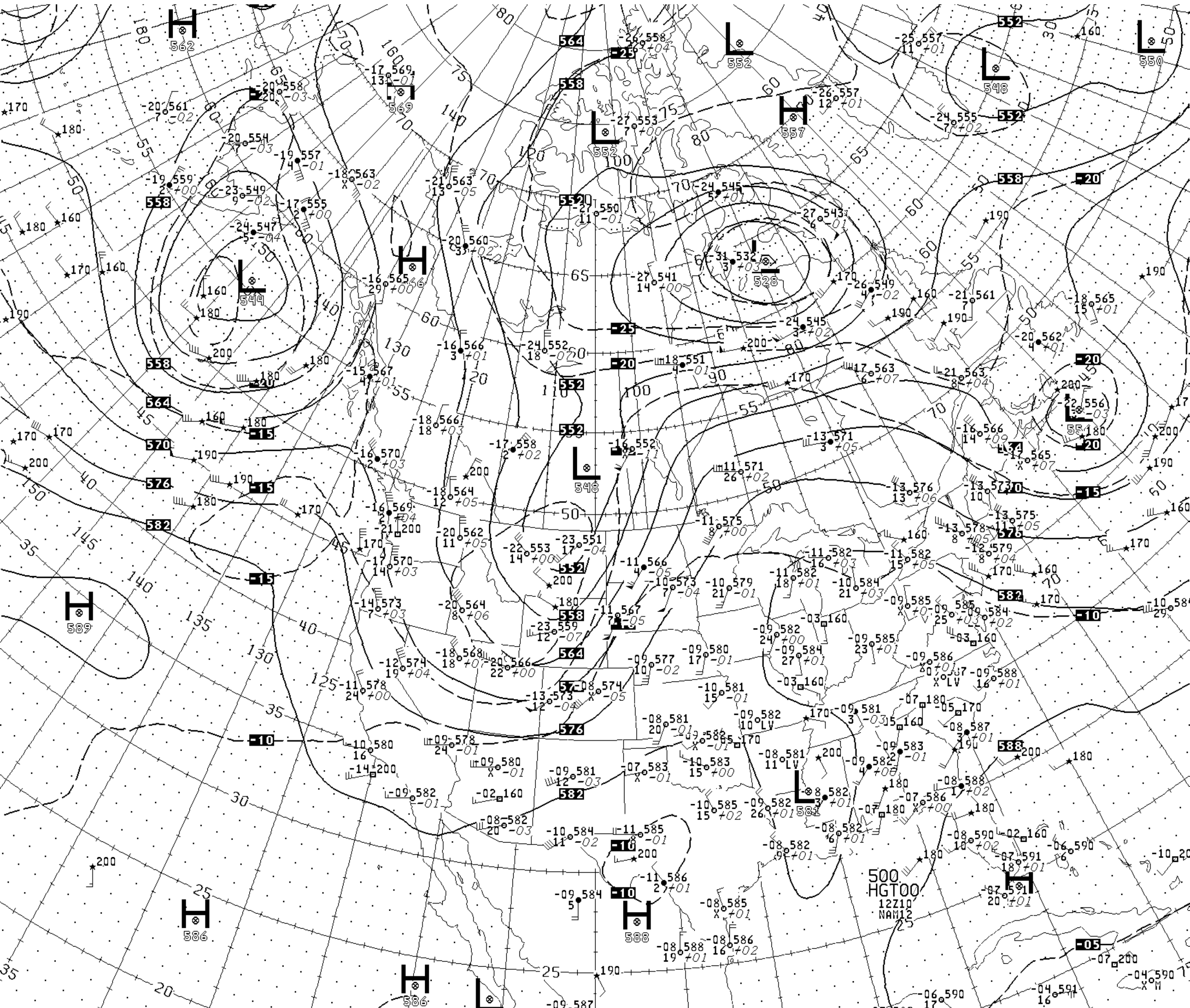
D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z MON 30 APR 2012

US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



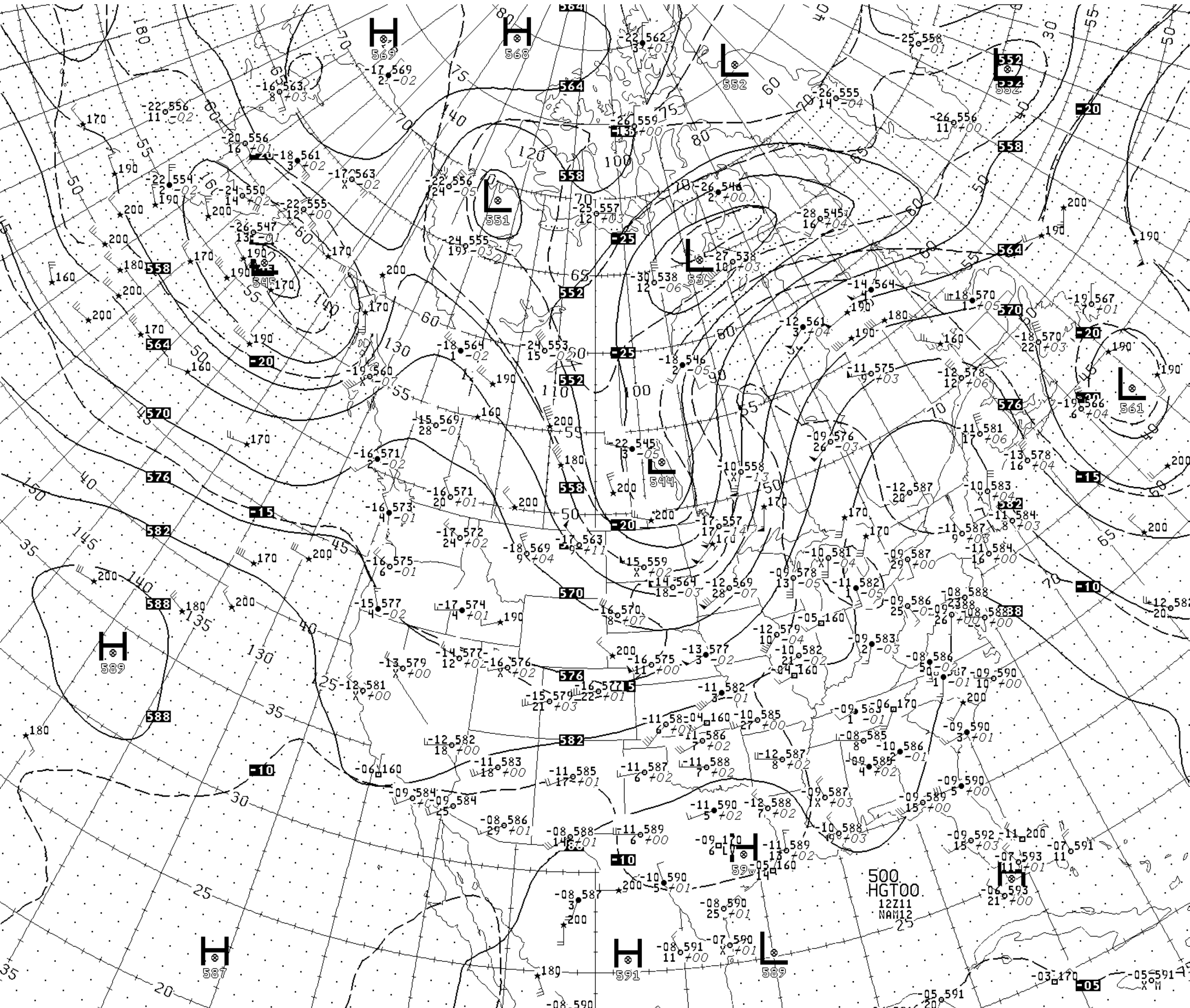
D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z TUE 01 MAY 2012

US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



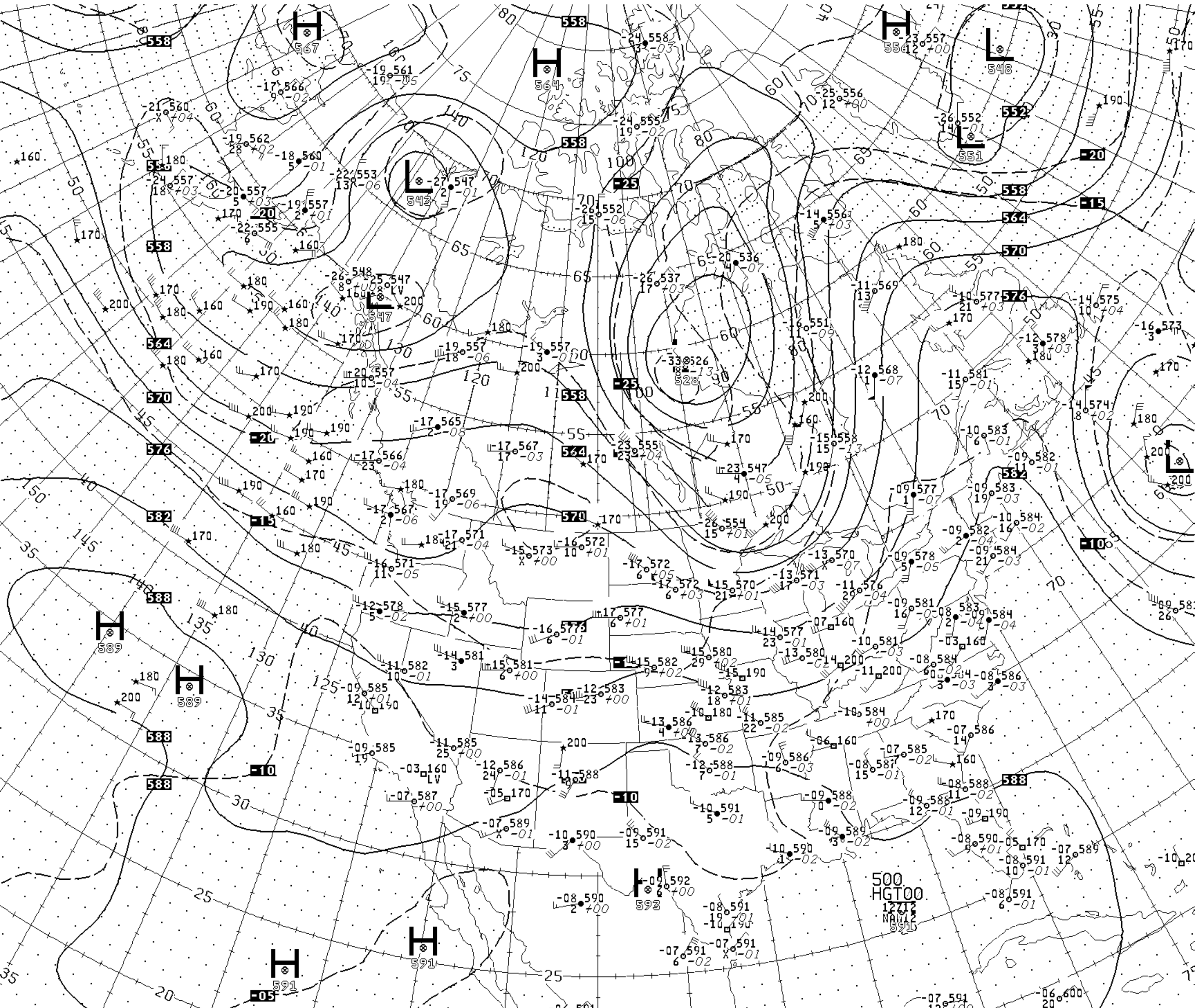
D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z SUN 10 JUN 2012

US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z MON 11 JUN 2012

US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



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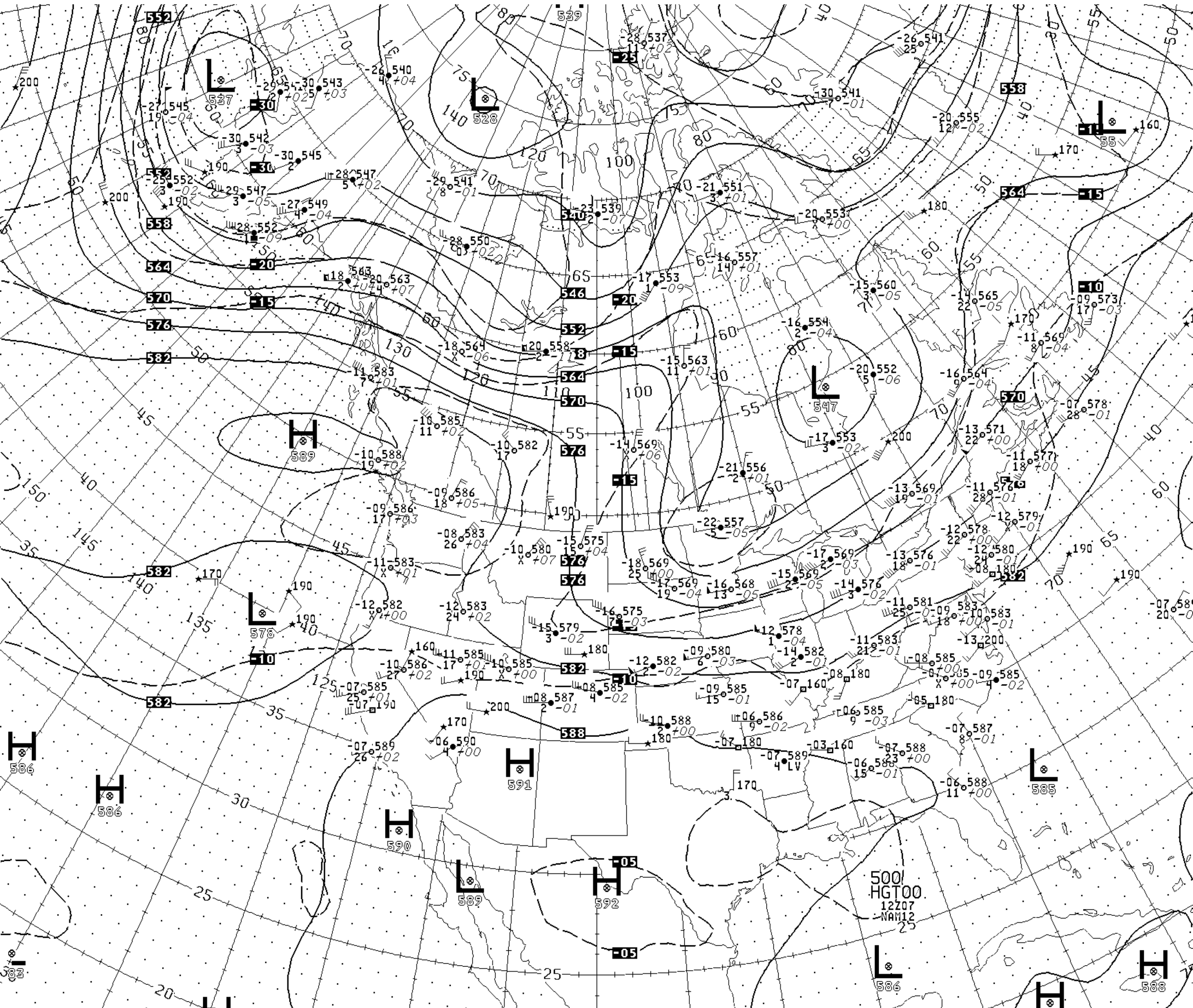
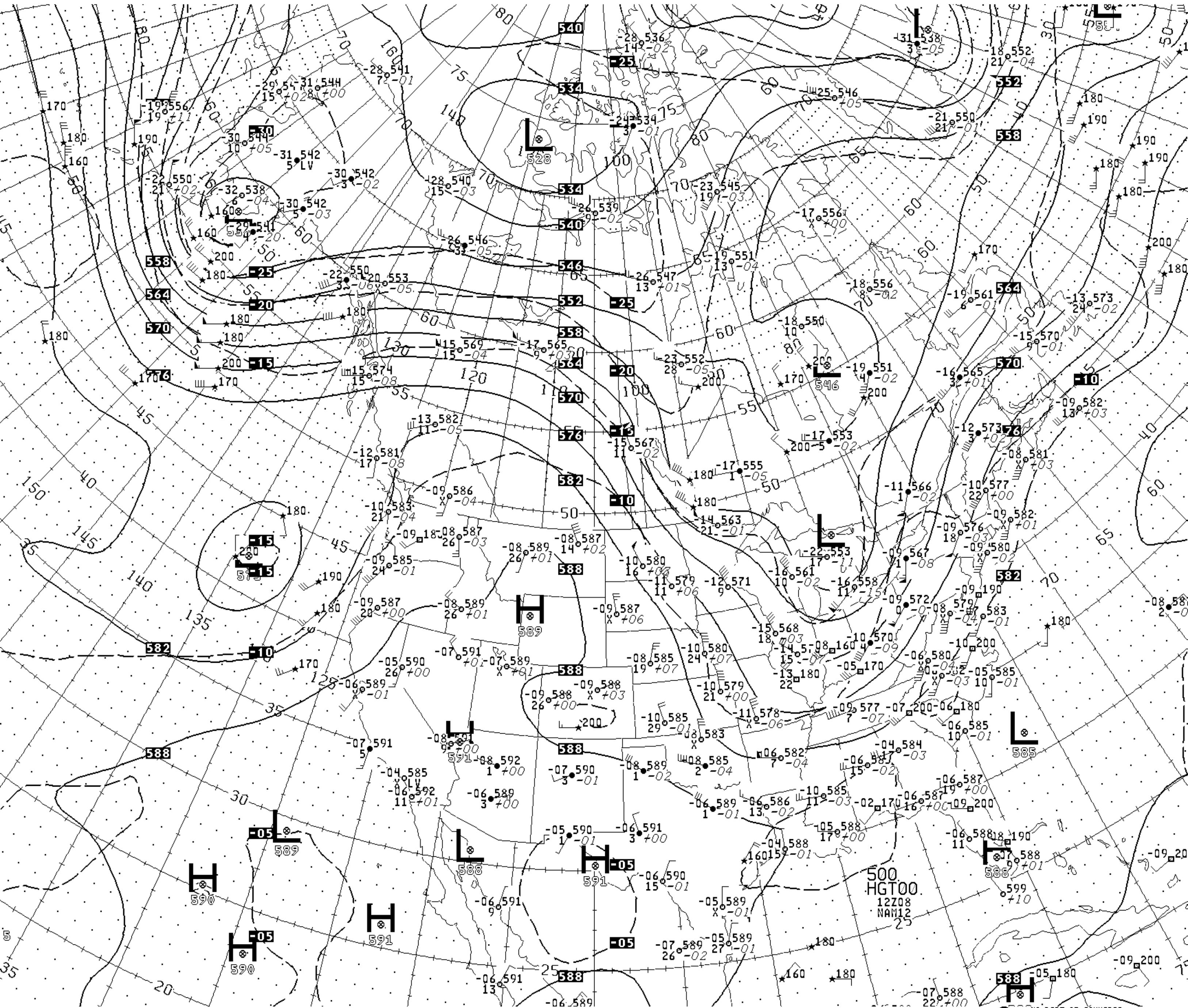
US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z FRI 07 SEP 2012

US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



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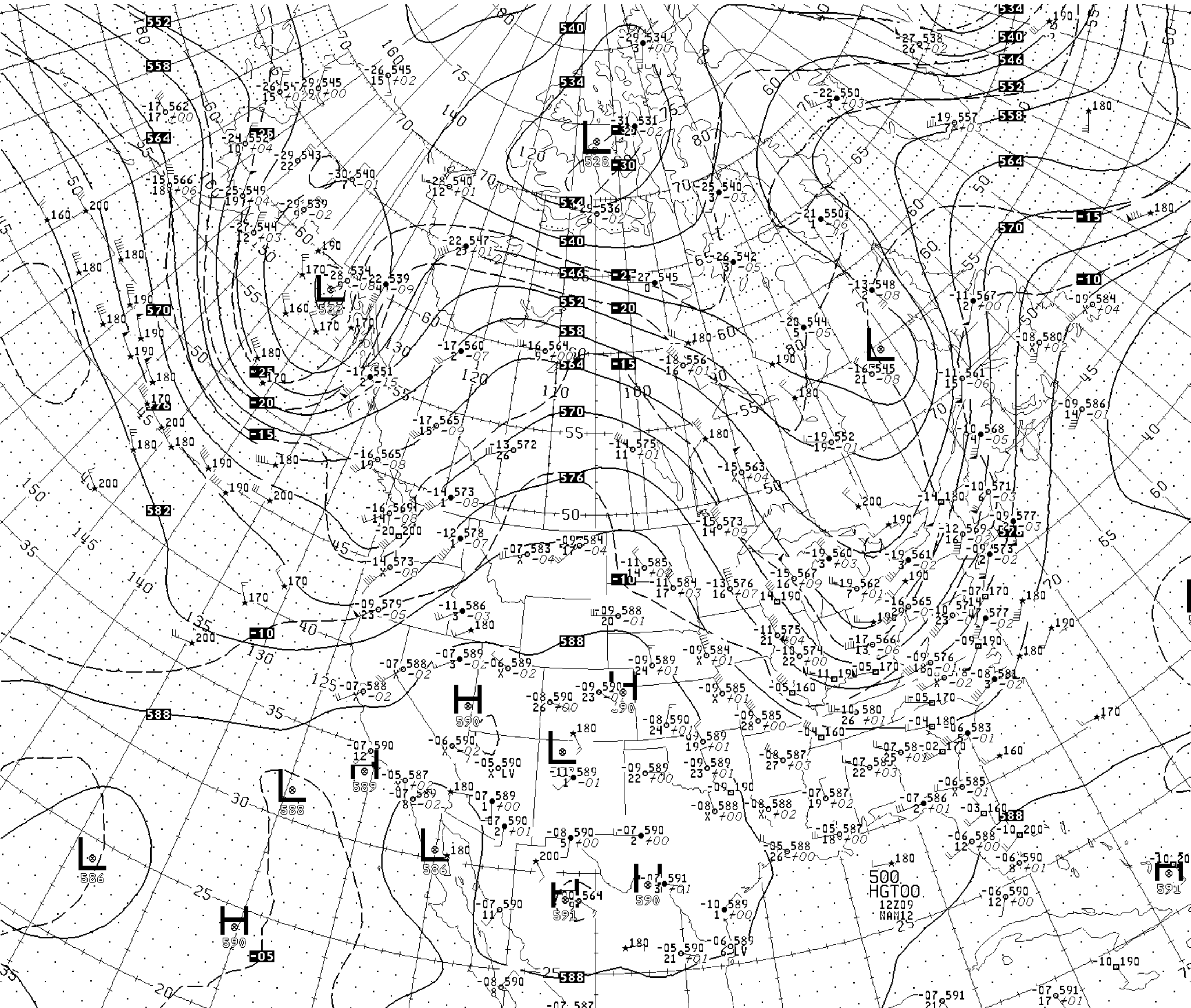

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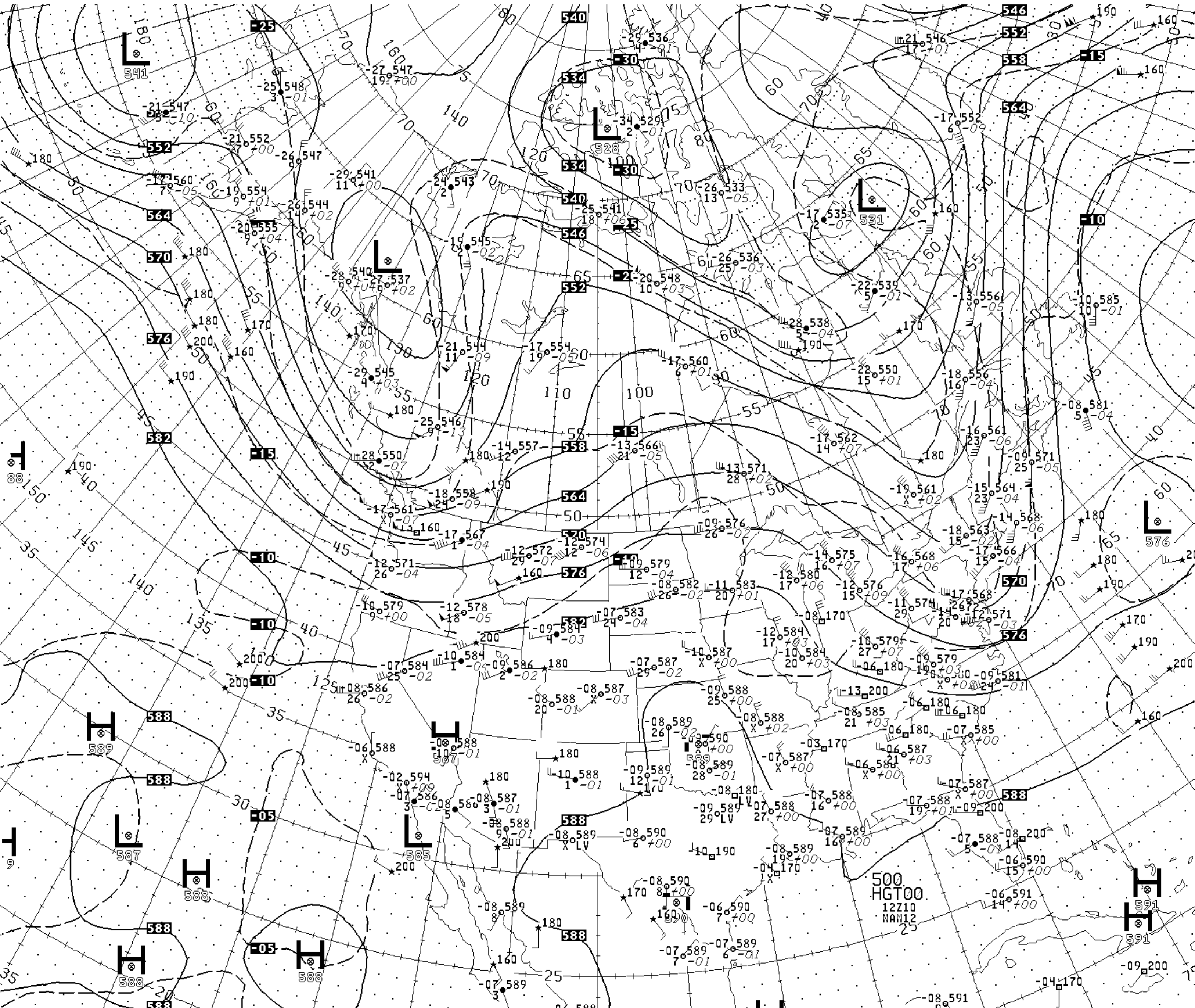
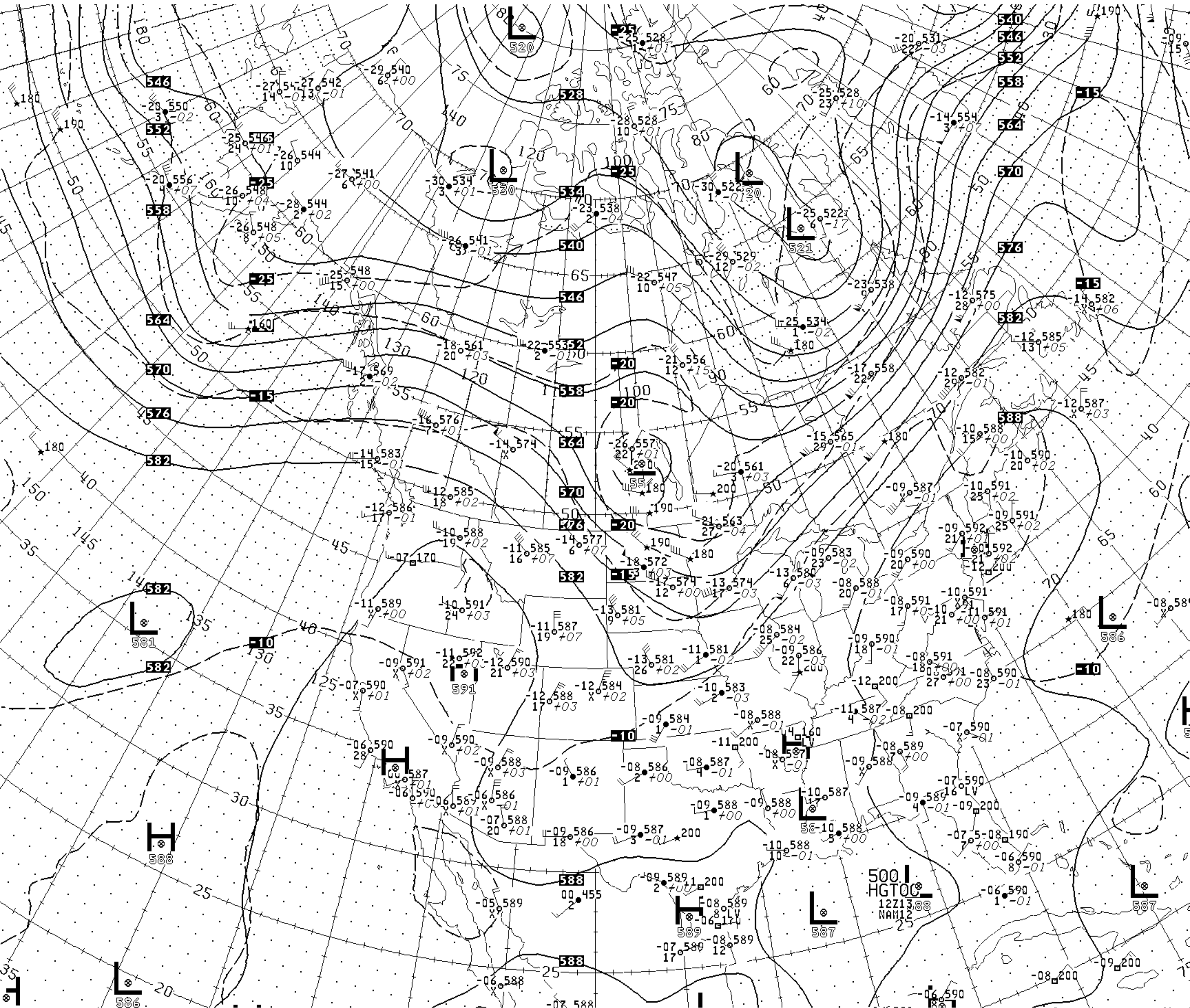


D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z MON 10 SEP 2012

US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



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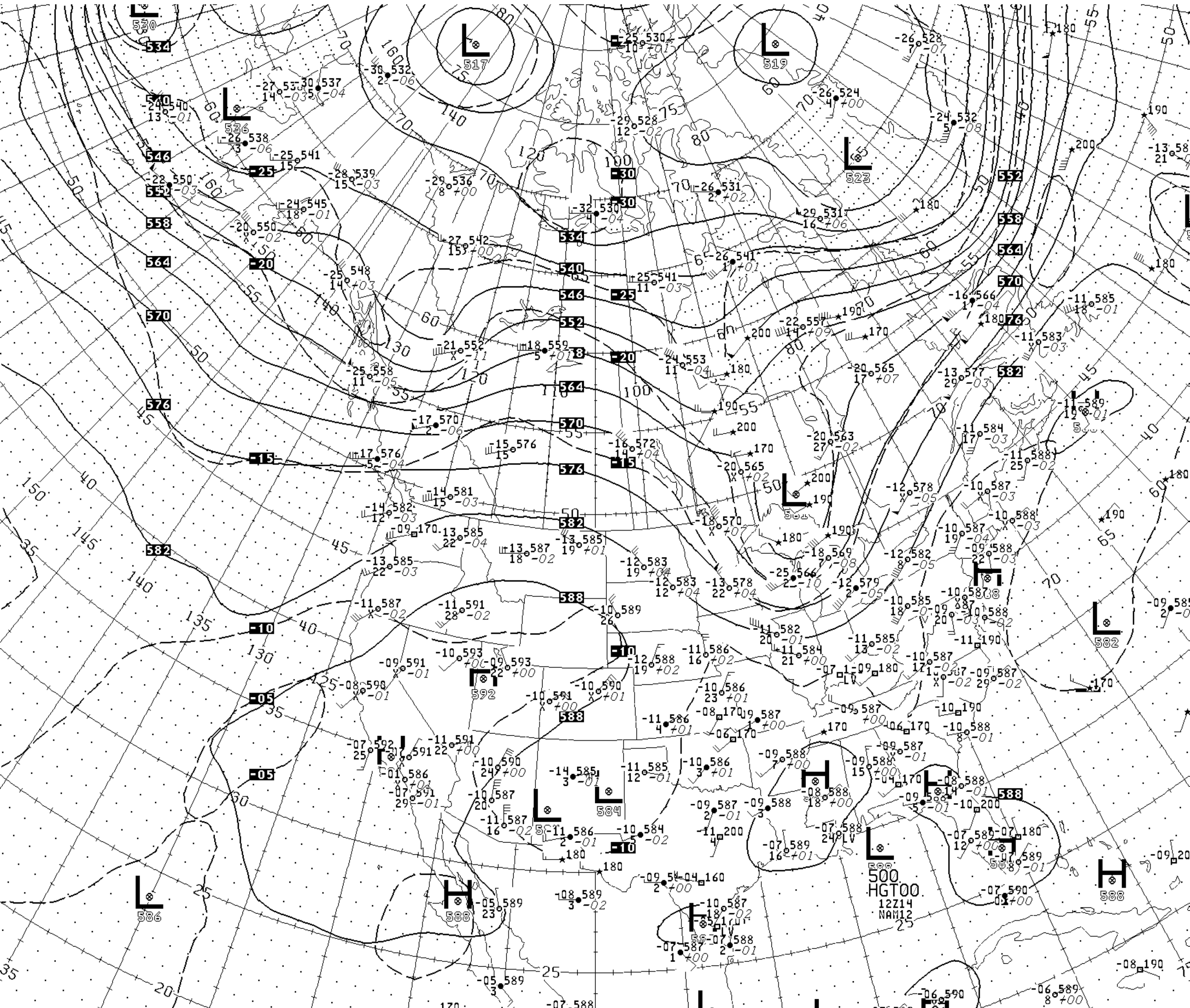
US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



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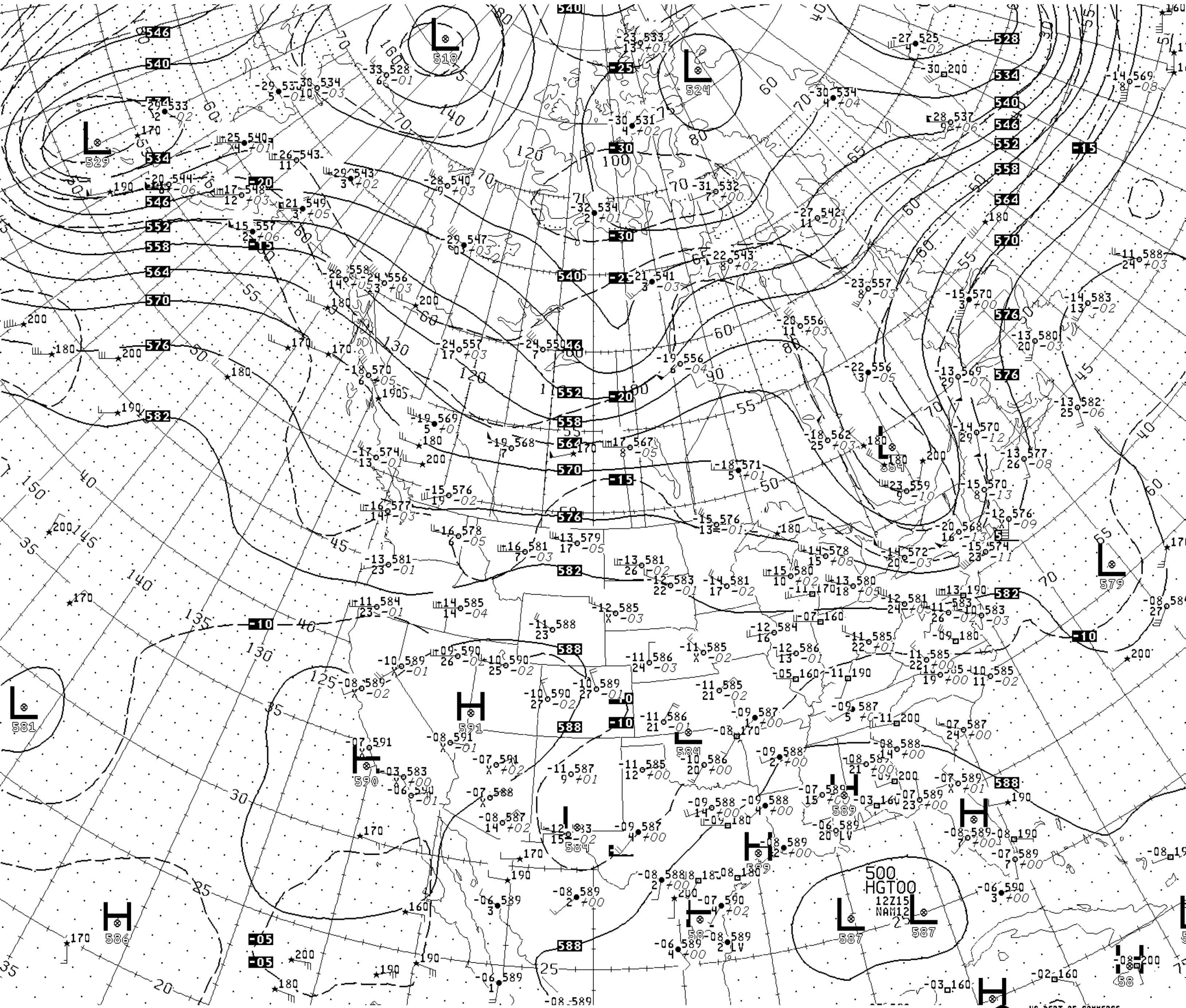
US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



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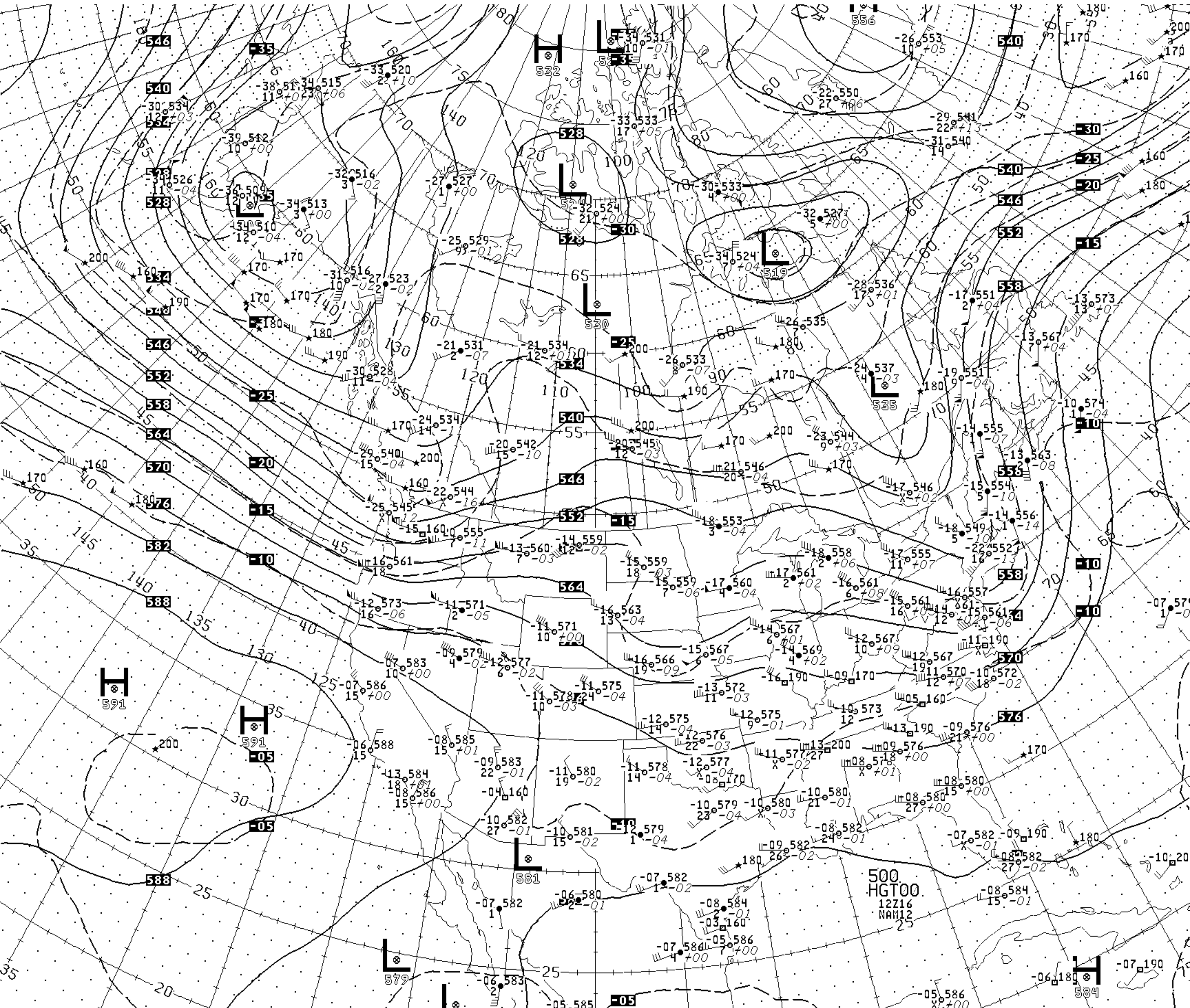
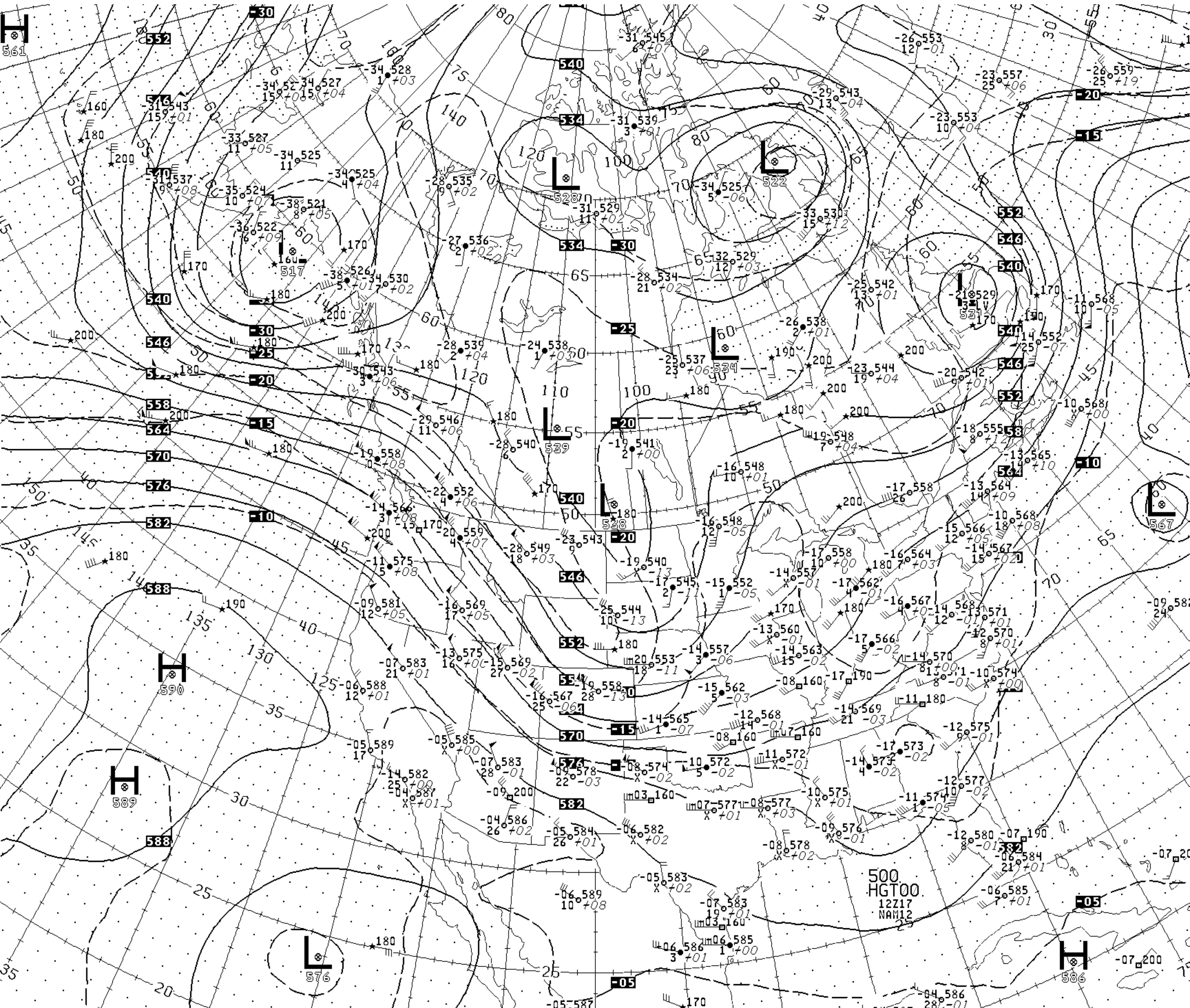
US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



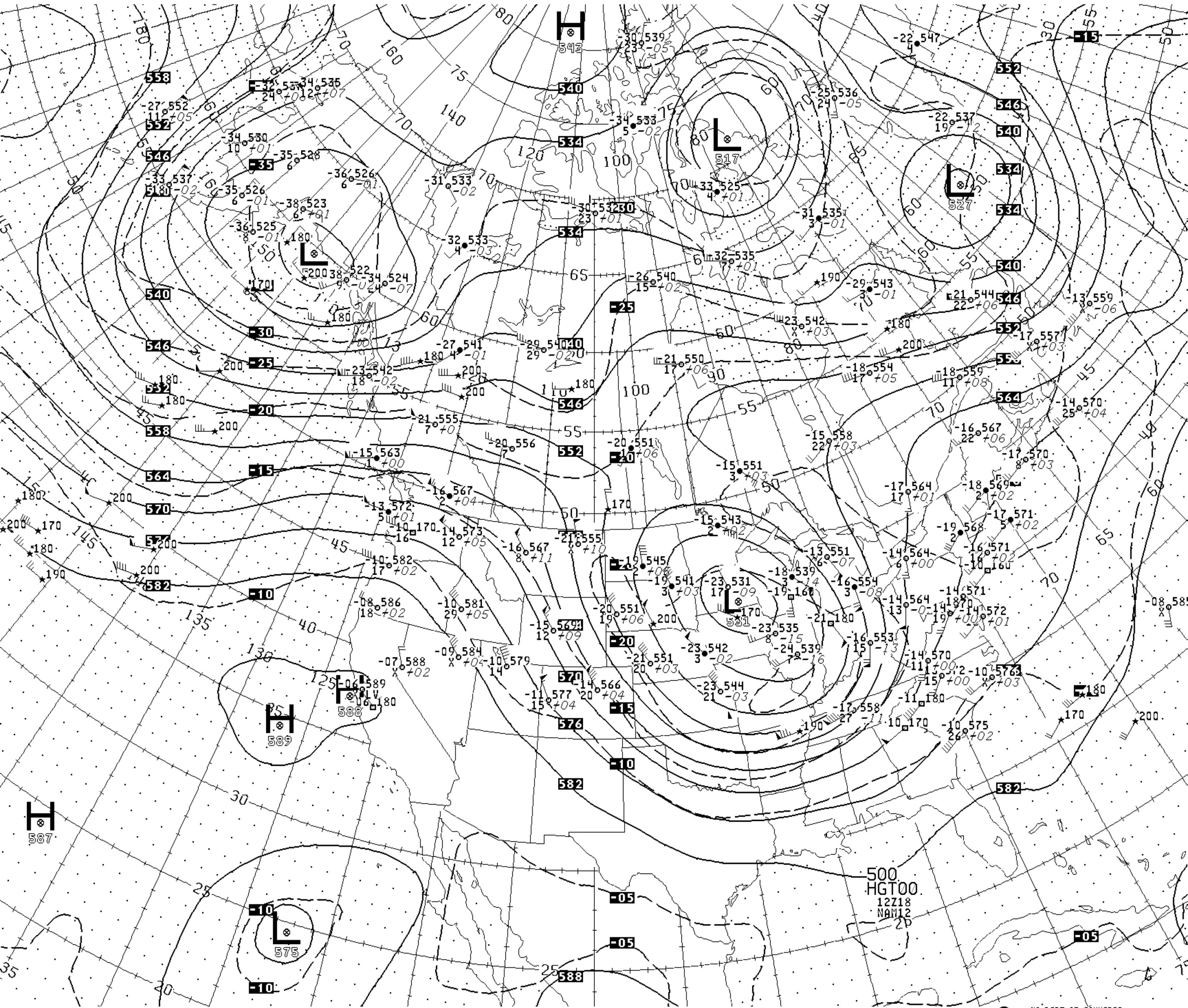
D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z TUE 16 OCT 2012

US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z WED 17 OCT 2012

US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



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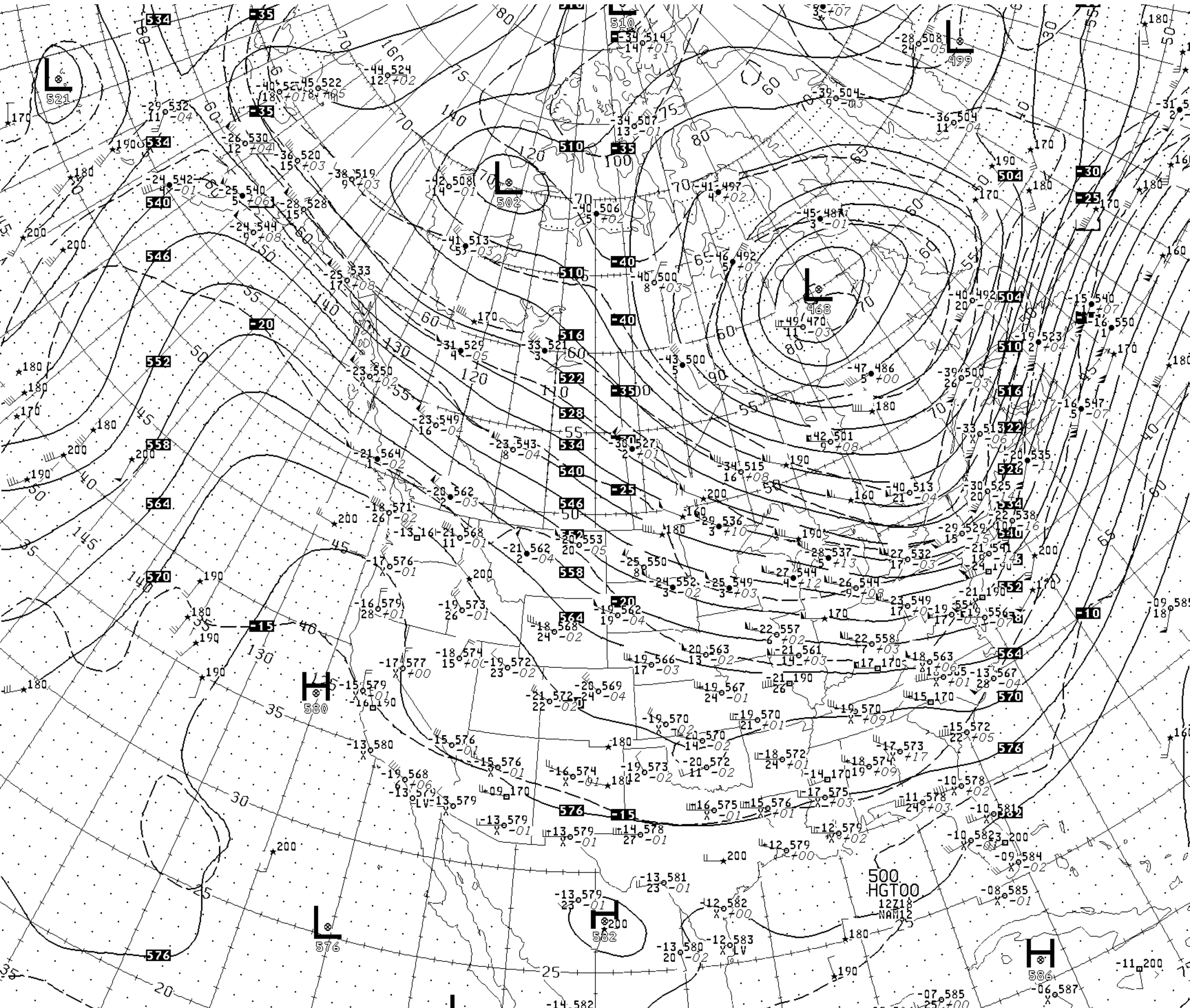
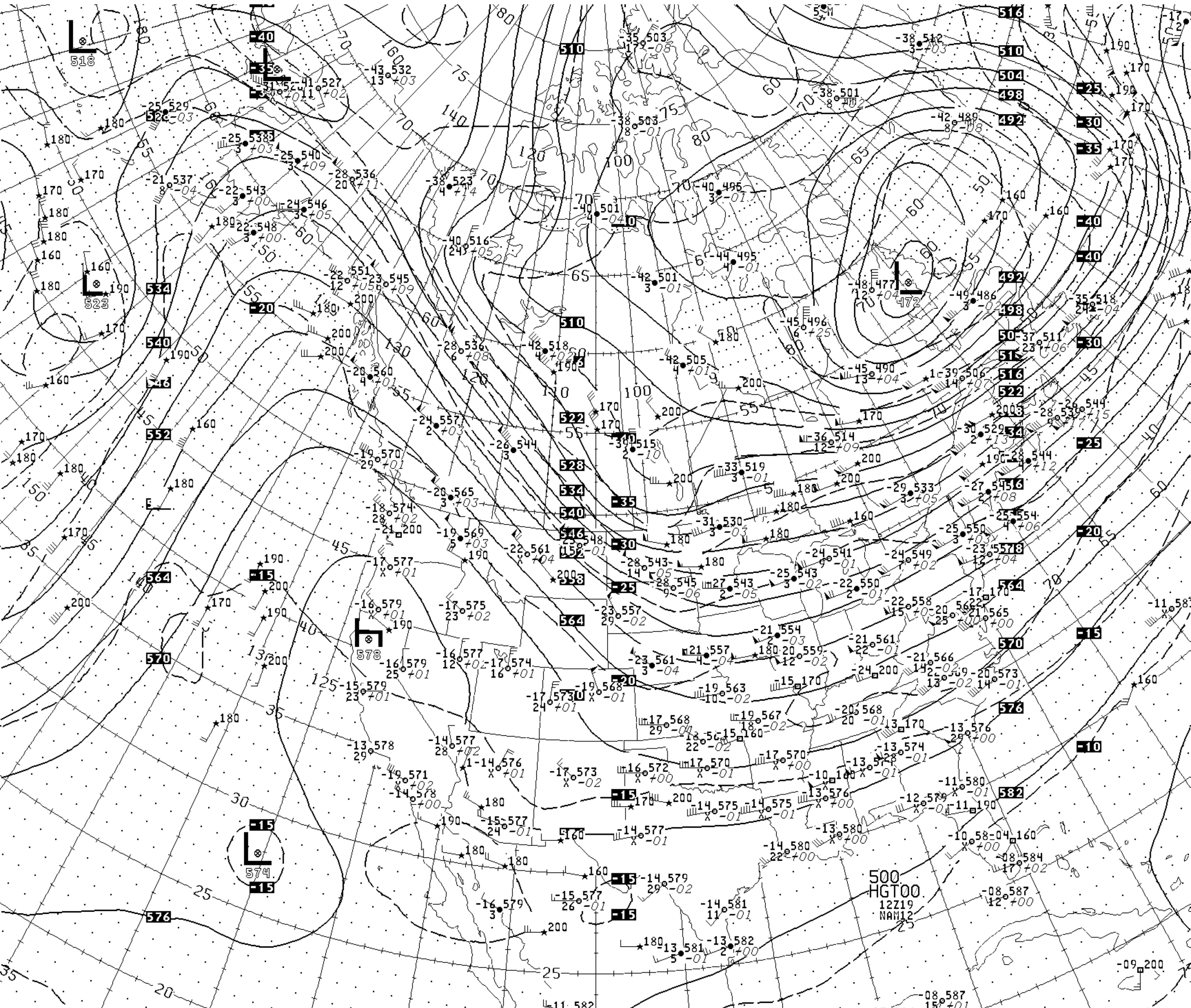
US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z FRI 18 JAN 2013

US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



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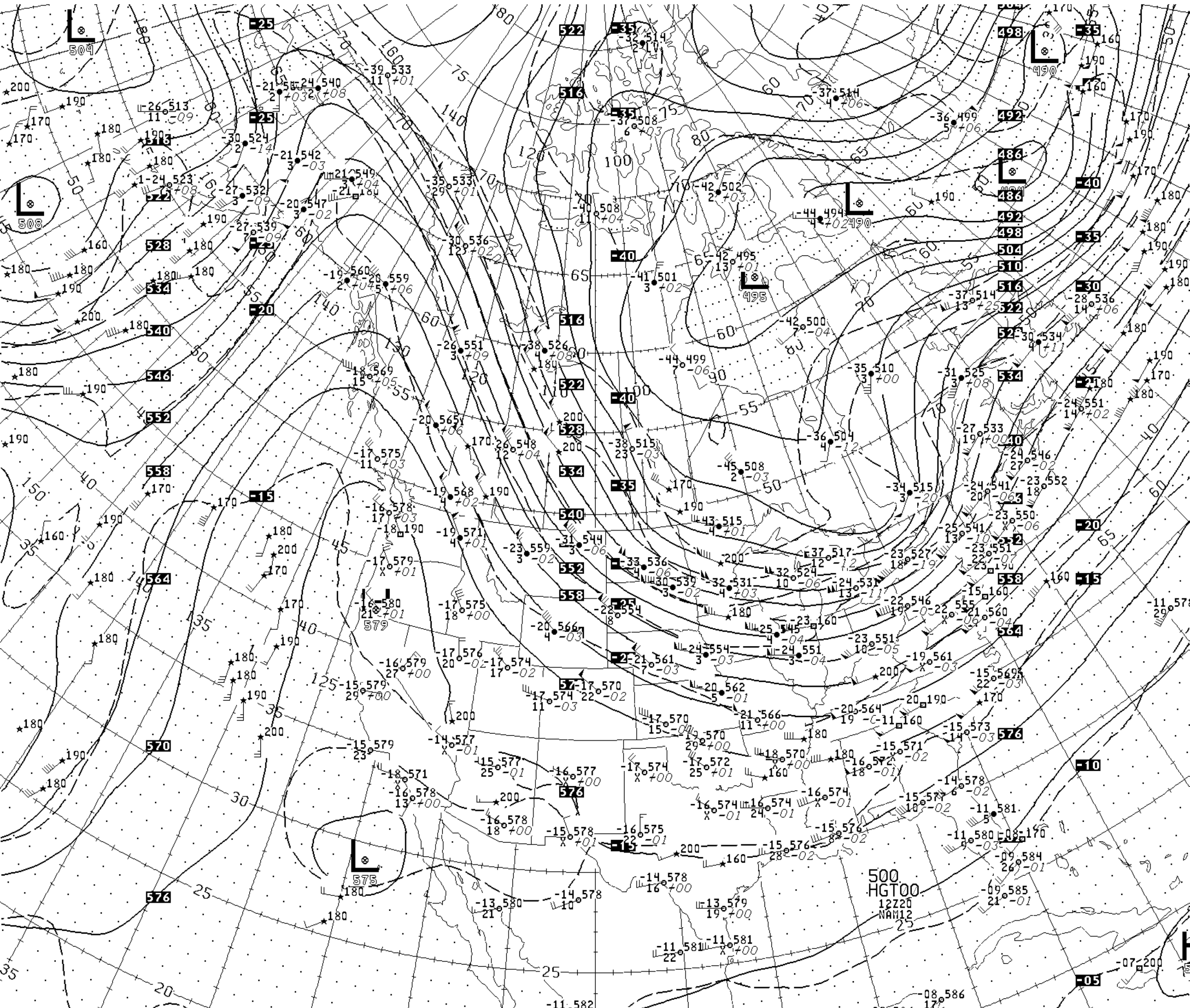
US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



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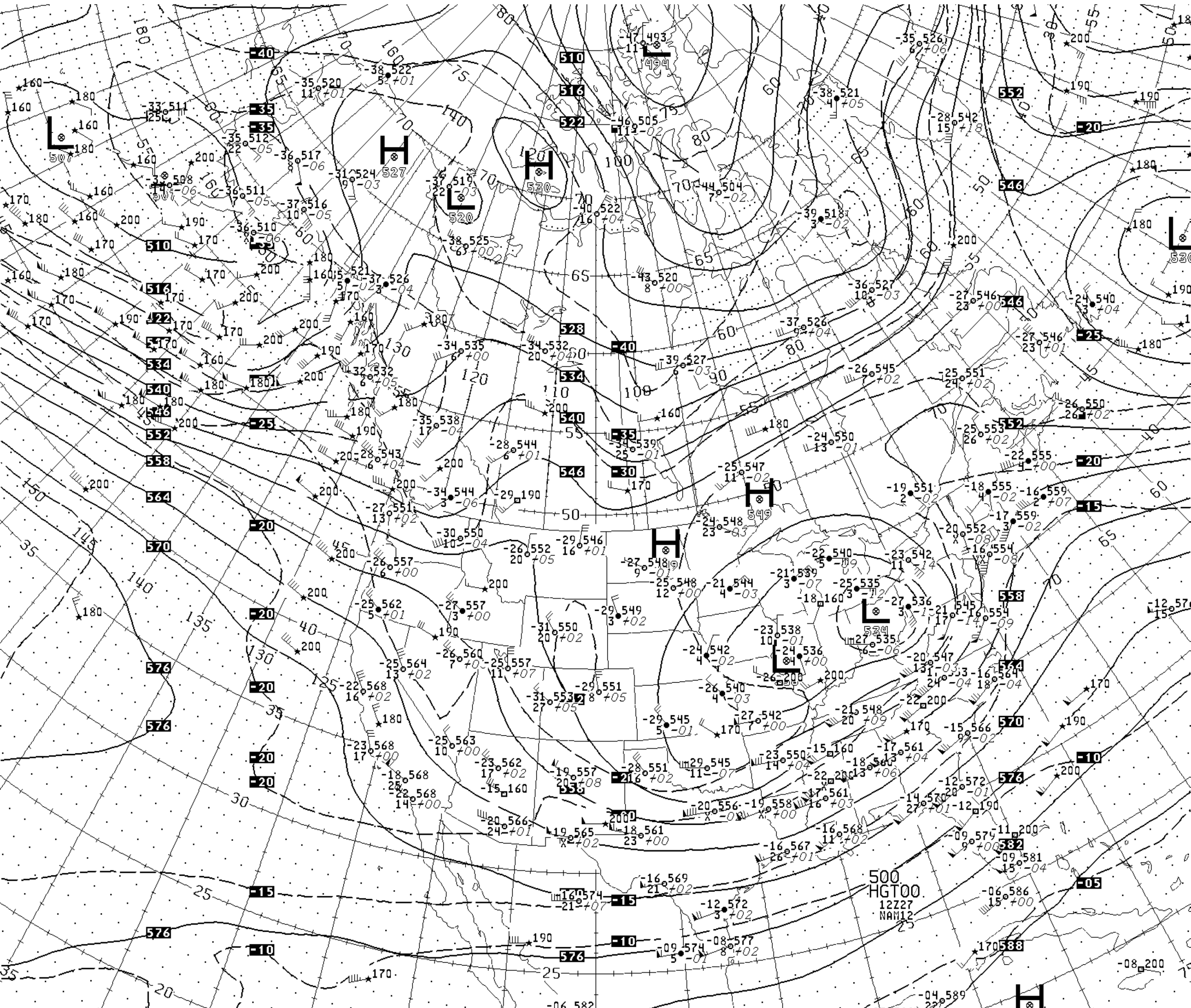
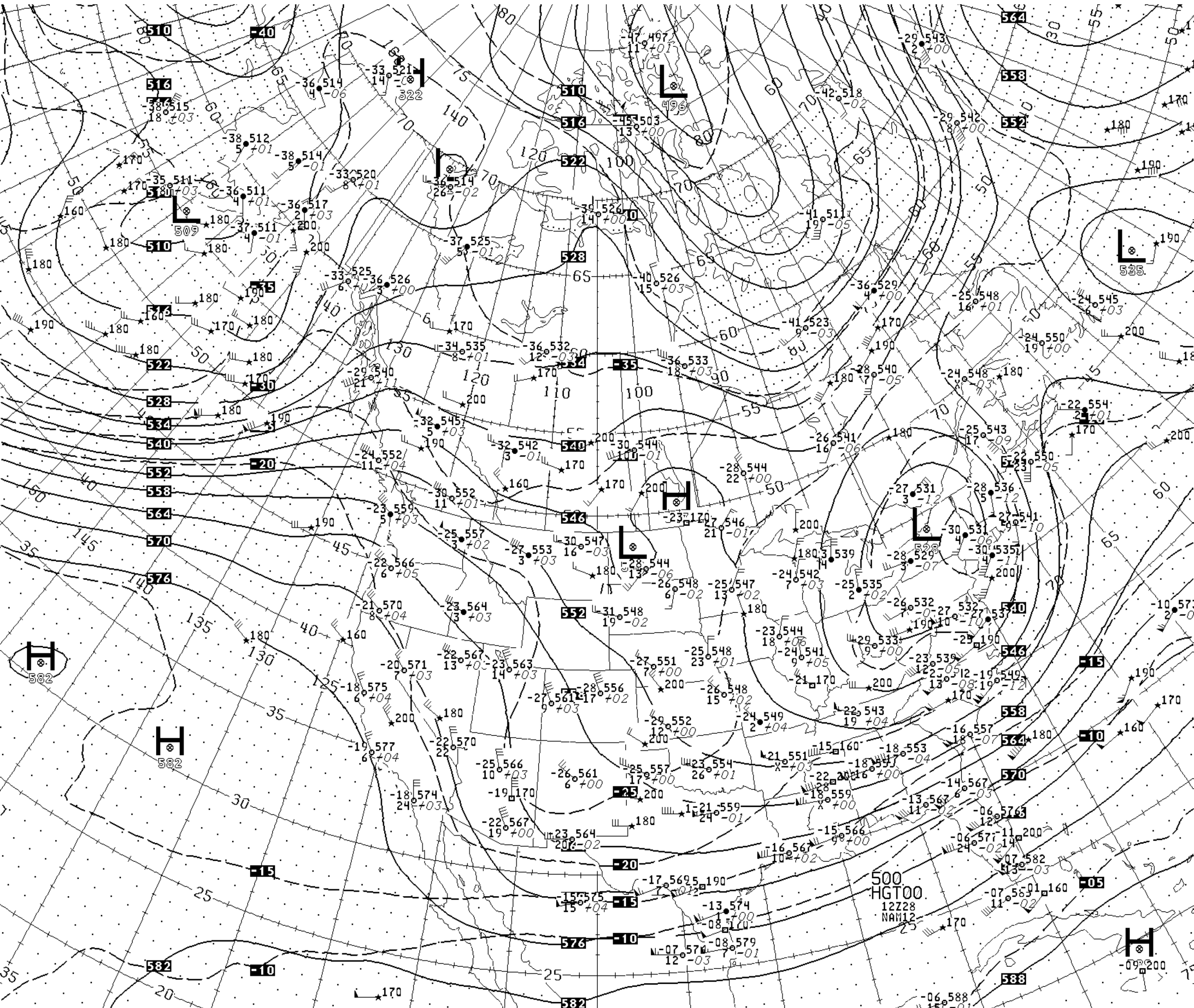
US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z WED 27 FEB 2013

US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



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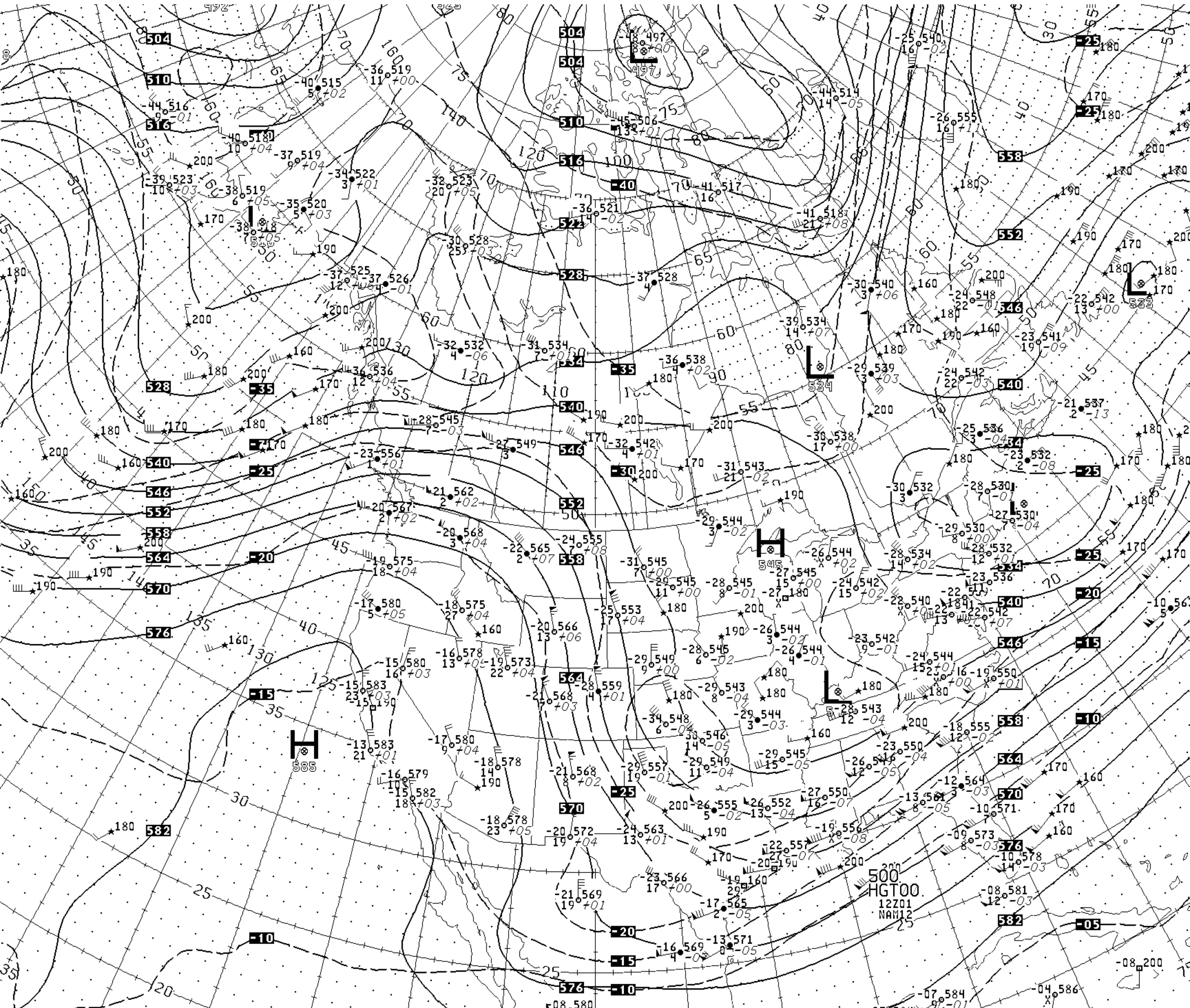
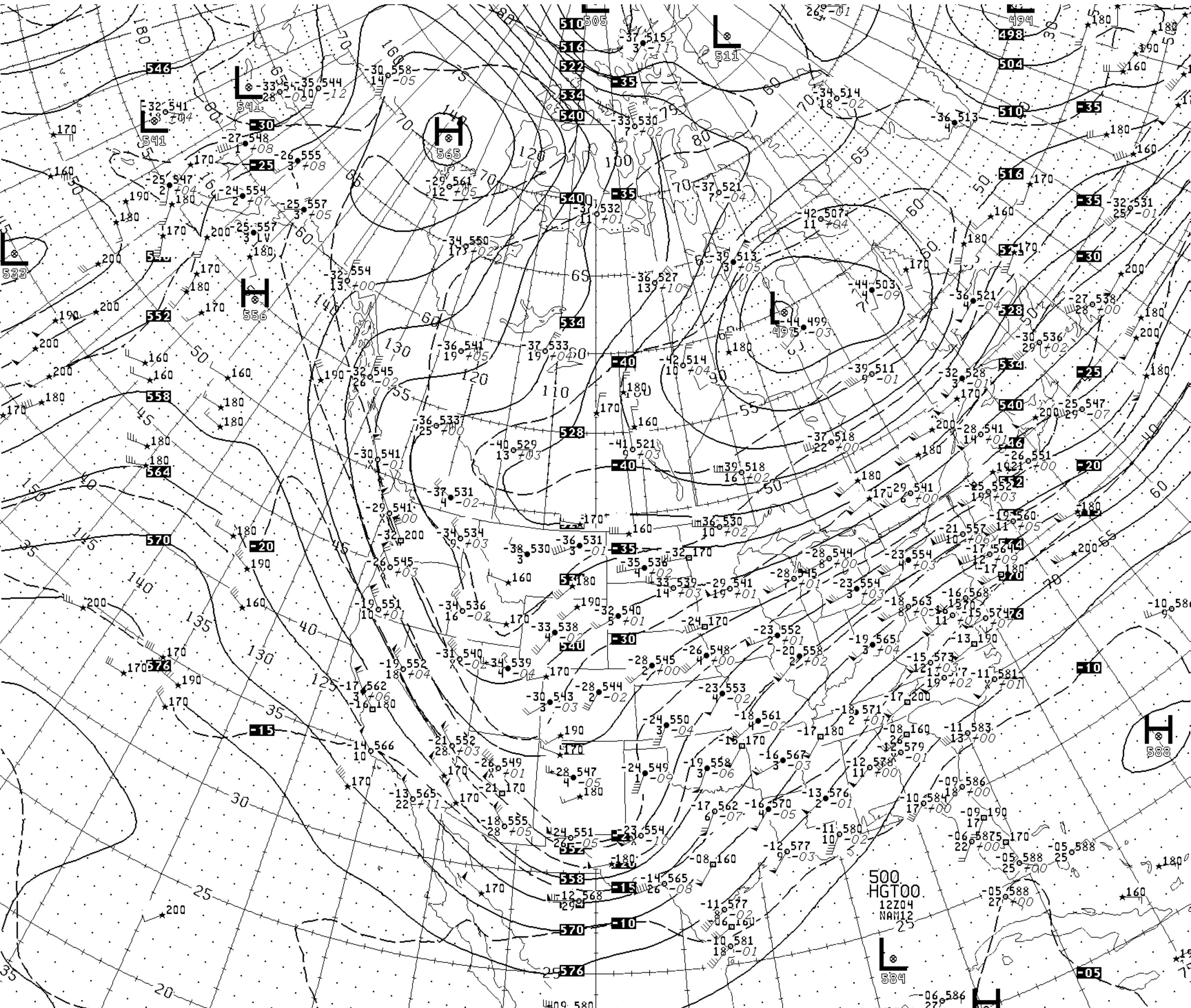
US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON

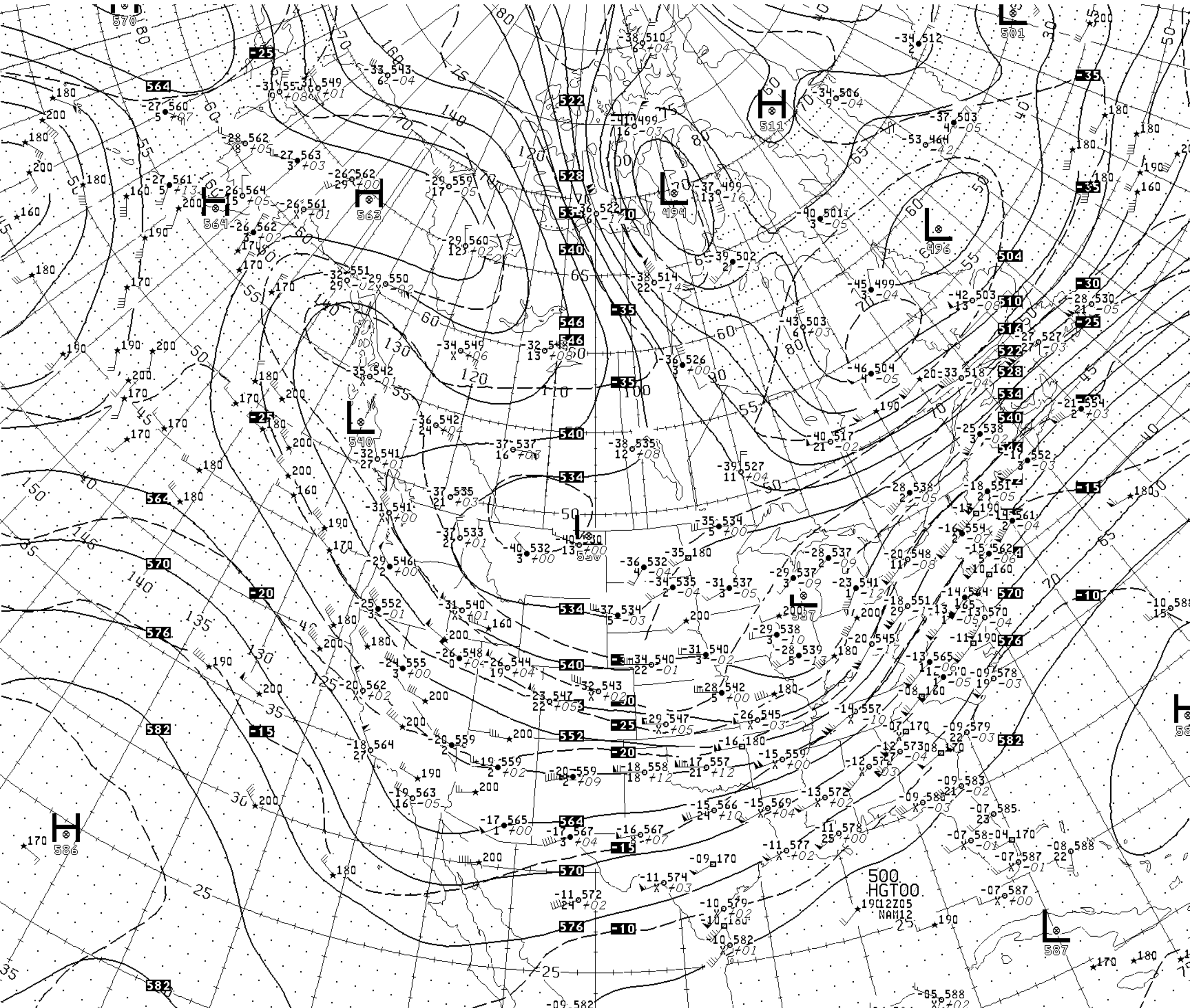


D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z FRI 01 MAR 2013

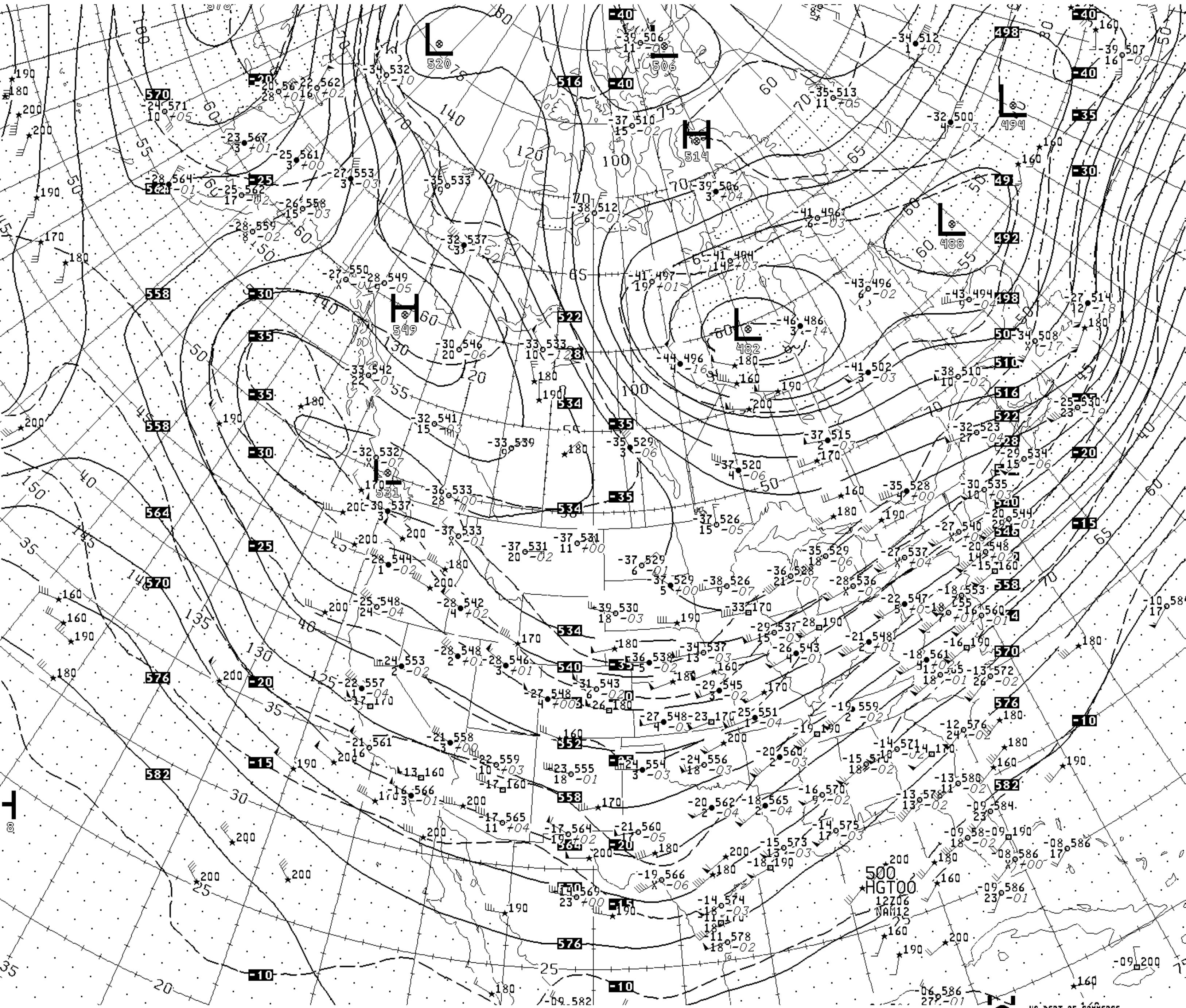
US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z TUE 04 FEB 2014

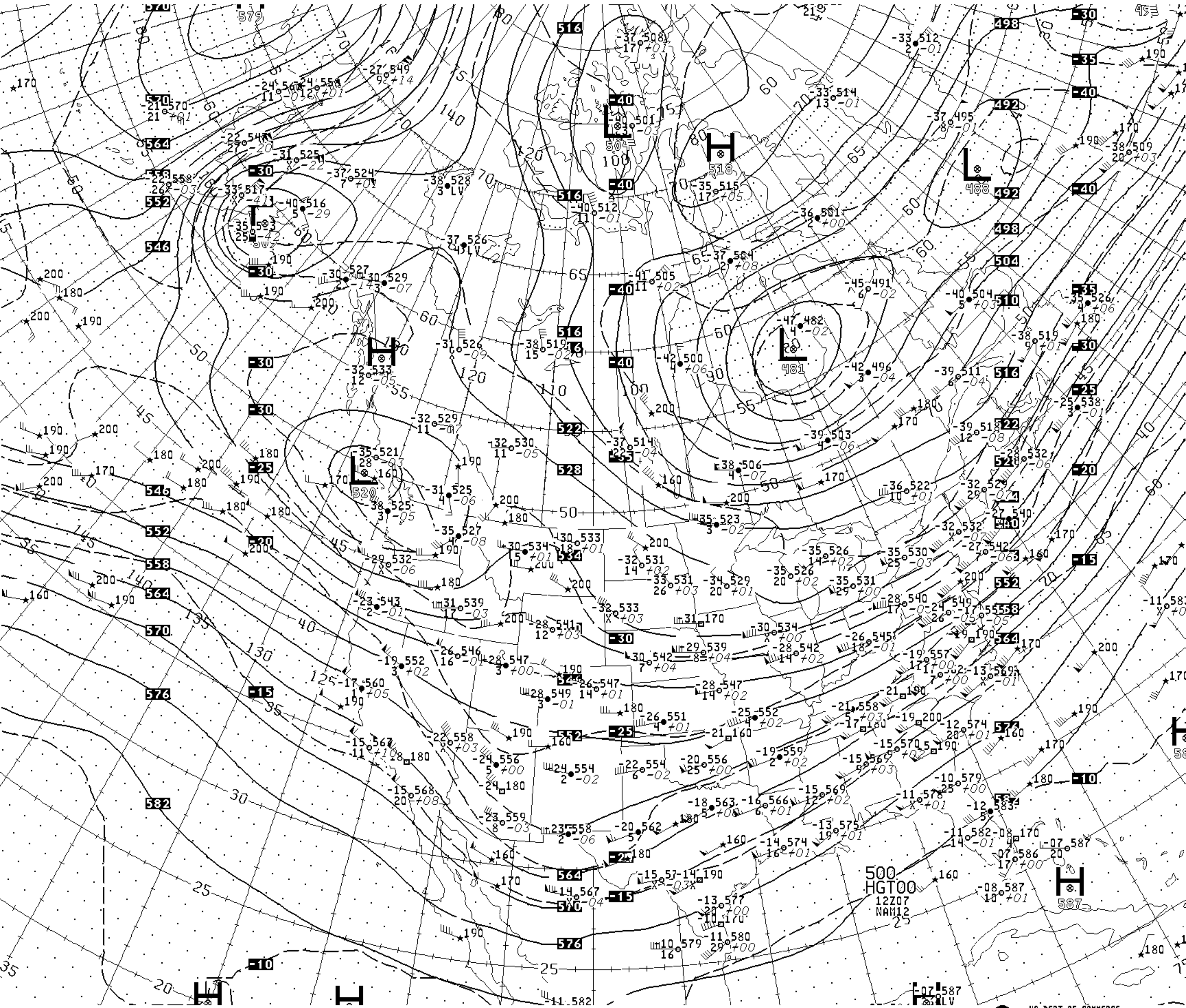


D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z WED 05 FEB 2014



D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z THU 06 FEB 2014

US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON



D155 .. 500MB ANALYSIS HEIGHTS/TEMPERATURE VALID 12Z FRI 07 FEB 2014

US DEPT OF COMMERCE
NOAA/NWS/NCEP WASHINGTON

APPENDIX C

Permitted Allowable Emission Rates and Source Release Parameters

Final Air Dispersion Modeling Report in Support of the 2010 1-Hour Sulfur Dioxide NAAQS Designation Recommendation

Wyoming Department of Environmental Quality - Air Quality Division
200 West 17th Street
Cheyenne, WY 82002

October 20, 2015

Wyoming Department of Environmental Quality - Air Quality Division
Air Dispersion Modeling Report in Support of the 2010 1-Hour Sulfur Dioxide NAAQS Designation Recommendation
Previously Modeled Point Source Emission Rates and Stack Parameters from Permit Action 15648, with Adjustments as Noted

MODEL ID	Source Description	Emission Rate (g/s)	UTM Easting (m)	UTM Northing (m)	Stack Base Elevation (m)	Stack Height (m)	Stack Temp. (K)	Stack Exit Velocity (m/s)	Stack Diameter (m)
HCUH3	Hydrocracker Heater H3	1.638E-01	324837.19	4627473.46	2010.11	33.53	744.26	8.96	1.62
#1TGTU	#1/#2 TGTU (Scrubber) [1]	8.890E-01	324994.00	4627237.00	2008.18	30.48	345.93	13.38	0.76
HCH1	#4 HDS H2 Heater 25HT101	6.300E-02	324770.74	4627580.82	2010.97	30.48	599.82	19.72	0.94
HCH3	#4 HDS H2 Heater 25 HT102	7.560E-02	324770.74	4627574.45	2010.92	30.48	605.37	12.95	1.10
FCCREGEN	FCCU Regenerator Vent	3.338E+00	325013.06	4627365.30	2008.90	30.48	560.93	16.03	2.19
NAPSPLH	Naphtha Splitter Heater	1.374E-01	324890.97	4627331.17	2009.08	36.58	477.59	6.17	1.22
#1HDSHTR	781 #1 HDS Heater	9.909E-02	324830.84	4627310.22	2009.08	27.43	1016.48	7.31	1.22
781LEFH	781 LEF Heater	7.119E-02	324974.30	4627299.44	2008.65	33.53	630.37	6.68	0.91
#1REF	781 #1 Reformer Heater [2]	1.386E-01	324836.84	4627310.22	2009.07	45.70	727.59	7.38	1.52
#2REF	781 #2 Reformer Heater [2]	2.268E-01	324816.15	4627310.22	2009.11	40.50	777.59	8.95	1.52
#3REF	781 #3 Reformer Heater	6.300E-02	324823.65	4627310.22	2009.10	19.20	855.37	2.92	1.22
STABIL	781 Stabilizer Heater [2]	3.780E-02	324847.93	4627310.22	2009.05	41.20	635.93	2.65	1.22
582HF101	582 Pre-Flash Heater, F101	8.820E-02	324853.08	4627328.42	2009.16	30.63	795.37	9.81	1.13
582HF103	582 Pre-Flash Heater, F103	1.247E-01	324839.89	4627328.42	2009.19	30.61	810.93	8.90	1.42
582H102A	582 Crude Heater, F102A	1.739E-01	324846.64	4627328.42	2009.17	30.62	810.93	13.59	1.36
582H102B	582 Crude Heater, F102B	1.021E-01	324869.87	4627328.42	2009.12	30.67	723.15	12.07	1.04
582VH104	582 Vacuum Heater, F104	1.739E-01	324865.08	4627341.02	2009.21	30.58	648.71	8.96	1.50
#2HDSHTR	#2 HDS Heater [2]	8.820E-02	324842.69	4627310.22	2009.06	41.20	422.04	5.21	1.22
#3HDSHTR	#3 HDS Heater	5.040E-02	324765.32	4627374.32	2009.63	23.77	710.93	3.73	1.22
#8HPBOIL	#8 High Pressure Boiler [2]	2.961E-01	324770.22	4627233.38	2008.64	32.00	533.15	12.96	1.52
#9HPBOIL	#9 High Pressure Boiler [2]	2.961E-01	324778.68	4627233.38	2008.62	32.00	533.15	12.96	1.52
HCH1/H2	Hydrocracker Heater H1/H2 [2]	1.134E-01	324781.70	4627486.38	2010.30	36.60	477.59	9.30	1.04
HCH4	Hydrocracker Heater H4 [2]	1.638E-01	324781.70	4627495.07	2010.36	43.00	605.37	11.09	1.31
#1H2HTR	#1 Hydrogen Plant Heater [2]	1.356E-02	324799.96	4627511.88	2010.43	30.50	533.15	21.24	2.06
HCH5	Hydrocracker Heater H5	1.332E-01	324856.53	4627473.45	2010.07	41.15	594.26	6.98	1.31
583VH	583 Vacuum Heater	1.905E-01	324885.01	4627232.65	2008.42	37.19	683.15	11.46	1.22
COKERHTR	Coker Heater	4.284E-01	325400.86	4627749.87	2007.91	53.34	597.04	10.53	2.07
COKEFLAR	Coker (North) Flare [3]	2.967E-01	325657.51	4627698.93	2006.52	60.50	1273.00	20.00	1.47

Wyoming Department of Environmental Quality - Air Quality Division
Air Dispersion Modeling Report in Support of the 2010 1-Hour Sulfur Dioxide NAAQS Designation Recommendation
Previously Modeled Point Source Emission Rates and Stack Parameters from Permit Action 15648, with Adjustments as Noted

MODEL ID	Source Description	Emission Rate (g/s)	UTM Easting (m)	UTM Northing (m)	Stack Base Elevation (m)	Stack Height (m)	Stack Temp. (K)	Stack Exit Velocity (m/s)	Stack Diameter (m)
JDEER	John Deere 4045D Water Pump	2.520E-03	329220.73	4628463.24	1994.52	1.40	799.82	39.99	0.10
BSIHTR	BS1 Heater	1.487E-01	324893.51	4627509.23	2010.19	30.48	318.33	5.15	1.71
CATOX	Catalytic Oxidizer	1.008E-04	324326.93	4627393.23	2011.17	4.57	616.48	3.05	0.36
581CH	581 Heater HT104	6.912E-01	324897.59	4627222.90	2008.33	30.48	533.15	15.99	1.52
#3TGTU	#3 TGTU	1.584E+00	325389.92	4627650.19	2008.00	30.48	604.15	15.81	0.91
#4TGTU	#4 TGTU	1.584E+00	325359.85	4627724.48	2008.11	30.48	604.15	15.81	0.91
#2H2HTR	#2 Hydrogen Plant Heater	4.309E-01	324722.01	4627507.26	2010.55	30.48	533.15	21.24	2.06
#11BOIL	#11 Boiler	4.284E-01	324771.28	4627269.79	2008.91	15.24	449.82	15.00	1.52
#12BOILR	#12 Boiler	6.552E-01	324825.76	4627233.33	2008.54	15.24	533.15	26.91	1.52
#7BOIL	#7 Boiler - New	5.229E-01	324813.60	4627211.45	2008.40	22.86	389.82	15.73	1.51
ASPHH#1	Asphalt Heater #1	2.520E-02	325036.01	4627243.83	2008.11	12.80	810.93	4.32	0.91
780FCCB3	780 FCC Heater B3	2.967E-02	324944.01	4627350.05	2009.06	33.53	616.48	4.11	0.91
780FCCH2	780 FCC Heater H2	5.755E-02	324980.85	4627299.79	2008.63	33.53	672.04	12.51	0.76
RTO	Regenerative Thermal Oxidizer	9.702E-02	325405.65	4627354.89	2006.37	4.80	1144.26	4.31	0.46
GEN1	Generator 1	8.820E-04	324759.50	4627306.47	2009.19	4.06	796.00	56.70	0.41
GEN2	Generator 2	8.820E-04	324771.42	4627306.47	2009.17	4.06	796.00	56.70	0.41
15BOIL	#15 Boiler	2.520E-01	324786.35	4627279.05	2008.95	9.14	449.82	8.85	1.52
NEWCATOX	Catalytic Oxidizer – New	5.166E-05	325327.88	4627804.65	2008.02	2.74	449.82	30.86	0.17
Bypass	#1TGTU Bypass Stack [4]	0.000E+00	324996.00	4627226.00	2008.10	50.90	0.00	0.00	0.82
VERTFLAR	Vertical (South) Flare [5]	0.000E+00	325647.52	4627403.35	2007.03	48.35	1273.00	20.00	2.13

[1] Corrected stack coordinates provided to WDEQ-AQD by SWRC on 8/5/15.

[2] Stack height is the actual stack height used in permit action MD-12620.

[3] The calculated 3-year average effective release height and diameter during upset conditions were used in the AERMOD input file for the stack height and diameter for the North Flare. Emissions represent normal operations from permit action MD-15648.

[4] The Bypass stack was not modeled in permit action MD-15648. The stack height and diameter were provided to WDEQ-AQD by SWRC on 8/5/15. The emission rate, stack temp, and velocity are zero on this table, which was used for normal operations (this EU does not emit SO2 during normal operations). The emission rates, stack temps, and velocities during upset conditions are provided in the AERMOD hourly emission file.

[5] The calculated 3-year average effective release height and diameter during upset conditions were used in the AERMOD input file for the stack height and diameter for the South Flare. Normal operation emissions were modeled as 0 g/s in permit action MD-12620; The South Flare was not modeled in permit action MD-15648.

Wyoming Department of Environmental Quality - Air Quality Division
Air Dispersion Modeling Report in Support of the 2010 1-Hour Sulfur Dioxide NAAQS Designation Recommendation
Modeled Volume Source Emission Rate and Release Parameters

MODEL ID	Source Description	Emission Rate (g/s)	UTM Easting (m)	UTM Northing (m)	Stack Base Elevation (m)	Release Height (m)	Sigma-Y Init (m)	Sigma-Z Init (m)
GRNDFLAR	Emergency Ground Flare [1]	0.000E+00	325521.9	4627439.9	2007.2	2.29	2.95	2.13

[1] The Emergency Ground Flare was not modeled in permit action MD-15648. The emission rate is zero in this table, which was used for normal operations (this EU does not emit SO2 during normal operations). The emission rate during upset conditions is provided in the AERMOD hourly emission file.

APPENDIX D

Summaries of RCFA Report Data

Final Air Dispersion Modeling Report in Support of the 2010 1-Hour Sulfur Dioxide NAAQS Designation Recommendation

Wyoming Department of Environmental Quality - Air Quality Division
200 West 17th Street
Cheyenne, WY 82002

October 20, 2015

WDEQ-AQD - Air Dispersion Modeling Report in Support of the 2010 1-Hour Sulfur Dioxide NAAQS Designation Recommendation
TGTU Root Cause Failure Analysis Report Summaries

Date	General Description	Excess Emissions	Emission Source to Model/ Hours Emissions Occurred
1/30/12	Tail Gas Incident: Excess SO2 tail gas emissions resulted when #4 TGTU shutdown on loss of flame indication.	503.9 lbs SO2	#4 SRU stack 1555 - 2130 Hours contributing to >500 lbs: 1700, 2100, 2200 (see RCFA report for hourly amounts)
2/11/12	Tail Gas Incident: Excess SO2 tail gas emissions resulted when #4 TGTU shutdown on loss of flame indication.	605.3 lbs SO2	#4 SRU stack 1445 – 1641 Hours contributing to >500 lbs: 1500- -1700 (see RCFA report hourly amounts)
2/26/12	Tail Gas Incident: Exceeded 500 lb excess SO2 tail gas emissions during cold-bed start up of #4 SRU.	851.7 lbs SO2	#4 SRU stack 0441 – 0815 Hours contributing to >500 lbs: 0600 – 0900 (see RCFA report hourly amounts)
3/10-3/11/12	Tail Gas Incident: Excess SO2 tail gas emissions resulted when #4 TGTU shutdown on loss of flame indication.	534.7 lbs SO2	#4 SRU stack 1345 on 3/10/12 – 0047 on 3/11/12 Hours contributing to >500 lbs: 1400 – 1500 (3/10); 0000 – 0100 (3/11) (see RCFA report hourly amounts)
4/11/12	EPCRA/CERCLA release: Upset on the #3 SRU/TGTU and TTO.	130 lbs H2S	#3 SRU/TGTU Started at 1242 and lasted 2.2 hours (included in 4/2/12 EPCRA/CERCLA report)
4/11/12	Tail Gas Incident: Excess SO2 tail gas emissions resulted when #3 TGTU shutdown due to dirty flame eyes.	660.5 lbs SO2	#3 SRU stack 1242 – 1451 Hours contributing to >500 lbs: 1200 – 1400 (see RCFA report hourly amounts)
4/20/12	Tail Gas Incident: Exceeded 500 lb excess SO2 tail gas emissions during cold-bed start up of #3 SRU.	703.3 lbs SO2	#3 SRU stack 1500 – 1800 Hours contributing to >500 lbs: 1500 – 1800 (see RCFA report hourly amounts)
5/18-5/19/12	Tail Gas Incident: Exceeded 500 lb excess SO2 tail gas emissions during cold-bed startup of #4 SRU and repairs to #3 SRU acid gas positioner.	4653.9 lbs SO2	#3 and #4 SRU stacks 0500 on 5/18/12 – 0700 on 5/19/12 Hours contributing to >500 lbs: #4 SRU: 0500 – 2300 on 5/18/12 #4 SRU: 0000 – 0700 on 5/19/12 #3 SRU: 1000 – 1500 on 5/18/12 (see RCFA report hourly amounts)

WDEQ-AQD - Air Dispersion Modeling Report in Support of the 2010 1-Hour Sulfur Dioxide NAAQS Designation Recommendation

TGTU Root Cause Failure Analysis Report Summaries

Date	General Description	Excess Emissions	Emission Source to Model/ Hours Emissions Occurred
5/20/12	Tail Gas Incident: Excess SO2 tail gas emissions on #4 TGTU.	1018.2 lbs SO2	#4 SRU stack 0706 – 1918 Hours contributing to >500 lbs: 1000, 1400 - 1900 (see RCFA report hourly amounts)
6/10/12	Tail Gas Incident: Excess SO2 tail gas emissions resulted when #3 TGTU shutdown.	2121.9 lbs SO2	#3 SRU stack 0322 – 1211 Hours contributing to >500 lbs: 0300 – 1200 (see RCFA report hourly amounts)
6/28/12	Acid Gas Flaring Incident: Hydrocarbon in the feed to #3 and #4 ARUs upset their operation and vaporized into the Acid Gas feed to #3 and #4 SRUs. This pressured up and shutdown both SRUs.	706.5 lbs SO2	South Flare 0251 – 0259 Hours contributing to >500 lbs: not provided, but assume it's hour 0200; however, hours 0400 – 0600 listed as "Acid Gas Event" in 6/28/12 Tail Gas Incident Report described below
6/28/12	Tail Gas Incident: Excess SO2 tail gas emissions on #4 TGTU.	787.9 lbs SO2	#4 SRU stack 1158 – 2308 Hours contributing to >500 lbs: 1100 – 1400, and 2100 – 2200 (see RCFA report hourly amounts); Total listed (and verified from hourly lbs) = 786.9 lbs
7/24/12	Tail Gas Incident: Excess SO2 tail gas emissions resulted when #3 TGTU shutdown.	916.0 lbs SO2	#3 SRU stack 1442 – 1806 Hours contributing to >500 lbs: 1500 – 1800 (see RCFA report hourly amounts).
7/24/12	EPCRA/CERCLA release: PLC problem on the #3 SRU/TGTU and TTO (this report included at the end of the 7/24/12 Tail Gas report listed above).	123 lbs H2S	#3 SRU stack Started at 1442 and lasted 3.3 hours (see SO2 emissions in Tail Gas report listed above)
7/25/12	Tail Gas Incident: Excess SO2 tail gas emissions resulted when #3 TGTU shutdown.	692.1 lbs SO2	#3 SRU stack 1345 – 1706 Hours contributing to >500 lbs: 1400 – 1700 (see RCFA report hourly amounts)
12/6/12	EPCRA/CERCLA release: Hydrocarbon carryover to the amine units resulting in the #3 and #4 SRU/TGTU and TTO units to be upset.	129 lbs H2S	#3 and #4 SRU/TGTU Started at 1432 and lasted 2.4 hours (see SO2 emissions in Tail Gas report listed below)

TGTU Root Cause Failure Analysis Report Summaries

Date	General Description	Excess Emissions	Emission Source to Model/ Hours Emissions Occurred
12/6/12	Tail Gas Incident: Exceeded 500 lb excess SO2 tail gas emissions during #3 and #4 SRU upset.	1710.8 lbs SO2	#3 and #4 SRU stacks 1432 – 1653 for #3 SRU 1357 – 1555 for #4 SRU Hours contributing to >500 lbs: #3 SRU: 1400 – 1600 #4 SRU: 1400 – 1600 (see RCFA report hourly amounts)
12/9/12	Tail Gas Incident: Excess SO2 tail gas emissions on #3 and #4 TGTU.	5354.9 lbs SO2	#3 and #4 SRU stacks 1350 – 1859 for #3 SRU 1358 – 2338 for #4 SRU Hours contributing to >500 lbs: #3 SRU: 1400 – 1800) #4 SRU: 1400 – 2300 (see RCFA report hourly amounts)
1/15/13	EPCRA/CERCLA release: Hydrocarbon carryover to the amine units resulting in the #3 and #4 SRU/TGTU and TTO units to be upset.	134 lbs H2S	#3 and #4 SRU/TGTU Started at 1136 and lasted 2.2 hours (see SO2 emissions in Tail Gas report listed below)
1/15/13	Tail Gas Incident: Excess SO2 tail gas emissions on #3 and #4 TGTU.	1279.6 lbs SO2	#3 and #4 SRU stacks 1136 – 1346 for #3 SRU 1139 – 1313 for #4 SRU Hours contributing to >500 lbs: #3 SRU: 0300 – 0600, 1100 - 1400 #4 SRU: 1100 – 1300 (see RCFA report hourly amounts)
5/8/13	Tail Gas Incident: Excess SO2 tail gas emissions from the #2 SRU bypass incinerator caused by a power failure.	869.7 lbs SO2	#1 TGTU bypass stack 1839 – 2053 Hours contributing to >500 lbs: 1800 – 2000 (see RCFA report hourly amounts)
5/22/13	Tail Gas Incident: Excess SO2 tail gas emissions from the #2 SRU bypass incinerator.	1723.9 lbs SO2	#1 TGTU bypass stack 0700 – 1222 Hours contributing to >500 lbs: 0700 – 1300 (see RCFA report hourly amounts)
5/23/13	Tail Gas Incident: Excess SO2 tail gas emissions from the #3 TGTU tripping offline.	1183.5 lbs SO2	#3 TGTU stack 1035 – 1415 Hours contributing to >500 lbs: 1000 – 1400 (see RCFA report hourly amounts)

TGTU Root Cause Failure Analysis Report Summaries

Date	General Description	Excess Emissions	Emission Source to Model/ Hours Emissions Occurred
8/2/13	Tail Gas Incident: Exceeded 500 lb excess SO2 tail gas emissions during cold-bed start up of #3 SRU.	910.9 lbs SO2	#3 SRU stack 1700 – 2131 Hours contributing to >500 lbs: 1700 – 2300 (see RCFA report hourly amounts)
8/31/13	Tail Gas Incident: Excess SO2 tail gas emissions from the #3 TGTU tripping offline.	814.0 lbs SO2	#3 TGTU stack 1609 – 2013 Hours contributing to >500 lbs: 1600 – 2000 (see RCFA report hourly amounts)
9/4/13	Tail Gas Incident: Excess SO2 tail gas emissions from the #4 TGTU tripping offline.	648.6 lbs SO2	#4 TGTU stack 1554 – 1759 Hours contributing to >500 lbs: 1600 – 1700 (see RCFA report hourly amounts)
10/2/13	Tail Gas Incident: Excess sulfur dioxide emissions from #3 and #4 TGTUs.	846.4 lbs SO2	#3 and #4 SRU stacks 0203 – 1018 for #3 TGTU 0648 – 0731 for #4 TGTU Hours contributing to >500 lbs: #3 SRU: 0400, 0800 – 1000) #4 SRU: 0700 (see RCFA report hourly amounts)
10/8/13	Tail Gas Incident: Excess SO2 tail gas emissions due to #4 SRU/#4TGTU shutdown.	1611.9 lbs SO2	#4 SRU stack 1615 – 2303 Hours contributing to >500 lbs: 1500 – 2300 (see RCFA report hourly amounts)
11/3/13	Tail Gas Incident: Excess SO2 tail gas emissions due to #4TGTU shutdown.	818.1 lbs SO2	#4 TGTU stack 0058 – 0259 Hours contributing to >500 lbs: 0100 – 0300 (see RCFA report hourly amounts)
11/15/13	Tail Gas Incident: Excess SO2 tail gas emissions due to #4TGTU shutdown.	2000.0 lbs SO2	#4 TGTU stack 1233 – 2245 Hours contributing to >500 lbs: 1200 – 1700, 2000 - 2300 (see RCFA report hourly amounts)

TGTU Root Cause Failure Analysis Report Summaries

Date	General Description	Excess Emissions	Emission Source to Model/ Hours Emissions Occurred
12/28/13	Tail Gas Incident: Excess SO2 tail gas emissions due to #4TGTU shutdown.	790.8 lbs SO2	#4 TGTU stack 1103 – 1925 Hours contributing to >500 lbs: 1100 – 1300, 1800 - 1900 (see RCFA report hourly amounts)
12/29/13	Tail Gas Incident: Excess SO2 tail gas emissions due to #4TGTU shutdown.	985.7 lbs SO2	#4 TGTU stack 1534 – 1817 Hours contributing to >500 lbs: 1500 – 1900 (see RCFA report hourly amounts)
12/30/13	Tail Gas Incident: Excess SO2 tail gas emissions due to #4TGTU shutdown.	665.5 lbs SO2	#4 TGTU stack 0956 – 1817 Hours contributing to >500 lbs: 1000 – 1100, 1600 - 1700 (see RCFA report hourly amounts)
1/3/14	Tail Gas Incident: Excess SO2 tail gas emissions due to #4 TGTU shutdown.	1075.0 lbs SO2	#4 TGTU stack 0635 - 1234 Hours contributing to >500 lbs: 0600 – 0700, 0900 – 1200 (see RCFA report for hourly amounts)
1/22-1/23/14	Tail Gas Incident: Excess SO2 tail gas emissions due to #3TGTU shutdown.	539.0 lbs SO2	#3 TGTU stack 1809 on 1/22/14 – 1500 on 1/23/14 Hours contributing to >500 lbs: 1800 – 2300 on 1/22, 0000 – 1400 on /23 (see RCFA report hourly amounts)
2/2/14	Tail Gas Incident: Excess SO2 tail gas emissions due to #4 SRU startup and #4 TGTU trips.	712.8 lbs SO2	#4 TGTU stack 0400 - 1320 Hours contributing to >500 lbs: 0400 – 1000, 1200 – 1300 (see RCFA report for hourly amounts)
2/16-2/17/14	Tail Gas Incident: Excess SO2 tail gas emissions due to #3 SRU startup and trips on the #3 and #4 TGTUs.	4531.4 lbs SO2	#3 and #4 TGTU stacks 0211 on 2/16/14 – 1732 on 2/17/14 Hours contributing to >500 lbs: #3 SRU: 0200 – 2300 on 2/16 0000 – 1700 on 2/17 #4 SRU: 0600 on 2/16 (see RCFA report hourly amounts)

WDEQ-AQD - Air Dispersion Modeling Report in Support of the 2010 1-Hour Sulfur Dioxide NAAQS Designation Recommendation

TGTU Root Cause Failure Analysis Report Summaries

Date	General Description	Excess Emissions	Emission Source to Model/ Hours Emissions Occurred
2/17/14	Tail Gas Incident: Excess SO2 tail gas emissions from the #1TGTU bypass incinerator.	2271.5 lbs SO2	#1 TGTU bypass stack 0444 - 1647 Hours contributing to >500 lbs: 0500 – 1600 (see RCFA report hourly amounts)
2/20-2/25/14	Tail Gas Incident: Excess SO2 tail gas emissions due to trips on the #4TGTU.	4053.0 lbs SO2	#4 TGTU stack 0030 on 2/20/14 – 2359 on 2/25/14 Hours contributing to >500 lbs: 0000 – 0100, 0800 – 0900, 2200 - 2300 on 2/20 0000 – 0300, 0500 – 0700, 0900, on 2/21 0500 – 0600, 1900, 2100 – 2300 on 2/22 0000, 0400 – 0500, 0800 – 0900, 1500, 1700 – 2300 on 2/23 0000 – 2300 on 2/24 0000 – 2300 on 2/25 (see RCFA report hourly amounts)
4/6/14	Tail Gas Incident: Exceeded 500 lb excess SO2 tail gas emissions during cold-bed start up of #4 SRU.	540.4 lbs SO2	#4 SRU stack 1313 - 1535 Hours contributing to >500 lbs: 0700 – 1500 (see RCFA report hourly amounts)
7/18 7/20/14	Tail Gas Incident: Exceeded 500 lb excess SO2 tail gas emissions during cold-bed start up of #4 SRU.	5045.3 lbs SO2	#4 SRU stack 1348 on 7/18/14 – 2359 on 7/20/14 Hours contributing to >500 lbs: 0000 – 1700 on 7/18 0800 – 2300 on 7/19 0000 – 2300 on 7/20 (see RCFA report hourly amounts)
11/14 11/15/14	Tail Gas Incident: Excess SO2 tail gas emissions due to #3 and #4 SRU and TGTU shutting down.	1802.1 lbs SO2	#3 and #4 TGTU stacks 1243 on 11/14/14 – 0007 on 11/15/14 Hours contributing to >500 lbs: #3 SRU: 1400 on 11/14 – 0000 on 11/15 #4 SRU: 1300 – 1800 on 11/14 (presumably; table lists 8/17/14) (see RCFA report hourly amounts)

TGTU Root Cause Failure Analysis Report Summaries

Date	General Description	Excess Emissions	Emission Source to Model/ Hours Emissions Occurred
12/7/14	Tail Gas Incident: Excess SO2 tail gas emissions due to #4 TGTU shutting down.	691.1 lbs SO2	#4 TGTU stack 0958 – 1132 Hours contributing to >500 lbs: 1000 – 1400 (see RCFA report hourly amounts)
12/27/14	Tail Gas Incident: Excess SO2 tail gas emissions due to #4 TGTU shutting down.	1967.2 lbs SO2	#4 TGTU stack 2123 on 12/27/14 - 0817 on 12/28/14 Hours contributing to >500 lbs: 2100 – 2300 on 12/27 0000 – 0800 on 12/28 (see RCFA report hourly amounts)

Wyoming Department of Environmental Quality - Air Quality Division
Air Dispersion Modeling Report in Support of the 2010 1-Hour Sulfur Dioxide NAAQS Designation Recommendation
SWRC Semi-Annual Progress Report Data Summary - Heat Content and Physical Flare Heights

Average Heat Content from Annual Emission Inventory Reports (MMBtu/MMscf)

Flare	Description	Year		
		2012	2013	2014
COKEFLAR	Coker (North) Flare	1230.8	1098.0	1000.0
VERTFLAR	Vertical (South) Flare	1230.8	1249.0	1000.0

Physical Flare Stack Heights (m) (from BPIP Input File for Permit Application 15648)

Flare	Stack Height (m)
COKEFLAR	53.34
VERTFLAR	38.1

Wyoming Department of Environmental Quality - Air Quality Division
Air Dispersion Modeling Report in Support of the 2010 1-Hour Sulfur Dioxide NAAQS Designation Recommendation
SWRC Semi-Annual Progress Report Data Summary - Flaring Event Hourly SO_2 Modeled Emission Rate, and Effective Release Height/Diameter Calculations - 2012

					Start Date/Time (Hour Ending)						Start Date/Time (Hour Ending)														
Reporting Period	Start Date/Time	End Date/Time	Duration (days)	Duration (hours)	YY	MM	DD	HH	MN		YY	MM	DD	HH	MN	Avg Emissions (lb/hr)	Total Emissions (Reported lb/event)	MODEL_ID [1]	Qs [2] (g/s)	Flow Rate (scf/hr)	Heat Rls Rate (MMBtu/hr)	Heat Rls Rate (cal/s)	Physical Hs (m)	Effective Hs (m)	Effective Ds (m)
1/1/12 - 6/30/12	3/26/12 3:38 PM	3/26/12 4:34 PM	0.04	0.93	12	3	26	16	38		12	3	26	17	34	5170.7	4,912.1	VERTFLAR	6.189E+02	196000.0	241.2	16886576.0	38.10	51.09	2.72
1/1/12 - 6/30/12	4/11/12 6:57 AM	4/11/12 7:23 AM	0.02	0.43	12	4	11	7	57		12	4	11	8	23	1220.2	1,220.2	VERTFLAR	1.537E+02	534830.0	658.3	46078813.5	38.10	59.10	4.50
7/1/12 - 12/31/12	8/16/12 4:37 AM	8/16/12 6:55 AM	0.10	2.30	12	8	16	5	37		12	8	16	7	55	6199.5		VERTFLAR	7.811E+02	235000.0	289.2	20246660.0	38.10	52.27	2.98
7/1/12 - 12/31/12	8/16/12 4:17 PM	8/18/12 3:10 PM	1.95	46.88	12	8	16	17	17		12	8	18	16	10	577.4		VERTFLAR	7.275E+01	341650.0	420.5	29435197.4	38.10	55.05	3.60
																Event Total (8/16-8/18/12) =>	41,200.0								
7/1/12 - 12/31/12	8/24/12 5:08 PM	8/24/12 8:35 PM	0.14	3.45	12	8	24	18	8		12	8	24	21	35	1204.4	4,175.3	VERTFLAR	1.518E+02	237560.0	292.4	20467219.4	38.10	52.34	3.00
7/1/12 - 12/31/12	11/19/12 9:17 PM	11/20/12 12:14 AM	0.12	2.95	12	11	19	22	17		12	11	20	1	14	812.6	2,397.3	VERTFLAR	1.024E+02	160280.0	197.3	13809083.7	38.10	49.90	2.46
7/1/12 - 12/31/12	11/22/12 1:53 AM	11/22/12 3:25 AM	0.06	1.53	12	11	22	2	53		12	11	22	4	25	472.2	731.8	VERTFLAR	5.950E+01	93130.0	114.6	8023708.3	38.10	47.20	1.88
7/1/12 - 12/31/12	11/23/12 1:48 AM	11/23/12 7:01 AM	0.22	5.22	12	11	23	2	48		12	11	23	8	1	1133.3	5,931.1	VERTFLAR	1.428E+02	223540.0	275.1	19259312.2	38.10	51.94	2.91

max VERTFLAR values =>	59.10	4.50
min VERTFLAR values =>	47.20	1.88
avg VERTFLAR values =>	52.36	3.01

[1] The allocations of emissions to the flare listed in this column was based on a review of each RCFA report. If the RCFA report was not clear on which flare emitted, then the following default assumptions were made based on input from SWRC (communication with Glenn Spangler of the AQD on 9/9/15):
For years 2012 and 2013, and through January 31, 2014, the South Flare (VERTFLAR) was the preferred flare for the refinery. Starting in February 2014, the preferred flare was changed to be the North Flare (COKEFLAR).
[2] The emission rate is the average emission rate from the RFCA. However, if a flaring event lasted less than one hour, then the reported lb/event value was used for the hour in which the emissions occurred.

Wyoming Department of Environmental Quality - Air Quality Division
Air Dispersion Modeling Report in Support of the 2010 1-Hour Sulfur Dioxide NAAQS Designation Recommendation
SWRC Semi-Annual Progress Report Data Summary - Flaring Event Hourly SO_2 Modeled Emission Rate, and Effective Release Height/Diameter Calculations - 2013

			Duration	Duration	Start Date/Time (Hour Ending)						Start Date/Time (Hour Ending)					Avg Emissions	Total Emissions		Qs [2]	Flow Rate	Heat Rls Rate	Heat Rls Rate	Physical Hs	Effective Hs	Effective Ds
Reporting Period	Start Date/Time	End Date/Time	(days)	(hours)	YY	MM	DD	HH	MN		YY	MM	DD	HH	MN	(lb/hr)	(Reported lb/event)	MODEL_ID [1]	(g/s)	(scf/hr)	(MMBtu/hr)	(cal/s)	(m)	(m)	(m)
1/1/13 - 6/30/13	2/18/13 12:59 PM	2/18/13 2:33 PM	0.07	1.57	13	2	18	13	59		13	2	18	15	33	682.6	1,080.7	VERTFLAR	8.601E+01	403880.0	504.4	35311228.4	38.10	56.59	3.94
1/1/13 - 6/30/13	2/23/13 12:57 PM	2/23/13 1:12 PM	0.01	0.25	13	2	23	13	57		13	2	23	14	12	9767.5	2,604.7	COKEFLAR	3.282E+02	370250.0	406.5	28457415.0	53.34	70.02	3.54
1/1/13 - 6/30/13	3/18/13 12:18 PM	3/18/13 3:57 PM	0.15	3.65	13	3	18	13	18		13	3	18	16	57	291.1	989.9	VERTFLAR	3.668E+01	104409.0	130.4	9128478.9	38.10	47.78	2.00
1/1/13 - 6/30/13	3/19/13 7:22 AM	3/19/13 11:59 PM	0.69	16.62	13	3	19	8	22		13	3	19	24	59	532.6		VERTFLAR	6.711E+01	157561.0	196.8	13775558.2	38.10	49.89	2.46
1/1/13 - 6/30/13	3/20/13 12:00 AM	3/20/13 11:13 PM	0.97	23.22	13	3	20	1	0		13	3	20	24	13	270.0		VERTFLAR	3.402E+01	159777.0	199.6	13969303.1	38.10	49.97	2.48
																Event Total (3/19-3/20/13) =>	15,087.1								
1/1/13 - 6/30/13	4/24/13 11:53 AM	4/24/13 1:27 PM	0.07	1.57	13	4	24	12	53		13	4	24	14	27	820.0	2,760.2	COKEFLAR	1.033E+02	32348.0	35.5	2486267.3	53.34	58.54	1.05
1/1/13 - 6/30/13	5/8/13 5:35 PM	5/9/13 12:22 PM	0.78	18.78	13	5	8	18	35		13	5	9	13	22	1961.7	8,703.5	VERTFLAR	2.472E+02	386920.1	483.3	33828424.3	38.10	56.21	3.85
1/1/13 - 6/30/13	5/26/13 3:46 AM	5/26/13 7:24 AM	0.15	3.63	13	5	26	4	46		13	5	26	8	24	160.1	583.7	VERTFLAR	2.017E+01	210531.9	263.0	18406804.0	38.10	51.64	2.84
7/1/13 - 12/31/13	7/29/13 6:19 AM	7/29/13 8:00 AM	0.07	1.68	13	7	29	7	19		13	7	29	9	0	316.2	530.7	VERTFLAR	3.984E+01	124750.4	155.8	10906927.5	38.10	48.64	2.19
7/1/13 - 12/31/13	9/17/13 10:07 AM	9/17/13 6:53 PM	0.37	8.77	13	9	17	11	7		13	9	17	19	53	272.1	2,391.5	VERTFLAR	3.428E+01	69998.6	87.4	6119977.6	38.10	46.10	1.64
7/1/13 - 12/31/13	9/26/13 11:22 AM	9/26/13 6:10 PM	0.28	6.80	13	9	26	12	22		13	9	26	19	10	138.1	875.9	VERTFLAR	1.740E+01	78576.5	98.1	6869943.4	38.10	46.55	1.74
7/1/13 - 12/31/13	9/28/13 6:03 AM	9/28/13 2:31 PM	0.35	8.47	13	9	28	7	3		13	9	28	15	31	571.3		VERTFLAR	7.198E+01	82454.0	103.0	7208953.2	38.10	46.75	1.78
7/1/13 - 12/31/13	9/30/13 3:00 PM	9/30/13 11:59 PM	0.37	8.98	13	9	30	16	0		13	9	30	24	59	173.2		VERTFLAR	2.182E+01	144355.0	180.3	12620957.7	38.10	49.41	2.35
7/1/13 - 12/31/13	10/1/13 12:00 AM	10/1/13 11:59 PM	1.00	23.98	13	10	1	1	0		13	10	1	24	59	116.4		VERTFLAR	1.467E+01	137771.0	172.1	12045318.5	38.10	49.16	2.30
7/1/13 - 12/31/13	10/2/13 12:00 AM	10/2/13 11:59 PM	1.00	23.98	13	10	2	1	0		13	10	2	24	59	203.9		VERTFLAR	2.569E+01	152749.0	190.8	13354845.1	38.10	49.72	2.42
7/1/13 - 12/31/13	10/3/13 12:00 AM	10/3/13 11:59 PM	1.00	23.98	13	10	3	1	0		13	10	3	24	59	175.5		VERTFLAR	2.211E+01	134908.0	168.5	11795006.4	38.10	49.05	2.28
7/1/13 - 12/31/13	10/4/13 12:00 AM	10/4/13 11:59 PM	1.00	23.98	13	10	4	1	0		13	10	4	24	59	273.6		VERTFLAR	3.447E+01	77092.0	96.3	6740153.6	38.10	46.48	1.72
7/1/13 - 12/31/13	10/5/13 12:00 AM	10/5/13 11:59 PM	1.00	23.98	13	10	5	1	0		13	10	5	24	59	264.1		VERTFLAR	3.328E+01	53906.0	67.3	4713001.6	38.10	45.16	1.44
7/1/13 - 12/31/13	10/6/13 12:00 AM	10/6/13 11:59 PM	1.00	23.98	13	10	6	1	0		13	10	6	24	59	265.1		VERTFLAR	3.340E+01	60335.0	75.4	5275089.1	38.10	45.55	1.52
7/1/13 - 12/31/13	10/7/13 12:00 AM	10/7/13 8:58 AM	0.37	8.97	13	10	7	1	0		13	10	7	9	58	214.3		VERTFLAR	2.700E+01	60395.0	75.4	5280334.9	38.10	45.55	1.52
																Event Total (9/28-10/7/13) =>	39,330.8								
7/1/13 - 12/31/13	10/13/13 8:39 AM	10/13/13 8:02 PM	0.47	11.38	13	10	13	9	39		13	10	13	21	2	223.4	2,544.0	VERTFLAR	2.815E+01	82625.7	103.2	7223965.0	38.10	46.76	1.78
7/1/13 - 12/31/13	10/30/13 8:03 PM	10/30/13 11:59 PM	0.16	3.93	13	10	30	21	3		13	10	30	24	59	205.1		COKEFLAR	2.584E+01	71403.0	78.4	5488034.6	53.34	60.93	1.55
7/1/13 - 12/31/13	10/31/13 12:00 AM	10/31/13 5:33 PM	0.73	17.55	13	10	31	1	0		13	10	31	18	33	42.5		COKEFLAR	5.355E+00	44127.0	48.5	3391601.2	53.34	59.37	1.22
																Event Total (10/30-10/31/13) =>	1,555.2								
7/1/13 - 12/31/13	11/6/13 12:00 AM	11/6/13 11:59 PM	1.00	23.98	13	11	6	1	0		13	11	6	24	59	426.6		VERTFLAR	5.375E+01	51512.9	64.3	4503772.8	38.10	45.01	1.41
7/1/13 - 12/31/13	11/7/13 12:00 AM	11/7/13 11:59 PM	1.00	23.98	13	11	7	1	0		13	11	7	24	59	444.3		VERTFLAR	5.598E+01	41729.6	52.1	3648418.9	38.10	44.35	1.27
7/1/13 - 12/31/13	11/8/13 12:00 AM	11/8/13 11:59 PM	1.00	23.98	13	11	8	1	0		13	11	8	24	59	484.5		VERTFLAR	6.105E+01	70101.4	87.6	6128965.4	38.10	46.10	1.64
7/1/13 - 12/31/13	11/9/13 12:00 AM	11/9/13 11:59 PM	1.00	23.98	13	11	9	1	0		13	11	9	24	59	410.2		VERTFLAR	5.168E+01	48840.4	61.0	4270116.2	38.10	44.83	1.37
7/1/13 - 12/31/13	11/10/13 12:00 AM	11/10/13 11:59 PM	1.00	23.98	13	11	10	1	0		13	11	10	24	59	265.2		VERTFLAR	3.341E+01	35346.7	44.1	3090362.0	38.10	43.87	1.17
7/1/13 - 12/31/13	11/11/13 12:00 AM	11/11/13 11:59 PM	1.00	23.98	13	11	11	1	0		13	11	11	24	59	260.8		VERTFLAR	3.286E+01	55506.4	69.3	4852924.6	38.10	45.26	1.46
7/1/13 - 12/31/13	11/12/13 12:00 AM	11/12/13 11:59 PM	1.00	23.98	13	11	12	1	0		13	11	12	24	59	87.0		VERTFLAR	1.096E+01	21459.4	26.8	1876195.3	38.10	42.65	0.91
7/1/13 - 12/31/13	11/13/13 12:00 AM	11/13/13 11:59 PM	1.00	23.98	13	11	13	1	0		13	11	13	24	59	15.9		VERTFLAR	2.003E+00	5375.4	6.7	469971.2	38.10	40.45	0.45
7/1/13 - 12/31/13	11/14/13 12:00 AM	11/14/13 11:54 PM	1.00	23.90	13	11	14	1	0		13	11	14	24	54	138.2		VERTFLAR	1.741E+01	23368.6	29.2	2043116.7	38.10	42.83	0.95
																Event Total (11/6-11/14/13) =>	54,415.1								
7/1/13 - 12/31/13	11/17/13 7:22 AM	11/17/13 11:09 AM	0.16	3.78	13	11	17	8	22		13	11	17	12	9	110.1	628.7	COKEFLAR	1.387E+01	22700.7	24.9	1744775.8	53.34	57.73	0.88
7/1/13 - 12/31/13	11/26/13 12:00 AM	11/26/13 11:59 PM	1.00	23.98	13	11	26	1	0		13	11	26	24	59	38.4		VERTFLAR	4.838E+00	89705.1	112.0	7842916.9	38.10	47.11	1.86
7/1/13 - 12/31/13	11/27/13 12:00 AM	11/27/13 6:12 PM	0.76	18.20	13	11	27	1	0		13	11	27	19	12	4.1		VERTFLAR	5.166E-01	81564.9	101.9	7131219.2	38.10	46.71	1.77
																Event Total (11/26-11/27/13) =>	994.6								
7/1/13 - 12/31/13	12/5/13 6:58 AM	12/5/13 10:20 PM	0.64	15.37	13	12	5	7	58		13	12	5	23	20	34.8	530.4	VERTFLAR	4.378E+00	44701.5	55.8	3908252.1	38.10	44.56	1.31
1/1/14 - 6/30/14	12/23/13 12:00 AM	12/23/13 11:59 PM	1.00	23.98	13	12	23	1	0		13	12	23	24	59	33.6	807.2	VERTFLAR	4.234E+00	5129.0	6.4	448428.5	38.10	40.39	0.44

[1] The allocations of emissions to the flare listed in this column was based on a review of each RCFA report. If the RCFA report was not clear on which flare emitted, then the following default assumptions were made based on input from SWRC (communication with Glenn Spangler of the AQD on 9/9/15):
For years 2012 and 2013, and through January 31, 2014, the South Flare (VERTFLAR) was the preferred flare for the refinery. Starting in February 2014, the preferred flare was changed to be the North Flare (COKEFLAR).

[2] The emission rate is the average emission rate from the RFCA. However, if a flaring event lasted less than one hour, then the reported lb/event value was used for the hour in which the emissions occurred.

max VERTFLAR values =>	56.59	3.94
min VERTFLAR values =>	40.39	0.44
avg VERTFLAR values =>	46.91	1.82

max COKEFLAR values =>	70.02	3.54
min COKEFLAR values =>	57.73	0.88
avg COKEFLAR values =>	61.32	1.65

Wyoming Department of Environmental Quality - Air Quality Division
Air Dispersion Modeling Report in Support of the 2010 1-Hour Sulfur Dioxide NAAQS Designation Recommendation
SWRC Semi-Annual Progress Report Data Summary - Flaring Event Hourly SO_2 Modeled Emission Rate, and Effective Release Height/Diameter Calculations - 2014

Reporting Period	Start Date/Time	End Date/Time	Duration (days)	Duration (hours)	Start Date/Time (Hour Ending) YY	MM	DD	HH	MN		Start Date/Time (Hour Ending) YY	MM	DD	HH	MN	Avg Emissions (lb/hr)	Total Emissions (Reported lb/event)	MODEL_ID [1]	Qs [2] (g/s)	Flow Rate (scf/hr)	Heat Rls Rate (MMBtu/hr)	Heat Rls Rate (cal/s)	Physical Hs (m)	Effective Hs (m)	Effective Ds (m)
1/1/14 - 6/30/14	1/6/14 7:51 AM	1/6/14 11:59 PM	0.67	16.13	14	1	6	8	51		14	1	6	24	59	95.5		VERTFLAR	1.203E+01	56501.0	56.5	3955070.0	38.10	44.59	1.32
1/1/14 - 6/30/14	1/7/14 12:00 AM	1/7/14 2:50 PM	0.62	14.83	14	1	7	1	0		14	1	7	15	50	11.6		VERTFLAR	1.457E+00	15549.3	15.5	1088451.0	38.10	41.60	0.69
																Event Total (1/6-1/7/14) =>	1,650.0								
1/1/14 - 6/30/14	1/10/14 9:35 AM	1/10/14 11:59 PM	0.60	14.40	14	1	10	10	35		14	1	10	24	59	81.9		VERTFLAR	1.031E+01	84970.0	85.0	5947900.0	38.10	45.99	1.62
1/1/14 - 6/30/14	1/11/14 12:00 AM	1/11/14 3:08 PM	0.63	15.13	14	1	11	1	0		14	1	11	16	8	144.1		VERTFLAR	1.816E+01	66080.0	66.1	4625600.0	38.10	45.10	1.43
																Event Total (1/10-1/11/14) =>	3,380.0								
1/1/14 - 6/30/14	1/20/14 1:04 PM	1/20/14 11:59 PM	0.45	10.92	14	1	20	14	4		14	1	20	24	59	237.5		VERTFLAR	2.992E+01	93679.6	93.7	6557572.0	38.10	46.37	1.70
1/1/14 - 6/30/14	1/21/14 12:00 AM	1/21/14 8:46 PM	0.87	20.77	14	1	21	1	0		14	1	21	21	46	288.8		VERTFLAR	3.639E+01	106785.6	106.8	7474992.0	38.10	46.90	1.81
																Event Total (1/20-1/21/14) =>	8,584.3								
1/1/14 - 6/30/14	1/23/14 4:58 AM	1/23/14 8:09 PM	0.63	15.18	14	1	23	5	58		14	1	23	21	9	67.1	1,018.4	VERTFLAR	8.454E+00	26461.7	26.5	1852319.0	38.10	42.62	0.90
1/1/14 - 6/30/14	1/25/14 12:00 AM	1/25/14 11:59 PM	1.00	23.98	14	1	25	1	0		14	1	25	24	59	202.9		VERTFLAR	2.556E+01	138025.0	138.0	9661750.0	38.10	48.05	2.06
1/1/14 - 6/30/14	1/26/14 12:00 AM	1/26/14 11:59 PM	1.00	23.98	14	1	26	1	0		14	1	26	24	59	118.6		VERTFLAR	1.494E+01	171092.5	171.1	11976475.0	38.10	49.13	2.29
1/1/14 - 6/30/14	1/27/14 12:00 AM	1/27/14 11:59 PM	1.00	23.98	14	1	27	1	0		14	1	27	24	59	122.1		VERTFLAR	1.538E+01	167977.0	168.0	11758390.0	38.10	49.03	2.27
1/1/14 - 6/30/14	1/28/14 12:00 AM	1/28/14 5:32 PM	0.73	17.53	14	1	28	1	0		14	1	28	18	32	220.7		VERTFLAR	2.781E+01	65944.7	65.9	4616129.0	38.10	45.09	1.42
																Event Total (1/25-1/28/14) =>	14,489.9								
1/1/14 - 6/30/14	2/4/14 7:29 AM	2/4/14 11:59 PM	0.69	16.50	14	2	4	8	29		14	2	4	24	59	29.1		COKEFLAR	3.667E+00	35854.6	35.9	2509822.0	53.34	58.56	1.05
1/1/14 - 6/30/14	2/5/14 12:00 AM	2/5/14 11:59 PM	1.00	23.98	14	2	5	1	0		14	2	5	24	59	14.6		COKEFLAR	1.840E+00	45460.9	45.5	3182263.0	53.34	59.19	1.18
1/1/14 - 6/30/14	2/6/14 12:00 AM	2/6/14 11:59 PM	1.00	23.98	14	2	6	1	0		14	2	6	24	59	38.6		GRNDFLAR [3]	4.864E+00	31690.1	#N/A	#N/A	#N/A	#N/A	#N/A
1/1/14 - 6/30/14	2/7/14 12:00 AM	2/7/14 11:59 PM	1.00	23.98	14	2	7	1	0		14	2	7	24	59	138.2		GRNDFLAR [3]	1.741E+01	138629.8	#N/A	#N/A	#N/A	#N/A	#N/A
1/1/14 - 6/30/14	2/8/14 12:00 AM	2/8/14 11:59 PM	1.00	23.98	14	2	8	1	0		14	2	8	24	59	75.6		GRNDFLAR [3]	9.525E+00	26311.4	#N/A	#N/A	#N/A	#N/A	#N/A
1/1/14 - 6/30/14	2/9/14 12:00 AM	2/9/14 11:59 PM	1.00	23.98	14	2	9	1	0		14	2	9	24	59	94.8		COKEFLAR	1.194E+01	29205.6	29.2	2044392.0	53.34	58.08	0.95
1/1/14 - 6/30/14	2/10/14 12:00 AM	2/10/14 11:59 PM	1.00	23.98	14	2	10	1	0		14	2	10	24	59	25.0		COKEFLAR	3.150E+00	37959.5	38.0	2657165.0	53.34	58.71	1.08
1/1/14 - 6/30/14	2/11/14 12:00 AM	2/11/14 11:59 PM	1.00	23.98	14	2	11	1	0		14	2	11	24	59	61.8		COKEFLAR	7.787E+00	81321.3	81.3	5692491.0	53.34	61.07	1.58
1/1/14 - 6/30/14	2/12/14 12:00 AM	2/12/14 11:59 PM	1.00	23.98	14	2	12	1	0		14	2	12	24	59	166.6		COKEFLAR	2.099E+01	102666.6	102.7	7186662.0	53.34	61.98	1.78
1/1/14 - 6/30/14	2/13/14 12:00 AM	2/13/14 11:59 PM	1.00	23.98	14	2	13	1	0		14	2	13	24	59	49.6		COKEFLAR	6.249E+00	62415.4	62.4	4369078.0	53.34	60.15	1.39
																Event Total (2/4-2/13/14) =>	16,414.4								
1/1/14 - 6/30/14	2/20/14 12:00 AM	2/20/14 11:59 PM	1.00	23.98	14	2	20	1	0		14	2	20	24	59	45.4		COKEFLAR	5.720E+00	72306.9	72.3	5061483.0	53.34	60.64	1.49
1/1/14 - 6/30/14	2/21/14 12:00 AM	2/21/14 11:59 PM	1.00	23.98	14	2	21	1	0		14	2	21	24	59	23.2		COKEFLAR	2.923E+00	52815.8	52.8	3697106.0	53.34	59.63	1.27
1/1/14 - 6/30/14	2/22/14 12:00 AM	2/22/14 11:59 PM	1.00	23.98	14	2	22	1	0		14	2	22	24	59	26.6		COKEFLAR	3.352E+00	54300.5	54.3	3801035.0	53.34	59.71	1.29
																Event Total (2/20-2/22/14) =>	2,278.1								
1/1/14 - 6/30/14	2/25/14 8:47 PM	2/25/14 11:59 PM	0.13	3.20	14	2	25	21	47		14	2	25	24	59	68.0		COKEFLAR	8.568E+00	89410.7	89.4	6258749.0	53.34	61.43	1.66
1/1/14 - 6/30/14	2/26/14 12:00 AM	2/26/14 3:39 PM	0.65	15.65	14	2	26	1	0		14	2	26	16	39	86.0		COKEFLAR	1.084E+01	66066.1	66.1	4624627.0	53.34	60.34	1.43
																Event Total (2/25-2/26/14) =>	1,579.1								
1/1/14 - 6/30/14	3/13/14 12:40 AM	3/13/14 3:53 PM	0.63	15.22	14	3	13	1	40		14	3	13	16	53	125.5	1,906.0	COKEFLAR	1.581E+01	53061.7	53.1	3714319.0	53.34	59.64	1.28
1/1/14 - 6/30/14	3/25/14 7:34 PM	3/25/14 11:59 PM	0.18	4.42	14	3	25	20	34		14	3	25	24	59	86.3		COKEFLAR	1.087E+01	96296.8	96.3	6740776.0	53.34	61.72	1.72
1/1/14 - 6/30/14	3/26/14 12:00 AM	3/26/14 11:59 PM	1.00	23.98	14	3	26	1	0		14	3	26	24	59	218.1		COKEFLAR	2.748E+01	65848.1	65.8	4609367.0	53.34	60.33	1.42
1/1/14 - 6/30/14	3/27/14 12:00 AM	3/27/14 11:59 PM	1.00	23.98	14	3	27	1	0		14	3	27	24	59	191.5		COKEFLAR	2.413E+01	46073.1	46.1	3225117.0	53.34	59.23	1.19
1/1/14 - 6/30/14	3/28/14 12:00 AM	3/28/14 6:11 PM	0.76	18.18	14	3	28	1	0		14	3	28	19	11	21.8		COKEFLAR	2.747E+00	21522.8	21.5	1506596.0	53.34	57.43	0.81
																Event Total (3/25-3/28/14) =>	10,596.0								
1/1/14 - 6/30/14	3/30/14 7:23 AM	3/30/14 11:59 PM	0.69	16.60	14	3	30	8	23		14	3	30	24	59	72.0		COKEFLAR	9.072E+00	37371.9	37.4	2616033.0	53.34	58.67	1.07
1/1/14 - 6/30/14	3/31/14 12:00 AM	3/31/14 11:59 PM	1.00	23.98	14	3	31	1	0		14	3	31	24	59	43.9		COKEFLAR	5.531E+00	20433.3	20.4	1430331.0	53.34	57.33	0.79
1/1/14 - 6/30/14	4/1/14 12:00 AM	4/1/14 11:59 PM	1.00	23.98	14	4	1	1	0		14	4	1	24	59	33.3		COKEFLAR	4.196E+00	25611.7	25.6	1792819.0	53.34	57.79	0.89
1/1/14 - 6/30/14	4/2/14 12:00 AM	4/2/14 11:26 AM	0.48	11.43	14	4	2	1	0		14	4	2	12	26	42.8		COKEFLAR	5.393E+00	26110.2	26.1	1827714.0	53.34	57.83	0.90
																Event Total (3/30-4/2/14) =>	3,533.6								
1/1/14 - 6/30/14	4/13/14 1:20 PM	4/13/14 2:13 PM	0.04	0.88	14	4	13	14	20		14	4	13	15	13	87.7	80.0	COKEFLAR	1.008E+01	133114.0	133.1	9317980.0	53.34	63.12	2.02
1/1/14 - 6/30/14	4/14/14 2:23 AM	4/14/14 5:03 AM	0.11	2.67	14	4	14	3	23		14	4	14	6	3	228.7		COKEFLAR	2.882E+01	23166.8	23.2	1621676.0	53.34	57.58	0.84
																Event Total (4/13-4/14/14) =>	695.5								
1/1/14 - 6/30/14	4/26/14 8:45 AM	4/26/14 3:00 PM	0.26	6.25	14	4	26	9	45		14	4	26	16	0	101.4	638.0	COKEFLAR	1.278E+01	29994.6	30.0	2099622.0	53.34	58.14	0.96
1/1/14 - 6/30/14	5/18/14 12:17 PM	5/18/14 6:55 PM	0.28	6.63	14	5	18	13	17		14	5	18	19	55	328.3	1,016.6	VERTFLAR	4.137E+01	60710.7	60.7	4249749.0	38.10	44.82	1.37
1/1/14 - 6/30/14	5/21/14 3:38 PM	5/21/14 6:36 PM	0.12	2.97	14	5	21	16	38		14	5	21	19	36	233.6	676.6	COKEFLAR	2.943E+01	57591.5	57.6	4031405.0	53.34	59.89	1.33
1/1/14 - 6/30/14	5/28/14 1:57 PM	5/28/14 4:54 PM	0.12	2.95	14	5	28	14	57		14	5	28	17	54	317.6	939.0	COKEFLAR	4.002E+01	170852.5	170.9	11959675.0	53.34	64.36	2.29
1/1/14 - 6/30/14	5/30/14 5:26 PM	5/30/14 11:59 PM	0.27	6.55	14	5	30	18	26		14	5	30	24	59	873.6	5,758.8	COKEFLAR	1.101E+02	66611.9	66.6	4662833.0	53.34	60.36	1.43
1/1/14 - 6/30/14	6/7/14 10:08 AM	6/7/14 5:45 PM	0.32	7.62	14	6	7	11	8		14	6	7	18	45	286.1	2,171.5	COKEFLAR	3.605E+01	141058.6	141.1	9874102.0	53.34	63.39	2.08
1/1/14 - 6/30/14	6/9/14 6:44 AM	6/9/14 8:16 AM	0.06	1.53	14	6	9	7	44		14	6	9	9	16	1840.8	2,849.9	COKEFLAR	2.319E+02	108923.1	108.9	7624617.0	53.34	62.23	1.83
1/1/14 - 6/30/14	6/11/14 4:11 AM	6/11/14 3:29 PM	0.47	11.30	14	6	11	5	11		14	6	11	16	29	66.0	744.7	COKEFLAR	8.316E+00	30030.4	30.0	2102128.0	53.34	58.14	0.96
7/1/14 - 12/31/14	7/26/14 6:39 AM	7/26/14 11:59 PM	0.72	17.33	14	7	26	7	39		14	7	26	24	59	339.3		COKEFLAR	4.275E+01	54253.2	54.3	3797724.0	53.34	59.71	1.29
7/1/14 - 12/31/14	7/27/14 12:00 AM	7/27/14 11:59 PM	1.00	23.98	14	7	27	1	0		14	7	27	24	59	166.1		COKEFLAR	2.093E+01	57796.2	57.8	4045734.0	53.34	59.90	1.33
7/1/14 - 12/31/14	7/28/14 12:00 AM	7/28/14 11:59 PM	1.00	23.98	14	7	28	1	0		14	7	28	24	59	215.4		COKEFLAR	2.714E+01	57936.1	57.9	4055527.0	53.34	59.91	1.33
7/1/14 - 12/31/14	7/29/14 12:00 AM	7/29/14 1:00 PM	0.54	13.00	14	7	29	1	0		14	7	29	14	0	68.5		COKEFLAR	8.631E+00	81051.2	81.1	5673584.0	53.34	61.05	1.58
																Event Total (7/26-7/28/14) =>	15,843.8								
7/1/14 - 12/31/14	7/30/14 12:00 PM	7/30/14 6:00 PM	0.25	6.00	14	7	30	13	0		14	7	30	19	0	90.5	542.5	COKEFLAR	1.140E+01	46173.4	46.2	3232138.0	53.34	59.24	1.19
7/1/14 - 12/31/14	8/4/14 10:59 AM	8/4/14 1:46 PM	0.12	2.78	14	8	4	11	59		14	8	4	14	46	371.1		COKEFLAR	4.676E+01	129156.6	129.2	9040962.0	53.34	62.98	1.99
7/1/14 - 12/31/14	8/4/14 5:14 PM	8/4/14 9:17 PM	0.17	4.05	14	8	4	18	14		14	8	4	22	17	202.8		COKEFLAR	2.555E+01	17414.0	17.4	1218980.0	53.34	57.04	0.73
																Event Total (8/4/14) =>	1,868.1								

Wyoming Department of Environmental Quality - Air Quality Division
Air Dispersion Modeling Report in Support of the 2010 1-Hour Sulfur Dioxide NAAQS Designation Recommendation
SWRC Semi-Annual Progress Report Data Summary - Flaring Event Hourly SO_2 Modeled Emission Rate, and Effective Release Height/Diameter Calculations - 2014

Reporting Period	Start Date/Time	End Date/Time	Duration (days)	Duration (hours)	Start Date/Time (Hour Ending) YY	MM	DD	HH	MN		Start Date/Time (Hour Ending) YY	MM	DD	HH	MN	Avg Emissions (lb/hr)	Total Emissions (Reported lb/event)	MODEL_ID [1]	Qs [2] (g/s)	Flow Rate (scf/hr)	Heat Rls Rate (MMBtu/hr)	Heat Rls Rate (cal/s)	Physical Hs (m)	Effective Hs (m)	Effective Ds (m)
7/1/14 - 12/31/14	8/9/14 1:44 PM	8/9/14 6:24 PM	0.19	4.67	14	8	9	14	44		14	8	9	19	24	184.6	866.7	COKEFLAR	2.326E+01	75865.0	75.9	5310550.0	53.34	60.81	1.53
7/1/14 - 12/31/14	8/28/14 8:52 AM	8/28/14 11:59 PM	0.63	15.12	14	8	28	9	52		14	8	28	24	59	340.3		COKEFLAR	4.288E+01	61018.2	61.0	4271274.0	53.34	60.08	1.37
7/1/14 - 12/31/14	8/29/14 12:00 AM	8/29/14 11:59 PM	1.00	23.98	14	8	29	1	0		14	8	29	24	59	213.4		COKEFLAR	2.689E+01	30358.2	30.4	2125074.0	53.34	58.16	0.97
7/1/14 - 12/31/14	8/30/14 12:00 AM	8/30/14 11:59 PM	1.00	23.98	14	8	30	1	0		14	8	30	24	59	135.2		COKEFLAR	1.703E+01	28574.9	28.6	2000243.0	53.34	58.03	0.94
7/1/14 - 12/31/14	8/31/14 12:00 AM	8/31/14 11:59 PM	1.00	23.98	14	8	31	1	0		14	8	31	24	59	53.7		COKEFLAR	6.766E+00	22714.9	22.7	1590043.0	53.34	57.54	0.84
7/1/14 - 12/31/14	9/1/14 12:00 AM	9/1/14 11:59 PM	1.00	23.98	14	9	1	1	0		14	9	1	24	59	6.5		COKEFLAR	8.190E-01	19303.2	19.3	1351224.0	53.34	57.23	0.77
7/1/14 - 12/31/14	9/2/14 12:00 AM	9/2/14 11:00 AM	0.46	11.00	14	9	2	1	0		14	9	2	12	0	153.0		COKEFLAR	1.928E+01	26620.2	26.6	1863414.0	53.34	57.87	0.90
																Event Total (8/28-9/2/14) =>	16,615.4								
7/1/14 - 12/31/14	9/4/14 8:14 AM	9/4/14 11:59 PM	0.66	15.75	14	9	4	9	14		14	9	4	24	59	353.4		COKEFLAR	4.453E+01	42768.7	42.8	2993809.0	53.34	59.02	1.15
7/1/14 - 12/31/14	9/5/14 12:00 AM	9/5/14 1:09 PM	0.55	13.15	14	9	5	1	0		14	9	5	14	9	181.7		COKEFLAR	2.289E+01	39826.6	39.8	2787862.0	53.34	58.83	1.11
																Event Total (9/4-9/5/14) =>	7,973.8								
7/1/14 - 12/31/14	9/15/14 2:16 PM	9/15/14 11:00 PM	0.36	8.73	14	9	15	15	16		14	9	15	24	0	80.5	780.2	COKEFLAR	1.014E+01	43319.4	43.3	3032358.0	53.34	59.06	1.15
7/1/14 - 12/31/14	9/21/14 11:02 AM	9/21/14 1:05 PM	0.09	2.05	14	9	21	12	2		14	9	21	14	5	257.9	644.1	COKEFLAR	3.249E+01	50879.9	50.9	3561593.0	53.34	59.52	1.25
7/1/14 - 12/31/14	11/6/14 1:36 PM	11/6/14 1:59 PM	0.02	0.38	14	11	6	14	36		14	11	6	14	59	2751.9	1,099.5	COKEFLAR	1.385E+02	108557.9	108.6	7599053.0	53.34	62.21	1.83
1/1/15 - 6/30/15	12/31/14 4:30 AM	12/31/14 10:36 AM	0.25	6.10	14	12	31	5	30		14	12	31	11	36	221.6		COKEFLAR	2.792E+01	87397.5	87.4	6117825.0	53.34	61.34	1.64
1/1/15 - 6/30/15	12/31/14 11:00 AM	12/31/14 6:18 PM	0.30	7.30	14	12	31	12	0		14	12	31	19	18	46.8		COKEFLAR	5.897E+00	27681.9	27.7	1937733.0	53.34	57.96	0.92
																Event Total (12/31/14) =>	1,688.1								

max VERTFLAR values =>	49.13	2.29
min VERTFLAR values =>	41.60	0.69
avg VERTFLAR values =>	45.77	1.57

max COKEFLAR values =>	64.36	2.29
min COKEFLAR values =>	57.04	0.73
avg COKEFLAR values =>	59.69	1.29

3-yr stats:

max VERTFLAR values =>	59.10	4.50
min VERTFLAR values =>	40.39	0.44
avg VERTFLAR values =>	48.35	2.13

max COKEFLAR values =>	70.02	3.54
min COKEFLAR values =>	57.04	0.73
avg COKEFLAR values =>	60.50	1.47

[1] The allocations of emissions to the flare listed in this column was based on a review of each RCFA report. If the RCFA report was not clear on which flare emitted, then the following default assumptions were made based on input from SWRC (communication with Glenn Spangler of the AQD on 9/9/15):
For years 2012 and 2013, and through January 31, 2014, the South Flare (VERTFLAR) was the preferred flare for the refinery. Starting in February 2014, the preferred flare was changed to be the North Flare (COKEFLAR).

[2] The emission rate is the average emission rate from the RFCA. However, if a flaring event lasted less than one hour, then the reported lb/event value was used for the hour in which the emissions occurred.

[3] GRNDFLAR (Emergency Ground Flare) was modeled as a volume source; therefore heat release rate, and effective release height/diameter are not applicable.

APPENDIX E

Temporally and Seasonally-Varying Background Concentrations

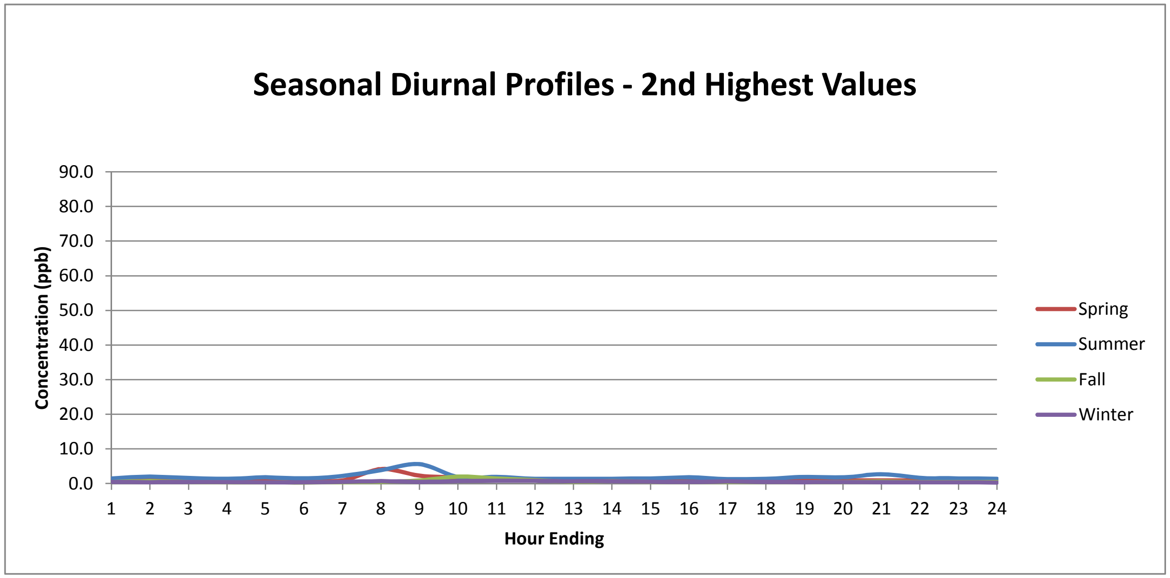
Final Air Dispersion Modeling Report in Support of the 2010 1-Hour Sulfur Dioxide NAAQS Designation Recommendation

Wyoming Department of Environmental Quality - Air Quality Division
200 West 17th Street
Cheyenne, WY 82002

October 20, 2015

Wyoming Department of Environmental Quality - Air Quality Division
Air Dispersion Modeling Report in Support of the 2010 1-Hour Sulfur Dioxide NAAQS Designation Recommendation
Temporally and Seasonally-Varying Background Concentrations

Season	Hour Ending	2^{nd} Highest Value (ppb)	Percent Available Values (%)
Spring	01	1.1	97.8
Spring	02	1.3	53.3
Spring	03	1.0	93.5
Spring	04	0.9	97.8
Spring	05	1.0	98.9
Spring	06	1.0	95.7
Spring	07	0.9	91.3
Spring	08	4.2	91.3
Spring	09	2.3	89.1
Spring	10	1.7	91.3
Spring	11	1.0	92.4
Spring	12	1.3	95.7
Spring	13	1.1	93.5
Spring	14	1.0	92.4
Spring	15	0.9	94.6
Spring	16	1.0	92.4
Spring	17	0.9	93.5
Spring	18	0.9	94.6
Spring	19	0.9	96.7
Spring	20	1.0	95.7
Spring	21	0.9	93.5
Spring	22	0.9	94.6
Spring	23	0.9	94.6
Spring	24	0.9	83.7
Summer	01	1.5	94.6
Summer	02	2.0	97.8
Summer	03	1.6	94.6
Summer	04	1.4	63.0
Summer	05	1.8	94.6
Summer	06	1.5	93.5
Summer	07	2.2	89.1
Summer	08	3.9	88.0
Summer	09	5.6	88.0
Summer	10	1.9	93.5
Summer	11	1.9	93.5
Summer	12	1.4	93.5
Summer	13	1.4	95.7
Summer	14	1.4	94.6
Summer	15	1.5	95.7
Summer	16	1.8	96.7
Summer	17	1.3	96.7
Summer	18	1.4	93.5
Summer	19	1.9	93.5
Summer	20	1.8	91.3
Summer	21	2.7	91.3
Summer	22	1.7	90.2
Summer	23	1.5	95.7
Summer	24	1.4	83.7



Wyoming Department of Environmental Quality - Air Quality Division
Air Dispersion Modeling Report in Support of the 2010 1-Hour Sulfur Dioxide NAAQS Designation Recommendation
Temporally and Seasonally-Varying Background Concentrations

Season	Hour Ending	2^{nd} Highest Value (ppb)	Percent Available Values (%)
Fall	01	0.5	71.4
Fall	02	0.7	39.6
Fall	03	0.5	72.5
Fall	04	0.3	58.2
Fall	05	0.4	74.7
Fall	06	0.3	71.4
Fall	07	0.4	74.7
Fall	08	0.5	73.6
Fall	09	0.9	74.7
Fall	10	2.0	72.5
Fall	11	1.5	68.1
Fall	12	1.0	69.2
Fall	13	0.5	73.6
Fall	14	0.7	75.8
Fall	15	0.5	73.6
Fall	16	0.5	74.7
Fall	17	0.5	75.8
Fall	18	0.5	75.8
Fall	19	0.5	74.7
Fall	20	0.5	75.8
Fall	21	0.6	73.6
Fall	22	0.5	72.5
Fall	23	0.5	72.5
Fall	24	0.5	64.8
Winter	01	0.5	87.5
Winter	02	0.4	62.5
Winter	03	0.5	86.6
Winter	04	0.4	85.7
Winter	05	0.4	86.6
Winter	06	0.4	83.0
Winter	07	0.5	83.9
Winter	08	0.7	79.5
Winter	09	0.5	83.0
Winter	10	0.7	82.1
Winter	11	0.8	84.8
Winter	12	0.8	85.7
Winter	13	0.6	85.7
Winter	14	0.7	88.4
Winter	15	0.5	87.5
Winter	16	0.5	88.4
Winter	17	0.6	88.4
Winter	18	0.5	87.5
Winter	19	0.4	86.6
Winter	20	0.5	83.0
Winter	21	0.4	83.9
Winter	22	0.4	87.5
Winter	23	0.4	90.2
Winter	24	0.3	74.1

Technical Support Document for Carbon County, Wyoming 1-hour SO_2 Designation

This technical support document is attached in support of the evaluation performed to determine an appropriate designation for Carbon County, Wyoming in response to Acting Assistant Administrator Janet McCabe's letter dated March 20, 2015 to Wyoming Department of Environmental Quality (WDEQ) Director Todd Parfitt.

These evaluations included a detailed review of the SO_2 air quality measurements during the times when the value of the 2010 SO_2 National Ambient Air Quality Standard (NAAQS) was exceeded, including data submissions to the EPA and WDEQ Air Quality Divisions (AQD) as required by the May 8, 2008 Consent Decree between the United States of America and SWRC, and other reports submitted by Sinclair Wyoming Refining Company (SWRC) to the WDEQ-AQD regarding ambient air quality monitoring. The WDEQ-AQD has also conducted a refined air dispersion modeling evaluation to inform the designation recommendation. Each of these evaluations is summarized in this letter.

SO_2 Air Quality Monitoring Data Evaluation

SWRC operates a SO_2 air quality monitor located approximately 650 meters northeast of the main SWRC emission units, as shown in Figure 1-1 in Attachment 1. Table 1-1 in Attachment 1 shows the hours when the value of the 2010 SO_2 NAAQS of 75 parts per billion (ppb) was exceeded. The calculated 1-hour SO_2 design value from this monitor for the period from 2012 to 2014 is 123 ppb.

Table 1-1 provides the wind speed and wind direction (the direction from which the wind is blowing) for each exceedance hour, along with a brief summary of the causes for the exceedances according to SWRC. The WDEQ-AQD has evaluated these exceedance hours in detail. Based on the wind flow during each monitored exceedance, the winds were blowing from the southwesterly direction with the SO_2 monitor directly downwind of SWRC emission units. As reported by SWRC, various emission units were upset during the monitored exceedances. Additionally, a detailed review of ambient SO_2 monitoring data collected by the WDEQ-AQD's mobile air monitoring station located in the Town of Sinclair (AQS ID number 56-007-1000) and review of other permitted stationary sources in the region, showed no other significant nearby sources of SO_2 emissions in the vicinity of SWRC that could have significantly contributed to the monitored exceedances. Therefore, the WDEQ-AQD has concluded that the elevated SO_2 air concentrations were clearly attributed to the SWRC upset conditions listed in Table 1-1.

The WDEQ-AQD also reviewed the location of this monitor as part of the evaluation of the data. It is evident that this monitor is located outside of SWRC's currently permitted modeling ambient boundary shown in Figure 1-1; however, it is also located within an existing fence that restricts public access to the area where the monitor is located. Because the monitor is located within an existing fence, the WDEQ-AQD cannot rely solely on the SO_2 concentrations measured at the SWRC SO_2 air quality monitor in making its designation recommendation for this area.

Refined Air Dispersion Modeling Evaluation

In an effort to further assess the air quality surrounding the SWRC stationary source, the WDEQ-AQD conducted a refined air dispersion modeling evaluation to inform its designation recommendation. The purpose of the modeling evaluation was to use all available information and data available to the WDEQ-AQD to determine if a modeled violation of the 1-hour SO_2 NAAQS would be identified in the vicinity of the SWRC stationary source and SO_2 air quality monitor.

The modeling was conducted in accordance with the EPA's December 2013 SO_2 NAAQS Designations Modeling Technical Assistance Document (Modeling TAD), as referenced in the final Data Requirements Rule[1] (DRR), as well as 40 CFR 51, Appendix W (EPA's Modeling Guideline). The Modeling TAD provides recommendations on several aspects of the 1-hour SO_2 dispersion modeling approach for designation purposes including the use of hourly actual emissions, source characterization, meteorological data, model selection, and background concentrations. The latest version of the EPA's AERMOD modeling system (Version 15181 and associated pre-processors) was used in its regulatory default mode.

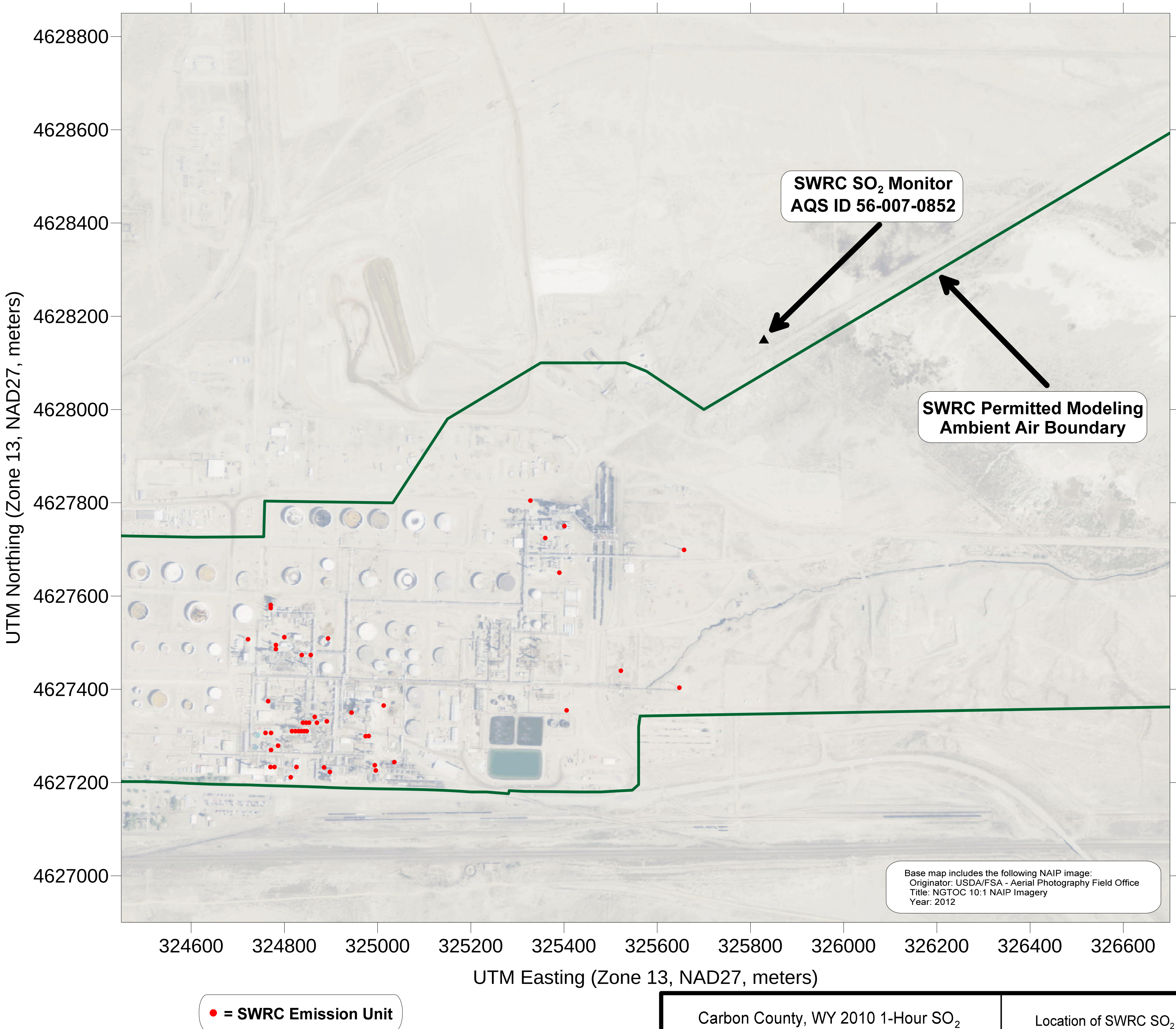
The WDEQ-AQD developed the model inputs using several sources of information and data to capture the SWRC operating conditions during the period from 2012 to 2014. The primary sources of hourly SO_2 emissions data used in the modeling were from SWRC's continuous emission monitoring systems (CEMS) where available, information about upset events obtained from various submittals required by the May 8, 2008 Consent Decree, existing Federally-enforceable permit limits, and other Federally-required reporting data. Other inputs developed by the WDEQ-AQD included direction-specific downwash parameters for SWRC emission units, appropriately located receptors, concurrent meteorological data collected at SWRC for the period from 2012 to 2014, nearby permitted stationary sources, and temporally and seasonally varying background SO_2 concentrations.

[1] 80 FR 51054.

The results of the modeling analysis indicated that there were no modeled violations of the 1-hour SO_2 NAAQS within the full receptor grid developed for areas on and outside of the SWRC permitted modeling ambient air boundary. The maximum modeled 1-hour SO_2 design value concentration predicted by AERMOD was 62.1 ppb [162.6 micrograms per cubic meter ($\mu g/m^3$)]. Isopleth maps of the modeled 1-hour SO_2 design value concentrations are provided in Figures 2-1 through 2-3 in Attachment 2. Review of Figures 2-1 and 2-2 indicate that the maximum modeled design values occur in the vicinity of SWRC with no elevated design value impacts in the near or far-field of the modeling domain. Figure 2-3 provides a near-field isopleth map of the modeled 1-hour SO_2 design value concentrations in the immediate vicinity of the SWRC stationary source and SO_2 air quality monitor. This figure shows a strong SO_2 concentration gradient to the north and northeast of SWRC emission units, and in the area around the SO_2 air quality monitor.

Based on the WDEQ-AQD's refined dispersion modeling evaluation results, the WDEQ-AQD determined that the available modeling evaluations were inconclusive for use in making a designation recommendation for the 1-hour SO_2 NAAQS.

The WDEQ-AQD's detailed air dispersion modeling report is included in Attachment 3, which provides the details of the model inputs, model options, and results of the evaluation.



Carbon County, WY 2010 1-Hour SO_2 NAAQS Designation Recommendation	Location of SWRC SO_2 Air Quality Monitor AQS ID 56-007-0852
Date: 10/03/2015	FIGURE 1-1

Table 1-1

Carbon County, WY 2010 1-Hour SO_2 NAAQS Designation Recommendation

SWRC Monitored 1-Hour SO_2 Air Quality Exceedance Summary (AQS ID 56-007-0852)

Date	Time (hour ending)	Monitored Concentration [1] (ppb)	10-m Wind Speed (m/s)	10-m Wind Direction (deg)	Summary of Known Causes [2]
4/24/2012	15:00	87	6.2	234	Hydrocarbon carryover from #4ARU to #3SRU
5/1/2012	14:00	255	10.7	230	Loss of amine level in #4ARU
	19:00	200	7.0	216	
5/17/2012	18:00	78	5.8	215	#3ARU, #4ARU upsets, #4SRU/TGTU startup after turnaround
6/26/2012	10:00	96	9.3	221	#1 TGTU spike, Possible caustic pump issue
7/24/2012	15:00	169	7.8	223	PLC power supply failure
11/7/2012	11:00	400	7.3	225	#3 TTO trip due to low BFW, Possible instrument failure
11/9/2012	6:00	129	9.3	214	#3SRU/TGTU shutdown and #4 TTO trip due to low BFW
8/2/2013	20:00	86	3.5	220	Cold start-up after turnaround
11/20/2013	13:00	77	8.7	217	#3SRU feed instability caused spikes from #3 TTO
1/3/2014	11:00	89	10.3	213	#4 TGTU trip, false flow path instrumentation reading
2/16/2014	4:00	454	8.5	210	Start-up #3SRU/TGTU, #4 TTO trip
	6:00	591	9.1	210	
	7:00	142	9.3	212	
	8:00	90	10.1	216	
	9:00	398	9.7	215	
	10:00	138	9.7	223	
	11:00	418	12.1	215	
	12:00	136	12.6	215	
	13:00	127	11.8	211	
	14:00	167	11.7	229	
2/17/2014	14:00	159	10.5	220	Start-up #3SRU/TGTU, #1TGTU FD fan trip
	15:00	207	13.0	216	
	16:00	172	14.3	215	

Table 1-1

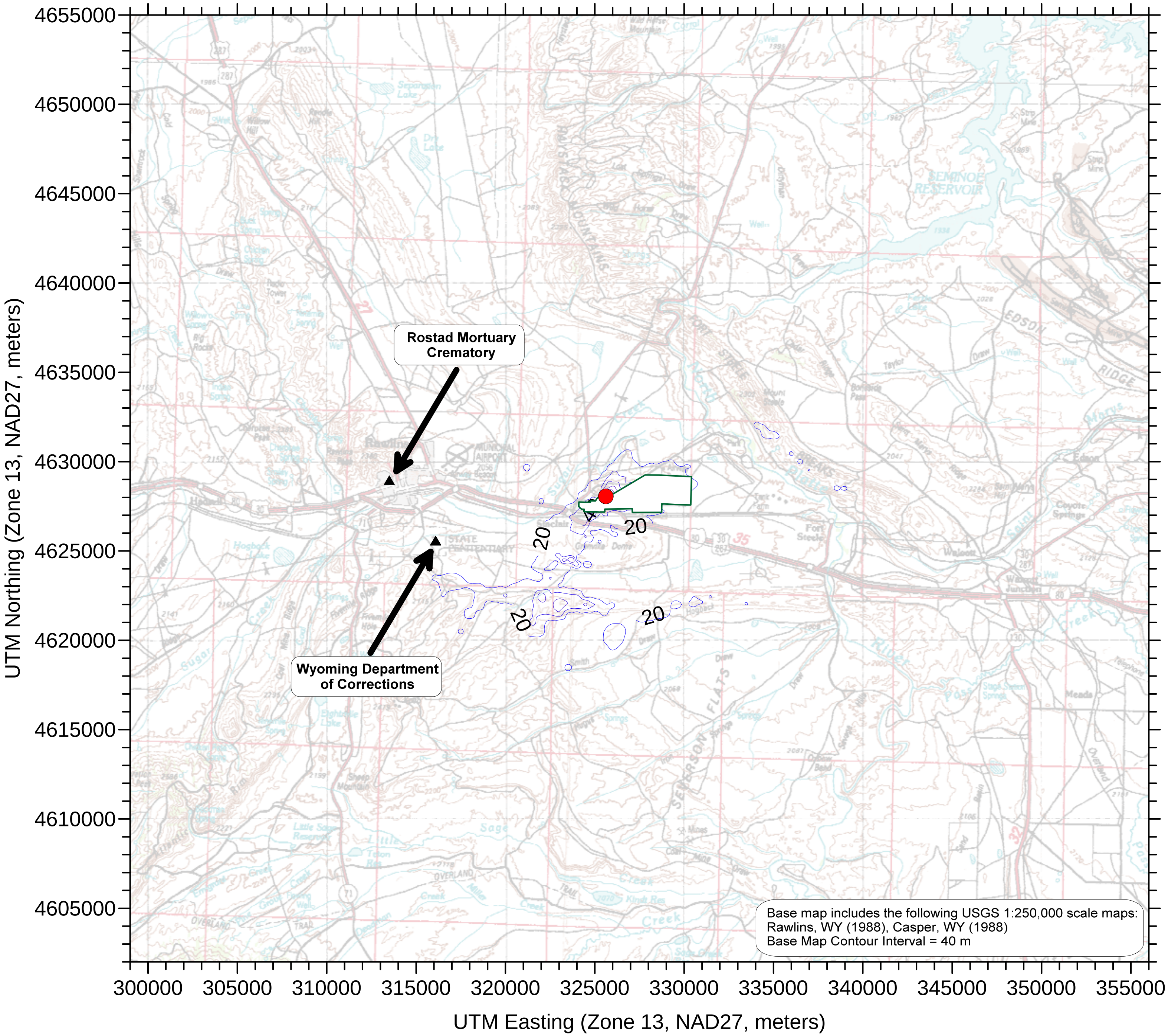
Carbon County, WY 2010 1-Hour SO_2 NAAQS Designation Recommendation

SWRC Monitored 1-Hour SO_2 Air Quality Exceedance Summary (AQS ID 56-007-0852)

Date	Time (hour ending)	Monitored Concentration [1] (ppb)	10-m Wind Speed (m/s)	10-m Wind Direction (deg)	Summary of Known Causes [2]
3/6/2014	3:00	193	10.3	216	#4TGTU shut-down, #3TGTU spike, Sulfur build up in valves
	6:00	93	9.0	206	
	7:00	81	8.7	202	
	13:00	116	9.7	215	
	14:00	253	12.0	213	
11/14/2014	14:00	108	10.5	211	#3 and #4 SRU/TGTU shut-down in response to boiler feed water disruption to #4TGTU due to frozen boiler feed water line
	16:00	347	8.6	213	
	19:00	81	7.0	208	
	20:00	77	6.6	215	
	23:00	158	6.9	215	
12/27/2014	23:00	82	6.0	207	#4TGTU mixing chamber trip on flame failure
	24:00	77	8.0	217	
12/28/2014	1:00	141	9.0	228	#4TGTU mixing chamber trip on flame failure
	2:00	106	10.3	229	
	3:00	162	10.2	221	
	6:00	121	8.5	218	
	8:00	184	10.9	224	

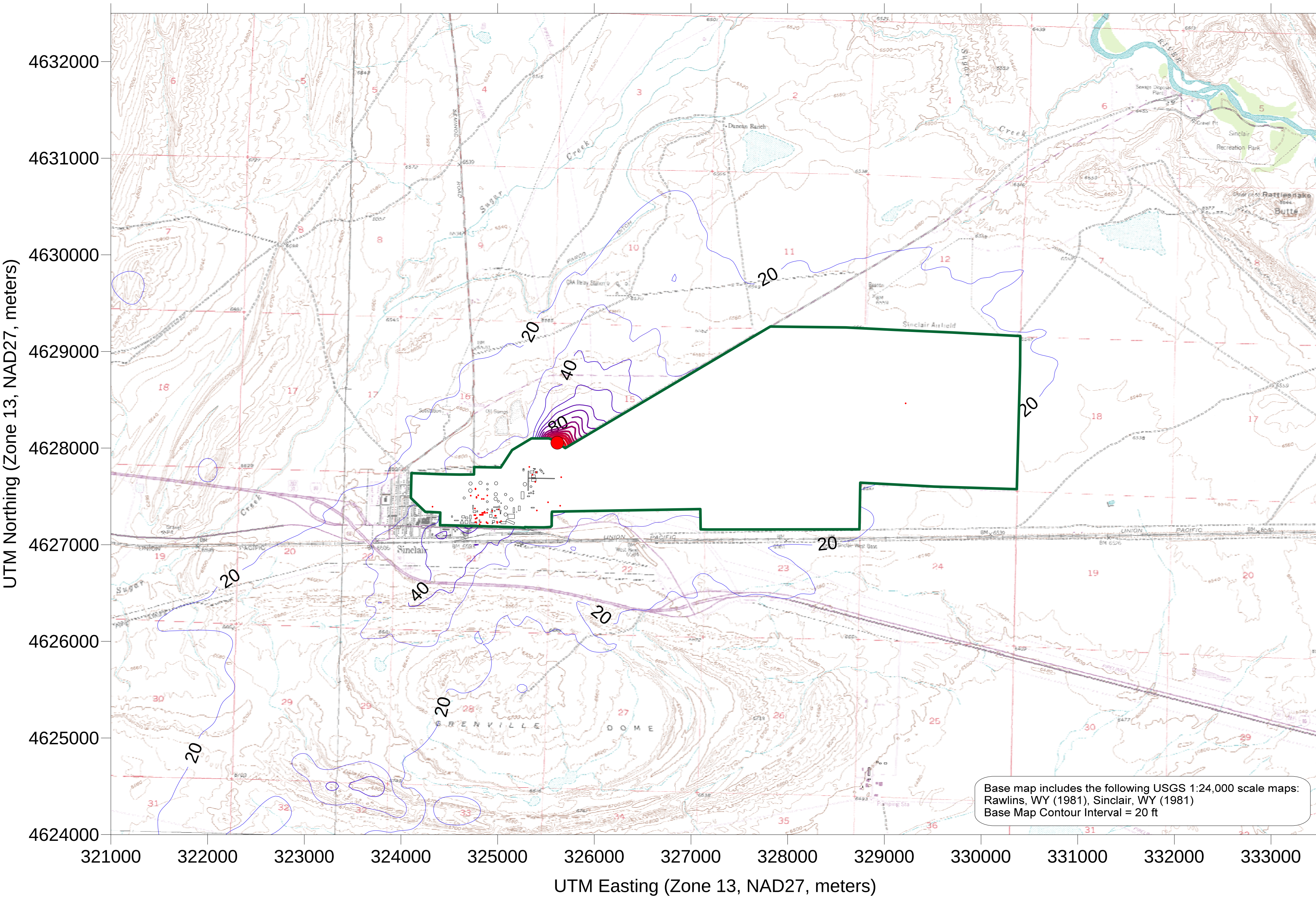
[1] Monitored concentrations during times when the value of the 2010 1-hour SO_2 NAAQS value of 75 ppb was exceeded.

[2] Known causes as identified by SWRC. Known causes for the 11/14/14, 12/27/14, and 12/28/14 events were obtained by the WDEQ-AQD from available Root Cause Failure Analysis Reports submitted by SWRC and as required by the May 8, 2008 Consent Decree.



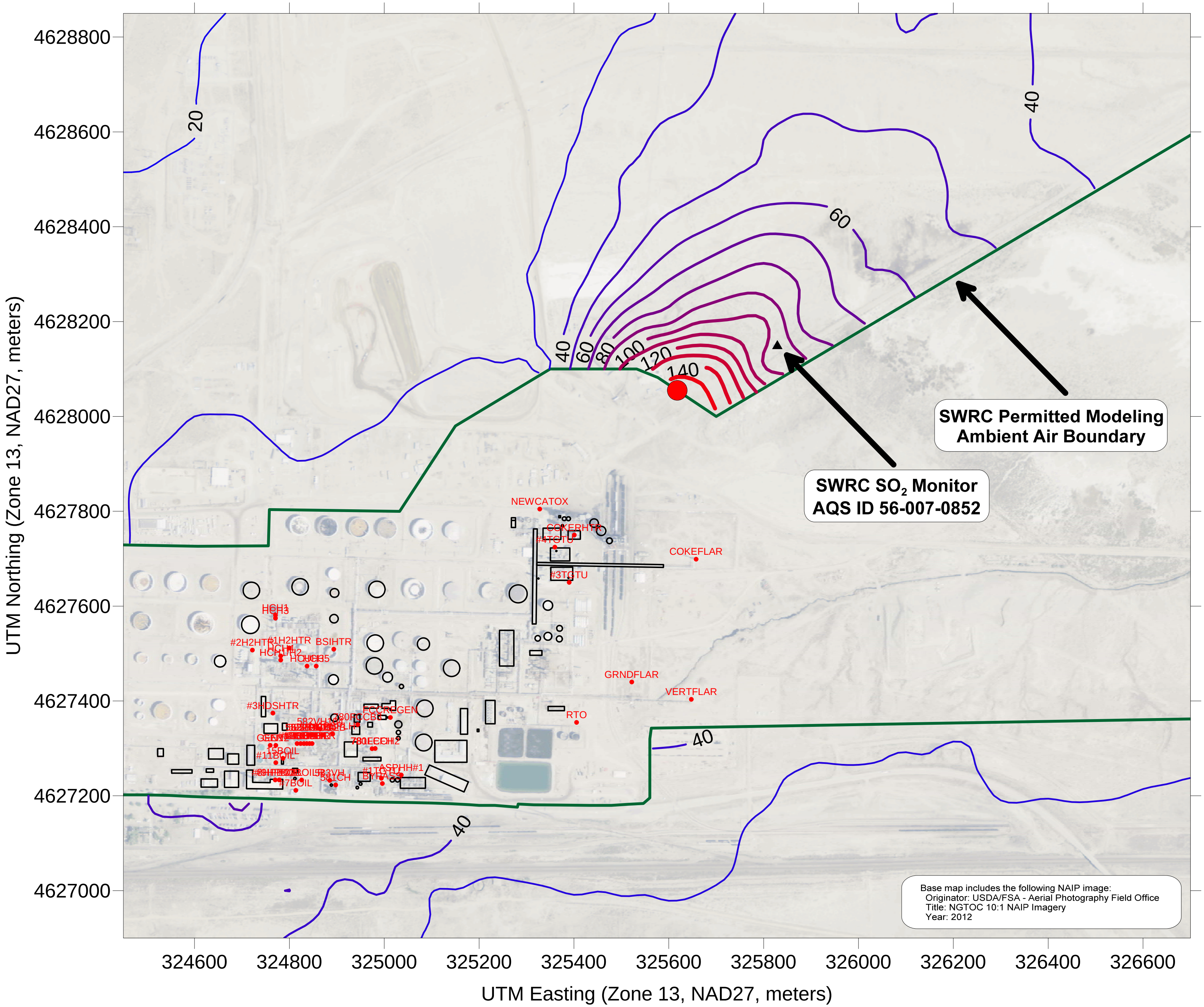
● = Maximum Impact Location (162.6 μg/m³; 62.1 ppb)

Carbon County, WY 2010 1-Hour SO_2 NAAQS Designation Recommendation	1-Hour SO_2 Impacts Due to All Modeled Sources 2012-2014 Modeled Design Values (H4H) Includes Temporally/Seasonally Varying Background
Date: 10/03/2015	FIGURE 2-1



= Maximum Impact Location (162.6 μg/m³; 62.1 ppb)

Carbon County, WY 2010 1-Hour SO_2 NAAQS Designation Recommendation	1-Hour SO_2 Impacts Due to All Modeled Sources 2012-2014 Modeled Design Values (H4H) Includes Temporally/Seasonally Varying Background
Date: 10/03/2015	FIGURE 2-2



● = **Maximum Impact Location (162.6 µg/m³; 62.1 ppb)**

Carbon County, WY 2010 1-Hour SO_2 NAAQS Designation Recommendation	1-Hour SO_2 Impacts Due to All Modeled Sources 2012-2014 Modeled Design Values (H4H) Includes Temporally/Seasonally Varying Background
Date: 10/03/2015	FIGURE 2-3