2014 Annual Report
Offshore Environmental Effects Monitoring Program
ExxonMobil Canada Properties - Sable Offshore Energy Project

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EXECUTIVE SUMMARY

This report is a compilation of results for the 2014 Sable Offshore Energy Project (SOEP) Environmental Effects Monitoring (EEM) program.

The 2014 offshore EEM program was developed by building on the results and lessons learned to date and following recommendations made by the CNSOPB EEM Review Committee which includes representation of Fisheries and Oceans Canada, Environment Canada, and the Canadian Environmental Assessment Agency. Since the SOEP offshore EEM is intended to be adaptive, efficient and meaningful, the monitoring plan is adjusted periodically. This includes removing or adding monitoring components or sampling sites with the prior approval of the CNSOPB EEM Review Committee based on the latest monitoring results and scientific information, or to address new Project activities.

Components of the 2014 EEM Program included:

- Chemical and Toxicity analysis of produced water from Thebaud, Alma and South Venture platforms
- Air quality monitoring on Sable Island
- Flare monitoring on the Thebaud platform
- Seabird and bird monitoring on platforms and supply vessels via assigned offshore personnel responsible for tracking bird observations/data
- Beached bird surveys on Sable Island

Produced water samples were collected by ExxonMobil Canada (EMC) staff. Chemical analysis was conducted by SGS Laboratories. Harris Industrial Testing Services and Aquatox conducted the toxicity testing and Hurley Environment Ltd. prepared the produced water discussion in Section 2 of this report.

Flare monitoring observations were compiled by EMC staff in 2014. Nova Scotia Environment has compiled air quality monitoring data from a station located on Sable Island for 2014. Some data has also been collected and downloaded from the National Air Pollution Surveillance (NAPS) data repository. This information has been provided to and collected by Kingfisher Environmental Health Consultants (KEHC) for further analysis of anomalies or potential air exceedences included in Section 3 of the report.

Further to SOEP's Canadian Wildlife Permit LS 2560 requirements, an annual report detailing the numbers of birds salvaged, released and deceased, provided monitoring data on those species observed on the offshore facilities. Beached bird survey data from Sable Island in section 5 were provided by Zoe Lucas, Sable Island Environmental Specialist.

Mussel collection and body burden analysis is planned for 2015. Ten years of monitoring the potential for uptake of hydrocarbons in mussels has shown that the presence of aliphatic hydrocarbons is attributable primarily to biogenic hydrocarbons generated by phytoplankton. Mussels collected from the legs of the Thebaud platform continually exhibit lower

concentrations of several metals relative to control mussels purchased at a local grocery store.

The SOEP offshore EEM program was designed principally to verify predictions made during the SOEP Environmental Assessment (EA) process. These predictions were based on underlying assumptions which were purposefully conservative. Overall, the EA process concluded that any residual effects of routine project activities (after mitigation) on Valued Ecosystem Components (VECs) in the marine environment would be minor or insignificant and would be restricted to within the 500 m-radius safety zones around offshore platforms. Since surveys began in 1998, EEM results have validated the predictions.

Several mitigative measures beyond those identified in the EA have been undertaken by EMC to further reduce the likelihood of environmental impacts. Some examples from 2014 include:

- All non-essential lighting was turned off at the North Triumph and Alma platforms to minimize potential attraction of marine birds;
- Strict monitoring and management of diesel fuel used in the offshore supply vessels, which yielded emissions reductions for the fleet; and
- Achieving an annual average OIW target of under 30mg/L in produced water for the offshore platforms.
- Achieving the goal of no Drains water excursions over 15 mg/L for the offshore platforms between 2011-2014.

Notable results of the 2014 program include:

Produced Water Chemistry and Toxicity (Section 2)

- Total Petroleum Hydrocarbon daily average values were below Offshore Waste Treatment Guidelines (OWTG) (2010) oil-in-water concentration limits at four SOEP platforms – Thebaud, Alma and South Venture and Venture.
- Annual PW characterization samples taken at Thebaud, Alma and South Venture and Venture platforms in 2014 are considered 'toxic' based on results of a variety of toxicity bioassays.
- Test results since 2005 show that chemical and toxicity levels vary widely over time and location in large part due to varying reservoir characteristics.
- Toxicity of produced water samples from SOEP platforms is not considered an environmentally relevant factor of concern based on findings in a DFO COOGER research study (2010) which found that potential contaminants in the relatively small PW discharges from SOEP platforms are diluted rapidly to no-effects concentration levels within tens of metres of the subsurface discharge caisson.

Air Quality/Flare Monitoring (Section 3)

- EMC is participating in an ESRF funded study led by Environment Canada and Dalhousie University entitled "Data Display and Source Apportionment of Volatile Organic Compounds and Particulate Matter on Sable Island". This project will provide regulators, industry and researchers with necessary data to evaluate the impacts attributable to contaminant emissions to ambient air from petroleum related activities.
- Kingfisher Environmental Health Consultants (KEHC) has conducted data analysis and graphing of air quality and meteorological data from 2014, identified spikes (no exceedences) in air monitoring data while cross referenced these to wind direction/wind speed. The objective is to determine potential correlation with a particular facility's operations, if required.
- 2014 data completeness was less than 2013 for the following parameters: PM2.5 (57%), H2S (63%), SO2 (67%) and NHMC (39%).. These results are a reflection of the difficulties gaining access to the Island for instrument maintenance due to intermittent flights and bad weather.
- The data completeness for NOx (99%), NO2 (99%) and NO (99%), O3 (98%) and BC (82%) was excellent in 2014.
- The most important feature of the air quality data acquired in 2014 is that there was one operational threshold breach for H2S. This threshold breach was likely a result of a short-term acid gas flaring issue on Deep Panuke.
- There were no breaches of the National Air Quality Standards, Canada Ambient Air Quality Objectives or Canada Wide Standard for any of the air pollution metrics contained in this report.
- Elevated PM2.5 concentrations could be a consequence of sea salt spray and further investigations of the PM2.5 chemistry and/or O&G operations would need to be conducted to confirm this.

Seabird Monitoring (Section 4)

- EMC supported the Acadia/Encana instrument-based automated bird monitoring study, " Assessment of bird interactions with offshore infrastructure associated with the oil and gas industry of Nova Scotia, Canada" (Acadia/Encana Study) by providing platforms (2 supply vessels) on which to install radio tracking receivers, and participation of field staff (on supply vessels and platforms) in the monitoring of physically tagged birds in the offshore areas between 2011- May 2014. (Note: no physically tagged birds were observed on the Sable facilities in 2014).
- In 2013, EMC provided an on-land access point to monitor the flare from its fractionation plant facility in Point Tupper, NS (Acadia/Encana Study). Following 8 monitoring evenings, during different seasons and weather conditions, radar images will be analyzed for bird interactions. No dates have been provided on when this analysis will be completed. (Update received 03-2015)
- Further to SOEP's Canadian Wildlife Permit LS 2560 requirements, an annual report detailing the numbers of birds salvaged, released and deceased on the platforms provided monitoring data on those species observed on the offshore facilities.

Beached Bird Surveys (Section 5)

- During 2014, the corpses and fragments of 352 beached seabird corpses were collected on Sable Island. Alcids accounted for 54% of total corpses recovered.
- The overall oiling rate for the 352 birds was 3.2% (compared with <0.5% in 2013). A total of six oiled corpses were recovered in 2014, and all were alcids (1 Atlantic Puffin, 3 Thick-billed Murre, 1 murre not identified to species, and 1 Dovekie). The oiling rate for alcids was 7.9% (compared with 0% in 2013).
- The six oiled bird corpses occurred during the first week of February, and samples of oiled feathers were collected from five of the corpses. The samples were determined to be moderately weathered Heavy Fuel Oil most typical of residuals or sludge from fuel tanks.

1. INTRODUCTION

Thebaud Platform

North Triumph Platform

Alma Platform

Venture/South Venture Platforms

1.1 OVERVIEW

This report is a compilation of studies for the 2014 Sable Offshore Energy Project (SOEP) Environmental Effects Monitoring (EEM) program. Figure 1-1 in the Appendix shows the location of the platforms and pipelines. Data were provided by various EMC staff, contracted specialists and laboratories and Nova Scotia Environment (air monitoring data):

- Beached bird survey data was collected by Zoe Lucas, Sable Island Environmental Specialist;
- Bird monitoring data on birds salvaged, released and deceased on the offshore platforms collected daily by EMC staff;
- Produced water toxicity analyses was provided by Harris Industrial Testing (contracted to EMC) and Aquatox (subcontracted to Harris) ;
- Produced water chemical analyses was provided by SGS Laboratories under contract to EMC;
- Flare monitoring observations were made daily by EMC staff;
- Air emissions monitoring data from the Sable Island Air Quality Monitoring Station was downloaded from NAPS data repository and collected by Nova Scotia Environment. Black carbon and non-methane hydrocarbon data was collected by Kingfisher Environmental Health Consultants supported by Dalhousie Departments of Process Engineering and Applied Science and Oceanography; and
- A summary of results from the Acadia University/Encana instrument-based automated bird monitoring study is included for additional information

The SOEP offshore EEM program initially focused on determining potential effects of drilling and production activities at Tier 1 sites (i.e., Venture, Thebaud, and North Triumph) beginning in 1997. With the majority of the development drilling completed and the start-up of operations at Tier 1 sites by 2000, EEM surveys undertaken from 2001 to 2003 focused on the effects on sediments and bottom fauna of exposure to intermittent discharges of muds/cuttings during drilling and continuous produced water discharges during operations. Until 2002, the assessment of produced water was delayed until the produced water volume was of sufficient quantity to study.

The 2005 program addressed start-up activities at Tier 2 sites (Alma in 2003 and South Venture in 2004) whilst considering lessons learned from the Tier I EEM Program and the recommendations from the 2003 Offshore Environmental Effects Monitoring Workshop held at the Bedford Institute of Oceanography.

Based on the results observed and the adaptive basis of the EEM program, the scope for the 2006 program was modified. Sediment chemistry and toxicity, scallop taint and body burden, and fish health components were discontinued in the 2006 program.

–Subsequent offshore EEM programs were built on the previous years' EEM programs, and were developed from recommendations made by the Canada-Nova

Scotia Offshore Petroleum Board (CNSOPB) EEM Review Committee which includes representatives of Fisheries and Oceans Canada (DFO), Environment Canada (EC), and the Canadian Environmental Assessment Agency (CEAA).

An operational study that addresses EEM components originally included in the baseline study will be undertaken in the future.

A summary of the history of the SOEP EEM program is provided in Table 1-4 in the Appendix.

1.2 BACKGROUND

The purpose of the EEM program is to test whether the effects of facility presence and production emissions into the marine and atmospheric environments occur within the zones of influence predicted by the Environmental Impact Statement (EIS) (Table 1-1). Environmental measurements are concentrated where meaningful changes are expected to occur and where the point source discharge is located. The 2014 offshore EEM program was designed to address relevant predictions made during the SOE environmental assessment process.

Table 1-1: EA Predictions Relevant To 2014 EEM Program

EIS PREDICTION [1]	VALUED ECOSYSTEM COMPONENT [2]	2014 EEM COMPONENT
"IMPACTS OF EFFLUENT DISCHARGES (E.G. PRODUCED WATER) WERE CONSIDERED TO HAVE NO SIGNIFICANT IMPACTS ON THE MARINE ENVIRONMENT."	• FISH • SHELLFISH	• PRODUCED WATER CHEMISTRY AND TOXICITY
"AIR EMISSIONS WERE CONSIDERED TO HAVE NO SIGNIFICANT IMPACTS ON THE MARINE ENVIRONMENT."	• SABLE ISLAND	• FLARE MONITORING • AIR QUALITY/ EMISSIONS ANALYSIS
"LIGHTS [FROM WORK LIGHTS AND GAS FLARES] MAY ATTRACT MIGRANT BIRD SPECIES, ESPECIALLY IN FOG AND/OR LOW CLOUD AND RAIN."[3]	• SEABIRDS	• ANNUAL REPORT TO CWS ON BIRDS SALVAGED, RELEASED AND DECEASED • SUPPORT OF ACADIA/ENCANA RESEARCH WORK
"BECAUSE OF THE IMPORTANCE OF SABLE ISLAND AND THE GULLY, SPECIAL ATTENTION WILL BE PAID TO THESE AREAS IN THE DEVELOPMENT OF MONITORING."[4]	• SEABIRDS • SABLE ISLAND	• AIR QUALITY/ EMISSIONS ANALYSIS • BEACHED SEABIRD SURVEYS

[1]Unless otherwise noted, the predictions apply only to routine construction and operations activities (i.e., not accidental events) as stated in the Executive Summary of the SOEP–EIS Vol. 3.
[2] Only offshore-related VECs assessed under the marine environment were considered
[3] As stated in Section 5.2.1.9 of the SOEP – EIS Vol. 3.
[4] As stated in Section 7.4 of the SOEP – EIS Vol. 3.

The EEM components were based on valued ecosystem components (VECs) identified during the EA process and components identified by Sable Offshore Environmental Effects Monitoring Advisory Group (SEEMAG) and the EEM study team.

The SOEP offshore EEM is intended to be adaptive, efficient and meaningful. Therefore, the monitoring plan is adjusted annually by dropping or adding monitoring components or sampling sites with the prior approval of the CNSOPB EEM Review Committee based on the latest monitoring results and scientific information, or to address new Project activities.

1.3 EMISSIONS AND DISCHARGES

The five platforms generate atmospheric, liquid, and solid wastes. Table 1-2 lists various emissions from the Thebaud, Venture, South Venture, North Triumph, and Alma platforms with the exception of solid wastes. Domestic waste and hazardous waste materials generated on the platforms are shipped to shore via supply vessel to approved and licensed waste receivers in Nova Scotia and Canada. (Various solid and liquid wastes generated offshore at SOEP platforms are skipped to shore for treatment and disposal at approved facilities in Nova Scotia or elsewhere in Canada depending on the type of waste.) This EEM program evaluates produced water and air emissions. No drilling activities took place in 2014 that would cause any changes in steady state emissions from the SOEP facilities. A field-wide one month planned maintenance shutdown occurred during late August and late September. In addition, North Triumph platform was shut in for approximately five months in 2014 during platform piping repair work. Venture and South Venture platforms were shutdown for 1 month for remedial work on sections of the pipeline between the Venture, South Venture and Thebaud platforms.

Table 1-2 provides a summary of the main sources of emissions on each platform.

Table 1-2: Summary of Emissions Sources on all Platforms

PLATFORM	OPERATION STATUS	POTENTIAL EMISSION SOURCES
THEBAUD {LAT: 43.53 LONG: -60.12}	STEADY-STATE PRODUCTION OPERATIONS THROUGH 2014	FLARE (~9.5E3M3/DAY)
		PRODUCED WATER (15.8 MG/L OIW AVG. 2014)
		DRAINS WATER DISCHARGES (VARIES BY WEATHER)
		NATURAL GAS TURBINES
		EMERGENCY DIESEL GENERATORS
VENTURE {LAT: 43.59 LONG: -59.37}	PRODUCTION SHUT-IN FOR ~60 DAYS IN 2014	VENTING (~0.3E3M3/DAY)
		PRODUCED WATER (16.4 MG/L OIW AVG. 2014))
		DRAINS WATER DISCHARGES (BROUGHT TO HRM FOR RECYCLING

		AND DISPOSAL OR TREATED OFFSHORE VIA CRUDESORB FILTRATION ON THEBAUD)
		DIESEL GENERATORS
NORTH TRIUMPH {LAT: 43.35 LONG: -59.51}	PRODUCTION SHUT-IN FOR ~6 MONTHS IN 2014	VENTING (~0.08E3M3/DAY)
		PRODUCED WATER ROUTED TO THEBAUD PLATFORM
		DRAINS WATER DISCHARGES (BROUGHT TO HRM FOR RECYCLING AND DISPOSAL OR TREATED OFFSHORE VIA CRUDESORB FILTRATION ON THEBAUD)
		DIESEL GENERATORS
ALMA {LAT: 43.35, LONG: -60.12}	STEADY-STATE PRODUCTION OPERATIONS THROUGH 2014	VENTING (~0.6E3M3/DAY)
		PRODUCED WATER (8.42 MG/L OIW AVG. 2014)
		DRAINS WATER DISCHARGES (VARIES BY WEATHER)
		DIESEL GENERATORS
SOUTH VENTURE {LAT: 43.59 LONG: -59.37}	PRODUCTION SHUT-IN FOR ~60 DAYS IN 2014	VENTING (~0.5E3M3/DAY)
		PRODUCED WATER (10.28 MG/L OIW AVG. 2014)
		DRAINS WATER DISCHARGES (VARIES BY WEATHER)
		DIESEL GENERATORS

1.4 PROJECT ACTIVITIES

Routine production activities were conducted during 2014 at the Thebaud and Alma platforms. As noted above, the Venture and South Venture platforms were shut in for one month in 2014. Remedial work was undertaken along sections of pipeline between the Venture, South Venture and Thebaud platforms. A dive support vessel was utilized to conduct this work. North Triumph platform was also shut in for an extended period during the year to complete platform piping repair work.

1.5 GOALS AND OBJECTIVES

This EEM program involves the collection of repeated measurements of environmental variables to detect changes directly or indirectly attributable to production discharges. The EEM program is undertaken with the following primary objectives:

- to verify whether the effects of discharging production wastes into the marine environment occur within the zones of influence predicted by the EA report;
- to evaluate the effectiveness of mitigation and identify the need for improved or altered mitigation; and
- to provide an early warning of undesirable change in the environment.

1.6 SCOPE

This report focuses on the EEM program of the Tier I and Tier II development and includes the natural gas well fields at Venture, South Venture, Thebaud, Alma, and North Triumph. (As the North Triumph platform does not discharge produced water, no sampling occurs at this platform). Potential effects of Project activities evaluated in the 2014 EEM program included produced water, air emissions (flaring observations and air quality analysis), and birds/seabirds. (Table 1-3).

Table 1-3: 2014 Sable Offshore EEM Program

Location	Environmental Component	Type of Monitoring/Analysis	2014 Program
Thebaud	Seabirds	– In kind support of an instrument-based automated bird monitoring study. – Daily monitoring for birds found on platform (stranded/perished).	– Receivers for bird tracking purposes installed on vessels until mid-2014 – Annual report to CWS on birds salvaged, released and deceased
	Air Quality	Visual observations of the Flare Plume from platform. Flare plume observations provided to EMC contractor (and government, as requested) for analysis with Sable Island Air Quality Monitoring data.	– Record flare plume characteristics twice daily (using EC supplied smoke chart) along with concurrent weather conditions on the platform – Investigate spikes in air monitoring data while checking wind direction/wind speed to identify potential correlation with facility operations.
Sable Island	Seabirds	Monthly Beached Bird Surveys	– Surveys to be carried out and report to be prepared by Zoe Lucas, resident biologist on Sable Island. Relate to historical time series data.
Thebaud, Venture, South Venture and Alma	Produced Water	Toxicity analysis as per OWTG	– Relate to OWTG expectation – Continue use of same bioassay species
Thebaud, Venture, South Venture and Alma	Produced Water	Chemistry analysis as per OWTG	– Relate to OWTG expectation (annual sample from each platform).

The surveys undertaken in 2014 continued to investigate or support data collection to later analyze potential effects of the development on:

- water quality of the receiving environment with respect to toxicity and chemical characterization;
- air quality from emissions from the offshore platforms on Sable Island; and
- the presence of the platforms on sea and land based birds.

1.7 REPORT ORGANIZATION

This report consists of an assemblage of component study reports relating to specific EEM requirements. Each component study report was prepared using a concise format agreed to by the C-NSOPB Review Committee to facilitate information summarization and readability. To the extent possible, references were provided for detailed methodological and analytical procedures.

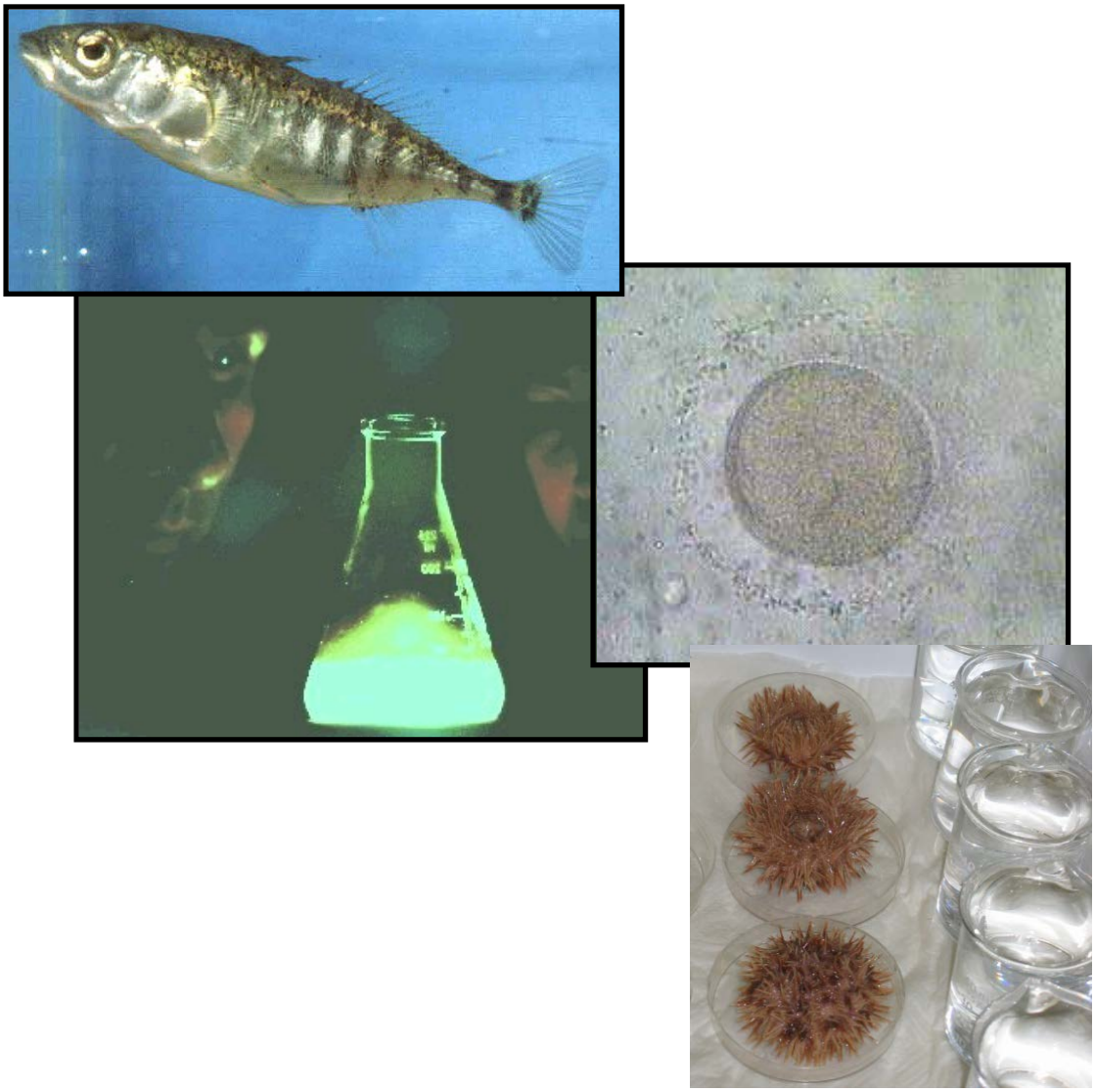
1.8 END OF FIELD LIFE MONITORING

As noted in previous EEM reports, ExxonMobil Canada has initiated preliminary evaluations for the end of Sable field life. Included in these evaluations is consideration of the scope of an environmental monitoring plan. Such a plan will be based upon SOEP EIS predictions, previous monitoring and historical discharges into the environment. EMC will continue to keep the CNSOPB apprised of the progress of the preliminary evaluations.

1.9 REFERENCES

DFO, 2003. *Workshop on Offshore Oil and Gas Environmental Effects Monitoring, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, May 26-30, 2003,* Environmental Science Research Fund Report.

2. PRODUCED WATER CHEMISTRY AND TOXICITY



2.1 RATIONALE & BACKGROUND

Produced water (PW) includes formation water, injection water and process water that is extracted along with oil and gas during petroleum production. At offshore production installations, this water is separated from the petroleum process stream and, after treatment, is discharged to the marine environment.

The general consensus of the 2007 International Produced Water Conference (St. John's, Newfoundland) was that "…any effects of PW on individual development sites in the open ocean are likely to be minor"(Neff et al. 2012). The overall conclusion of a cooperative research study carried out in 2010 (DFO COOGER, 2010) (Venture and Thebaud field sampling conducted in 2009) was that "…the toxicity of produced water from the SOEP Venture/Thebaud platforms is not considered an environmentally relevant factor of concern".

Based largely on these findings and previous SOEP EEM results, the scope of the 2014 program focused on Environmental Compliance Monitoring (ECM)[1] which was consistent with PW monitoring and characterization requirements as outlined in the Offshore Waste Treatment Guidelines (OWTG 2002 & 2010). While EMCP provided condensate samples to DFO (COOGER, BIO) in 2013 for ESRF-funded laboratory research studies[2] , they were not requested to provide any produced water samples this year as COOGER is no longer conducting research with produced water and in particular no work related to the biological effects of contaminants.

Various platforms were shut-in during different periods in 2014. Venture and South Venture were shut-in intermittently from Mid-March to Mid-May 2014 for pipeline maintenance. Alma was shut-in from mid-January to mid-February for maintenance purposes and the entire field was shut-in for 1 month between late August and late September for a planned field wide maintenance turnaround. The Thebaud central processing platform had relatively steady production throughout the year. PW from the North Triumph platform was routed to the Thebaud for treatment and discharge.

Toxicology bioassay analyses using the Microtox[3] , the Sea Urchin Fertilization[4] , and the Threespine Stickleback[5] tests were carried out as in previous years as per

[1] With respect to PW, the annual SOEP EEM report has typically summarized the results of EEM, ECM and any PW-related research studies.
[2] The study is a joint project between DFO (COOGER) and the National Research Council looking at methods to evaluate the biodegradation of natural and chemical dispersion of crude oil (from Grand Banks) and Scotian Shelf condensate.
[3] The basic technology of the Microtox Test System is based upon the use of luminescent bacteria, specifically the strain *Vibrio fisheri* NRRL B-11177, to measure toxicity from environmental samples. Luminescent bacteria produce light as a byproduct of cellular respiration. Cell respiration is fundamental to cellular metabolism and all associated life processes. Bacterial bioluminescence is tied directly to cell respiration, and any inhibition of cellular activity (toxicity) results in a decreased rate of respiration and a corresponding decrease in the rate of luminescence. The more toxic the sample, the greater the percent light loss from the test suspension of luminescent bacteria. Bacterial bioluminescence has proved to be a convenient measure of cellular metabolism and consequently, a reliable sensor for measuring the presence of toxic chemicals

guidance from Harris Industrial Testing Ltd. in consultation with the Environment Canada Toxicology Laboratory in Moncton, NB. Each toxicity test was conducted contemporaneously with chemical characterization tests described below. There is no pass/fail stipulation for any of these acute toxicity tests.

The OWTG does not specify threshold limits for any chemical parameters to be tested. Chemical parameters measured were: aluminum, ammonium, antimony, arsenic, barium, boron, cadmium, chromium, cobalt, copper, iron, lead, magnesium, mercury, molybdenum, nickel, phosphorus, selenium, silver, strontium, sulphur, thorium, tin, uranium, vanadium, and zinc and total petroleum hydrocarbons (TPH).

The performance target with respect to TPH monitoring under the OWTG (2010) are a 30-day volume weighted average of oil in discharged PW (OIW) that does not exceed 30 mg/L and a 24-hour average of oil-in-water, as calculated at least twice per day, that does not exceed 44 mg/L.

2.2 GOALS

- Review the CNSOPB PW ECM results for 2014 in light of requirements specified in the OWTG (2010);
- Review 2014 ECM results in light of historical monitoring and characterization data at SOEP facilities;
- Recommend a PW monitoring strategy for 2015 in light of combined ECM, EEM and research findings at SOEP facilities and internationally

2.3 OBJECTIVES

- Summarize 2014 ECM PW TPH daily monitoring and note exceedences (if any) from OWTG (2010)
- Discuss PW chemical characterization (selected chemicals) of ECM samples in light of historical data.
- Comment on level of toxicity of PW ECM samples based on recognized suite of standard bioassay tests for application to marine discharges.

in aquatic samples. Strain 11177 was originally chosen for the acute and chronic tests because it displayed a high sensitivity to a broad range of chemicals.

[4] The Echinoid Fertilization test is a common marine bioassay used for routine environmental monitoring, investigative evaluations, and/or regulatory testing of effluents and sediment pore waters. The test organism was the sea urchin, *Lytechinus pictus*.

[5] The acute lethality test with seawater-acclimated Threespine Stickleback (*Gastreostreus acculeatus*) (TSS) has been used by Environment Canada and several Canadian laboratories concerned with evaluating the potential toxic effects of effluents discharged into estuarine or marine environments.

2.4 SAMPLING PROCEDURES

PW samples, which were supplied by EMC, were collected and analyzed following procedures outlined in tables below and in attached "*Produced Water Sampling Procedures*" provided by SGS (Appendix for Section 2).

Table 2.1 2014 PW Sampling Procedures

Collection Date(s): Chemistry & Toxicity samples	Thebaud: Oct. 20 Alma: Oct. 26 South Venture: Oct. 22 Venture: Oct. 21
Platforms:	Thebaud, Alma, South Venture, Venture
Type of Sample::	Produced water
Test Sample Locations:	Taken directly from the discharge caisson on the platform (prior to overboard discharge to the marine environment).
Reference Sample Locations:	N/A
Sample Preparation[6]:	Sample Bottles were provided by SGS as follows (see Attachment 2-1): • BTEX/TPH – 2x40ml amber vials (filled to top; no head space) and 1x1L glass bottle (filled approximately 90%) • Metals (dilute and shoot) – 1x250ml plastic (filled approximately 80%) • Mercury – 100 ml amber glass • Ammonia and TKN – 60ml amber glass (filled approximately 80%) • Toxicity sample - HDPE container
Sampling QA/QC[7]:	• Each bottle was supplied by the SGS laboratory to ensure the integrity of the samples. • PW samples were stored in a sealed cooler with a frozen gel pack to keep samples cool. They were shipped to shore by helicopter following sample collection. The samples were then picked up by SGS for chemical testing. • For toxicity testing, PW was collected in a HDPE container on each platform. The container was shipped to shore by helicopter following sample collection. The samples were collected from the heliport by Harris Industrial Testing Service (HITS). Subsamples were extracted from each, and then shipped to appropriate subcontractors (see Section 2.5) for specific toxicity testing. In all cases, testing was carried out within the maximum holding time for each specific toxicology parameter (3-5 days) with the exception of the Echinoid Fertilization test on the South Venture sample.

[6] Cougar Helicopters do not currently allow any preservatives on flights offshore. Preservatives are added upon receipt at the laboratory, if necessary.

[7] The QA/QC procedures for the each laboratory involved with the various testing included the use of duplicates, method blanks, surrogates, spikes, chain of custody, and certified reference materials where applicable.

2.5 ANALYTICAL METHODS

Contractors:

1. Harris Industrial Testing Service Ltd. (Threespine Stickleback toxicology)
2. AquaTox Testing & Consulting Inc. (Microtox and Sea Urchin Fertilization toxicology)
3. SGS (Chemical Analysis)

Table 2.2 Parameters Analyzed:

Parameters	Analysis Method
Microtox	Environment Canada Protocol EPS 1/RM/24 1992 with 1997 Amendments
Sea Urchin Fertilization	Environment Canada EPS 1/RM/27, 2nd ed 2011
Threespine Stickleback	Environment Canada Protocol EPS/1/RM/10 1990 with 2000 Amendments
TPH	CCME, Standard Methods 5520
Chemical Characterization	Standard Methods 3125
Sulphur	EPA 200.7
Thorium	EPA 200.8
Mercury	Standard Methods 3112 B
Ammonia-N	Standard Methods 4500-NH3 G
Total Kjeldahl Nitrogen	Standard Methods 4500-N0RG D

2.6 RESULTS

Table 2.3 PW Toxicity Characterization

Toxicity Test	96-Hour Lethal/Inhibition Threshold Value (95% confidence limits in brackets)			
	Thebaud	**Venture**	**Alma**	**South Venture**
	Oct. 20:	Oct.21	*Oct 26:*	*Oct 22:*
Threespine Stickleback Fish Toxicity[8] (LC50[9])	**6.10% (4.44-8.58)**	**6.51% (4.84-8.83)**	**33.0% (28.9-37.6)**	**52.1% (38.7-70.6)**
Microtox[10] (IC50[11])	**2.79% (2.18-3.56)**	**7.72% (6.82-8.74)**	**2.38% (2.26-2.51)**	**12.2% (10.8-13.7)**
Sea Urchin Fertilization[12] (IC25[13])	**0.21% (0.17-0.25)**	**0.07% (0.06-0.09)**	**99.2% (88.3-110)**	**100%**
Salinity (ppt)	**135**	**187**	**12.6**	**3**
Oil-in-Water (mg/L)*	**15.6**	**6.6**	**3.7**	**4.9**

*Thebaud lab results

[8] As per Environment Canada's test protocol EPS/1/RM/10 (July 1990 with 2000 Amendments),
[9] LC50 is the medial lethal concentration, i.e., the concentration is estimated to be lethal to 50% of the test organisms
[10] As per Environment Canada's test protocol EPS 1/RM/24 (1992)
[11] IC50 is the concentration at which growth or activity is inhibited by 50%
[12] As per Environment Canada's test protocol EPS 1/RM/27, 2nd ed.(February 2011);
[13] IC25 is the concentration at which growth or activity is inhibited by 25%

Table 2.4 PW Chemical Characterization[14]

Sampling Date (2014)		20 October	21 October	26 October	22 October
Chemical Parameter	**Units**	**THEBAUD**	**VENTURE**	**ALMA**	**SOUTH VENTURE**
Thorium	mg/L	ND	ND	ND	ND
Mercury	mg/L	0.00232	ND	ND	ND
Aluminum	mg/L	0.025	0.179	0.007	ND
Arsenic	mg/L	ND	ND	0.009	ND
Barium	**mg/L**	**739**	**1250**	**19.2**	**9.96**
Boron	**mg/L**	**0.671**	**0.046**	**8.03**	**0.624**
Cadmium	mg/L	0.000078	0.000066	ND	ND
Chromium	mg/L	0.009	0.005	0.002	0.001
Cobalt	mg/L	0.01	0.033	0.001	0.001
Copper	mg/L	0.024	0.052	0.004	0.002
Iron	mg/L	**112**	**154**	**12.4**	**7.14**
Manganese	mg/L	15.6	27.2	0.265	0.265
Magnesium	mg/L	1060	1330	55.9	14.8
Lead	**mg/L**	**0.0089**	**0.0081**	**ND**	**ND**
Molybdenum	mg/L	0.002	0.004	ND	0.002
Nickel	mg/L	0.139	2.21	0.011	0.015
Phosphorus	mg/L	0.022	0.009	0.027	0.024
Selenium	mg/L	ND	ND	ND	ND
Strontium	**mg/L**	**1180**	**2000**	**71.9**	**13.2**
Sulphur	mg/L	ND	ND	ND	14.8
Thorium	mg/L	ND	ND	ND	ND
Uranium	mg/L	ND	ND	ND	0.0014
Vanadium	mg/L	ND	ND	ND	ND
Zinc	**mg/L**	**1.56**	**0.146**	**ND**	**0.006**
TPH*	**mg/L**	**15.6**	**6.6**	**3.7**	**4.9**
Ammonia	**mg/L**	**315**	**499**	**23.8**	**36.6**
TK Nitrogen	mg/L	265	459	20.0	32.4

*Thebaud lab results

[14] Bolded values for selected chemical parameters were plotted below (see Section 2.7.2) to facilitate comparisons between platforms in recent years of sampling.

2.7 DISCUSSION

2.7.1 Toxicity [15]

Thebaud:

The OWTG (2010) does not have a pass/fail criterion, however most effluent discharge regulations stipulate that if an effluent has greater than a test-specific threshold lethal or activity inhibition level at 100% concentration, it fails. Based on this criterion, Thebaud PW samples taken in 2014 (and all previous samples since 2005) would be considered toxic to Threespine Stickleback (TSS), (Sprague, 1973; Environment Canada, 1984; Gary Harris, HITS Ltd. pers comm; Figure 2.1). There are no pass/fail criteria available for Microtox and Echinoid fertilization toxicity tests.

Normal seawater salinity values range from 28 – 32 ppt. As stated above, the Thebaud PW sample had a much higher salinity of 135 ppt. In the Echinoid Fertilization test, toxicity (*i.e.* fertilization inhibition) continued to occur in concentrations diluted to normal salinity values (2.7 and 0.81% concentrations). Two additional concentrations in the TSS LC50 were tested at the lower range (3.13% & 1.56%) in order to better assess the sample's toxicity at normal salinity levels. Salinity levels remained above normal until the sample was diluted to the 1.56% concentration (salinity 32 ppt). Based on the salinity values measured in the Aquatox sea urchin fertilization test concentrations, it can be extrapolated that toxicity continued to occur in the Microtox test within the salinity range of approximately 32 – 40 ppt (*i.e.* normal and slightly higher than normal).

From these results, mortality (Fig. 2.1) in all three aquatic toxicity tests may have occurred at the higher concentration due to high salinity, toxicity from petroleum hydrocarbons, or a combination of both.

Venture:

Normal seawater salinity values range from 28 – 32 ppt. The salinity value for this platform (187 ppt) is much higher than normal.

HITS tested two additional concentrations in the TSS LC50 test at the lower range (3.13% & 1.56%) in order to better assess the sample's toxicity at more normal salinity levels. Salinity levels remained above normal until the sample was diluted to the 1.56% concentration (salinity 33 ppt, slightly higher than normal levels). No significant mortality occurred in the concentrations that fell within the salinity ranges for these two lowest concentrations (35 – 33 ppt) tested. In the Echinoid Fertilization test toxicity (*i.e.* fertilization inhibition) continued to

[15] The statistical method used to compare LC50 values was the pairwise comparison test delineated in Sprague & Fogels (1977).

occur in concentrations diluted to normal salinity values. Based on the salinity values measured in the Aquatox sea urchin fertilization test concentrations, it can be extrapolated that toxicity continued to occur in the Microtox test within the salinity range of approximately 31 – 34 ppt (*i.e.* normal and slightly higher than normal).

From these results, mortality (Fig. 2.1) may have occurred in all aquatic toxicity tests at the higher concentration due to high salinity, toxicity from petroleum hydrocarbons, or a combination of both.

Alma:

Normal seawater salinity values range from 28 – 32 ppt. The salinity value (12.6 ppt) for this platform is lower than normal.

The protocol states that TSS are used for effluent with a salinity of >10 ppt. The use of TSS at the sample salinity of 12.6 ppt does not constitute a deviation from the protocol. There was 10% mortality in the control and all test validity criteria as specified in the method were met. Mortality in the test occurred from the toxicity of the sample (*i.e.* petroleum hydrocarbons), not from low salinity. In the salinity adjusted Echinoid Fertilization test, the results were 99.2%, meaning that the effluent had minimal toxicity.

Considering that the salinity was adjusted for the Microtox test, low salinity was not the cause of mortality. Mortality likely occurred in the test from the toxicity of the sample (*i.e.* petroleum hydrocarbons).

South Venture:

Normal seawater salinity values range from 28 – 32 ppt. The salinity value (3 ppt) for this platform is lower than normal.

The protocol states that TSS is used for testing effluent with a salinity of 10 ppt or greater. The use of TSS at this salinity constitutes a deviation from the protocol. For this reason two controls were run with the TSS test. Control #1 was run with normal salinity. Control #2 was run with a salinity of 3.1 ppt. There was no mortality in the normal salinity control and there was 10% mortality in the adjusted control, meeting the validity criteria for both. This data suggests that mortality occurred in the TSS test from the toxicity of the sample (*i.e.* petroleum hydrocarbons), not from low salinity. In the salinity-adjusted Echinoid Fertilization test, the results were >100%, meaning that the effluent was not toxic and did not inhibit fertilization. However, the sample exceeded the recommended holding time which may have had an influence on the results (*i.e.* decreased the toxicity of the effluent). Considering that the salinity was adjusted for the Microtox test, low salinity was not the cause of mortality. Mortality occurred in the test from the toxicity of the sample (*i.e.*petroleum hydrocarbons).

Figure 2.1 Three-spine Stickleback Bioassay

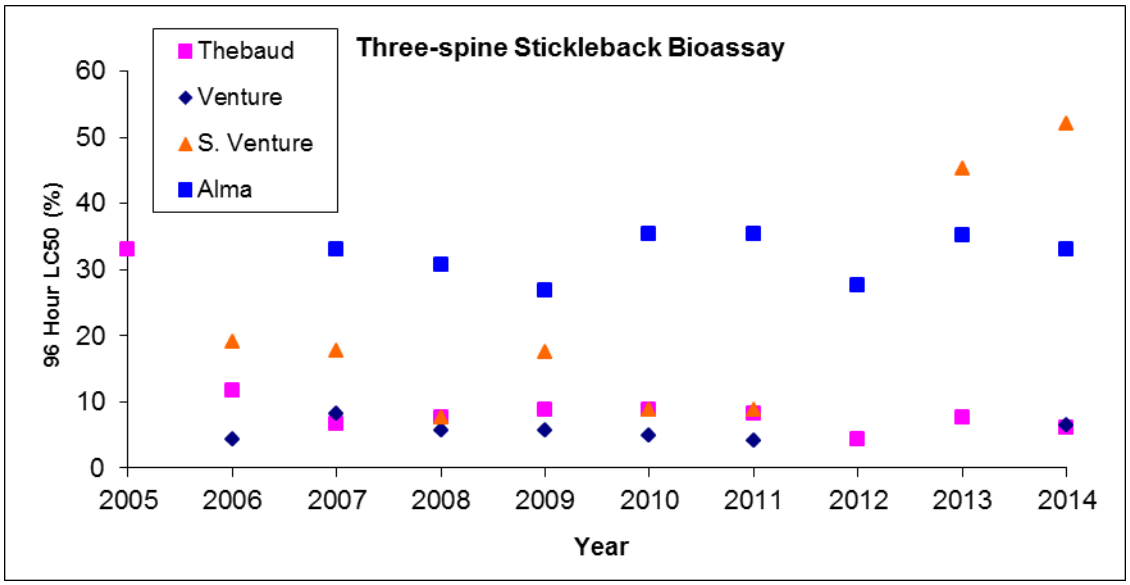


Figure 2.2 Microtox Bioassay

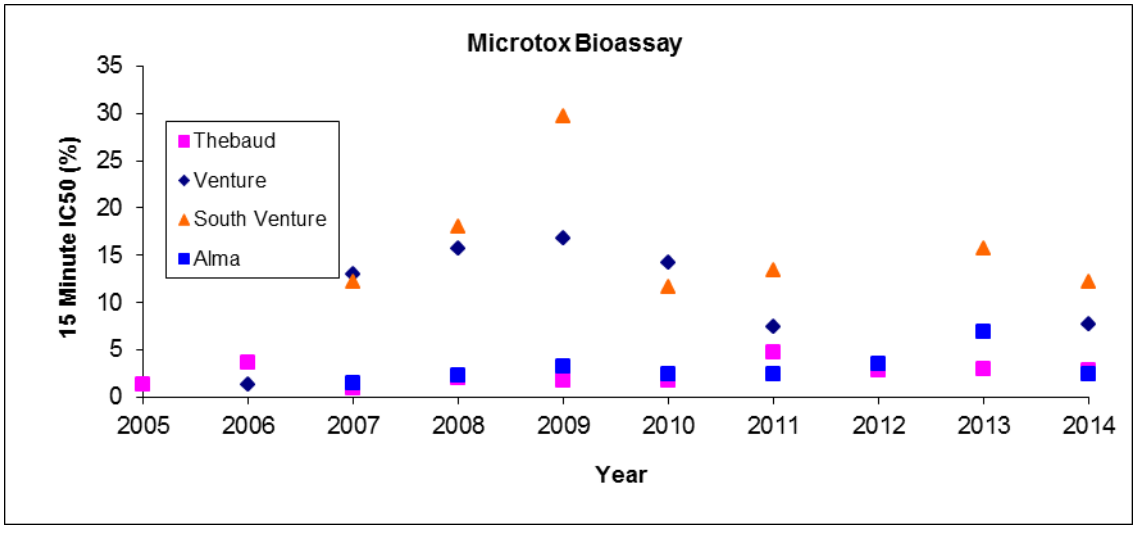
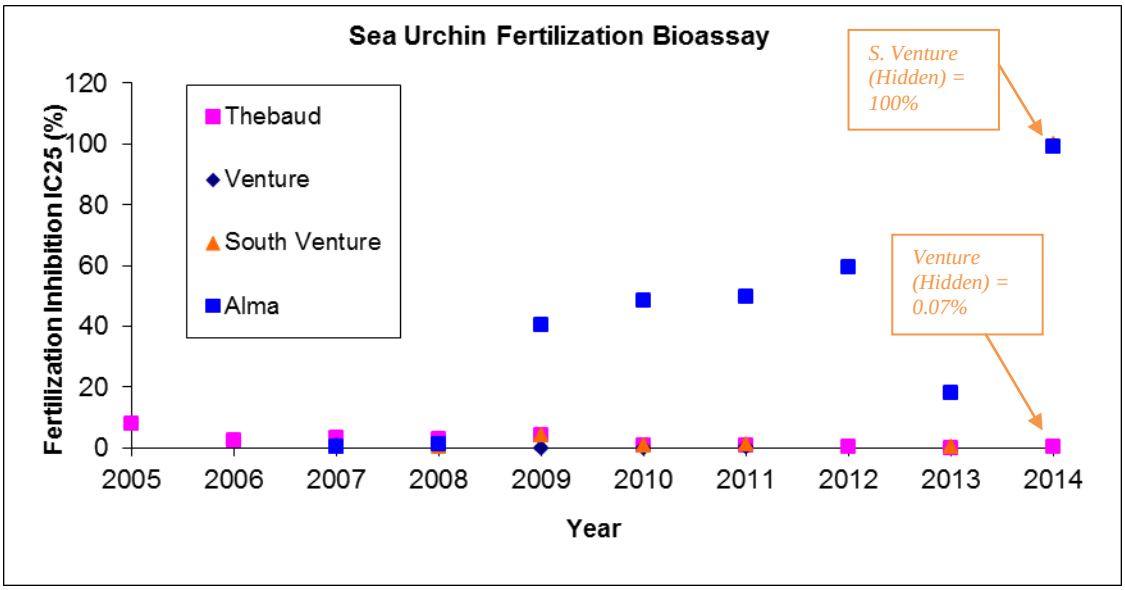


Figure 2.3 Sea Urchin Fertilization Bioassay



2.7.2 Chemistry

Daily average TPH values at the Thebaud, Alma and South Venture platforms for the days samples were taken for toxicity evaluation in 2014 (Table 2.4; Figure 2.4) were below the 24-hour threshold limit (i.e., 44 mg/L) for TPH specified in the OWTG (2010)[16]. The 2014 TPH values for the Thebaud and Alma platforms were somewhat lower than in recent years of sampling (Figure 2.4) while the TPH value at South Venture approximated recent levels (2009-11 incl.).

The greatest volumes of PW discharged were at Venture and Thebaud in 2014 (Table 2.5). All facilities discharged very little PW in September 2014, due to a planned field-wide shut-down that began late August and ended late September. With respect to TPH concentrations measured on a routine daily basis at the manned SOEP central processing platform (i.e., Thebaud) and on an opportunistic basis at unmanned platforms (i.e., Venture, South Venture, Alma) throughout the year, there were no exceedences of the OWTG (2010) OIW limits in 2014.

Besides differences in reservoir characteristics, factors which contribute to variation in TPH concentrations in PW samples include time of sampling, efficiency of the onboard treatment system, and operational upsets. Sand production in the reservoir has occasionally shown to influence the effectiveness of the treatment systems. Iron and ammonia levels vary over time, again related to which wells are producing and geotechnical factors as mentioned above.

[16] http://www.cnsopb.ns.ca/sites/default/files/pdfs/owtg_redraft.pdf

Figure 2.4 TPH (PW Chemical Characterization Samples)

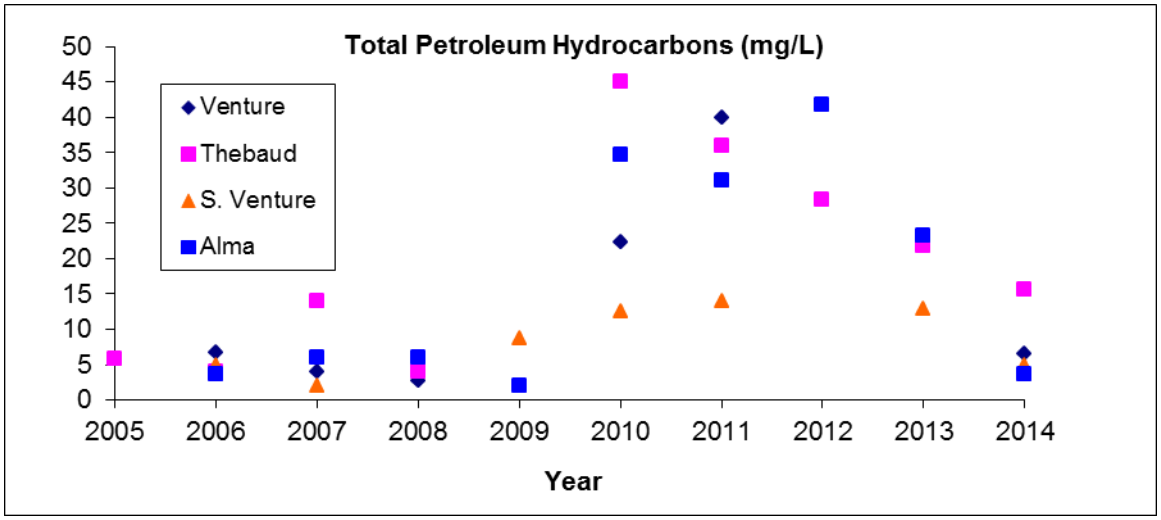


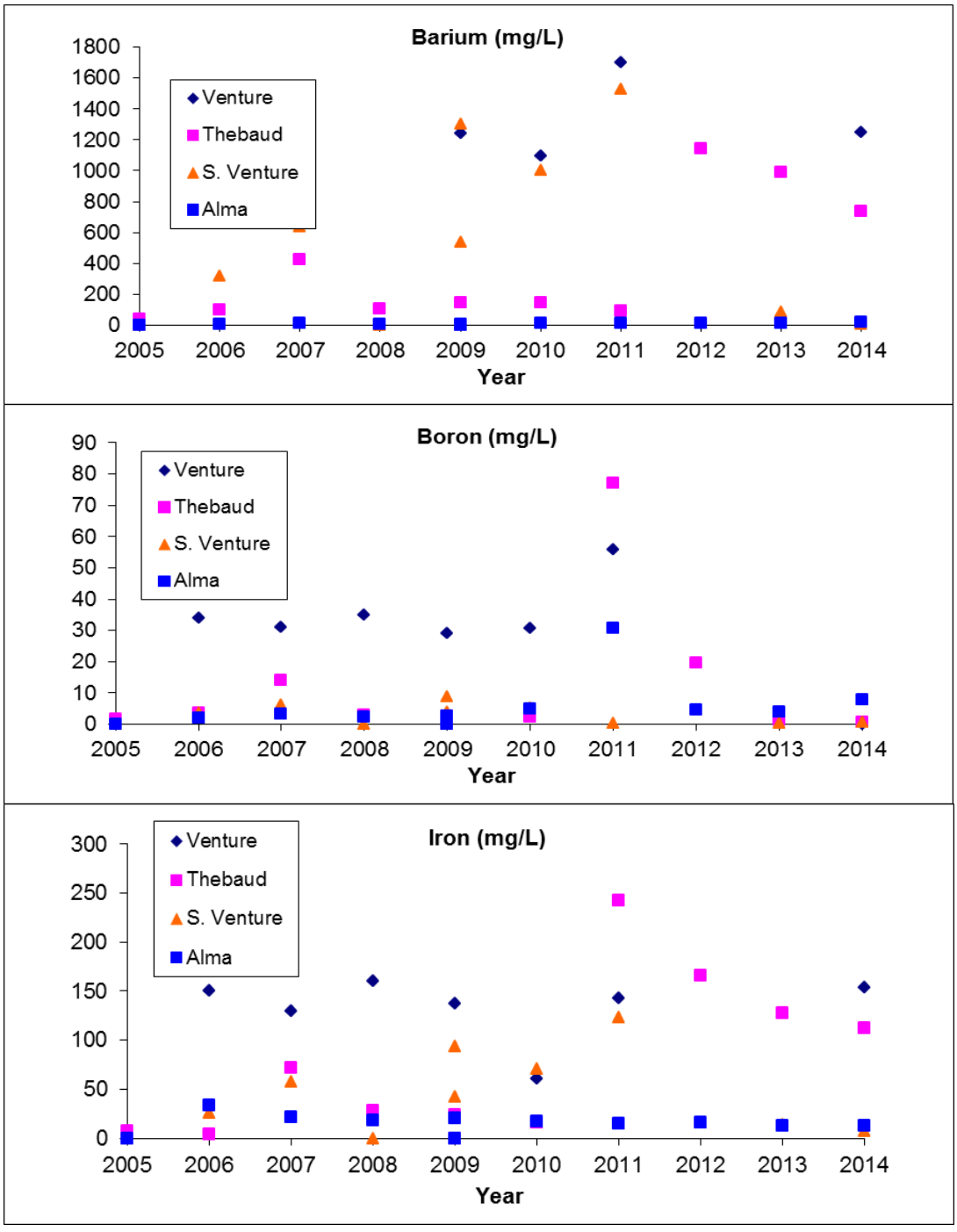
Table 2.5 Total annual PW Volumes/ Mean Daily TPH Values (2014)

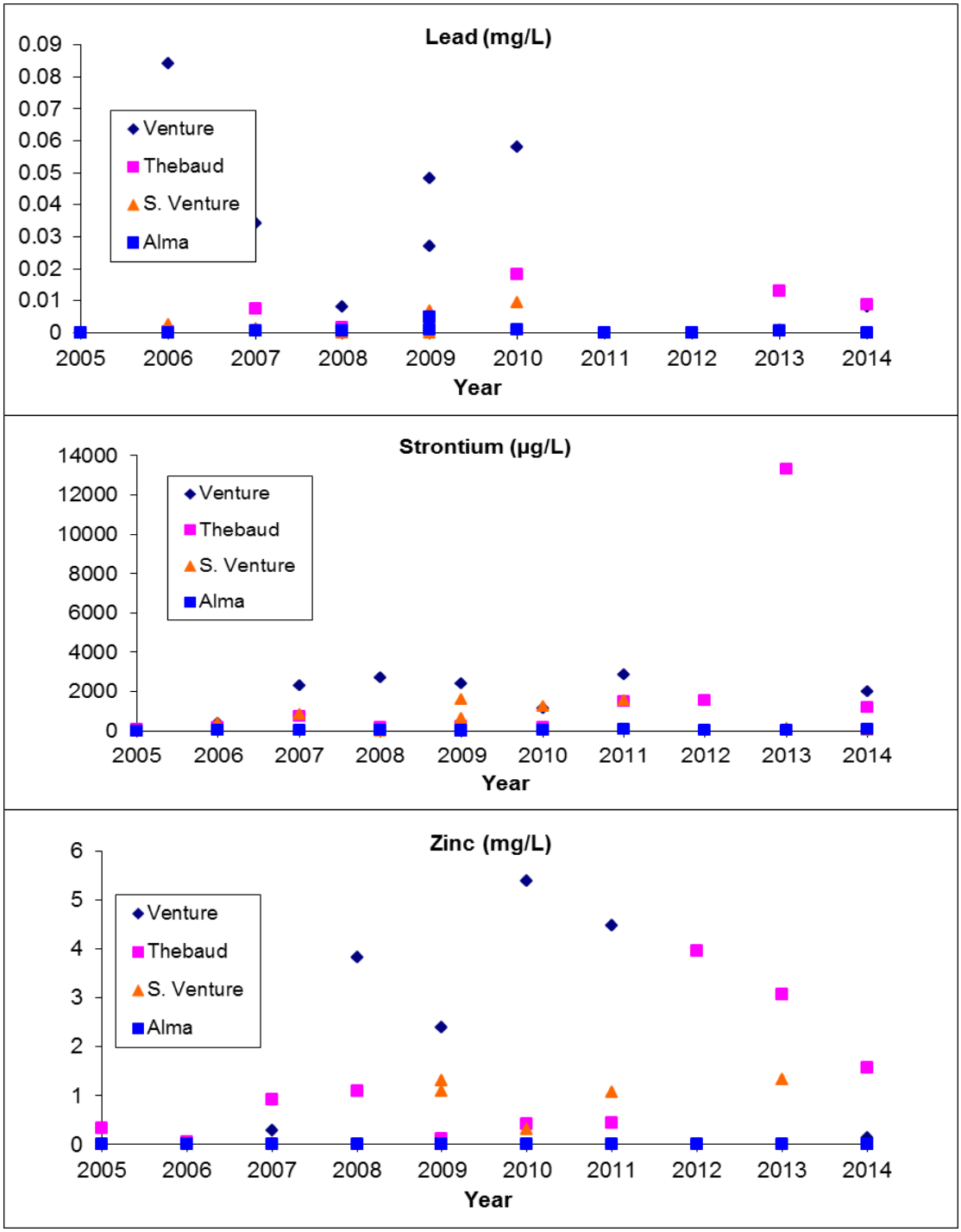
Platform	Total Volume (m3)	Average Daily Concentration (mg/L)
Thebaud	23,633[17]	15.8
Alma	4,575	8.4
Venture	67,613	16.4[18]
S. Venture	1,243	10.3
Total	97,064	15.8

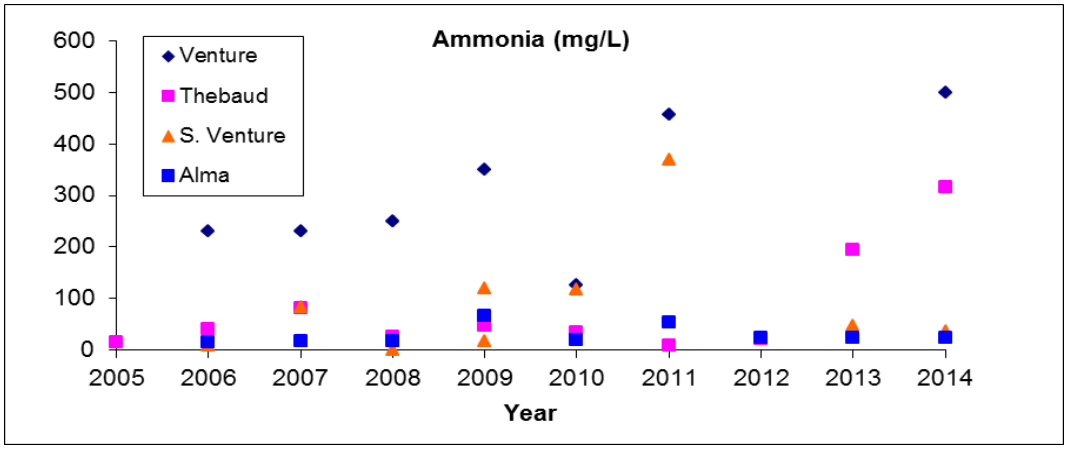
While petroleum hydrocarbon compounds such as PAHs and phenols and heavy metals such as lead are known to be toxic, they are likely to have contributed little to the overall toxicity of PW due to their low concentrations. Concentrations of key non-organic PW constituents (i.e., barium, boron, iron, lead, zinc and ammonia) have shown a recent (since 2010) downward trend at most locations most noticeably at Thebaud (see Figure 2.6). The 2013 value for strontium (13300 mg/L) was inexplicably an order of magnitude higher than most recent levels (i.e., 2010, 2011) and the latest value (i.e., 2014). With few exceptions, these constituents have been relatively low at the Alma platform over the entire sampling period (2005-14 incl.). The two most potentially toxic constituents, iron and ammonia, have been found in relatively high concentrations in Thebaud and Venture PW samples (Figure 2.6) which may explain in part the relatively high toxicity observed at those locations (Figures 2.1-3 incl.) in most years (DFO COOGER, 2010).

[17] Thebaud value includes contributions from North Triumph platform since PW is routed from that platform to Thebaud for processing and discharge.
[18] Venture and South Venture were shut-in and did not discharge PW in April 2014 due to maintenance on a section of pipeline between the two platforms

Figure 2.6 Non-organic PW Constituents




Lead (mg/L)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Venture
Thebaud
S. Venture
Alma
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Year
Strontium (µg/L)
14000
12000
10000
8000
6000
4000
2000
0
Venture
Thebaud
S. Venture
Alma
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Year
Zinc (mg/L)
6
5
4
3
2
1
0
Venture
Thebaud
S. Venture
Alma
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Year



2.8 PW MONITORING PLAN FOR 2015

Based on a comprehensive literature review of national and international monitoring results, there is limited potential for acute toxicity beyond the immediate vicinity (within 500 m of discharge point) of platform sites (Neff et al. 2012). Effects of PW on marine floral and faunal communities near platform sites have been shown to be minimal and localized.

With respect to SOEP specifically, a DFO COOGER research study in 2009 (DFO COOGER, 2010) showed that potential contaminants in the relatively small PW discharges[19] from the SOEP central processing platform (Thebaud) and Venture satellite platform were diluted rapidly[20] to no-effects concentration levels within a few metres[21] of the mouth of the discharge caisson located several metres below the sea surface. The resulting narrow plume of PW shifts primarily under the influence of the ebb and flow of tidal currents. The overall conclusion of the study was that "*…the toxicity of produced water from the Venture/Thebaud platforms is not considered an environmentally relevant factor of concern"*.

EMCP will strive to be consistent with performance targets for the treatment and monitoring of PW outlined in the latest version of the OWTG (2010). Annual PW sampling at SOEP platforms in 2015 will continue to the extent practicable for chemical characterization and toxicity. As in previous years, toxicity testing will be in the form of Acute Lethality Testing using Threespine Stickleback, Microtox and Sea Urchin Fertilization Test methods.

[19]The discharge rates of PW at SOEP platforms are one or two orders of magnitude less than at other East Coast offshore facilities. For example, the average daily discharge rates (m3) for SOEP platforms in 2014 are as follows: Venture (220), Thebaud (90), S. Venture (4) and Alma (14). Average daily discharge rates for other former, current and proposed East Coast projects respectively are as follows: previous COPAN (18,140); current (2013): Hibernia (18,000), Terra Nova (10,520) Deep Panuke (2014): (315) and proposed Hebron (45,000).

[20] Organic constituents of SOEP produced water have also been shown to be highly volatile and therefore readily vaporize prior to discharge (Section 6.2.14; DFO COOGER, 2010), (Terrens et al. 1996)

[21] Predicted using the DREAM (Dose-related Risk and Effect Assessment Model)

2.9 REFERENCES

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Terrens, G.W, Tait, R.D. 1996, Monitoring Ocean Concentrations of Aromatic Hydrocarbons from Produced Formation Water Discharges to Bass Strait, Australia. SPE 36033, [In Proceedings of the International Conference on Health, Safety and Environment. Society of Petroleum Engineers, Richardson, TX, pp. 739-747]

3. AIR QUALITY

Photo courtesy of ExxonMobil Canada

Courtesy of Green Horse Society

ACRONYMS

APS	Aerodynamic Particle Sizer
AS	Air Server
BC	Black carbon
CH4	Methane
ESRF	Environmental Studies Research Funds
GC	Gas Chromatograph
GEM-MACH-10	Global Environmental Multiscale model - Modelling Air quality and Chemistry (10 km^2 grid cell)
H_2S	Hydrogen Sulfide
O_3	Ground-level ozone
LRT	Long-Range Transport
MS	Mass Spectrometer
NAPS	National Air Pollution Surveillance network
NMHC	total-Non Methane Hydrocarbons
NO	Nitrogen monoxide
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
PM	Particulate matter
$PM_{2.5}$	Fine atmospheric particles with a median aerodynamic diameter less than, or equal to, 2.5 microns
SO_2	Sulfur dioxide
TD	Thermal Desorber
VOC	Volatile organic compounds
WHO	World Health Organization

EXECUTIVE SUMMARY

Kingfisher Environmental Health Consultants were contracted to complete a number of specific tasks related to air emissions on Sable Island for ExxonMobil Canada Properties (EMCP) that include:

- acquisition of meteorological and air quality data pertaining to monitoring on Sable Island for 2014;
- conducting data analysis and graphing of air quality and meteorological data;
- investigating spikes in air monitoring data, checking wind direction/wind speed and contacting EMC to identify potential correlation with a particular facility's operations, as required.

This air monitoring report covers the following air quality metrics measured on Sable Island:

- nitric oxide (NO)
- nitrogen dioxide (NO_2)
- nitrogen oxides (NO_x)
- sulphur dioxide (SO_2)
- hydrogen sulphide (H_2S)
- fine airborne particulate matter with a median aerodynamic diameter $\leq$ 2.5 microns ($PM_{2.5}$)
- non-methane hydrocarbons (equivalent to the total-volatile organic compound species concentration)
- black carbon (BC).

It was found that the average wind vector for 2014 was 252° which is consistent with prevailing winds on the Scotian shelf and advecting over Sable Island. Pollution rose analysis revealed that the average wind directional dependence of the air pollution metrics was as follows: NO_x 252°, SO_2 254°, $PM_{2.5}$ 241°, O_3 251°, H_2S 240°, BC 263° and NMHC 241°. The general agreement between the annual average wind directional dependence with the average wind direction suggests that long-range transport (LRT) from the continent as the main source of these air pollution metrics on Sable Island. However, some spikes in $PM_{2.5}$ are likely due to sea salt spray on stormy days.

The most important feature of the air pollution data acquired in 2014 was the recording of a H_2S emission threshold breach of 3.4 ppb (threshold 3.11 ppb) observed at 4 am on August 7 that lasted for 1-hour. After an investigation by facility management it was determined that it was likely related to an issue with acid gas flaring a few hours earlier on Deep Panuke natural gas production platform (Personal communication from M. Thillet, Encana, August 14, 2014). This breach is well below any health regulation standard, e.g. Canadian Ambient Air Quality Objective (1-hr average of 30 ppb). There were no other threshold breaches for the remaining air pollutant metrics in 2014.

The mean (min:max) air pollution metric concentrations observed on Sable Island during 2014 were as follows:

Non methane hydrocarbons	0.001 (0.0 : 0.061) ppm
BC	0.082 (0.0 : 22.34) $\mu g/m^3$
SO_2	0.65 (0.1 : 4.3) ppb
NO_x	0.87 (0.0 : 44.1) ppb
$PM_{2.5}$	8.1 (0.0 : 69.0) $\mu g/m^3$
O_3	35.8 (15.0 : 65.0) ppb
H_2S	0.68 (0.1 : 3.4) ppb

There were no breaches of the National Air Quality Standards, Canada Ambient Air Quality Objectives (CAAQO) or Canada Wide Standard for any of the air pollution metrics contained in this report.

NOAA HYSPLIT air mass back trajectory system, NASA Aqua and Terra MODIS satellites and the Canadian Wildland Fire Information System were used to further investigate, and aid the identification of spikes in the air pollution metrics (~ 3x standard deviation above the mean). Spikes in NO_x, $PM_{2.5}$, and O_3 originate from known source regions in the Ohio valley, Ontario, Quebec, NE US and Nova Scotia prior to arriving on Sable Island.

Spikes in H_2S seen on June 15 and July 16 are likely due to H_2S acid gas emissions from Deep Panuke by virtue of local wind directional analysis. The spike on August 7 was attributed to acid gas emissions from Deep Panuke natural gas production platform as mentioned above. Spikes in SO_2 were likely a result of continental outflow from known source regions with possible input from Deep Panuke and Thebaud due to the local wind crossing these platforms on the day of the spikes. However, attributing SO_2 to the total concentration observed on Sable Island from theses O&G platforms is impossible at present without conducting source apportionment and dispersion modelling efforts (outside the scope of this report).

From scrutiny of the NRCan Canadian Wildland Fire Maps online, together with air mass back trajectory analysis, pointed to the spikes seen for BC on April 19, July 13 and July 20 likely being associated with wildland fire smoke plumes advected to Sable Island on these dates. There is intriguing evidence (stagnant marine air flow) that the spikes in NMHC on May 26, June 9 and June 23 through 28 are associated with marine biogenic emissions and neither continental outflow or O&G production operations.

3.1 RATIONALE & BACKGROUND

Sable Island is one of the most important locations in the world for conducting climate monitoring with weather records dating back to the 1871 (Inkpen et al., 2009; GreenHorseSociety, 2012). Because the Island is 160 km from main land Nova Scotia it can be thought of as a truly marine influenced sampling location. Because of this, it is in the perfect position to monitor emissions from the ocean as well as continental outflow from

North America (Inkpen et al., 2009). While sources of anthropogenic $PM_{2.5}$, VOCs and trace reactive gases are well known, it is recognized that there are still large gaps in knowledge with regards to biogenic emissions of terpenes and other VOC emissions from terrestrial (forest fires and vegetation) and marine sources (phytoplankton and direct emissions from the ocean) that act as pre-cursors of cloud condensation nuclei (CCN), secondary organic aerosols (SOA) and O_3; all of which perturb climate, earth systems and health (Gibson et al., 2013c; Gibson et al., 2013a; Palmer et al., 2013; Gibson et al., 2009b; Gibson et al., 2009a; Monks et al., 2009; Palmer and Shaw, 2005). In addition the transport of nitrogen and sulphur aerosol species from local and upwind continental sources can impact the terrestrial and aquatic flora and fauna on Sable Island {Gibson, 2013 #1204}. Therefore, understanding local and long-range upwind sources of $PM_{2.5}$, VOCs and trace reactive gases to the Sable Island airshed is vital, not just for local air quality, but from the perspective of climate inventories and climate forcing (Monks et al., 2009).

Two detailed air emission reports have been conducted pertaining to the Sable Island airshed, (Inkpen et al., 2009) and (Waugh et al., 2010). The Environment Canada led ESRF project report "Sable Island Air Monitoring Program Report 2003-2006", identified a knowledge gap in monitoring to adequately identify impacts from the offshore O&G, pointing to the need for enhanced on-island monitoring of industrial emissions, including VOC and PM speciation in the Scotian Shelf Airshed (SSA) (Inkpen et al., 2009). Waugh et al., (2010) mention in their report that some of the short-term spikes in data might be due to local source influences resulting from off-shore oil and gas (O&G) activities in the vicinity of Sable Island.

Sable Island's unique location in the Atlantic ensures that it receives significant transboundary air pollutant flows from areas in the NE US and the Windsor - Québec corridor as well as significant amounts of sea salt (Waugh et al., 2010). Frontal systems have been shown to "push" pollution into narrow "vertical bands" of high concentrations ahead of the front and have been identified as causing relatively large, but short-lived, spikes in air quality data on Sable Island (Waugh et al., 2010). In addition, previous studies have shown that seasonal fluxes of natural marine emissions (terpenes, dimethylsulfide, volatile organic compound) are likely to react in the atmosphere to form secondary O_3 and $PM_{2.5}$ which further contribute to the total air pollution mix on Sable Island (Gibson et al., 2013c; Gantt et al., 2010). Waugh et al., (2010) reported a number of long-range transport (LRT) events that were identified from air mass back trajectories, synoptic charts and maps of air pollution monitoring data in the NE US and E Canada prior to the air mass reaching Sable Island. These air pollution maps were obtained from the US data base AIRNow (http://airnow.gov/) (Waugh et al., 2010).

Personal communication has revealed that in addition to the on-Island diesel generators that generate power, there a number of other on-Island source of $PM_{2.5}$ and trace gases, these include other small generators and trash burning. The practice of trash burning may be causing spikes in observations. There is the potential for trash burning to be miss-assigned as O&G production emissions.

Because of the recommendations of the Inkpen et al., (2009) and Waugh et al., (2010) reports, funding was made available through the Environmental Studies Research Funds

(ESRF) for a four year project, the aim of which is to unambiguously apportion the source contribution of the O&G facility operations to the total concentration of VOC's on Sable Island. This ESRF funding was awarded to Drs' Mark Gibson and Susanne Craig, Departments of Process Engineering and Applied Science and Oceanography respectively. This project will also have the value added component of being able to apportion the marine and LRT emissions/pollution impacting the Sable Island airshed. A feature of this project is the live streaming of the continuous monitoring data to a website data display. In addition, threshold concentrations for O&G relevant air pollutants have been set and will alert Encana and EMC in the event of spikes in air pollution concentrations. If this occurs, Dr. Gibson's Atmospheric Forensics Research Group (AFRG) will work in concert with the O&G facility operators to determine if the spike was related to O&G facility activity or a result of another local or LRT source. The ability of O&G facility operators to quickly respond to any air pollution spikes will safeguard air quality, marine ecosystems, marine fisheries, O&G facility operations, as well as O&G occupational health and safety.

The O&G industry has had a presence on the Scotian shelf since the late 1960's (CNSOPB, 1990). Currently, EMC have five fields in operation offshore Nova Scotia: Thebaud, Venture, North Triumph, Alma and South Venture. A platform at Thebaud provides central facilities for gathering and dehydration. A second platform provides compression of the gas from all fields, while a third platform at this location provides wellhead facilities for the Thebaud field itself. Hydrocarbons produced at the four other platforms are transported through a system of subsea flowlines to the Thebaud platform. After dehydration at Thebaud, the raw gas is transported through a subsea flowline to landfall at Goldboro, Nova Scotia, and to a gas processing plant located nearby. There the gas is conditioned by the removal of natural gas liquids (NGLs) to meet high quality sales gas specifications. The sales gas is then shipped to markets in eastern Canada and the northeastern United States, through the Maritimes & Northeast Pipeline (M&NP). NGLs are transported by pipeline to the Point Tupper Fractionation Plant for final processing before being sent to market in the form of propane, butane and condensate (Per. Comm, Environmental Advisor – EMC).
Figure **1** below shows the location of the O&G platforms surrounding Sable Island (source: http://www.cnsopb.ns.ca/pdfs/sable_area_platforms.pdf).

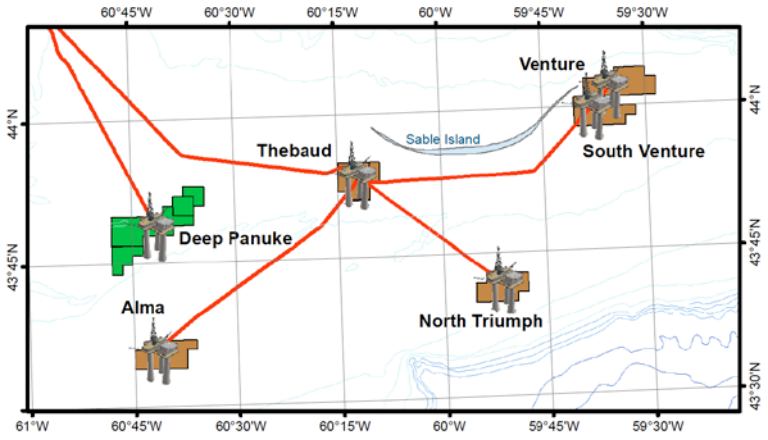

Figure 1. Location of the O&G platforms surrounding Sable Island

Platform Name	Platform Centre Location - NAD83			
	Geographic		UTM (Zone 20)	
	Latitude	Longitude	Northing	Easting
Thebaud	43° 53' 28.4" N	60° 11' 57.2" W	4863604.8	724963.3
Thebaud Process Jacket	43° 53' 30.8" N	60° 12' 00.0" W	4863676.7	724898.3
Venture	44° 01' 59.8" N	59° 34' 54.3" W	4881245.1	773902.9
North Triumph	43° 41' 56.6" N	59° 51' 13.6" W	4843261.4	753522.2
Alma	43° 35' 47.1" N	60° 41' 19.3" W	4829644.9	686560.9
South Venture	43° 59' 50.6" N	59° 37' 38.6" W	4876899.3	770420.7
Deep Panuke	43° 48' 45.704" N	60° 41' 18.126" W	4853666.9	685917.2

Platform Name	Platform Centre Location - NAD27			
	Geographic		UTM (Zone 20)	
	Latitude	Longitude	Northing	Easting
Thebaud	43° 53' 28.1" N	60° 11' 59.9" W	4863377.6	724909.9
Thebaud Process Jacket	43° 53' 30.5" N	60° 12' 02.7" W	4863449.5	724844.9
Venture	44° 01' 58.0" N	59° 34' 12.5" W	4881019.4	773848.6
North Triumph	43° 41' 56.4" N	59° 51' 16.4" W	4843035.7	753467.9
Alma	43° 35' 46.8" N	60° 41' 22.0" W	4829417.0	686507.0
South Venture	43° 59' 50.4" N	59° 37' 41.4" W	4876673.5	770366.4
Deep Panuke	43° 48' 45.439" N	60° 41' 20.804" W	4853441.1	685863.0

Table 1. Geographic locations of the O&G platforms surrounding Sable Island

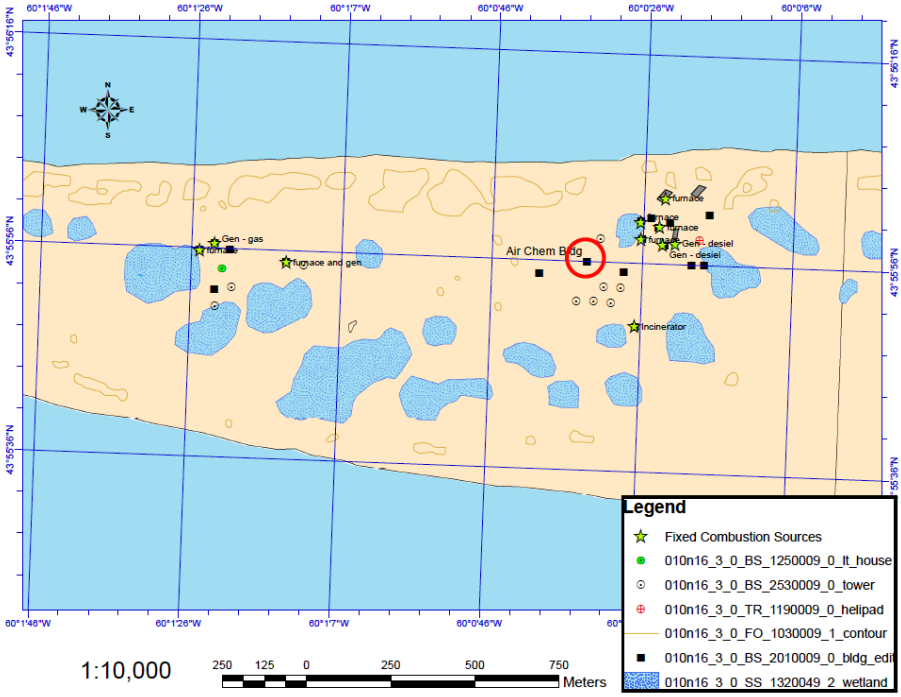

Figure 2. Location of facilities and on-Island combustion sources on Sable Island.

3.2 GOALS

The goal of the air quality monitoring component of the EEM program is to collect information on potential effects originating from the offshore platforms that may affect Sable Island or that can be monitored from the island. Sable Island provides a unique platform upon which to augment the offshore EEM program.

3.3 OBJECTIVES

Acquire a better understanding of both ambient air concentrations in the Sable area and quantitatively identify any possible effects from offshore operations, while taking into consideration localized emission sources on Sable Island itself including air traffic to and from the island, diesel electric supply and waste incinerations at the research station.

3.4 2014 AIR QUALITY MONITORING ON SABLE ISLAND

3.4.1 Nova Scotia Environment, Sable Island, Air Quality Monitoring and Reporting

In 2008 a new data management system was installed on Sable Island. This new system includes the hardware (an industrial computer, uninterrupted power supply and surge protector) and software (DRDAS). The new system collects digital monitoring and diagnostic data from the instruments for O_3, $PM_{2.5}$, NO_x, SO_2 and H_2S on a continuous basis (Waugh et al., 2010).

A request was made to Nova Scotia Environment on January 14, 2015 for detailed information regarding the maintenance, management and QA/QC of the instruments on Sable Island. Feedback has not yet been received.

It has been indicated that Nova Scotia Environment will discontinue to manage air emissions monitoring on Sable Island from January 1st 2015. This pertains to the measurement of NO_x, H_2S, SO_2, O_3 and $PM_{2.5}$. An alternate to conduct this air monitoring is currently being sought.

3.4.2 Instrumentation on Sable Island

2 provides a summary of the air pollution instrumentation that is currently, or shortly to be deployed in 2015, on Sable Island. Table 2 also provides the temporal resolution of the measurement of sample collection.

Table 2. Summary of instrumentation on Sable Island

Equipment	Data Collection Comments
Air Monitoring Shed	
Teledyne NO_x Analyzer	Hourly
METOne BAM $PM_{2.5}$	Hourly
Teledyne H_2S Analyzer	Hourly
Teledyne SO_2 Analyzer	Hourly
TECO O_3 Analyzer	Hourly
Thermo Partisol 2000 dichotomous sampler Federal Reference Method	24-hr, simultaneous, integrated filter sample of $PM_{2.5}$ (fine) and $PM_{2.5\text{-}10}$ (coarse) particle mass
TSI 3031 Ultrafine particle monitor	15-min
TSI 3321 Aerodynamic Particle Sizer	1-15 min
Thermo 55i total VOC Analyzer	Hourly
Markes International Air Server 3 and Unity 2 for VOC species concentration on the Island	Hourly
Additional Markes International Unity 2 and Thermo GC-ISQELITE MS for the analysis of VOC species collected on Island by thermal desorption tubes	Daily
TSI DRX DustTrak 8533 for Total PM, PM_{10}, $PM_{2.5}$ and PM_1	1-60 min
Thermo 5012 black carbon analyzer	Hourly
Data display and data archive	N/A
2x Markes International MTS-32, for the collection of 32-daily VOC species samples onto	24-hr
Thermo 1300 GC and Thermo ISQ MS for VOC species concentration	Hourly

3.5 ANALYSES

3.5.1 Data Acquisition

Air quality data for 2014 was obtained from two sources, Nova Scotia Environment and Kingfisher Environmental Health Consultants' data collection on Sable Island of BC and NMHC. Black carbon and NMHC analysis began in May 2013. All data were cleaned, negative baseline drift corrected, calibration values removed and text flags removed.

3.5.2 Air Quality Standards pertaining to Sable Island

Table 3 contains the air quality standards for Canada, Nova Scotia and the World Health Organization (WHO). These air quality regulations will be used for comparison with the 2014 air quality data pertaining to Sable Island.

Table 3. Nova Scotia Air Quality Regulations (*Environment Act*) and *Canadian Environmental Protection Act*
Ambient Air Quality Objectives (Suggested air monitoring thresholds - µg/m^3 (ppb))

Pollutant and units (alternative units in brackets)	Averaging Time Period	Nova Scotia	Canada				
		Maximum Permissible Ground Level Concentration	Canada Wide Standard	Ambient Air Quality Objectives			World Health Organization (Who)
				Maximum Desirable	Maximum Acceptable	Maximum Tolerable	
Nitrogen dioxide ug/m^3 (ppb)	1 hour	400 (213)	-	-	400 (213)	1000 (532)	(105)
	24 hour	200 (106)	-	-	200 (106)	300 (160)	
	Annual	100 (53)	-	60 (32)	100 (53)	-	(21)
Sulfur dioxide up/m^3 (ppb)	1 hour	900 (344)	-	450 (172)	900 (344)	-	
	24 hour	300 (115)	-	150 (57)	300 (115)	800 (306)	(75)
	Annual	60 (23)	-	30 (11)	60 (23)	-	
Total Suspended Particulate Matter (TSP) up/m^3	24 hour	120	-	-	120	400	
	Annual	70 (geometric mean)	-	60	70	-	
PM2.5 (fine) up/m^3	24 hour, 98th percentile over 3 consecutive years	-	30 (by 2010)	-		-	
	24 hour				120		25
	Annual			60	70		10
PM10-2.5 (coarse) up/m^3		-	-	-	-	-	
PM_{10} (sum of fine and coarse)	Annual						50
Carbon Monoxide mg/m^3 (ppm)	1 hour	34.6 (30)	-	15 (13)	35 (31)	-	
	8 hour	12.7 (11)	-	6 (5)	15 (13)	20 (17)	

Oxidants – ozone up/m^3 (ppb)	1 hour	160 (82)	-	100 (51)	160 (82)	300 (153)	
	8 hour, based on 4th highest annual value, averaged over 3 consecutive years	-	(65) {by 2010}	-	-	-	(50)
	24 hour	-	-	30 (15)	50 (25)	-	
	Annual	-	-	-	30 (15)	-	
Hydrogen sulphide up/m^3 (ppb)	1 hour	42 (30)	-	-	-	-	
	24 hour	8 (6)	-	-	-	-	

3.5.3 On Island Emission Sources

Because of the need to provide power, space heating, water heating and cooking facilities it was necessary to install generators, furnaces and cooking appliance infrastructure on Sable Island to meet this requirement. Due to the anticipated impact on air quality measurements from these heating appliances and power generators they were situated as far away as possible to the East of the air chemistry building (per. comm. Gerry Forbes, 2013). The combustion sources on Sable Island include:

- Generators
- All-purpose utility vehicle & vehicle garage
- Furnace at Operations building
- Furnace at the staff house
- Furnace at the OIC house
- Furnace at the Triplex

3.6 RESULTS

This section covers data analysis results, graphing and additional analysis results related to the assessment of air quality on Sable Island.

3.6.1 2014 Air Quality Data

Table 4 contains the descriptive statistics and data completeness for 2014 air pollutant metrics.

Table 4. Descriptive Statistics and Data Completeness for 2014 Air Pollutant Metrics

Metric	NMHC *[ppm]*	BC *[µg m^{-3}]*	SO_2 *[ppb]*	NO_x *[ppb]*	NO *[ppb]*	NO_2 *[ppb]*	$PM_{2.5}$ *[µg m^{-3}]*	O_3 *[ppb]*	H_2S *[ppb]*
n	6001	7197	5854	8711	8695	8701	5035	8576	5522
Mean	0.001	0.082	0.654	0.867	0.404	0.468	8.113	35.778	0.682
Std Dev	0.005	0.472	0.792	1.069	0.420	0.714	5.057	7.223	0.291
Max	0.061	22.34	4.3	44.1	22.4	24.4	69	65	3.4
99pct	0.032	0.727	4	3.29	1	2.4	25	53	1.3
98pct	0.008	0.404	3.5	2.5	0.8	1.8	22	50	1.258
95pct	0	0.23	2.7	1.7	0.6	1.2	18	47	1.2
75pct	0	0.078	0.7	0.9	0.5	0.6	10	41	0.9
Median	0	0.038	0.3	0.7	0.4	0.3	7	36	0.6
25pct	0	0.012	0.2	0.6	0.3	0.2	5	31	0.5
Min	0	0	0.1	0	0	0	0	15	0.1
Data Completeness	68.50%	82.16%	66.83%	99.44%	99.26%	99.33%	57.48%	97.90%	63.04%

pct = percentile

From Table 4 it can be seen that the data completeness for 2014 is less than desired for PM2.5 (57.48%), H2S (63.04%), SO2 (66.83%), and NMHC (68.50%). These poor data completeness results are a reflection of the difficulties gaining access to the Island for instrument maintenance due to intermittent flights and bad weather. This is a major challenge conducting air quality measurements on Sable Island. In terms of the instruments managed by Dr. Gibson's group, it has been difficult to find a flight to transport carrier gas to the Island for the NMHC analyzer. Kingfisher has recommended that a N2 carrier gas generator be purchased for the Thermo 55i total-VOC (NMHC) instrument. This would improve data completeness for this instrument.

It can be seen in Table 4 that the data completeness during 2014 for O3 (97.90%), BC (82.16%) and NOx, NO & NO2 (99.44%, 99.26% and 99.33%) was excellent. When annual data completeness is below 75% it impairs robust seasonal statistical analysis of the data.

As can be seen in Table 4 the mean (minimum : maximum) NOx concentration was found to be 0.87 (0.0 : 44.1) ppb; SO2 0.65 (0.1 : 4.3) ppb; H2S 0.68 (0.1 : 3.4) ppb; PM2.5 8.11 (0.0 : 69.0) µg/m3; O3 35.78 (15.0 : 65.0) ppb; BC 0.082 (0.0 : 22.34) µg/m3; NMHC 0.001 (0.0 : 0.061) ppm. All but SO2, O3 and H2S recorded minimums with a concentration of 0.0 ppb/ µg/m3.

The observed maximum hourly H2S concentration of 3.4 ppb was likely due to an operational issue on the Deep Panuke facility related to dilution gas dosing problem that resulted in incomplete combustion of acid gas on August 7. M. Thillet (Encana) relayed this information on August 14, 2014. In addition, further evidence pointing to Deep Panuke as the source of the H2S spike was obtained from air mass back trajectory modelling. This modelling revealed that the airflow crossed Deep Panuke en route to Sable Island during this period, with the likely consequence of advecting H2S emissions to the Island. In addition, the ExxonMobil Thebaud platform reported a smell of 'sour gas' on the same day. Thebaud is

roughly inline, and between, Deep Panuke and Sable Island. This evidence points toward Deep Panuke as being the likely source of the H2S during the threshold breach. This is the only occurrence of a H2S threshold breach (set at 3.11 ppb) in 2014. This breach is well below any health regulation standard, e.g. Canadian Ambient Air Quality Objective (1-hr average of 30 ppb). There were no other threshold breaches for the remaining air pollutant metrics in 2014.

Figure 3 provides a non-parametric visualization (box-whisker plot) of the daily average air pollution data for 2014. Box plots provide insight into the central tendency, variance and range of data by means of a non-parametric visualization.

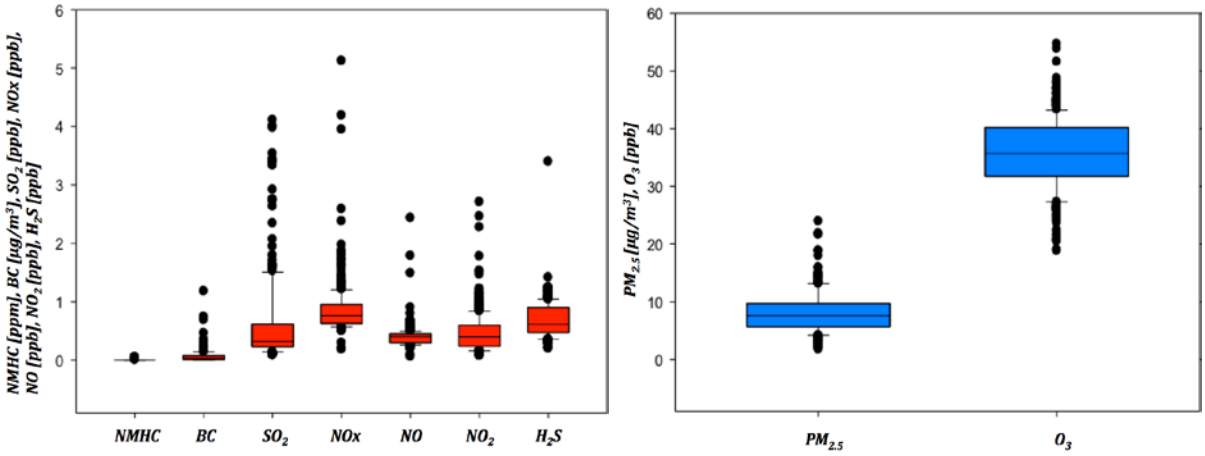

Figure 3. Box-whisker plot of the daily average air pollution data for 2014

Figure 4 provides a time series plot of the available NO, NO_2 and NO_x daily averages data for 2014.

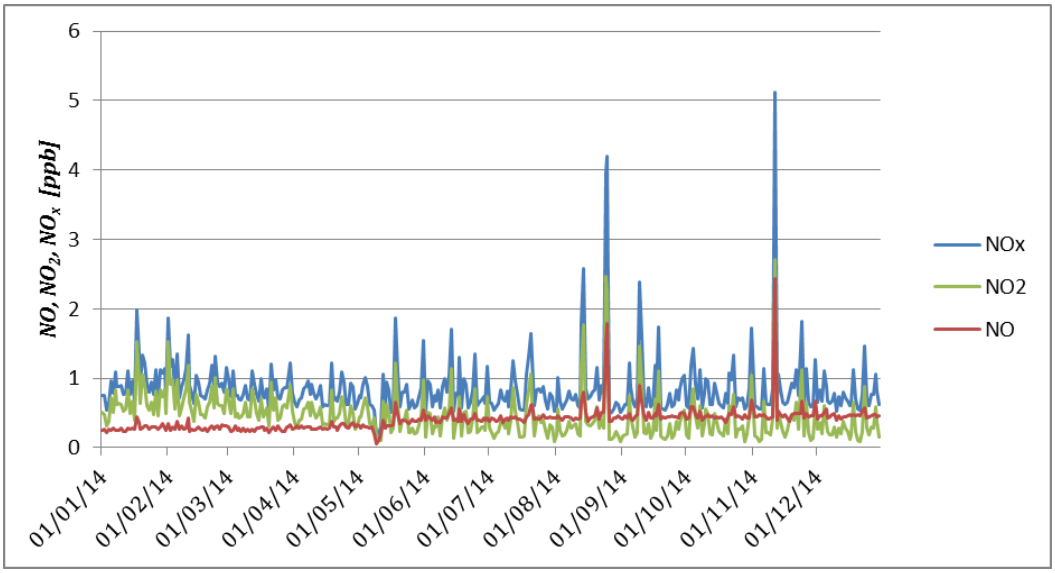

Figure 4. Time series plot of the available NO, NO_2 and NO_x daily averages data for 2014

The time series shown in Figure 4 shows three NO, NO2 and NOx 'spikes' that occurred on August 14 (0.8, 1.78 and 2.59 ppb respectively), August 25 (1.79, 2.28, 4.19 ppb respectively) and November 11 (2.44, 2.71, 5.13 ppb respectively). Scrutiny of the HYSPLIT 5-day air mass back trajectories in the Appendix show that the air parcels on August 14th and 25th originated from the N and NE prior to arriving on Sable Island and therefore these spikes are not likely to be associated with O&G production or on Island combustion. The air mass back trajectories on November 11th originate from the NW, crossing Ontario, Quebec, NE US and Nova Scotia prior to arriving on Sable Island. Therefore the spike in NOx observed on this date is most likely due to LRT of mainland combustion related emissions and not associated with O&G production or on Island combustion.

Figure 5 provides a time series plot of the available SO_2 daily average data for 2014.

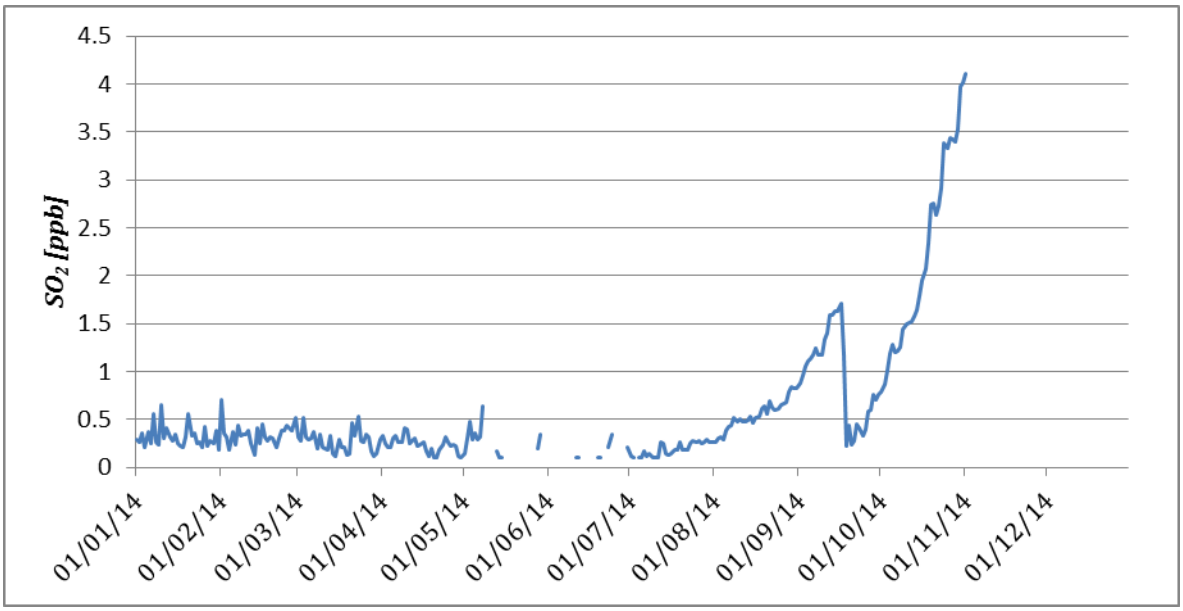

Figure 5. Time series plot of the available SO_2 daily average data for 2014

From the time series of SO2 provided in Figure 5 it can be seen that the instrument drifted from approximately August 1 onwards with a re-calibration on September 20. Scrutiny of the data prior to August 1, 2014 shows a pike in SO2 on January 10, February 1 and May 8. Scrutiny of the NOAA HYSPLIT 5-day air mass back trajectories show that prior to January 10 the air parcel crossed known source regions of SO2 in the Ohio valley, Windsor – Québec corridor and the NE USA and therefore the spike in SO2 was unlikely to be due to O&G production operations.

The 5-day air mass back trajectories related to February 1 show that the air parcel crossed known source regions of SO2 in the Ohio valley, Ontario, NE USA, Deep Panuke and Thebaud en route to Sable Island. It is therefore possible that a contribution to the SO2 spike observed on February 1 was from O&G production, but most likely a result of LRT from the continent. Dispersion modelling of SO2 from these O&G platforms would confirm this hypothesis. However, this is outside the scope of this report. The 5-day air mass back trajectories for May 8 show that the air parcel crossed over Sydney and the Langan coal fired

power station in Cape Breton Nova Scotia. In addition, there was a marine inversion on this day that likely trapped the SO2 emissions from Langan coal fired power station close to the surface prior to reaching Sable Island. Therefore, the SO2 spike on May 8 was unlikely to be due to O&G production operations.

Figure **6** provides a time series plot of the available $PM_{2.5}$ daily average data for 2014.

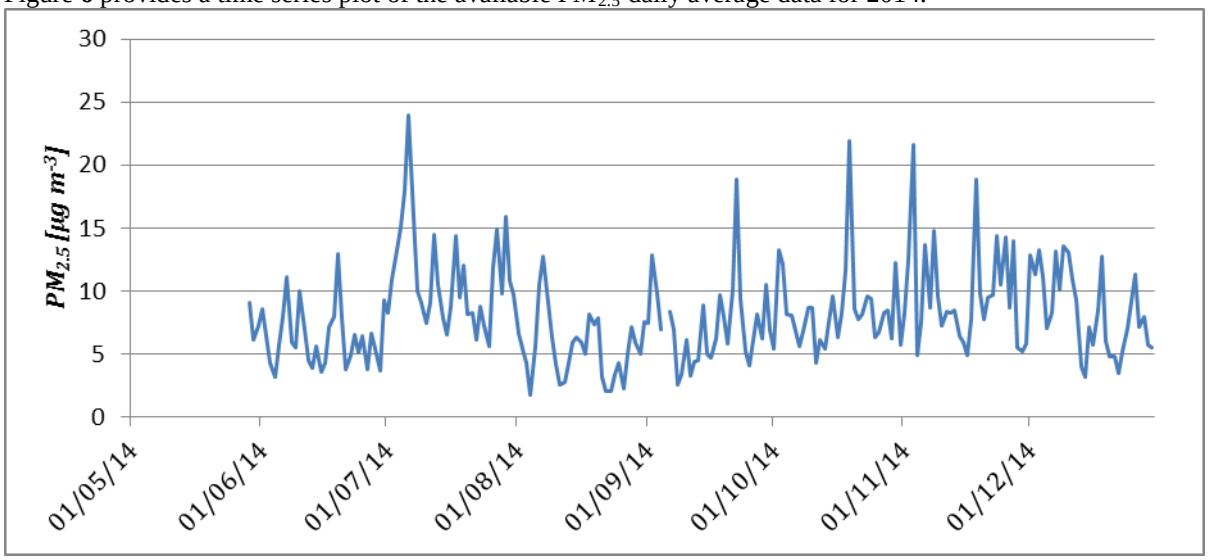

Figure 6. Time series plot of available $PM_{2.5}$ daily average data for 2014

The time series plot of PM2.5 shown in Figure 6 shows spikes in PM2.5 on July 6, October 19 and November 11. The PM2.5 spikes on all of these dates appear to be related to westerly continental outflow from known upwind source regions, e.g. NE US and Southern Ontario (Gibson et al., 2015; Gibson et al., 2013).

Figure **7** provides a time series plot of the available O_3 daily average data for 2014.

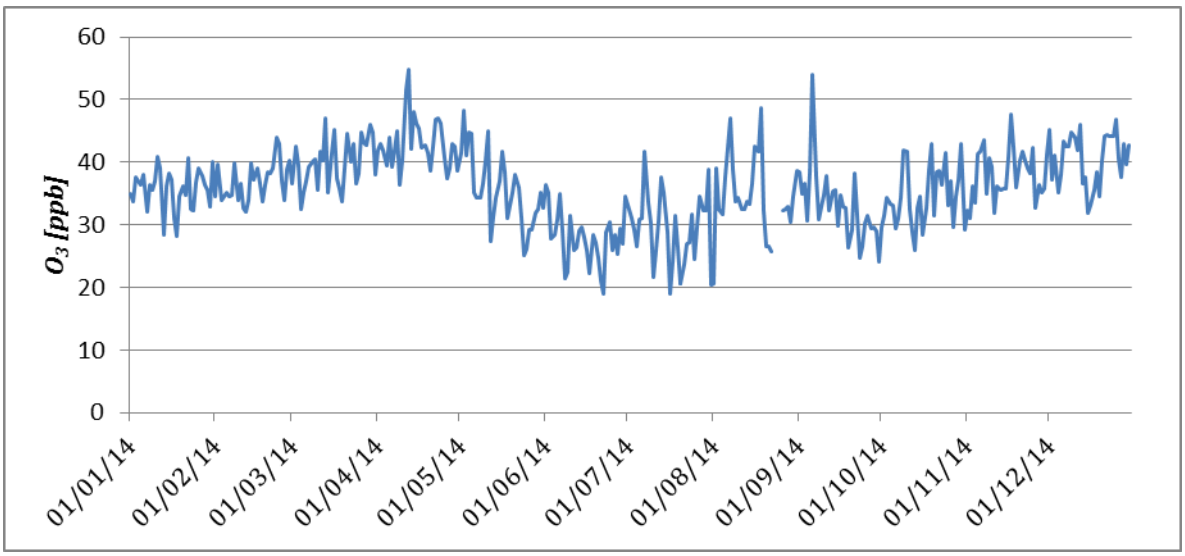

Figure 7. Time series plot of the available O_3 daily average data for 2014

Since O3 is a secondary air pollutant that takes many hours to form it is probably not related to O&G production around Sable Island but rather associated with smog outflow from the mainland.

The annual spring maximum O3 concentration is typically found between mid-March and mid-April (Gibson et al., 2009a). Figure 7 also displays characteristic episodic spikes during the summer due to LRT smog outflow from the continent and an increase in O3 during the winter due to a reduce ceiling height and air pollution outflow from the NA continent (Gibson et al., 2009a). There are no spikes in the data above where the daily average concentrations are greater than 3 standard deviations above the mean daily average concentration. The spike on April 11 and September 6 were related to air flow crossing known source regions of ozone pre-cursors (VOCs and NOx) in Ontario and the Ohio valley, and given the season, likely related to the photochemical formation of secondary ozone which was then advected to Sable Island on these dates.

Figure **8** provides a time series plot of the available H_2S daily average data for 2014.

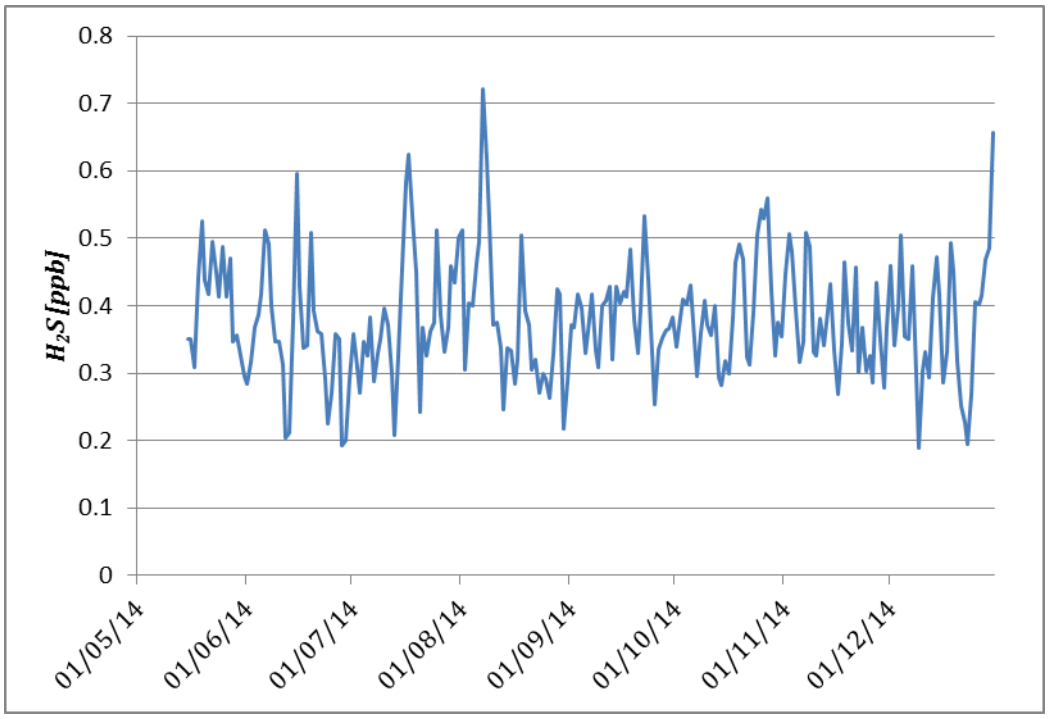

Figure 8. Time series plot of the available H_2S daily average data for 2014 that has been corrected for instrument drift beginning on June 25, 2014.

Figure 8 shows three H2S spikes on June 15, July 16 and August 7. Local wind directional analysis and 5-day air mass back trajectories show that air flow on these dates was from the SW and crossed the Deep Panuke and Thebaud O&G production facilities prior to reaching Sale Island. It is known that there was an issue with the acid gas flaring on August 7 on Deep Panuke that caused a 1-hour threshold breach. The spikes on the other two days were also likely due to H2S acid gas emissions from Deep Panuke. However, these spikes are well below any regulatory and health standards so of minor environmental or health concern.

Figure 9 provides a time series plot of the available black carbon daily average data for 2014.

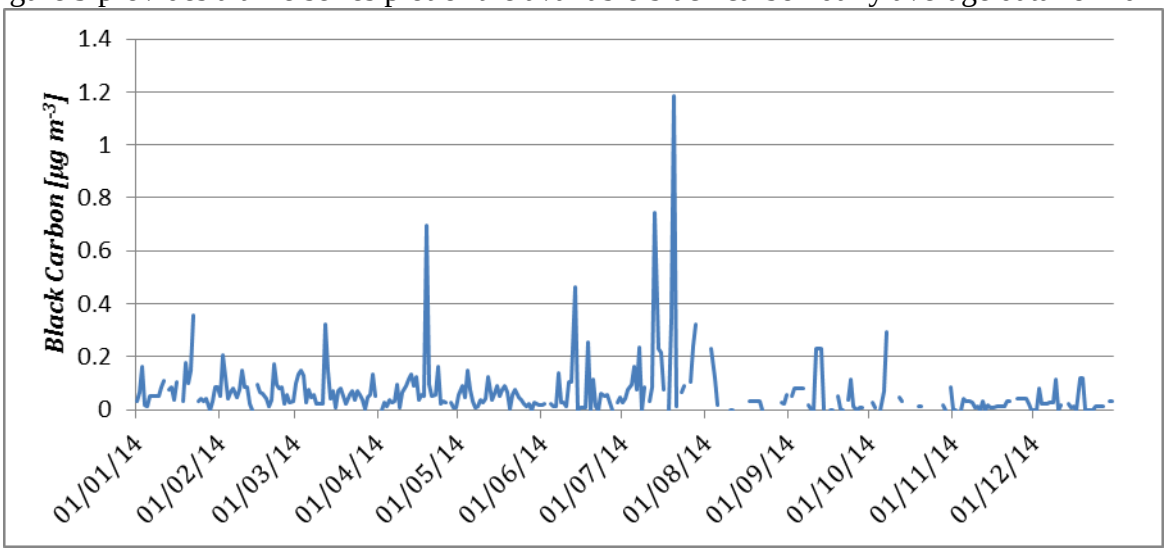

Figure 9. Time series plot of the available black carbon daily average data for 2014

The time series plot for Black Carbon shown in Figure 9 shows spikes in the BC data on observed on April 19, July 13 and July 20. Air mass back trajectories related to April 19 and July 13 show that the air parcels both originated in Northern Manitoba and Ontario prior to arrival at Sable Island. The air mass back trajectory related to July 20 crossed Québec and New Brunswick prior to reaching Sable Island. Using the online Canadian Wildland Fire Information System (http://cwfis.cfs.nrcan.gc.ca/maps/fm3?type=fwih&year=2014&month=7&day=20) it was possible to determine that all the air parcels associated with these dates crossed know regions experiencing wild fires and this is the likely cause of the spikes in BC on those days.

Figure **10** provides a time series plot of the available NMHC daily average data for 2014.

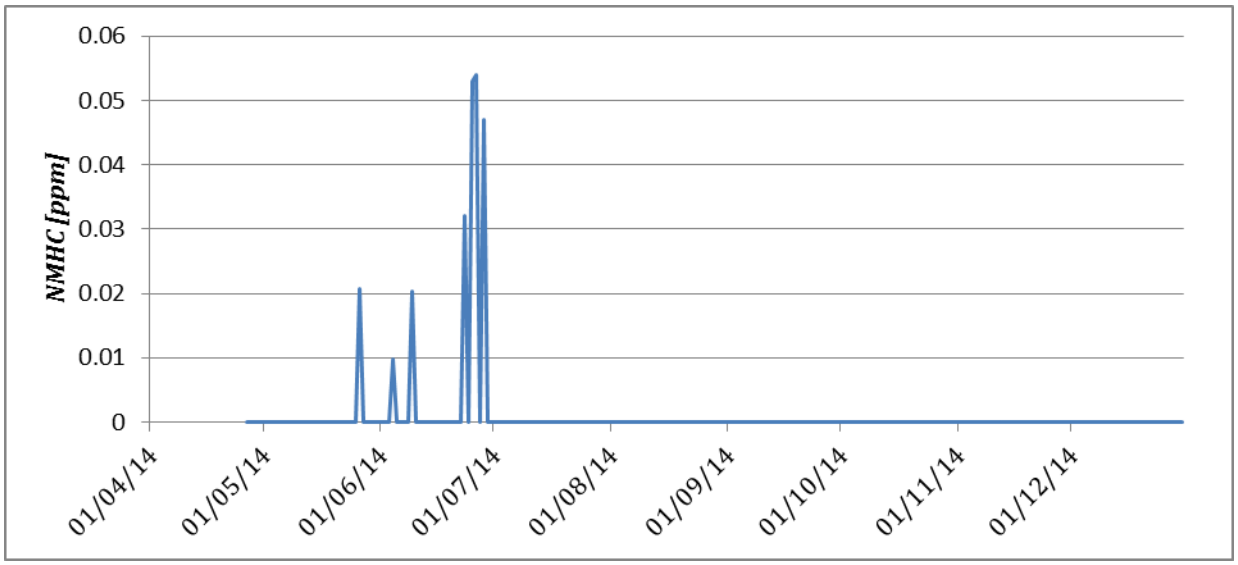

Figure 10. Time series plot of the available NMHC daily average data 2014

The time series plot shown in Figure 10 shows spikes in NMHC on May 26, June 9 and June 23 through 28. The air mass back trajectories for these dates show that the air parcel stagnated over the Scotian shelf prior to reaching Sable Island. It is therefore likely that these spikes in NMHC concentrations observed on Sable Island during these dates are due to marine biogenic emissions and neither continental outflow or O&G production operations.

Figure **11** shows a pollution rose for NO, NO_2 and NO_x in 2014.

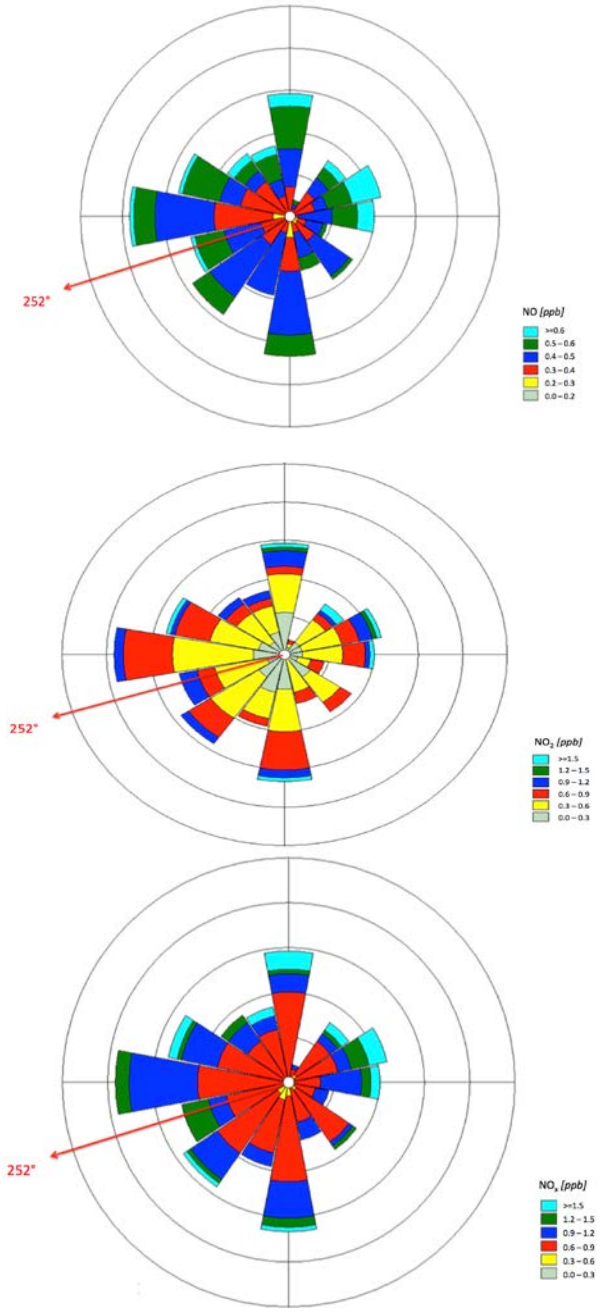

Figure 11. Pollution rose for NO, NO_2 and NO_X in 2014

Figure 11 shows that the average NO, NO2 and NOX vector for 2014 was 252° which aligns with the Deep Panuke and Thebaud O&G platforms, but also LRT from the mainland. In future, source apportionment of VOC species and PM2.5 species would offer a robust method to aid with the identification of the source of the NOx wind directional dependence on Sable Island.

Figure **12** shows a pollution rose for SO_2 in 2014.

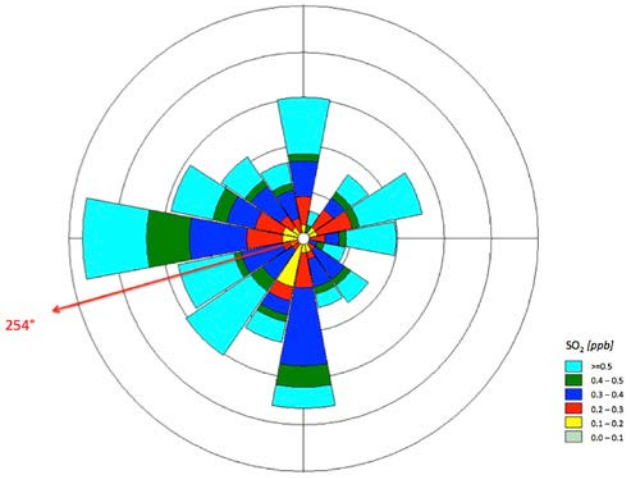

Figure 12. Pollution rose for SO_2 in 2014

Figure 12 shows that the average SO2 vector for 2014 was 254˚ which is roughly in line with the Deep Panuke and Thebaud O&G platforms. The SW SO2 wind directional dependence may be related to the O&G platforms, but more likely a result of prevailing winds advecting SO2 from mainland sources to Sable Island. Source apportionment, dispersion modelling and remote sensing work would need to be conducted to determine the exact source of the SO2.

Figure **13** shows a pollution rose for $PM_{2.5}$ in 2014.

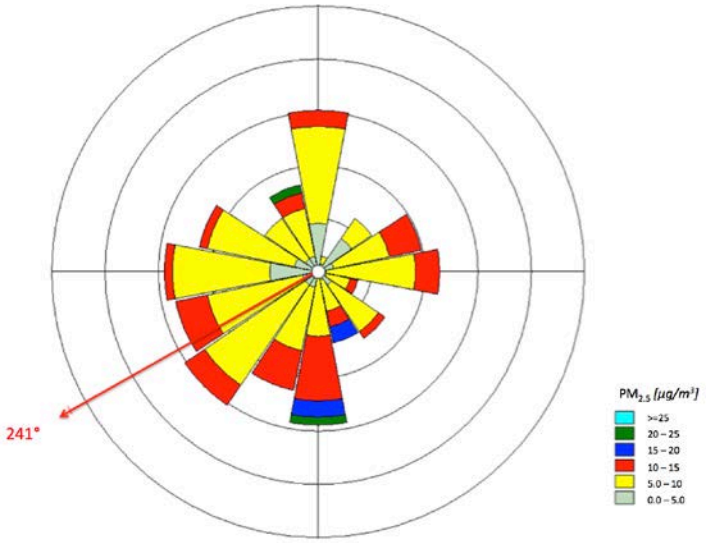

Figure 13. Pollution rose for $PM_{2.5}$ in 2014

Figure 13 shows that the average directional dependence for PM2.5 was from 241°. The PM2.5 pollution rose also shows elevated concentrations (> 15 µg/m3) from the South and NW. The S direction is in line with the North Triumph platform. However, the elevated PM2.5 from the S is more likely related to sea spray PM2.5 during stormy weather.

The directional dependence from the N is likely continental smog outflow or wildfire smoke plumes advected to Sable Island. Further analysis of air mass back trajectories, facility operations, on-Island operations and PM2.5 chemistry would be required before associating the PM2.5 directional dependence to any particular source.

Figure **14** shows a pollution rose for O_3 in 2014.

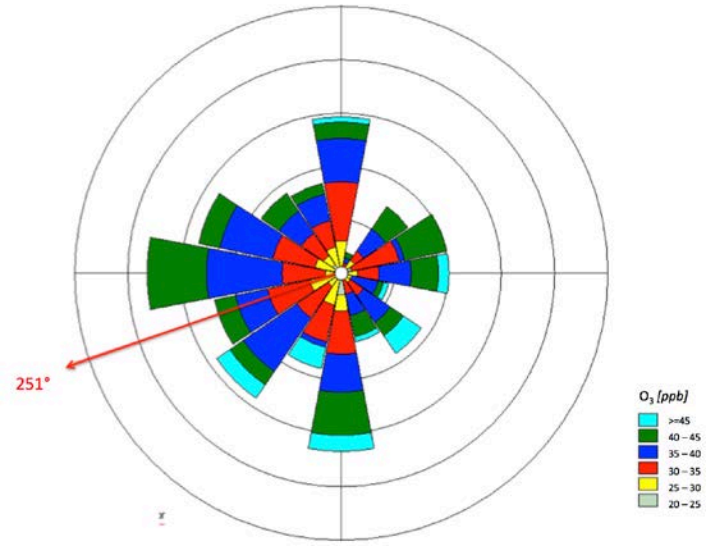

Figure 14. Pollution rose for O_3 in 2014

Figure 14 demonstrates that the average O3 vector for 2014 was from 251°. As O3 is a known LRT air pollutant it is likely not to be related to any O&G production activity. The average wind vector from the SW is the same as the prevailing wind that advects ozone pre-cursors (NOx and VOCs) and O3 to Sable Island from mainland anthropic and natural biogenic sources.

Figure **15** shows a pollution rose for H_2S in 2014.

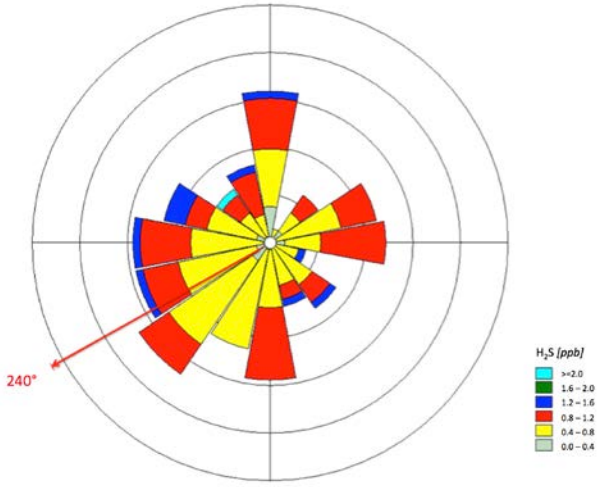

Figure 15. Pollution rose for H_2S in 2014

Figure 15 shows that the average H2S vector for 2014 was 240° which is in line with the Thebaud, Alma, Deep Panuke O&G platforms. Deep Panuke is a known source of low concentrations of H2S that impact Sable Island, concentrations significantly lower than Canadian Air Quality standards.

Figure **16** shows a pollution rose for BC in 2014.

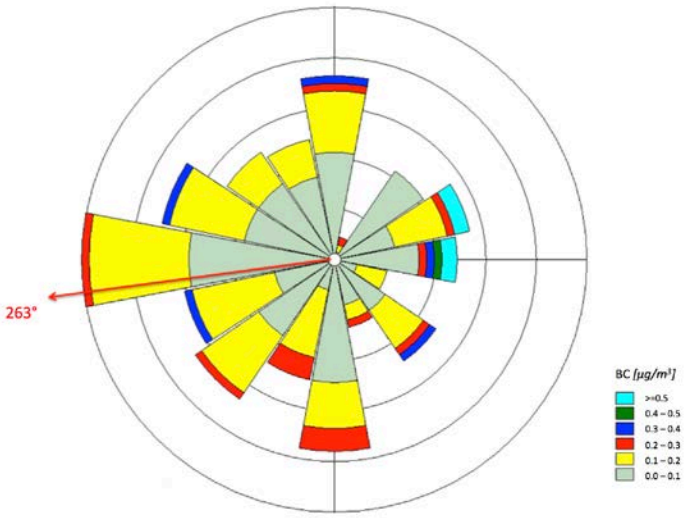

Figure 16. Pollution rose for BC in 2014

Figure 16 shows that the average BC direction vector for 2014 was 263°. It can be seen that there is an Easterly directional dependence for BC concentrations above 0.5 µg/m3. The Easterly direction is in line with the Venture and South Venture O&G platforms, and on-island combustion sources. Further monitoring located between the on-island combustion sources and the Venture platforms under Easterly airflow would be one way to differentiate these sources.

Figure **17** shows a pollution rose for NMHC in 2014.

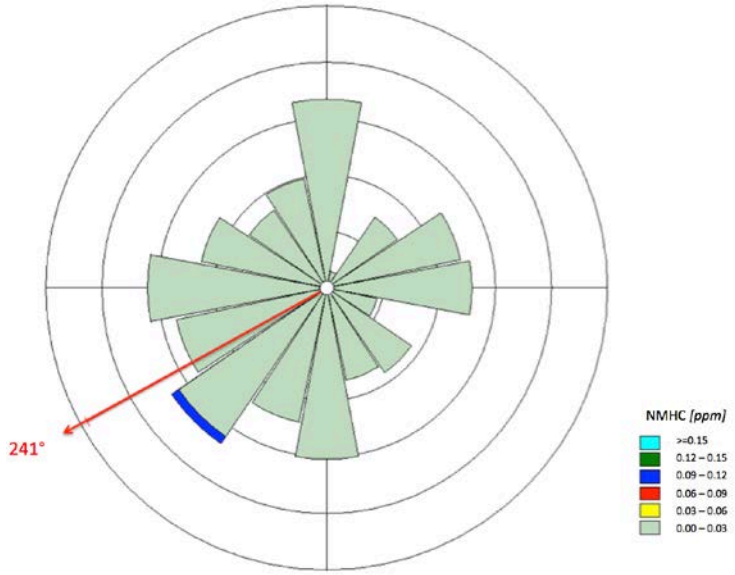

Figure 17. Pollution rose for NMHC in 2014

Figure 17 demonstrates an average wind directional dependence for NMHC from 241° with the highest concentration (> 0.09 ppm) from the SW which is roughly in line with Deep Panuke and Thebaud, but also continental air pollution outflow. Without conducting source apportionment analysis utilizing source marker VOC species and dispersion modelling from theses O&G facilities it is not possible to state if they are the source of the increase in NMHC seen from this wind vector.

3.6.2 Air Emission Spike Thresholds and Threshold Breaches

Air emission monitoring thresholds values were calculated by Dr. Mark Gibson (Dalhousie University) in consultation with Encana and Exxon Mobil. The threshold values were calculated using extreme value analysis. These thresholds were established for monitoring purposes to identify possible "spikes" in air emissions parameters on Sable Island that could be related to O&G production operations. They are not regulatory thresholds, and are well below any international/Canadian/provincial health impact thresholds (see Table 5).

A spike is not a reportable incident but only indicates that an air parameter is above typical background levels. All spikes are investigated to determine if they are related to O&G operations near to Sable Island. Investigations include air mass back-trajectory analysis and pollution rose analysis to determine the long-range and local upwind sources respectively. Table 5 provides the threshold values chosen for the air emission evaluation of O&G operations.

Table 5. Air emission 'spike thresholds for Sable Island

Metric	Reference: extreme value analysis (1-hr data period) [1]	Suggested threshold value (1-hr)	Canada Ambient Air Quality Objectives
NO_x [2]	3/year return threshold for data available from 01/01/10 to 16/07/10	17.0 ppbv	213 ppb (1-hr)
SO_2	1/year return threshold for data available from 01/04/08 to 01/10/11	6.0 ppbv	344 ppb (1-hr)
H_2S [3]	1/year return threshold for data available from 02/05/12 to 09/10/12	3.11 ppbv	30 ppb (1-hr, NS)
$PM_{2.5}$	1/year return threshold for data available from 01/01/07 to 01/10/11	168.0 $\mu g/m^3$	120 $\mu g/m^3$ (24-hr)
Ozone	1/year return threshold for data available from 01/01/07 to 01/04/11 (1-hr data period)	104.0 ppbv	82 ppb (1-hr)
NMHC (Total VOC)	1/year return threshold data available from 01/01/14 to 31/12/14 (1-hr data period)	0.07 (ppmv)	N/A
BC	1/year return threshold data available from 01/01/14 to 31/12/14 (1-hr data period)	1.5 $\mu g/m^3$	N/A

Note 1: An extreme value analysis (see Appendix 4 for details) was conducted on air emissions data available between 2007 and 2011. For each metric, the period mentioned in this column indicates the period for which data was available for this specific metric during these five years. For H2S, the data available for these five years was poor quality; therefore, 2012 H2S emission data was obtained from NSE to calculate the H2S threshold. All thresholds will be reviewed on an annual basis and recalculated with the new emissions data that becomes available.

Note 2: A higher return threshold (3/year) was used for the extreme value analysis for NOx (which should results in a higher number of spikes to investigate) because "elevated pollution events" identified during the 2003-2006 ESRF study for this parameter were linked to oil and gas operations as a possible causal factor.

Note 3: When Deep Panuke first starts flaring acid gas during the start-up phase, in addition to the automatic alarm system (i.e. even if H2S levels are below the alarm threshold), H2S data will be monitored by Dalhousie personnel in real-time to confirm EA predictions that levels of H2S generated by acid gas flaring would be negligible on Sable Island. Observer(s) will be monitoring H2S values in conjunction with acid gas flaring activities and weather conditions to identify any potential correlation between acid gas flaring and H2S levels on the island.

Note 4: Canada Ambient Air Quality Objectives (CAAQO), maximum acceptable 1-hr thresholds are provided as a reference. For PM2.5, the 24-hr CAAQO threshold was provided because a 1-hr threshold was not available. For H2S, the Nova Scotia 1-hr ground-level concentration threshold was used because a CAAQO threshold was not available. The ozone "spike" threshold is higher than the CAAQO threshold because of historical elevated ozone levels in the area.

Table 6 below summarizes the number of hourly spikes that exceeded the suggested concentration thresholds.

Table 6. Air emission 'spike' thresholds for Sable Island and threshold exceedences in 2014

Metric	Suggested threshold value (1-hr)	Number of spikes over threshold	Total hours over threshold	Time and date of start of spike	Highest value during spike
NOx	17.0 ppbv	0	0		
SO_2	6.0 ppbv	0	0		
H_2S	3.11 ppbv	1	1	4:00pm, Aug 7 2014	3.4 ppb
$PM_{2.5}$	168.0 μg/m^3	0	0		
Ozone	104.0 ppbv	0	0		
BC	1.5 μg/m^3	0	0		
NMHC (total VOC)	0.07 ppm	0	0		

Table 6 shows that there was only one spike where H2S exceeded the operational threshold. This threshold breach only lasted 1-hour. Encana communicated that this H2S threshold spike was related to an issue with acid gas flaring on their Deep Panuke platform.

3.6.3 Meteorological Analysis

The meteorological data was downloaded from the Environment Canada website (http://climate.weatheroffice.gc.ca/climateData/canada_e.html).

Table 7. Meteorological Variable Descriptive Statistics for 2014

Variables	Temperature (°C)	Wind Speed (km/h)	Wind Direction (°)
n	5720	7902	7902
Mean	13.09	24.6	252
Std Dev	6.02	12.0	N/A
Max	24	85.2	N/A
99pct	23	57.4	N/A
98pct	22.0	53.7	N/A
95pct	22	46.3	N/A
75pct	18	31.5	N/A
Median	14	22.2	N/A
25pct	8	14.8	N/A
Min	1	0	N/A
Data Completeness	65.3%	90.21%	90.21%

Table 7 provides the descriptive statistics for the meteorological variables for the period January 1, 2014 to December 31 2014.

Figure 18 provides a wind rose for 2014. The average wind vector for 2014 was 252°.

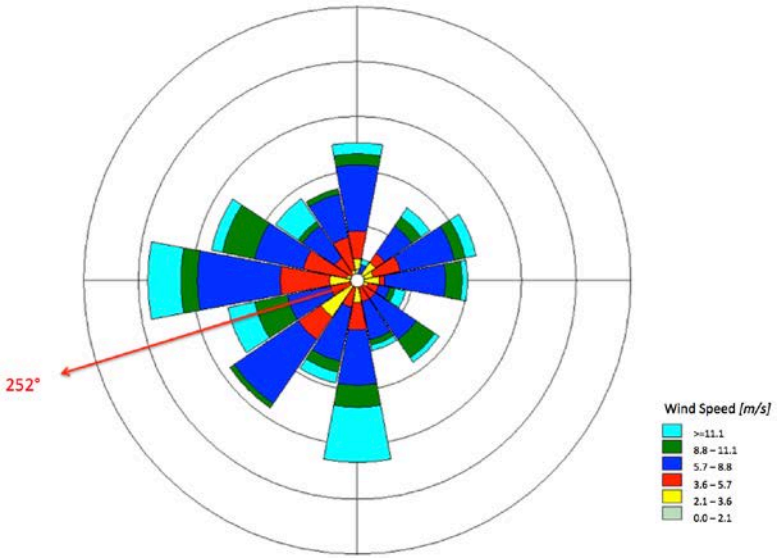

Figure 18. Wind rose for 2014

3.7 DISCUSSION

Wind rose analysis showed that the average wind vector for 2014 was 252° which is consistent with the known prevailing winds from the SW advecting over the Scotian shelf (Gibson et al., 2009a, Gibson et al., 2013b).

NOAA HYSPLIT air mass back trajectory system, NASA Aqua and Terra MODIS satellites and the Canadian Wildland Fire Information System were used to aid the identification of spikes in the air pollution metrics typically observed (~ 3x standard deviation above the mean). Spikes in NOx, PM2.5 and O3 originate from known source regions in the Ohio valley, Ontario, Quebec, NE US and Nova Scotia prior to arriving on Sable Island. Three spikes in H2S spikes (June 15, July 16 and August 7) are likely due to H2S acid gas emissions from Deep Panuke (only one was above the operational spike threshold). However, these spikes are well below any regulatory and health standards so of minor environmental or health concern. Spikes in the BC on April 19, July 13 and July 20 were likely related to wildland fires smoke advected to Sable Island on these dates. There is intriguing evidence that the spikes in NMHC on May 26, June 9 and June 23 through 28 are associated with marine biogenic emissions and neither continental outflow or O&G production operations. Twice daily NOAA HYSPLIT air mass back trajectories are provided in the Appendix for Section 3.

3.8 CONCLUSIONS

The most important feature of the air quality data acquired on Sable Island for 2014 is that there was one operational threshold breach for H2S (3.4 ppbv, 1-hr period; threshold at 3.11 ppb) on August 7. This threshold breach was likely a result of a short-term acid gas flaring issue on the Deep Panuke natural gas production facility (Encana communication).

There were no breaches of the National Air Quality Standards, Canada Ambient Air Quality Objectives (CAAQO) or Canada Wide Standard for any of the air pollution metrics contained in this report.

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4. BIRD MONITORING

4.1 RATIONALE / HISTORY

Seabird monitoring observations were conducted on a relatively continuous basis at the Thebaud production platform from 1999 until 2004 by independent observers supplied by Offshore Oil and Gas Observer Program. (OGOP). The OGOP observers received periodic training in seabird identification from various experts including Canadian Wildlife Service (CWS) biologists. While CWS believed that these observations provided a general appreciation of seabird/platform interactions, the observations were unable to fully assess the relative distribution of seabirds around the platform since they were restricted to a single location and limited field of view (Wilhelm and Boyne 2006). As an alternative to earlier observations at a single location (i.e., platform) by OGOP observers, a vessel-based approach using transect surveys was adopted in 2005 involving systematic observations of seabirds by CWS-trained biologists along supply vessel transits to and from offshore platforms. The transect approach offered the possibility of detecting changes in density of seabirds in relation to distance from SOEP offshore manned and unmanned gas platforms off Nova Scotia. This vessel-based approach was conducted in 2007, 2008, 2010, and 2011. Analysis of these data were supplemented by the availability of vessel-based transects conducted in other areas of the Scotian Shelf (i.e., not along regular supply vessel tracks to and from SOEP platforms) by CWS observers aboard 'vessels-of-opportunity' as part of a multi-year monitoring program to document the distribution and abundance of seabirds in offshore areas of Atlantic Canada.

In 2011 EMC assessed the feasibility of installing radar instrumentation as a means to monitor seabird movements in the vicinity of a satellite platform. The assessment concluded that the installation was not feasible based on the scope of platform modifications needed, the competing work priorities for the platform and the intervention plans. An alternative approach that incorporated receivers on standby/supply vessels was implemented. One standby vessel is located at the Thebaud location; one other is used to support satellite platform interventions and this provides data for the full field.

Logistical challenges associated with the seabird monitoring component are expected to become more prevalent as the Sable field matures and supply/standby vessel availability declines. In a meeting with the CNSOPB (MacDonald) and CWS (Boyne/Allard) on March 13, 2012, EMC support for a seabird monitoring technology research project was proposed as an alternative to the previous monitoring activities. Positive feedback was received at the March 2012 meeting and EMC was engaged with the lead researcher and direct financial (in 2012) and in-kind support (in 2013 and 2014) for the project was provided.

Participation of EMC field staff in the monitoring of tagged birds offshore was helpful to the research project as it provided valuable information on bird behaviour and movements. It alsoaugmented data that was collected in conjunction with the current research project. The support for the project was acknowledged as helpful by the lead researcher.

EMC field staff also look for birds during their daily surveillance checks on the offshore platforms further to SOEP's Canadian Wildlife Permit LS 2560 requirements. An annual report detailing the numbers of birds salvaged, released and deceased on the platforms, provides monitoring data on those species observed on the offshore facilities.

EMC has developed a training package and informational tools to help offshore personnel carry-out the required monitoring and reporting.

Stranded bird handling procedures were jointly developed in 2012 and 2013 with Encana after discussions and review with the CNSOPB. This protocol was developed to ensure consistent procedures are used on the offshore facilities on the Scotian Shelf. These measures include assigning offshore personnel responsible for tracking bird observations/data, directions on bird handling, and offshore personnel awareness/training. This protocol was submitted to the CNSOPB and subsequently Environment Canada for review along with clarification on required bird handling procedures.

4.2 GOALS

The goal of the 2014 bird monitoring component was to ensure SOEP was in compliance with the CWS permit issued under section 19 of the Migratory Birds Regulations and provide information to the regulator on the number and types of birds salvaged, released and deceased on the offshore facilities. Monitoring of tagged birds by offshore personnel should help with the evaluation of seabird abundance and behavior and how this may be affected by the presence of the platforms and flaring activities.

4.3 OBJECTIVES

The objective of the bird monitoring component of the EEM program is to provide bird observational data from platforms on the Sable Island Bank. This is undertaken in order to:

1) document the number of birds and species in the vicinity of the offshore facilities, by documenting those observed, salvaged, released and deceased, and

2) determine the extent of attraction of birds to SOEP manned and unmanned offshore platforms and support vessels.

Objective 2 has been addressed by the Acadia/Encana instrument-based automated bird monitoring study, "Assessment of Bird Interactions with Offshore Infrastructure Associated with the Oil and Gas Industry of Nova Scotia, Canada" that took place 2011- 2014. EMC's support included: VHF radio-tracking on Sable Project supply vessels, providing monitoring data related on the physically tagged gulls observed on or near the SOEP facilities (2011-2014), providing financial support for the purchase of storm petrel tracking tags (2012), and providing a flight to transport bird monitoring equipment to Sable Island in Spring 2012. EMC also provided an on-land access point to monitor the flare from its fractionation plant facility in Point Tupper, NS (2013). Following 8 monitoring evenings, during different seasons and weather conditions, radar images are planned to be analyzed for bird interactions.

4.4 METHODOLOGY

Offshore operations personnel are tasked with conducting walk-arounds on the platforms and supply vessels and reporting any stranded or dead birds to the Logistics office on Thebaud. This data is compiled and a report is submitted annually to the Canadian Wildlife Service detailing numbers of all birds (oiled or not) that were captured and released as well as those deceased during the year. Table 4-1 provides the methodology for the survey.

Table 4-1: Bird Field Survey Methods

Parameter	Sampling Methodology
Survey date:	Between January 1 and December 31, 2014, surveys for stranded and dead birds were conducted on SOEP offshore platforms.
Number of Surveys	Daily (weather permitting) on Thebaud and during interventions on satellite platforms.
Type of Sample:	Species identification, condition (alive or dead, oiled, wet, lethargic, dazed), date, action taken and fate of bird were recorded for birds found.
Sample Preparation	No samples prepared in 2014. If a bird is found oiled, corpse to be packaged in aluminum foil, labeled, kept frozen, and may be analyzed (instructed per CWS-Dartmouth). In the case of birds found dead on the platform in numbers greater than 10 per incident, these are to be frozen and shipped to shore to UPEI Atlantic Veterinary Pathology lab for analysis.
Number of Samples	71 (no instances of greater than 10 birds)

4.5 ANALYSIS/RESULTS

The Acadia/Encana field studies using telemetry and other tags were conducted from Sable Island, Country Island, Bon Portage Island and various mainland Nova Scotia sites between 2011 and 2014. Data obtained through this approach seemed to address the objective to quantify the species-specific temporal and spatial patterns of attraction or repulsion of birds around offshore platforms; and the second objective to identify the environmental and anthropogenic factors that influence the spatial and temporal variation in bird distribution, abundance and movements at offshore platforms. Results seemed to provide some direct and indirect evidence of observed and potential bird-platform interactions occurring around Sable Island, NS.

At the conclusion of the Acadia/Encana study, a relative risk assessment was completed. The relative risk assessment was conducted for platform interactions with each species studied (or species group). High risk ratings were concluded for Leach's Storm petrels and Ipswich sparrows (during Spring migration), based on the observed interactions with platforms and supply vessels. Recommendations included further monitoring via VHF tagging for Ipswich sparrows and Storm Petrels as well as a more systematic approach to stranded bird visual surveys on offshore platforms.

No physically tagged birds were observed on SOEP facilities in 2014.

Currently, walk-arounds are conducted on the platforms and supply vessels and operators and crew are tasked with reporting any stranded or dead birds to the Logistics office on the Thebaud platform.

SOEP has been reporting data to CWS since 2007, and in 2012, the reporting format was revised to capture additional data for CWS with regards to the discovery dates, the condition of the birds and whether the bird may have died in care, was found dead, released or sent for rehab. Results for 2014 and the 4 previous years are provided in Table 4-2 below:

Table 4-2:Retrieval and Release of Birds on SOEP Thebaud, Venture and North Triumph platforms and Venture Sea and Panuke Sea supply vessels Year 2014

			Found Dead		Captured Alive				Comments		
					Un-oiled		Oiled*				
Date	Species	Total	DOAS	Oiled*	DIC	Rls'd	DIC	SFR	Condition	Action Taken	Fate of Bird
May 18, 2014	Seaside Sparrow	1	1		1				Found on Compression cellar deck by Operator Dead un-oiled		
May 7 to June 4, 2014 hitch	Northern Waterthrush	20	20						Panuke Sea on location at various Sable platforms (30% @ Venture and 70% @ Thebaud) between May 7 and June 4, 2014. Late reporting: deck crew didn't see any more than 2 dead birds per day and sometimes none during the day. It was estimated that approximately 40 dead birds were found over the 4 week hitch. (20-Northern Waterthrush and 20-White throated sparrows)		
May 7 to June 4, 2014 hitch	White throated Sparrow	20	20						Panuke Sea on location at various Sable platforms (30% @ Venture and 70% @ Thebaud) between May 7 and June 4, 2014. Late reporting: deck crew didn't see any more than 2 dead birds per day and sometimes none during the day. It was estimated that approximately 40 dead birds were found over the 4 week hitch. (20-Northern Waterthrush and 20-White throated sparrows)		
Sept 3, 2014	Greater Shearwater	2				1			Observed on Venture Sea supply vessel, on location at North Triumph platform – birds appeared dazed/lethargic, after resting for a few hours, flew away.		
Sept 23. 2014	Goldfinch	1	1						Found Dead on Venture Production Deck – un-oiled		
Sept 26 2014	Blackpoll Warbler	1	1						Found Dead on Cellar deck of Thebaud – un-oiled		
Sept 27 2014	Blackpoll Warbler	5	5						Found dead on the cellar deck of Thebaud in various locations – un-oiled		
Oct 1 2014	Blackpoll Warbler	1	1						Found Dead on Cellar Deck of Thebaud outside the TSR – un-oiled		
Oct 12-2014	Peregrine Falcon	1							1 observed flying around top deck of Thebaud, no other birds spotted		
Oct 12-2014	Peregrine Falcon	2							2 observed at North Triumph Platform chasing and eating small sea birds, mainly STORM PETRELS		

Date	Species	Total	Found Dead		Captured Alive				Comments		
					Un-oiled		Oiled*				
			DOAS	Oiled*	DIC	Rls'd	DIC	SFR	Condition	Action Taken	Fate of Bird
Oct 14-2014	White throated Sparrow	1							Observed on Thebaud deck, good condition		
Oct 14-2014	Goldfinch	1	1						Observed on Venture Sea supply vessel, on location at Venture – un-oiled		
Oct 19-2014	Cattle Egret	1							Observed by night operator on Thebaud wellhead bridge, sleeping		
Oct 19-2014	Virginia Rail	1							Observed resting on Thebaud production deck pipe support		
Oct 21-2014	Blackpoll Warbler	1	1						Found dead on Thebaud heli-deck landing South side		
Oct 24 2014	Shearwater	1				1			Found on Thebaud Compression platform, given shelter and time to rest, then released.		
Oct 24 2014	Peregrine Falcon	1							2 observed at Thebaud perching on wellhead platform		
Oct 27 2014	Leaches Storm Petrel	1	1						Observed on Panuke Sea supply vessel, on location at Thebaud. Bird appeared to perish of natural causes, no signs of pollution or other. Disposed of overboard.		
Oct 29 2014	UNKN	1							Small bird eaten on the forward deck of the Panuke Sea supply vessel by a Peregrine Falcon. Vessel was on location at Thebaud.		
Oct 31 2014	Blackpoll Warbler	1	1						Found dead on Thebaud process cellar deck bird was singed		
Oct 31 2014	Blackpoll Warbler	1							Observed on Thebaud process cellar deck alive but with singed feathers (at tips), bird was gone in the morning. Note: Peregrine Falcons also observed on Thebaud at this time.		
Nov 3 2014	Leaches Storm Petrel	1	1						Observed on Panuke Sea supply vessel, on location at Thebaud. Bird appeared to perish of natural causes, no signs of pollution or other. Disposed of overboard.		
Nov 18 2014	Hermit Thrush	1				1			Observed on Panuke Sea supply vessel, enroute from Thebaud Platform to Halifax. Bird appeared dazed, lethargic initially, was placed in cardboard box and given water (approx.. 5 hours). When vessel arrived at Dartmouth dock, the box was opened on a grassy hillside and bird flew away within 20 minutes.		

Date	Species	Total	Found Dead		Un-oiled		Oiled*		Comments		
			DOAS	Oiled*	DIC	Rls'd	DIC	SFR	Condition	Action Taken	Fate of Bird
Dec 7 2014	Peregrine Falcon	1							1 observed flying around Venture platform.		
Dec 19 2014	Great Blue Heron	1							1 observed flying from perch to perch on the Thebaud complex (afternoon). Appeared to be in good shape. There was high winds and some freezing rain and appeared to be taking some shelter from the weather.		
Dec 19 2014	Great Blue Heron	1							Observed on Venture Sea supply vessel, on location at Thebaud. The bird landed on board, stayed overnight and flew away in the morning. It appeared to be in good condition.		
Dec 26 2014	Dovekie	1	1						Found dead on top deck Thebaud, looked healthy, un- oiled		

DOAS – Disposed of at Sea
DIC – Died in Care.
Rls'd – Released.
SFR – Sent for Rehab.
***Oiled Birds**: **Both live and dead birds are to be sent to shore**

Table 4-3:Retrieval and Release of Birds on SOEP Thebaud platform and Venture Sea supply vessel Year 2013

Date	Species	Total	Found Dead		Captured Alive				Comments		
					Un-oiled		Oiled*				
			DOAS	Oiled*	DIC	Rls'd	DIC	SFR	Condition	Action Taken	Fate of Bird
April 4, 2013	Northern Waterthrush	1			1				Found on Thebaud platform, held in box with water and died shortly after. Approximately 12 Northern Waterthrush were observed and all flew away later that same day.		
June 3, 2013	Purple Gallinule	1				1			Found on Venture Sea supply vessel walking on the main deck. It was left alone and was gone the next morning.		
June 13, 2013	Goldfinch	1	1						Found on Thebaud cellar deck. Bird appeared to perish of natural causes, no signs of pollution (it was wet). Disposed of overboard.		
June 17, 2013	Storm Petrel (WISP)	1				1			Found on Thebaud deck at night. Petrel held in box with water for rest. Released later that night. It flew away without issue from the platform.		
September 11, 2013	Northern Waterthrush	1	1						Found on Thebaud wellhead top deck. Bird appeared to perish of natural causes, no signs of pollution. Disposed		

									of overboard.
October 10, 2013	Ipswich Sparrow	1				1			Found perched on railing of Thebaud cellar deck. Appeared in good condition and flew away.
October 11, 2013	Peregrine Falcon	1				1			Peregrine Falcon observed perched on railing of Thebaud wellhead deck. Close by were black wings (appeared to be Storm Petrel wings).
October 16, 2013	Ipswich Sparrow	1				1			Found perched on railing of Thebaud sub cellar deck. Appeared in good condition and flew away.
October 21, 2013	Seaside Sparrow	1	1						Found on Theabud cellar deck. Bird appeared to perish of natural causes, no signs of pollution. Disposed of overboard.
October 24, 2013	Black and white warbler	1	1						Found on Thebaud compression cellar deck. Bird appeared to perish of natural causes, no signs of pollution. Disposed of overboard.

DOAS – Disposed of at Sea
DIC – Died in Care.
Rls'd – Released.
SFR – Sent for Rehab.
***Oiled Birds**: **Both live and dead birds are to be sent to shore**

Table 4-4:Retrieval and Release of Birds on SOEP Thebaud and South Venture platforms Year 2012

			Found Dead		Captured Alive				Comments
					Un-oiled		Oiled*		
Date	Species	Total	DOAS	Oiled*	DIC	Rls'd	DIC	SFR	Condition Action Taken Fate of Bird
13SEP	BLACKPOLL WARBLER	1	1						Bird appeared to perish of natural causes, no signs of pollution or other. Disposed of overboard.
20 OCT	NOTHERN WATER THRUSH	1	1						Bird appeared to perish of natural causes, no signs of pollution or other. Bird unreachable.
7 NOV	GOLD FINCH	1	1						Bird appeared to perish of natural causes, no signs of pollution or other. Disposed of overboard.
14 NOV	BLACKPOLL WARBLER	2	2						South Venture: Birds appeared to perish of natural causes, no signs of pollution or other. Disposed of overboard.
20 NOV	BLACKPOLL WARBLER	1	1						Bird appeared to perish of natural causes, no signs of pollution or other. Disposed of overboard.
20 NOV	STORM PETREL	1				1			Found one Storm Petrel on Thebaud Compression. Held captive for 24hrs. Fed and nourished and released on site. Flown away successfully.

DOAS – Disposed of at Sea
DIC – Died in Care.
Rls'd – Released.
SFR – Sent for Rehab.
***Oiled Birds**: **Both live and dead birds are to be sent to shore**

Table 4-5 Specimens Salvaged in 2011

Common Name	Province	Number Collected			Final Disposition of Specimens Collected
		Birds	Eggs	Nests	
Blackpoll warbler	Nova Scotia	35	0	0	Disposed of overboard
Leach's Storm Petrel	Nova Scotia	15	0	0	Disposed of overboard
Goldfinch	Nova Scotia	1	0	0	Disposed of overboard
Pine Siskin	Nova Scotia	1	0	0	Disposed of overboard

In 2011, the 52 deceased birds discovered on the offshore platforms were collected mainly through the spring and fall; a few in the summer and very rarely during the winter months. Many of the birds that are reported above were not intact and presumed to have been preyed upon by at least one peregrine falcon that was spotted on the Thebaud platform in late summer and early fall.

Table 4-6 Specimens Salvaged in 2010

Common Name	Province	Number Collected			Final Disposition of Specimens Collected
		Birds	Eggs	Nests	
Juvenile blackpoll warbler	Nova Scotia	9	0	0	Disposed of overboard
Adult blackpoll warbler	Nova Scotia	11	0	0	Disposed of overboard
Goldfinch	Nova Scotia	7	0	0	Disposed of overboard
Unknown	Nova Scotia	3	0	0	Disposed of overboard

Please note that the 30 deceased birds discovered on the offshore platforms in 2010 were collected mainly through the spring and fall; a few in the summer and very rarely during the winter months. The three birds that are reported as "unknown" above were not intact and presumed to have been preyed upon by between 2 and 3 juvenile peregrine falcons that were spotted on the Thebaud platform in late summer and early fall.

4.6 CONCLUSIONS

EMC will continue to report the numbers of birds and species physically impacted by the presence of the offshore facilities, by documenting those salvaged, released and deceased. The number of birds found in 2014 was up from previous years (71) found in 2014, (10) found in 2013, (7) found in 2012, (52) found in 2011 and (30) found in 2010. It should be noted that 16 of the 71 birds observed in 2014 were released and did not perish offshore.

It has been noted that 2014 had low instances of periods of poor visibility (foggy weather) offshore, with the exception of a few months during the springtime. Visibility is tracked hourly in the offshore area, as transportation via helicopter is impacted greatly by fog events. SOEP was able to complete approximately 140

flight hours per month in 2014. In 2013, SOEP experienced its highest level of successful flight segments in the project's history averaged 155 flight hours per month due to clear weather. The increase in bird observations may be related to foggier weather during the spring migration months.

Section 5.2.1.9 of the SOEP – EIS Vol. 3 predicted that "Lights [from work lights and gas flares] may attract migrant bird species, especially in fog and/or low cloud and rain." The 2012, 2013 and 2014 data would seem to align with this prediction. Further data collection is necessary in order to confirm this observation.

4.7 CURRENT AND FUTURE MONITORING

EMC completed its participation in the implementation and testing of new monitoring techniques around offshore platforms in mid-2014. Dr. Phil Taylor and Dr. Rob Ronconi, Acadia University, concluded studies with Encana's Deep Panuke project on the use of instrument-based automated monitoring tools to enhance the monitoring and study of bird activities and bird attraction to offshore platforms. This technology was thought to overcome detection limitations inherent in observer-based monitoring, particularly during periods of poor visibility (ie. fog/darkness). EMC provided the following in-kind support in 2014 for this study:

- support by offering platforms (2 supply vessels) on which to install radio tracking receivers; and
- participation of field staff (on supply vessels and platforms) in the monitoring of physically tagged birds in the offshore areas.

EMC understands that in the future, potential tagging may occur on Ipswich Sparrows and Storm Petrels. Should monitoring platforms be required at that time to accomodate radio tracking receivers, EMC is amenable to installing these on the Project supply vessels in order to support this potential research.

4.8 REFERENCES

Wilhelm, S.I. and A.W. Boyne (2006) Evaluation of seabird observations collected from 2001-2003 by the Oil and Gas Observer Program. Canadian Wildlife Service Technical Report Series No. 464. Atlantic Region. vii + 26 pp.

5. BEACHED SEABIRD SURVEYS

Photos: Sable Island Green Horse Society

5.1 RATIONALE

Since 1993, regular surveys for beached oiled birds have been conducted on Sable Island to monitor trends in numbers and rates of oiling in beached seabirds, and to collect specimens of contamination for gas chromatographic analysis to generically identify oil types. Results of analysis of oil samples collected during 1996-2005 have been reported in [1]. Results of beached surveys conducted during 1993-2009 are reported in [2].

5.2 GOAL

By monitoring numbers and oiling rates in beached seabirds on Sable Island, industry and regulators can identify and correct potential sources of oil contamination arising from industry operations.

5.3 OBJECTIVES

There are two main objectives of the beached bird surveys:

- To monitor trends in oiling rate in beached seabird corpses; and
- To generically identify oil types found on seabird feathers and in pelagic tar.

5.4 METHODOLOGY

Zoe Lucas, biologist and long-time resident of Sable Island, conducted the beach bird surveys on Sable Island. Table 5-1 provides the methodology for the beached seabird survey.

Table 5-1: Beached Seabird Field Survey Methods

Parameter	Sampling Methodology
Survey date:	Between January 1 and December 31, 2014, nine surveys for beached seabirds were conducted on Sable Island. No survey was conducted in March, September or December.
Number of Surveys	9
Type of Sample:	Species identification, corpse condition and extent of oiling were recorded for seabird specimens. When possible, the time since death was estimated based on freshness of tissues and degree of scavenging and sandblasting. The oiling rate was calculated using only complete or largely intact corpses (i.e. with >70% of body intact) during 2014. The presence and degree of oiling of complete corpses was recorded as a code using a four-point scale: (0) clean plumage; (1) slight surface oiling, or <10% of the body oiled; (2) moderate oil, penetrating to the base of feathers, 10-25% oiled; (3) heavy oil, >25% oiled. Incomplete corpses, with less than 70% of the plumage present, were categorized as Code 4.

Sample Preparation	Oil samples were packaged in aluminum foil, labeled, kept frozen for periods ranging from one week to several months, and delivered to the laboratory for gas chromatographic analysis (Maxxam Analytics). Interpretation of GC/FID results were conducted by MacGregor & Associates (Halifax) Ltd.
Number of Samples	6
Equipment:	Normally collected by hand using metal foil containers

5.5 ANALYSIS

Maxxam Analytics Inc. conducted the analyses of six oil samples collected from the feathers of beached seabird corpses in February 2014.

Table 5-2: Analytical Method for Oiled Seabirds

Parameters	Analysis Method
HCR, MHCP, URM, URM/MHCP ratio	gas chromatograph (GC/FID)

Oil specimens were solid samples (oiled seabird feathers) and were extracted with Hexane. This extract, filtered to remove solids, was injected on a glass capillary column (HP5-MS) on an HP 6890 Gas Chromatograph with Flame Ionization Detector (GC/FID). Outputs from the GC were retrieved on HP Chemstation software, with chromatograms produced and assessed manually.

Concurrently standard oils such as Marine Diesel, Jet (Helicopter) Fuel, Heavy Fuel Oil (Bunker C), Arabian Crude Oil, Lubricating Oil and n-alkane standards (C12 to C36) were run under the same conditions. This permitted identification of the n-alkane peaks in the sample and standard oil chromatograms. The n-alkane maximum, range of n-alkanes and unresolved peak maximum were identified by carbon number and relative response.

These results were compared to standard oils to permit identification of oil within that class and determine roughly degree of weathering or time at sea. Oils with mixtures of fuel and lube oil were identified as bilge or slop tank sources, oils identified as heavy fuel oil or marine diesel oil were identified as fuel oil sources, and those identified as crude oil were identified as tanker cargo oil sources.

For oiling rate and number of clean birds/km (see Section 5, Figures 1 - 7), annual trends were first analyzed with generalized linear models (with Poisson links for densities and binomial links for oiling rate), but yielded excessive overdispersion even after corrections. Thus instead data were transformed (log transformation for densities, arcsine transformation for oiling rate) and analyzed by least squares regression. Statistically significant trends ($P < 0.05$) are marked with an asterisk (*).

Laboratory QA/QC
Maxxam Analytics is a CALA facility (Canadian Association for Laboratory Accreditation).

5.6 RESULTS

During 2014, the corpses and fragments of 352 beached seabird corpses were collected on Sable Island. Alcids accounted for 54% of total seabird corpses recovered. Of the 352 corpses, 184 (52.3%) were complete (i.e. with >70% of body intact, Codes 0-3). Table 5-3 shows totals & linear densities for clean complete corpses (Code 0) for winter (November-April) and summer (May-October), and annual oiling rate based on complete corpses (i.e., with >70% of body intact, Codes 0 - 3).

Table 5-3: Beached Seabird Corpses Collected on Sable Island During 2014

Bird species & groups	Total [1] number corpses	Code 0 number Winter	Code 0 number Summer	Code 0 number/km Winter	Code 0 number/km Summer	Oiling rate %
Common Loon	1	1	0	0.0031	0	0
Northern Fulmar	23	7	12	0.0219	0.0300	0
Shearwater	57	0	37	0	0.0925	0
Northern Gannet	16	3	11	0.0094	0.0275	0
Larus Gulls	46	20	14	0.0625	0.0350	0
Alcids [2]	190	59	11	0.1844	0.0275	7.9
Common & Thick-billed Murres	65	22	8	0.0688	0.0200	11.8
Dovekie	72	13	0	0.0406	0	7.1
other species [3]	19	2	7	0.0063	0.0175	0

[1] Codes 0 - 4 combined.
[2] All alcid species combined (Razorbill, Atlantic Puffin, Common and Thick-billed Murre, Dovekie, and unidentified large alcids).
[3] Includes Leach's Storm-petrel, Black-legged Kittiwake, and Double-crested Cormorant

Seasonal occurrence of clean complete corpses (Code 0) varied by bird group and species (Table 5.3). More Larus gulls and alcids occurred in winter (58.8% and 84.3%, respectively). More Northern Fulmars (63.2%) and Northern Gannets (78.6%) and all shearwaters, occurred in summer.

The overall oiling rate for all species combined (based on complete corpses, Codes 0 to 3) was 3.2% (compared with <0.5% in 2013). A total of six oiled corpses were recovered in 2014, and all were alcids (1 Atlantic Puffin, 3 Thick-billed Murre, 1

murre not identified to species and 1 Dovekie). The oiling rate for alcids was 7.9% (compared with 0% in 2013).

The collection of the six oiled bird corpses occurred during the first week of February, and samples of oiled feathers were collected from five of the corpses. The samples were determined to be moderately weathered Heavy Fuel Oil most typical of residuals or sludge from fuel tanks.

Figure 5-1 Northern Fulmar Results

Figure 5.1. Northern Fulmar
Number/km: $F_{1,20}$=2.03, P=0.17
Oiling rate: $F_{1,20}$=16.71, P=0.0006*

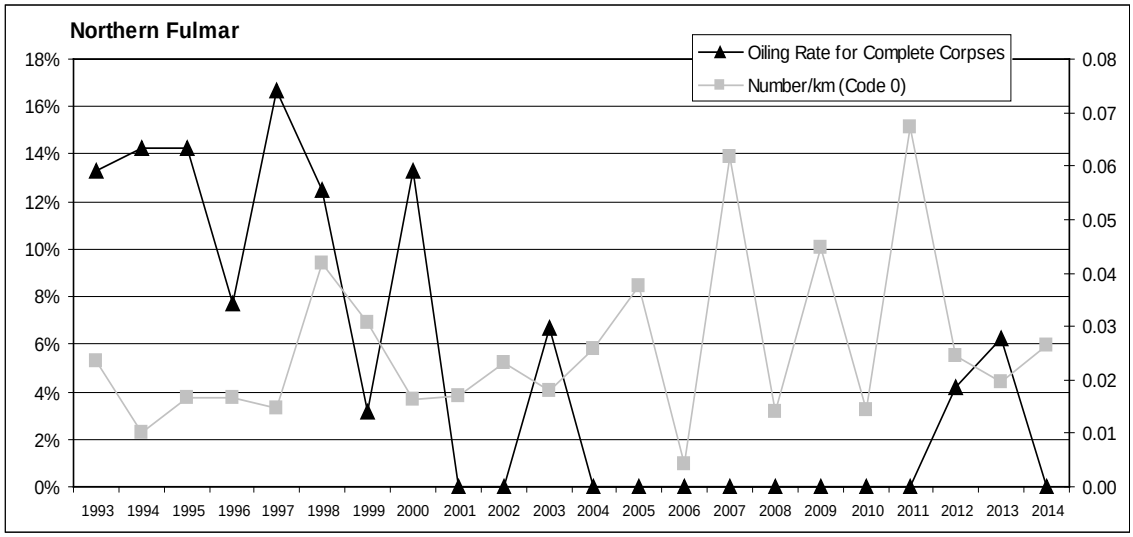


Figure 5-2 Shearwaters Results

Figure 5.2. Shearwaters
Number/km: $F_{1,20}$=0.04, P=0.84
Oiling rate: $F_{1,20}$=7.06, P=0.0151*

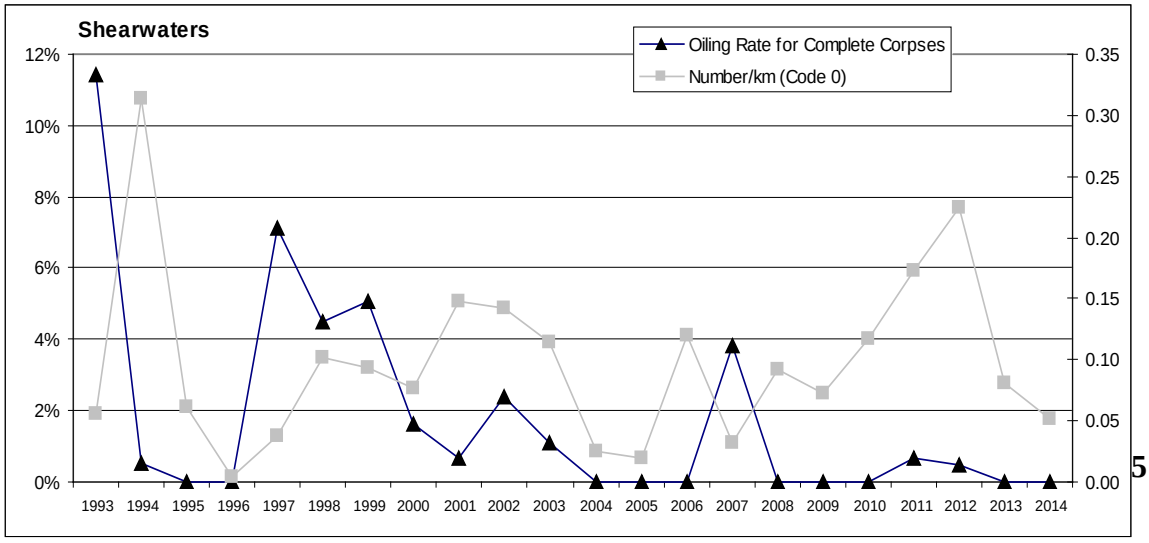


Figure 5-3 Northern Gannet Results

Figure 5.3. Northern Gannet
Number/km: $F_{1,20}$=0.02, P=0.90
Oiling rate: $F_{1,20}$=7.41, P=0.0131*

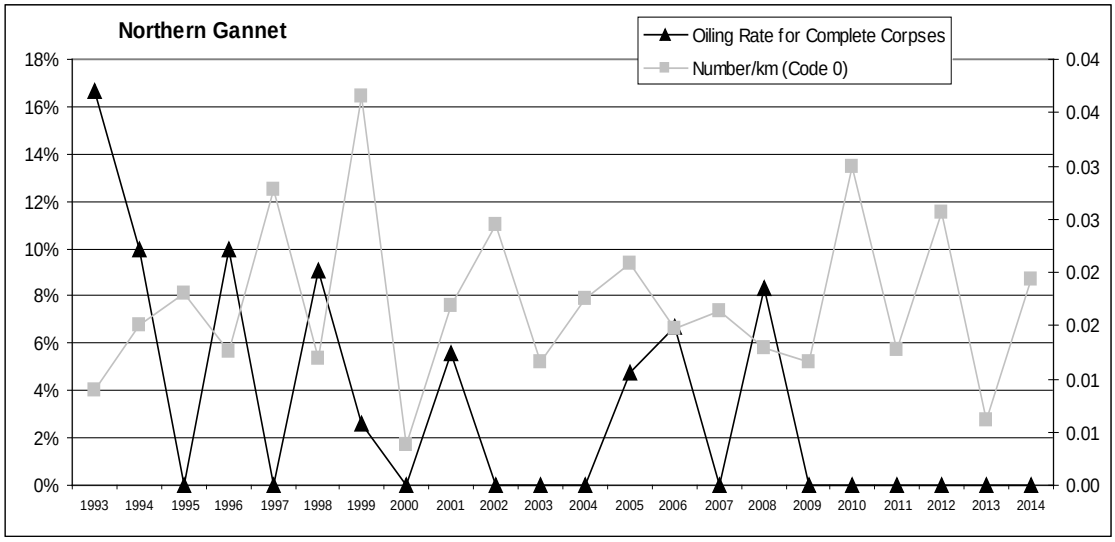


Figure 5-4 Larus Gulls Results

Figure 5.4. Larus Gulls
Number/km: $F_{1,20}$=0.00, P=0.99
Oiling rate: $F_{1,20}$=12.06, P=0.0024*

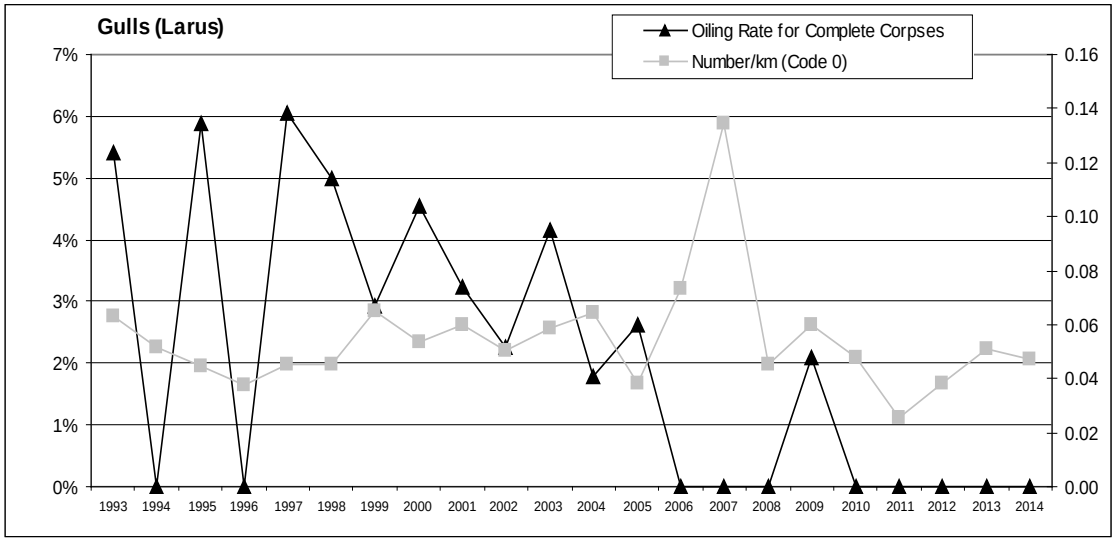


Figure 5-5 Alcids Results

Figure 5.5. Alcids (all species combined)
Number/km: $F_{1,20}$=0.04, P=0.85
Oiling rate: $F_{1,20}$=39.46, P<0.0001*

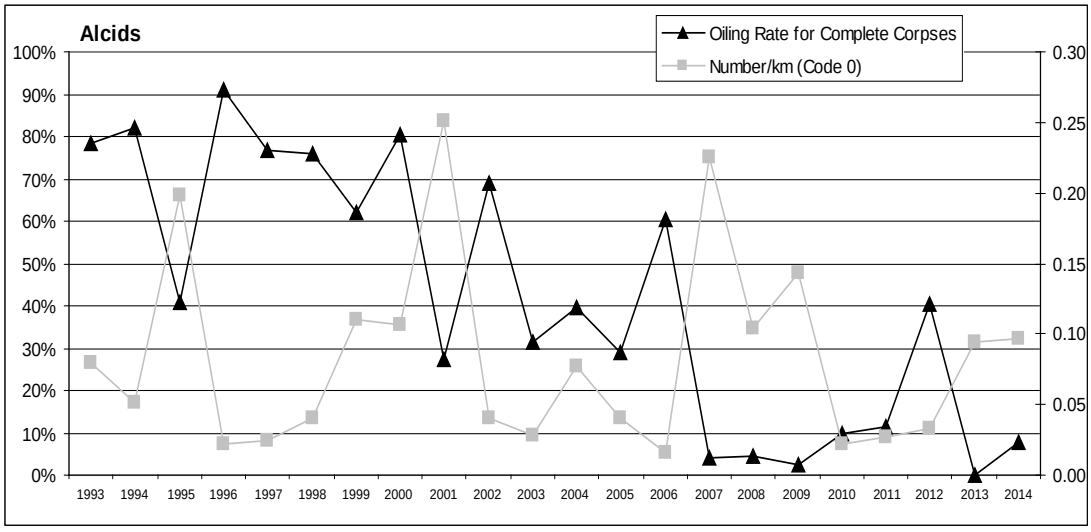


Figure 5-6 Common & Thick-billed Murres Results

Figure 5.6. Common & Thick-billed Murres
Number/km: $F_{1,20}$=0.04, P=0.85
Oiling rate: $F_{1,20}$=16.24, P=0.0007*

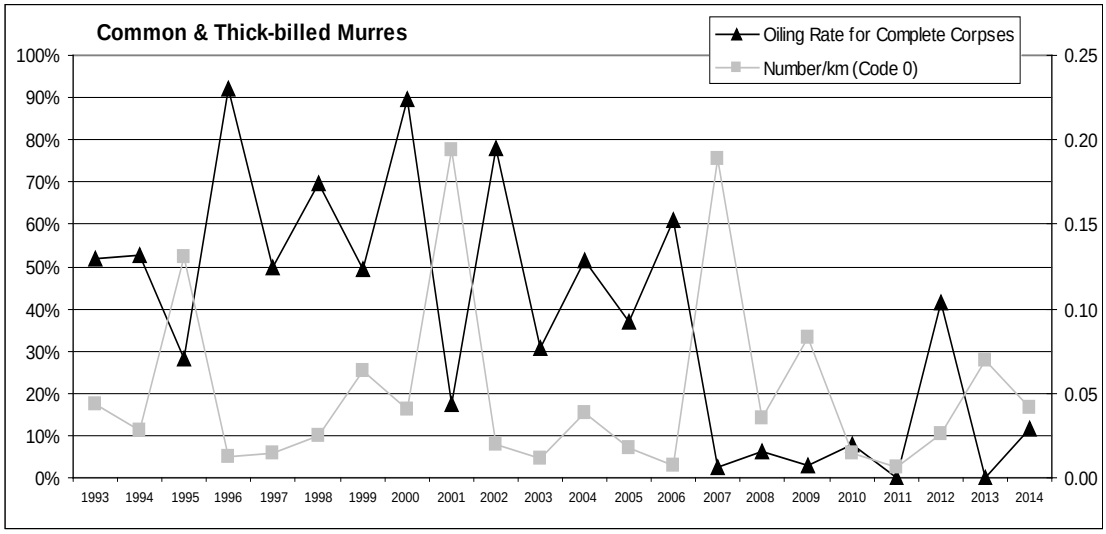
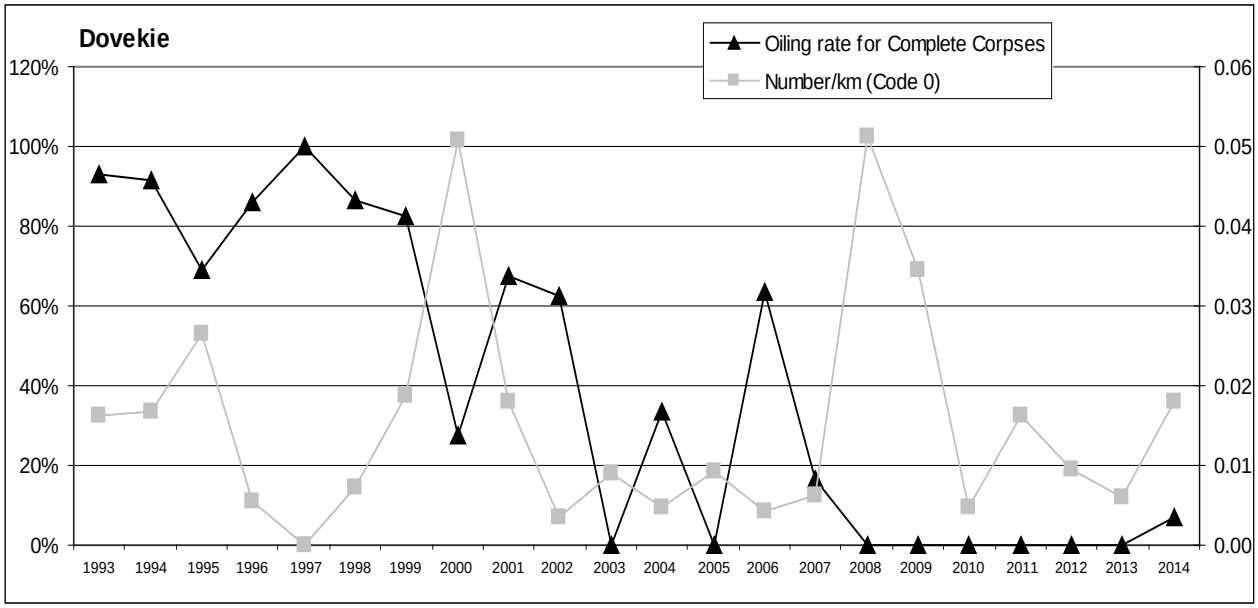


Figure 5-7 Dovekie Results

Figure 7.7. Dovekie
Number/km: $F_{1,20}$=0.00, P=1.00
Oiling rate: $F_{1,20}$=51.01, P<0.0001*



5.7 CONCLUSIONS

The overall oiling rate for all species combined (based on complete corpses, Codes 0 to 3) was <3.2%. A total of six oiled corpses were recovered in 2014, and all were alcids. Alcids accounted for 54% of total corpses collected and the oiling rate for this species was 7.9% (compared to 0% in 2013).

The collection of the six oiled bird corpses occurred during the first week of February, and samples of oiled feathers were collected from five of the corpses. The samples were determined to be moderately weathered Heavy Fuel Oil most typical of residuals or sludge from fuel tanks.

5.8 REFERENCES

[1] Lucas, Z. and C. MacGregor. 2006. Characterization and source of oil contamination on the beaches and seabird corpses, Sable Island, Nova Scotia, 1996-2005. Marine Pollution Bulletin 52: 778-789.

[2] Lucas, Z., A. Horn and B. Freedman. Beached bird surveys on Sable Island, Nova Scotia, 1993 to 2009, show a recent decline in the incidence of oiling. Manuscript submitted to the Proceedings of the Nova Scotian Institute of Science, January 2012, and in review.

6. SUMMARY AND CONCLUSIONS

The summary and conclusions for 2014 EEM Program specific components are as follows:

- Produced Water at the Alma, South Venture, Venture and Thebaud platform locations was interpreted as being 'toxic' based on 2014 bioassay results of EMC samples.

- Test results since 2005 show that chemical and toxicity levels can vary widely over time and location in large part due to varying reservoir characteristics.

- Toxicity of produced water samples from SOEP platforms is not considered an environmentally relevant factor of concern based on findings in a DFO COOGER research study (2010) which found that potential contaminants in the relatively small PW discharges from SOEP platforms are diluted rapidly to no-effects concentration levels within 10's of metres of the subsurface discharge caisson.

- Data completeness was less than desired for PM2.5 (57%), H2S (63%), SO2 (67%) and NHMC (39%) during 2014. These results are a reflection of the difficulties gaining access to the Island for instrument maintenance due to intermittent flights and bad weather.

- The data completeness for NOx (99%), NO2 (99%) and NO (99%), O3 (98%) and BC (82%) was excellent in 2014.

- The most important feature of the air quality data acquired in 2014 is that there was one operational threshold breach for H2S. This threshold breach was likely a result of a short-term acid gas flaring issue on Deep Panuke.

- There were no breaches of the National Air Quality Standards, Canada Ambient Air Quality Objectives or Canada Wide Standard for any of the air pollution metrics contained in this report.

- EMC supported the Acadia/Encana instrument-based automated bird monitoring study, "Assessment of bird-human interactions at offshore installations" (Acadia/Encana Study) by providing platforms (2 supply vessels) on which to install radio tracking receivers, and participation of field staff (on supply vessels and platforms) in the monitoring of physically tagged birds in the offshore areas.

- Further to SOEP's Canadian Wildlife Permit LS 2560 requirements, an annual report detailing the numbers of birds salvaged, released and deceased on the platforms provided monitoring data on those species observed on the offshore facilities.

- During 2014, the corpses and fragments of 352 beached seabird corpses were collected on Sable Island. Fulmars and shearwaters accounted for 23% of total seabird corpses recovered. Alcids comprised 54% of total birds recovered.

- The six oiled bird corpses occurred during the first week of February, and samples of oiled feathers were collected from five of the corpses. The samples were determined to be moderately weathered Heavy Fuel Oil most typical of residuals or sludge from fuel tanks.

- The overall oiling rate for the 352 bird was 3.2%. All oiled corpses were Alcids (1 Atlantic Puffin, 3 Thick-billed Murre, 1 Murre not identified to species and 1 Dovekie.

Appendix for Section 1

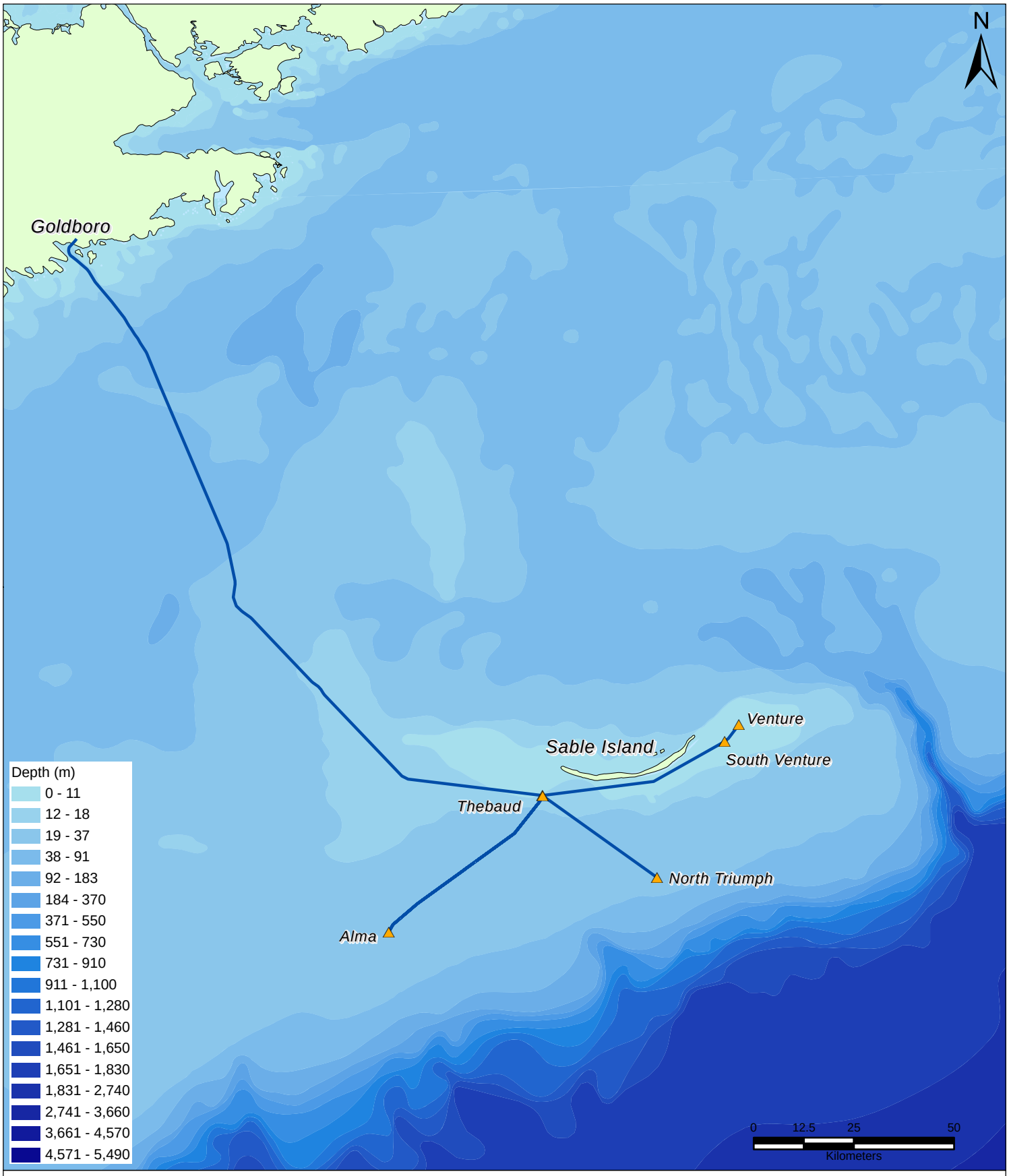


Figure 1-1
SOEP Offshore Facilities and Pipelines
SOEP EEM Report 2011
ExxonMobil Canada

Table 1-4 History of SOEP EEM Program 1998-2013

VEC / EEM Component	1998-2000		2001-2003	
	Program	**Observations**	**Program**	**Observations**
Benthic Boundary Layer	**Frequency:** baseline and semi-annual **Location:** 38 stations per field **Parameters**: SPM, barium in SPM	No evidence of drill waste floc as modeled by bblt model following 3 years of study Specialized analytical equipment not readily available	frequency based on drilling activity	No change
Sediment Toxicity	**Frequency:** baseline and semi-annual **Location**: 8 stations at Venture, North Triumph, South Venture, 10 stations at Thebaud, and 5 Gully stations **Parameters**: Amphipod survival Echinoderm fertilization Bioluminescence (Microtox)	Microtox test showed low sensitivity and sea urchins fertilization produced inconsistent results Amphipod tests correlated with TPH concentration in sediments; continued with amphipod tests	**Frequency:** annual **Location**: 14 stations per field **Parameter:** amphipod survival	Amphipod survival tests continue to correlate with TPH concentration in sediments. No change in protocol other than species change due to unavailability of original test organism.
Sediment Chemistry	**Frequency**: baseline and semi-annual **Location:** 38 stations per field, 5 Gully stations **Parameter:** full (24) metal scan, grain size, C_6-C_{32} hydrocarbons, BTEX,TIC, TOC, ammonia and sulphide.	No statistical significant difference detected with distance or survey times except in barium and total petroleum hydrocarbons (TPH) (C_{11}-C_{32}) No change in: - Sediment metal concentration (other than Ba); - Carbon concentrations; BTEX; or - Sediment grain size	**Frequency**: annual **Location:** In 2001, dropped mid-field stations (i.e., 5, 6, 7.5, 9, 10, 12 km rings) and increased axes sampling at 250 and 500 m rings. Resolution not improved with increased sampling, so dropped minor axes stations at 250 and 500 m. In 2002 – 22 stations per field, 5 Gully **Parameter:** Analyze for key indicators Ba, TPH, ammonia and sulphide.	Venture stations back to baseline at 250 m Thebaud and North Triumph stations showed elevated TPH and barium out to 500 m along direction of prevailing current.
Benthic Habitat and Benthos	**Frequency**: six months **Location:** 38 Stations per field **Parameters**: Epibenthic megafauna at Thebaud and Venture by photography (still and video) Epibenthic megfauna and infauna at North Triumph	Characterized drill cuttings piles for recovery assessment in conjunction with storm scour evaluations Collected samples of cuttings piles Added ROV inspection during EEM surveys to evaluate habitat and communities	**Frequency (biota):** annual **Frequency (cuttings piles):** quarterly[4] and storm event based **Locations**: 22 stations per field **Parameter**: Epibenthic megafauna at Thebaud and Venture by photography (still and video) Epibenthic megfauna and infauna at North Triumph	No statistical change in epibenthic megafauna at Venture, Thebaud and North Triumph Observed apparent enrichment effect of infauna at North Triumph (increase in species numbers, abundance and diversity) at 250 and 500 m during/after drilling. Returned to background levels twelve months after drilling completed. Cuttings piles have been relatively stable at Venture and Thebaud,; No cuttings pile created at North Triumph
Fish and Fish Habitat	Not part of original EEM program as fish and fish habitat were not scoped as a VEC	Added to EEM Program as a result of requirement under HADD Authorization	**Frequency:** Annual **Location:** Tier I platforms and marine pipeline (biannual) **Parameter**: ROV inspection of growth, percent coverage After four years, the colonization of the platform jackets and protective mattresses generated approximately ten times the original biomass of attached flora and fauna, yielding a net gain in production of 68,618 kg The platforms and subsea pipeline have also created a 'reef effect' by attracting aggregations of a variety of mobile fish and invertebrate species.	No change

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2013

VEC / EEM Component	1998-2000		2001-2003	
	Program	**Observations**	**Program**	**Observations**
Taint and Body Burden	**Frequency:** Quarterly[3] (mussels) six months[1](scallops) **Locations:** Mussels moored at 250, 500, 1000, 2000, 5000, 15000 and 20000 m from Thebaud, Venture and North Triumph, plus two moored reference stations Wild scallops collected from beds closest to each platform **Parameter:** Aliphatic Hydrocarbons Moisture and Lipid Content Lipid Classes Sensory Evaluations	Integrity of moorings were problematic due to sediment transport (burial), interference with supply vessel operations and pipeline construction. Changed mooring depth locations from surface and bottom positions to mid water as operations changed from drilling to producing Reduced mooring locations to platform and near field	**Frequency:** Quarterly[4] (mussels) Annual[2] (snow crabs) annual[2] (scallops) **Location:** Collect surface mussel samples from Venture and Thebaud wellhead leg and Thebaud nearest to overboard discharge caisson (C3) leg Kept the 1000 m mussel mooring at Venture. **Parameters**: Aliphatic Hydrocarbons Moisture and Lipid Content Lipid Classes Sensory Evaluations	Adapted program to include other potential sentinel species No evidence of taint due to hydrocarbons in scallops and mussels. No apparent health effects on mussels. In 2001 included snow as potential sentinel species crabs at North Triumph. No evidence of hydrocarbons therefore discontinued sampling in 2002. In 2002 included Jonah crabs as potential sentinel species at Thebaud. Found evidence of drilling mud (Novaplus) in tissue. Additional Jonah crabs collected in 2003 for analysis. Continue wild scallops at closest beds
Produced Water	Not in production phase	Collected discharge samples at 'end of pipe' (near mouth of discharge caisson at Thebaud) and carried out bioassay toxicity testing using Microtox, 3 -spine stickleback and sea urchin. Estimated Zone of Influence (ZOI) of Monethylene Glycol (MEG) discharged at Thebaud	**Frequency**: Once in 2001 **Location:** Thebaud, in receiving water adjacent to caisson **Parameter:** Toxicity on three-spine stickleback, sea urchin and Microtox. Observed no apparent toxic effects of produced water based on field observations and laboratory testing of samples collected near the mouth of the discharge caisson at Thebaud	Insufficient volumes of produced water to justify further sampling and analysis
Marine Mammals and Seabirds	**Frequency**: Daily **Location:** Strategic placement of independent fishery observer on all major construction vessels; full-time at Thebaud when space-permitted. **Parameter**: Regular observations of marine mammals and seabirds from facilities	Strategic placement on drilling rigs; full-time observer coverage on Thebaud during Operations phase No major incidents during construction.	**Frequency:** Daily **Location:** Thebaud **Parameter**: Regular observations of marine mammals and seabirds from platform	In Spring 2003, full time observers on Thebaud were discontinued. Observers were placed on vessels and other platforms as required Few incidents reported of effects of operations (i.e., flaring, attraction to lights, collisions, etc) on seabirds, results to-date, inconclusive. ; and No obvious avoidance of platforms by marine mammals. No observer data after May 2003
Air Quality	**Frequency**: Continuous on 4-6 week change out **Location:** Sable Island – Weather Station **Parameter**: Particulates,VOCs, NOx	No changes	In 2001 discontinue because sandy salt environment corroded equipment and interfered with filters	With support from the offshore oil and gas industry, Environment Canada installed real time air quality samplers at Sable Island Weather Station. Initiated platform-based twice daily visual monitoring of flare plume at Thebaud.
Vessel Traffic	Development and adherence to the Codes of Practice restricts air and vessel traffic near the Gully, Sable Island and Country Island	No change	No change	No change
Noise	During pile driving at Venture (1998) and pipe laying (1999) near Country Island and DREA ambient noise report (1999)	The loudest measured noise levels associated with offshore construction activities (i.e. pile driving and pipe-laying) were predicted not to effect whales in the Gully and had no observed effects on tern breeding on Country Island	No monitoring	No routine monitoring of marine noise was carried out near platforms during drilling or operations

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2013

VEC / EEM Component	2005		2006	
	Program	**Observations**	**Program**	**Observations**
Sediment Toxicity	**Frequency:** annual **Location:** 3 stations at South Venture, 3 stations at Thebaud and 4 Gully stations at MPA boundary **Parameters:** Amphipod survival Echinoderm fertilization Bioluminescence (Microtox)	Amphipod tests *Rhepoxynius abronius* No toxic responses since 2003, as correlated to sediment toxicity back to baseline	Discontinued - see 2005 observations	N/A
Sediment Chemistry	**Frequency:** annual **Location:** 3 stations at Thebaud, 3 stations at South Venture and 4 Gully stations **Parameter**: TPH, barium, strontium, mercury, ammonia, sulfides and aluminum.	Sediment chemistry back to baseline condition	Discontinued - see 20005 observations	N/A
Benthic Habitat and Benthos	**Frequency:** annual **Location:** Thebaud **Parameters:** cutting pile estimation	ROV inspection during EEM surveys to evaluate habitat and communities: -no commercial or at-risk species of fish or crustacean species identified. -jacket legs and cross members generally 100% covered in marine growth - mostly blue mussels. -large schools of cunners near platform No cuttings pile evident in 2005.	**Frequency:** annual **Location:** Thebaud and pipeline corridor in Strait of Canso **Parameters:** cutting pile estimation, Analysis of videotape to identify distribution of associated marine life with focus on commercial and species-at-risk	Client supplied ROV video taken of the cutting pile and platform. No cuttings pile evident. No marine species at risk observed. Cod school observed around platforms. Cunner also observed but an inshore species and not commercial species
Fish Health	Not part of original EEM program as not scoped as a VEC. **Frequency:** Annual **Location:** Thebaud: **Parameters:** mixed-function oxygenase (MFO), gross pathology and histopathology of cod.	Using a weight of evidence approach, comparable results were obtained at both sites indicating that the health of cod which are possibly aggregating at Thebaud, was similar to that at the reference site.	Discontinued - see 2005 observations	N/A
Fish and Fish Habitat	Not part of original EEM program as fish and fish habitat were not scoped as a VEC. **Frequency:** Opportunistic/ supplied UW videotape acquired by ROV camera **Location:** 26” export pipeline **Parameter:** Fish density near platform jacket and along randomly selected exposed sections of subsea pipeline to shore	Several small redfish were observed on the undersides of span sections of the 26" export pipeline. Numerous snow crabs were observed on and near exposed sections of the pipeline (maximum density KP 20 -80) ~ 12 snow crabs/km). Large schools of cunners (a non-commercial fish species) were observed in the immediate vicinity of the Thebaud platform.	**Frequency:** Opportunistic/ supplied UW videotape acquired by ROV camera **Location:** 26” export pipeline **Parameter:** Fish density near platform jacket and along selected exposed sections of subsea pipeline to shore	No species at risk or corals observed along pipeline Colonization of pipeline as in previous years

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3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2013

VEC / EEM Component	2005		2006	
	Program	**Observations**	**Program**	**Observations**
Taint and Body Burden	**Frequency:** Annual mussels and scallops **Locations:** Jacket legs at Thebaud for mussels and nearest bed for scallops **Parameter:** Aliphatic Hydrocarbons Moisture and Lipid Content Lipid Classes Sensory Evaluations (scallop only)	Higher TAH attributed to biogenic (phytoplankton) in mussels and scallops TAH concentration found in Western Bank, Superstore (Control) and Sable Bank scallops as well as Thebaud and Superstore mussels due to phytoplankton. Sensory evaluation by triangle test showed no significant difference in the odour and flavour of the Sable Bank scallops as compared to the Superstore scallops.	Scallop sampling/sensory evaluation discontinued - see 2005 observations Body burden of mussels continued on Thebaud jacket legs.	N/A Logistical issues prevented collection of mussels
Produced Water	**Frequency:** Annual for toxicity, semi annual for chemistry. **Location:** Thebaud **Parameter:** trace metal composition, HC concentration, IC_{50} and aquatic LC_{50} toxicity testing, as required by OWTG (2002).	TPH well below OWTG limits Chemistry data consistent between sampling events. Microtox, sea urchin fertilization and stickleback test proved toxic results Produced water quality variable due to variability in contributions from other platforms.	**Frequency:** Semi annual for chemistry, Annual for toxicity **Location:** Thebaud, Alma, South Venture and Venture **Parameter:** trace metal composition HC concentration, IC_{50} and acquatic LC_{50} toxicity testing as required by OWTG (2002).	Produced water at Thebaud, Venture and Alma have elevated levels of some metals and each platform is relatively consistent in chemical signature from year to year. The total petroleum hydrocarbon concentrations in the various samples of produced water at Thebaud, Venture and Alma were well below the OWTG limits of 30 mg/L (30 days) and 60 mg/L (24-hour) for oil in water. The results of the 96 hour LC_{50} and IC_{50} tests indicate that produced water from Thebaud, was slightly more toxic than in 2006 for stickleback. For stickleback Venture had higher toxicity than Thebaud which was higher than South Venture. These platforms are also toxic to Mictotox and sea urchins. It is surmised that the cause of the toxicity may be due to petroleum hydrocarbons. Given the hydrodynamic marine environment near Sable Island, the chemical constituents of produced water will likely be diluted to background levels within a few metres of the mouth of the discharge caisson.
Marine Mammals and Seabirds	**Frequency:** Annual for marine noise level monitoring and marine mammal observations. Four seabird surveys/year (CWS surveys) Monthly beach survey **Location:** 250m, 500m, and 1000m from the Venture platform and one (1) reference station near western boundary of Gully MPA CWS seabird surveys from supply boats on transects between Thebaud platform and shorebase and reference areas. Oiled beach seabirds studies ongoing on Sable Island	Underwater acoustic environment dominated by noise from standby/supply vessels. Results indicated that underwater noise levels generated by coincident drilling/production operations attenuated to below threshold for adverse effects on marine mammals (180 dB re 1 µPa) 250-300 m from sound source (i.e., Venture platform).. No obvious evidence of attraction to platforms. Results, to-date inconclusive. No petroleum hydrocarbon or condensate from any NS offshore installations were found on oiled seabirds	**Frequency:** Marine mammals only observation during pile driving for new compression platform at Thebaud. Monthly beached bird surveys Opportunistic transect surveys **Location:** Seabird surveys from supply boats on transects between Thebaud platform and shorebase and reference areas. Oiled beach seabirds studies ongoing on Sable Island	A few whales and dolphins(no species-at-risk) observed around construction. There was no evidence that seabirds were attracted to the SOEP offshore platform. Distribution of seabirds appeared to be independent of proximity to Sable Island. Results, to-date, inconclusive. Of the 14 oiled birds collected from Sable Island beach and analyzed, none of the 13 samples contained light or mid-range distillate fuels or condensates that would be typical of oils produced on SOEP facilities. One sample was inconclusive as to its source in the region, however there were no spills from SOEP facilities for several months prior to the contaminated specimen.
Air Quality	**Frequency:** Realtime continuous Twice daily flare plume monitoring by EM personnel **Location:** Sable Island **Parameter:** NOx, SO_2/H_2S, O_3, $PM_{2.5}$ NSEL Scale readings of flare colour	Air monitoring data from this project has shown that Sable island can be affected by long range transport of air pollution from the continental mainland. Monitoring program and observations of various emission producing activities on and around the island do not yet allow Environment Canada to confirm whether the effects of offshore activities can be measured on the island.	**Frequency:** Real time continuous Twice daily flare plume monitoring by EM personnel **Location:** Sable Island **Parameter:** NOx, SO_2/H_2S, O_3, $PM_{2.5}$ NSEL Scale readings of flare colour	Flare data collected and provided to EC. Awaiting data from EC for further analysis and reporting (M. Hingston, EC. pers.comm.) Preliminary analysis to date by EC indicates that all pollutant (i.e., SO2, NOx) concentrations measured on Sable Island are at much lower levels than in Halifax with the exception of PM2.5 which is believed to be high on Sable Island due to sea-salt aerosols

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2013

VEC / EEM Component	2007		2008	
	Program	**Observations**	**Program**	**Observations**
Sediment Toxicity	Discontinued since 2005 (see 2005 observations) DFO conducted sediment samples at Thebaud and The Gully 2006 and 2007	N/A No toxic responses (based on amphipod survival) were observed.	Discontinued since 2005 (see 2005 observations)	N/A
Sediment Chemistry	Discontinued since 2005 (see 2005 observations) DFO conducted sediment samples at Thebaud and The Gully 2006 and 2007	N/A Barium concentrations slightly above baseline levels out to 500 m from Thebaud platform at along direction of prevailing current. TPH concentrations at baseline levels.	Discontinued since 2005 (see 2005 observations)	N/A
Benthic Habitat and Benthos	**Frequency:** annual **Location:** Thebaud **Parameters:** cutting pile estimation, Analysis of videotape to identify distribution of associated marine life with focus on commercial and species-at-risk	No cuttings evident in 2007	**Frequency:** annual **Location:** Thebaud **Parameters:** cutting pile estimation, Analysis of videotape to identify distribution of associated marine life with focus on commercial and species-at-risk	No ROV video taken in 2008 of the cutting pile Colonization on pipeline and Strait as in previous reports. No species at risk observed.
Fish Health	Detailed fish health analysis discontinued since 2005 (see 2005 observations) Summarize fish health indices obtained from 2007 DFO bottom trawl groundfish survey for selected sampling station(s) on Sable Island Bank. Delineate and characterize thermal plume from compression platform. Investigate possible attraction of fish to thermal plume.	N/A DFO was unable to provide fish condition factor data (as a potential measure of fish health) since there were no random bottom trawl sampling stations in close proximity to any of the SOEP offshore platforms in 2007 (M. Showell, DFO, pers.comm.). Continued discussions with COOGER on meaningful and achievable approach	Detailed fish health analysis discontinued since 2005 (see 2005 observations) Summarize fish health indices obtained from 2007 DFO bottom trawl groundfish survey for selected sampling station(s) on Sable Island Bank. Collaborate with DFO COOGER to characterize PW plume using chemical and microbial evaluation Delineate and characterize thermal plume from compression platform. Investigate possible attraction of fish thermal plume.	N/A DFO was unable to provide fish condition factor data (as a potential measure of fish health) since there were no random bottom trawl sampling stations in close proximity to any of the SOEP offshore platforms in 2007 (J. Emberley, DFO, pers.comm.). Continued discussions with COOGER on meaningful and achievable approach Attempted in field; unsuccessful due to equipment problems No ROV video surveys conducted in area of compression platform in 2008

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2013

VEC / EEM Component	2007		2008	
	Program	**Observations**	**Program**	**Observations**
Fish and Fish Habitat	**Frequency:** Opportunistic/ supplied UW videotape acquired by ROV camera **Location:** 26" export pipeline **Parameter:** Fish density near platform jacket and along randomly selected exposed sections of subsea pipeline to shore	No ROV video collected at platform or along exposed sections of subsea pipeline to shore in 2007	**Frequency:** annual **Location:** Thebaud **Parameters:** Analysis of videotape to identify distribution of associated marine life with focus on commercial and species-at-risk **Frequency:** Opportunistic/ supplied UW videotape acquired by ROV camera **Location:** 26" export pipeline **Parameter:** Fish density near platform jacket and along randomly selected	No ROV video taken in 2008 of the cutting pile No change in pattern of colonization on exposed sections of pipeline to shore and Canso Strait from most recent previous survey. No species at risk or corals observed.
Taint and Body Burden	**Frequency:** Annual mussels **Locations:** Jacket legs at Thebaud for mussels **Parameter:** Aliphatic Hydrocarbons Moisture and Lipid Content Lipid Classes	Aliphatic hydrocarbons in mussel tissues re-confirmed (as all previous years) to be biogenic in origin.	**Frequency:** Annual mussels **Locations:** Jacket legs at Thebaud for mussels **Parameter:** Aliphatic Hydrocarbons Moisture and Lipid Content Lipid Classes	Mussel samples could not be collected for logistical reasons (i.e. sea conditions, availability of fast rescue craft etc)
Produced Water	**Frequency:** Semi-annual for chemistry, annual for toxicity **Location:** Thebaud, Alma, South Venture and Venture **Parameter:** trace metal composition and HC concentration, as required by OWTG (2002).	Produced water at Thebaud, Venture, South Venture and Alma have elevated levels of some metals and each platform is relatively consistent in chemical signature from year to year. The total petroleum hydrocarbon concentrations in the various samples of produced water at Thebaud, Venture, South Venture and Alma were well below the OWTG limits of 30 mg/L (30 days) and 60 mg/L (24-hour) for oil in water. The results of the 96 hour LC_{50} and IC_{50} tests indicate that produced water from Thebaud, Venture, South Venture and Alma is toxic. It is surmised that the cause of the toxicity may be due to petroleum hydrocarbons. Given the hydrodynamic marine environment near Sable Island, the chemical constituents of produced water will likely be diluted to background levels within a few metres of the mouth of the discharge caisson.	**Frequency:** Semi-annual for chemistry, annual for toxicity **Location:** Thebaud, Alma, South Venture and Venture **Parameter:** trace metal composition and HC concentration, as required by OWTG (2002).	Produced water at Thebaud, Venture and Alma are very high in some metals. Mercury level found at all but Alma platforms. Cadmium levels only metal to exceed CCME guidelines once at Thebaud. South Venture samples, when received by lab were too old to analyze for chemistry in 2008. The total petroleum hydrocarbon concentrations in the various samples of produced water at Thebaud, Venture and Alma were well below the OWTG limits of 30 mg/L (30 days) and 60 mg/L (24-hour) for oil in water. The results of the 96 hour LC_{50} and IC_{50} tests indicate that produced water from Thebaud, Venture, South Venture and Alma is toxic. (High salinity is considered a factor as in previous years.)
Marine Mammals and Seabirds	**Frequency:** Monthly beached bird surveys Opportunistic transect surveys **Location:** Thebaud CWS seabird surveys from supply boats on transects between Thebaud platform and shorebase and reference areas. Oiled beach seabirds studies ongoing on Sable Island	Based on the limited seasonal dataset collected in 2007, there is insufficient information to state conclusively whether the SOEP platforms attract seabirds based on analysis of transect data. Interpretation of seabird observation data in the vicinity of the SOEP platforms is complicated by the nearby presence of Sable Island, which supports colonies of many bird species. Several predominantly land-based birds likely died of trauma caused by collisions with superstructures on the Thebaud platform (October 10 2007) and on a DFO research vessel (October 7 2007). Of the three oil samples collected from Sable Island beach and analyzed, none contained light or mid-range distillate fuels or condensates that would be typical of oils produced on SOEP facilities.	**Frequency:** Monthly beached bird surveys Opportunistic transect surveys **Location:** Thebaud CWS seabird surveys from supply boats on transects between Thebaud platform and shorebase and reference areas. Oiled beach seabirds studies ongoing on Sable Island	No avoidance of the supply vessel route or an attraction to the SOEP platform was evident. None of the 8 oiled bird samples collected on Sable Island contained petroleum hydrocarbons characteristic of those originating from SOEP facilities. Bilge and fuel oil ranges could have been from any vessel. Several predominantly land-based birds likely died of trauma caused by collisions with superstructures on the Thebaud platform during at least 3 separate incidents between October 7-14 2008.

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2013

VEC / EEM Component	2007		2008	
	Program	**Observations**	**Program**	**Observations**
Air Quality	**Frequency:** Real time continuous Twice daily flare plume monitoring by EM personnel **Location:** Sable Island & Thebaud Platform **Parameter:** NOx, SO_2/H_2S, O_3, $PM_{2.5}$ NSEL Scale readings of flare colour	Flare plume was typically either clear or very light gray (#1 or #2 on NSDOEL Smoke Chart). There appeared to be a general improvement in flare plume colour. Awaiting data from EC for further analysis and reporting (M. Hingston, EC. pers.comm.) Preliminary analysis to date by EC indicates that all pollutant (i.e., SO2, NOx) concentrations measured on Sable Island are at much lower levels than in Halifax with the exception of PM2.5 which is believed to be high on Sable Island due to sea-salt aerosols	**Frequency:** Real time continuous Twice daily flare plume monitoring by EM personnel **Location:** Sable Island & Thebaud Platform **Parameter:** NOx, SO_2/H_2S, O_3, $PM_{2.5}$ NSEL Scale readings of flare colour	Flare plume was typically either clear or very light gray (#1 on NSDOEL Smoke Chart). There appeared to be a general improvement in flare plume colour. The monitoring program and current observations of various emissions producing activities on and around the island do not yet allow for confirmation as to whether the effects of offshore oil and gas activities can be measured on the island. H_2S and SO_2 peaks was hard to attribute to any particular source based upon current information. PM2.5 which is believed to be high on Sable Island due to sea-salt aerosols

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2013

VEC / EEM Component	2009		2010	
	Program	**Observations**	**Program**	**Observations**
Sediment Toxicity	Discontinued since 2005 (see 2005 observations)	N/A	Discontinued since 2005 (see 2005 observations)	N/A
Sediment Chemistry	Discontinued since 2006 (see 2005 observations)	N/A	Discontinued since 2005 (see 2005 observations)	N/A
Benthic Habitat and Benthos	**Frequency:** annual **Location:** Thebaud **Parameters:** cutting pile estimation, Analysis of videotape to identify distribution of associated marine life with focus on commercial and species-at-risk	No cuttings evident since 2005. Using ROV imagery over the years has allowed general observations on community succession and qualitative comparisons across years showing that the platforms have attracted aggregations of a variety of mobile fish and invertebrate species.	Discontinued since 2009	N/A
Fish Health	Detailed fish health analysis discontinued since 2005 (see 2005 observations)	N/A	Detailed fish health analysis discontinued since 2005 (see 2005 observations)	N/A
Fish and Fish Habitat	**Frequency:** Opportunistic/ supplied UW videotape acquired by ROV camera **Location:** 26” export pipeline **Parameter:** Fish density near platform jacket and along randomly selected exposed sections of subsea pipeline to shore	No change in pattern of colonization on exposed sections of pipeline to shore and Canso Strait from most recent previous survey. No species at risk or corals observed. Using ROV imagery over the years has allowed general observations on community succession and qualitative comparisons across years showing that the subsea pipelines have attracted aggregations of a variety of mobile fish and invertebrate species and that the pipeline does not act as a barrier to movement for commercially important lobster and crab stocks.	Discontinued since 2010	N/A

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2013

VEC / EEM Component	2009		2010	
	Program	**Observations**	**Program**	**Observations**
Taint and Body Burden	**Frequency:** Annual mussels **Locations:** Jacket legs at Thebaud for mussels **Parameter:** Aliphatic Hydrocarbons Moisture and Lipid Content Lipid Classes	Aliphatic hydrocarbons in mussel tissues re-confirmed (as all previous years) to be biogenic in origin. Higher concentration of biogenic hydrocarbons in filter feeding mussels indicates that the platforms may promote phytoplankton growth due to local nutrient enrichment. Mussels from Thebaud exhibit slightly higher levels of vanadium, strontium, and cadmium relative to control mussels	**Frequency:** Annual mussels **Locations:** Jacket legs at Thebaud for mussels **Parameter:** Aliphatic Hydrocarbons Moisture and Lipid Content Lipid Classes	Aliphatic hydrocarbons in mussel tissues re-confirmed (as all previous years) to be biogenic in origin. Higher concentration of biogenic hydrocarbons in filter feeding mussels indicates that the platforms may promote phytoplankton growth due to local nutrient enrichment. Mussels from Thebaud exhibit slightly higher levels of vanadium, strontium, and cadmium relative to control mussels
Produced Water	**Frequency:** semi annual for chemistry, annual for toxicity **Location:** Thebaud, Alma, South Venture and Venture **Parameter:** trace metal composition and HC concentration, as required by OWTG (2002). Note: ExxonMobil's lab contractor changed in mid-2009, therefore two different commercial chemistry laboratories were used to analyze the produced water samples.	Produced water at Thebaud, Venture, Alma and South Venture have elevated levels of some metals. The highest metal values recorded at each platform were for boron, barium, iron, lithium, and strontium. Of these metals, the Theabud and venture platforms discharged the highest concentrations in comparison with the sample events at the other platforms. The total petroleum hydrocarbon concentrations in the various samples of produced water at Thebaud, Venture and Alma were well below the OWTG limits of 30 mg/L (30 days) and 60 mg/L (24-hour) for oil in water. The results of the 96 hour LC_{50} and IC_{50} tests indicate that produced water from Thebaud, Venture, South Venture and Alma is toxic. It is surmised that the cause of the toxicity may be due to petroleum hydrocarbons. The COOGER dispersion study concluded that "considering the present volume of produced water released, and the expected rates of dilution following discharge, based on microbiological analysis the toxicity of produced water from Venture/Thebaud offshore platforms is not considered an environmentally relevant factor of concern."	**Frequency:** semi annual for chemistry, annual for toxicity **Location:** Thebaud, Alma, South Venture and Venture **Parameter:** trace metal composition and HC concentration, as required by OWTG (2002).	Produced water at Thebaud, Venture, Alma and South Venture have elevated levels of some metals. The highest metal values recorded at each platform were for boron, barium, iron, manganese, and strontium. Of these metals, the Theabud and venture platforms discharged the highest concentrations in comparison with the sample events at the other platforms. The total petroleum hydrocarbon concentrations in the various samples of produced water at Thebaud, Venture and Alma were below the OWTG limits 60 mg/L (24-hour) for oil in water. The results of the 96 hour LC_{50} and IC_{50} tests indicate that produced water from Thebaud, Venture, South Venture and Alma is toxic. It is surmised that the cause of the toxicity may be due to petroleum hydrocarbons and possibly salinity. While petroleum hydrocarbon compounds such as PAHs and phenols and heavy metals such as lead are known to be toxic, they are likely to have contributed little to the overall toxicity of PW due to their low concentrations. Concentrations of other key non-organic PW constituents (i.e., barium, boron, iron, lead, zinc, strontium, and ammonia) have been relatively low in recent years. Two potentially toxic constituents, iron and ammonia, would more likely have contributed to the high toxicity observed (DFO COOGER, 2010).

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2013

VEC / EEM Component	2009		2010	
	Program	**Observations**	**Program**	**Observations**
Marine Mammals and Seabirds	**Frequency:** Monthly beached bird surveys Opportunistic transect surveys **Location:** Thebaud CWS seabird surveys from supply boats on transects between Thebaud platform and shorebase and reference areas. Oiled beach seabirds studies ongoing on Sable Island	Species showing higher densities within the platform area and/or within 0-10km of platforms include terns, Heerring Gull, Black-legged Kittiwake, and Northern Gannet. Species showing lower densities within the platform area and/or within 0-10km of platforms include Dovekie, Northern Fulmar, Greater Shearwater, murres, and storm petrels. Effects of platform attraction or avoidance by seabirds are inconclusive due to potentially confounding effects of seabird habitat associations, which were not assessed in the 2009 analysis. Of the six oil samples collected from Sable Island beach and analyzed, none contained light or mid-range distillate fuels or condensates that would be typical of oils produced on SOEP facilities. The relatively steady decrease in percent oiling rate of seabird species from 2000 to 2009 suggests measures to reduce illegal oil discharges from vessels has resulted in a reduction in seabird oiling events.	**Frequency:** Monthly beached bird surveys Opportunistic transect surveys **Location:** Thebaud CWS seabird surveys from supply boats on transects between Thebaud platform and shorebase and reference areas. Oiled beach seabirds studies ongoing on Sable Island	• Survey effort was increased during winter periods in 2010/2011. • Overall seabird densities were equal between 2010/2011 and 2006-2009 periods (4.03 birds/km2) • For areas within 25 km of platforms and comparison between 2010/2011 and 2006-2009 periods: o Overall bird density showed no significant changes within seasons o During winter periods Dovekie densities were higher and Northern Fulmar densities were lower in 2010/2011 o During summer periods fulmar and storm-petrel densities were lower and tern densities were higher in 2010 o During autumn periods, Great Shearwater densities were lower in 2010, but this likely reflects the timing of the survey which occurred after the peak fall migration period. Of the four oil samples collected from Sable Island beach and analyzed, none contained light or mid-range distillate fuels or condensates that would be typical of oils produced on SOEP facilities. The relatively steady decrease in percent oiling rate of seabird species (overall) from 2000 to 2010 suggests measures to reduce illegal oil discharges from vessels has resulted in a reduction in the seabird oiling events in the Sable Island area.
Air Quality	**Frequency:** Real time continuous Twice daily flare plume monitoring by EM personnel **Location:** Sable Island & Thebaud Platform **Parameter:** NOx, SO_2/H_2S, O_3, $PM_{2.5}$ NSEL Scale readings of flare colour	Flare plume was typically either clear or very light gray (#1 or #2 on NSDOEL Smoke Chart). There appeared to be a general improvement in flare plume colour. The monitoring program and current observations of various emissions producing activities on and around the island do not yet allow for confirmation as to whether the effects of offshore oil and gas activities can be measured on the island. H_2S and SO_2 peaks was hard to attribute to any particular source based upon current information. PM2.5 which is believed to be high on Sable Island due to sea-salt aerosols The EC Sable Island Air Monitoring Program has produced some useful results in its first 6 years. Data from Sable Island is also being used to improve air quality modeling scenarios and to validate air quality models.	**Frequency:** Real time continuous Twice daily flare plume monitoring by EM personnel **Location:** Sable Island & Thebaud Platform **Parameter:** NOx, SO_2/H_2S, O_3, $PM_{2.5}$ NSEL Scale readings of flare colour	The air quality monitoring program and past observations of various emission-producing activities on and around the island do not yet allow for confirmation as to whether the effects of offshore oil and gas activities can be measured on the island. EMC is participating in an ESRF funded study led by Environment Canada and Dalhousie University entitled "Data Display and Source Apportionment of Volatile Organic Compounds and Particulate Matter on Sable Island". This project will provide regulators, industry and researchers with necessary data to evaluate the impacts attributable to contaminant emissions to ambient air from petroleum related activities.

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2013

VEC / EEM Component	2011		2012	
	Program	Observations	Program	Program
Sediment Toxicity	Discontinued since 2005 (see 2005 observations)	N/A	Discontinued since 2005 (see 2005 observations)	N/A
Sediment Chemistry	Discontinued since 2006 (see 2005 observations)	N/A	Discontinued since 2006 (see 2005 observations)	N/A
Benthic Habitat and Benthos	Discontinued since 2010 (see 2009 observations)	N/A	Discontinued since 2010 (see 2009 observations)	N/A
Fish Health	Detailed fish health analysis discontinued since 2005 (see 2005 observations)	N/A	Detailed fish health analysis discontinued since 2005 (see 2005 observations)	N/A
Fish and Fish Habitat	Discontinued since 2010 (see 2009 observations)	N/A	Discontinued since 2010 (see 2009 observations)	N/A

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2013

VEC / EEM Component	2011		2012	
	Program	**Observations**	**Program**	**Program**
Taint and Body Burden	**Frequency:** Annual mussels **Locations:** Jacket legs at Thebaud for mussels **Parameter:** Aliphatic Hydrocarbons Moisture and Lipid Content Lipid Classes	• Ten years of monitoring the uptake of hydrocarbons in mussels has shown that the presence of aliphatic hydrocarbons is attributable primarily to biogenic hydrocarbons generated by phytoplankton. • Higher concentration of biogenic hydrocarbons in filter feeding mussels indicates that the platforms promote phytoplankton growth. • Polycyclic aromatic hydrocarbons (PAHs), petroleum hydrocarbons, and PCBs were below detectable levels (0.05 mg/kg, 15 mg/kg, and 0.05 µg/g respectively) in both the control and Thebaud mussels. • With the exception of a slight increase in cadmium and strontium, and lower levels of some other metals (aluminum, arsenic, boron, copper, iron, manganese, mercury, selenium, and zinc), total metal concentrations in mussels from the Thebaud platform were similar to those measured in mussels from a reference location. • Sensory evaluations conducted up until 2001 showed that any odour and taste difference was attributable to the condition of the Control mussel samples.	Discontinued since 2012 (see 2011 observations). Will initiate mussel analyses in 2015.	N/A
Produced Water	**Frequency:** annual for chemistry, annual for toxicity **Location:** Thebaud, Alma, South Venture and Venture **Parameter:** trace metal composition and HC concentration, as required by OWTG (2002).	• TPH levels in produced water samples for toxicity analyses were below the OWTG (2010) limit (44 mg/L over 24-hrs). • PW at all SOEP platform locations was interpreted as being 'toxic' based on 2011 bioassay results of EMC samples. • Test results over this period clearly show that toxicity levels can vary widely over time and location in most part due to variation in reservoir characteristics. • High salinity levels (up to 207 ppt) may also have contributed to the toxicity observed in samples although toxicity continued to occur in concentrations diluted to normal salinity values in bioassay tests. Further, toxicity occurring at the higher concentrations was likely due in many cases to a combination of both salinity and petroleum hydrocarbons. • High toxicity of produced water samples from SOEP platforms is not considered an environmentally relevant factor of concern based on findings in a 2010 DFO COOGER research study. The COOGER study also concluded that potential contaminants in the relatively small PW discharges from SOEP platforms are diluted rapidly to no-effects concentration levels within metres of the mouth of the discharge caisson located below the sea surface.	**Frequency:** annual for chemistry, annual for toxicity **Location:** Thebaud, Alma **Parameter:** trace metal composition and HC concentration, as required by OWTG (2002).	• With one exception, TPH levels in produced water samples for toxicity analyses were below the OWTG (2010) limit (44 mg/L over 24-hrs). • PW at all SOEP platform locations was interpreted as being 'toxic' based on 2012 bioassay results of EMC samples. • Test results over this period clearly show that toxicity levels can vary widely over time and location in most part due to variation in reservoir characteristics. • High salinity levels (up to 147 ppt) may also have contributed to the toxicity observed in samples although toxicity continued to occur in concentrations diluted to normal salinity values in bioassay tests. Further, toxicity occurring at the higher concentrations was likely due in many cases to a combination of both salinity and petroleum hydrocarbons. • High toxicity of produced water samples from SOEP platforms is not considered an environmentally relevant factor of concern based on findings in a 2010 DFO COOGER research study. The COOGER study also concluded that potential contaminants in the relatively small PW discharges from SOEP platforms are diluted rapidly to no-effects concentration levels within metres of the mouth of the discharge caisson located below the sea surface. • The potential for cumulative environmental impacts related to the discharge of PW from SOEP offshore platforms is also considered a low risk due to the low density of operational platforms and the low intensity of other marine activities such as commercial fishing, marine transportation, military activity, tourism, etc. (DFO, 2012) on Sable Island Bank in the past, present, and in the foreseeable future.

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2013

VEC / EEM Component	2011		2012	
	Program	**Observations**	**Program**	**Program**
Marine Mammals and Seabirds	**Frequency:** Monthly beached bird surveys Opportunistic transect surveys **Location:** Thebaud CWS seabird surveys from supply boats on transects between Thebaud platform and shorebase and reference areas. Oiled beach seabirds studies ongoing on Sable Island	• Overall seabird densities were higher in 2011 SOEP area compared to Scotian Shelf reference surveys 2006-2010, likely owing focus on winter surveys in 2011 when some seabird species are highly abundant. • Dovekies were encountered most frequently during watches (12.3% of watches), accounted for 37% of all bird sightings, and had the highest average densities of 2.04 birds per km^2. • Northern Fulmars densities in 2011 were approximately one third of the numbers that are typical in winter on the Scotian Shelf. • During 2011, the corpses of 413 beached fulmars, shearwaters, gannets, Larusgulls, and alcids were collected on Sable Island. Fulmars and shearwaters accounted for 67.6% of total seabird corpses recovered, and alcids comprised 22.5%. • The highest oiling rate for a seabird group, 11.5%, was observed in alcids. • Six samples of oil were collected in 2011, and likely represented four separate discharge events. • None of the six samples contained light or mid-range distillate fuels, or condensates that would be typical of oils produced on offshore gas facilities such as the SOEP processing platforms off Sable Island.	**Frequency:** Monthly beached bird surveys Surveillance surveys by offshore operators Annual Radio-tracking of birds via receivers on supply boats **Location:** Thebaud 2 Supply vessels Monetary and logistical upport of Acadia/Encana instrument-based automated bird monitoring study, “Assessment of bird-human interactions at offshore installations” Oiled beach seabirds studies ongoing on Sable Island	• During 2012, the corpses of 606 beached fulmars, shearwaters, gannets, larusgulls, and alcids were collected on Sable Island. Shearwaters accounted for 57.6% of total seabird corpses recovered, and alcids comprised 26.2%. • The highest oiling rate for a seabird group , 40.4%, was observed in alcids. • Seventeen samples of oil were collected in 2012, and likely represented five separate discharge events. • Of the 17 samples collected from the feathers of birds and the beach, 8 contained fuel oils in the mid-range distillate (or marine diesel) range. Marine diesel is commonly used by most vessels, including vessels associated with the offshore energy industry. None of the samples contained light distillate fuels or condensates that would be typical of oils produced on offshore gas facilities such as SOEP processing platforms offshore Sable Island. • There were no spills reported from any of the vessels supporting the Sable Project during 2012. • Further to SOEP’s Canadian Wildlife Permit LS 2560 requirements, an annual report detailing the numbers of birds salvaged, released and deceased on the platforms provided monitoring data on those species observed on the offshore facilities. • Acadia/Encana bird monitoring study scheduled to complete in 2014.
Air Quality	**Frequency:** Real time continuous Twice daily flare plume monitoring by EM personnel **Location:** Sable Island & Thebaud Platform **Parameter:** NOx, SO_2/H_2S, O_3, $PM_{2.5}$ NSEL Scale readings of flare colour	Flare plume was typically either clear or very light gray (#1 or #2 on NSDOEL Smoke Chart). • Based on results reported in 2009, the monitoring program and past observations of various emission producing activities on and around Sable Island do not yet allow for confirmation as to whether the effects of offshore oil and gas activities can be measured on the Island. • EMC is participating in an ESRF funded study led by Environment Canada and Dalhousie University entitled "Data Display and Source Apportionment of Volatile Organic Compounds and Particulate Matter on Sable Island". This project will provide regulators, industry and researchers with necessary data to evaluate the impacts attributable to contaminant emissions to ambient air from petroleum related activities. • Nova Scotia Environment has compiled audited air quality monitoring data for the last few years and provided this information to the offshore Operators. The Operators are currently discussing the future data analysis options with the Federal and Provincial environment agencies. Analysis of any air quality exceedences or anomalies measured on the island in recent years will be the focus of a future submission related to this report.	**Frequency:** Real time continuous Twice daily flare plume monitoring by EM personnel **Location:** Sable Island & Thebaud Platform **Parameter:** NOx, SO_2/H_2S, O_3, $PM_{2.5}$ NSEL Scale readings of flare colour	Flare plume was typically either clear or very light gray (#1 or #2 on NSDOEL Smoke Chart). • Kingfisher Environmental Health Consultants (KEHC) conducted data analysis and graphing of air quality and meteorological data from 2010/2011, identified spikes in air monitoring data while cross referenced these to wind direction/wind speed. The objective was to determine potential correlation with a particular facility's operations, if required. • The data acquired by the monitoring station on Sable Island lacked sufficient completeness to be considered adequate for a valid statistical analysis. Because of the paucity of data it was difficult to conduct seasonal analysis or compare the data from both years. • It appears that the only air pollutant that may be influenced by O&G production around Sable Island is NOx, by virtue of the 3rd highest NOx concentrations in both 2010 and 2011. • Elevated PM2.5 concentrations could be a consequence of sea salt spray and further investigations of the PM2.5 chemistry and/or O&G operations would need to be conducted to confirm this.

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2013

VEC / EEM Component	2013			
	Program	**Observations**	**Program**	**Program**
Sediment Toxicity	Discontinued since 2005 (see 2005 observations)	N/A		
Sediment Chemistry	Discontinued since 2006 (see 2005 observations)	N/A		
Benthic Habitat and Benthos	Discontinued since 2010 (see 2009 observations)	N/A		
Fish Health	Detailed fish health analysis discontinued since 2005 (see 2005 observations)	N/A		
Fish and Fish Habitat	Discontinued since 2010 (see 2009 observations)	N/A		
Taint and Body Burden	Discontinued since 2012 (see 2011 observations). Will initiate mussel analyses in 2015.	N/A		

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2013

VEC / EEM Component	2013			
	Program	**Observations**	**Program**	**Program**
Produced Water	**Frequency:** annual for chemistry, annual for toxicity **Location:** Thebaud, Alma, South Venture **Parameter:** trace metal composition and HC concentration, as required by OWTG (2002).	• With one exception, Total Petroleum Hydrocarbon daily average values were well below Offshore Waste Treatment Guidelines (OWTG) (2010) oil-in-water concentration limits at three SOEP platforms – Thebaud, Alma and South Venture. Venture was shut-in during 2013. • Annual PW characterization samples taken at Thebaud, Alma and South Venture platforms in 2013 are considered 'toxic' based on results of a variety of toxicity bioassays. • Test results since 2005 show that chemical and toxicity levels vary widely over time and location in large part due to varying reservoir characteristics. • Besides differences in reservoir characteristics, factors which contribute to variation in TPH concentrations in PW samples include time of sampling, efficiency of the onboard treatment system, and operational upsets. • Sand production in the reservoir has occasionally shown to influence the effectiveness of the treatment systems. • Iron and ammonia levels vary over time, again related to which wells are producing and geotechnical factors as mentioned above. • Toxicity of produced water samples from SOEP platforms is not considered an environmentally relevant factor of concern based on findings in a DFO COOGER research study (2010) which found that potential contaminants in the relatively small PW discharges from SOEP platforms are diluted rapidly to no-effects concentration levels within tens of metres of the subsurface discharge caisson.		•
Marine Mammals and Seabirds	**Frequency:** Monthly beached bird surveys Surveillance surveys by offshore operators Annual Radio-tracking of birds via receivers on supply boats In 2013: Radar monitoring of bird interactions near the flare @ the Pt. Tupper Fractionation plant **Location:** Thebaud 2 Supply vessels **Parameter:** Logistical support of Acadia/Encana instrument-based automated bird monitoring study, “Assessment of bird interactions with offshore infrastructure associated with the oil and gas industry of Nova Scotia, Canada” Oiled beach seabirds studies ongoing on Sable Island	• During 2013, the corpses and fragments of 461 beached seabird corpses were collected on Sable Island. Fulmars and shearwaters accounted for 25.8% of total corpses recovered, and alcids comprised 55.5%. • The overall oiling rate for the 461 birds was <0.5% — a single bird (one of 16 Northern Fulmar corpses). • The 2013 oiling rate for alcids (all species combined) was markedly lower than that observed in 2012 (i.e. 0% compared with 40.4%). This is the first time in 21 years (since beginning the beached seabird survey program in 1993) that the annual oiling rate for alcids was 0%. • There were no spills reported from any of the vessels supporting the Sable Project during 2013. • EMC supported the Acadia/Encana instrument-based automated bird monitoring study by providing platforms (2 supply vessels) on which to install radio tracking receivers, and participation of field staff (on supply vessels and platforms) in the monitoring of physically tagged birds in the offshore areas. • EMC also provided an on-land access point to monitor the flare from its fractionation plant facility in Point Tupper, NS (Acadia/Encana Study). Following 8 monitoring evenings, during different seasons and weather conditions, radar images to be analyzed for bird interactions.(results pending as at 03/2015) • Further to SOEP’s Canadian Wildlife Permit LS 2560 requirements, an annual report detailing the numbers of birds salvaged, released and deceased on the platforms provided monitoring data on those species observed on the offshore facilities. • Acadia/Encana bird monitoring study to be completed in 2014.		•

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Table 1-4 History of SOEP EEM Program 1998-2013

VEC / EEM Component	2013			
	Program	**Observations**	**Program**	**Program**
Air Quality	**Frequency:** Real time continuous Twice daily flare plume monitoring by EM personnel **Location:** Sable Island & Thebaud Platform **Parameter:** NOx, SO_2/H_2S, O_3, $PM_{2.5}$ NSDOEL Scale readings of flare colour	Flare plume was typically clear with very few occasions observing very light gray (#1 or #2 on NSDOEL Smoke Chart). • Kingfisher Environmental Health Consultants (KEHC) conducted data analysis and graphing of air quality and meteorological data from 2013, identified spikes in air monitoring data while cross referenced these to wind direction/wind speed. The objective was to determine potential correlation with a particular facility's operations, if required. • Data completeness was excellent for PM2.5 (87%) and O3 (93%) during 2012. The data completeness for NOx (73%), NO2 (72%) and NO (74%) were below the NAPS accepted data completeness of 75%, but are close enough to be acceptable for statistical analysis. • Air monitoring data acquired in the 2012 year indicates that there were four events where the NOX air emissions 'spike' threshold (1-hr period) was exceeded. Investigation of these spikes revealed that one out of the four 'spikes' was possibly due to O&G operations around Sable Island. • The two highest daily average PM2.5 concentrations (September 22nd and December 22nd) were aligned with airflow from the south, which aligns with the North Triumph O&G production facility. It was also seen that PM2.5 in 2012 showed a spread directional dependence from the WSW, SW, SE, ESE and E for PM2.5 concentrations above 20 µg/m3, which aligns with multiple platforms. • Elevated PM2.5 concentrations could be a consequence of sea salt spray and further investigations of the PM2.5 chemistry and/or O&G operations would need to be conducted to confirm this. • It is unlikely that the Sable O&G production had any influence on the three elevated daily average O3 concentrations seen in 2012.		

1 - Scallops in cages only
2 - North Triumph/Alma locations only
3 - Thebaud only (caged)
4 - Thebaud location only

Note: EEM program was re-evaluated in 2004; no field work undertaken for that year.

Appendix for Section 2

Produced Water Sampling and Analysis Procedures - SGS Laboratories

Collection of Produced Water:
The samples that are collected directly from the discharge pipe should be sampled into the bottles supplied by the laboratory to ensure the integrity of the samples.

Produced Water / Filtration of Produced Water / Sub-Sampling Procedures / Salinity, pH, Oxygen
N/A to laboratory

Nutrients
The nutrient samples that are taken for ExxonMobil are to be analysed for Ammonia and
TKN – 60 ml amber bottle filled approximately 80%.

Inorganics (SPM)
N/A to laboratory

Metals
The following are the bottles needed for metals analysis:

1X250 ml plastic bottle filled approximately 80%.

Organics
The bottles required for BTEX/TPH are 2x40ml glass amber vials (vials must be filled to the top and contain no headspace) and 1X1L amber glass bottle (filled approximately 90%).

Methods and method summaries of analysis are available upon request.

Quality Control
Blank samples can be supplied by the client to run as samples within the laboratory. They will be treated the same as all other samples.

Field and Trip blanks can be supplied to the client upon request and can be run as actual samples.

SGS follows a very stringent QA/QC Program with the analysis of duplicates, method blanks, surrogates, spikes and certified reference materials where applicable.

General Info on Sampling / Preparing to go to the field / Locating Site Stations / Field Notes / Observations
N/A to laboratory

Sampling Equipment Containers

The following is what the Produced Water for ExxonMobil has been analysed for in the past as well as bottles required:

250 ml metals
60 ml TKN
2X40 ml vials TPH/BTEX
1X1L amber glass
500 ml plastic

Ammonia+Ammonium (N) (mg/L), T. Kjeldahl Nitrogen (as N mg/L), Mercury (mg/L),
Aluminum (mg/L), Arsenic (mg/L), Barium (mg/L), Boron (mg/L), Cadmium (mg/L),
Cobalt (mg/L), Chromium (mg/L), Copper (mg/L), Iron (mg/L), Magnesium (mg/L), Manganese (mg/L), Molybdenum (mg/L), Nickel (mg/L), Phosphorus (mg/L),
Lead (mg/L), Antimony (mg/L), Selenium (mg/L), Tin (mg/L), Strontium (mg/L), Sulphur (mg/L), Thorium (mg/L), Uranium (mg/L), Vanadium (mg/L), Zinc (mg/L), F1 (C6-C10)-water (ug/L), F1 (C10-C16)-water (ug/L), F1 (C16-C34)-water (ug/L), F1 (C34-C50)-water (ug/L), pH

Sampling Collection Methods
N/A to laboratory

Preservation / Holding Times
CHC will not allow any preservatives on flights offshore. Preservatives will be added upon receipt at the laboratory, if necessary.

Analytical Methods
BTEX/TPH – CCME
Metals – ICP-MS
Mercury – Cold Vapour Atomic Absorption
Ammonia – SM4500-N C
TKN – SM4500-NH3 G

Other Considerations
N/A to laboratory

AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Rd.
RR 3
Guelph ON N1H 6H9
Tel: (519) 763-4412 Fax: (519) 763-4419

MICROTOX® ACUTE TOXICITY TEST REPORT

Work Order : 226807
Sample Number : 41846

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.	Time Collected :	12:00
Location :	South Rawden NS	Date Collected :	2014-10-26
Substance :	Alma Produced Water	Sample Volume :	1 x 1L jar
Sampling Method :	Grab	Date Received :	2014-10-28
Sampled By :	B.M.	Date Tested :	2014-10-28
Sample Description :	Clear, light pink, strong odour.	Temp. on arrival :	19.0°C

Test Method : Toxicity Test Using Luminescent Bacteria, Protocol EPS 1/RM/24, Environment Canada, 1992.

TEST RESULTS

Test Endpoint	Value	95% Confidence Limits	Calculation Method
15 minute IC50	2.38%	2.26-2.51	Least Square Regression

The results reported relate only to the sample tested.

REFERENCE TOXICANT DATA

Reagent Batch :	14G4106A	15 minute IC50 :	0.97 mg/L
Expiry Date :	08/2016	95% Confidence Limits :	0.80-1.18 mg/L
Date Tested (yyyy-mm-dd) :	2014-10-28	Historical Mean IC50 :	0.70 mg/L
Reference Substance :	Zinc (as zinc sulphate)	Warning Limits (± 2SD) :	0.49-1.00 mg/L
Statistical Method :	Least Square Regression	Analyst(s):	CN

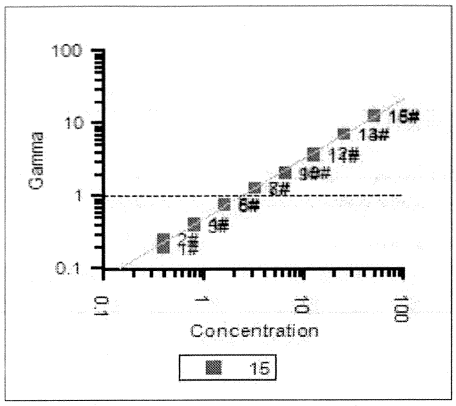
CONDITIONS OF ACUTE MICROTOX TEST

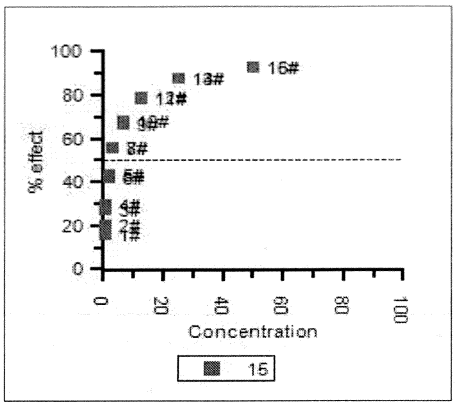
Test Organism :	*Vibrio fischeri*	Test Initiation Time :	16:00
Reagent Batch :	14G4106A	Observation Time(s) :	15 minutes
Date Reagent Received :	2014-10-23	Sample Pre-aeration/Aeration :	None
Reagent Holding Temperature :	-22 °C	Sample pH :	6.1
Analyzer Model Number :	M500	pH Adjustment :	None
Test Well Temperature :	15.0 ± 0.3 °C	Salinity Adjustment :	Yes
Highest Concentration Tested :	50 %	Final Salinity :	≥2% NaCl
Number of Controls :	2	Dilution Water :	AquaTox Diluent
Number of Concentrations Tested :	8	Sample Storage :	4±2 °C
Number of Replicates :	2	Colour Correction :	None
Appearance of Test Solutions :	No changes noted.	Analyst(s):	CN
		Test Method Deviation(s) :	None

Date: 2014-11-14
yyyy-mm-dd

Approved by: _____
Project Manager

Work Order : 226807
Sample Number : 41846





Time	Sample	Conc. (%)	I0	It	Gamma	% Effect
15 Mins						
	Control	0.00	91	85	0.9362#	
	Control	0.00	87	83	0.9445#	
	Control	0.00	86	81	0.9411#	
	Control	0.00	87	84	0.9595#	
	1	0.39	85	67	0.1917#	16.09%
	2	0.39	86	65	0.2577#	20.49%
	3	0.78	86	58	0.3863#	27.87%
	4	0.78	85	56	0.4273#	29.94%
	5	1.56	87	47	0.7756#	43.68%
	6	1.56	85	47	0.7264#	42.08%
	7	3.13	90	37	1.278#	56.10%
	8	3.13	89	37	1.261#	55.77%
	9	6.25	88	28	2.029#	66.99%
	10	6.25	92	27	2.166#	68.42%
	11	12.50	85	18	3.529#	77.92%
	12	12.50	90	18	3.830#	79.30%
	13	25.00	91	11	6.968#	87.45%
	14	25.00	92	11	6.930#	87.39%
	15	50.00	88	6	13.02#	92.87%
	16	50.00	87	6	12.35#	92.51%

- included, * - invalid

Statistics:

Data: 15 Mins

EC50 Concentration: 2.382%
(95% Confidence Range: 2.258 to 2.514)
95% Confidence Factor: 1.055
Estimating Equation:
LOG C = 1.215 x LOG G +0.3770
Correction Factor: 0.9453
Slope: 0.8205
Coeff of Determination (R^2): 0.9970

Test Data Reviewed By : JL
Date : 2014-11-14

AQUATOX
AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Rd.
RR 3
Guelph ON N1H 6H9
Tel: (519) 763-4412 Fax: (519) 763-4419

Work Order : 226807
Sample Number : 41846

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.		
Location :	South Rawden NS	Date Collected :	2014-10-26
Substance :	Alma Produced Water	Time Collected :	12:00
Sampling Method :	Grab	Date Received :	2014-10-28
Sampled By :	B.M.	Time Received :	08:40
Temp. on arrival :	19.0°C	Date Tested :	2014-10-29
Sample Description :	Clear, light pink, strong odour.		

Test Method : Fertilization Assay Using Echinoids (Sea Urchins and Sand Dollars). Environment Canada, Conservation and Protection. Ottawa, Ontario. EPS 1/RM/27, 2nd ed. (February 2011).

TEST RESULTS

Effect	Value	95% Confidence Limits	Statistical Method
IC25 (Fertilization)	99.2%	88.3-110*	Non Linear Regression** (CETIS) a

The results reported relate only to the sample tested.

COPPER (AS COPPER SULPHATE) REFERENCE TOXICANT DATA

Date Tested :	2014-10-29	Statistical Method :	Non-Linear Regression** (CETIS)[a]
Gamete Batch :	Ur14-10-02	Historical Mean IC25 :	132 µg/L
Test Duration :	20 minutes	Warning Limits (± 2SD) :	62 - 283 µg/L
IC25 Fertilization :	193 µg/L	Analyst(s) :	DK, SF
95% Confidence Limits :	184 - 201 µg/L		

The reference toxicant test was performed under the same experimental conditions as those used with the test sample.

TEST CONDITIONS

Test Vessel :	20 mL glass scintillation vial	Control/Dilution Water[1] :	Artificial Sea Water
Volume per Replicate :	10 mL	Sperm Exposure Time [2]:	20 min
Number of Replicates :	4 per treatment	Egg Exposure Time :	10 min
Depth of Test Solution :	Approx. 3 cm	Total Duration of Test :	20 min
Sperm Density :	40000000 per vessel	pH Adjustment :	None
Sperm : Egg Ratio :	20000 : 1	Sample Filtration :	None
Males Used to Pool Sperm :	3	Test Aeration :	None
Females Used to Pool Eggs :	4	Test Method Deviation(s) :	None

[1] no additional chemicals
[2] 10 min exposure, continued for an additional 10 min after addition of eggs

COMMENTS

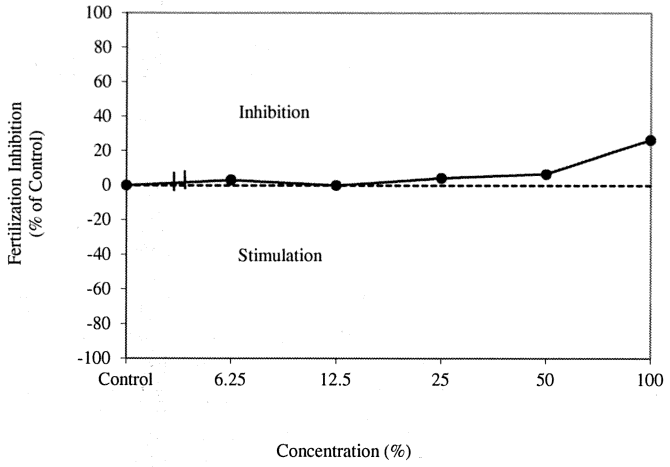
*Note: In the case of effluents, an upper 95% confidence limit of 100% is inferred since a concentration greater than full strength is not possible. Statistically, however, a confidence limit which is greater than full strength effluent is valid.

**Binomial weighting (CETIS[a]) was applied.

•All test validity criteria as specified in the test method cited above were satisfied.

Work Order : 226807
Sample Number : 41846

Sea Urchin Fertilization Inhibition



TEST ORGANISM

Adult Test Organism :	*Lytechinus pictus*	Holding Salinity :	34 ± 2 ‰
Adult Organism Source :	Marinus Scientific	Holding Vessel :	Glass aquaria
Source Location :	Garden Grove CA USA	Adult Mortality Rate :	0% (previous 7 days)
Date Received :	2013-05-30	Life Stage Tested :	Gamete (sperm/egg)
Holding Water :	Artificial Sea Water	Gamete Batch Tested :	Ur14-10-02
Holding Temperature :	12 - 15 °C		

Reference : Recommended Procedure for the Importation of Test Organisms for Sublethal Toxicity Testing. Environment Canada, September 1999.

REFERENCES

[a] CETIS, © 2001-2007. V.1.8.5.5. Comprehensive Environmental Toxicity Information System. Tidepool Scientific Software, McKinleyville, Calif. 95519[Program on disk and printed User's Guide].

[e]Environment Canada. 2001. Revised Procedures for Adjusting Salinity of Effluent Samples for Marine Sublethal Toxicity Testing Conducted under Environmental Effects Monitoring (EEM) Programs. Method Development and Applications Section, Environmental Technology Centre, December 2001.

Date : 2014-11-14
yyyy-mm-dd

Approved By : _____
Project Manager

Work Order : 226807
Sample Number : 41846

FERTILIZATION DATA

Test Conducted By : SF/DK
Enumerated By : AS

Concentration (%)	Replicate	Fertilized	Unfertilized	% Fertilized	Treatment Mean Fertilization (%)	Standard Deviation
Control	A	94	6	94	**95.25**	**2.22**
	B	96	4	96		
	C	98	2	98		
	D	93	7	93		
Blank	A	0	100	0	**0**	**0.00**
	B	0	100	0		
	C	0	100	0		
	D	0	100	0		
1.56	A	–	–	–	–	–
	B	–	–	–		
	C	–	–	–		
	D	–	–	–		
3.13	A	–	–	–	–	–
	B	–	–	–		
	C	–	–	–		
	D	–	–	–		
6.25	A	92	8	92	**92.25**	**2.50**
	B	89	11	89		
	C	95	5	95		
	D	93	7	93		
12.5	A	96	4	96	**95.25**	**1.71**
	B	93	7	93		
	C	97	3	97		
	D	95	5	95		
25	A	92	8	92	**91.25**	**2.50**
	B	94	6	94		
	C	91	9	91		
	D	88	12	88		
50	A	92	8	92	**89**	**3.83**
	B	84	16	84		
	C	92	8	92		
	D	88	12	88		
100	A	75	25	75	**70**	**4.97**
	B	64	36	64		
	C	68	32	68		
	D	73	27	73		

"–" = not counted/not required

NOTES :

- No organisms or gametes exhibiting unusual appearance, behaviour, or undergoing unusual treatment were used in the test.
- Gamete viability test was performed prior to pooling of test gametes.
- A pre-test was conducted prior to testing.
- Preserved eggs were stored for 8 days prior to enumeration.
- No outlying data points were detected according to Grubbs Test (CETIS)[a]

Data Reviewed By : JL
Date : 2014-11-13

Work Order : 226807
Sample Number : 41846

INITIAL WATER CHEMISTRY (100% SAMPLE)

	Temp.(°C)	pH	Dissolved O_2 (mg/L)	O_2 Sat. (%)*	Salinity (‰)	Pre-aeration Time (h)
Initial Chemistry:	21.0	6.8	8.1	94	13	–
Chemistry after Salinity Adjustment [3]:	20.0	6.9	7.2	98	30	–
Chemistry after Pre-Aeration[3,4]:	20.0	7.5	6.4	88	30	0:00

SALINITY ADJUSTMENT

Method :	Direct Salt Addition	Volume Adjusted :	1500 mL
Salt Added :	Instant Ocean™	Amount of Salt Added :	10 g
Date Adjusted :	2014-10-28	Aging Time :	~17 hours
Aging Conditions :	Sealed, complete darkness, minimal air space	Aging Temperature :	4±2°C

Reference : Salinity Adjustment Guidance Document. Environment Canada, revised December 2001[e].

EXPOSURE CONCENTRATIONS WATER CHEMISTRY

Concentration (%)	Temp.(°C)	pH	Dissolved O_2 (mg/L)	O_2 Sat. (%)*	Salinity (‰)
Control	20.0	8.2	7.2	100	30
Blank	20.0	8.2	7.2	100	30
1.56	20.0	8.2	7.0	98	30
3.13	20.0	–	–	–	–
6.25	20.0	–	–	–	–
12.5	20.0	–	–	–	–
25	20.0	8.0	7.0	98	30
50	20.0	–	–	–	–
100	20.0	7.5	6.4	88	30

* % saturation, adjusted for temperature and barometric pressure
"–" not required/not measured
[3] if required
[4] at <100 bubbles/min

Data Reviewed By : JL
Date : 2014-11-13

CHAIN OF CUSTODY RECORD

AQUATOX

AquaTox Work Order No: 226807

Shipping Address: AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Road, RR #3
Guelph, Ontario Canada N1H 6H9

Voice: (519) 763-4412 **Fax:** (519) 763-4419

P.O. Number: ALMA
Field Sampler Name (print): BILLY MacLEAN
Signature: N/A
Affiliation: EXXON MOBIL
Sample Storage (prior to shipping): COOLER
Custody Relinquished by: G. Harris
Date/Time Shipped: Oct 27/14

Client: Harris Industrial Testing Svc. Ltd.
1320 Ashdale Rd
South Rawdon, NS
BON 1Z0
Phone: 902-757-0232
Fax: 902-757-2839
Contact: Carol Harris

Sample Identification					Analyses Requested								Sample Method and Volume		
Date Collected (yyyy-mm-dd)	Time Collected (e.g. 14:30, 24 hr clock)	Sample Name	AquaTox Sample Number	Temp. on arrival	Silverside Growth	Sea Urchin Fertilization	Champia Reproduction	Blue Mussel Larval Development	Sea Urchin Larval Development	Marine Amphipod Survival	Marine Polycheate Survival and Growth	Microtox (Solid phase)	Grab	Composite	# of Containers and Volume (eg. 2 x 1L, 3 x 10L, etc.)
2014-10-26	1200	Alma Produced Water	41846	9.0		✓						✓	✓		1 x 1L DK

For Lab Use Only
Received By: DK
Date: 2014-10-28
Time: 8:40
Storage Location:
Storage Temp.(°C)

Please list any special requests or instructions:
Permission given to hold sample until testing on Thursday.

DK

AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Rd.
RR 3
Guelph ON N1H 6H9
Tel: (519) 763-4412 Fax: (519) 763-4419

Work Order : 226790
Sample Number : 41819

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.	Time Collected :	Not given
Location :	South Rawden NS	Date Collected :	2014-10-22
Substance :	SO. Venture Produced Water	Sample Volume :	1 x 1L jar
Sampling Method :	Grab	Date Received :	2014-10-24
Sampled By :	Not given	Date Tested :	2014-10-24
Sample Description :	Clear, colourless, odourless.	Temp. on arrival :	15.0°C

Test Method : Toxicity Test Using Luminescent Bacteria, Protocol EPS 1/RM/24, Environment Canada, 1992.

TEST RESULTS

Test Endpoint	Value	95% Confidence Limits	Calculation Method
15 minute IC50	12.2%	10.8-13.7	Least Square Regression

The results reported relate only to the sample tested.

REFERENCE TOXICANT DATA

Reagent Batch :	13J4129	15 minute IC50 :	0.78 mg/L
Expiry Date :	10/2015	95% Confidence Limits :	0.66-0.92 mg/L
Date Tested (yyyy-mm-dd) :	2014-11-04	Historical Mean IC50 :	0.70 mg/L
Reference Substance :	Zinc (as zinc sulphate)	Warning Limits (± 2SD) :	0.48-1.02 mg/L
Statistical Method :	Least Square Regression	Analyst(s):	CN

CONDITIONS OF ACUTE MICROTOX TEST

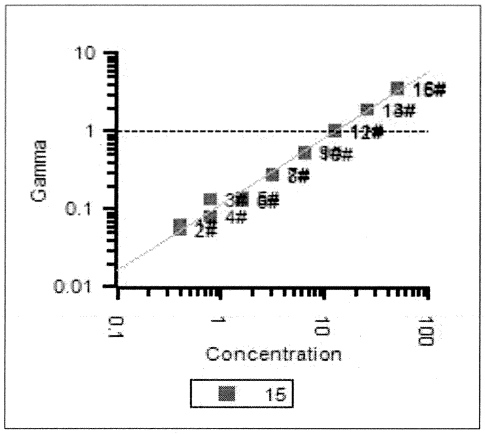
Test Organism :	*Vibrio fischeri*	Test Initiation Time :	14:50
Reagent Batch :	13J4129	Observation Time(s) :	15 minutes
Date Reagent Received :	2014-06-17	Sample Pre-aeration/Aeration :	None
Reagent Holding Temperature :	-21 °C	Sample pH :	6.4
Analyzer Model Number :	M500	pH Adjustment :	None
Test Well Temperature :	15.0 ± 0.3 °C	Salinity Adjustment :	Yes
Highest Concentration Tested :	50 %	Final Salinity :	≥2% NaCl
Number of Controls :	2	Dilution Water :	AquaTox Diluent
Number of Concentrations Tested :	8	Sample Storage :	4±2 °C
Number of Replicates :	2	Colour Correction :	None
Appearance of Test Solutions :	No changes noted.	Analyst(s):	AW
		Test Method Deviation(s) :	None

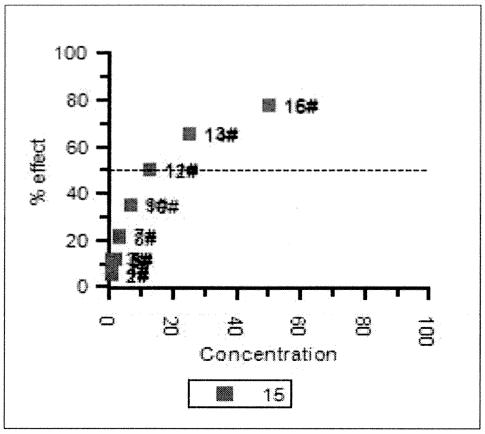
Date: 2014-11-14
yyyy-mm-dd

Approved by:
Project Manager

Work Order : 226790

Sample Number : 41819





Time	Sample	Conc. (%)	I0	It	Gamma	%Effect
15 Mins						
	Control	0.00	93	86	0.9301#	
	Control	0.00	91	87	0.9461#	
	Control	0.00	93	91	0.9842#	
	Control	0.00	98	86	0.8757*	
	1	0.39	89	80	0.0626#	5.89%
	2	0.39	91	82	0.0559#	5.30%
	3	0.78	94	79	0.1373#	12.07%
	4	0.78	93	82	0.0803#	7.44%
	5	1.56	93	78	0.1397#	12.26%
	6	1.56	90	76	0.1286#	11.40%
	7	3.13	97	72	0.2927#	22.65%
	8	3.13	95	71	0.2699#	21.25%
	9	6.25	98	60	0.5519#	35.56%
	10	6.25	94	59	0.5269#	34.51%
	11	12.50	96	45	1.030#	50.74%
	12	12.50	95	45	1.009#	50.22%
	13	25.00	97	31	1.942#	66.01%
	14	25.00	94	31	1.896#	65.47%
	15	50.00	91	19	3.475#	77.66%
	16	50.00	99	20	3.635#	78.42%

- included, * - invalid

Statistics:

Data: 15 Mins

EC50 Concentration: 12.18%
(95% Confidence Range: 10.81 to 13.72)
95% Confidence Factor: 1.127
Estimating Equation: LOG C = 1.152 x LOG G +1.085
Correction Factor: 0.9535
Slope: 0.8576
Coeff of Determination (R^2): 0.9878

Test Data Reviewed By : JL

Date : 2014-11-05

AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Rd.
RR 3
Guelph ON N1H 6H9
Tel: (519) 763-4412 Fax: (519) 763-4419

Work Order : 226790
Sample Number : 41819

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.		
Location :	South Rawden NS	Date Collected :	2014-10-22
Substance :	SO. Venture Produced Water	Time Collected :	Not given
Sampling Method :	Grab	Date Received :	2014-10-24
Sampled By :	Not given	Time Received :	10:30
Temp. on arrival :	15.0°C	Date Tested :	2014-10-29
Sample Description :	Clear, colourless, odourless.		

Test Method : Fertilization Assay Using Echinoids (Sea Urchins and Sand Dollars). Environment Canada, Conservation and Protection. Ottawa, Ontario. EPS 1/RM/27, 2nd ed. (February 2011), with deviation(s) as noted below.

TEST RESULTS

Effect	Value	95% Confidence Limits	Statistical Method
IC25 (Fertilization)	>100%	-	-

The results reported relate only to the sample tested.

COPPER (AS COPPER SULPHATE) REFERENCE TOXICANT DATA

Date Tested :	2014-10-29	Statistical Method :	Non-Linear Regression* (CETIS)[a]
Gamete Batch :	Ur14-10-02	Historical Mean IC25 :	132 µg/L
Test Duration :	20 minutes	Warning Limits (± 2SD) :	62 - 283 µg/L
IC25 Fertilization :	193 µg/L	Analyst(s) :	DK, SF
95% Confidence Limits :	184 - 201 µg/L		

The reference toxicant test was performed under the same experimental conditions as those used with the test sample.

TEST CONDITIONS

Test Vessel :	20 mL glass scintillation vial	Control/Dilution Water[1] :	Artificial Sea Water
Volume per Replicate :	10 mL	Sperm Exposure Time [2]:	20 min
Number of Replicates :	4 per treatment	Egg Exposure Time :	10 min
Depth of Test Solution :	Approx. 3 cm	Total Duration of Test :	20 min
Sperm Density :	40000000 per vessel	pH Adjustment :	None
Sperm : Egg Ratio :	20000 : 1	Sample Filtration :	None
Males Used to Pool Sperm :	3	Test Aeration :	None
Females Used to Pool Eggs :	4	Test Method Deviation(s) :	Yes (see 'Comments')

[1] no additional chemicals
[2] 10 min exposure, continued for an additional 10 min after addition of eggs

COMMENTS

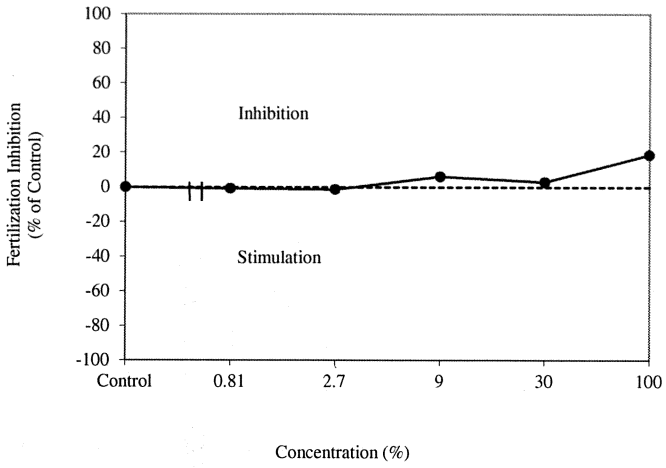
Noted Deviation(s): The maximum 3 day sample holding time as specified by the test method was exceeded. Testing was conducted with the consent of the client.

*Binomial weighting (CETIS[a]) was applied.

•All test validity criteria as specified in the test method cited above were satisfied.

Work Order : 226790
Sample Number : 41819

Sea Urchin Fertilization Inhibition



TEST ORGANISM

Adult Test Organism :	*Lytechinus pictus*	Holding Salinity :	34 ± 2 ‰
Adult Organism Source :	Marinus Scientific	Holding Vessel :	Glass aquaria
Source Location :	Garden Grove CA USA	Adult Mortality Rate :	0% (previous 7 days)
Date Received :	2013-05-30	Life Stage Tested :	Gamete (sperm/egg)
Holding Water :	Artificial Sea Water	Gamete Batch Tested :	Ur14-10-02
Holding Temperature :	12 - 15 °C		

Reference : Recommended Procedure for the Importation of Test Organisms for Sublethal Toxicity Testing. Environment Canada, September 1999.

REFERENCES

[a] CETIS, © 2001-2007. V.1.8.5.5. Comprehensive Environmental Toxicity Information System. Tidepool Scientific Software, McKinleyville, Calif. 95519[Program on disk and printed User's Guide].

[e]Environment Canada. 2001. Revised Procedures for Adjusting Salinity of Effluent Samples for Marine Sublethal Toxicity Testing Conducted under Environmental Effects Monitoring (EEM) Programs. Method Development and Applications Section, Environmental Technology Centre, December 2001.

Date : 2014-11-14
yyyy-mm-dd

Approved By : *Project Manager*

Work Order : 226790
Sample Number : 41819

FERTILIZATION DATA

Test Conducted By : SF/DK
Enumerated By : AS

Concentration (%)	Replicate	Fertilized	Unfertilized	% Fertilized	Treatment Mean Fertilization (%)	Standard Deviation
Control	A	96	4	96	**95**	**2.16**
	B	95	5	95		
	C	92	8	92		
	D	97	3	97		
Blank	A	0	100	0	**0**	**0.00**
	B	0	100	0		
	C	0	100	0		
	D	0	100	0		
0.02	A	–	–	–	–	–
	B	–	–	–		
	C	–	–	–		
	D	–	–	–		
0.07	A	–	–	–	–	–
	B	–	–	–		
	C	–	–	–		
	D	–	–	–		
0.24	A	–	–	–	–	–
	B	–	–	–		
	C	–	–	–		
	D	–	–	–		
0.81	A	96	4	96	**95.75**	**1.71**
	B	98	2	98		
	C	95	5	95		
	D	94	6	94		
2.7	A	97	3	97	**96.25**	**0.96**
	B	97	3	97		
	C	95	5	95		
	D	96	4	96		
9	A	90	10	90	**89.25**	**2.22**
	B	91	9	91		
	C	90	10	90		
	D	86	14	86		
30	A	95	5	95	**92.25**	**1.89**
	B	92	8	92		
	C	91	9	91		
	D	91	9	91		
100	A	72	28	72	**77.25**	**5.12**
	B	74	26	74		
	C	80	20	80		
	D	83	17	83		

"–" = not counted/not required

NOTES :

- No organisms or gametes exhibiting unusual appearance, behaviour, or undergoing unusual treatment were used in the test.
- Gamete viability test was performed prior to pooling of test gametes.
- A pre-test was conducted prior to testing.
- Preserved eggs were stored for 8 days prior to enumeration.
- No outlying data points were detected according to Grubbs Test (CETIS)[a]

Data Reviewed By : JL
Date : 2014-11-13

Work Order : 226790
Sample Number : 41819

INITIAL WATER CHEMISTRY (100% SAMPLE)

	Temp.(°C)	pH	Dissolved O_2 (mg/L)	O_2 Sat. (%)*	Salinity (‰)	Pre-aeration Time (h)
Initial Chemistry:	21.0	7.1	7.7	90	6	–
Chemistry after Salinity Adjustment [3]:	20.0	7.1	7.6	104	30	–
Chemistry after Pre-Aeration[3,4]:	20.0	7.6	7.0	96	30	0:20

SALINITY ADJUSTMENT

Method :	Direct Salt Addition	Volume Adjusted :	500 mL
Salt Added :	Instant Ocean™	Amount of Salt Added :	14 g
Date Adjusted :	2014-10-28	Aging Time :	~17 hours
Aging Conditions :	Sealed, complete darkness, minimal air space	Aging Temperature :	4±2°C

Reference : Salinity Adjustment Guidance Document. Environment Canada, revised December 2001[e].

EXPOSURE CONCENTRATIONS WATER CHEMISTRY

Concentration (%)	Temp.(°C)	pH	Dissolved O_2 (mg/L)	O_2 Sat. (%)*	Salinity (‰)
Control	20.0	8.2	7.2	100	30
Blank	20.0	8.2	7.2	100	30
0.02	20.0	8.2	7.2	99	30
0.07	20.0	–	–	–	–
0.24	20.0	–	–	–	–
0.81	20.0	–	–	–	–
2.7	20.0	–	–	–	–
9	20.0	8.2	7.1	98	30
30	20.0	–	–	–	–
100	20.0	7.6	7.0	96	30

* % saturation, adjusted for temperature and barometric pressure
"–" not required/not measured
[3] if required
[4] at <100 bubbles/min

Data Reviewed By : JC
Date : 2014-11-13

CHAIN OF CUSTODY RECORD

AQUATOX

AquaTox Work Order No: 226790

Shipping Address: AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Road, RR #3
Guelph, Ontario Canada N1H 6H9

Voice: (519) 763-4412 **Fax:** (519) 763-4419

P.O. Number: SO. VENTURE PLATFORM
Field Sampler Name (print):
Signature: N/A
Affiliation: EXXONMOBIL
Sample Storage (prior to shipping): COOLER
Custody Relinquished by:
Date/Time Shipped: OCT 23/14

Client: HARRIS INDUSTRIAL TESTING SVC. LTD.
1320 ASHDALE RD. SO. RAWDON NS
B0N 1Z0

Phone: 902 757-0232
Fax: 902 757-2839
Contact: CAROL HARRIS

Sample Identification					Analyses Requested									Sample Method and Volume		
Date Collected (yyyy-mm-dd)	Time Collected (e.g. 14:30, 24 hr clock)	Sample Name	AquaTox Sample Number	Temp. on arrival	Rainbow Trout Single Concentration	Rainbow Trout LC50	*Daphnia magna* Single Concentration	*Daphnia magna* LC50	Fathead Minnow Survival & Growth	*Ceriodaphnia dubia* Survival & Reproduction	*Lemna minor* Growth	*Pseudokirchneriella subcapitata* Growth	* Microtox	Grab	Composite	# of Containers and Volume (eg. 2 x 1L, 3 x 10L, etc.)
OCT 22-14		SO. VENTURE PRODUCED WATER	4189	15.0									✓	✓		1 L

For Lab Use Only
Received By: AW
Date: 2014-10-24
Time: 10:30
Storage Location:
Storage Temp.(°C):

Please list any special requests or instructions:
* ECHINOID FERTILIZATION. PERMISSION FROM MEGAN TUTTLE @ EXXONMOBIL TO HOLD THIS TESTING UNTIL OCT 30-14.

AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Rd.
RR 3
Guelph ON N1H 6H9
Tel: (519) 763-4412 Fax: (519) 763-4419

Test Report Revision

Client:	Harris Industrial Testing Service Ltd.
Address:	1320 Ashdale Rd., South Rawden NS, B0N 1Z0
AquaTox Sample #:	41774
Test Description:	EPS 1/RM/24 and EPS 1/RM/27

Revision Requested By: ☐ Internal Audit ☒ Client ☐ External Audit

Description of Report Revision(s):

The sample collection date provided on the chain of custody was incorrect.

Remedial Action(s):

At the request of the client, the sampling date was changed from 2014-10-21 to 2014-10-20. Test reports were revised and submitted to the client.

Attachment(s) :

Revised test reports.

Name	Title	Date
	Laboratory Technician	2014-11-20

AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Rd.
RR 3
Guelph ON N1H 6H9
Tel: (519) 763-4412 Fax: (519) 763-4419

Work Order : 226759
Sample Number : 41774

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.	Time Collected :	Not given
Location :	South Rawden NS	Date Collected :	2014-10-20
Substance :	THEBAUD PRODUCED WATER	Sample Volume :	1 x 1L jar
Sampling Method :	Grab	Date Received :	2014-10-22
Sampled By :	Not given	Date Tested :	2014-10-23
Sample Description :	Cloudy, light yellow, strong odour.	Temp. on arrival :	17.0°C

Test Method : Toxicity Test Using Luminescent Bacteria, Protocol EPS 1/RM/24, Environment Canada, 1992.

TEST RESULTS

Test Endpoint	Value	95% Confidence Limits	Calculation Method
15 minute IC50	2.79%	2.18-3.56	Least Square Regression

The results reported relate only to the sample tested.

REFERENCE TOXICANT DATA

Reagent Batch :	13J4129	15 minute IC50 :	0.62 mg/L
Expiry Date :	10/2015	95% Confidence Limits :	0.49-0.79 mg/L
Date Tested (yyyy-mm-dd) :	2014-10-07	Historical Mean IC50 :	0.71 mg/L
Reference Substance :	Zinc (as zinc sulphate)	Warning Limits (± 2SD) :	0.49-1.04 mg/L
Statistical Method :	Least Square Regression	Analyst(s):	CN

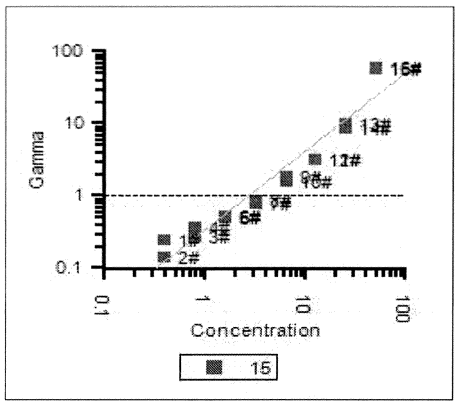
CONDITIONS OF ACUTE MICROTOX TEST

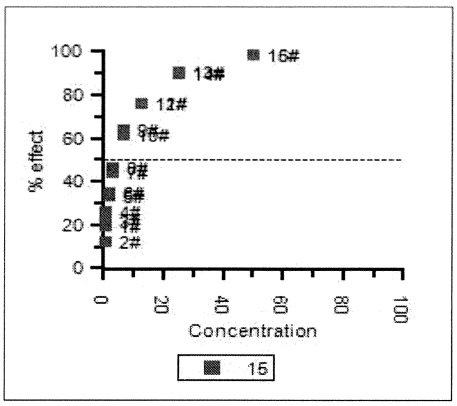
Test Organism :	*Vibrio fischeri*	Test Initiation Time :	15:40
Reagent Batch :	13J4129	Observation Time(s) :	15 minutes
Date Reagent Received :	2014-06-17	Sample Pre-aeration/Aeration :	None
Reagent Holding Temperature :	-23 °C	Sample pH :	5.8
Analyzer Model Number :	M500	pH Adjustment :	None
Test Well Temperature :	15.0 ± 0.3 °C	Salinity Adjustment :	Not required
Highest Concentration Tested :	50 %	Final Salinity :	≥2% NaCl
Number of Controls :	2	Dilution Water :	AquaTox Diluent
Number of Concentrations Tested :	8	Sample Storage :	4±2 °C
Number of Replicates :	2	Colour Correction :	None
Appearance of Test Solutions :	No changes noted.	Analyst(s):	AW
		Test Method Deviation(s) :	None

Date: 2014-11-21
yyyy-mm-dd

Approved by: _____
Project Manager

Work Order : 226759
Sample Number : 41774





Time	Sample	Conc. (%)	I0	It	Gamma	% Effect
15 Mins						
	Control	0.00	91	78	0.8547#	
	Control	0.00	94	80	0.8526#	
	Control	0.00	89	79	0.8858#	
	Control	0.00	93	85	0.9110#	
	1	0.39	95	67	0.2445#	19.65%
	2	0.39	89	68	0.1432#	12.53%
	3	0.78	88	60	0.2747#	21.55%
	4	0.78	94	61	0.3594#	26.44%
	5	1.56	88	52	0.4932#	33.03%
	6	1.56	92	52	0.5349#	34.85%
	7	3.13	87	43	0.7891#	44.11%
	8	3.13	97	45	0.8749#	46.66%
	9	6.25	95	30	1.786#	64.11%
	10	6.25	94	32	1.607#	61.65%
	11	12.50	93	20	3.170#	76.02%
	12	12.50	95	20	3.216#	76.28%
	13	25.00	94	8	9.816#	90.75%
	14	25.00	92	8	8.698#	89.69%
	15	50.00	94	1	57.09#	98.28%
	16	50.00	97	1	61.76#	98.41%

- included, * - invalid

Statistics:

Data: 15 Mins

EC50 Concentration: 2.785%
(95% Confidence Range: 2.178 to 3.561)
95% Confidence Factor: 1.279
Estimating Equation:
LOG C = 0.8567 x LOG G +0.4449
Correction Factor: 0.8760
Slope: 1.089
Coeff of Determination (R^2): 0.9332

Test Data Reviewed By : JL
Date : 2014-11-20

AQUATOX
AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Rd.
RR 3
Guelph ON N1H 6H9
Tel: (519) 763-4412 Fax: (519) 763-4419

Work Order : 226759
Sample Number : 41774

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.		
Location :	South Rawden NS	Date Collected :	2014-10-20
Substance :	THEBAUD PRODUCED WATER	Time Collected :	Not given
Sampling Method :	Grab	Date Received :	2014-10-22
Sampled By :	Not given	Time Received :	08:45
Temp. on arrival :	17.0°C	Date Tested :	2014-10-23
Sample Description :	Cloudy, light yellow, strong odour.		

Test Method : Fertilization Assay Using Echinoids (Sea Urchins and Sand Dollars). Environment Canada, Conservation and Protection. Ottawa, Ontario. EPS 1/RM/27, 2nd ed. (February 2011), with deviation(s) as noted below.

TEST RESULTS

Effect	Value	95% Confidence Limits	Statistical Method
IC25 (Fertilization)	0.21%	0.17-0.25	Non Linear Regression* (CETIS) a

The results reported relate only to the sample tested.

COPPER (AS COPPER SULPHATE) REFERENCE TOXICANT DATA

Date Tested :	2014-10-23	Statistical Method :	Linear Interpolation (CETIS)[a]
Gamete Batch :	Ur14-10-01	Historical Mean IC25 :	139 µg/L
Test Duration :	20 minutes	Warning Limits (± 2SD) :	65 - 301 µg/L
IC25 Fertilization :	86 µg/L	Analyst(s) :	SF, DK
95% Confidence Limits :	68 - 114 µg/L		

The reference toxicant test was performed under the same experimental conditions as those used with the test sample.

TEST CONDITIONS

Test Vessel :	20 mL glass scintillation vial	Control/Dilution Water[1] :	Artificial Sea Water
Volume per Replicate :	10 mL	Sperm Exposure Time [2]:	20 min
Number of Replicates :	4 per treatment	Egg Exposure Time :	10 min
Depth of Test Solution :	Approx. 3 cm	Total Duration of Test :	20 min
Sperm Density :	40000000 per vessel	pH Adjustment :	None
Sperm : Egg Ratio :	20000 : 1	Sample Filtration :	None
Males Used to Pool Sperm :	4	Test Aeration :	None
Females Used to Pool Eggs :	3	Test Method Deviation(s) :	Yes (see 'Comments')

[1] no additional chemicals
[2] 10 min exposure, continued for an additional 10 min after addition of eggs

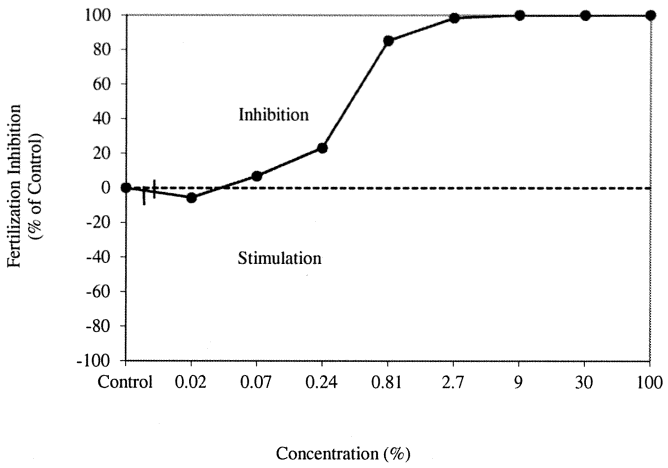
COMMENTS

Noted Deviation(s): The salinity of the 100% sample as submitted was 139‰. Therefore, salinity of the 9%, 30%, and 100% exposure concentrations exceeded the maximum of 32‰ allowed by the test method cited above.

*Binomial weighting (CETIS[a]) was applied.
•All test validity criteria as specified in the test method cited above were satisfied.

Work Order : 226759
Sample Number : 41774

Sea Urchin Fertilization Inhibition



TEST ORGANISM

Adult Test Organism :	*Lytechinus pictus*	Holding Salinity :	34 ± 2 ‰
Adult Organism Source :	Marinus Scientific	Holding Vessel :	Glass aquaria
Source Location :	Garden Grove CA USA	Adult Mortality Rate :	0% (previous 7 days)
Date Received :	2013-05-30	Life Stage Tested :	Gamete (sperm/egg)
Holding Water :	Artificial Sea Water	Gamete Batch Tested :	Ur14-10-01
Holding Temperature :	12 - 15 °C		

Reference : Recommended Procedure for the Importation of Test Organisms for Sublethal Toxicity Testing. Environment Canada, September 1999.

REFERENCES

[a] CETIS, © 2001-2007. V.1.8.5.5. Comprehensive Environmental Toxicity Information System. Tidepool Scientific Software, McKinleyville, Calif. 95519[Program on disk and printed User's Guide].

[e]Environment Canada. 2001. Revised Procedures for Adjusting Salinity of Effluent Samples for Marine Sublethal Toxicity Testing Conducted under Environmental Effects Monitoring (EEM) Programs. Method Development and Applications Section, Environmental Technology Centre, December 2001.

Date : 2014-11-21
yyyy-mm-dd

Approved By :
Project Manager

Work Order : 226759
Sample Number : 41774

FERTILIZATION DATA

Test Conducted By : SF/DK
Enumerated By : DK

Concentration (%)	Replicate	Fertilized	Unfertilized	% Fertilized	Treatment Mean Fertilization (%)	Standard Deviation
Control	A	81	19	81	**79.75**	**1.50**
	B	79	21	79		
	C	81	19	81		
	D	78	22	78		
Blank	A	0	100	0	**0**	**0.00**
	B	0	100	0		
	C	0	100	0		
	D	0	100	0		
0.02	A	84	16	84	**84.25**	**1.71**
	B	82	18	82		
	C	85	15	85		
	D	86	14	86		
0.07	A	73	27	73	**74.25**	**2.22**
	B	77	23	77		
	C	72	28	72		
	D	75	25	75		
0.24	A	50	50	50	**61.25**	**8.06**
	B	61	39	61		
	C	66	34	66		
	D	68	32	68		
0.81	A	12	88	12	**11.75**	**2.50**
	B	15	85	15		
	C	9	91	9		
	D	11	89	11		
2.7	A	2	98	2	**1.25**	**0.50**
	B	1	99	1		
	C	1	99	1		
	D	1	99	1		
9	A	0	100	0	**0**	**0.00**
	B	0	100	0		
	C	0	100	0		
	D	0	100	0		
30	A	0	100	0	**0**	**0.00**
	B	0	100	0		
	C	0	100	0		
	D	0	100	0		
100	A	0	100	0	**0**	**0.00**
	B	0	100	0		
	C	0	100	0		
	D	0	100	0		

"–" = not counted/not required

NOTES :

- No organisms or gametes exhibiting unusual appearance, behaviour, or undergoing unusual treatment were used in the test.
- Gamete viability test was performed prior to pooling of test gametes.
- A pre-test was conducted prior to testing.
- Preserved eggs were stored for 1 day prior to enumeration.
- No outlying data points were detected according to Grubbs Test (CETIS)[a]

Data Reviewed By : JL
Date : 2014-11-20

Work Order : 226759
Sample Number : 41774

INITIAL WATER CHEMISTRY (100% SAMPLE)

	Temp.(°C)	pH	Dissolved O_2 (mg/L)	O_2 Sat. (%)*	Salinity (‰)	Pre-aeration Time (h)
Initial Chemistry:	20.0	5.5	6.6	88	139	–
Chemistry after Salinity Adjustment [3]:	–	–	–	–	–	–
Chemistry after Pre-Aeration[3,4]:	–	–	–	–	–	0:00

SALINITY ADJUSTMENT

Method :	Not applicable[5]	Volume Adjusted :	Not applicable[5]
Salt Added :	Not applicable[5]	Amount of Salt Added :	Not applicable[5]
Date Adjusted :	Not applicable[5]	Aging Time :	Not applicable[5]
Aging Conditions :	Not applicable[5]	Aging Temperature :	Not applicable[5]

[5]Note: The 100% effluent did not require salinity adjustment since the initial sample salinity was 139‰. Therefore the effluent was tested as received.

Reference : Salinity Adjustment Guidance Document. Environment Canada, revised December 2001[e].

EXPOSURE CONCENTRATIONS WATER CHEMISTRY

Concentration (%)	Temp.(°C)	pH	Dissolved O_2 (mg/L)	O_2 Sat. (%)*	Salinity (‰)
Control	20.0	8.3	7.5	101	30
Blank	20.0	8.3	7.5	101	30
0.02	20.0	8.3	6.6	89	30
0.07	20.0	–	–	–	–
0.24	20.0	–	–	–	–
0.81	20.0	–	–	–	–
2.7	20.0	8.0	7.0	94	32
9	20.0	7.5	6.3	84	40
30	20.0	6.9	6.1	81	60
100	20.0	6.4	6.0	81	140

* % saturation, adjusted for temperature and barometric pressure
"–" not required/not measured
[3] if required
[4] at <100 bubbles/min

Data Reviewed By : JL
Date : 2014-11-20

CHAIN OF CUSTODY RECORD

AQUATOX

AquaTox Work Order No: 226759

Shipping Address: AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Road, RR #3
Guelph, Ontario Canada N1H 6H9

Voice: (519) 763-4412 **Fax:** (519) 763-4419

P.O. Number: THEBAUD PLATFORM
Field Sampler Name (print):
Signature: N/A
Affiliation: EXXONMOBIL
Sample Storage (prior to shipping): COOLER
Custody Relinquished by:
Date/Time Shipped: OCT 21 2014 - PUROLATOR

Client: HARRIS INDUSTRIAL TESTING SERVICE LTD.

Phone: 902 757-0232
Fax: 902 757-2839
Contact: CAROL HARRIS

Sample Identification					Analyses Requested									Sample Method and Volume		
Date Collected (yyyy-mm-dd)	Time Collected (e.g. 14:30, 24 hr clock)	Sample Name	AquaTox Sample Number	Temp. on arrival	Rainbow Trout Single Concentration	Rainbow Trout LC50	*Daphnia magna* Single Concentration	*Daphnia magna* LC50	Fathead Minnow Survival & Growth	*Ceriodaphnia dubia* Survival & Reproduction	*Lemna minor* Growth	*Pseudokirchneriella subcapitata* Growth	Microtox *	Grab	Composite	# of Containers and Volume (eg. 2 x 1L, 3 x 10L, etc.)
~~2014-10-21~~ 20		THEBAUD PRODUCED WATER	41774	17.0									↘	↘		1 L DK
as per email from Carol at Harris on 2014-11-20 (20)																

For Lab Use Only
Received By: DK
Date: 2014-11-22
Time: ~~8:50~~ DK 8:45
Storage Location:
Storage Temp.(°C)

Please list any special requests or instructions:
* ECHINOID FERTILIZATION

AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Rd.
RR 3
Guelph ON N1H 6H9
Tel: (519) 763-4412 Fax: (519) 763-4419

MICROTOX® ACUTE TOXICITY TEST REPORT

Work Order : 226758
Sample Number : 41773

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.	Time Collected :	08:00
Location :	South Rawden NS	Date Collected :	2014-10-21
Substance :	VENTURE PRODUCED WATER	Sample Volume :	1 x 1L jar
Sampling Method :	Grab	Date Received :	2014-10-22
Sampled By :	G.M.	Date Tested :	2014-10-23
Sample Description :	Cloudy, light brown, strong odour	Temp. on arrival :	17.0°C

Test Method : Toxicity Test Using Luminescent Bacteria, Protocol EPS 1/RM/24, Environment Canada, 1992.

TEST RESULTS

Test Endpoint	Value	95% Confidence Limits	Calculation Method
15 minute IC50	7.72%	6.82-8.74	Least Square Regression

The results reported relate only to the sample tested.

REFERENCE TOXICANT DATA

Reagent Batch :	13J4129	15 minute IC50 :	0.62 mg/L
Expiry Date :	10/2015	95% Confidence Limits :	0.49-0.79 mg/L
Date Tested (yyyy-mm-dd) :	2014-10-07	Historical Mean IC50 :	0.71 mg/L
Reference Substance :	Zinc (as zinc sulphate)	Warning Limits (± 2SD) :	0.49-1.04 mg/L
Statistical Method :	Least Square Regression	Analyst(s):	CN

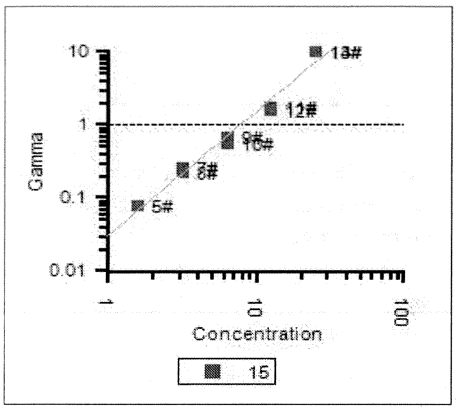
CONDITIONS OF ACUTE MICROTOX TEST

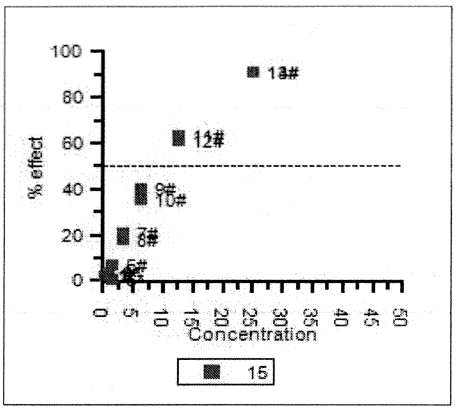
Test Organism :	*Vibrio fischeri*	Test Initiation Time :	14:40
Reagent Batch :	13J4129	Observation Time(s) :	15 minutes
Date Reagent Received :	2014-06-17	Sample Pre-aeration/Aeration :	None
Reagent Holding Temperature :	-23 °C	Sample pH :	5.8
Analyzer Model Number :	M500	pH Adjustment :	None
Test Well Temperature :	15.0 ± 0.3 °C	Salinity Adjustment :	Not required
Highest Concentration Tested :	50 %	Final Salinity :	≥2% NaCl
Number of Controls :	2	Dilution Water :	AquaTox Diluent
Number of Concentrations Tested :	8	Sample Storage :	4±2 °C
Number of Replicates :	2	Colour Correction :	None
Appearance of Test Solutions :	No changes noted.	Analyst(s):	AW
		Test Method Deviation(s) :	None

Date: 2014-11-14
yyyy-mm-dd

Approved by: _____
Project Manager

Work Order : 226758
Sample Number : 41773





Time	Sample	Conc (%)	I0	It	Gamma	%Effect
15 Mins						
	Control	0.00	88	69	0.7873#	
	Control	0.00	92	72	0.7864#	
	Control	0.00	91	69	0.7573#	
	Control	0.00	92	71	0.7716#	
	1	0.39	88	67	0.0198*	1.95%
	2	0.39	90	68	0.0218*	2.14%
	3	0.78	88	66	0.0390*	3.75%
	4	0.78	87	65	0.0372*	3.59%
	5	1.56	88	63	0.0764#	7.10%
	6	1.56	80	61	0.0094*	0.93%
	7	3.13	92	57	0.2637#	20.87%
	8	3.13	90	57	0.2174#	17.86%
	9	6.25	91	42	0.6665#	39.99%
	10	6.25	88	44	0.5408#	35.10%
	11	12.50	91	26	1.713#	63.14%
	12	12.50	88	27	1.568#	61.06%
	13	25.00	88	6	9.816#	90.75%
	14	25.00	88	6	9.777#	90.72%
	15	50.00	84	0	270.7*	99.63%
	16	50.00	84	0	281.5*	99.65%

- included, * - invalid

Statistics:

Data: 15 Mins

EC50 Concentration: 7.722%
(95% Confidence Range: 6.823 to 8.739)
95% Confidence Factor: 1.132
Estimating Equation:
LOG C = 0.5751 x LOG G +0.8877
Correction Factor: 0.7756
Slope: 1.699
Coeff of Determination (R^2): 0.9770

Test Data Reviewed By : VC
Date : 2014-11-03

AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Rd.
RR 3
Guelph ON N1H 6H9
Tel: (519) 763-4412 Fax: (519) 763-4419

Work Order : 226758
Sample Number : 41773

SAMPLE IDENTIFICATION

Company :	Harris Industrial Testing Service Ltd.		
Location :	South Rawden NS	Date Collected :	2014-10-21
Substance :	VENTURE PRODUCED WATER	Time Collected :	08:00
Sampling Method :	Grab	Date Received :	2014-10-22
Sampled By :	G.M.	Time Received :	08:45
Temp. on arrival :	17.0°C	Date Tested :	2014-10-23
Sample Description :	Cloudy, light brown, strong odour		

Test Method : Fertilization Assay Using Echinoids (Sea Urchins and Sand Dollars). Environment Canada, Conservation and Protection. Ottawa, Ontario. EPS 1/RM/27, 2nd ed. (February 2011), with deviation(s) as noted below.

TEST RESULTS

Effect	Value	95% Confidence Limits	Statistical Method
IC25 (Fertilization)	0.07%	0.06-0.09	Non Linear Regression* (CETIS) a

The results reported relate only to the sample tested.

COPPER (AS COPPER SULPHATE) REFERENCE TOXICANT DATA

Date Tested :	2014-10-23	Statistical Method :	Linear Interpolation (CETIS)[a]
Gamete Batch :	Ur14-10-01	Historical Mean IC25 :	139 µg/L
Test Duration :	20 minutes	Warning Limits (± 2SD) :	65 - 301 µg/L
IC25 Fertilization :	86 µg/L	Analyst(s) :	SF, DK
95% Confidence Limits :	68 - 114 µg/L		

The reference toxicant test was performed under the same experimental conditions as those used with the test sample.

TEST CONDITIONS

Test Vessel :	20 mL glass scintillation vial	Control/Dilution Water[1] :	Artificial Sea Water
Volume per Replicate :	10 mL	Sperm Exposure Time [2]:	20 min
Number of Replicates :	4 per treatment	Egg Exposure Time :	10 min
Depth of Test Solution :	Approx. 3 cm	Total Duration of Test :	20 min
Sperm Density :	40000000 per vessel	pH Adjustment :	None
Sperm : Egg Ratio :	20000 : 1	Sample Filtration :	None
Males Used to Pool Sperm :	4	Test Aeration :	None
Females Used to Pool Eggs :	3	Test Method Deviation(s) :	Yes (see 'Comments')

[1] no additional chemicals
[2] 10 min exposure, continued for an additional 10 min after addition of eggs

COMMENTS

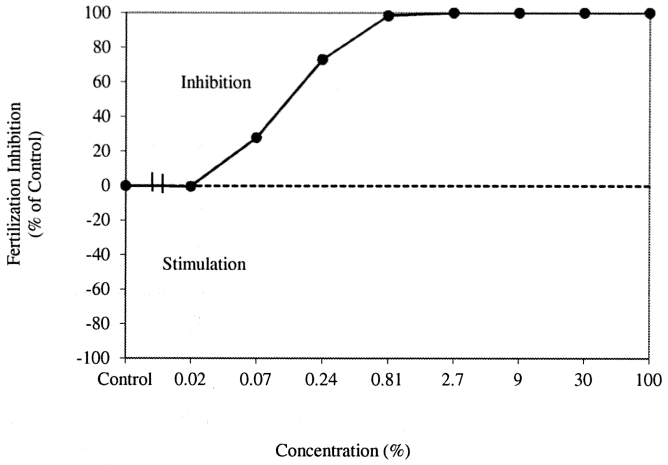
Noted Deviation(s): The salinity of the 100% sample as submitted was 196‰. Therefore, salinity of the 100%, 30%, 9%, and 2.7% exposure concentrations exceeded the maximum of 32‰ allowed by the test method cited above.

*Binomial weighting (CETIS[a]) was applied.

•All test validity criteria as specified in the test method cited above were satisfied.

Work Order : 226758
Sample Number : 41773

Sea Urchin Fertilization Inhibition



TEST ORGANISM

Adult Test Organism :	*Lytechinus pictus*	Holding Salinity :	34 ± 2 ‰
Adult Organism Source :	Marinus Scientific	Holding Vessel :	Glass aquaria
Source Location :	Garden Grove CA USA	Adult Mortality Rate :	0% (previous 7 days)
Date Received :	2013-05-30	Life Stage Tested :	Gamete (sperm/egg)
Holding Water :	Artificial Sea Water	Gamete Batch Tested :	Ur14-10-01
Holding Temperature :	12 - 15 °C		

Reference : Recommended Procedure for the Importation of Test Organisms for Sublethal Toxicity Testing. Environment Canada, September 1999.

REFERENCES

[a] CETIS, © 2001-2007. V.1.8.5.5. Comprehensive Environmental Toxicity Information System. Tidepool Scientific Software, McKinleyville, Calif. 95519[Program on disk and printed User's Guide].

[e]Environment Canada. 2001. Revised Procedures for Adjusting Salinity of Effluent Samples for Marine Sublethal Toxicity Testing Conducted under Environmental Effects Monitoring (EEM) Programs. Method Development and Applications Section, Environmental Technology Centre, December 2001.

Date : 2014-11-14
yyyy-mm-dd

Approved By :
Project Manager

Work Order : 226758
Sample Number : 41773

FERTILIZATION DATA

Test Conducted By : SF/DK
Enumerated By : DK

Concentration (%)	Replicate	Fertilized	Unfertilized	% Fertilized	Treatment Mean Fertilization (%)	Standard Deviation
Control	A	77	23	77	**80.75**	**2.87**
	B	83	17	83		
	C	83	17	83		
	D	80	20	80		
Blank	A	0	100	0	**0**	**0.00**
	B	0	100	0		
	C	0	100	0		
	D	0	100	0		
0.02	A	86	14	86	**81**	**4.16**
	B	80	20	80		
	C	82	18	82		
	D	76	24	76		
0.07	A	62	38	62	**58.25**	**3.50**
	B	54	46	54		
	C	60	40	60		
	D	57	43	57		
0.24	A	21	79	21	**21.75**	**2.22**
	B	23	77	23		
	C	19	81	19		
	D	24	76	24		
0.81	A	1	99	1	**1.25**	**0.50**
	B	1	99	1		
	C	1	99	1		
	D	2	98	2		
2.7	A	0	100	0	**0**	**0.00**
	B	0	100	0		
	C	0	100	0		
	D	0	100	0		
9	A	0	100	0	**0**	**0.00**
	B	0	100	0		
	C	0	100	0		
	D	0	100	0		
30	A	0	100	0	**0**	**0.00**
	B	0	100	0		
	C	0	100	0		
	D	0	100	0		
100	A	0	100	0	**0**	**0.00**
	B	0	100	0		
	C	0	100	0		
	D	0	100	0		

"–" = not counted/not required

NOTES :

- No organisms or gametes exhibiting unusual appearance, behaviour, or undergoing unusual treatment were used in the test.
- Gamete viability test was performed prior to pooling of test gametes.
- A pre-test was conducted prior to testing.
- Preserved eggs were stored for 1 day prior to enumeration.
- No outlying data points were detected according to Grubbs Test (CETIS)[a]

Data Reviewed By : _____
Date : 2014-11-13

Work Order : 226758
Sample Number : 41773

INITIAL WATER CHEMISTRY (100% SAMPLE)

	Temp.(°C)	pH	Dissolved O_2 (mg/L)	O_2 Sat. (%)*	Salinity (‰)	Pre-aeration Time (h)
Initial Chemistry:	20.0	5.6	7.4	100	196	–
Chemistry after Salinity Adjustment [3]:	–	–	–	–	–	–
Chemistry after Pre-Aeration[3,4]:	–	–	–	–	–	0:00

SALINITY ADJUSTMENT

Method :	Not applicable[5]	Volume Adjusted :	Not applicable[5]
Salt Added :	Not applicable[5]	Amount of Salt Added :	Not applicable[5]
Date Adjusted :	Not applicable[5]	Aging Time :	Not applicable[5]
Aging Conditions :	Not applicable[5]	Aging Temperature :	Not applicable[5]

[5]Note: The 100% effluent did not require salinity adjustment since the initial sample salinity was 196‰. Therefore the effluent was tested as received.

Reference : Salinity Adjustment Guidance Document. Environment Canada, revised December 2001[e].

EXPOSURE CONCENTRATIONS WATER CHEMISTRY

Concentration (%)	Temp.(°C)	pH	Dissolved O_2 (mg/L)	O_2 Sat. (%)*	Salinity (‰)
Control	20.0	8.3	7.5	101	30
Blank	20.0	8.3	7.5	101	30
0.02	20.0	8.3	6.9	93	30
0.07	20.0	–	–	–	–
0.24	20.0	–	–	–	–
0.81	20.0	8.2	7.3	98	31
2.7	20.0	8.0	6.9	92	34
9	20.0	7.3	6.8	91	44
30	20.0	6.8	6.1	82	83
100	20.0	6.1	6.0	81	198

* % saturation, adjusted for temperature and barometric pressure
"–" not required/not measured
[3] if required
[4] at <100 bubbles/min

Data Reviewed By : _____
Date : 2014-11-13

CHAIN OF CUSTODY RECORD

AQUATOX

AquaTox Work Order No: 226758

Shipping Address: AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Road, RR #3
Guelph, Ontario Canada N1H 6H9

Voice: (519) 763-4412 **Fax:** (519) 763-4419

P.O. Number: VENTURE PLATFORM
Field Sampler Name (print): Graham MacKay
Signature: N/A
Affiliation: EXXON MOBIL
Sample Storage (prior to shipping): COOLER
Custody Relinquished by:
Date/Time Shipped: OCT 21 2014 - PUROLATOR

Client: HARRIS INDUSTRIAL TESTING SERVICE LTD.
1320 ASHDALE RD.
SOUTH RAWDON NS
B0N 1Z0

Phone: 902 757-0232
Fax: 902 757-2839
Contact: CAROL HARRIS

Sample Identification					Analyses Requested									Sample Method and Volume		
Date Collected (yyyy-mm-dd)	Time Collected (e.g. 14:30, 24 hr clock)	Sample Name	AquaTox Sample Number	Temp. on arrival	Rainbow Trout Single Concentration	Rainbow Trout LC50	*Daphnia magna* Single Concentration	*Daphnia magna* LC50	Fathead Minnow Survival & Growth	*Ceriodaphnia dubia* Survival & Reproduction	*Lemna minor* Growth	*Pseudokirchneriella subcapitata* Growth	Microtox *	Grab	Composite	# of Containers and Volume (eg. 2 x 1L, 3 x 10L, etc.)
2014-10-21	8:00* OK	VENTURE PRODUCED WATER	41773	17.0									✓	✓		1L DK

For Lab Use Only
Received By: DK
Date: 2014-10-22
Time: 8:45
Storage Location:
Storage Temp.(°C)

Please list any special requests or instructions:
* ECHINOID FERTILIZATION
* From sample label DK

Standard COC with Microtox rev 2 2009 07 09 TC

REPORT OF ANALYSIS - PRODUCED WATER

CLIENT: ExxonMobil Canada, 500 Sable Road, Highway 316, Goldboro, NS B0H 1L0

CLIENT REFERENCE NO.: *SO#4502315718 WO#70424146*

SGS JOB/SAMPLE NO.: EMC-2256 **DATE SAMPLED:** October 26, 2014

SAMPLE DESCRIPTION: Produced Water **TIME SAMPLED:** N/A

SAMPLE SOURCE: Alma Platform **SAMPLED BY:** N/A

METAL PREP: (Total or Dissolved): Total **DATE RECEIVED:** October 27, 2014

DATE REPORTED: November 4, 2014

TEST	METHOD	Detection Limit (mg/L)	RESULT	SMC
Ammonia+Ammonium (N) (mg/L)	SM4500-NH3 G	0.1	42.3	20112272
T. Kjeldahl Nitrogen (as N mg/L)	SM4500-NORG D	0.4	20	20112278
Mercury (mg/L)	SM3112 B	0.00005	<00005	20112276
Aluminum (mg/L)	SM3125	0.005	0.007	20112272
Arsenic (mg/L)	SM3125	0.002	0.009	20112272
Barium (mg/L)	SM3125	0.005	19.2	20112272
Boron (mg/L)	SM3125	0.005	8.03	20112272
Cadmium (mg/L)	SM3125	0.000017	<0.000017	20112272
Cobalt (mg/L)	SM3125	0.001	0.001	20112272
Chromium (mg/L)	SM3125	0.001	0.002	20112272
Copper (mg/L)	SM3125	0.001	0.004	20112272
Iron (mg/L)	SM3125	0.05	12.4	20112272
Magnesium (mg/L)	SM3125	0.1	56	20112272
Manganese (mg/L)	SM3125	0.0005	<0.0005	20112272
Molybdenum (mg/L)	SM3125	0.002	<0.002	20112272
Nickel (mg/L)	SM3125	0.002	0.011	20112272
Phosphorus (mg/L)	SM3125	0.006	0.027	20112272
Lead (mg/L)	SM3125	0.0005	<0.0005	20112272
Antimony (mg/L)	SM3125	0.002	<0.002	20112272
Selenium (mg/L)	SM3125	0.001	<0.001	20112272
Tin (mg/L)	SM3125	0.002	<0.002	20112272
Strontium (mg/L)	SM3125	0.005	71.9	20112272
Sulphur (mg/L)	EPA 200.7	0.5	<0.5	20112272
Thorium (mg/L)	EPA 200.8	0.1	<0.1	20112272
Uranium (mg/L)	SM3125	0.0001	<0.0001	20112272
Vanadium (mg/L)	SM3125	0.002	<0.002	20112272
Zinc (mg/L)	SM3125	0.005	<0.005	20112272
Total Petroleum Hydrocarbons (mg/L)	CCME	0.1	41.5	20112256
pH (no unit)	SM4500 H+B	-	6.6	5106294

Notes: Tested by AGAT Laboratories, Dartmouth, NS

Approved by Supervisor: R' O'Donnell

SGS Canada Inc. | Oil, Gas & Chemicals Services
4092 Port Malcolm Road Point Tupper NS B9A 1Z5 t (902) 625-3233 f (902) 625-0264 www.sgs.ca

---End of Report---

REPORT OF ANALYSIS - PRODUCED WATER

CLIENT: ExxonMobil Canada, 500 Sable Road, Highway 316, Goldboro, NS B0H 1L0

CLIENT REFERENCE NO.: *SO#4502315718 WO#70424146*

SGS JOB/SAMPLE NO.: EMC-2256 **DATE SAMPLED:** October 21, 2014

SAMPLE DESCRIPTION: Produced Water **TIME SAMPLED:** N/A

SAMPLE SOURCE: Venture Platform **SAMPLED BY:** N/A

METAL PREP: (Total or Dissolved): Total **DATE RECEIVED:** October 21, 2014

DATE REPORTED: November 4, 2014

TEST	METHOD	Detection Limit (mg/L)	RESULT	SMC
Ammonia+Ammonium (N) (mg/L)	SM4500-NH3 G	0.1	887	20112272
T. Kjeldahl Nitrogen (as N mg/L)	SM4500-NORG D	0.4	459	20112278
Mercury (mg/L)	SM3112 B	0.00005	<0.00005	20112276
Aluminum (mg/L)	SM3125	0.005	0.179	20112272
Arsenic (mg/L)	SM3125	0.002	0.008	20112272
Barium (mg/L)	SM3125	0.005	1250	20112272
Boron (mg/L)	SM3125	0.005	0.046	20112272
Cadmium (mg/L)	SM3125	0.000017	0.000066	20112272
Cobalt (mg/L)	SM3125	0.001	0.033	20112272
Chromium (mg/L)	SM3125	0.001	0.005	20112272
Copper (mg/L)	SM3125	0.001	0.052	20112272
Iron (mg/L)	SM3125	0.05	154	20112272
Magnesium (mg/L)	SM3125	0.1	1330	20112272
Manganese (mg/L)	SM3125	0.002	27.2	20112272
Molybdenum (mg/L)	SM3125	0.002	0.004	20112272
Nickel (mg/L)	SM3125	0.002	2.210	20112272
Phosphorus (mg/L)	SM3125	0.006	0.009	20112272
Lead (mg/L)	SM3125	0.0005	0.0081	20112272
Antimony (mg/L)	SM3125	0.002	0.008	20112272
Selenium (mg/L)	SM3125	0.001	<0.001	20112272
Tin (mg/L)	SM3125	0.002	<0.002	20112272
Strontium (mg/L)	SM3125	0.005	2000	20112272
Sulphur (mg/L)	EPA 200.7	50	<50	20112272
Thorium (mg/L)	EPA 200.8	3	<3	20112272
Uranium (mg/L)	SM3125	0.0001	<0.0001	20112272
Vanadium (mg/L)	SM3125	0.002	<0.002	20112272
Zinc (mg/L)	SM3125	0.005	0.146	20112272
Total Petroleum Hydrocarbons (mg/L)	CCME	0.1	36.85	20112256
pH (no unit)	SM4500 H+B	-	6.1	5106294

Notes: Tested by AGAT Laboratories, Dartmouth, NS

Approved by Supervisor: R' O'Donnell

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---End of Report---

REPORT OF ANALYSIS - PRODUCED WATER

CLIENT: ExxonMobil Canada, 500 Sable Road, Highway 316, Goldboro, NS B0H 1L0

CLIENT REFERENCE NO.: *SO#4502315718 WO#70424146*

SGS JOB/SAMPLE NO.: EMC-2256 **DATE SAMPLED:** October 20, 2014

SAMPLE DESCRIPTION: Produced Water **TIME SAMPLED:** N/A

SAMPLE SOURCE: Thebaud Platform **SAMPLED BY:** N/A

METAL PREP: (Total or Dissolved): Total **DATE RECEIVED:** October 21, 2014

DATE REPORTED: November 4, 2014

TEST	METHOD	Detection Limit (mg/L)	RESULT	SMC
Ammonia+Ammonium (N) (mg/L)	SM4500-NH3 G	0.1	560	20112272
T. Kjeldahl Nitrogen (as N mg/L)	SM4500-NORG D	0.4	265	20112278
Mercury (mg/L)	SM3112 B	0.00005	0.00232	20112276
Aluminum (mg/L)	SM3125	0.005	0.025	20112272
Arsenic (mg/L)	SM3125	0.002	<0.002	20112272
Barium (mg/L)	SM3125	0.005	739	20112272
Boron (mg/L)	SM3125	0.005	0.671	20112272
Cadmium (mg/L)	SM3125	0.000017	0.000078	20112272
Cobalt (mg/L)	SM3125	0.001	0.010	20112272
Chromium (mg/L)	SM3125	0.001	0.010	20112272
Copper (mg/L)	SM3125	0.001	0.024	20112272
Iron (mg/L)	SM3125	0.05	112	20112272
Magnesium (mg/L)	SM3125	0.0001	817	20112272
Manganese (mg/L)	SM3125	0.002	15.6	20112272
Molybdenum (mg/L)	SM3125	0.002	0.002	20112272
Nickel (mg/L)	SM3125	0.002	0.139	20112272
Phosphorus (mg/L)	SM3125	0.006	0.02	20112272
Lead (mg/L)	SM3125	0.0005	0.0089	20112272
Antimony (mg/L)	SM3125	0.002	0.003	20112272
Selenium (mg/L)	SM3125	0.001	<0.001	20112272
Tin (mg/L)	SM3125	0.002	<0.002	20112272
Strontium (mg/L)	SM3125	0.005	1180	20112272
Sulphur (mg/L)	EPA 200.7	50	<50	20112272
Thorium (mg/L)	EPA 200.8	3	<3	20112272
Uranium (mg/L)	SM3125	0.0001	<0.0001	20112272
Vanadium (mg/L)	SM3125	0.002	<0.002	20112272
Zinc (mg/L)	SM3125	0.005	1.56	20112272
Total Petroleum Hydrocarbons (mg/L)	CCME	0.1	79.5	20112256
pH (no unit)	SM4500 H+B	-	6.0	5106294

Notes: Tested by AGAT Laboratories, Dartmouth, NS

Approved by Supervisor: R' O'Donnell

SGS Canada Inc. | Oil, Gas & Chemicals Services
4092 Port Malcolm Road Point Tupper NS B9A 1Z5 t (902) 625-3233 f (902) 625-0264 www.sgs.ca

---End of Report---

REPORT OF ANALYSIS - PRODUCED WATER

CLIENT: ExxonMobil Canada, 500 Sable Road, Highway 316, Goldboro, NS B0H 1L0

CLIENT REFERENCE NO.: *SO#4502315718 WO#70424146*

SGS JOB/SAMPLE NO.: EMC-2256 **DATE SAMPLED:** October 22, 2014

SAMPLE DESCRIPTION: Produced Water **TIME SAMPLED:** N/A

SAMPLE SOURCE: South Venture Platform **SAMPLED BY:** N/A

METAL PREP: (Total or Dissolved): Total **DATE RECEIVED:** October 23, 2014

DATE REPORTED: November 4, 2014

TEST	METHOD	Detection Limit (mg/L)	RESULT	SMC
Ammonia+Ammonium (N) (mg/L)	SM4500-NH3 G	0.1	65.1	20112272
T. Kjeldahl Nitrogen (as N mg/L)	SM4500-NORG D	0.4	32.4	20112278
Mercury (mg/L)	SM3112 B	0.00005	<0.00005	20112276
Aluminum (mg/L)	SM3125	0.005	<0.005	20112272
Arsenic (mg/L)	SM3125	0.002	<0.002	20112272
Barium (mg/L)	SM3125	0.005	9.96	20112272
Boron (mg/L)	SM3125	0.005	0.624	20112272
Cadmium (mg/L)	SM3125	0.000017	<0.000017	20112272
Cobalt (mg/L)	SM3125	0.001	0.001	20112272
Chromium (mg/L)	SM3125	0.001	0.001	20112272
Copper (mg/L)	SM3125	0.001	0.002	20112272
Iron (mg/L)	SM3125	0.05	7.14	20112272
Magnesium (mg/L)	SM3125	0.1	15	20112272
Manganese (mg/L)	SM3125	0.002	0.265	20112272
Molybdenum (mg/L)	SM3125	0.002	0.002	20112272
Nickel (mg/L)	SM3125	0.002	0.015	20112272
Phosphorus (mg/L)	SM3125	0.006	0.024	20112272
Lead (mg/L)	SM3125	0.0005	<0.0005	20112272
Antimony (mg/L)	SM3125	0.002	<0.002	20112272
Selenium (mg/L)	SM3125	0.001	<0.001	20112272
Tin (mg/L)	SM3125	0.002	<0.002	20112272
Strontium (mg/L)	SM3125	0.005	13.2	20112272
Sulphur (mg/L)	EPA 200.7	0.5	14.8	20112272
Thorium (mg/L)	EPA 200.8	0.1	<0.1	20112272
Uranium (mg/L)	SM3125	0.0001	0.0014	20112272
Vanadium (mg/L)	SM3125	0.002	<0.002	20112272
Zinc (mg/L)	SM3125	0.005	0.01	20112272
Total Petroleum Hydrocarbons (mg/L)	CCME	0.1	50.7	20112256
pH (no unit)	SM4500 H+B	-	6.6	5106294

Notes: Tested by AGAT Laboratories, Dartmouth, NS

Approved by Supervisor: R' O'Donnell

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---End of Report---

FISH TOXICITY REPORT (LC_{50})

Client:	Exxon Mobil Canada	Test Facility:	Harris Industrial Testing Service Ltd.
Address:	Founders Square Halifax, N.S.	Location:	1320 Ashdale Rd., South Rawdon, Nova Scotia Canada B0N 1Z0
Contact:	Megan Tuttle	Ph : 902 757-0232	Fax: 902 757-0973 hits@eastlink.ca

SAMPLE DATA

Lab ID. # 14-515

Sample/Location:	Alma Platform Produced Water		
Sampling Method:	Grab	Sample Homogenized: No	Sampler: B. MacLean
Date/Time Collected:	Oct. 26 2014 1200 Hrs		Received: Oct. 27 2014
Date/Time Started:	Oct. 28 2014 1145 Hrs		Completed: Nov. 01 2014 1145 Hrs
Sample Description:	Pale orange, slightly hazy liquid with mild petroleum odour.		

TEST INFORMATION

Reference Method:
EPS 1/RM/10 July 1990
with 2000 Amendments
Type: LC_{50} Tox 9B
Test Organism: Threespine Stickleback

PRE-TEST PARAMETERS

Pre-test Temperature: 16.0 ºC
Pre-test D.O.: 6.9 mg/L
Pre-test pH: 6.3 Adjusted: No
Salinity of Sample: 12.6 ppt
Salinity of Control: 30.9 ppt

Mandatory 30 minute pre-aeration:
Rate: 6.5 ± 1 ml/min/L
Time: 1115 hrs D.O.: 7.5 mg/L
Continued: _ min. @ _ hrs
Cont'd throughout test by airstone

TEST CONDITIONS

TSS Batch #: 42
Mortality: 1.4% over 7 days prior to test

Test Volume: 9 L Depth: 15.8 cm
Replicates: No
Number of fish per vessel: 10

Loading Density: 0.31 g/L
Mean fork length: 31 mm ± 2.0 mm SD
Range: 27 mm - 34 mm

Mean wet weight: 0.28 g ± 0.05 g SD
Range: 0.19 g - 0.35 g

Photoperiod: 16L/8D
Lux: 100 - 500
Static Test
Duration: 96 hours
Control/Dilution Water: Seawater
Temperature: 15±1ºC

TEST PARAMETERS / RESULTS

Conc %	Initial (0 Hrs) Temp ºC	D.O mg/L	pH	Sal. ppt	Final (96 Hrs) Temp ºC	D.O mg/L	pH	Number Dead	Number Stressed	Comments
100	16.0	7.5	6.2	12.2	15.5	7.6	6.5	**10/10**	**0/10**	All dead @ 23 hrs.
50	15.5	8.6	6.6	21.6	14.5	8.3	6.9	**10/10**	**0/10**	All dead @ 23 hrs.
25	16.0	8.3	7.2	26.6	16.0	7.3	7.4	**1/10**	**0/10**	1 dead @ 23 hrs.
12.5	16.0	8.1	7.5	28.4	16.0	7.5	7.6	**0/10**	**0/10**	
6.25	16.0	7.9	7.7	29.7	16.0	7.4	7.6	**0/10**	**0/10**	
Ctl	16.0	8.0	7.9	30.9	16.0	7.3	7.7	**1/10**	**0/10**	1 dead @ 43.25 hrs.

96 HOUR LC_{50} RESULTS

LC_{50} Value: **33.0%**
95% Confidence Limits: 28.9 – 37.6%
Statistical Method: Spearman Karber - Toxstats

REFERENCE TOXICANT DATA:

Batch: 42

Reference Substance: Phenol
Test Date: Oct. 03 – 07 2014
96 Hour LC_{50} for Phenol: 12.6 mg/L
95% C.L.: 9.70 – 16.2 mg/L
Historical Phenol Mean: 15.5 mg/L
Warning Limits ± 2 SD: 11.7 – 20.5 mg/L

Comments:

Analyst(s): K. Marks, A. Huybers & G. Harris Verified by: C. Harris  Date: Nov. 03 2014

Accredited by the Canadian Association for Laboratory Accreditation (CALA). The test included in this report is within the scope of this accreditation. The results reported apply only to the sample tested. Results are based on nominal concentrations.

FISH TOXICITY REPORT (LC_{50})

Client:	Exxon Mobil Canada	Test Facility:	Harris Industrial Testing Service Ltd.
Address:	Founders Square Halifax, N.S.	Location:	1320 Ashdale Rd., South Rawdon, Nova Scotia Canada B0N 1Z0
Contact:	Megan Tuttle	Ph : 902 757-0232	Fax: 902 757-0973 hits@eastlink.ca

SAMPLE DATA

Sample/Location:	South Venture Produced Water	Lab ID. #	14-511
Sampling Method:	Grab Sample Homogenized: No	Sampler:	B. Huber
Date/Time Collected:	Oct. 22 2014 1200 Hrs	Received:	Oct. 23 2014
Date/Time Started:	Oct. 23 2014 1530 Hrs	Completed:	Oct. 27 2014 1530 Hrs
Sample Description:	Clear, colourless liquid.		

TEST INFORMATION

Reference Method:
EPS 1/RM/10 July 1990
with 2000 Amendments
Type: LC_{50} Tox 9B
Test Organism: Threespine Stickleback

PRE-TEST PARAMETERS

Pre-test Temperature: 16.0 ºC
Pre-test D.O.: 7.6 mg/L
Pre-test pH: 6.4 Adjusted: No
Salinity of Sample: 2.9 ppt
Salinity of Control: 30 ppt

Mandatory 30 minute pre-aeration:
Rate: 6.5 ± 1 ml/min/L
Time: 1500 hrs D.O.: 7.8 mg/L
Continued: _ min. @ _ hrs
Cont'd throughout test by airstone

TEST CONDITIONS

TSS Batch #: 42
Mortality: 3.0% over 7 days prior to test

Test Volume: 9 L Depth: 15.8 cm
Replicates: No
Number of fish per vessel: 10

Loading Density: 0.37 g/L
Mean fork length: 35 mm ± 4.5 mm SD
Range: 28 mm - 40 mm

Mean wet weight: 0.33 g ± 0.08 g SD
Range: 0.21 g - 0.44 g

Photoperiod: 16L/8D
Lux: 100 - 500
Static Test
Duration: 96 hours
Control/Dilution Water: Seawater
Temperature: 15±1ºC

TEST PARAMETERS / RESULTS

Conc %	Initial (0 Hrs) Temp ºC	D.O mg/L	pH	Sal. ppt	Final (96 Hrs) Temp ºC	D.O mg/L	pH	Number Dead	Number Stressed	Comments
100	16.0	7.9	6.3	2.9	14.0	9.8	7.4	**10/10**	**0/10**	All dead @ 16.5 hrs.
50	16.0	8.2	6.7	17.0	14.0	8.1	7.6	**3/10**	**0/10**	3 dead @ 16.5 hrs.
25	15.5	8.5	7.2	23.5	14.0	8.0	7.6	**1/10**	**0/10**	1 dead @ 66.5 hrs.
12.5	15.5	8.3	7.4	27.2	14.0	8.5	7.7	**0/10**	**0/10**	
6.25	15.5	8.4	7.6	28.7	14.0	8.5	7.8	**0/10**	**0/10**	
Seawater Control	15.5	8.4	7.8	31.1	14.0	8.4	7.8	**0/10**	**0/10**	
Sal. Adj. Control*	16.0	9.7	8.0	3.1	14.5	10.1	8.0	**1/10**	**0/10**	1 dead @ 42.5 hrs.

96 HOUR LC_{50} RESULTS

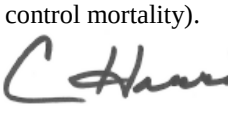
LC_{50} Value:	**52.1%**
95% Confidence Limits:	38.7 – 70.6
Statistical Method:	Probit - Toxstats

REFERENCE TOXICANT DATA:

Batch: 42

Reference Substance: Phenol
Test Date: Oct. 03 – 07 2014
96 Hour LC_{50} for Phenol: 12.6 mg/L
95% C.L.: 9.70 – 16.2 mg/L
Historical Phenol Mean: 15.5 mg/L
Warning Limits ± 2 SD: 11.7 – 20.5 mg/L

Comments: *This control was made by using Harris Industrial Well Water and adjusted using natural seawater to 3.1 ppt to match the salinity of the sample. 10% mortality occurred in this control (acceptable control mortality).

Analyst(s): K. Marks, A. Huybers & G. Harris Verified by: C. Harris  Date: Oct. 27 2014

Accredited by the Canadian Association for Laboratory Accreditation (CALA). The test included in this report is within the scope of this accreditation. The results reported apply only to the sample tested. Results are based on nominal concentrations.

FISH TOXICITY REPORT (LC_{50})

Client: Exxon Mobil Canada
Address: Founders Square
Halifax, N.S.
Contact: Megan Tuttle

Test Facility: Harris Industrial Testing Service Ltd.
Location: 1320 Ashdale Rd., South Rawdon, Nova Scotia
Canada B0N 1Z0
Ph : 902 757-0232 Fax: 902 757-0973 hits@eastlink.ca

SAMPLE DATA

Lab ID. # 14-504-B

Sample/Location: Thebaud Platform Produced Water
Sampling Method: Grab Sample Homogenized: No
Sampler: M. Burt
Date/Time Collected: Oct. 20 2014 1850 Hrs
Received: Oct. 21 2014
Date/Time Started: Oct. 22 2014 1300 Hrs
Completed: Oct. 26 2014 1300 Hrs
Sample Description: Pale yellow, hazy liquid with hydrocarbon odour.

TEST INFORMATION

Reference Method:
EPS 1/RM/10 July 1990
with 2000 Amendments
Type: LC_{50} Tox 9B
Test Organism: Threespine Stickleback

PRE-TEST PARAMETERS

Pre-test Temperature: 16.0 ºC
Pre-test D.O.: 5.7* mg/L
Pre-test pH: 5.4 Adjusted: No
Conductivity of Sample: --- µS/cm
Salinity of Sample: 135 ppt
Salinity of Control: 30 ppt

Mandatory 30 minute pre-aeration:
Rate: 6.5 ± 1 ml/min/L
Time: 1230 hrs D.O.: 5.9 mg/L
Continued: _ min. @ _ hrs
Cont'd throughout test by airstone

TEST CONDITIONS

TSS Batch #: 42
Mortality: 3.5% over 7 days prior to test

Test Volume: 9 L Depth: 15.8 cm
Replicates: No
Number of fish per vessel: 10

Loading Density: 0.49 g/L
Mean fork length: 39 mm ± 2.5 mm SD
Range: 35 mm - 42 mm

Mean wet weight: 0.44 g ± 0.12 g SD
Range: 0.31 g - 0.69 g

Photoperiod: 16L/8D
Lux: 100 - 500
Static Test
Duration: 96 hours
Control/Dilution Water: Seawater
Temperature: 15±1ºC

TEST PARAMETERS / RESULTS

Conc %	Initial (0 Hrs) Temp ºC	D.O mg/L	pH	Sal. ppt	Final (96 Hrs) Temp ºC	D.O mg/L	pH	Number Dead	Number Stressed	Comments
100	15.5	5.9*	5.5	138	15.5	5.9*	5.5	**10/10**	**0/10**	All dead @ 0.75 hrs.
50	15.5	7.3*	6.2	82	15.5	7.2*	6.2	**10/10**	**0/10**	All dead @ 0.75 hrs.
25	16.0	7.4*	6.7	50	14.5	7.5	6.9	**10/10**	**0/10**	All dead @ 43 hrs.
12.5	15.5	7.3	6.9	39	14.5	7.6	7.1	**10/10**	**0/10**	All dead @ 43 hrs.
6.25	15.5	7.4	7.1	37	15.5	7.7	7.5	**3/10**	**0/10**	3 dead @ 93 hrs.
3.13	15.5	7.5	7.4	33	15.5	7.9	7.7	**2/10**	**0/10**	2 dead @ 93 hrs.
1.56	15.5	8.1	7.7	32	15.5	8.1	7.9	**0/10**	**0/10**	
Ctl.	15.5	8.0	7.8	30	15.5	8.1	7.9	**0/10**	**0/10**	

96 HOUR LC_{50} RESULTS

LC_{50} Value: **6.1%**
95% Confidence Limits: 4.44 – 8.58
Statistical Method: Probit - Toxstats

REFERENCE TOXICANT DATA:

Batch: 42

Reference Substance: Phenol
Test Date: Oct. 03 – 07 2014
96 Hour LC_{50} for Phenol: 12.6 mg/L
95% C.L.: 9.70 – 16.2 mg/L
Historical Phenol Mean: 15.5 mg/L
Warning Limits ± 2 SD: 11.7 – 20.5 mg/L

Comments: * D.O. meter was set to maximum salinity setting of 40 ppt. As salinity increases, D.O. value decreases, therefore reported measurements are higher than true measurements. 2 additional concentrations run due to historically high mortality.

Analyst(s): K. Marks, A. Huybers & G. Harris Verified by: C. Harris  Date: Oct. 27 2014

Accredited by the Canadian Association for Laboratory Accreditation (CALA). The test included in this report is within the scope of this accreditation. The results reported apply only to the sample tested. Results are based on nominal concentrations.

FISH TOXICITY REPORT (LC_{50})

Client: Exxon Mobil Canada
Address: Founders Square
Halifax, N.S.
Contact: Megan Tuttle

Test Facility: Harris Industrial Testing Service Ltd.
Location: 1320 Ashdale Rd., South Rawdon, Nova Scotia
Canada B0N 1Z0
Ph : 902 757-0232 Fax: 902 757-0973 hits@eastlink.ca

SAMPLE DATA

Lab ID. # 14-504-A

Sample/Location: Venture Platform Produced Water
Sampling Method: Grab Sample Homogenized: No
Sampler: G. MacKay
Date/Time Collected: Oct. 21 2014 0800 Hrs
Received: Oct. 21 2014
Date/Time Started: Oct. 22 2014 1300 Hrs
Completed: Oct. 26 2014 1300 Hrs
Sample Description: Orange, opaque liquid with hydrocarbon odour.

TEST INFORMATION

Reference Method:
EPS 1/RM/10 July 1990
with 2000 Amendments
Type: LC_{50} Tox 9B
Test Organism: Threespine Stickleback

PRE-TEST PARAMETERS

Pre-test Temperature: 16.0 ºC
Pre-test D.O.: 3.8* mg/L
Pre-test pH: 5.3 Adjusted: No
Conductivity of Sample: --- µS/cm
Salinity of Sample: 188 ppt
Salinity of Control: 31 ppt

Mandatory 30 minute pre-aeration:
Rate: 6.5 ± 1 ml/min/L
Time: 1230 hrs D.O.: 5.7* mg/L
Continued: _ min. @ _ hrs
Cont'd throughout test by airstone

TEST CONDITIONS

TSS Batch #: 42
Mortality: 3.5% over 7 days prior to test

Test Volume: 9 L Depth: 15.8 cm
Replicates: No
Number of fish per vessel: 10

Loading Density: 0.49 g/L
Mean fork length: 38 mm ± 2.2 mm SD
Range: 35 mm - 42 mm

Mean wet weight: 0.44 g ± 0.11 g SD
Range: 0.29 g - 0.63 g

Photoperiod: 16L/8D
Lux: 100 - 500
Static Test
Duration: 96 hours
Control/Dilution Water: Seawater
Temperature: 15±1ºC

TEST PARAMETERS / RESULTS

Conc %	Initial (0 Hrs) Temp ºC	D.O mg/L	pH	Sal. ppt	Final (96 Hrs) Temp ºC	D.O mg/L	pH	Number Dead	Number Stressed	Comments
100	16.0	5.7*	5.5	187	15.5	5.8	5.6	**10/10**	**0/10**	All dead @ 0.75 hrs.
50	16.0	7.1*	6.2	126	15.5	7.1	6.2	**10/10**	**0/10**	All dead @ 0.75 hrs.
25	16.0	7.3*	6.7	76	14.5	7.4	6.8	**10/10**	**0/10**	All dead @ 43 hrs.
12.5	16.0	7.3*	6.9	51	14.5	7.5	7.0	**10/10**	**0/10**	All dead @ 43 hrs.
6.25	15.5	7.3*	7.0	42	15.5	7.8	7.5	**3/10**	**0/10**	3 dead @ 93 hrs.
3.13	15.5	7.6	7.4	35	15.5	7.9	7.5	**1/10**	**0/10**	1 dead @ 93 hrs.
1.56	15.5	7.9	7.5	33	15.5	8.1	7.8	**0/10**	**0/10**	
Ctl.	15.5	8.1	7.9	31	15.5	8.0	7.9	**0/10**	**0/10**	

96 HOUR LC_{50} RESULTS

LC_{50} Value: **6.51%**
95% Confidence Limits: 4.84 – 8.83
Statistical Method: Probit - Toxstats

REFERENCE TOXICANT DATA:

Batch: 42

Reference Substance: Phenol
Test Date: Oct. 03 – 07 2014
96 Hour LC_{50} for Phenol: 12.6 mg/L
95% C.L.: 9.70 – 16.2 mg/L
Historical Phenol Mean: 15.5 mg/L
Warning Limits ± 2 SD: 11.7 – 20.5 mg/L

Comments: * D.O. meter was set to maximum salinity setting of 40 ppt. As salinity increases, D.O. value decreases, therefore reported measurements are higher than true measurements. 2 additional concentrations run due to historically high mortality.

Analyst(s): K. Marks, A. Huybers & G. Harris Verified by: C. Harris  Date: Oct. 27 2014

Accredited by the Canadian Association for Laboratory Accreditation (CALA). The test included in this report is within the scope of this accreditation. The results reported apply only to the sample tested. Results are based on nominal concentrations.

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November 20, 2014

Exxon Mobil
1701 Hollis St.
Halifax NS
B3J 3M8

Attn: Megan Tuttle

Re: Offshore Toxicity Testing

Dear Megan,

The following is a brief discussion of the aquatic toxicity test results of Alma Produced Water to Threespine stickleback, Microtox and Echinoid Fertilization.

1.0 Introduction

The Alma platform was sampled on October 26, 2014 by B. MacLean at 1200 hours and the sample was picked-up by HITS lab October 27, 2014. A sub-sample was taken from the original sample (HITS Lab ID # 14-515) and shipped by courier to AquaTox Testing and Consulting Inc. in Guelph, ON, on October 27, 2014, received on October 28, 2014.

2.0 Methods

The Threespine stickleback test (TSS) was conducted at HITS lab according to Environment Canada's test protocol EPS 1/RM/10 July 1990 with 2000 Amendments within the 5 days allowed between sampling and test commencement.

HITS Lab Method "Tox 9B" is held on file in the lab. This method describes but is not limited to the following:

- collection and acclimation of marine fish;
- preparation of reference toxicant;
- conduct of testing.

The sample salinity measured at HITS was 12.6 ppt meeting the protocol salinity requirement for this species of $\geq$10 ppt.

The Microtox test was conducted at Aquatox according to the protocol EPS 1/RM/24, Environment Canada (1992) within the maximum 3-day holding time allowed.

The Echinoid Fertilization test was conducted at Aquatox according to the protocol EPS 1/RM/27, 2nd Edition (February 2011) within the maximum 3-day holding time allowed.

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The sample salinity measured at Aquatox was 13 ppt and samples were adjusted to normal salinity values prior to testing for Microtox and Echinoid Fertilization.

3.0 Results

See Table 1 below for results from Nov. 2006 to October 2014.

Table 1. Alma Toxicity Results (2008 - **2014)**.

Date	TSS		Microtox		Echinoid Fertilization		Sal.
	LC50	(95% C.L.)	IC50	(95% C.L.)	IC25	(95% C.L.)	(ppt)
Jan. 2008	33.0%	(28.9 – 37.6)	1.44%	(1.27 – 1.64)	0.54%	(0.38 – 0.70)	6
Sept. 28 2008	30.8%	(35.8 – 36.7)	2.32%	(2.22 – 2.42)	1.06%	(0.19 – 1.54)	4.5
Oct. 29 2009	26.8%	(21.6 – 33.2)	3.21%	(3.01 – 3.42)	40.4%	(27.0 – 46.7)	5.0
Oct. 23 2010	35.4%	(25 – 50)	2.44%	(2.34 – 2.54)	48.4%	(42.3 – 52.9)	8.5
Oct. 17 2011	35.4%	(25 – 50)	2.36%	(2.19 – 2.55)	49.9%	(33.5 – 66.9)	8.7
Aug. 19 2012	27.7%	(20.6 – 37.8)	3.50%	(3.25 – 3.77)	59.4%	(40.1 – 76.8)	7.4
Oct. 14 2013	35.1%	(25.0 – 50.0)	6.84%	(6.35 – 7.36)	18.1%	(14.7 – 21.6)	8.6
Oct. 26 2014	**33.0%**	**(28.9 – 37.6)**	**2.38%**	**(2.26 – 2.51)**	**99.2%**	**(88.3 – 110)**	**12.6**

"The Offshore Waste Treatment Guidelines" August 2002 do not have pass/fail criteria, however most effluent discharge regulations stipulate that if and effluent has greater than 50% mortality at the 100% concentration it fails. Based on this, the Alma Produced Water would be considered toxic to TSS. There are no pass/fail criteria available for Microtox and Echinoid fertilization toxicity tests.

4.0 Discussion

Normal seawater salinity values range from 28 – 32 ppt. The salinity value for this platform is lower than normal.

The statistical method used to compare LC50, IC50 and IC25 values was the pairwise comparison test delineated in Sprague & Fogels (1977).

Threespine Stickleback

The protocol states that TSS are used for effluent with a salinity of $\geq$10 ppt. The use of TSS at the sample salinity of 12.6 ppt does not constitute a deviation from the protocol. There was 10% mortality in the control and all test validity criteria as specified in the method were met. Mortality in the test occurred from the toxicity of the sample (*i.e.* petroleum hydrocarbons), not from low salinity.

The salinity measured in 2013 (8.6 ppt) and the salinity measured in 2014 (12.6 ppt) were both low. The toxicity results were not statistically different.

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Echinoid Fertilization

In the salinity adjusted Echinoid Fertilization test, the results were 99.2%, meaning that the effluent had minimal toxicity. All validity criteria for this test were met.

Even though the salinity measured in 2013 (8.6 ppt) and the salinity measured in 2014 (12.6 ppt) were both low, the toxicity results were statistically different.

Microtox

Considering that the salinity was adjusted for the Microtox test, low salinity was not the cause of mortality. Mortality occurred in the test from the toxicity of the sample (*i.e.* petroleum hydrocarbons).

Even though the salinity measured in 2013 (8.6 ppt) and the salinity measured in 2014 (12.6 ppt) were both low, the toxicity results were statistically different.

If you have any questions, please do not hesitate to contact me at your earliest convenience.

Best regards,

Gary Harris
President

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November 20, 2014

Exxon Mobil
1701 Hollis St.
Halifax NS
B3J 3M8

Attn: Megan Tuttle

Re: Offshore Toxicity Testing

Dear Megan,

The following is a brief discussion of the aquatic toxicity test results of South Venture Produced Water to Threespine stickleback, Microtox and Echinoid Fertilization.

1.0 Introduction

The South Venture platform was sampled on October 22, 2014 by B. Huber at 1200 hours and the sample was picked-up by HITS lab October 23, 2014. A sub-sample was taken from the original sample (HITS Lab ID # 14-514) and shipped by courier to AquaTox Testing and Consulting Inc. in Guelph, ON, on October 23, 2014, received on October 24, 2014. Sampling on the platform could not be coordinated with Echinoid Fertilization testing at Aquatox, therefore the sample was held and tested at 7 days old. This was approved in advance by the client.

2.0 Methods

The Threespine stickleback test (TSS) was conducted at HITS lab according to Environment Canada's test protocol EPS 1/RM/10 July 1990 with 2000 Amendments within the 5 days allowed between sampling and test commencement.

HITS Lab Method "Tox 9B" is held on file in the lab. This method describes but is not limited to the following:

- collection and acclimation of marine fish;
- preparation of reference toxicant;
- conduct of testing.

The sample salinity measured at HITS was 2.9 ppt.

The Microtox test was conducted at Aquatox according to the protocol EPS 1/RM/24, Environment Canada (1992) within the maximum 3-day holding time allowed.

The Echinoid Fertilization test was conducted at Aquatox according to the protocol EPS 1/RM/27, 2nd Edition (February 2011). A deviation was noted in that the maximum 3-day holding time allowed was exceeded.

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The sample salinity measured at Aquatox was 6 ppt and samples were adjusted to normal salinity values prior to testing for Microtox and Echinoid Fertilization.

3.0 Results

See Table 1 below for results from Nov. 2006 to October 2014.

Table 1. South Venture Toxicity Results (2007 - **2014)**.

Date	TSS		Microtox		Echinoid Fertilization		Sal.
	LC50	**(95% C.L.)**	**IC50**	**(95% C.L.)**	**IC25**	**(95% C.L.)**	**(ppt)**
Dec. 15 2007	17.8%	(12.5 – 25.0)	12.2%	(10.1 – 14.7)	0.37%	(0.15 - 0.51)	89
Nov. 21 2008	7.69%	(6.45 – 9.17)	18.0%	(16.3 – 20.0)	0.50%	(0.42 – 0.59)	135
Nov. 8 2009	17.6%	(12.5 – 25.0)	29.7%	(27.2 – 32.5)	4.15%	(3.28 – 4.41)	60
Nov. 4 2010	8.84%	(6.25 - 12.5)	11.6%	(10.1 – 13.3)	0.64%	(0.37 – 1.06)	130
Oct. 15 2011	8.84%	(6.25 – 12.5)	13.4%	(11.5 – 15.6)	1.27%	(0.92 – 1.69)	170
Aug. 18 2013 (Untrimmed results)	42.1%		15.7%	(14.0 – 17.6)	0.39%	(0.09 – 0.72)	12
Aug. 18 2013 (Trimmed results)	45.3%	(34.7 – 59.1)					
Oct. 22 2014	**52.1%**	**(38.7 – 70.6)**	**12.2%**	**(10.8 – 13.7)**	**>100%**	**-**	**3**

"The Offshore Waste Treatment Guidelines" August 2002 do not have pass/fail criteria, however most effluent discharge regulations stipulate that if and effluent has greater than 50% mortality at the 100% concentration it fails. Based on this, the South Venture Produced Water would be considered toxic to TSS. There are no pass/fail criteria available for Microtox and Echinoid fertilization toxicity tests.

4.0 Discussion

Normal seawater salinity values range from 28 – 32 ppt. The salinity value for this platform is lower than normal.

The statistical method used to compare LC50, IC50 and IC25 values was the pairwise comparison test delineated in Sprague & Fogels (1977).

Threespine Stickleback

The produced water sample had a salinity of 3 ppt. The protocol states that TSS are used for testing effluent with a salinity of 10 ppt or greater. The use of TSS at this salinity constitutes a deviation from the protocol. For this reason two controls were run with the TSS test. Control #1 was run with normal salinity. Control #2 was run with a salinity of 3.1 ppt. There was no mortality in the normal salinity control and there was 10% mortality in the adjusted control, meeting the validity criteria for both. This data suggests that mortality occurred in the test from the toxicity of the sample (*i.e.* petroleum hydrocarbons), not from low salinity.

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The salinity measured in 2013 (12 ppt) and the salinity measured in 2014 (3 ppt) were both low. The toxicity results were not statistically different.

Echinoid Fertilization

In the salinity-adjusted Echinoid Fertilization test, the results were >100%, meaning that the effluent was not toxic and did not inhibit fertilization. The sample exceeded the holding time and that may have had an influence on the results, *i.e.* decreased the toxicity of the effluent.

Even though the salinity measured in 2013 (12 ppt) and the salinity measured in 2014 (3 ppt) were both low, the toxicity results were statistically different.

Microtox

Considering that the salinity was adjusted for the Microtox test, low salinity was not the cause of mortality. Mortality occurred in the test from the toxicity of the sample (*i.e.*petroleum hydrocarbons).

Even though the salinity measured in 2013 (12 ppt) and the salinity measured in 2014 (3 ppt) were both low, the toxicity results were statistically different.

If you have any questions, please do not hesitate to contact me at your earliest convenience.

Best regards,

Gary Harris
President

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November 20, 2014

Exxon Mobil
1701 Hollis St.
Halifax NS
B3J 3M8

Attn: Megan Tuttle

Re: Offshore Toxicity Testing

Dear Megan,

The following is a brief discussion of the aquatic toxicity test results of Thebaud Produced Water to Threespine stickleback, Microtox and Echinoid Fertilization.

1.0 Introduction

The Thebaud platform was sampled on October 20, 2014 by M. Burt at 1850 hours and the sample was picked-up by HITS lab October 21, 2014. A sub-sample was taken from the original sample (HITS Lab ID # 14-504-B) and shipped by courier to AquaTox Testing and Consulting Inc. in Guelph, ON, on October 21, 2014, received on October 22, 2014.

2.0 Methods

The Threespine stickleback test (TSS) was conducted at HITS lab according to Environment Canada's test protocol EPS 1/RM/10 July 1990 with 2000 Amendments within the 5 days allowed between sampling and test commencement.
HITS Lab Method "Tox 9B" is held on file in the lab. This method describes but is not limited to the following:

- collection and acclimation of marine fish;
- preparation of reference toxicant;
- conduct of testing.

The sample salinity measured at HITS was 135 ppt.

The Microtox test was conducted at Aquatox according to the protocol EPS 1/RM/24, Environment Canada (1992) within the maximum 3-day holding time allowed.

The Echinoid Fertilization test was conducted at Aquatox according to the protocol EPS 1/RM/27, 2nd Edition (February 2011) within the maximum 3-day holding time allowed.

A deviation is noted on the Aquatox Echinoid Fertilization report that the maximum allowable salinity (32 ppt) as specified in the test method was exceeded in the 100, 30, and 9% test concentrations, due to the salinity of the 100% concentration being 139 ppt.

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3.0 Results

See Table 1 below for results from Nov. 2006 to October 2014.

Table 1. Thebaud Toxicity Results (2007 - **2014)**.

Date	TSS		Microtox		Echinoid Fertilization		Sal.
	LC50	**(95% C.L.)**	**IC50**	**(95% C.L.)**	**IC25**	**(95% C.L.)**	**(ppt)**
Jan. 11 2007	11.7%	(9.41 - 14.5)	3.68%	(3.61 - 3.76)	2.58%	(2.09 - 3.32)	30
Aug. 13 2007	<6.25%		0.53%	(0.49 - 0.58)	6.1%	(5.7 - 6.4)	20
Nov. 27 2007	7.11%	(6.55 - 7.71)	1.19%	(0.98 - 1.44)	0.11%	(0.07 - 0.14)	82
Nov. 24 2008	7.7%	(6.46 - 9.17)	1.99%	(1.88 - 2.10)	3.0%	(1.1 - 5.0)	38
Jul. 14 2009	8.84%	(6.25 – 12.5)	1.72%	(1.61 – 1.84)	4.02%	(3.53 – 4.22)	34
Aug. 10 2010	8.85%	(6.25 – 12.3)	1.70%	(1.50 – 1.93)	0.83%	(0.13 – 1.38)	55
Oct. 12 2011	8.25%	(7.23 – 9.41)	4.66%	(3.59 – 6.05)	0.61%	(0.44 – 0.91)	165
Oct. 21 2012	4.42%	(3.32 – 5.89)	2.86%	(2.50 – 3.28)	0.44%	(0.39 – 0.50)	152
Aug. 19 2013	7.66%	(5.82 – 10.07)	2.97%	(2.69 – 3.29)	0.04%	(0.03 – 0.06)	154
Oct. 21 2014	**6.10%**	**(4.44 – 8.58)**	**2.79%**	**(2.18 – 3.56)**	**0.21%**	**(0.17 – 0.25)**	**135**

"The Offshore Waste Treatment Guidelines" August 2002 do not have pass/fail criteria, however most effluent discharge regulations stipulate that if and effluent has greater than 50% mortality at the 100% concentration it fails. Based on this, the Thebaud Produced Water would be considered toxic to TSS. There are no pass/fail criteria available for Microtox and Echinoid fertilization toxicity tests.

4.0 Discussion

Normal seawater salinity values range from 28 – 32 ppt. The salinity value for this platform is much higher than normal.

The statistical method used to compare LC50, IC50 and IC25 values was the pairwise comparison test delineated in Sprague & Fogels (1977).

Threespine Stickleback

HITS tested two additional concentrations in the TSS LC50 test at the lower range (3.13% & 1.56%) in order to better assess the sample's toxicity at normal salinity levels. Salinity levels remained above normal until the sample was diluted to the 1.56% concentration (salinity 32 ppt). No significant mortality occurred in the concentrations that fell within the normal salinity range. From these results, mortality may have occurred at the higher concentration due to high salinity, toxicity from petroleum hydrocarbons, or a combination of both.

The salinity measured in 2013 (154 ppt) was similar to the salinity measured in 2014 (135 ppt). The toxicity results were not statistically different.

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Echinoid Fertilization

In the Echinoid Fertilization test toxicity (*i.e.* fertilization inhibition) continued to occur in concentrations diluted to normal salinity values (2.7 and 0.81%) and from these results, mortality may have occurred at the higher concentration due to high salinity, toxicity from petroleum hydrocarbons, or a combination of both.

Even though the salinity measured in 2013 (154 ppt) was similar to the salinity measured in 2014 (135 ppt), the toxicity results were statistically different.

Microtox

Based on the salinity values measured in the Aquatox sea urchin fertilization test concentrations, it can be extrapolated that toxicity continued to occur in the Microtox test within the salinity range of approximately 32 – 40 ppt (*i.e.* normal and slightly higher than normal). From these results, mortality may have occurred at the higher concentration due to high salinity, toxicity from petroleum hydrocarbons, or a combination of both.

The salinity measured in 2013 (154 ppt) was similar to the salinity measured in 2014 (135 ppt). The toxicity results were not statistically different.

If you have any questions, please do not hesitate to contact me at your earliest convenience.

Best regards,

Gary Harris
President

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November 21, 2014

Exxon Mobil
1701 Hollis St.
Halifax NS
B3J 3M8

Attn: Megan Tuttle

Re: Offshore Toxicity Testing

Dear Megan,

The following is a brief discussion of the aquatic toxicity test results of Venture Produced Water to Threespine stickleback, Microtox and Echinoid Fertilization.

1.0 Introduction

The Venture platform was sampled on October 21, 2014 by G. MacKay at 0800 hours and the sample was picked-up by HITS lab October 21, 2014. A sub-sample was taken from the original sample (HITS Lab ID # 14-504-A) and shipped by courier to AquaTox Testing and Consulting Inc. in Guelph, ON, on October 21, 2014, received on October 22, 2014.

2.0 Methods

The Threespine stickleback test (TSS) was conducted at HITS lab according to Environment Canada's test protocol EPS 1/RM/10 July 1990 with 2000 Amendments within the 5 days allowed between sampling and test commencement.
HITS Lab Method "Tox 9B" is held on file in the lab. This method describes but is not limited to the following:

- collection and acclimation of marine fish;
- preparation of reference toxicant;
- conduct of testing.

The sample salinity measured at HITS was 187 ppt.

The Microtox test was conducted at Aquatox according to the protocol EPS 1/RM/24, Environment Canada (1992) within the maximum 3-day holding time allowed.

The Echinoid Fertilization test was conducted at Aquatox according to the protocol EPS 1/RM/27, 2nd Edition (February 2011) within the maximum 3-day holding time allowed.

A deviation is noted on the Aquatox Echinoid Fertilization report that the maximum allowable salinity (32 ppt) as specified in the test method was exceeded in the 100, 30, and 9 and 2.7% test concentrations, due to the salinity of the 100% concentration being 196 ppt.

HITS
AQUATIC TOXICITY TESTING

Harris Industrial Testing Service Ltd.
1320 Ashdale Rd. South Rawdon NS
Bus: (902)757-0232 Fax: (902)757-2839
Email: hits@eastlink.ca

3.0 Results

See Table 1 below for results from Nov. 2006 to October 2014 (sampling was not conducted 2012 and 2013).

Table 1. Venture Toxicity Results (2007 - **2014)**.

Date	TSS		Microtox		Echinoid Fertilization		Sal.
	LC50	**(95% C.L.)**	**IC50**	**(95% C.L.)**	**IC25**	**(95% C.L.)**	**ppt**
Nov. 2006	4.4%						>150
Oct. 2007	8.25%		13.0%	(12.8 – 13.1)	0.69%	(0.47 – 1.0)	210
Oct. 2008	5.66%	(3.2 – 10.0)	1.19%	(0.98 - 1.44)	0.11%	(0.07 - 0.14)	240
July 14 2009	5.66%	(3.2 – 10.0)	16.8%	(16.6 – 17.0)	0.124%	(0.01 – 0.23)	190
July 5 2010	5%	(4.1 – 6.3)	14.2%	(13.1 – 15.3)	0.06%	(0.02 – 0.13)	185
Nov. 14 2011	4.13%	(3.62 – 4.71)	7.45%	(5.79 – 10.3)	0.18%	(0.15 – 0.21)	207
Oct. 21 2014	6.51%	(4.84 – 8.83)	7.72%	(6.82 – 8.74)	0.07%	(0.06 – 0.09)	187

"The Offshore Waste Treatment Guidelines" August 2002 do not have pass/fail criteria, however most effluent discharge regulations stipulate that if and effluent has greater than 50% mortality at the 100% concentration it fails. Based on this, the Venture Produced Water would be considered toxic to TSS. There are no pass/fail criteria available for Microtox and Echinoid fertilization toxicity tests.

4.0 Discussion

Normal seawater salinity values range from 28 – 32 ppt. The salinity value for this platform is much higher than normal.

The statistical method used to compare LC50, IC50 and IC25 values was the pairwise comparison test delineated in Sprague & Fogels (1977).

Threespine Stickleback

HITS tested two additional concentrations in the TSS LC50 test at the lower range (3.13% & 1.56%) in order to better assess the sample's toxicity at more normal salinity levels. Salinity levels remained above normal until the sample was diluted to the 1.56% concentration (salinity 33 ppt, slightly higher than normal levels). No significant mortality occurred in the concentrations that fell within the salinity ranges for these two lowest concentrations (35 – 33 ppt) tested. From these results, mortality may have occurred at the higher concentrations due to high salinity, toxicity from petroleum hydrocarbons, or a combination of both.

Even though the salinity measured in 2011 (207 ppt) and the salinity measured in 2014 (187 ppt) were both elevated, the toxicity results were statistically different.

HITS
AQUATIC TOXICITY TESTING

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Echinoid Fertilization

In the Echinoid Fertilization test toxicity (*i.e.* fertilization inhibition) continued to occur in concentrations diluted to normal salinity values and from these results, mortality may have occurred at the higher concentration due to high salinity, toxicity from petroleum hydrocarbons, or a combination of both.

Even though the salinity measured in 2011 (207 ppt) and the salinity measured in 2014 (187 ppt) were both elevated, the toxicity results were statistically different.

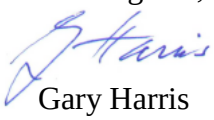
Microtox

Based on the salinity values measured in the Aquatox sea urchin fertilization test concentrations, it can be extrapolated that toxicity continued to occur in the Microtox test within the salinity range of approximately 31 – 34 ppt (*i.e.* normal and slightly higher than normal). From these results, mortality may have occurred at the higher concentration due to high salinity, toxicity from petroleum hydrocarbons, or a combination of both.

The salinity measured in 2011 (207 ppt) was similar to the salinity measured in 2014 (187 ppt). The toxicity results were not statistically different.

If you have any questions, please do not hesitate to contact me at your earliest convenience.

Best regards,



Gary Harris
President

Appendix for Section 3

Daily Thebaud Flare Observations

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
JAN 01/2014	08:00 HRS	Clear	NORMAL	West Strong Winds
JAN 01/2014	18:00 HRS	Clear	NORMAL	West Strong Winds
JAN 02/2014	08:00 HRS	Clear	NORMAL	NW Strong Winds
JAN 02/2014	18:00 HRS	Clear	NORMAL	NW Moderate Winds
JAN 03/2014	08:00 HRS	Clear	Very Small	NE Storm Force Winds
JAN 03/2014	18:00 HRS	Clear	NORMAL	NW Storm Force Winds
JAN 04/2014	08:00 HRS	Clear	NORMAL	NW Gale Force Winds
JAN 04/2014	18:00 HRS	Clear	NORMAL	NW Gale Force Winds
JAN 05/2014	08:00 HRS	Clear	NORMAL	West Strong Winds
JAN 05/2014	18:00 HRS	Clear	NORMAL	West Moderate Winds
JAN 06/2014	08:00 HRS	Clear	NORMAL	East Moderate Winds
JAN 06/2014	18:00 HRS	Clear	NORMAL	SE Stong Winds
JAN 07/2014	08:00 HRS	Clear	NORMAL	W Stong Winds
JAN 07/2014	18:00 HRS	Clear	NORMAL	W Stong Winds
JAN 08/2014	08:00 HRS	Clear	NORMAL	W Gale Force Winds
JAN 08/2014	18:00 HRS	Clear	NORMAL	W Gale Force Winds
JAN 09/2014	08:00 HRS	Clear	NORMAL	W Stong Winds
JAN 09/2014	18:00 HRS	Clear	NORMAL	W Stong Winds
JAN 10/2014	08:00 HRS	Clear	NORMAL	W Light Winds
JAN 10/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
JAN 11/2014	08:00 HRS	Clear	NORMAL	SW Light Winds
JAN 11/2014	18:00 HRS	Clear	NORMAL	S Light Winds
JAN 12/2014	08:00 HRS	Clear	NORMAL	SW Strong Winds
JAN 12/2014	18:00 HRS	Clear	NORMAL	SW Strong Winds
JAN 13/2014	08:00 HRS	Clear	NORMAL	W Strong Winds
JAN 13/2014	18:00 HRS	Clear	NORMAL	W Strong Winds
JAN 14/2014	08:00 HRS	Clear	NORMAL	S Moderate Winds
JAN 14/2014	18:00 HRS	Clear	NORMAL	S Moderate Winds
JAN 15/2014	08:00 HRS	Clear	NORMAL	SW Strong Winds
JAN 15/2014	18:00 HRS	Clear	NORMAL	SW Strong Winds
JAN 16/2014	08:00 HRS	Clear	NORMAL	SE Light Winds
JAN 16/2014	18:00 HRS	Clear	NORMAL	S Moderate Winds
JAN 17/2014	08:00 HRS	Chart # 2	NORMAL	N Light Winds
JAN 17/2014	18:00 HRS	Clear	NORMAL	N Light Winds
JAN 18/2014	08:00 HRS	Clear	NORMAL	E Light Winds
JAN 18/2014	18:00 HRS	Clear	NORMAL	SE Light Winds
JAN 19/2014	08:00 HRS	Clear	NORMAL	W Strong Winds
JAN 19/2014	18:00 HRS	Clear	NORMAL	W Strong Winds
JAN 20/2014	08:00 HRS	Clear	NORMAL	W Strong Winds
JAN 20/2014	18:00 HRS	Clear	NORMAL	SW Strong Winds
JAN 21/2014	08:00 HRS	Clear	NORMAL	W Moderate Winds
JAN 21/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
JAN 22/2014	08:00 HRS	Clear	NORMAL	NE Gale Force Winds
JAN 22/2014	18:00 HRS	Clear	NORMAL	NE Moderate Winds
JAN 23/2014	08:00 HRS	Clear	NORMAL	W Strong Winds
JAN 23/2014	18:00 HRS	Clear	NORMAL	SW Strong Winds
JAN 24/2014	08:00 HRS	Clear	NORMAL	W Moderate Winds
JAN 24/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
JAN 25/2014	08:00 HRS	Clear	NORMAL	W Moderate Winds
JAN 25/2014	18:00 HRS	Clear	NORMAL	SE Strong Winds
JAN 26/2014	08:00 HRS	Clear	NORMAL	SW Gale Force Winds
JAN 26/2014	18:00 HRS	Clear	NORMAL	W Storm Force Winds
JAN 27/2014	08:00 HRS	Clear	NORMAL	S Moderate Winds
JAN 27/2014	18:00 HRS	Clear	NORMAL	S Strong Winds
JAN 28/2014	08:00 HRS	Clear	NORMAL	W Strong Winds
JAN 28/2014	18:00 HRS	Clear	NORMAL	W Strong Winds
JAN 29/2014	08:00 HRS	Clear	NORMAL	NE Moderate Winds
JAN 29/2014	18:00 HRS	Clear	NORMAL	NE Strong Winds
JAN 30/2014	08:00 HRS	Clear	NORMAL	W Strong Winds
JAN 30/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
JAN 31/2014	08:00 HRS	Clear	NORMAL	S Strong Winds
JAN 31/2014	18:00 HRS	Clear	NORMAL	S Moderate Winds

Daily Thebaud Flare Observations

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
FEB 01/2014	08:00 HRS	Clear	NORMAL	NNW Moderate Winds
FEB 01/2014	18:00 HRS	Clear	NORMAL	W Light Winds
FEB 02/2014	08:00 HRS	Clear	NORMAL	S Strong Winds
FEB 02/2014	18:00 HRS	Clear	NORMAL	SSW Strong Winds
FEB 03/2014	08:00 HRS	Clear	NORMAL	N Moderate Winds
FEB 03/2014	18:00 HRS	Clear	NORMAL	NNE Light Winds
FEB 04/2014	08:00 HRS	Clear	NORMAL	N Moderate Winds
FEB 04/2014	18:00 HRS	Clear	NORMAL	N Moderate Winds
FEB 05/2014	08:00 HRS	Clear	NORMAL	N Moderate Winds
FEB 05/2014	18:00 HRS	Clear	NORMAL	N Moderate Winds
FEB 06/2014	08:00 HRS	Clear	NORMAL	N Gale Force Winds
FEB 06/2014	18:00 HRS	Clear	NORMAL	N Strong Winds
FEB 07/2014	08:00 HRS	Clear	NORMAL	W Moderate Winds
FEB 07/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
FEB 08/2014	08:00 HRS	Clear	NORMAL	W Moderate Winds
FEB 08/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
FEB 09/2014	08:00 HRS	Clear	NORMAL	N Moderate Winds
FEB 09/2014	18:00 HRS	Clear	NORMAL	N Moderate Winds
FEB 10/2014	08:00 HRS	Clear	NORMAL	E Light Winds
FEB 10/2014	18:00 HRS	Clear	NORMAL	E Light Winds
FEB 11/2014	08:00 HRS	Clear	NORMAL	N Moderate Winds
FEB 11/2014	18:00 HRS	Clear	NORMAL	NW Light Winds
FEB 12/2014	08:00 HRS	Clear	NORMAL	N Strong Winds
FEB 12/2014	18:00 HRS	Clear	NORMAL	N Strong Winds
FEB 13/2014	08:00 HRS	Clear	NORMAL	S Light Winds
FEB 13/2014	18:00 HRS	Clear	NORMAL	Moderate to Strong SSE winds
FEB 14/2014	08:00 HRS	Obscured in Fog and Rain	Obscured	Gale to Storm Force SSE winds
FEB 14/2014	18;00 HRS	CLEAR	NORMAL	GALE FORCE W Winds
FEB 15/2014	08:00 HRS	CLEAR	NORMAL	GALE TO STORM FORCE W Winds
FEB 15/2014	18;00 HRS	CLEAR	NORMAL	Light Variable Winds
FEB 16/2014	08:00 HRS	CLEAR	NORMAL	S Gale Force Winds
FEB 16/2014	18:00 HRS	CLEAR	NORMAL	W Storm Force Winds
FEB 17/2014	08:00 HRS	CLEAR	NORMAL	W Strong winds
FEB 17/2014	18:00 HRS	CLEAR	NORMAL	W Strong winds
FEB 18/2014	08:00 HRS	CLEAR	NORMAL	NW Strong Winds
FEB 18/2014	18:00 HRS	CLEAR	NORMAL	NW Moderate Winds
FEB 19/2014	08:00 HRS	CLEAR	NORMAL	S Strong Winds
FEB 19/2014	18;00 HRS	CLEAR	NORMAL	W Strong Winds
FEB 20/2014	08:00 HRS	CLEAR	NORMAL	SW Gale Force Winds
FEB 20/2014	18;00 HRS	CLEAR	NORMAL	W Gale Force Winds
FEB 21/2014	08:00 HRS	CLEAR	NORMAL	NW Moderate Winds
FEB 21/2014	18:00 HRS	CLEAR	NORMAL	NW Moderate Winds
FEB 22/2014	08:00 HRS	CLEAR	NORMAL	S Strong Winds
FEB 22/2014	18:00 HRS	CLEAR	NORMAL	W Strong Winds
FEB 23/2014	08:00 HRS	CLEAR	NORMAL	SW Moderate Winds
FEB 23/2014	18:00 HRS	CLEAR	NORMAL	SW Moderate Winds
FEB 24/2014	08:00 HRS	CLEAR	NORMAL	Winds Light and Variable
FEB 24/2014	18;00 HRS	CLEAR	NORMAL	NW Moderate Winds
FEB 25/2014	08:00 HRS	CLEAR	NORMAL	NW Strong Winds
FEB 25/2014	18;00 HRS	CLEAR	NORMAL	NW Strong Winds
FEB 26/2014	08:00 HRS	CLEAR	NORMAL	W Moderate Winds
FEB 26/2014	18;00 HRS	CLEAR	NORMAL	W Light Winds
FEB 27/2014	08:00 HRS	CLEAR	NORMAL	E Light Winds
FEB 27/2014	18;00 HRS	CLEAR	NORMAL	E Light Winds
FEB 28/2014	08:00 HRS	CLEAR	NORMAL	W Light Winds
FEB 28/2014	18;00 HRS	CLEAR	NORMAL	W Strong Winds

Daily Thebaud Flare Observations

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
MAR 01/2014	08:00 HRS	Clear	NORMAL	N Light Winds
MAR 01/2014	18:00 HRS	Clear	NORMAL	NE Light Winds
MAR 02/2014	08:00 HRS	Clear	NORMAL	S Moderate Winds
MAR 02/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
MAR 03/2014	08:00 HRS	Clear	NORMAL	S Moderate Winds
MAR 03/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
MAR 04/2014	08:00 HRS	Clear	NORMAL	NW Moderate Winds
MAR 04/2014	18:00 HRS	Clear	NORMAL	NW Moderate Winds
MAR 05/2014	08:00 HRS	Clear	NORMAL	SW Light Winds
MAR 05/2014	18:00 HRS	Clear	NORMAL	SW Light Winds
MAR 06/2014	08:00 HRS	Clear	NORMAL	N Moderate Winds
MAR 06/2014	18:00 HRS	Clear	NORMAL	N Moderate Winds
MAR 07/2014	08:00 HRS	Clear	NORMAL	W Moderate Winds
MAR 07/2014	18:00 HRS	Clear	NORMAL	SW Moderate Winds
MAR 08/2014	08:00 HRS	Clear	NORMAL	E Moderate Winds
MAR 08/2014	18:00 HRS	Clear	NORMAL	E Moderate Winds
MAR 09/2014	08:00 HRS	Clear	NORMAL	NW Moderate Winds
MAR 09/2014	18:00 HRS	Clear	NORMAL	NW Moderate Winds
MAR 10/2014	08:00 HRS	Clear	NORMAL	N Light Winds
MAR 10/2014	18:00 HRS	Clear	NORMAL	W Light Winds
MAR 11/2014	08:00 HRS	Clear	LARGE	SE Moderate Winds
MAR 11/2014	18:00 HRS	No Flare	No Flare	E Moderate Winds
MAR 12/2014	08:00 HRS	No Flare	No Flare	NW Moderate Winds
MAR 12/2014	18:00 HRS	Clear	NORMAL	S Moderate Winds
MAR 13/2014	08:00 HRS	Clear	NORMAL	S Gale Force Winds
MAR 13/2014	18:00 HRS	Clear	NORMAL	SW Strong Winds
MAR 14/2014	08:00 HRS	Clear	NORMAL	W Strong Winds
MAR 14/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
MAR 15/2014	08:00 HRS	Clear	NORMAL	S Moderate Winds
MAR 15/2014	18:00 HRS	Clear	NORMAL	S Strong Winds
MAR 16/2014	08:00 HRS	Clear	NORMAL	SW Moderate Winds
MAR 16/2014	18:00 HRS	Clear	NORMAL	WSW Strong Winds
MAR 17/2014	08:00 HRS	Clear	NORMAL	W Strong Winds
MAR 17/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
MAR 18/2014	08:00 HRS	Clear	NORMAL	W Strong Winds
MAR 18/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
MAR 19/2014	08:00 HRS	Clear	NORMAL	NE Light Winds
MAR 19/2014	18:00 HRS	Clear	NORMAL	ENE Light Winds
MAR 20/2014	08:00 HRS	Clear	NORMAL	E Strong Winds
MAR 20/2014	18:00 HRS	Clear	NORMAL	ESE Gale Force Winds
MAR 21/2014	08:00 HRS	Clear	NORMAL	SW Moderate Winds
MAR 21/2014	18:00 HRS	Clear	NORMAL	WSW Moderate Winds
MAR 22/2014	08:00 HRS	Clear	NORMAL	W Strong Winds
MAR 22/2014	18:00 HRS	Clear	NORMAL	W Strong Winds
MAR 23/2014	08:00 HRS	Clear	NORMAL	W Strong Winds
MAR 23/2014	18:00 HRS	Clear	NORMAL	W Strong Winds
MAR 24/2014	08:00 HRS	Clear	NORMAL	NNW Strong Winds
MAR 24/2014	18:00 HRS	Clear	NORMAL	NNW Strong Winds
MAR 25/2014	08:00 HRS	Clear	NORMAL	NW Moderate Winds
MAR 25/2014	18:00 HRS	Clear	NORMAL	NW Moderate Winds
MAR 26/2014	08:00 HRS	Clear	NORMAL	E Storm Force Winds
MAR 26/2014	18:00 HRS	Clear	NORMAL	E Storm Force Winds
MAR 27/2014	08:00 HRS	Clear	NORMAL	W Storm Force Winds
MAR 27/2014	18:00 HRS	Clear	NORMAL	W Storm Force Winds
MAR 28/2014	08:00 HRS	Clear	NORMAL	W Moderate Winds
MAR 28/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
MAR 29/2014	08:00 HRS	Clear	NORMAL	W Moderate Winds
MAR 29/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
MAR 30/2014	08:00 HRS	Clear	NORMAL	E Moderate Winds
MAR 30/2014	18:00 HRS	Clear	NORMAL	E Moderate Winds
MAR 31/2014	08:00 HRS	Obscured in Fog	OBSCURED	S Strong Winds
MAR 31/2014	18:00 HRS	Clear	NORMAL	S Strong Winds

Daily Thebaud Flare Observations

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
April 01/2014	08:00 HRS	Clear	NORMAL	NE Strong Winds
April 01/2014	18:00 HRS	Clear	NORMAL	NE Gale Force Winds
April 02/2014	08:00 HRS	Clear	NORMAL	NE Strong Winds
April 02/2014	18:00 HRS	Clear	NORMAL	NE Gale Force Winds
April 03/2014	08:00 HRS	Clear	NORMAL	NE Light Winds
April 03/2014	18:00 HRS	Clear	NORMAL	NE Light Winds
April 04/2014	08:00 HRS	Clear	NORMAL	NE Light Winds
April 04/2014	18:00 HRS	Clear	NORMAL	NW Light Winds
April 05/2014	08:00 HRS	Clear	NORMAL	SE Light Winds
April 05/2014	18:00 HRS	Clear	NORMAL	SE Strong Winds
April 06/2014	08:00 HRS	Clear	NORMAL	W Strong Wings
April 06/2014	18:00 HRS	Clear	NORMAL	W Gale Force Winds
April 07/2014	08:00 HRS	Clear	NORMAL	W Moderate Wings
April 07/2014	18:00 HRS	Clear	NORMAL	Moderate Westerly winds
April 08/2014	08:00 HRS	Clear	NORMAL	Light to Moderate Southerly winds
April 09/2014	08:00 HRS	Obscured in Fog	Obscured	Strong SSW winds
April 09/2014	18:00 HRS	Clear	NORMAL	Strong Westerly winds
April 10/2014	08:00 HRS	Clear	NORMAL	Strong NW winds
April 10/2014	18:00 HRS	Clear	NORMAL	Moderate NW winds
April 11/2014	08:00 HRS	Clear	NORMAL	Moderate SSW winds
April 11/2014	18:00 HRS	Clear	NORMAL	Moderate SW winds
April 12/2014	08:00 HRS	Obscured in Fog	Obscured	Moderate ssw winds
April 12/2014	18:00 HRS	Clear	NORMAL	Moderate westerly winds
April 13/2014	08:00 HRS	Clear	NORMAL	Light to Moderate SW winds
April 13/2014	18:00 HRS	No2	NORMAL	Light vrbl. Winds
April 14/2014	08:00 HRS	Clear	NORMAL	Moderate SE Winds
April 14/2014	18:00 HRS	Clear	NORMAL	Moderate SSW wind
April 15/2014	08:00 HRS	Obscured in Fog	Obscured	Moderate SSW winds
April 15/2014	18:00 HRS	Obscured in Fog	Obscured	Moderate SSW winds
April 16/2014	08:00 HRS	Clear	NORMAL	SW Strong Winds
April 16/2014	18:00 HRS	Clear	NORMAL	SW Strong Winds
April 17/2014	08:00 HRS	Clear	NORMAL	NE Strong Winds
April 17/2014	18:00 HRS	Clear	NORMAL	NE Strong Winds
April 18/2014	08:00 HRS	Clear	NORMAL	E Strong Winds
April 18/2014	18:00 HRS	Clear	NORMAL	E Strong Winds
April 19/2014	08:00 HRS	Obscured in Fog	Obscured	N Light Winds
April 19/2014	18:00 HRS	Clear	NORMAL	Moderate W winds
April 20/2014	08:00 HRS	Clear	NORMAL	Moderate SW winds
April 20/2014	18:00 HRS	Clear	NORMAL	Moderate SW winds
April 21/2014	08:00 HRS	Clear	NORMAL	Moderate SW winds
April 21/2014	18:00 HRS	Clear	NORMAL	Moderate SW winds
April 22/2014	08:00 HRS	Clear	NORMAL	Light SW winds
April 22/2014	18:00 HRS	Clear	NORMAL	Light SW winds
April 23/2014	08:00 HRS	Clear	NORMAL	Moderate E winds
April 23/2014	18:00 HRS	Clear	NORMAL	Moderate E winds
April 24/2014	08:00 HRS	Clear	NORMAL	E Gale Force Winds
April 24/2014	18:00 HRS	Clear	NORMAL	E Gale Force Winds
April 25/2014	08:00 HRS	Clear	NORMAL	N Gale Force Winds
April 25/2014	18:00 HRS	Clear	NORMAL	N Gale Force Winds
April 26/2014	08:00 HRS	Clear	NORMAL	NW Gale Force Winds
April 26/2014	18:00 HRS	Clear	NORMAL	NW Strong Winds
April 27/2014	08:00 HRS	Clear	NORMAL	E Light Winds
April 27/2014	18:00 HRS	Clear	NORMAL	E Strong Winds
April 28/2014	08:00 HRS	Obscured in Fog	Obscured	E strong Winds
April 28/2014	18:00 HRS	Clear	NORMAL	E Gale Force Winds
April 29/2014	08:00 HRS	Clear	NORMAL	NE Gale Force Winds
April 29/2014	18:00 HRS	Clear	NORMAL	NE Gale Force Winds
April 30/2014	08:00 HRS	Clear	NORMAL	NNE Moderate Winds
April 30/2014	18:00 HRS	Clear	NORMAL	NNE Light Winds

Daily Thebaud Flare Observations

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
May 01/2014	08:00 HRS	Clear	NORMAL	W Light Winds
May 01/2014	18:00 HRS	Clear	NORMAL	W Light Winds
May 02/2014	08:00 HRS	Obscured in Fog	Obscured	W Light Winds
May 02/2014	18:00 HRS	Clear	NORMAL	W Light Winds
May 03/2014	08:00 HRS	Clear	NORMAL	W Light Winds
May 03/2014	18:00 HRS	Clear	Clear	W Light Winds
May 04/2014	08:00 HRS	Obscured in Fog	Obscured	W Light Winds
May 04/2014	18:00 HRS	Clear	NORMAL	W Light Winds
May 05/2014	08:00 HRS	Clear	NORMAL	S Light Winds
May 05/2014	18:00 HRS	Clear	NORMAL	S Light Winds
May 06/2014	08:00 HRS	Clear	NORMAL	NW Gale Force Winds
May 06/2014	18:00 HRS	Clear	NORMAL	NW Strong Winds
May 07/2014	08:00 HRS	Clear	NORMAL	N Moderate Winds
May 07/2014	18:00 HRS	Clear	NORMAL	W Light Winds
May 08/2014	08:00 HRS	No 1 on chart	NORMAL	N Light Winds
May 08/2014	18:00 HRS	Clear	NORMAL	N Light Winds
May 09/2014	08:00 HRS	Clear	NORMAL	Winds Light and Variable
May 09/2014	18:00 HRS	Clear	NORMAL	SE Light Winds
May 10/2014	08:00 HRS	Clear	NORMAL	S Moderate Winds
May 10/2014	18:00 HRS	Clear	NORMAL	S Strong Winds
May 11/2014	08:00 HRS	Obscured in Fog	NORMAL	S Strong Winds
May 11/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
May 12/2014	08:00 HRS	Clear	NORMAL	N Moderate Winds
May 12/2014	18:00 HRS	Clear	NORMAL	Winds Light and Variable
May 13/2014	08:00 HRS	Clear	NORMAL	N Moderate Winds
May 13/2014	18:00 HRS	Clear	NORMAL	W Light Winds
May 14/2014	08:00 HRS	Clear	NORMAL	Winds Light and Variable
May 14/2014	18:00 HRS	Clear	NORMAL	Winds Light and Variable
May 15/2014	08:00 HRS	Clear	NORMAL	W Light Winds
May 15/2014	18:00 HRS	Clear	NORMAL	W Light Winds
May 16/2014	08:00 HRS	Clear	NORMAL	SW Light Winds
May 16/2014	18:00 HRS	Clear	NORMAL	W Light Winds
May 17/2014	08:00 HRS	No 1 on chart	NORMAL	E Light Winds
May 17/2014	18:00 HRS	Clear	NORMAL	E Light Winds
May 18/2014	08:00 HRS	Clear	NORMAL	E Moderate Winds
May 18/2014	18:00 HRS	Clear	NORMAL	E Moderate Winds
May 19/2014	08:00 HRS	Clear	NORMAL	E Moderate Winds
May 19/2014	18:00 HRS	Clear	NORMAL	E Moderate Winds
May 20/2014	08:00 HRS	Clear	NORMAL	SW Moderate Winds
May 20/2014	18:00 HRS	Clear	NORMAL	SW Moderate Winds
May 21/2014	08:00 HRS	Clear	NORMAL	ESE Moderate Winds
May 21/2014	18:00 HRS	Clear	NORMAL	ESE Moderate Winds
May 22/2014	08:00 HRS	Clear	NORMAL	NW Moderate Winds
May 22/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
May 23/2014	08:00 HRS	Clear	NORMAL	SW Light Winds
May 23/2014	18:00 HRS	Clear	NORMAL	SW Light Winds
May 24/2014	08:00 HRS	Clear	NORMAL	NW Light Winds
May 24/2014	18:00 HRS	Clear	NORMAL	NE Light Winds
May 25/2014	08:00 HRS	Clear	NORMAL	NE Strong Winds
May 25/2014	18:00 HRS	Clear	NORMAL	NE Strong Winds
May 26/2014	08:00 HRS	Clear	NORMAL	NW Moderate Winds
May 26/2014	18:00 HRS	Clear	NORMAL	SW Light Winds
May 27/2014	08:00 HRS	Obscured in Fog	NORMAL	NW Moderate Winds
May 27/2014	18:00 HRS	Clear	NORMAL	N Moderate Winds
May 28/2014	08:00 HRS	No 1 on chart	NORMAL	NW Moderate Winds
May 28/2014	18:00 HRS	Clear	NORMAL	N Moderate Winds
May 29/2014	08:00 HRS	Clear	NORMAL	N Moderate Winds
May 29/2014	18:00 HRS	Clear	NORMAL	NW Moderate Winds
May 30/2014	08:00 HRS	Clear	NORMAL	W Moderate Winds
May 30/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
May 31/2014	08:00 HRS	Clear	NORMAL	NE Light Winds
May 31/2014	18:00 HRS	Clear	NORMAL	NE Moderate Winds

Daily Thebaud Flare Observations

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
June 01/2014	08:00 HRS	Clear	NORMAL	NE Strong Winds
June 01/2014	18:00 HRS	Clear	NORMAL	NE Strong Winds
June 02/2014	08:00 HRS	Clear	NORMAL	E Moderate Winds
June 02/2014	18:00 HRS	Clear	NORMAL	E Moderate Winds
June 03/2014	08:00 HRS	Obscured in Fog	NORMAL	E Moderate Winds
June 03/2014	18:00 HRS	Obscured in Fog	NORMAL	E Moderate Winds
June 04/2014	08:00 HRS	Obscured in Fog	NORMAL	E Moderate Winds
June 04/2014	18:00 HRS	Obscured in Fog	NORMAL	E Moderate Winds
June 05/2014	08:00 HRS	Clear	NORMAL	SE Moderate Winds
June 05/2014	18:00 HRS	Obscured in Fog	NORMAL	SE Moderate Winds
June 06/2014	08:00 HRS	Obscured in Fog	NORMAL	S Strong Winds
June 06/2014	18:00 HRS	Clear	NORMAL	S Strong Winds
June 07/2014	08:00 HRS	Clear	NORMAL	SE Moderate Winds
June 07/2014	18:00 HRS	Clear	NORMAL	NW Moderate Winds
June 08/2014	08:00 HRS	Clear	NORMAL	NW Moderate Winds
June 08/2014	18:00 HRS	Clear	NORMAL	NW Moderate Winds
June 09/2014	08:00 HRS	No 1 on chart	NORMAL	N Moderate Winds
June 09/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
June 10/2014	08:00 HRS	Clear	NORMAL	W Light Winds
June 10/2014	18:00 HRS	Clear	NORMAL	W Light Winds
June 11/2014	08:00 HRS	Clear	NORMAL	NW Moderate Winds
June 11/2014	18:00 HRS	Clear	NORMAL	N Moderate Winds
June 12/2014	08:00 HRS	Clear	NORMAL	N Moderate Winds
June 12/2014	18:00 HRS	Clear	NORMAL	NE Light Winds
June 13/2014	08:00 HRS	Clear	NORMAL	E Light Winds
June 13/2014	18:00 HRS	Clear	NORMAL	SE Light Winds
June 14/2014	08:00 HRS	Clear	NORMAL	SE Moderate Winds
June 14/2014	18:00 HRS	Clear	NORMAL	S Strong Winds
June 15/2014	08:00 HRS	Clear	Very Small	S Moderate Winds
June 15/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
June 16/2014	08:00 HRS	No 1 on chart	NORMAL	N Moderate Winds
June 16/2014	18:00 HRS	Clear	NORMAL	NW Moderate Winds
June 17/2014	08:00 HRS	Clear	NORMAL	NNW Moderate Winds
June 17/2014	18:00 HRS	Clear	NORMAL	NNW Moderate Winds
June 18/2014	08:00 HRS	Clear	NORMAL	S Moderate Winds
June 18/2014	18:00 HRS	Clear	NORMAL	S Moderate Winds
June 19/2014	08:00 HRS	Clear	NORMAL	W Moderate Winds
June 19/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
June 20/2014	08:00 HRS	Clear	NORMAL	W Light Winds
June 20/2014	18:00 HRS	Clear	NORMAL	W Light Winds
June 21/2014	08:00 HRS	Clear	NORMAL	W Moderate Winds
June 21/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
June 22/2014	08:00 HRS	Clear	NORMAL	W Light Winds
June 22/2014	18:00 HRS	Clear	NORMAL	W Light Winds
June 23/2014	08:00 HRS	Clear	NORMAL	W Light Winds
June 23/2014	18:00 HRS	Clear	NORMAL	W Light Winds
June 24/2014	08:00 HRS	Clear	NORMAL	S Light Winds
June 24/2014	18:00 HRS	Clear	NORMAL	SW moderate Winds
June 25/2014	08:00 HRS	Clear	NORMAL	SW Strong Winds
June 25/2014	18:00 HRS	Clear	NORMAL	SW moderate Winds
June 26/2014	08:00 HRS	Clear	NORMAL	SW Moderate Winds
June 26/2014	18:00 HRS	Obscured in Fog	NORMAL	SW moderate Winds
June 27/2014	08:00 HRS	Obscured in Fog	NORMAL	NW Moderate Winds
June 27/2014	18:00 HRS	Clear	NORMAL	N Moderate Winds
June 28/2014	08:00 HRS	Clear	NORMAL	N Moderate Winds
June 28/2014	18:00 HRS	Clear	NORMAL	N Moderate Winds
June 29/2014	08:00 HRS	Clear	NORMAL	N Moderate Winds
June 29/2014	18:00 HRS	Clear	NORMAL	W Light Winds
June 30/2014	08:00 HRS	Clear	NORMAL	SW Light Winds
June 30/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds

Daily Thebaud Flare Observations

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
July 01/2014	08:00 HRS	Clear	NORMAL	SW Strong Winds
July 01/2014	18:00 HRS	Clear	NORMAL	SW Strong Winds
July 02/2014	08:00 HRS	Clear	NORMAL	SW Moderate Winds
July 02/2014	18:00 HRS	Clear	NORMAL	SW Strong Winds
July 03/2014	08:00 HRS	Clear	NORMAL	SSW Strong winds
July 03/2014	18:00 HRS	Clear	NORMAL	SSW Strong winds
July 04/2014	08:00 HRS	Clear	NORMAL	S Strong Winds
July 04/2014	18:00 HRS	Clear	NORMAL	S Strong Winds
July 05/2014	08:00 HRS	Clear	NORMAL	SE Strong Winds
July 05/2014	18:00 HRS	Clear	NORMAL	S Gale Force Winds
July 06/2014	08:00 HRS	Clear	NORMAL	SW Gale Force Winds
July 06/2014	18:00 HRS	Clear	NORMAL	SW Gale Force Winds
July 07/2014	08:00 HRS	Clear	NORMAL	SW Strong Winds
July 07/2014	18:00 HRS	Clear	NORMAL	SW Strong Winds
July 08/2014	08:00 HRS	Obscured in Fog	NORMAL	S Strong Winds
July 08/2014	18:00 HRS	Clear	NORMAL	S Strong Winds
July 09/2014	08:00 HRS	Obscured in Fog	NORMAL	S Strong Winds
July 09/2014	18:00 HRS	Obscured in Fog	NORMAL	S Strong Winds
July 10/2014	08:00 HRS	Clear	NORMAL	SW Strong Winds
July 10/2014	18:00 HRS	Obscured in Fog	NORMAL	SW Moderate Winds
July 11/2014	08:00 HRS	Obscured in Fog	NORMAL	SW Light winds
July 11/2014	18:00 HRS	Clear	NORMAL	SW Light winds
July 12/2014	08:00 HRS	No1 on the chart	NORMAL	SW Light winds
July 12/2014	18:00 HRS	Clear	NORMAL	S Light Winds
July 13/2014	08:00 HRS	Clear	NORMAL	N Light Winds
July 13/2014	18:00 HRS	Clear	NORMAL	SW Light Winds
July 14/2014	08:00 HRS	Clear	NORMAL	S Light Winds
July 14/2014	18:00 HRS	Clear	NORMAL	S Light Winds
July 15/2014	08:00 HRS	Obscured in Fog	NORMAL	SW Moderate Winds
July 15/2014	18:00 HRS	Clear	NORMAL	SW Moderate Winds
July 16/2014	08:00 HRS	Obscured in Fog	NORMAL	SW Moderate Winds
July 16/2014	18:00 HRS	Clear	NORMAL	SW Moderate Winds
July 17/2014	08:00 HRS	Clear	NORMAL	S Moderate Winds
July 17/2014	18:00 HRS	Clear	NORMAL	S Moderate Winds
July 18/2014	08:00 HRS	Obscured in Fog	NORMAL	W Moderate Winds
July 18/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
July 19/2014	08:00 HRS	Clear	NORMAL	W Moderate Winds
July 19/2014	18:00 HRS	Clear	NORMAL	NW Moderate Winds
July 20/2014	08:00 HRS	Clear	NORMAL	E Moderate Winds
July 20/2014	18:00 HRS	Clear	NORMAL	E Moderate Winds
July 21/2014	08:00 HRS	Clear	NORMAL	E Moderate Winds
July 21/2014	18:00 HRS	Clear	NORMAL	E Moderate Winds
July 22/2014	08:00 HRS	Clear	NORMAL	W Light Winds
July 22/2014	18:00 HRS	Clear	NORMAL	W Light Winds
July 23/2014	08:00 HRS	Clear	NORMAL	SW Moderate Winds
July 23/2014	18:00 HRS	Clear	NORMAL	SW Moderate Winds
July 24/2014	08:00 HRS	Clear	NORMAL	SW Light Winds
July 24/2014	18:00 HRS	Clear	NORMAL	SW Moderate Winds
July 25/2014	08:00 HRS	Obscured in Fog	NORMAL	W Light Winds
July 25/2014	18:00 HRS	Clear	NORMAL	NW Light Winds
July 26/2014	08:00 HRS	Clear	NORMAL	W Light Winds
July 26/2014	18:00 HRS	Clear	NORMAL	SW Moderate Winds
July 27/2014	08:00 HRS	Clear	NORMAL	S Light Winds
July 27/2014	18:00 HRS	Clear	NORMAL	SSE Moderate Winds
July 28/2014	08:00 HRS	Clear	NORMAL	SSE Moderate Winds
July 28/2014	18:00 HRS	Clear	NORMAL	S Moderate Winds
July 29/2014	08:00 HRS	Clear	NORMAL	SSE Strong Winds
July 29/2014	18:00 HRS	Clear	NORMAL	SSE Strong Winds
July 30/2014	08:00 HRS	Clear	NORMAL	SW Moderate Winds
July 30/2014	18:00 HRS	Clear	NORMAL	SSE Moderate Winds
July 31/2014	08:00 HRS	Clear	NORMAL	S Strong Winds
July 31/2014	18:00 HRS	Clear	NORMAL	S Strong Winds

Daily Thebaud Flare Observations

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
Aug 01/2014	08:00 HRS	Clear	NORMAL	S Moderate Winds
Aug 01/2014	18:00 HRS	Clear	NORMAL	S Moderate Winds
Aug 02/2014	08:00 HRS	Clear	NORMAL	NNW Light Winds
Aug 02/2014	18:00 HRS	Clear	NORMAL	Winds Light and Variable
Aug 03/2014	08:00 HRS	Clear	NORMAL	Winds Light and Variable
Aug 03/2014	18:00 HRS	Clear	NORMAL	Winds Light and Variable
Aug 04/2014	08:00 HRS	Clear	NORMAL	W Light Winds
Aug 04/2014	18:00 HRS	No.1 on chart	NORMAL	W Light Winds
Aug 05/2014	08:00 HRS	Clear	NORMAL	Winds Light and Variable
Aug 05/2014	18:00 HRS	Clear	NORMAL	S Light Winds
Aug 06/2014	08:00 HRS	Clear	NORMAL	S Light Winds
Aug 06/2014	18:00 HRS	Clear	NORMAL	E Moderate Winds
Aug 07/2014	08:00 HRS	Clear	NORMAL	SSW Light Winds
Aug 07/2014	18:00 HRS	Clear	NORMAL	SW Moderate Winds
Aug 08/2014	08:00 HRS	Clear	NORMAL	SW Light Winds
Aug 08/2014	18:00 HRS	Clear	NORMAL	SW Moderate Winds
Aug 09/2014	08:00 HRS	Clear	NORMAL	SW Moderate Winds
Aug 09/2014	18:00 HRS	Clear	NORMAL	NW Light Winds
Aug 10/2014	08:00 HRS	Clear	NORMAL	NW Moderate Winds
Aug 10/2014	18:00 HRS	Clear	NORMAL	NW Light Winds
Aug 11/2014	08:00 HRS	Clear	NORMAL	NW Light Winds
Aug 11/2014	18:00 HRS	Clear	NORMAL	NW Light Winds
Aug 12/2014	08:00 HRS	Clear	NORMAL	N Light Winds
Aug 12/2014	18:00 HRS	Clear	NORMAL	N Light Winds
Aug 13/2014	08:00 HRS	Clear	NORMAL	NE Light Winds
Aug 13/2014	18:00 HRS	Clear	NORMAL	NE Light Winds
Aug 14/2014	08:00 HRS	Clear	NORMAL	E Light Winds
Aug 14/2014	18:00 HRS	Clear	NORMAL	E Moderate Winds
Aug 15/2014	08:00 HRS	Clear	NORMAL	E Moderate Winds
Aug 15/2014	18:00 HRS	Clear	NORMAL	SE Moderate Winds
Aug 16/2014	08:00 HRS	Clear	NORMAL	W Light Winds
Aug 16/2014	18:00 HRS	Clear	NORMAL	W Light Winds
Aug 17/2014	08:00 HRS	Clear	NORMAL	SW Moderate Winds
Aug 17/2014	18:00 HRS	Clear	NORMAL	SW Moderate Winds
Aug 18/2014	08:00 HRS	Clear	NORMAL	S Moderate Winds
Aug 18/2014	18:00 HRS	Clear	NORMAL	SW Moderate Winds
Aug 19/2014	08:00 HRS	Clear	NORMAL	W Moderate Winds
Aug 19/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
Aug 20/2014	08:00 HRS	Clear	NORMAL	W Moderate Winds
Aug 20/2014	18:00 HRS	Clear	NORMAL	W Moderate Winds
Aug 21/2014	08:00 HRS	Clear	NORMAL	N Moderate Winds
Aug 21/2014	18:00 HRS	Clear	NORMAL	N Moderate Winds
Aug 22/2014	08:00 HRS	Clear	NORMAL	NNE Moderate Winds
Aug 22/2014	18:00 HRS	Clear	NORMAL	NNE Moderate Winds
Aug 23/2014	08:00 HRS	Clear	NORMAL	NE Moderate Winds
Aug 23/2014	18:00 HRS	Chart #3	LARGE BLOWDOWN	NE Moderate Winds
Aug 24/2014	08:00 HRS	SHUT IN		
Aug 24/2014	18:00 HRS	SHUT IN		
Aug 25/2014	08:00 HRS	SHUT IN		
Aug 25/2014	18:00 HRS	SHUT IN		
Aug 26/2014	08:00 HRS	SHUT IN		
Aug 26/2014	18:00 HRS	SHUT IN		
Aug 27/2014	08:00 HRS	SHUT IN		
Aug 27/2014	18:00 HRS	SHUT IN		
Aug 28/2014	08:00 HRS	SHUT IN		
Aug 28/2014	18:00 HRS	SHUT IN		
Aug 29/2014	08:00 HRS	SHUT IN		
Aug 29/2014	18:00 HRS	SHUT IN		
Aug 30/2014	08:00 HRS	SHUT IN		
Aug 30/2014	18:00 HRS	SHUT IN		
Aug 31/2014	08:00 HRS	SHUT IN		
Aug 31/2014	18:00 HRS	SHUT IN		

Daily Thebaud Flare Observations

DATE	TIME	PLUME COLOR	SIZE	COMMENTS
Sept 01/2014	08:00 HRS	SHUT IN		
Sept 01/2014	18:00 HRS	SHUT IN		
Sept 02/2014	08:00 HRS	SHUT IN		
Sept 02/2014	18:00 HRS	SHUT IN		
Sept 03/2014	08:00 HRS	SHUT IN		
Sept 03/2014	18:00 HRS	SHUT IN		
Sept 04/2014	08:00 HRS	SHUT IN		
Sept 04/2014	18:00 HRS	SHUT IN		
Sept 05/2014	08:00 HRS	SHUT IN		
Sept 05/2014	18:00 HRS	SHUT IN		
Sept 06/2014	08:00 HRS	SHUT IN		
Sept 06/2014	18:00 HRS	SHUT IN		
Sept 07/2014	08:00 HRS	SHUT IN		
Sept 07/2014	18:00 HRS	SHUT IN		
Sept 08/2014	08:00 HRS	SHUT IN		
Sept 08/2014	18:00 HRS	SHUT IN		
Sept 09/2014	08:00 HRS	SHUT IN		
Sept 09/2014	18:00 HRS	SHUT IN		
Sept 10/2014	08:00 HRS	SHUT IN		
Sept 10/2014	18:00 HRS	SHUT IN		
Sept 11/2014	08:00 HRS	SHUT IN		
Sept 11/2014	18:00 HRS	SHUT IN		
Sept 12/2014	08:00 HRS	SHUT IN		
Sept 12/2014	18:00 HRS	SHUT IN		
Sept 13/2014	08:00 HRS	SHUT IN		
Sept 13/2014	18:00 HRS	SHUT IN		
Sept 14/2014	08:00 HRS	SHUT IN		
Sept 14/2014	18:00 HRS	SHUT IN		
Sept 15/2014	08:00 HRS	SHUT IN		
Sept 15/2014	18:00 HRS	SHUT IN		
Sept 16/2014	08:00 HRS	SHUT IN		
Sept 16/2014	18:00 HRS	SHUT IN		
Sept 17/2014	08:00 HRS	SHUT IN		
Sept 17/2014	18:00 HRS	SHUT IN		
Sept 18/2014	08:00 HRS	SHUT IN		
Sept 18/2014	18:00 HRS	SHUT IN		
Sept 19/2014	08:00 HRS	SHUT IN		
Sept 19/2014	18:00 HRS	SHUT IN		
Sept 20/2014	08:00 HRS	SHUT IN		
Sept 20/2014	18:00 HRS	SHUT IN		
Sept 21/2014	08:00 HRS	COLD VENTING	NIL	STRONG S WINDS
Sept 21/2014	18:00 HRS	COLD VENTING	NIL	STRONG S WINDS
Sept 22/2014	08:00 HRS	COLD VENTING	NIL	GALE FORCE SW WINDS
Sept 22/2014	18:00 HRS	COLD VENTING	NIL	GALE FORCE SW WINDS
Sept 23/2014	08:00 HRS	COLD VENTING	NIL	STRONG W WINDS
Sept 23/2014	18:00 HRS	COLD VENTING	NIL	STRONG W WINDS
Sept 24/2014	08:00 HRS	COLD VENTING	NIL	STRONG NNW WINDS
Sept 24/2014	18:00 HRS	COLD VENTING	NIL	MODERATE N WINDS
Sept 25/2014	08:00 HRS	COLD VENTING	NIL	MODERATE W WINDS
Sept 25/2014	18:00 HRS	COLD VENTING	NIL	MODERATE W WINDS
Sept 26/2014	08:00 HRS	COLD VENTING	NIL	MODERATE W WINDS
Sept 26/2014	18:00 HRS	Clear	Normal	MODERATE W WINDS
Sept 27/2014	08:00 HRS	Clear	Normal	MODERATE W WINDS
Sept 27/2014	18:00 HRS	Clear	Normal	Light N Winds
Sept 28/2014	08:00 HRS	Clear	Normal	Light and Variable
Sept 28/2014	18:00 HRS	No 1 on chart	Normal	MODERATE W WINDS
Sept 29/2014	08:00 HRS	Clear	Normal	MODERATE W WINDS
Sept 29/2014	18:00 HRS	Clear	Normal	MODERATE NE WINDS
Sept 30/2014	08:00 HRS	Clear	Normal	MODERATE E WINDS
Sept 30/2014	18:00 HRS	Clear	Normal	MODERATE E WINDS

Daily Thebaud Flare Observations

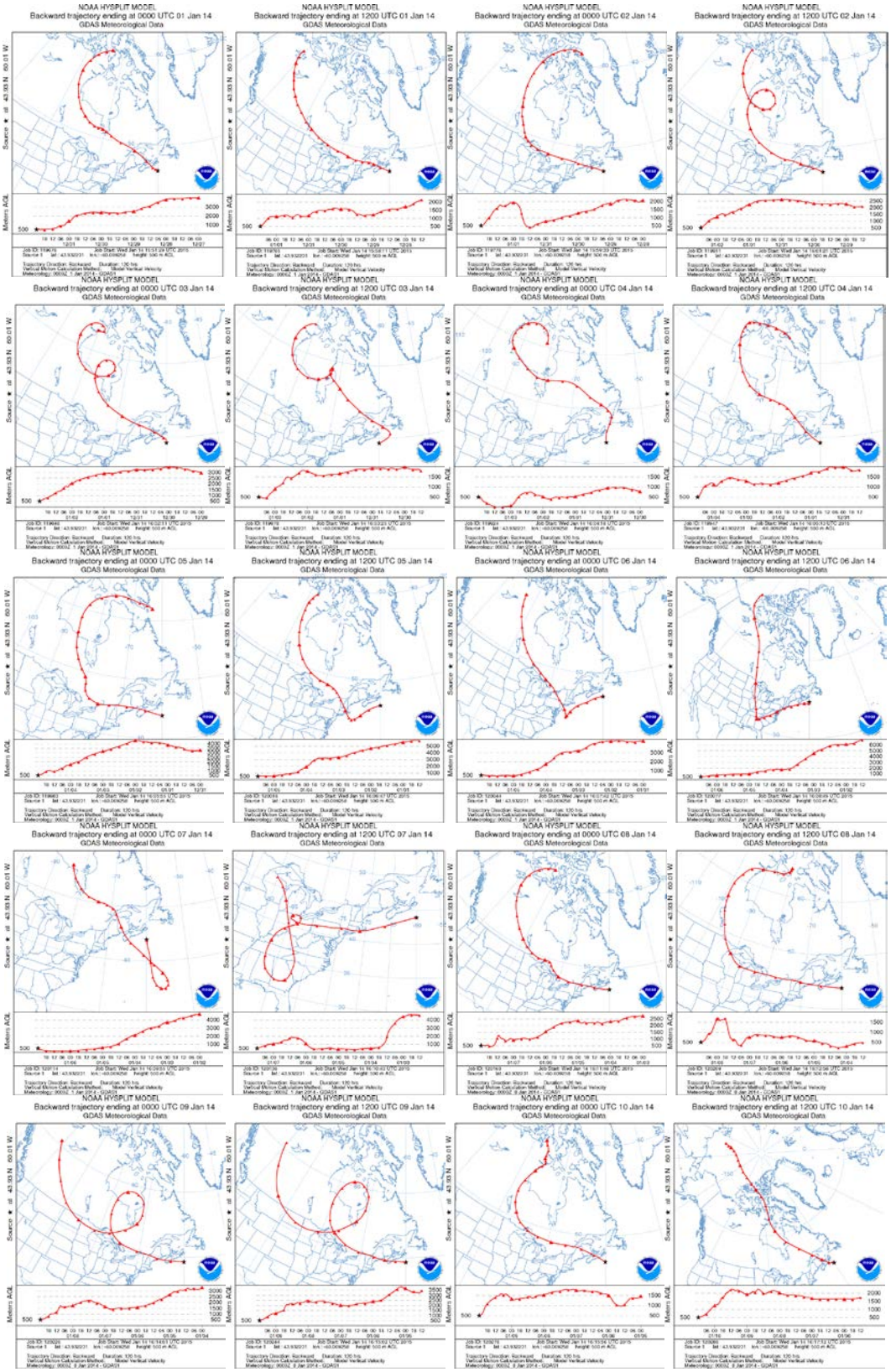
DATE	TIME	PLUME COLOR	SIZE	COMMENTS
Oct 01/2014	08:00 HRS	Clear	Normal	MODERATE E WINDS
Oct 01/2014	18:00 HRS	Clear	Normal	STRONG E WINDS
Oct 02/2014	08:00 HRS	Clear	Normal	STRONG NE WINDS
Oct 02/2014	18:00 HRS	Clear	Normal	GALE FORCE NE WINDS
Oct 03/2014	08:00 HRS	Clear	Normal	GALE FORCE NE WINDS
Oct 03/2014	18:00 HRS	Clear	Normal	STRONG ENE WINDS
Oct 04/2014	08:00 HRS	Clear	Normal	STRONG ENE WINDS
Oct 04/2014	18:00 HRS	Clear	Normal	STRONG E WINDS
Oct 05/2014	08:00 HRS	Clear	Normal	STRONG E WINDS
Oct 05/2014	18:00 HRS	Clear	Normal	MOD E WINDS
Oct 06/2014	08:00 HRS	Clear	Normal	MOD WNW WINDS
Oct 06/2014	18:00 HRS	Clear	Normal	MOD WNW WINDS
Oct 07/2014	08:00 HRS	Clear	Normal	MODERATE E WINDS
Oct 07/2014	18:00 HRS	Clear	Normal	MODERATE E WINDS
Oct 08/2014	08:00 HRS	Clear	Normal	STRONG SE WINDS
Oct 08/2014	18:00 HRS	Clear	Normal	STRONG SE WINDS
Oct 09/2014	08:00 HRS	Clear	Normal	MODERATE SW WINDS
Oct 09/2014	18:00 HRS	Clear	Normal	MODERATE SW WINDS
Oct 10/2014	08:00 HRS	Clear	Normal	STRONG W WINDS
Oct 10/2014	18:00 HRS	Clear	Normal	STRONG W WINDS
Oct 11/2014	08:00 HRS	Clear	Normal	LIGHT W WINDS
Oct 11/2014	18:00 HRS	Clear	Normal	LIGHT NW WINDS
Oct 12/2014	08:00 HRS	Clear	Normal	GALE FORCE NW WINDS
Oct 12/2014	18:00 HRS	Clear	Normal	GALE FORCE NW WINDS
Oct 13/2014	08:00 HRS	Clear	Normal	STRONG NW WINDS
Oct 13/2014	18:00 HRS	Clear	Normal	STRONG W WINDS
Oct 14/2014	08:00 HRS	Clear	Normal	MODERATE W WINDS
Oct 14/2014	18:00 HRS	Clear	Normal	MODERATE W WINDS
Oct 15/2014	08:00 HRS	Clear	Normal	MODERATE W WINDS
Oct 15/2014	18:00 HRS	Clear	Normal	STRONG W WINDS
Oct 16/2014	08:00 HRS	Clear	Normal	MODERATE E WINDS
Oct 16/2014	18:00 HRS	Clear	Normal	MODERATE E WINDS
Oct 17/2014	08:00 HRS	Clear	Normal	STRONG SE WINDS
Oct 17/2014	18:00 HRS	Clear	Normal	STRONG SE WINDS
Oct 18/2014	08:00 HRS	Clear	Normal	MODERATE SE WINDS
Oct 18/2014	18:00 HRS	Clear	Normal	STRONG SE WINDS
Oct 19/2014	08:00 HRS	Clear	Normal	MODERATE SSW WINDS
Oct 19/2014	18:00 HRS	Clear	Normal	MODERATE S WINDS
Oct 20/2014	08:00 HRS	Clear	Normal	GALE FORCE W WINDS
Oct 20/2014	18:00 HRS	Clear	Normal	GALE FORCE W WINDS
Oct 21/2014	08:00 HRS	Clear	Normal	LIGHT W WINDS
Oct 21/2014	18:00 HRS	Clear	Normal	LIGHT W WINDS
Oct 22/2014	08:00 HRS	Clear	Normal	STRONG E WINDS
Oct 22/2014	18:00 HRS	Clear	Normal	STRONG E WINDS
Oct 23/2014	08:00 HRS	Clear	Normal	STRONG E WINDS
Oct 23/2014	18:00 HRS	Clear	Normal	STRONG E WINDS
Oct 24/2014	08:00 HRS	Clear	Normal	MODERATE SE WINDS
Oct 24/2014	18:00 HRS	Clear	Normal	MODERATE S WINDS
Oct 25/2014	08:00 HRS	Clear	Normal	MODERATE W WINDS
Oct 25/2014	18:00 HRS	Clear	Normal	MODERATE W WINDS
Oct 26/2014	08:00 HRS	Clear	Normal	MODERATE W WINDS
Oct 26/2014	18:00 HRS	Clear	Normal	MODERATE SE WINDS
Oct 27/2014	08:00 HRS	Clear	Normal	GALE FORCE W WINDS
Oct 27/2014	18:00 HRS	Clear	Normal	GALE FORCE W WINDS
Oct 28/2014	08:00 HRS	Clear	Normal	GALE FORCE NW WINDS
Oct 28/2014	18:00 HRS	Clear	Normal	GALE FORCE NW WINDS
Oct 29/2014	08:00 HRS	No 1 on chart	Normal	LIGHT & VARIABLE
Oct 29/2014	18:00 HRS	Clear	Normal	STRONG S WINDS
Oct 30/2014	08:00 HRS	Clear	Normal	STRONG SW WINDS
Oct 30/2014	18:00 HRS	Obscured in fog	Normal	MODERATE W WINDS
Oct 31/2014	08:00 HRS	Clear	Normal	MODERATE NE WINDS
Oct 31/2014	18:00 HRS	Clear	Normal	MODERATE NE WINDS

Daily Thebaud Flare Observations

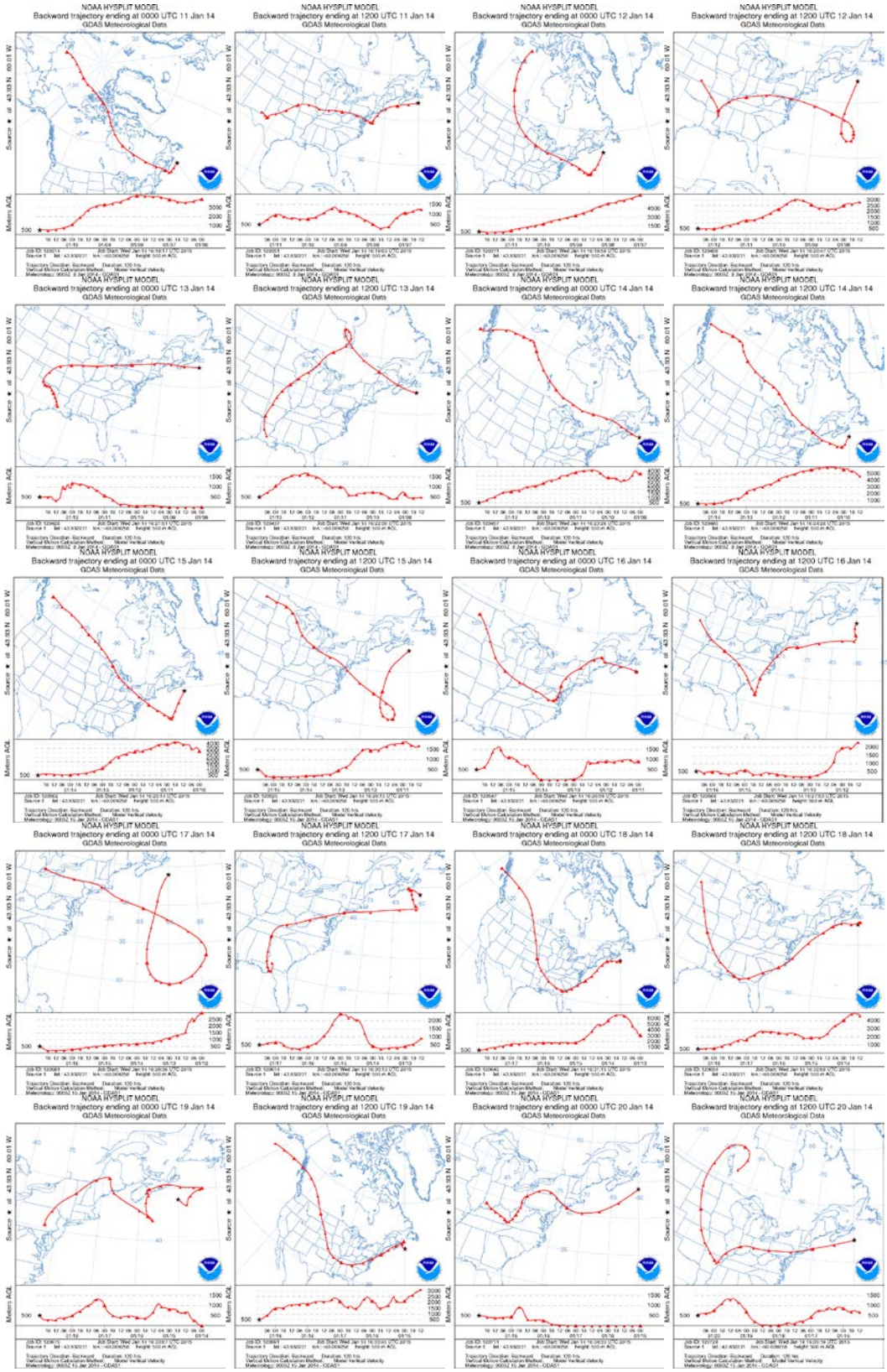
DATE	TIME	PLUME COLOR	SIZE	COMMENTS
Nov 1/2014	08:00 HRS	Clear	Normal	GALE FORCE NE WINDS
Nov 1/2014	18:00 HRS	Clear	Normal	STRONG NE WINDS
Nov 2/2014	08:00 HRS	Clear	Normal	STRONG S WINDS
Nov 2/2014	18:00 HRS	Clear	Normal	STRONG S WINDS
Nov 3/2014	08:00 HRS	Clear	Normal	HURRICANE FORCE SW WINDS
Nov 3/2014	18:00 HRS	Clear	Normal	GALE FORCE WSW WINDS
Nov 4/2014	08:00 HRS	Clear	Normal	STRONG WNW WINDS
Nov 4/2014	18:00 HRS	Clear	Normal	STRONG WNW WINDS
Nov 5/2014	08:00 HRS	Clear	Normal	LIGHT W WINDS
Nov 5/2014	18:00 HRS	Clear	Normal	STRONG W WINDS
Nov 6/2014	08:00 HRS	Clear	Normal	LIGHT NNW WINDS
Nov 6/2014	18:00 HRS	Clear	Normal	LIGHT N WINDS
Nov 7/2014	08:00 HRS	Clear	Normal	Moderate S Winds
Nov 7/2014	18:00 HRS	Clear	Normal	Moderate S Winds
Nov 8/2014	08:00 HRS	Clear	Normal	GALE FORCE W WINDS
Nov 8/2014	18:00 HRS	Clear	Normal	GALE FORCE W WINDS
Nov 9/2014	08:00 HRS	Clear	Normal	Moderate SW Winds
Nov 9/2014	18:00 HRS	Clear	Normal	Light SSW Winds
Nov 10/2014	08:00 HRS	Clear	Normal	Moderate N Winds
Nov 10/2014	18:00 HRS	Clear	Normal	Moderate N Winds
Nov 11/2014	08:00 HRS	Clear	Normal	Light SE Winds
Nov 11/2014	18:00 HRS	Clear	Normal	Light SE Winds
Nov 12/2014	08:00 HRS	Clear	Normal	Moderate E Winds
Nov 12/2014	18:00 HRS	Clear	Normal	STRONG E WINDS
Nov 13/2014	08:00 HRS	Clear	Normal	Moderate E Winds
Nov 13/2014	18:00 HRS	Clear	Normal	STRONG SE WINDS
Nov 14/2014	08:00 HRS	Clear	Normal	STRONG W WINDS
Nov 14/2014	18:00 HRS	Clear	Normal	STRONG W WINDS
Nov 15/2014	08:00 HRS	Clear	Normal	STRONG NW Winds
Nov 15/2014	18:00 HRS	Clear	Normal	STRONG NW Winds
Nov 16/2014	08:00 HRS	Clear	Normal	STRONG W Winds
Nov 16/2014	18:00 HRS	Clear	Normal	STRONG W Winds
Nov 17/2014	08:00 HRS	Clear	Normal	Moderate SW Winds
Nov 17/2014	18:00 HRS	Clear	Normal	Moderate SW Winds
Nov 18/2014	08:00 HRS	Clear	Normal	GALE FORCE SW WINDS
Nov 18/2014	18:00 HRS	Clear	Normal	GALE FORCE SW WINDS
Nov 19/2014	08:00 HRS	Clear	Normal	GALE FORCE W WINDS
Nov 19/2014	18:00 HRS	Clear	Normal	GALE FORCE W WINDS
Nov 20/2014	08:00 HRS	Clear	Normal	Light Variable Winds
Nov 20/2014	18:00 HRS	Clear	Normal	STRONG S WINDS
Nov 21/2014	08:00 HRS	Clear	Normal	STRONG NW WINDS
Nov 21/2014	18:00 HRS	Clear	Normal	GALE FORCE NW WINDS
Nov 22/2014	08:00 HRS	Clear	Normal	GALE FORCE NW WINDS
Nov 22/2014	18:00 HRS	Clear	Normal	GALE FORCE W WINDS
Nov 23/2014	08:00 HRS	Clear	Normal	GALE FORCE W WINDS
Nov 23/2014	18:00 HRS	Clear	Normal	STRONG NW WINDS
Nov 24/2014	08:00 HRS	Clear	Normal	E MODERATE WNDS
Nov 24/2014	18:00 HRS	Clear	Normal	SSE STRONG WINDS
Nov 25/2014	08:00 HRS	Clear	Normal	GALE FORCE SSW WINDS
Nov 25/2014	18:00 HRS	Clear	Normal	STRONG SW WINDS
Nov 26/2014	08:00 HRS	Clear	Normal	MODERATE NW WINDS
Nov 26/2014	18:00 HRS	Clear	Normal	MODERATE NE WINDS
Nov 27/2014	08:00 HRS	Clear	Normal	STORM FORCE SW WINDS
Nov 27/2014	18:00 HRS	Clear	Normal	GALE FORCE W WINDS
Nov 28/2014	08:00 HRS	Clear	Normal	MODERATE N WINDS
Nov 28/2014	18:00 HRS	Clear	Normal	MODERATE N WINDS
Nov 29/2014	08:00 HRS	Clear	Normal	STRONG NW WINDS
Nov 29/2014	18:00 HRS	Clear	Normal	STRONG NW WINDS
Nov 30/2014	08:00 HRS	Clear	Normal	MODERATE SW WINDS
Nov 30/2014	18:00 HRS	Clear	Normal	STRONG S WINDS

Daily Thebaud Flare Observations

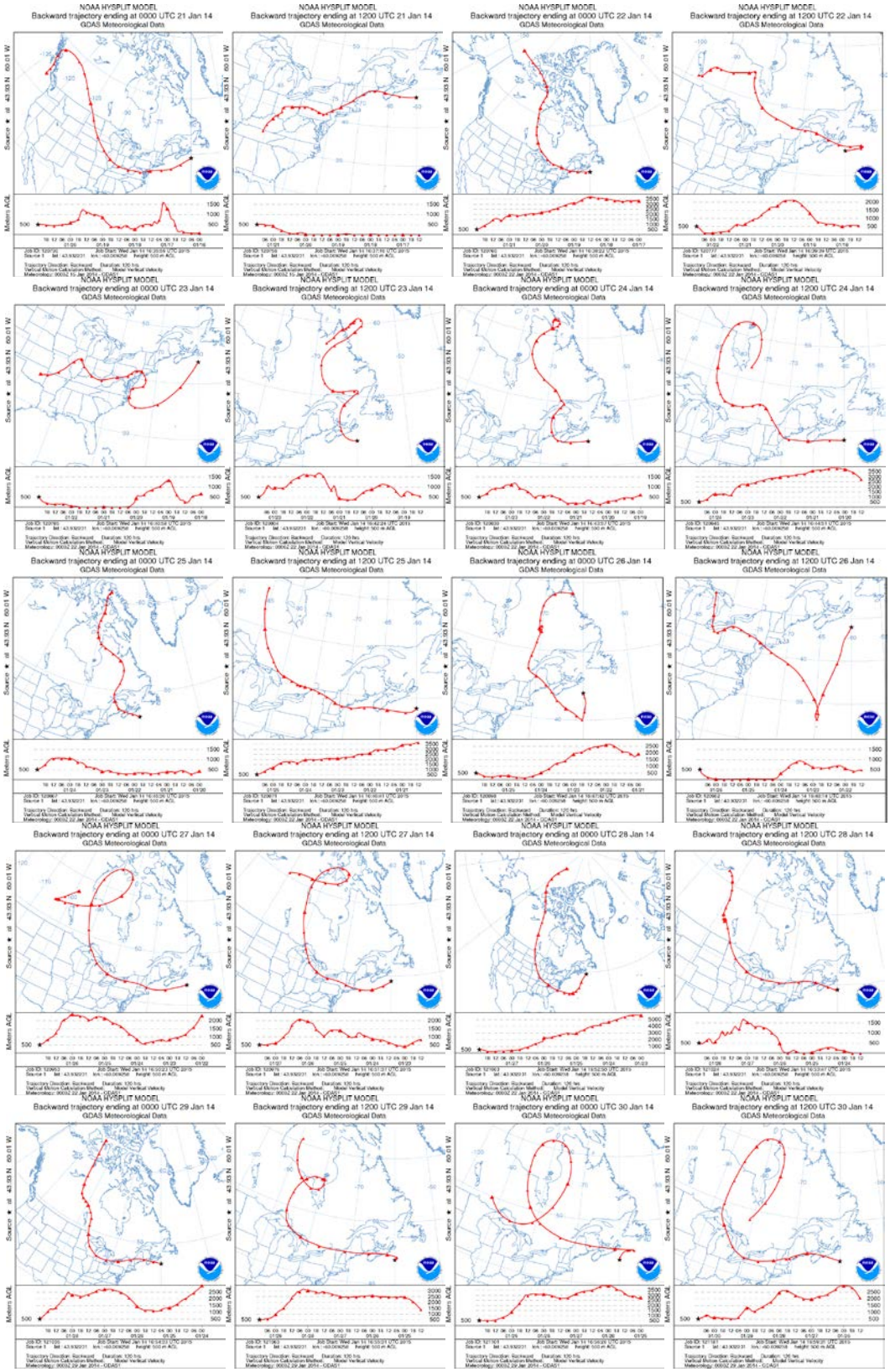
DATE	TIME	PLUME COLOR	SIZE	COMMENTS
Dec 1/2014	08:00 HRS	Clear	Normal	Strong S Winds
Dec 1/2014	18:00 HRS	Clear	Normal	Strong SW Winds
Dec 2/2014	08:00 HRS	Clear	Normal	Gale Force N Winds
Dec 2/2014	18:00 HRS	Clear	Normal	Gale Force N Winds
Dec 3/2014	08:00 HRS	Clear	Normal	Strong NE Winds
Dec 3/2014	18:00 HRS	Clear	Normal	Strong NE Winds
Dec 4/2014	08:00 HRS	Clear	Normal	Strong NW winds
Dec 4/2014	18:00 HRS	Clear	Normal	Strong NW winds
Dec 5/2014	08:00 HRS	Clear	Normal	Moderate N Winds
Dec 5/2014	18:00 HRS	Clear	Normal	Light N Winds
Dec 6/2014	08:00 HRS	Clear	Normal	Moderate SE Winds
Dec 6/2014	18:00 HRS	Clear	Normal	Moderate SE Winds
Dec 7/2014	08:00 HRS	Clear	Normal	Moderate W Winds
Dec 7/2014	18:00 HRS	Clear	Normal	Strong N winds
Dec 8/2014	08:00 HRS	Clear	Normal	Strong E winds
Dec 8/2014	18:00 HRS	Clear	Normal	Strong E winds
Dec 9/2014	08:00 HRS	Clear	Normal	Strong E winds
Dec 9/2014	18:00 HRS	Clear	Normal	Strong E winds
Dec 10/2014	08:00 HRS	Obscured in Fog	Normal	Strong S winds
Dec 10/2014	18:00 HRS	Clear	Normal	Light SE winds
Dec 11/2014	08:00 HRS	Clear	Normal	Strong S winds
Dec 11/2014	18:00 HRS	Clear	Normal	Light SE winds
Dec 12/2014	08:00 HRS	Clear	Large	Strong S winds
Dec 12/2014	18:00 HRS	Clear	Normal	Light SE winds
Dec 13/2014	08:00 HRS	Obscured in Fog	Normal	Moderate NW Winds
Dec 13/2014	18:00 HRS	Clear	Normal	Moderate N Winds
Dec 14/2014	08:00 HRS	Clear	Normal	Moderate N Winds
Dec 14/2014	18:00 HRS	Clear	Normal	Strong N Winds
Dec 15/2014	08:00 HRS	Clear	Normal	Moderate N Winds
Dec 15/2014	18:00 HRS	Clear	Normal	Moderate N Winds
Dec 16/2014	08:00 HRS	Clear	Normal	Strong N Winds
Dec 16/2014	18:00 HRS	Clear	Normal	Moderate NE winds
Dec 17/2014	08:00 HRS	No 1 on Chart	Normal	Light and Variable
Dec 17/2014	18:00 HRS	Clear	Normal	Moderate E Winds
Dec 18/2014	08:00 HRS	Clear	Normal	SW Moderate winds
Dec 18/2014	18:00 HRS	Clear	Normal	SW Moderate winds
Dec 19/2014	08:00 HRS	Clear	Normal	W Strong Winds
Dec 19/2014	18:00 HRS	Clear	Normal	W Strong Winds
Dec 20/2014	08:00 HRS	Clear	Normal	NE Moderate Winds
Dec 20/2014	18:00 HRS	Clear	Normal	NE Moderate Winds
Dec 21/2014	08:00 HRS	Clear	Normal	NE Moderate Winds
Dec 21/2014	18:00 HRS	Clear	Normal	NE Light Winds
Dec 22/2014	08:00 HRS	Clear	Normal	NNE Moderate Winds
Dec 22/2014	18:00 HRS	Clear	Normal	NNE Light Winds
Dec 23/2014	08:00 HRS	Clear	Normal	NE Moderate Winds
Dec 23/2014	18:00 HRS	Clear	Normal	NE Moderate Winds
Dec 24/2014	08:00 HRS	Clear	Normal	ENE Strong Winds
Dec 24/2014	18:00 HRS	Clear	Normal	ENE Strong Winds
Dec 25/2014	08:00 HRS	Clear	Normal	S Gale Force Winds
Dec 25/2014	18:00 HRS	Obscured in Fog	Normal	S Gale Force Winds
Dec 26/2014	08:00 HRS	Clear	Normal	W Strong Winds
Dec 26/2014	18:00 HRS	Clear	Normal	W Strong Winds
Dec 27/2014	08:00 HRS	Clear	Normal	W Strong Winds
Dec 27/2014	18:00 HRS	Clear	Normal	W Strong Winds
Dec 28/2014	08:00 HRS	Clear	Normal	SW Moderate winds
Dec 28/2014	18:00 HRS	Clear	Normal	SW Strong Winds
Dec 29/2014	08:00 HRS	Clear	Normal	W Strong Winds
Dec 29/2014	18:00 HRS	Clear	Normal	W Strong Winds
Dec 30/2014	08:00 HRS	Clear	Normal	NW Strong Winds
Dec 30/2014	18:00 HRS	Clear	Normal	NW Strong Winds
Dec 31/2014	08:00 HRS	Clear	Normal	W Strong Winds
Dec 31/2014	18:00 HRS	Clear	Normal	W Strong Winds



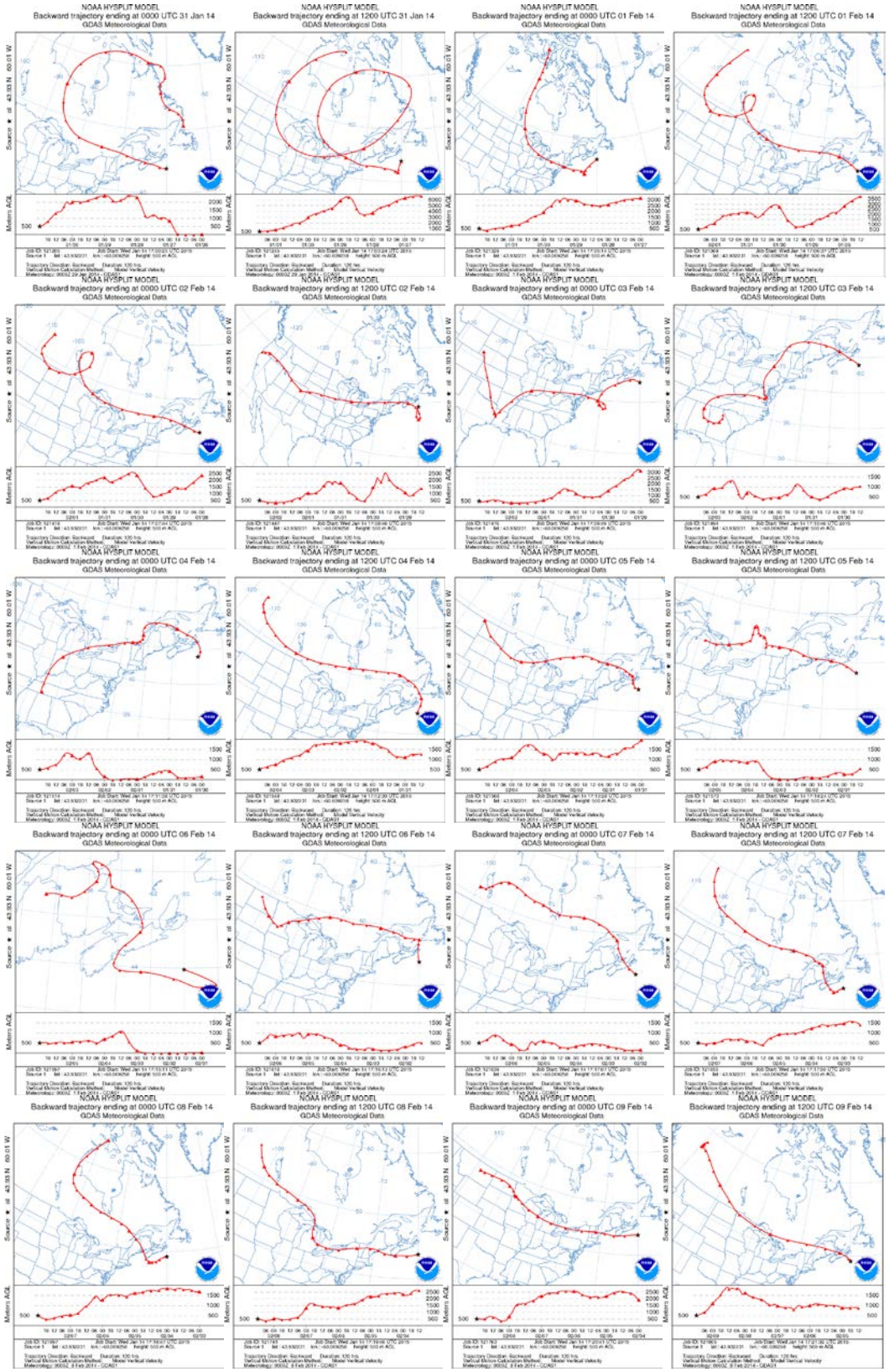
January 01st – 10th, 2014



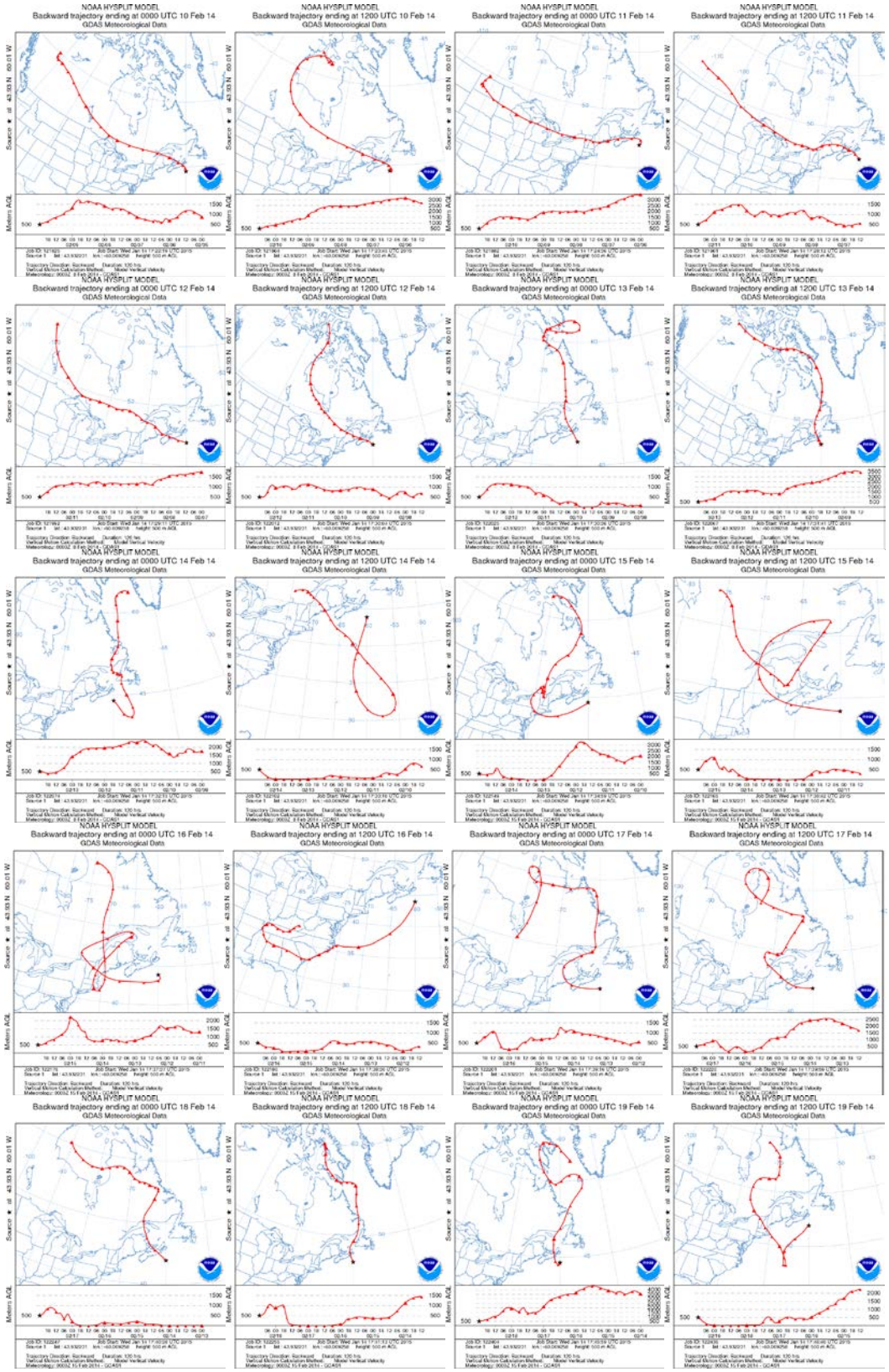
January 11th – 20th, 2014



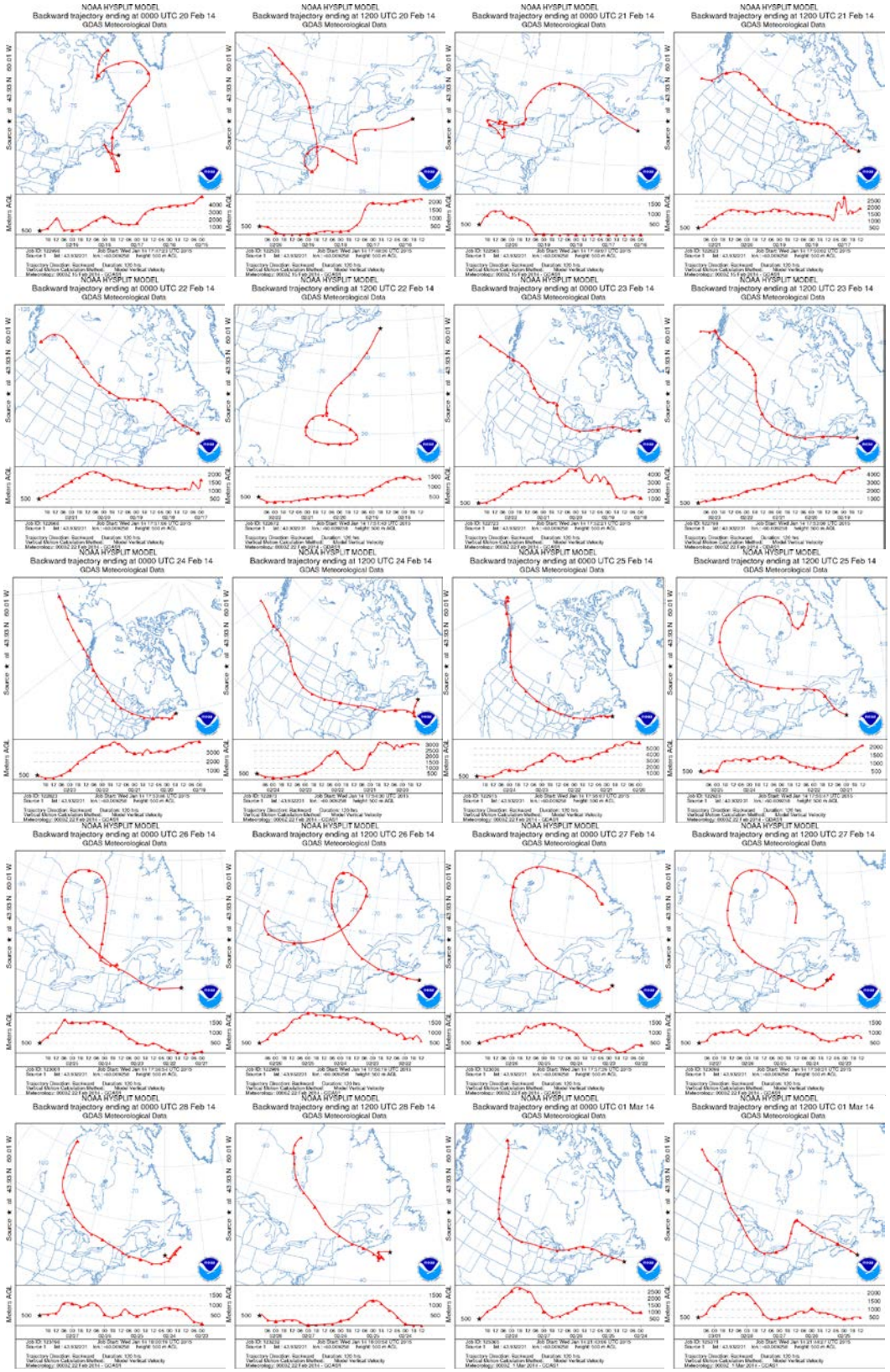
January 21th – 30th, 2014



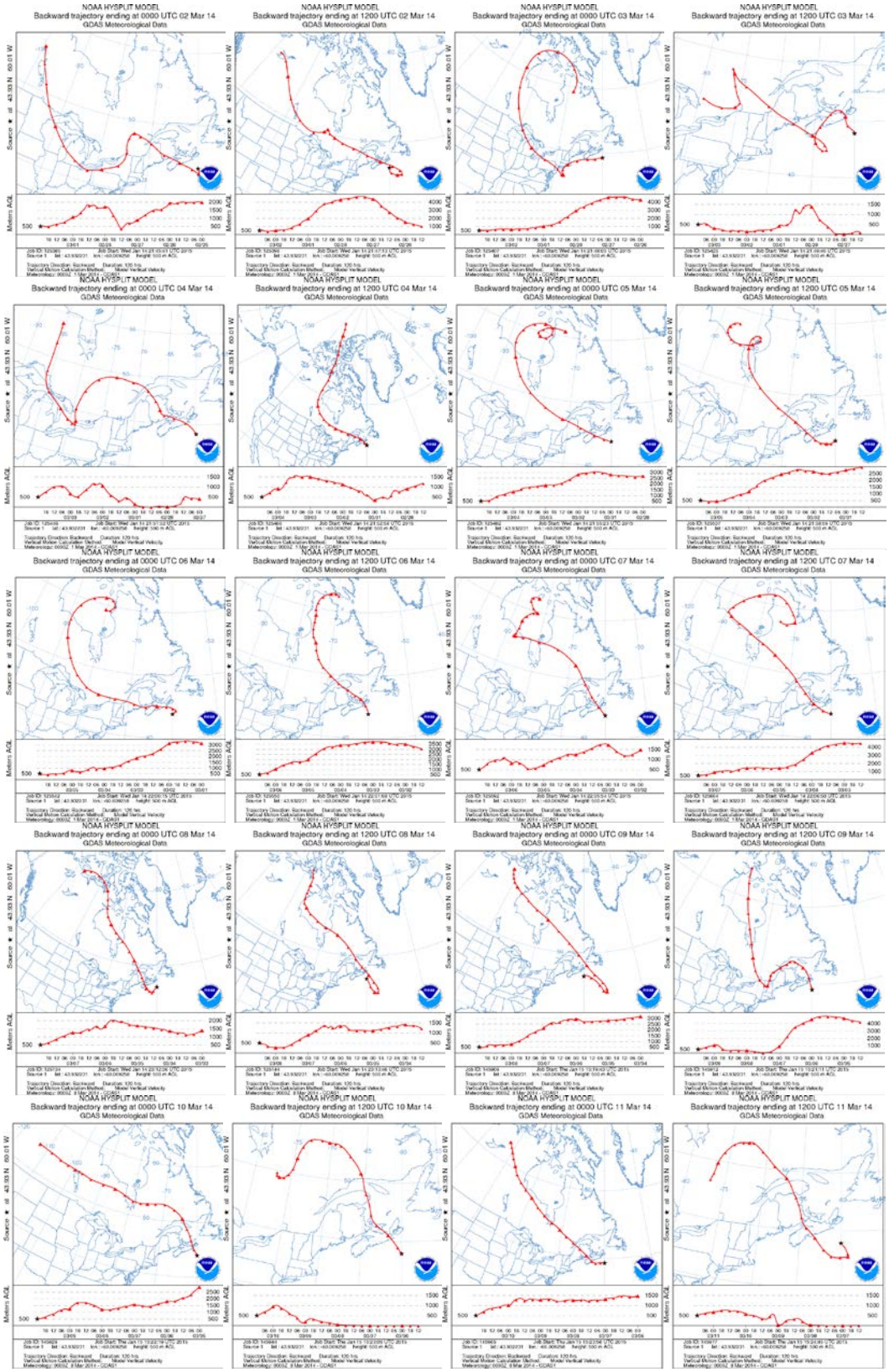
January 31st – February 09th, 2014



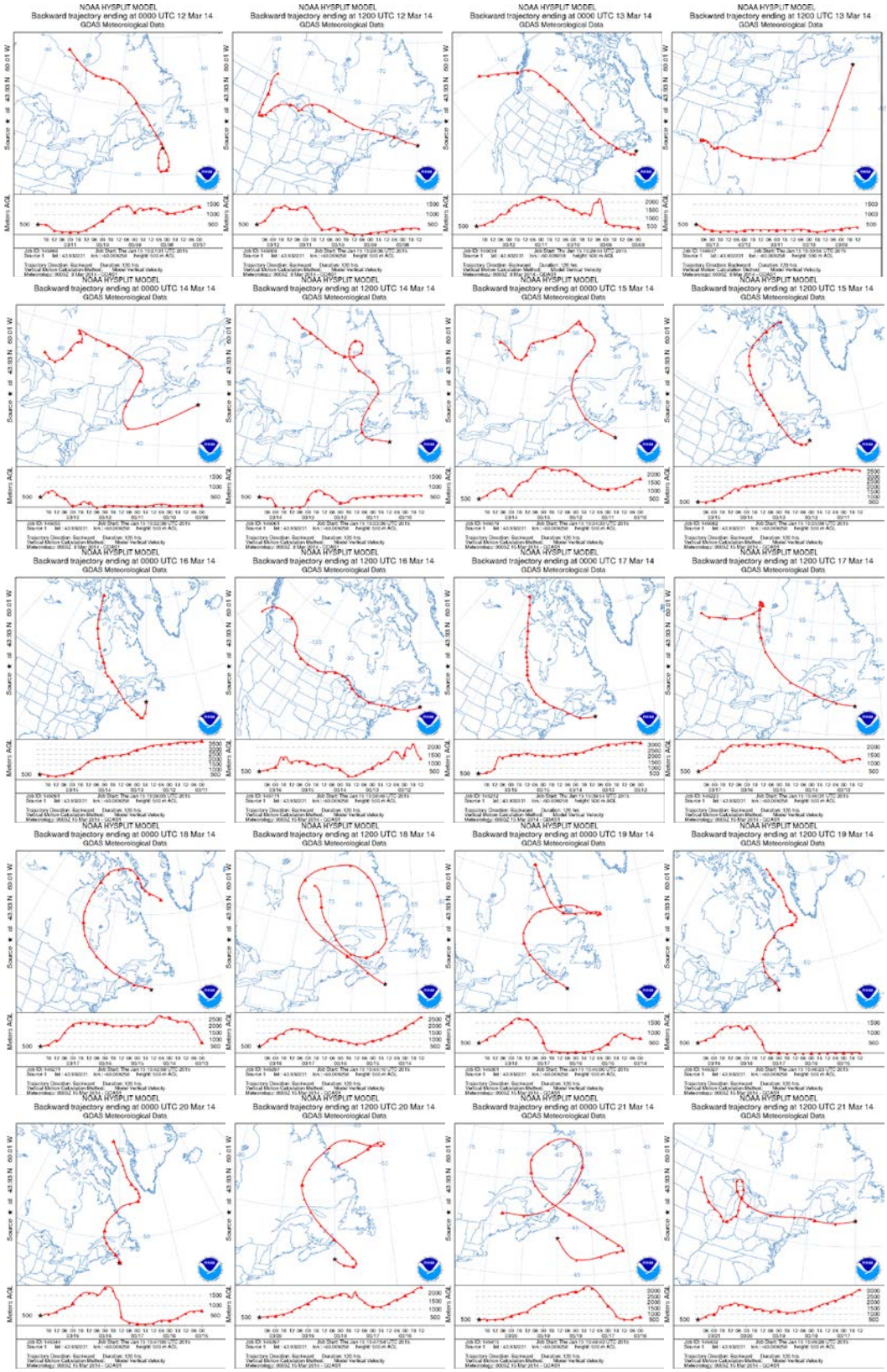
February 10th – 19th, 2014



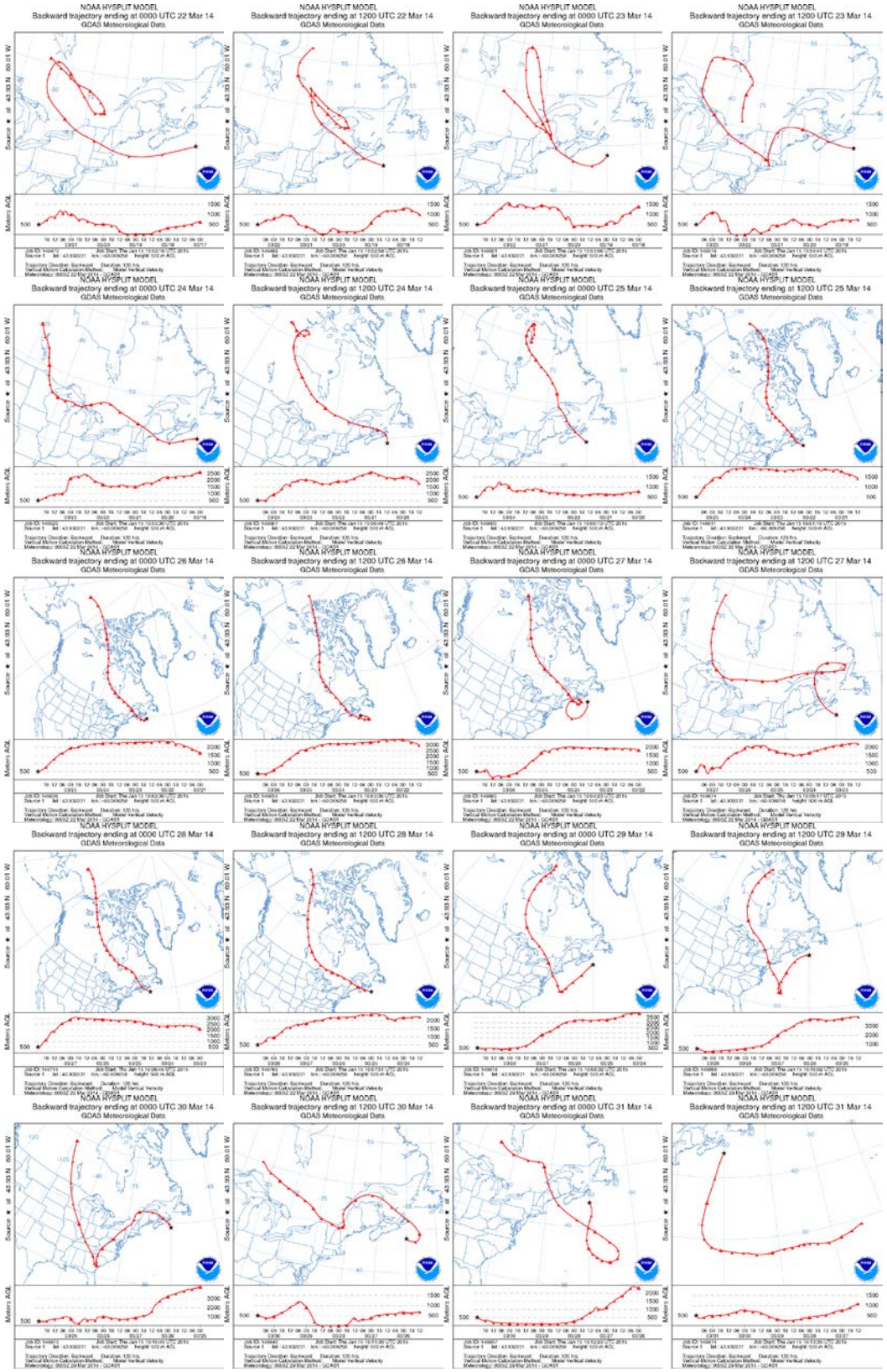
February 20th – March 01st, 2014



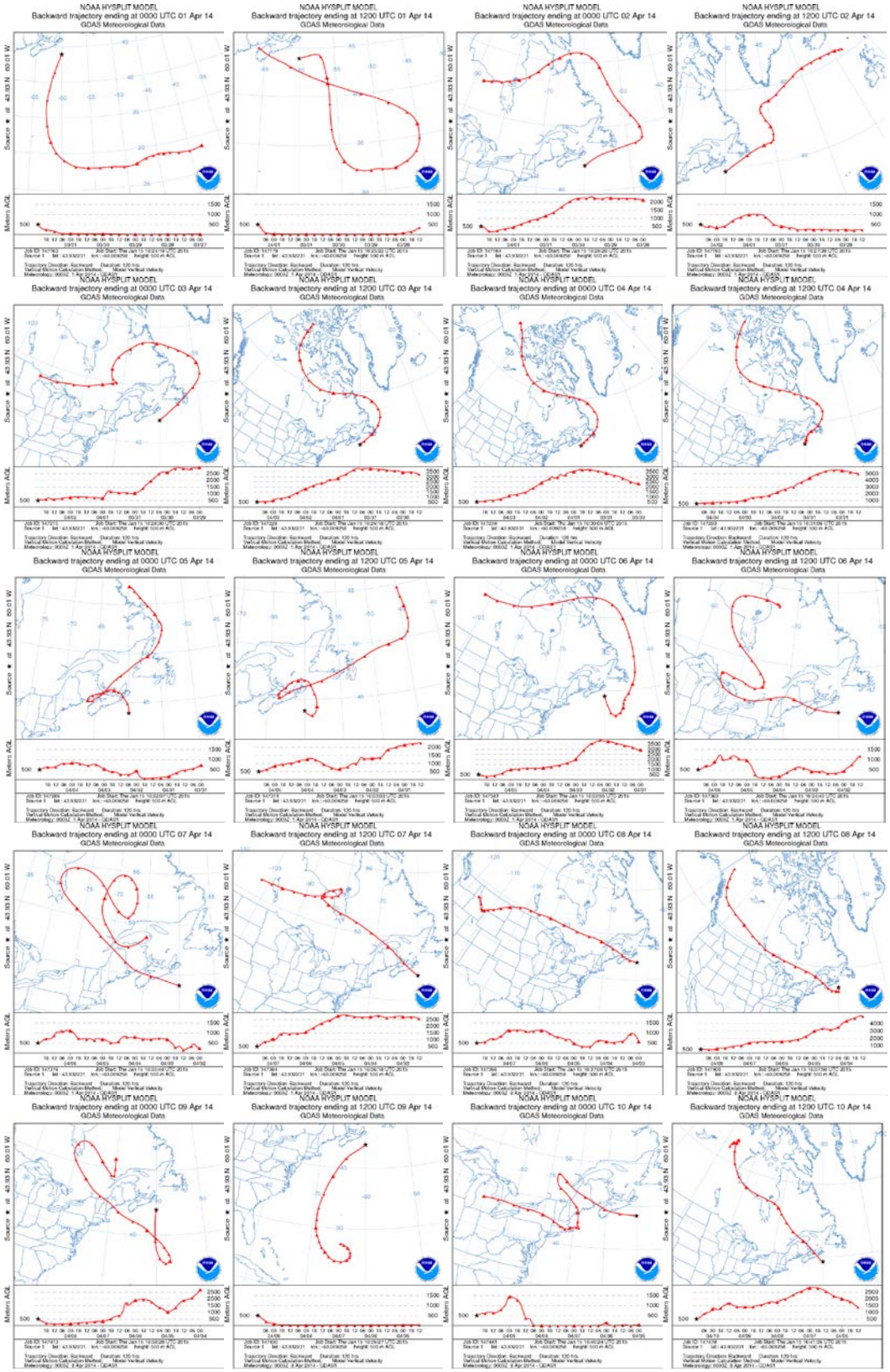
March 02nd – 11th, 2014



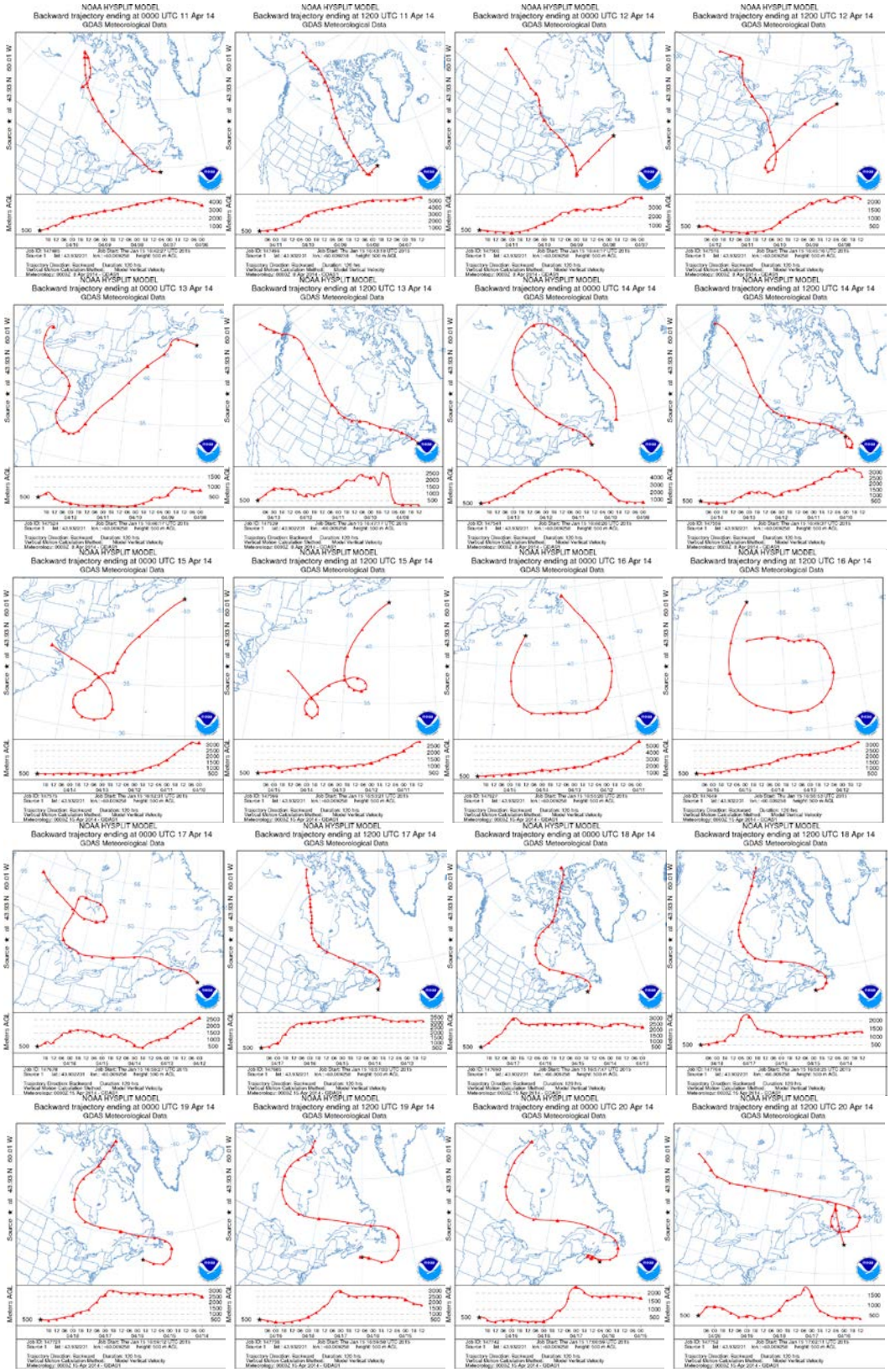
March 12th – 21st, 2014



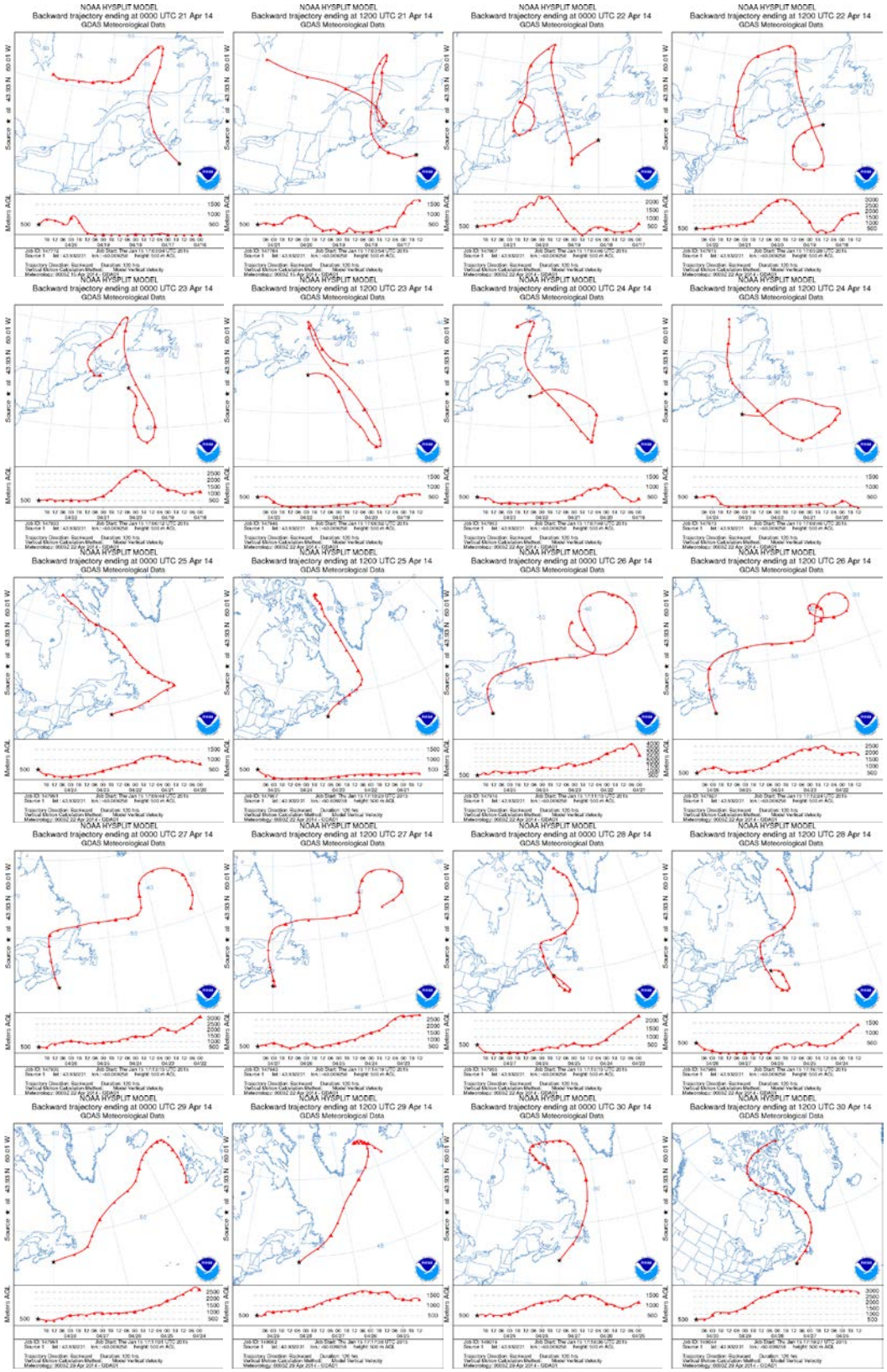
March 22nd – 31st, 2014



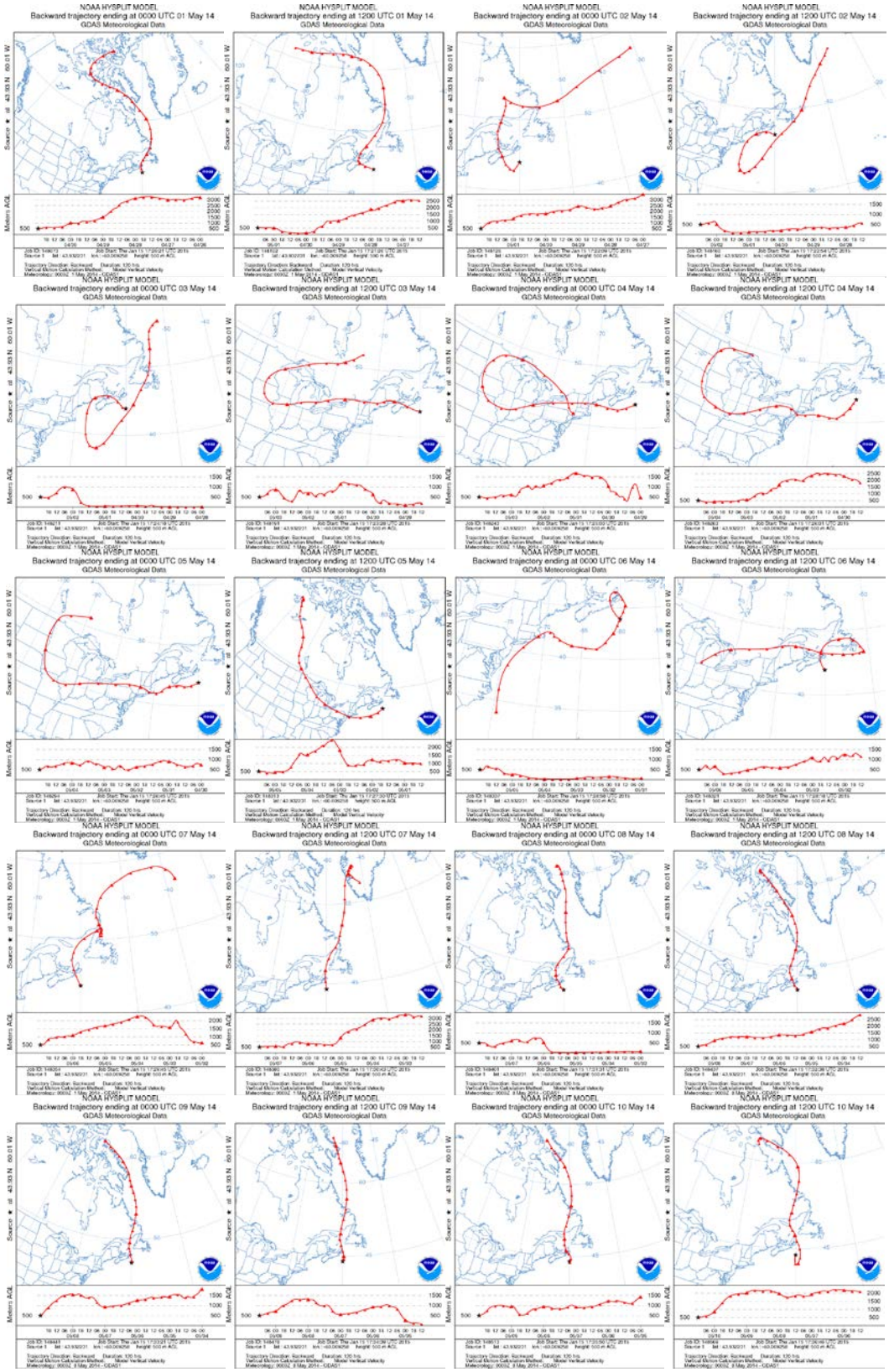
April 01st – 10th, 2014



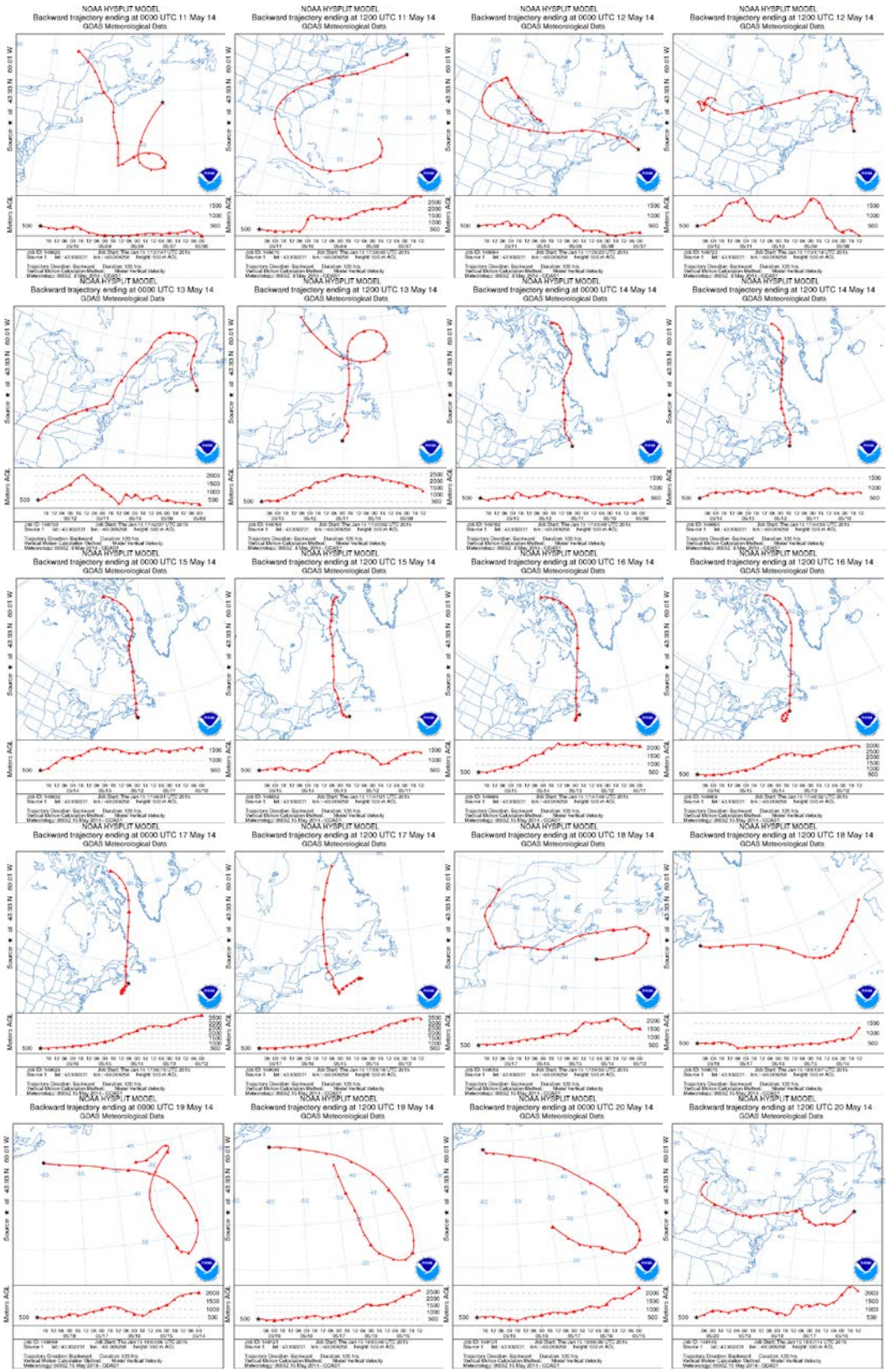
April 11th – 20th, 2014



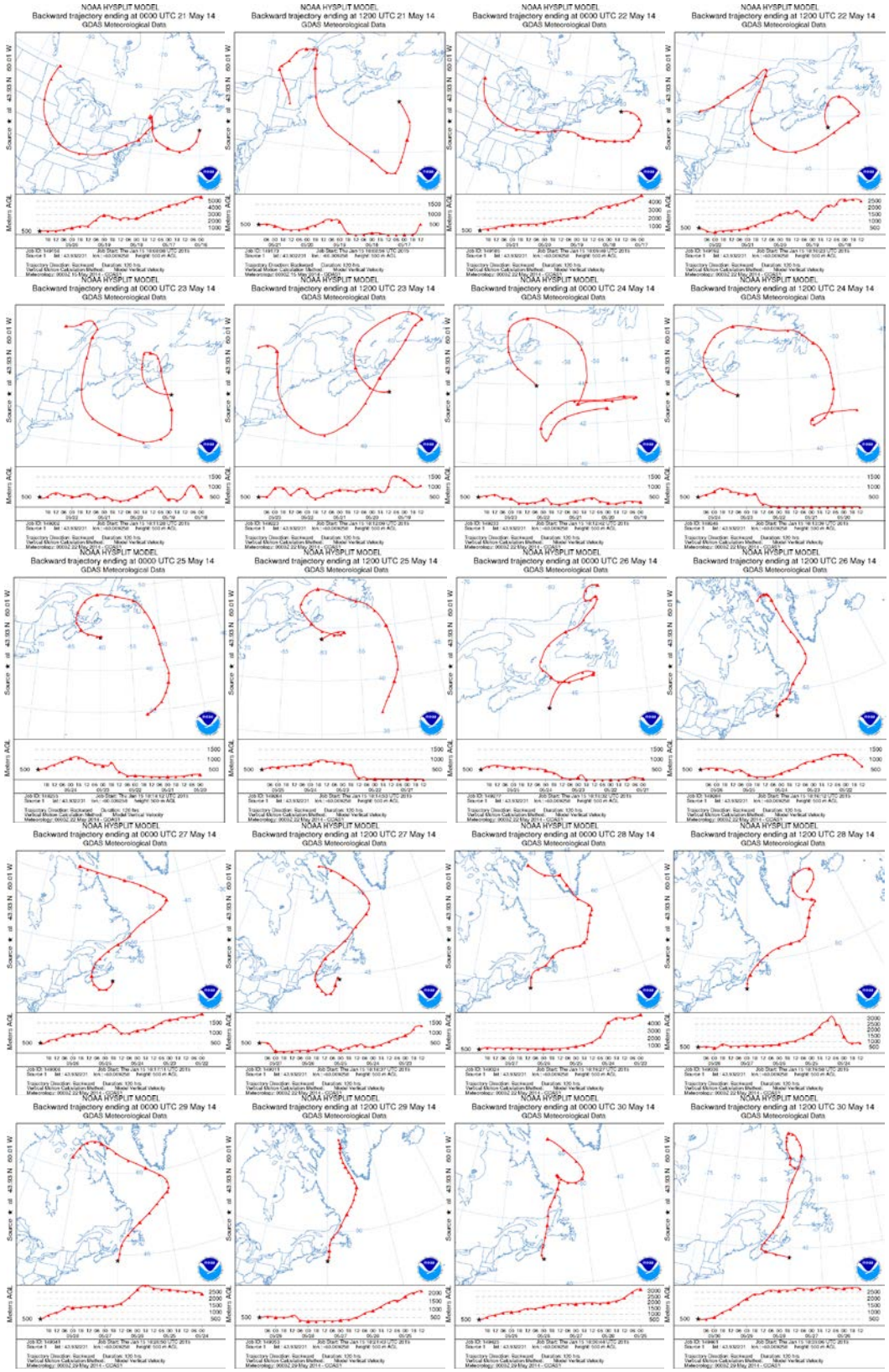
April 21st – 30th, 2014



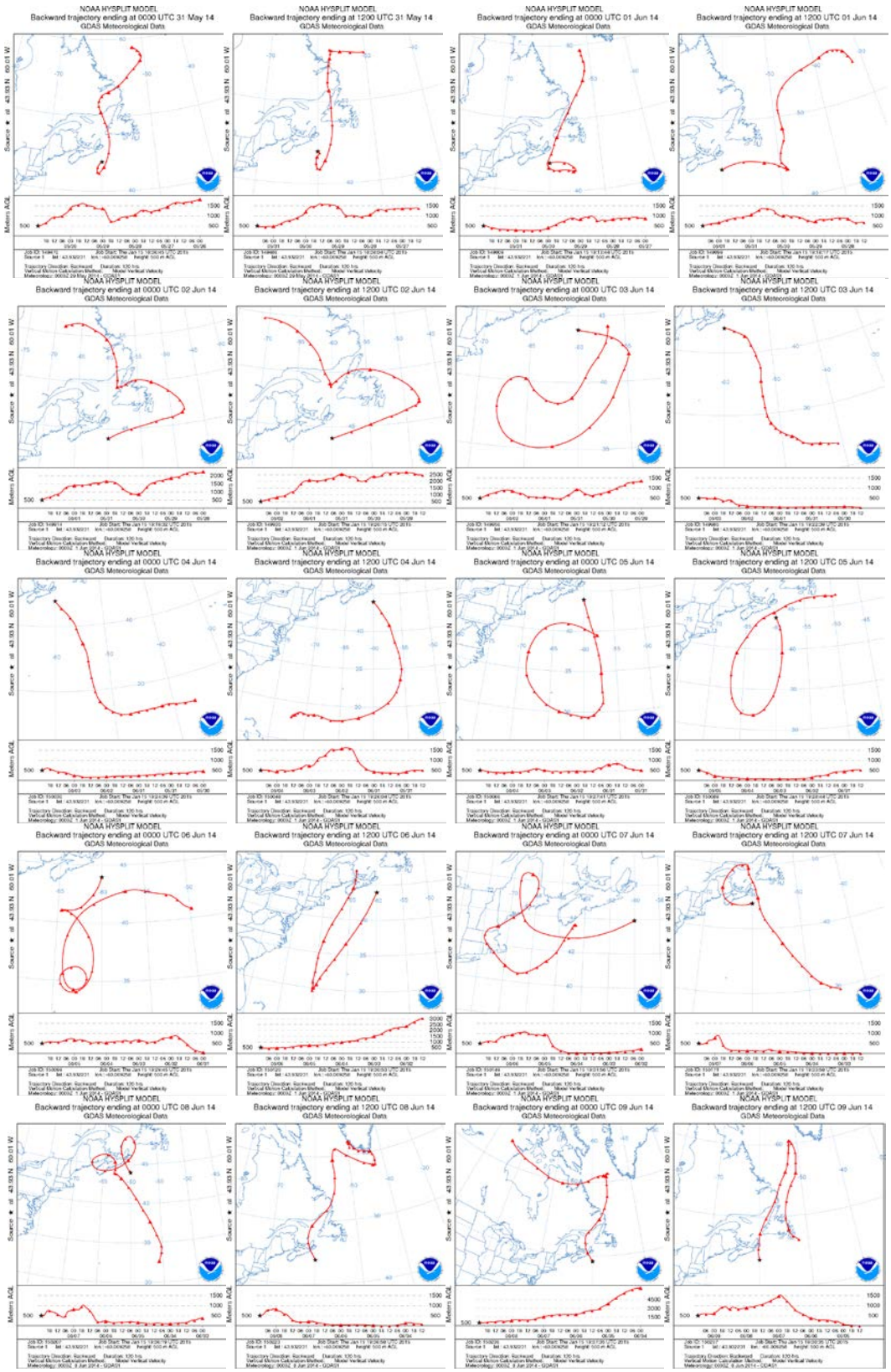
May 01st – 10th, 2014



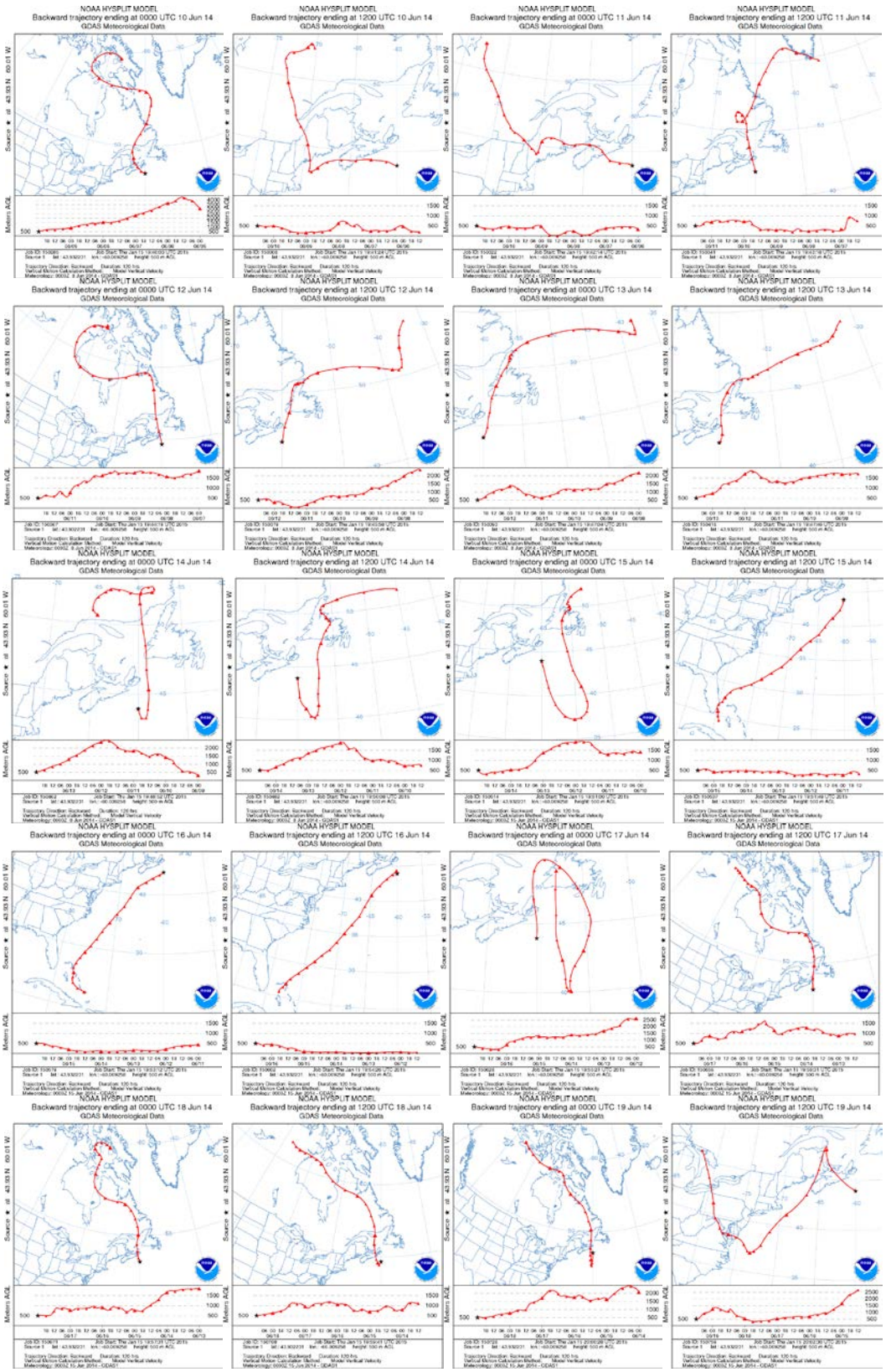
May 11th – 20th, 2014



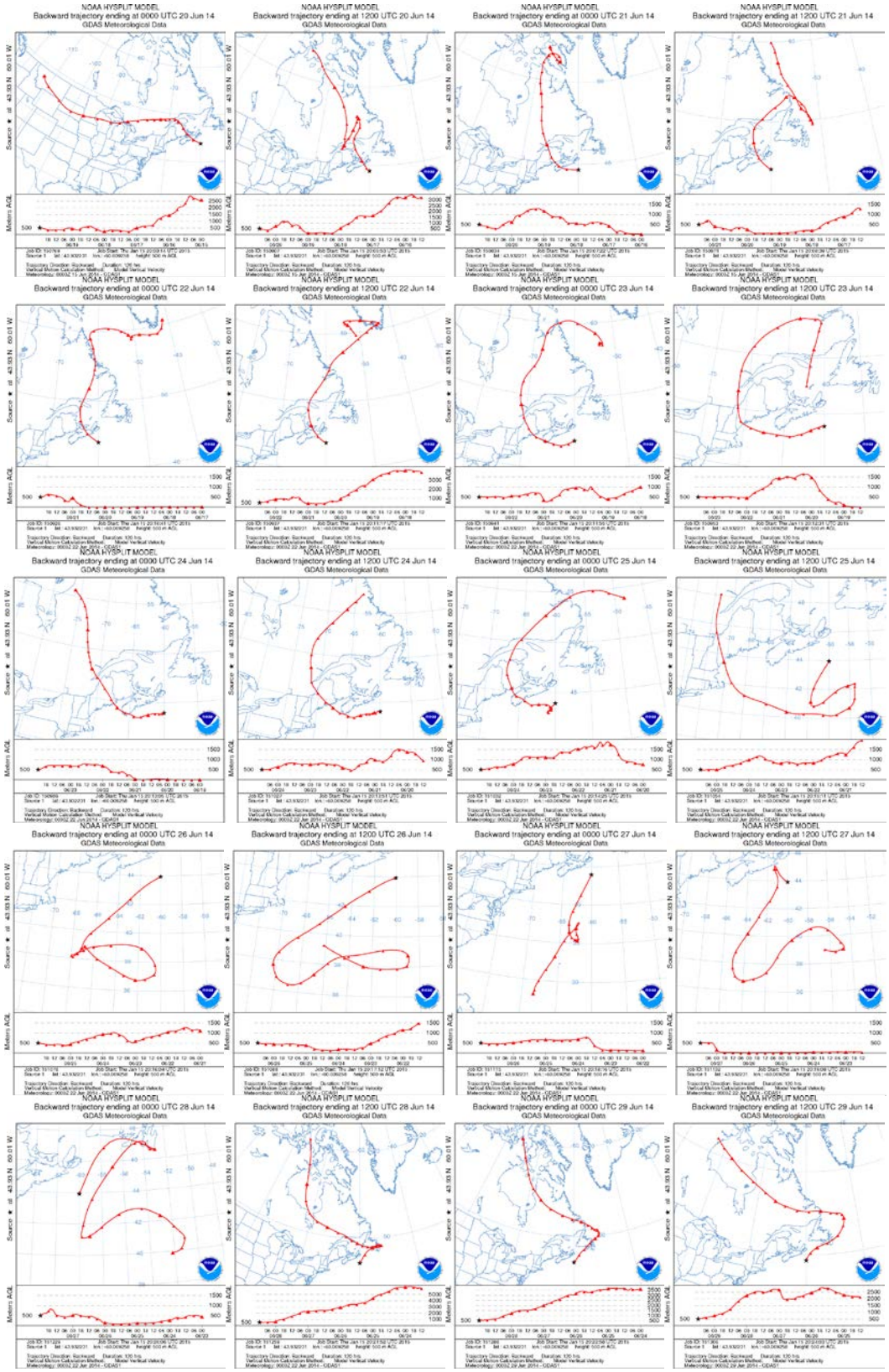
May 21st – 30th, 2014



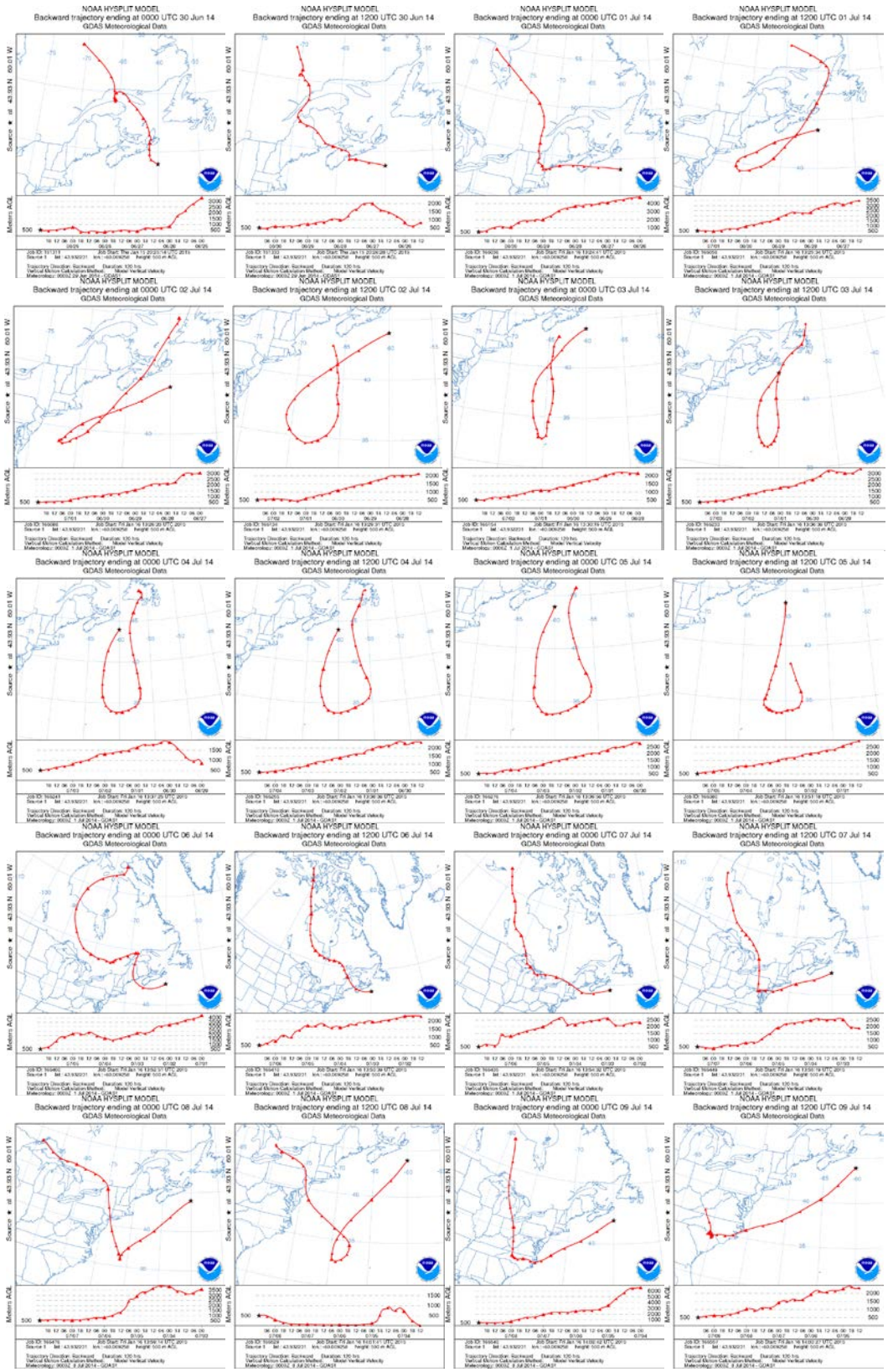
May 31st – June 09th, 2014



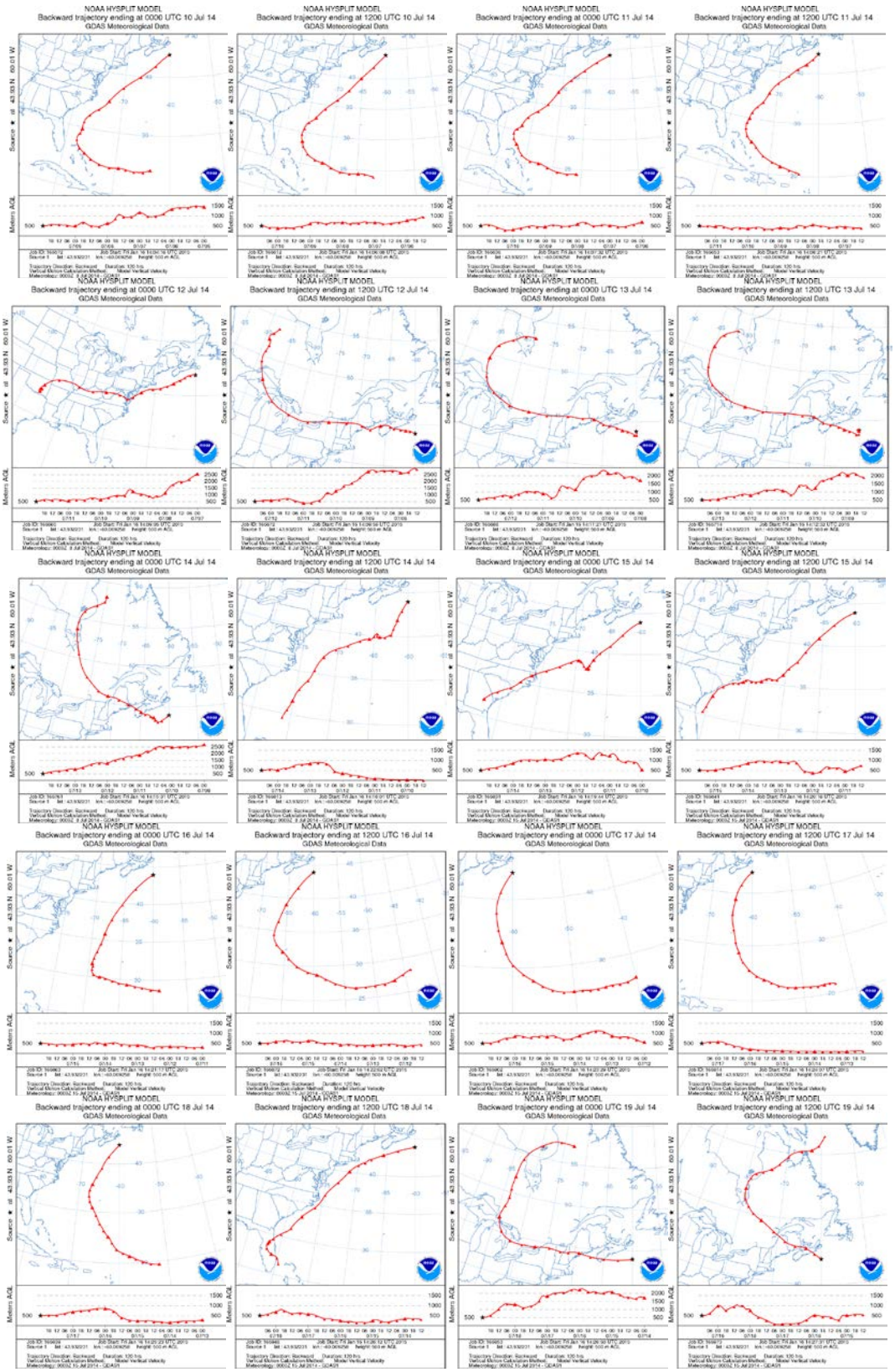
June 10th – 19th, 2014



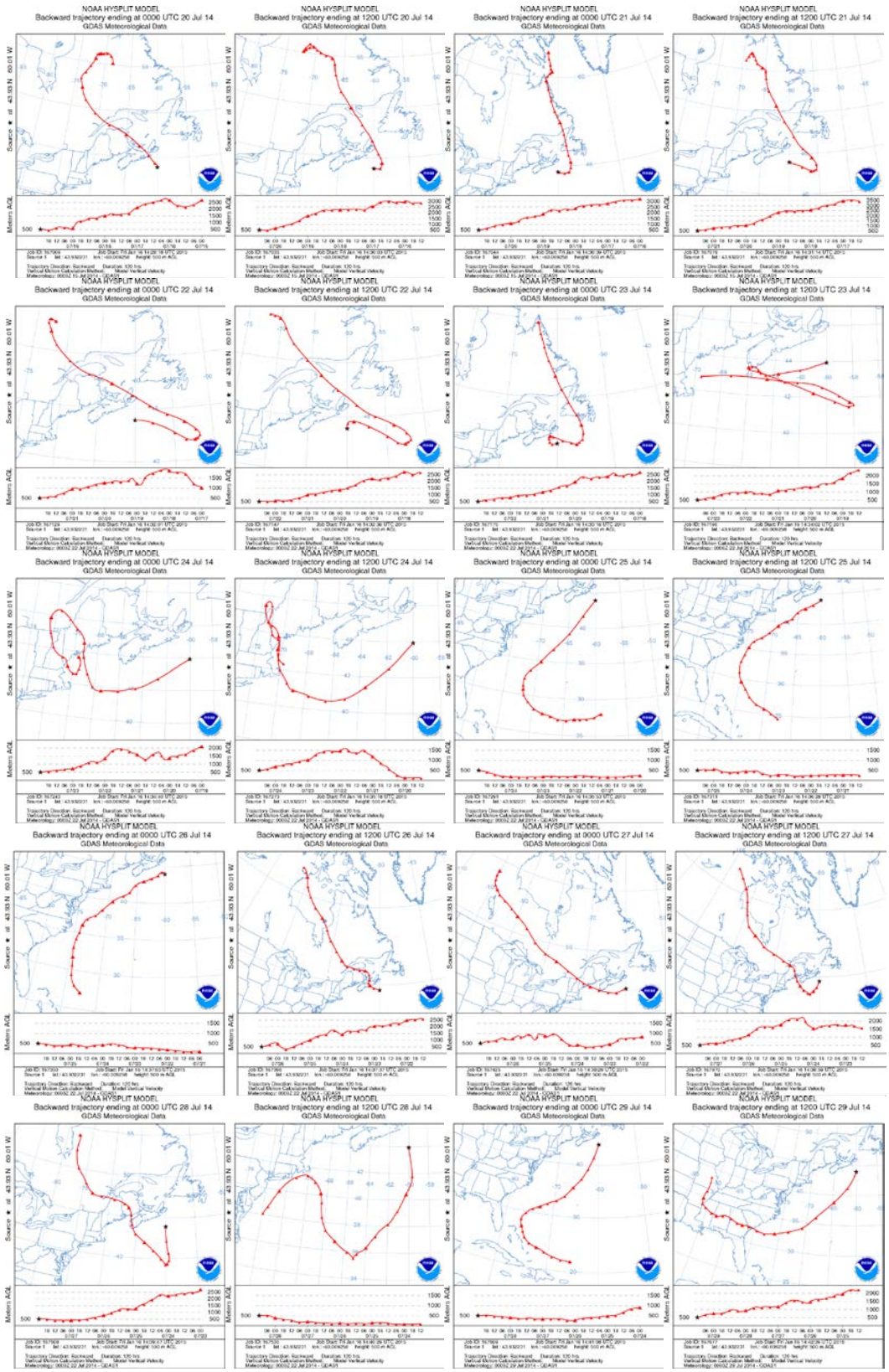
June 20th – 29th, 2014



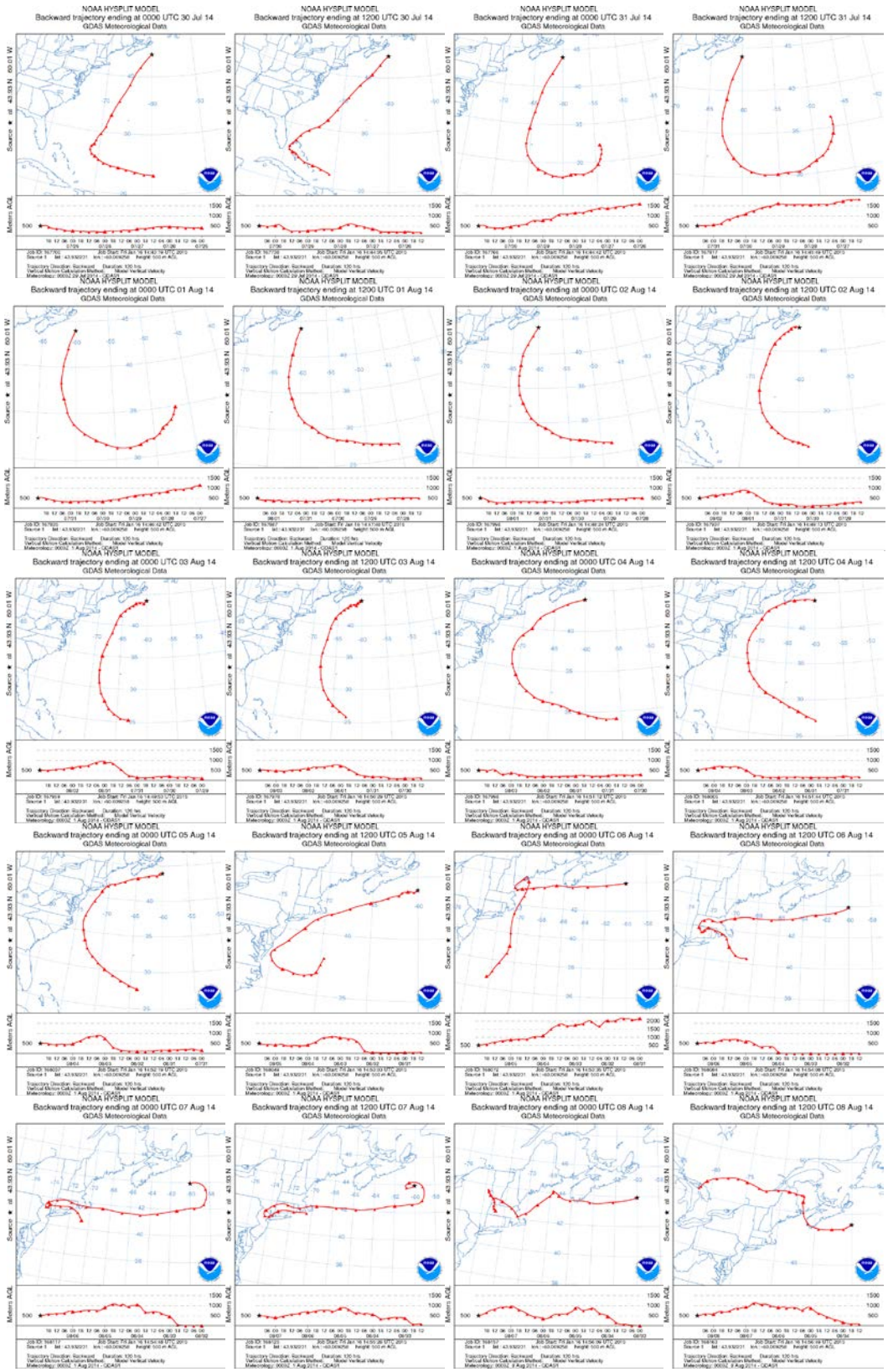
June 30th – July 09st, 2014



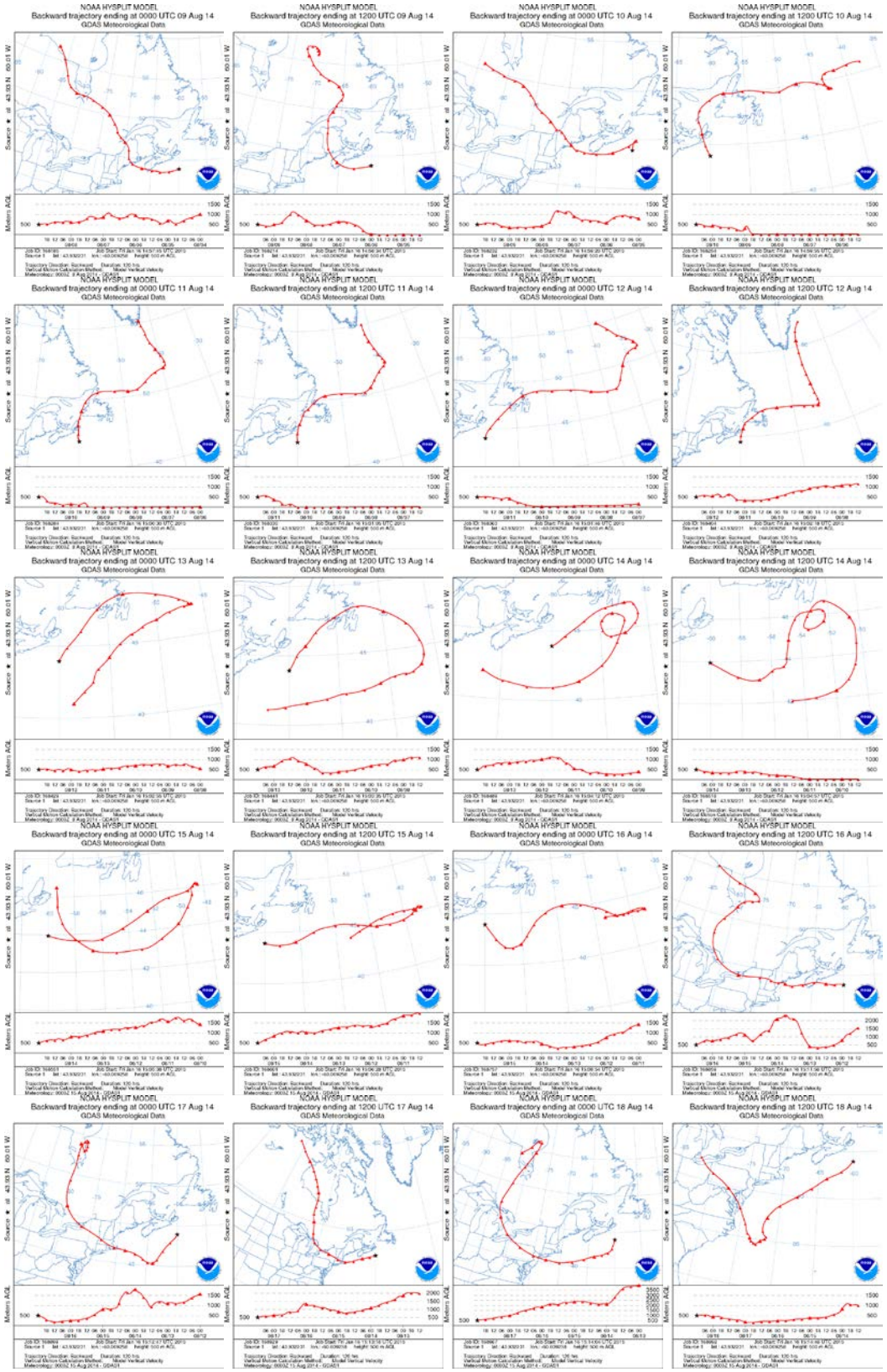
July 10th – 19th, 2014



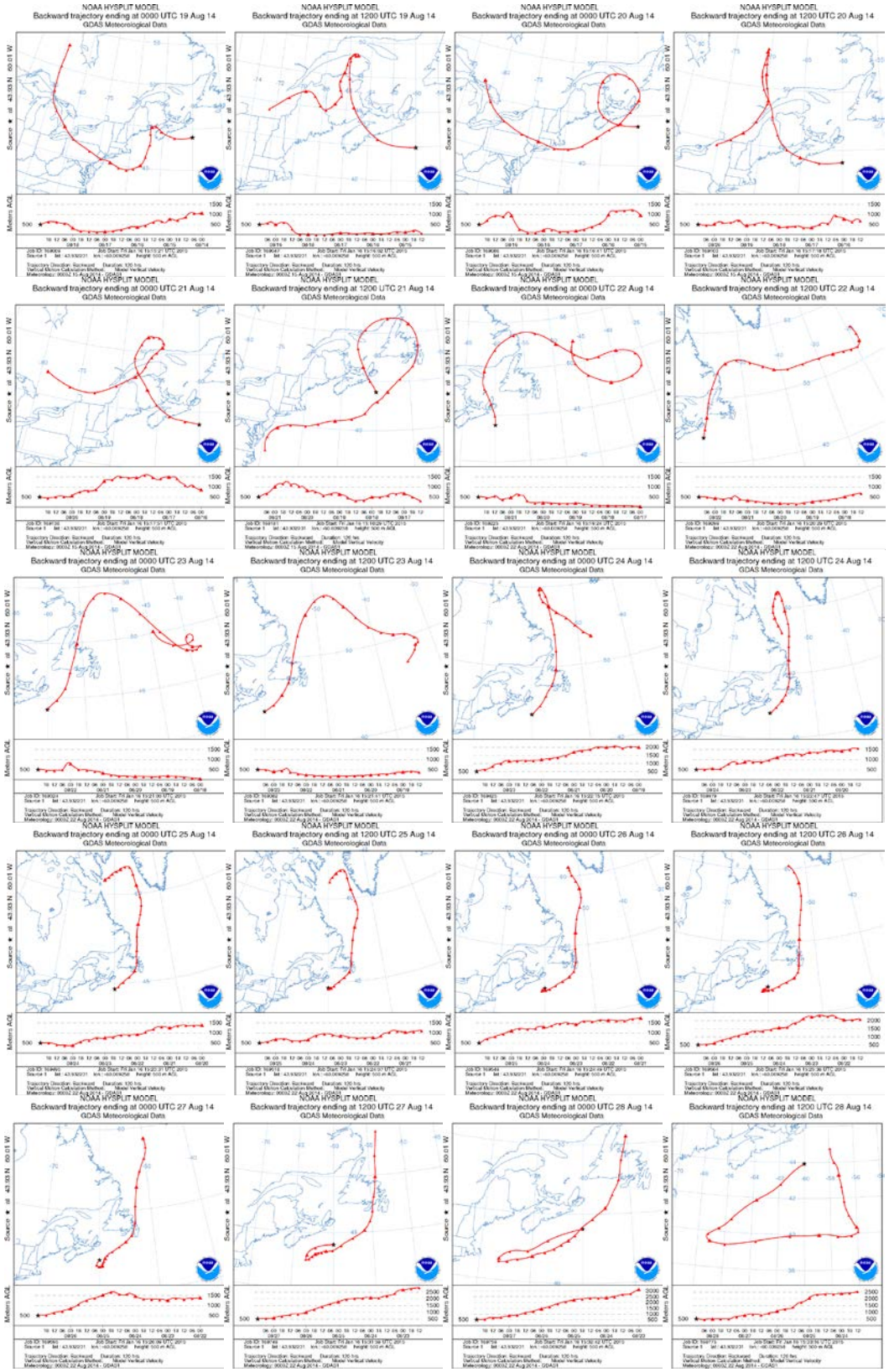
July 20th – 29th, 2014



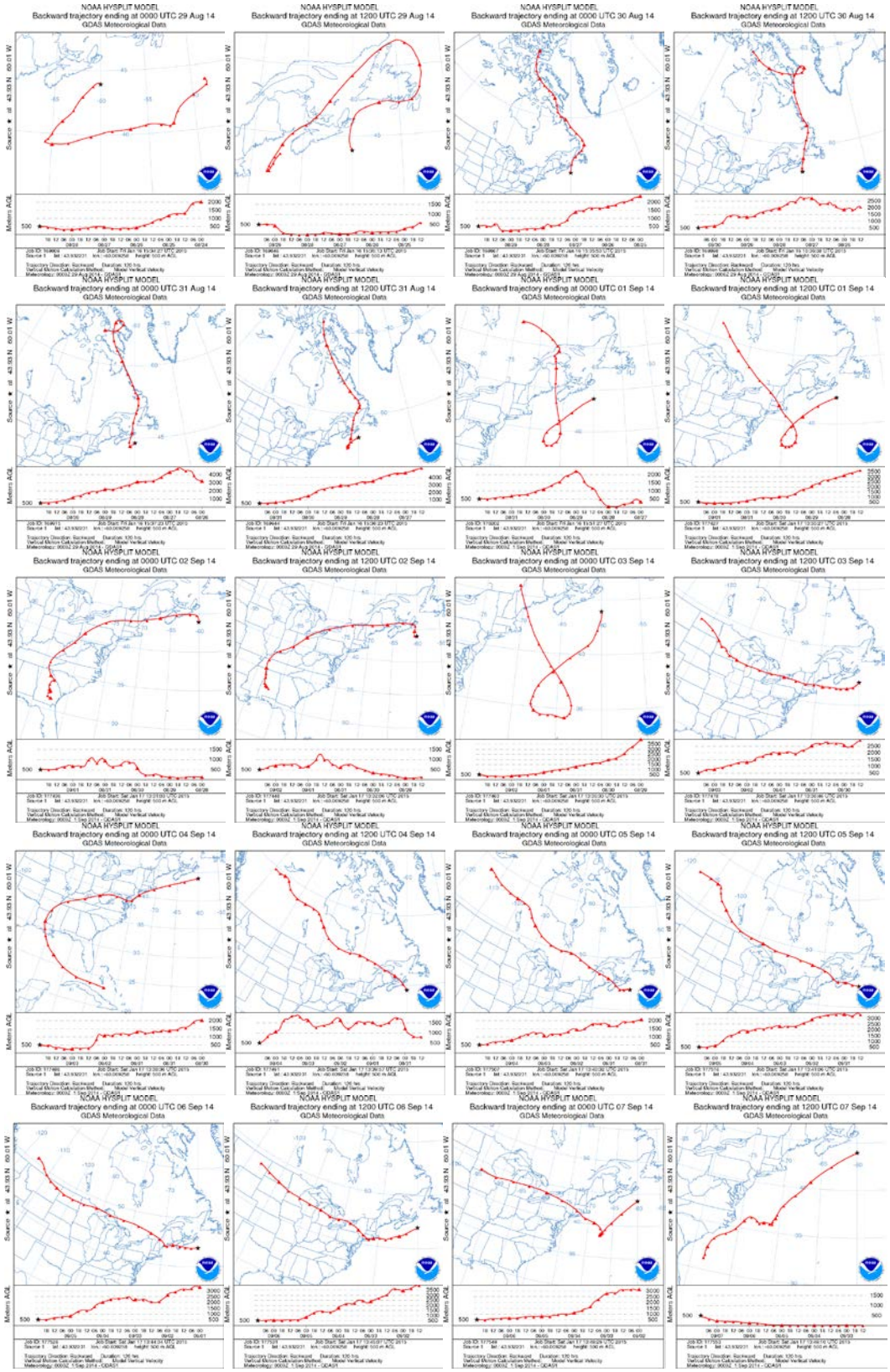
July 30th – August 08th, 2014



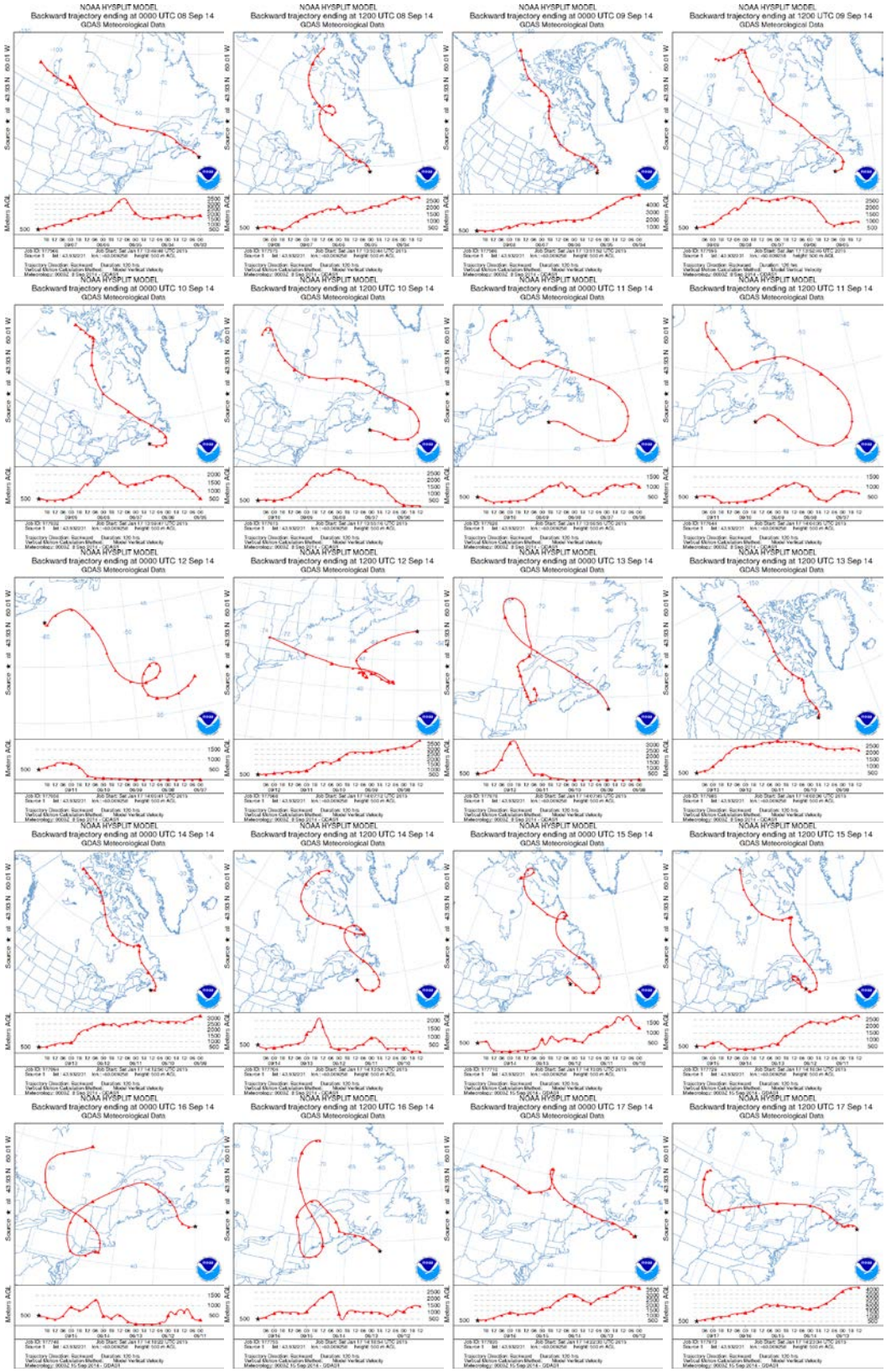
August 09th – 18th, 2014



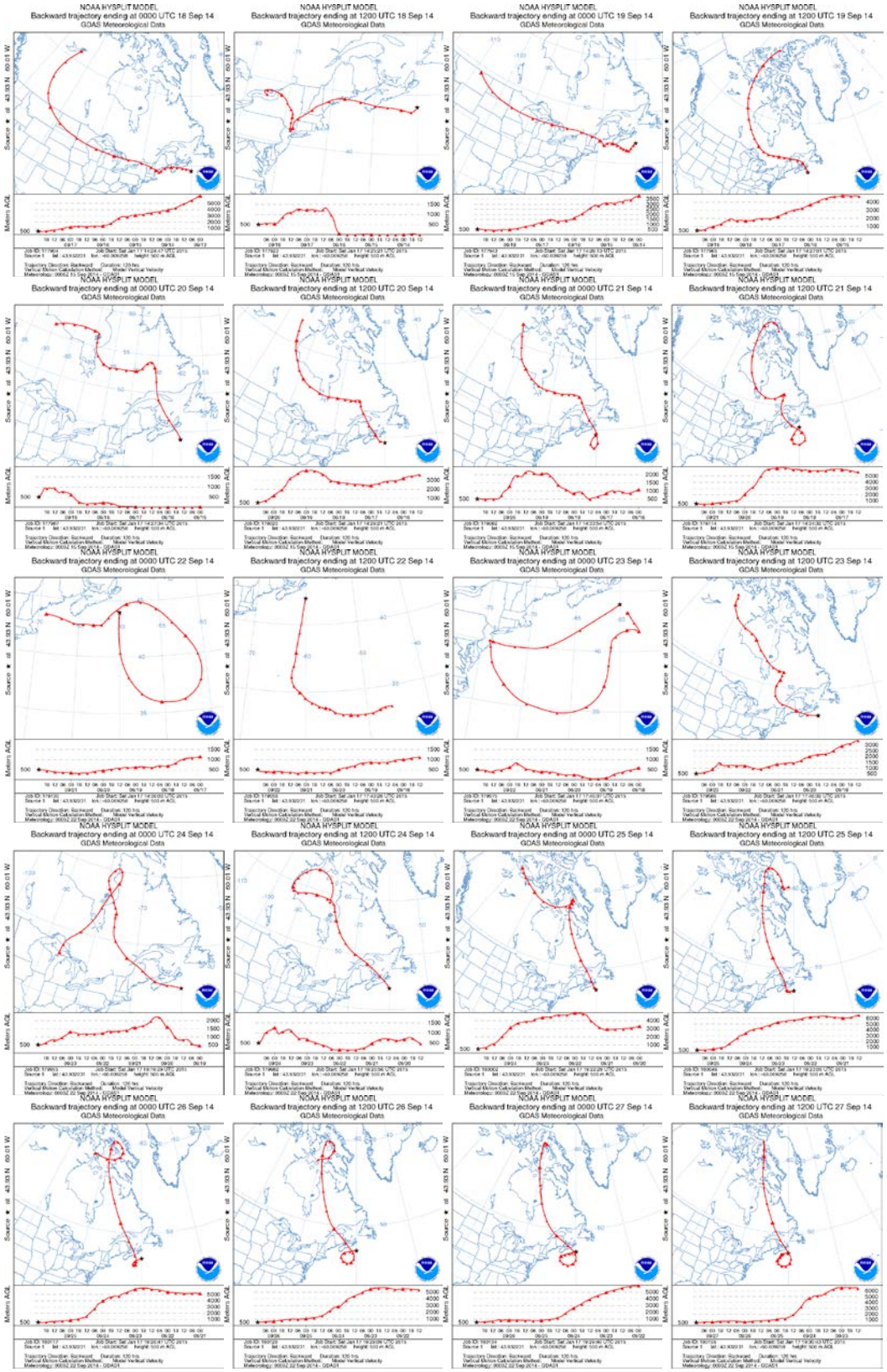
August 19th – 28th, 2014



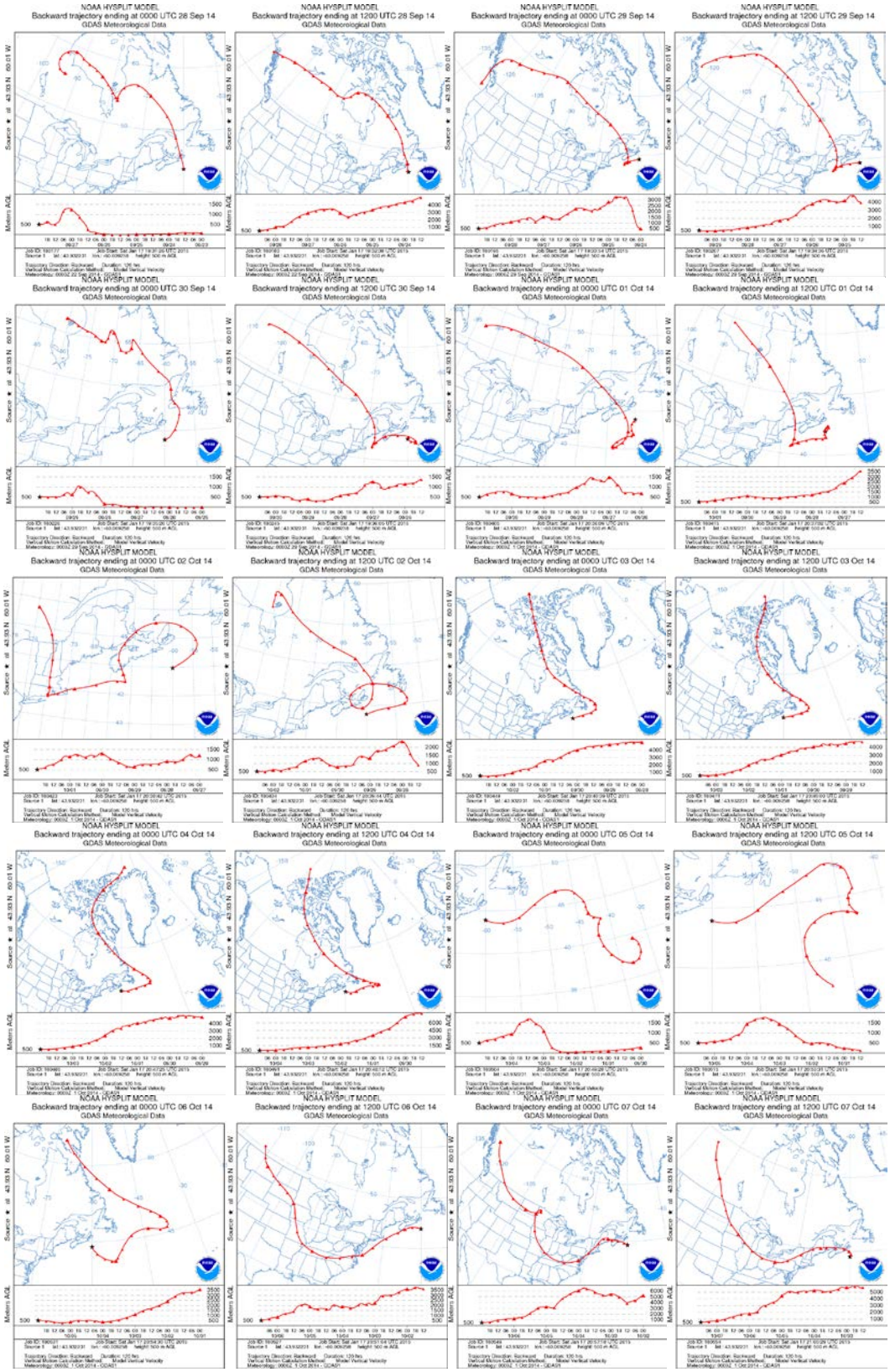
August 29th – September 07th, 2014



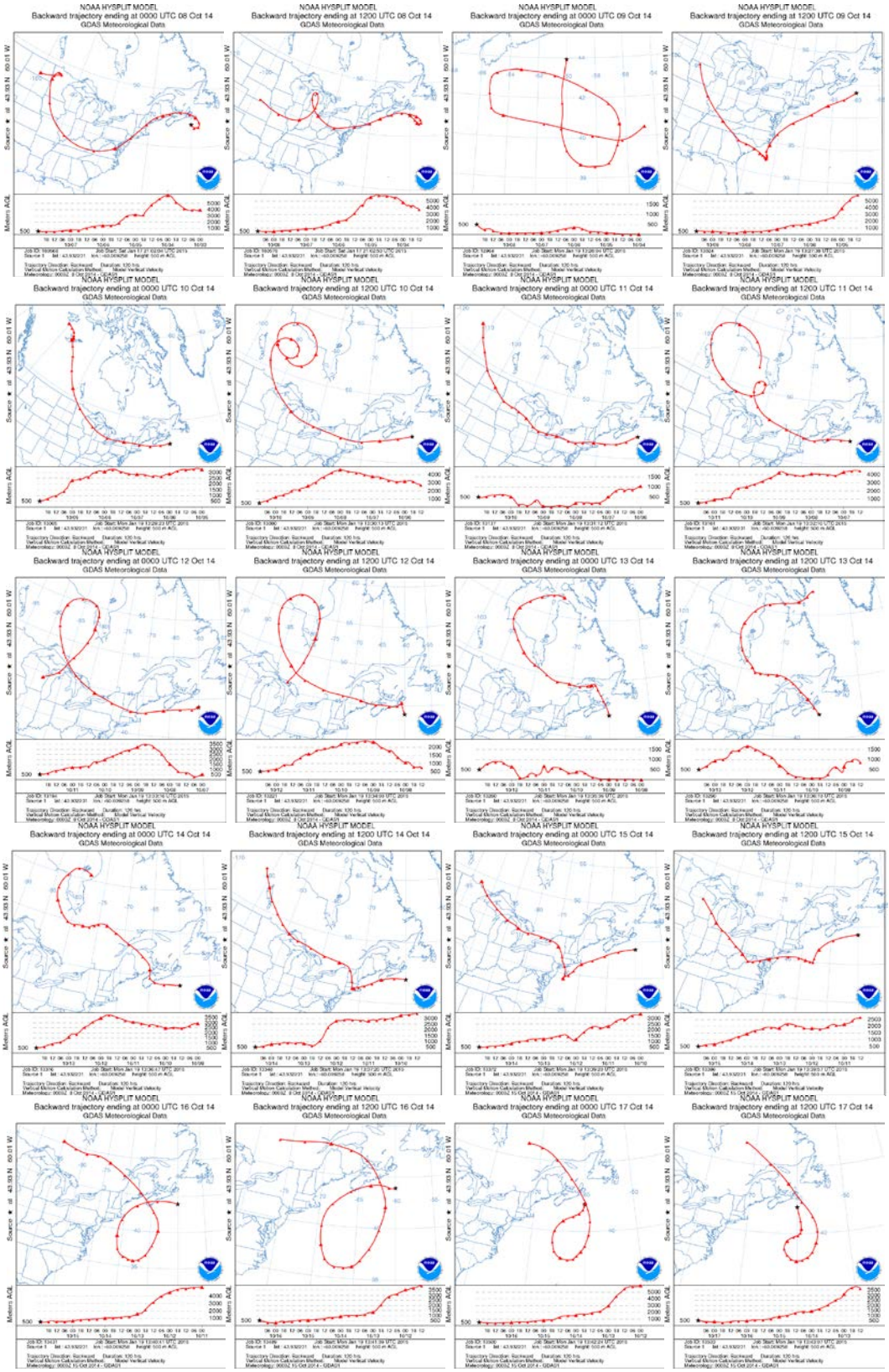
September 08th – 17th, 2014



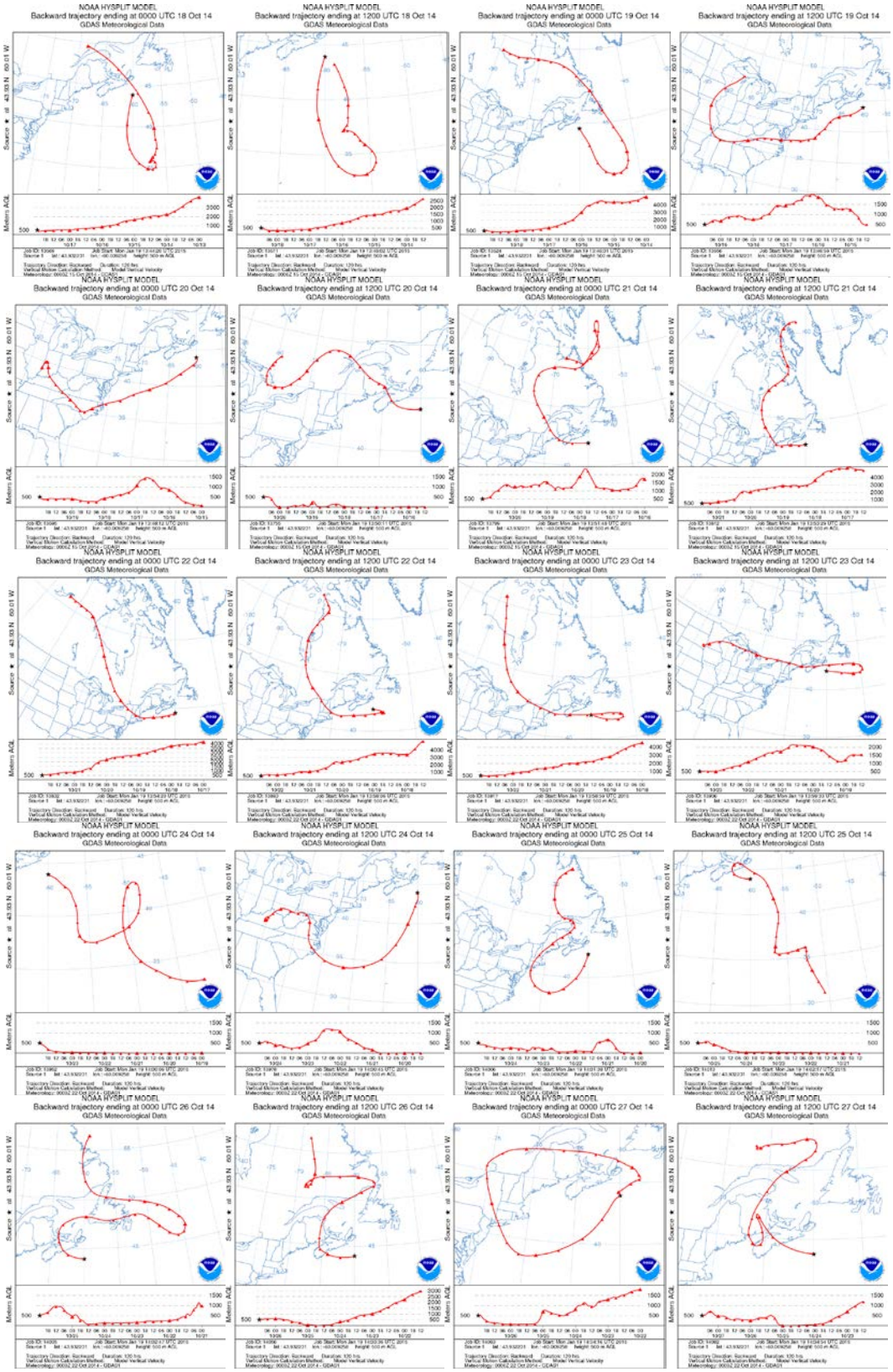
September 18th – 27th, 2014



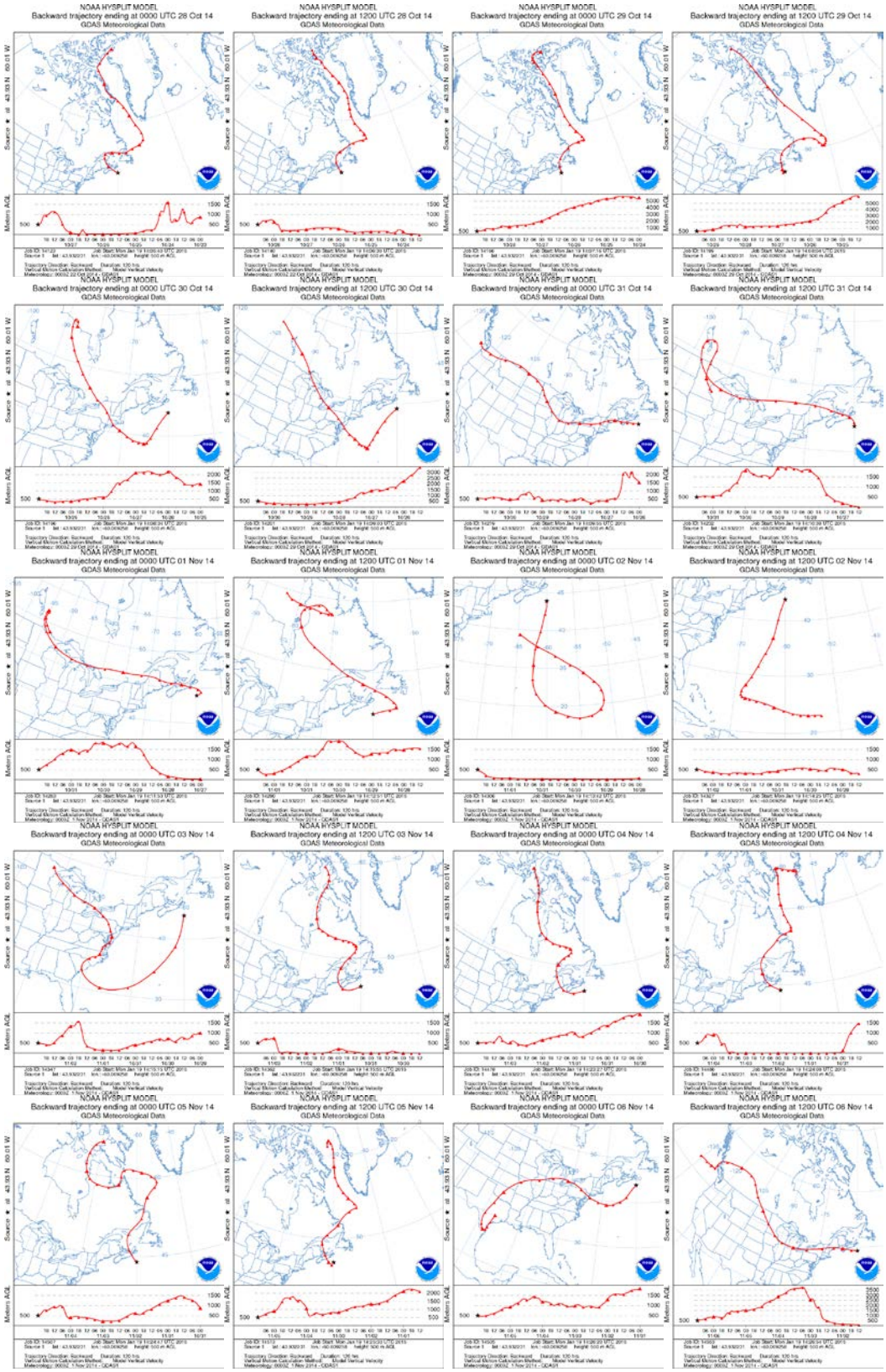
September 28th – October 07th, 2014



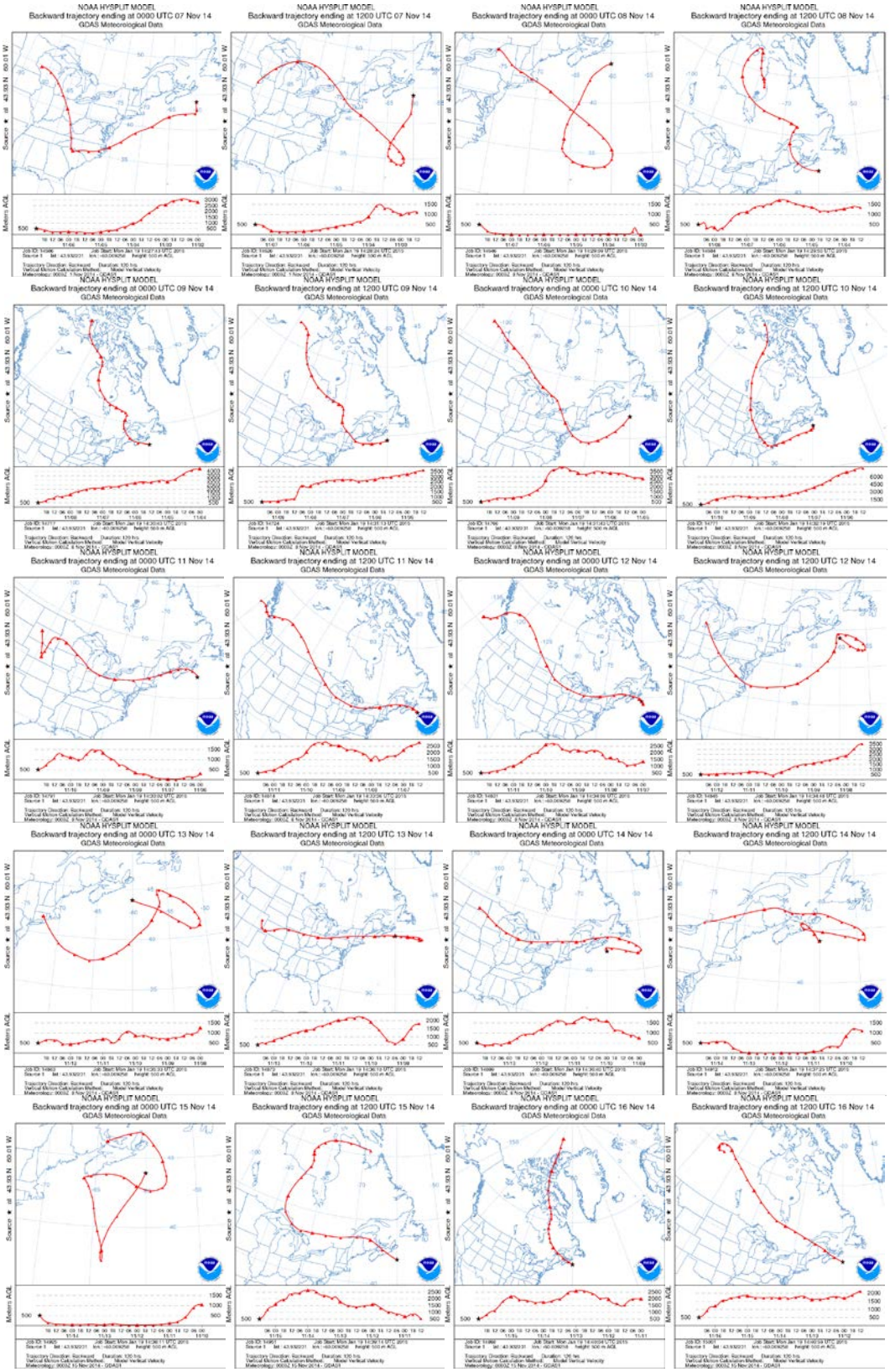
October 08th – 17th, 2014



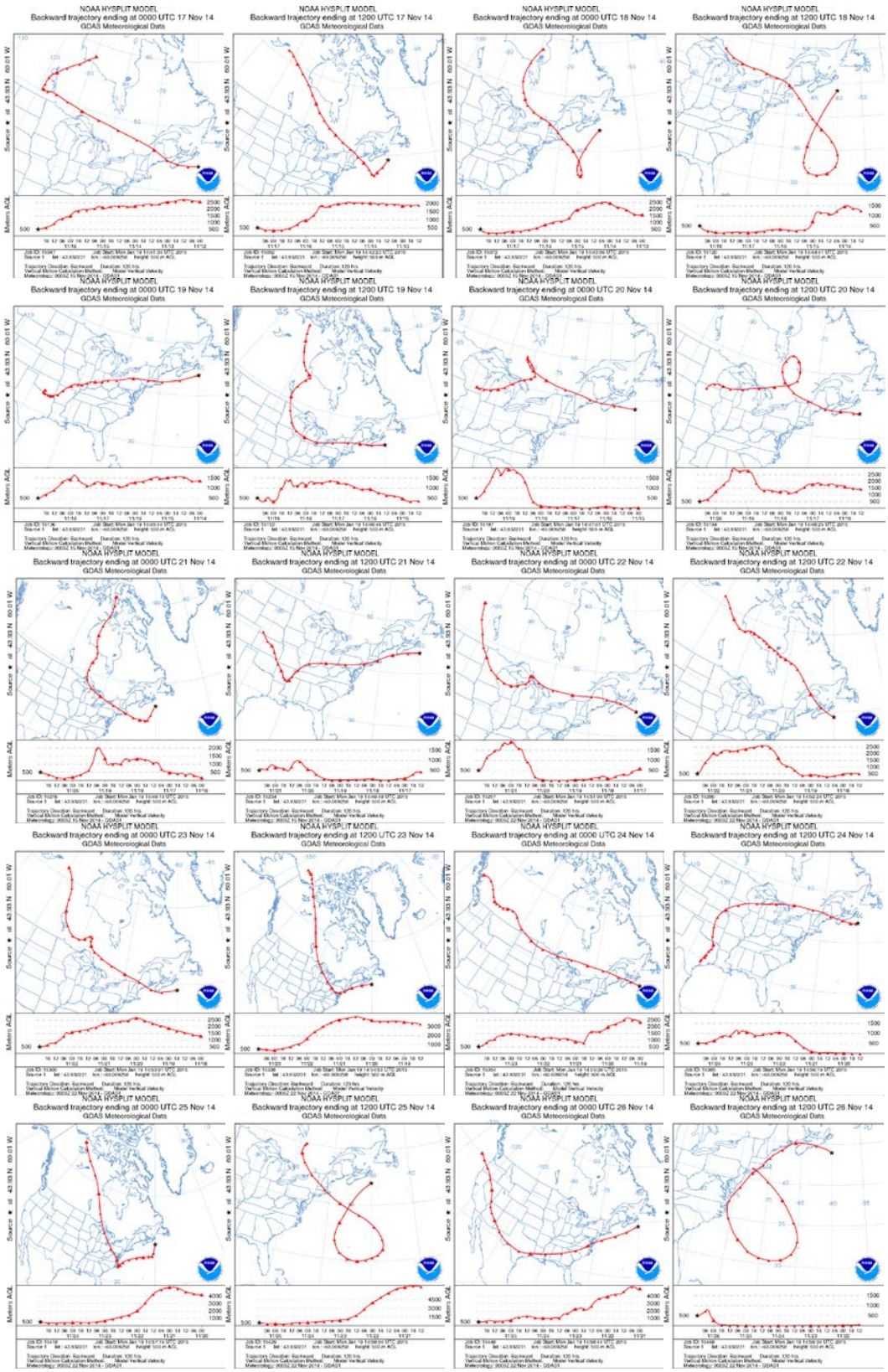
October 18th – 27th, 2014



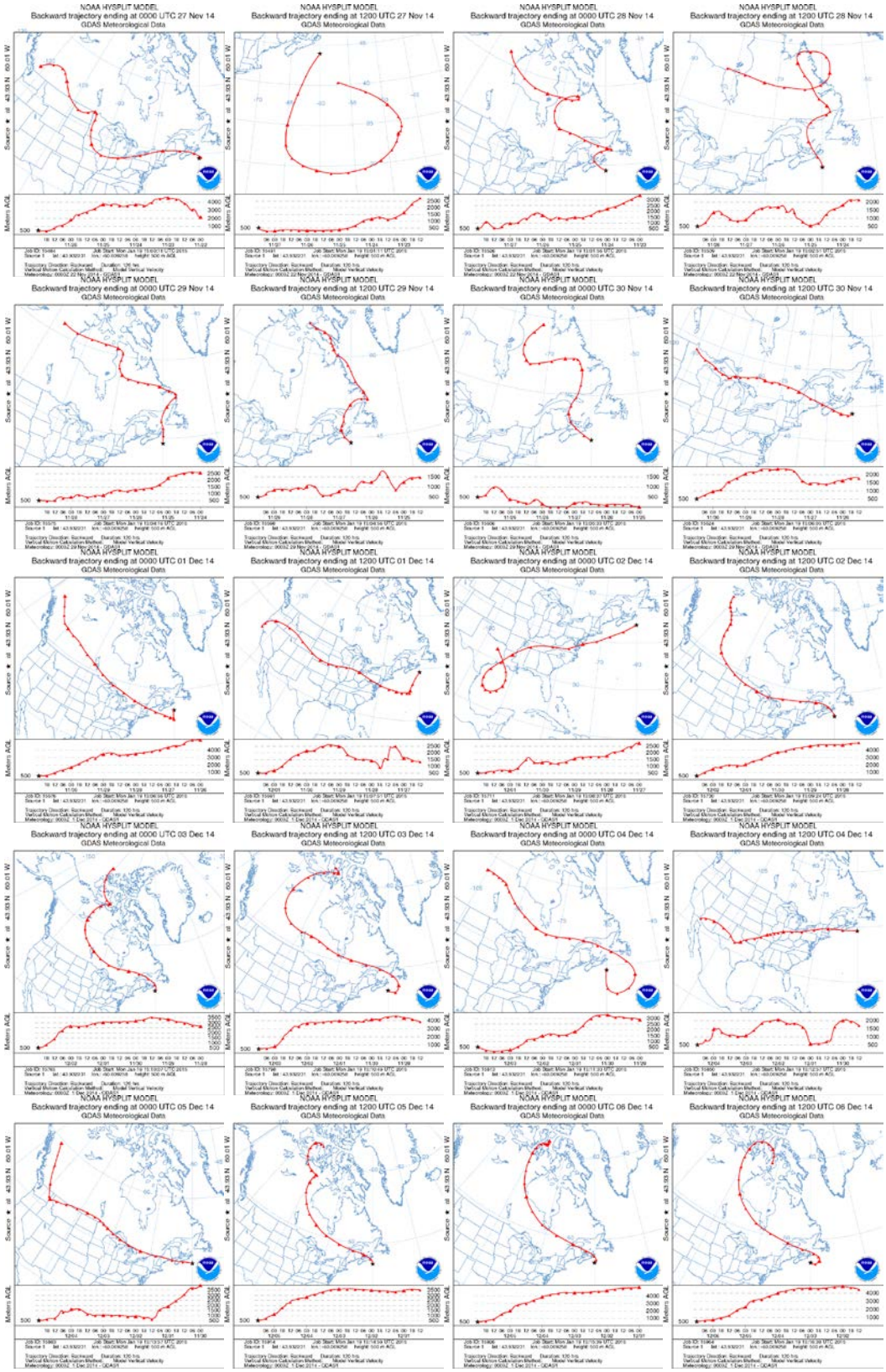
October 27th – November 06th, 2014



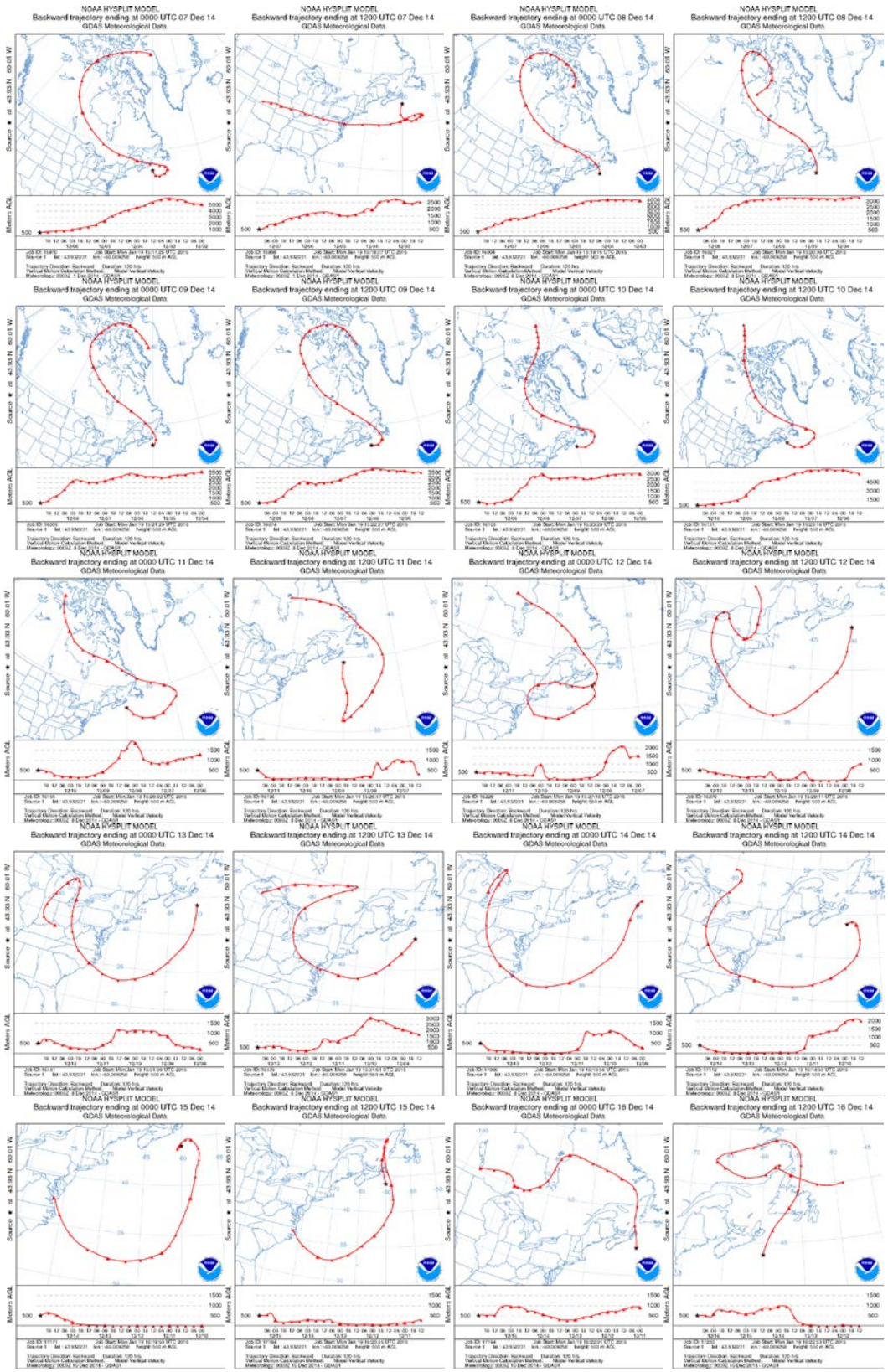
November 07th – 16th, 2014



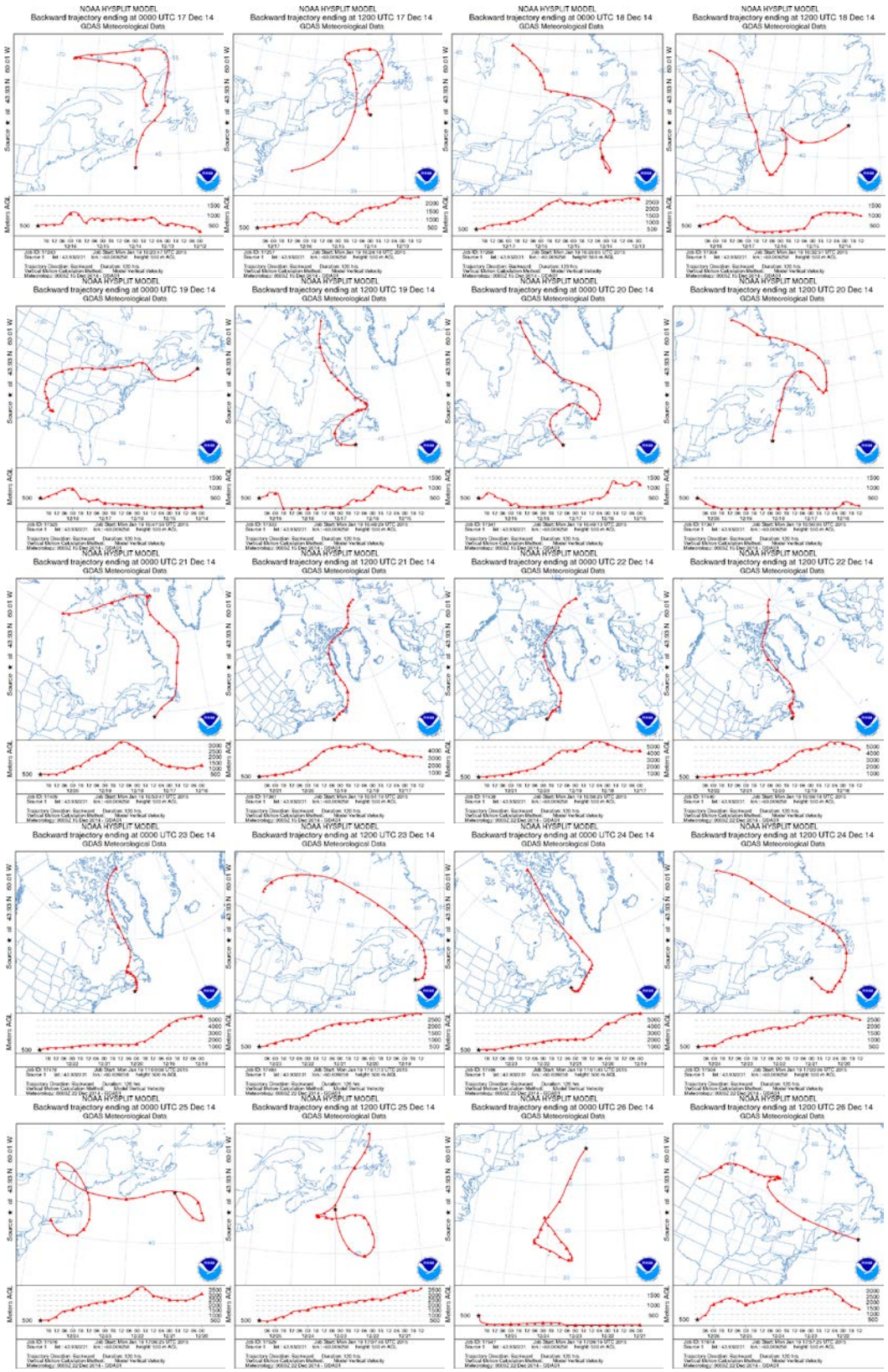
November 17th – 26th, 2014



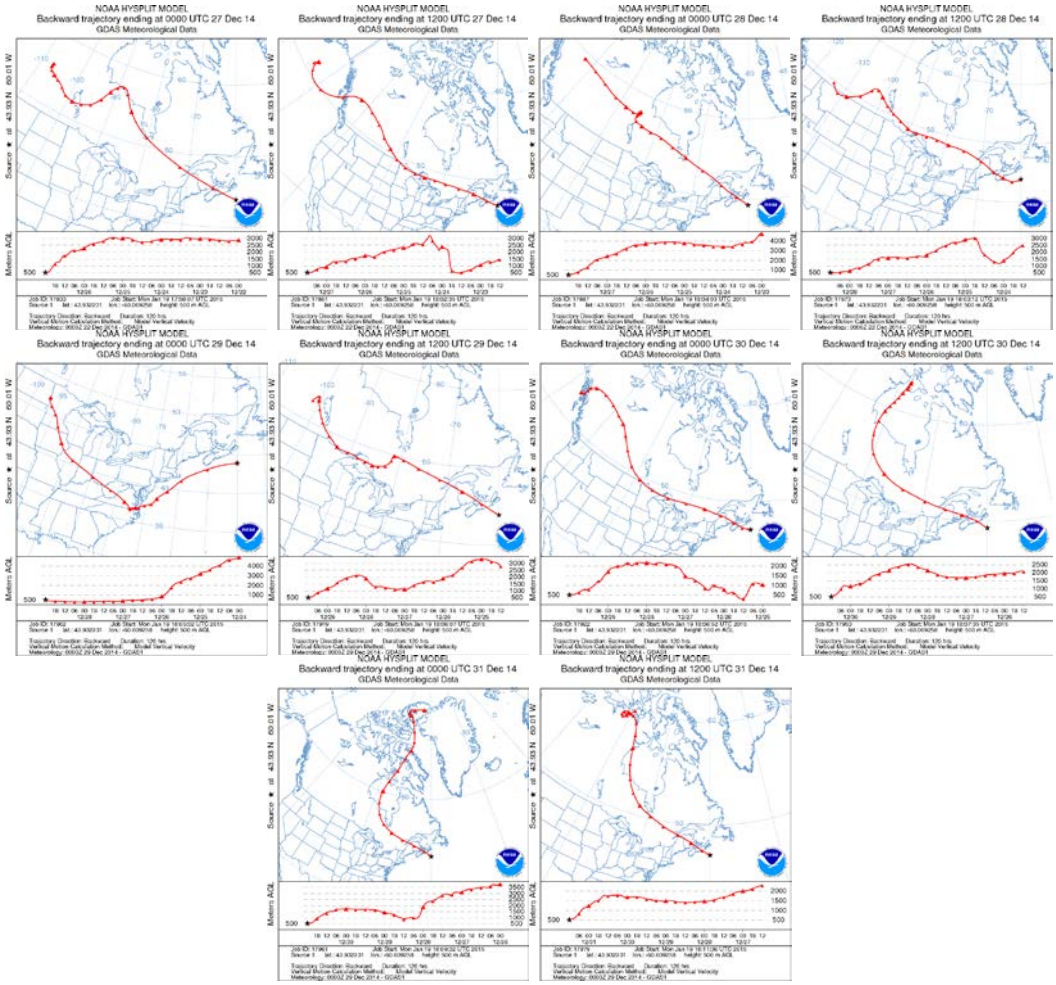
November 27th – December 06th, 2014



December 07th – 16th, 2014



December 17th – 26th, 2014



December 27th – 31st, 2014