

The Environment Authority, Meeting 25th May 2021 (#351) AGENDA

1. CONFIRMATION OF MINUTES of Meetings 349, 350
2. MATTERS ARISING
3. PRESENTATION BY BELCO ON DRAFT RESPONSE TO EA LETTER OF 4th MARCH 2021
4. APPLICATIONS FOR CONSTRUCTION PERMITS & OPERATING LICENCES
 - 4.1 CP-696, OL-1100, Froud, Marsh Lane, Devonshire, Sifter/crusher – DEFERRED.
 - 4.2 CP-698, OL-1102, Tomlinson, 1 Sandy Mount Lane, Warwick 100 kW genset – DEFERRED.
 - 4.3 CP-700, OL-1104, Intelligent Excavating, Lukes Pond, Southampton, crusher - DEFERRED
 - 4.4 CP-702, OL-1106, C Hames, 3 Mill Point Rd, 22 kW NG/LPG genset – DEFERRED
 - 4.5 OL-1123 – 1131, “MV Viking Orion:
 - Two 5040 kW MGO auxiliary engines
 - One dry cleaning unit
 - One Scanship 600 m³/day WWTP
 - One 36 m³/hr emergency air compressor
 - One 1390 kW emergency diesel generator
 - One 5 m³/hr oily water separator
 - Two 6000 kg/hr MGO boilers
 - 4.3 CP716, OL1132, Edgewood Pediatrics, 13 Richmond Rd, 20 KW NG/LPG genset.
 - 4.4 CP-714, OL-1119, Mr S Talley, 16 Store Hill, Smith’s. 22 kW NG/LPG genset.
 - 4.5 CP-715, OL-1122, Mr B Kizer, 35 grape Bay Drive, Paget 20 kW diesel genset (DEFER).
5. APPLICATIONS FOR OPERATING LICENCES (RE-ISSUES) – printout, see pdf presentation
6. APPLICATION FOR IMPORT PERMIT
7. APPLICATIONS FOR NEW WATER RIGHTS
8. APPLICATIONS FOR WATER RIGHTS (Reissues) – printout – see pdf presentation
9. ANY OTHER BUSINESS
10. DATE OF NEXT MEETING: 8:30 am, Tuesday, 29 June 2021



2. MATTERS ARISING

2.1. BELCO Air Quality Complaints – Ocean Lane, etc:

- Air Quality data - *To be partly covered in preparation for BELCO presentation today.*
- Water Tank Sampling - Sediment data - *Update next Month*

Previous Matters Arising:

2.2. *Elbow Beach Hotel WWTP - Update Next month.*

2.3. *Corporation of Hamilton WWTP - CoH letter (26th Nov) to PS Rochester MPW stating they can not meet EA conditions for OL-142 Meeting required to either: (i) Approve budget for improvements or (ii) Amend licence conditions. - Update next Month.*

2.4. *MPW Raw Ash Deposition to AWMF - Update Next Month.*



3. PRESENTATION BY BELCO ON RESPONSE TO EA LETTER OF 4th MARCH 2021



3. PRESENTATION BY BELCO ON RESPONSE TO EA LETTER OF 4th MARCH 2021

1. Draft response received from BELCO - 26th March 2021
2. DENR shared information with RA
3. DENR setting up a contract with Ricardo Energy & Environment Ltd, who are one of the RA's consultants, who have expertise in Diesel engine operation and associated pollutants - Due early June.
4. DENR shared Draft BELCO response with EA on 5th May 2021
5. Provisional collective review by DENR and EA today.
6. **DENR recommends that we listen to BELCO today and ask relevant questions but save providing them with our opinion until formally presented as a letter response to their draft report.**



3. Review of BELCO Response to EA Letter 4th March

- **EA Letter Question 1.a:** Provide details of BELCO's current understanding of the 'Downdrafting' phenomenon at Ocean Lane.
- **BELCO Response:**
 - Since Feb 2020 BELCO a downward air current on the north side of Langton Hill has been suspected to negatively impact ground level air quality at Ocean Lane.
 - The periods of suspected poor air quality observed and measured to occur during periods of **medium to strong horizontal winds (i.e. >15 to 20+ knots)**. **(See DENR Slide - BELOW)**.



3. **BELCO Response to Question 1.a:** The periods of poor air quality observed and measured to occur during periods of **medium to strong** horizontal winds (i.e. **>15 to 20+ knots**). (see DENR Slide).

- **DENR Comment:** For the 40 exceedances of the UK Air Quality Objective for 15-min SO₂ (i.e. 266µg/m³) since Jan 2021 the nearest hourly wind speed at Ocean Lane ranged from **6.7 to 16.3 knots**.

- **Suggests poor air quality from light to gentle breeze and stronger.**

Date/Time (AST)	15-minute SO2 Concentration (ug/m3)	Wind Direction (Degrees)	Wind Direction (Degrees)	Wind Speed (knots)
28-01-21 14:15	272	213	SSW	9.61
28-01-21 14:45	270	213	SSW	9.61
28-01-21 15:00	304	209	SSW	13.07
28-01-21 15:15	291	209	SSW	13.07
28-01-21 15:30	294	209	SSW	13.07
28-01-21 15:45	309	238	SW	16.34
02-02-21 19:45	299	214	SSW	11.18
02-02-21 20:30	300	212	SSW	7.15
02-02-21 20:45	267	212	SSW	7.15
03-02-21 6:00	289	209	SSW	7.07
03-02-21 6:15	282	209	SSW	7.07
03-02-21 7:00	281	216	SSW	12.16
03-02-21 15:30	292	212	SSW	10.01
03-02-21 15:45	287	212	SSW	10.01
03-02-21 16:15	306	218	SSW	8.76
03-02-21 16:30	335	218	SSW	8.76
23-02-21 13:15	283	209	SSW	7.13
23-02-21 13:30	306	209	SSW	7.13
23-02-21 14:00	289	206	SSW	8.14
23-02-21 14:15	268	206	SSW	8.14
23-02-21 14:30	294	206	SSW	8.14
23-02-21 15:15	280	208	SSW	6.70
23-02-21 15:45	269	208	SSW	6.70
23-02-21 16:00	346	211	SSW	9.86
23-02-21 16:45	272	211	SSW	9.86
23-02-21 17:30	270	211	SSW	7.56
23-02-21 18:15	304	211	SSW	9.04
23-02-21 18:30	280	211	SSW	9.04
23-02-21 18:45	288	211	SSW	9.04
23-02-21 19:15	274	211	SSW	9.09
23-02-21 19:30	278	211	SSW	9.09
03-03-21 23:45	276	206	SSW	8.72
04-03-21 0:00	300	209	SSW	9.10
04-03-21 0:45	280	231	SW	9.96
12-04-21 10:00	318	241	SW	9.98
16-04-21 11:15	282	213	SSW	8.42
16-04-21 11:30	275	213	SSW	8.42
16-04-21 11:45	300	213	SSW	8.42
16-04-21 12:45	351	215	SSW	8.47
16-04-21 13:45	276	218	SSW	9.35
RANGE	267 - 351	206 - 241	SW - SSW	6.7 - 16.3



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 - The periods of suspected poor air quality observed and measured to occur during periods of **medium to strong horizontal winds (i.e. >15 to 20+ knots)**.
 - Generally, atmospheric stability will vary depending on meteorological conditions (**Solar insolation/ground heating**, wind speed). Under unstable atmospheric conditions, this terrain effect could result in the plumes from BELCO impacting ground level receptors at a distance closer to BELCO than previously modelled. **(See DENR Slides - BELOW).**



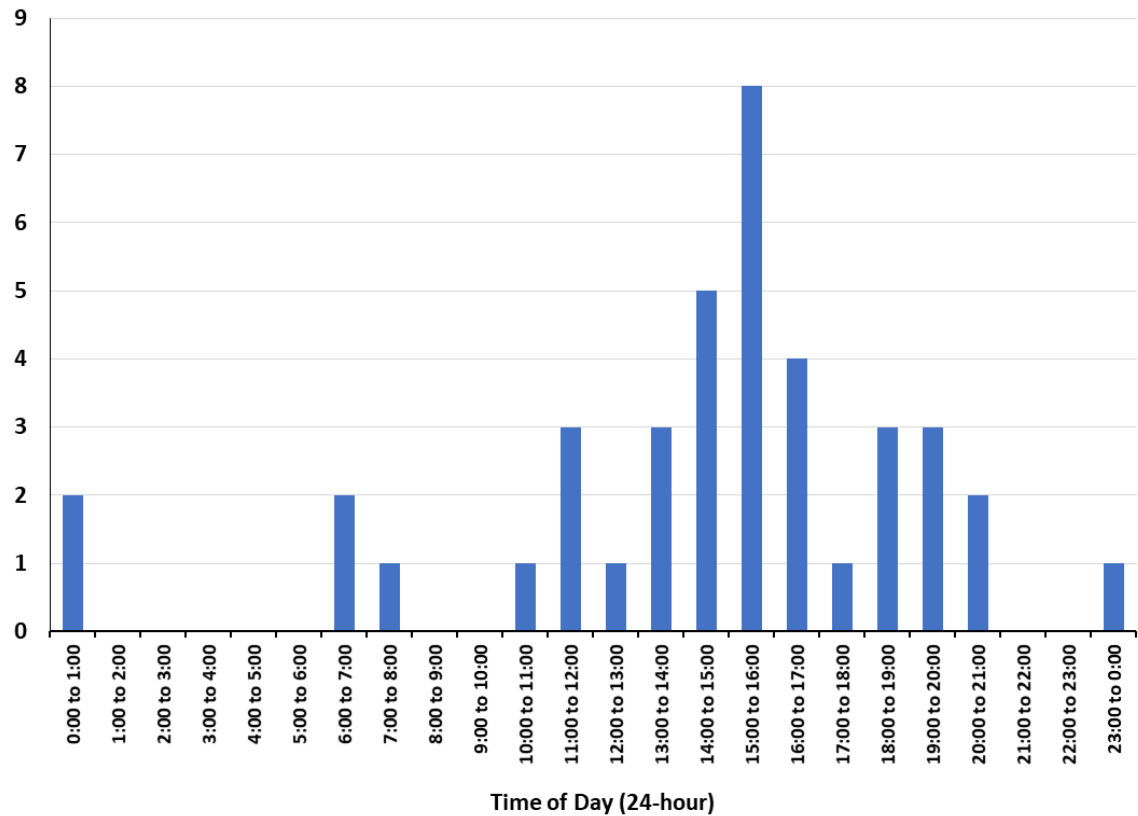
3. BELCO Response to

Question 1.a: Generally, atmospheric stability will vary depending on meteorological conditions (**Solar insolation/ground heating, wind speed**). Under unstable atmospheric conditions, this terrain effect could result in the plumes from BELCO impacting ground level receptors at a distance closer to BELCO than previously modelled.

DENR Comment:

Ground Heating: Time of day when the ~40 exceedances of the UK Air Quality Objective for 15-min SO₂ ranged from: late morning to early evening with a few exceptions.

Number Of Exceedances of UK Air Quality Objective 15-min SO₂ and times of day when exceedances occurred at Ocean Lane, Pembroke



- **Times of day when poor air quality was observed could be anytime when the neighbours could be in their gardens or at home with their windows open.**
- **Ground heating did not limit the potential time window of potential poor air quality.**

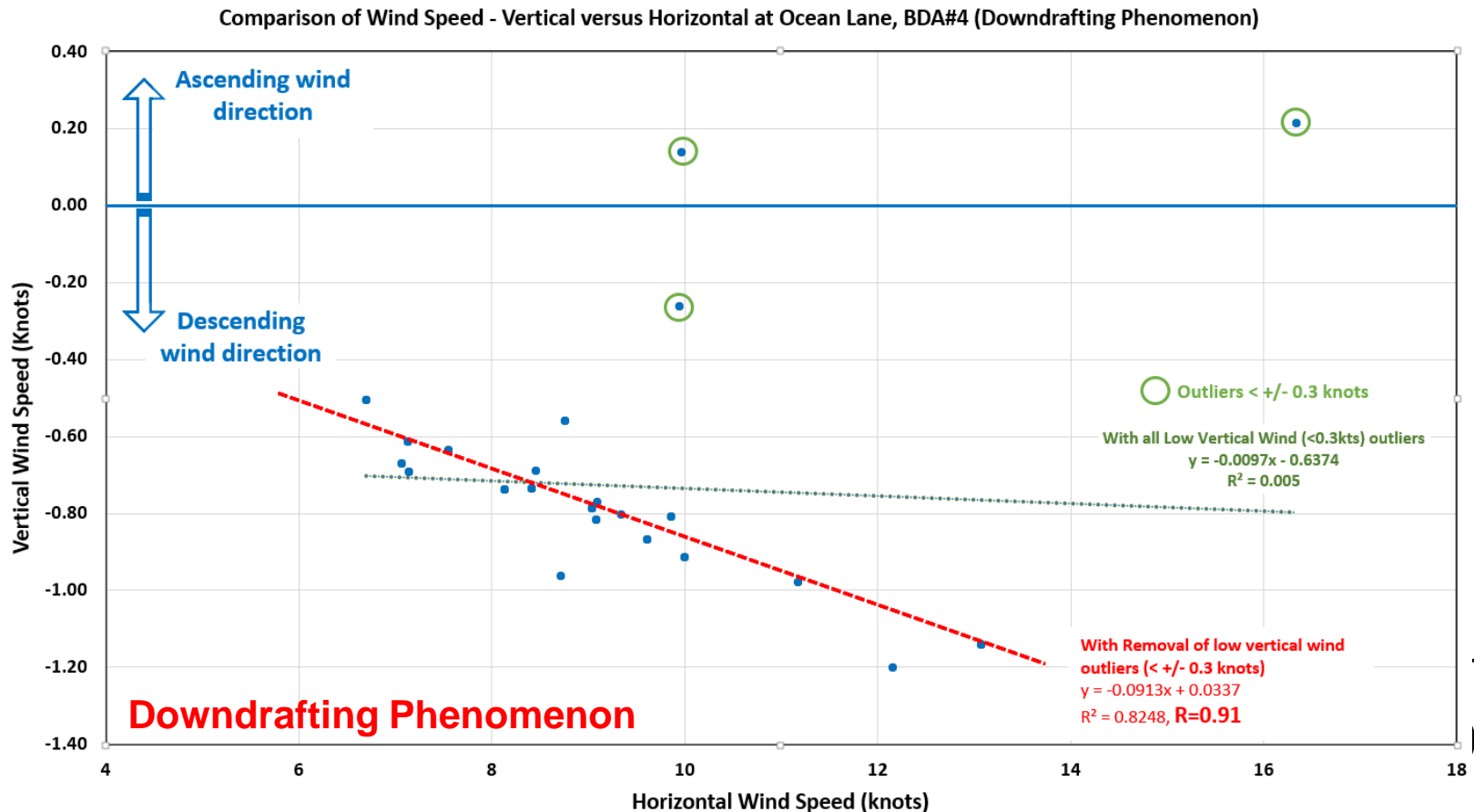


3. **BELCO Response to Question 1.a:** Generally, atmospheric stability will vary depending on meteorological conditions (Solar insolation/ground heating, **wind speed**). Under unstable atmospheric conditions, this terrain effect could result in the plumes from BELCO impacting ground level receptors at a distance closer to BELCO than previously modelled.

- **DENR Comment:**

Wind Speed: The nearest hourly horizontal wind speeds recorded at Ocean Lane during the exceedances of the 15-min SO₂ UK Air Quality Objective showed a strong correlation to downward wind speed (r=0.91).

- **The stronger the horizontal wind speed the stronger the downdraft.**



3. Review of BELCO Response to EA Letter 4th March

- **EA Letter Question 1.a:** Provide details of BELCO's current understanding of the 'Downdrafting' phenomenon at Ocean Lane.
- **BELCO Response:**
 - An initial review of meteorological conditions during a subset of the observed periods of elevated concentrations suggest that the terrain of Langton and Mount Hill are creating turbulence that enhances vertical mixing in the lower atmosphere. Under unstable atmospheric conditions, this terrain effect could result in the plumes from BELCO's generating stations impacting ground level receptors at a distance closer to BELCO than previously modeled.
 - **DENR requires professional input from UK Consultants to RA: *Ricardo Energy & Environment Ltd* to comment on the potential meteorological and topographical conditions that are leading to this downdrafting phenomenon at Ocean Lane, Pembroke.**



3. Review of BELCO Response to EA Letter 4th March

- **EA Letter Question 1.b:** Provide The latest air quality data and how that compares to the Bermuda Clean Air Regulations and the UK Air Quality Objectives.
- **BELCO Response:**
 - All air quality data collected at BELCO Ambient Air Monitoring Stations BDA1, BDA2 and BDA4 has been fully compliant when compared to BAAQS and UK DEFRA air quality limits for all measured pollutants across 1-hour and 24-hour time periods between 1 October 2020 and 15 March 2021. Please see Tables 1-3 for a summary for the period.
 - **DENR comment: The above statement is CORRECT. BELCO has met ALL 1-hour and 24-hour standards for pollutants (SO₂, NO₂, PM) for both Bermuda Clean Air Regulations and UK Air Quality Standard Regulations 2010 (No. 1001) that are based on the EU Directive: 2008/50/EC.**
 - Highest 24-hour SO₂ reading: **123 µg/m³** at Ocean Lane (74µg/m³ at Langton Hill) where the UK/EU standard is **125µg/m³** (not greater than 3-times per year) and Bermuda standard is currently **150µg/m³** **(See DENR Slide - BELOW).**



3. Provide The latest air quality data and how that compares to the Bermuda Clean Air Regulations and the UK Air Quality Objectives.

Summary Output from the Ocean Lane Monitoring Station:

*Bermuda Ambient Air Quality Standards as provided by Bermuda Clean Air Regulations 1993.

Station	Parameter	BAAQS* - 1-Hr ($\mu\text{g}/\text{m}^3$)	Max. 1-Hr Avg. ($\mu\text{g}/\text{m}^3$)	Exceedances (1-hr)	BAAQS* - 24-Hr ($\mu\text{g}/\text{m}^3$)	Max. 24-hr Avg. ($\mu\text{g}/\text{m}^3$)	Exceedances (24-Hr)
BDA4	NO ₂	400	105	0	200	69	0
	SO ₂	450	300 UK: 350	0	150	123 UK: 125	0
	PM ₁₀	-	-	-	50	33	0
	PM _{2.5}	-	-	-	-	21	-
Total Number of BAAQS Exceedances Recorded During Reporting Period							0

*UK National Air Quality Objectives UK used as jurisdiction where standards differ.

Station	Parameter	UK* - 15-Min ($\mu\text{g}/\text{m}^3$)	Max. 15-Min Avg. ($\mu\text{g}/\text{m}^3$)	Exceedances (15-min)	UK* - 1-Hr ($\mu\text{g}/\text{m}^3$)	Max. 1-Hr Avg. ($\mu\text{g}/\text{m}^3$)	Exceedance s (1-hr)	UK* - 24-Hr ($\mu\text{g}/\text{m}^3$)	Max. 24-hr Avg. ($\mu\text{g}/\text{m}^3$)	Exceedance s (24-Hr)
BDA4	NO ₂	-	-	-	200	105	0	-	-	-
	SO ₂	266	351	40	350	300	0	125	123	0
	PM ₁₀	-	-	-	-	-	-	50	33	0
	PM _{2.5}	-	-	-	-	-	-	-	21	0
Total Number of BAAQS Exceedances Recorded During Reporting Period										40



3. Review of BELCO Response to EA Letter 4th March

- **EA Letter Question 1.b:** Provide The latest air quality data and how that compares to the Bermuda Clean Air Regulations and the UK Air Quality Objectives.
- **BELCO Response:**
 - It is noted that there have been 35 total exceedances of the UK/EU DEFRA 15-minute SO₂ standard measured over the same period occurring on November 2 (1), 28 January (6), 2 February (3), 3 February (7), and 23 February (15), 3 March (1), 4 March (2) 2021 at BDA4 (Ocean Lane). **All occurred during periods of strong sustained south-southwest winds.** An all-time peak 15-min average concentration of 346 µg/m³ was recorded at 16:00 on 23 February at a sustained wind speed of 24 knots (BWS). **It is noted that a 15-minute obligation for SO₂ is not currently listed in Bermuda Clean Air Regulations 1993 (BAAQS).**
 - **DENR comment:** It has been shown that the now 40 exceedances of the 15-min SO₂ UK Air Quality Objective have occurred at wind speeds described by Beaufort as ranging from **light / gentle breeze to moderate breeze (and probably stronger).**
Agreed: These UK Objectives are NOT part of Bermuda's standards.



3. Review of BELCO Response to EA Letter 4th March

- **EA Letter Question 1.b:** Provide The latest air quality data and how that compares to the Bermuda Clean Air Regulations and the UK Air Quality Objectives.
- **BELCO Response:**
 - Although revised **AERMOD modeling** completed in April 2020, which considered metrological conditions observed between January 1 and April 7, 2020 and the elevation of Langton Hill and the Ocean Lane neighborhood, suggested that the Ocean Lane area would be impacted by BELCO exhaust, it did not suggest that the 1-hour or 24-hour BAAQS or UK Standards would be exceeded. There was no consideration given to a 15-minute averaging period at the time, however.
 - **DENR comment:** The Air Dispersion Model AERMOD is used to assess the potential impact of exhaust pollutants from stacks to the ground level and takes into consideration ground topography, exhaust emission rates, meterological conditions and air quality stadnards to be met. AERMOD can be used to set the minimum height of an exhaust stack to ensure the air quality at grade level is compliant and therefore safe to breathe. In Bermuda AERMOD has been used on all BELCO stacks, Tynes bay and Southside Crematorium. (*continued..*)



3. Review of BELCO Response to EA Letter 4th March

- **EA Letter Question 1.b:** Provide The latest air quality data and how that compares to the Bermuda Clean Air Regulations and the UK Air Quality Objectives.
- **DENR comment (*continued*):** AERMOD is generally configured to be **over-predictive** of the expected maximum concentrations of pollutants at grade level. AERMOD was used for BELCO in 2010 to show that the following maximum modelled and measured pollutant concentrations at Cemetery Lane (BDA#1) and the top of Langton Hill (BDA#2).

Pollutant	Averaging Period	Maximum Measured Concentration at Cemetery Lane (ug/m ³)	Maximum Modeled Concentration at Cemetery Lane (ug/m ³)	Maximum Measured Concentration at Mount Langton (ug/m ³)	Maximum Modeled Concentration at Mount Langton (ug/m ³)	BAAQS (ug/m ³)
SO ₂	1-Hour	141	189	243	321	450
	24-Hour	78	109	77	140	150
	Annual	5	10	8	14	30

Note that for SO₂ gases, which are primarily associated with BELCO HFO emissions, the maximum modelled concentrations at BDA#1 and #2 are typically higher than the maximum measured (data up to 2010).



3. Review of BELCO Response to EA Letter 4th March

- **EA Letter Question 1.b:** Provide The latest air quality data and how that compares to the Bermuda Clean Air Regulations and the UK Air Quality Objectives.
- **DENR comment (*continued*):** When the poor air quality complaints were first verified at Ocean Lane in 2020 and before the new portable sensor was installed DENR requested that BELCO re-run the AERMOD model specifically for the Ocean Lane area. Predicted **maximum modeled** SO₂ concentrations at #14 Ocean Lane from Jan to Apr 2020 were:
 - 1-hour SO₂: 111 µg/m³
 - 24-hour SO₂: 31 µg/m³
- **Maximum Measured** SO₂ concentrations at #14 Ocean Lane from Jan to Apr 2021 were:
 - 1-hour SO₂: 300 µg/m³
 - 24-hour SO₂: 123 µg/m³

Data suggests that the normally Over-Predictive nature of air pollutant concentrations by the AERMOD model in fact under-predicted air pollutant concentrations in the Ocean Lane Area.

AERMOD may therefore not be taking into full consideration the full effects of downdrafting phenomenon in this area.



3. Review of BELCO Response to EA Letter 4th March

- **EA Letter Question 1.c:** Provide the sources and causes of the pollutants measured in the ambient air at Ocean Lane.
- **BELCO Response:**
 - Both the North Power Station (N1 to N4) stack and East Power Station (E5 to E8) stack **are known** to contribute to poor air quality concerns at Ocean Lane. A review of data together with DENR personnel in March 2021 was performed to summarize operational and air quality trends in the Ocean Lane area. Although the data is limited to date, the review included hourly engine dispatch logs, hourly meteorological conditions and hourly ambient air pollutant concentrations measured at BDA4 during periods of known diesel exhaust impact. Days were selected where air quality complaints were made to BELCO from 14 Ocean Lane residents and to demonstrate ground level pollutant concentrations over a range of winds speeds. The selected days reviewed included: 17 December 2020; 22 January 2021; and 3, 13, 23 February 2021. Detailed hourly data from each of these days is presented in Attachment 1.
- **DENR comment:** BELCO has proven that the EPS can contribute to the poor air quality complaints when it turned off the NPS engines for 10 days in June 2020 and complaints from Ocean Lane continued. DENR has not seen data proving that the NPS engines are contributing to this poor air quality but DENR also suspects this.



3. Review of BELCO Response to EA Letter 4th March

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- **DENR comment:** BELCO has proven that the EPS can contribute to the poor air quality complaints when it turned off the NPS engines for 10 days in June 2020 and complaints from Ocean Lane continued. DENR has not seen data proving that the NPS engines are contributing to this poor air quality but DENR also suspects this.
- DENR is awaiting on BELCO to explain what can be interpreted from Attachment 1.



3. Review of BELCO Response to EA Letter 4th March

- **EA Letter Question 1.c:** Provide the sources and causes of the pollutants measured in the ambient air at Ocean Lane.
- **BELCO Response:**
 - Identified weather trends for adverse ambient air include periods of **high horizontal wind conditions (>15 – 20+ knots)** from a narrow compass bearing of 210-220 degrees (SSW). Significant BELCO operational contributors during periods of poor air quality include engine run-in periods at low engine load for prolonged periods following major maintenance and multiple regular engine start-ups over short time periods. Both these operational conditions adversely affect exhaust plume loft and ground level concentrations of pollutants at Ocean Lane..
- **DENR comments:** DENR suggests that the data from the times when the 15-min SO₂ UK Air Quality Objective was exceeded suggests that poor air quality can occur at Ocean Lane when the wind is from the SW/SSW from a light breeze and stronger.
- DENR agrees that long engine run-ins may cause more poor air quality in terms of soot from a stack through inefficient operation but would argue that a similar amount of SO₂ may be expected to be emitted from the stack irrespective of the efficiency of the engine during periods of run in. DENR would welcome a more qualified input on this.



3. Review of BELCO Response to EA Letter 4th March

- **EA Letter Question 1.d:** Provide the mitigation options that are available to BELCO to improve the air quality at Ocean Lane. Details of the expected improvement in air quality should be provided for each mitigation option together with an approximate timeline, if considered for implementation, and any other relevant considerations. . .
 - **BELCO Response:**
 - Primary abatement (or partial primary abatement during adverse wind conditions) by the selection of LFO over HFO for electricity generation is an available mitigation measure to BELCO however, this choice would have significant cost implications to the retail price of electricity. Operational efficiencies with BELCO Bulk Generation should also be highlighted as available mitigation measures for BELCO including the scheduling engine run-ins when wind conditions likely to cause elevated levels of pollution are present..
 - **DENR comments:** DENR considers that other lower sulphur fuel types could be considered instead of jumping from 2% sulphur HFO to 0.0015% sulphur LFO. For example, 1% sulphur HFO would effectively halve the SO₂ levels at Ocean Lane. What would be the impact of this change on the retail price of electricity?
 - DENR would require further clarification from Ricardo Energy & Environment Ltd to determine whether operational efficiencies could be used to address poor air quality at Ocean Lane.
-



3. Review of BELCO Response to EA Letter 4th March

- **EA Letter Question 1.d:** Provide the **mitigation options** that are available to BELCO to improve the air quality at Ocean Lane. Details of the expected improvement in air quality should be provided for each mitigation option together with an approximate timeline, if considered for implementation, and any other relevant considerations. . .
- **BELCO Response:**
 - It is noted that secondary abatement options have always proved to be economically and technically unfeasible when compared to primary abatement methods. Further details for mitigation have been explored in a previous letter to DENR dated 29 January which is included with this response as Attachment 2.
- **DENR comments:**
 - See point #3 of attachment 2.
 - DENR agrees that it would be far simpler and cheaper (to BELCO) to improve the quality of the fuel used in the EPS/NPS engines than it would to try and attempt to place scrubbers on the exhaust.
 - Scrubbers are more economically suited to more polluting combustion sources where the fuel quality is difficult to control - such as mass burn incinerators or coal-fired power plants.



3. Review of BELCO Response to EA Letter 4th March

- **EA Letter Question 1.d:** Provide the mitigation options...
- **BELCO Response:**
 - Further it should be highlighted that manufacturer's recommended mitigation measures are underway and ongoing at the North Power Station including **increasing cylinder operating pressures for all NPS diesel engines**. The shim change in connecting rods for N1 to N4 engines has been completed, while **swap out of piston crown type has begun**, with N1 being complete to date. It is expected that N4 will have its piston crowns replaced by mid-April while N2 and N3 will have crowns replaced in Q3 after the summer production season. The expected outcome of these cylinder changes is increased compression ratio and higher temperature in cylinder to promote overall lower fuel consumption and **more complete combustion**.
- **DENR comments:** It is noted that BELCO is in the process of changing the NPS engine setup from NG to HFO.
- It is further noted that there are no changes due to be made to the EPS engines that have already been implicated in the poor air quality at Ocean Lane.
- DENR will require further technical input to show how improvements in efficiency will affect the amount of sulphur to be emitted from the stack. It could be argued that more efficient operation of the engines will lead to higher levels of SO₂ being generated instead of more reduced sulphur compounds.



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