3 Improper Determination of Potential Impact Significance

CEQA guidelines were improperly applied in determining potential significant impacts. An alternate analysis is presented herein.

3.1 Arbitrary and Inappropriate Threshold of Significance

In preceding sections of these Comments, substantial differences were described between this Project in the City of Brisbane and 300 Airport Boulevard in the City of Burlingame. Despite these differences, the threshold for impact significance used in the Project DEIR was substantially or entirely appropriated from the 300 Airport Boulevard DEIR from the City of Burlingame.

This threshold has not been adopted by the City of Brisbane under an official CEQA significance threshold adoption process, has not gone through public review in the City of Brisbane, and does not accurately measure the impact on usability of the Resource as shown below.

The DEIR further states that no universal criteria for acceptable windsurfing activity exists, admitting that "wind standards" of the sort specified by the City of Burlingame are not necessarily transferable.

CEQA requires that the cross-application of such a standard from a source jurisdiction be appropriate for the target jurisdiction. No justification was given for the suitability of such a wind standard for this Project, for the City of Brisbane, and for the Resource.

Relative Wind Speed Reduction is Insufficient Measure

Regarding the significance threshold used by the City of Burlingame, there are two main problems with using relative mean wind speed reduction as a proxy for studying impacts to the Resource:

1. Mean wind speed is just one of many factors in determining availability of the Resource
2. Impacts on availability of the Resource due to changes in mean wind speed are assuredly non-linear[2] [16].

Accepting the logic used in the City of Burlingame threshold would be analogous to implying that a 10% increase in temperature would necessarily cause 10% less snowfall.

Instead of relative change, one must consider absolute pre-impact and post-impact levels of many factors that determine the viability and availability of the Resource.

Basic Requirements of Windsurfing

Windsurfing requires certain minimum lull, mean, and gusts speeds [16] just like aircraft require certain minimum takeoff, stall, and landing speeds [33]. Windsurfing does not operate under the same physics principles as other sailing vessels because of the unique planing hull design and the change in drag that occurs above certain critical speeds (cf. Figure 20).

Windsurfing requires minimum gusts to provide enough impulse to achieve a state of hydro-planing (planing) and perform maneuvers such as turning around; it requires minimum mean speeds to continue in this planing state; and it requires minimum lull wind speeds that are not too frequent such that the windsurfer's momentum would be insufficient to continue planing through the lull.

The behavior of a sailboard below these minimum speeds is dramatically different. The behavior does not change smoothly and proportionally with board speed but changes abruptly at a critical minimum much like at a critical minimum "takeoff speed" an aircraft becomes airborne or below a critical "stall speed" an

[2]Non-linear means that a change in an input factor may not necessarily produce a proportional change in an output quantity.

aircraft cannot stop descending [33].

This planing operating mode of sailboards is very similar to the hydrofoiling state (foilborne sailing) of the America's Cup AC72 catamarans. Minimum speed is required to create hydrofoil lift to offset the weight of the vessel and cargo. Once critical lift has been achieved, the performance and operation of the AC72 is very different from the non-foiling state.

Below planing speeds, the sailboard moves through the water rather than on top of the water and flotation, maneuverability, balance, and the ability to return to the launch or offset tidal currents is severely impacted. If the wind drops below a critical point for too long or too often, it is considered unsailable as too much of the time will be in this sub-planing state. Many sites that have strong wind but possess many regular adversely located wind shadows[3] are effectively unsailable.

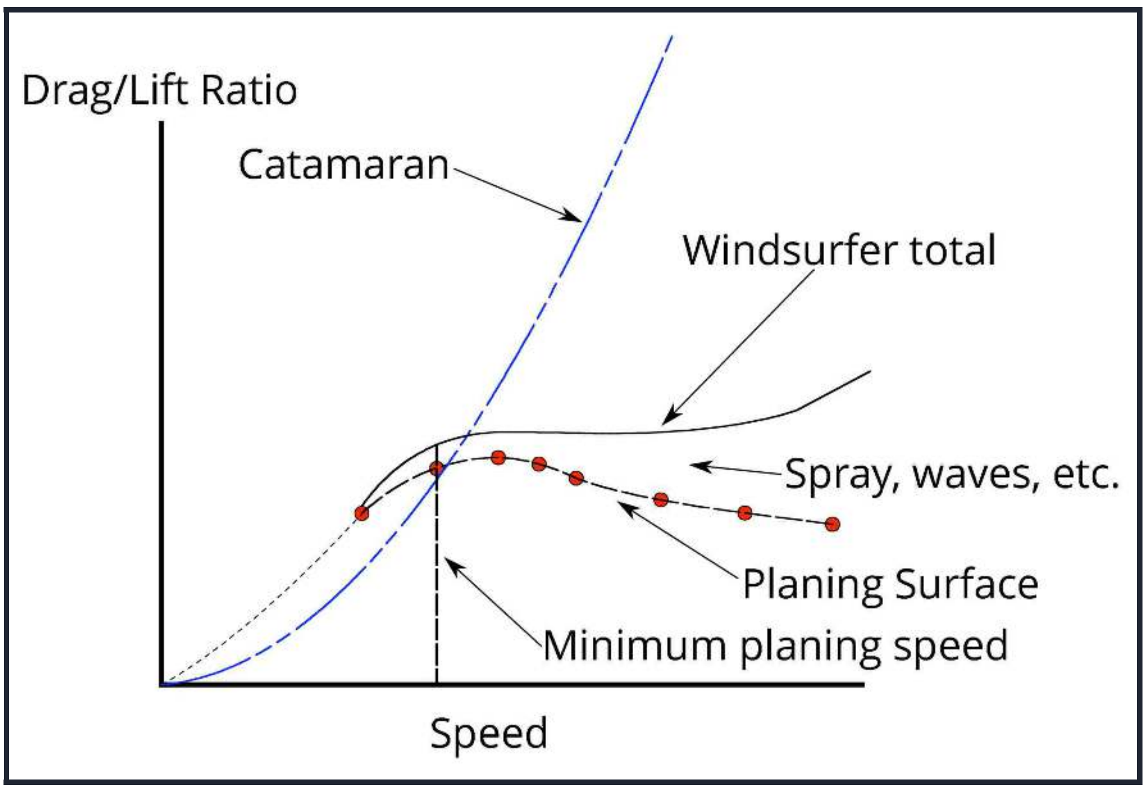

Figure 20: Windsurfer Drag/Lift vs. Speed
Adapted from *An Introduction to the Physics of Windsurfing* lectures by Jim Drake (co-inventor of windsurfing) [16]. Below the minimum planing speed, increased speed increases drag of the windsurfer faster than lift. Above the minimum planing speed, the planing surface (windsurfer hull) begins to experience reduced drag compared to lift as speeds increase. Drag/lift response to speed for a windsurfer is highly non-linear unlike other sailing vessels such as the catamaran profile shown above as well. Relative change in wind speed is not sufficient to determine the ability to continue to achieve a planing state. Furthermore, due to lulls or decreases in mean wind speeds caused by wind shadows or highly turbulent sections, when board speed falls below the minimum planing speed, the sudden reduction in lift can cause an sudden increase in drag and the loss in speed, maneuverability, and flotation will be compounded. More energy is required to achieve the planing state than to keep the planing state.

[3]Wind shadows are extraordinary upwind obstructions that create permanent decreases in wind speed in their wake.

If the regular range of lull-to-gust wind speeds is too severe, as can be caused by high turbulence (cf. [30], [19], [34], [26], [9], [13]), no windsurfing equipment can safely be used to accommodate the range of forces experienced.

Another important consideration is that negative impacts should not only be not too severe, but should also not be too frequent or distributed in such a way as to prevent sufficient uninterrupted use of the Resource. It is not simply a matter of thresholding based on a percentage of sailing area impacted (e.g. a "large portion"), it is critical to consider the actual locations and distribution of these areas.

Gusts and lulls in these Comments refer to the very specific measured quantities known as the maximum and minimum short-term wind speeds within a longer observation. These extreme values are well understood and well studied in wind energy and structural engineering sciences. Gusts and lulls are known to be directly related to turbulence, which is influenced by factors such as surface roughness and upwind obstacles. For more information, see Appendix H.

Figure 21: Planing Windsurfing
Windsurfing operating in planing conditions. Most of the board is lifted above the water. Drag is substantially reduced. Mobility, flotation, and maneuverability is greatly impaired below planing speeds. The ability for a windsurfer to offset tidal effects, avoid obstacles, and navigate back to shore is drastically reduced below planing speeds.

Need for Calibrated Absolute Measurements

The Analysis made no effort to establish critical absolute measurements or thresholds for the Resource but only considered relative changes to a baseline that has not been calibrated to actual sailing conditions. Not calibrated means that the absolute values of a baseline give no information since it is unknown how such values correspond to actual sailing conditions. An uncalibrated value is simply a number.

Each anemometer needs to be calibrated to its sailing location because the exact placement of the anemometer and its operating characteristics make for an unique ability to represent a complex wind system.

For example, there are at least four anemometers that are regularly used to gauge conditions at Crissy Field. The importance and acceptable absolute wind level thresholds of each of these sensors need to be calibrated to prevailing wind direction, season, experience from the past, and other environmental conditions in order to be effective. Using just one of these sensors or using thresholds for one sensor applied to another would give very misleading indications of the true sailing conditions.

Beyond Mean Wind Speed

The Analysis also did not consider the impact on gust and lull wind speeds that is caused by increased turbulence (cf. [30], [19], [34], [26], [18], [9], [13]). These short-term minimum and maximum wind speeds are well studied in the context of wind energy and building loading. The relationship between turbulence-increasing upwind development and gust factors is well known.

To again use the illustrative example of the America's Cup boats, it is crucial for their crew to consider a variety of environmental factors, the absolute not relative levels of each factor, and how these levels compare to known safe operating ranges. Relative mean wind speed (such as "10% windier than yesterday") must be translated to some absolute value (such as "18 knots") in order to be of any use.

In addition to absolute mean wind speed, operating the AC72 safely also hinges on knowing the range of maximum short-term wind speeds known as gusts to avoid precisely the conditions that led to the tragic death of a crewmember this summer [4]. These gust values must also be considered in absolute terms.

The DEIR should not dismiss any level of projected impacts to relative mean wind speed as insignificant. Thresholding the projected change in relative mean wind speed in isolation cannot yield a valid test of significance. There is no way to project the change in availability of the Resource without considering absolute pre-impact and post-impact calibrated wind flow characteristics in the context of reasonable Required Conditions for pre-impact use of the Resource.

3.2 Impacts Projected Using an Appropriate Measure

The chaotic nature of wind systems and the relationship of wind speed to sail force ([20], [17]) mean that even a seemingly small impact in one environmental factor can have a devastating impact on a sailing area.

Understanding Wind Speed Impact on Sail Force

Dismissing a 5% or 10% difference in an environmental factor as arbitrarily "small" is dangerous. This would be akin to describing the difference between 33 and 31 degrees Fahrenheit as insignificant although the difference is less than 10%. Obviously water may freeze at one temperature and may not freeze at the other even though the magnitude of the difference is similarly "small" by some measures. To continue with that analogy, one would also be unable to assess the significance of the two temperatures relative to impact on freezing without considering the atmospheric pressure, presence of solutes in the water, etc.

In the case of windsurfing, the difference in wind force acting on a sail changes quadratically with wind speed. A 10% change in wind speed will produce a change in sail force larger than 10% ([20], [17]). For example, a decrease from 10 mph to 9 mph results in a 19% decrease in sail force[4]. A decrease from 16 mph to 15 mph, while only a 6% decrease in wind speed, results in a 12% decrease in sail force[5].

In addition, the range between lulls and gusts generally increases given higher mean wind speeds and the same wind turbulence intensity. For example, a gust factor of 1.4x would predict gusts of 28 mph for a 20 mph mean wind speed (cf. [30], [19], [34], [26], [18], [9], [13]). After a 10% relative decrease in mean wind speed, the same gust factor would only predict gusts of 25 mph[6]. The decrease from a 28 mph gust to a 25

[4] $1 - 9^2/10^2$
[5] $1 - 15^2/16^2$
[6] 1.4x gust factor applied to a mean wind speed of 18 mph

mph gust results in a 20% reduction in sail force[7].

The reality is even more complex. Typically, a decrease in mean wind speed due to upwind obstruction is met with an increase in wind turbulence intensity (this is confirmed by the Analysis).

To capture the full extent of the potential change in the above example including wind turbulence intensity, consider in addition to a 10% relative mean wind speed decrease, a 10% relative wind turbulence intensity increase is also experienced[8]. This can be accounted for by changing the gust factor from 1.4x to 1.44x[9].

In the above example, the pre-impact lull, mean and gust wind speeds would be in the range of 12, 20, and 28 mph respectively[10]. The post-impact lull, mean, and gust would be in the range of 10, 18, and 26 mph respectively.

So while this change would only suggest a 14% decrease in sail force from gusts, it would suggest a 31% decrease in sail force from lulls. Furthermore, the change would suggest going from pre-impact gusts providing 540% the force of lulls[11] to post-impact gusts providing 680% the force of lulls[12].

	1 Minute Observation			5 Minute Observation			12 Minute Observation		
	Lull	Gust	Sail Force Range	Lull	Gust	Sail Force Range	Lull	Gust	Sail Force Range
$TI_u = 0.10$	16	20	1.6x	15	21	2.0x	14	22	2.5x
$\boldsymbol{TI_u = 0.16*}$	14	22	2.5x	12	24	4.0x	11	25	5.2x
$TI_u = 0.20$	13	23	3.1x	11	25	5.2x	10	26	6.8x

Table 1: Wind Range and Sail Force Sensitivity Summary

Summary of sensitivity analysis tables showing predicted impact on wind range and sail force range when going from lull wind speed to gust wind speed due to change in turbulence. For example, over a 5 minute period, the difference between experiencing a turbulence intensity of 0.10 vs. 0.20 is the difference between dealing with gust sail force 2x that of lull sail force and dealing with gust sail force over 5x that of lull sail force. Existing conditions from sensor observations shown as "$\boldsymbol{TI_u = 0.16*}$." The mean wind speed used above is 18. Turbulence intensities are converted to gust factor using the methods described in Appendix H of these Comments. Numbers above reflect effects of rounding.

The conclusion shown by this example is that from a decrease in mean wind speed and an increase in wind turbulence intensity, all critical wind speeds would provide disproportionately less sail force while the sailor would simultaneously have to deal with a much wider range of forces on the sail[13].

Lulls and gusts were not considered in the DEIR, although wind turbulence intensity was considered. Wind turbulence intensity can predict lull and gust values. No such analysis was done in the DEIR.

[7] $1 - 25^2/28^2$

[8] For the purposes of these Comments, an increase in wind turbulence intensity from 0.10 to 0.11 is referred to as a 10% increase in wind turbulence intensity, for example.

[9] $GF' = 1.4 + (1.4 - 1) \times 10\%$

[10] Lulls and gusts relative to a sufficiently strong mean wind speed are treated as symmetric about the mean, which is empirically supported.

[11] $28^2/12^2$

[12] $26^2/10^2$

[13] Windsurfing equipment has a fixed and limited range of wind speeds in which it can be safely and effectively operated.

For more information about lulls, gusts, and gust factors, see Appendix H and the References section of these Comments.

A 5% or 10% difference in mean wind speed around the critical sailability thresholds necessary for a windsurfing site is assuredly important. Such a difference can make or break a decision to commit to a 1.5 hour round-trip drive through traffic. It can mean a successful Sailable Day or a complete waste of time, money, and energy.

Site-Specific Criteria for Sailability

The argument that there are no universal criteria in terms of wind speeds for acceptable windsurfing conditions at all locations is misleading. While it is true that there are no single criteria for all sites, there are absolutely specific criteria for specific locations tied to specific sensors. This is demonstrated by professional forecasting services that predict future sensor values and apply well-known thresholds for predicting future sailable conditions at specific sites.

Each windsurfing location has different requirements for sailability. These requirements include the mean wind speed, range of extreme wind speeds (lulls and gusts), variability in the wind, duration and frequency of the lulls and gusts, temperature, altitude, humidity, length of unobstructed sections of wind exposure, length of reaches, topographical constraints and obstructions, amount and direction of swell or chop in the water, tidal currents, and other factors. The precise relationships between these factors and the operation of a sailing vessel are well-studied in aerodynamic, hydrodynamic, and marine engineering (cf. [20], [17], [16]).

While the DEIR does not consider such standards, it is clear that such standards can be defined. For example, in the related field of AC72 racing, the 34th America's Cup Regatta provided clear minimum and maximum wind ranges that were specific to time of year, tidal condition, and sea state [29]. These standards were relative to local sensors that had been calibrated and thresholded based on the experience of sailors operating at the racing site.

Appropriately Measuring Absolute Impact on Resource Availability

To meaningfully relate relative wind flow changes to absolute post-impact change in the availability of the Resource, several steps are required:

1. Identify a data source that measures absolute levels of wind flow that is calibrated and correlated with on-the-ground conditions at the Resource
2. Establish thresholds of these absolute wind flow levels to determine Required Conditions for use of the Resource prior to impact
3. Select either a historic set of the data or a projection of future data with which to assess impacts
4. Determine the pre-impact availability of the Resource by applying the Required Conditions to the selected data
5. Determine the post-impact availability of the Resource by applying the relative wind flow changes to the selected data and reapplying the Required Conditions to the modified data
6. Compare the change in pre-impact and post-impact availability of the Resource

The DEIR includes none of these steps in the Analysis. However, these steps were performed in a "Sailable Day Impact Analysis" and reported in these Comments. Each step in this Sailable Day Impact Analysis is described below:

Identify a data source that measures absolute levels of wind flow that is calibrated and correlated with on-the-ground conditions at the Resource

In the case of the CPSRA, the single most representative measure for the condition of the Resource is an anemometer maintained by Weatherflow, Inc [35] for the CPSRA. Historic data from this CPSRA Sensor served as the data source required for the Sailable Day Impact Analysis.

CPSRA Sensor data points include lull wind speed, mean wind speed, gust wind speed, observation time, and wind direction. The CPSRA Sensor is calibrated to the Resource such that users of this Resource have intimate knowledge of how the absolute levels of various readings of this sensor correspond to specific on-the-ground sailing conditions.

The CPSRA Sensor is operated by the same company and provides the same level of information as the sensors used in the recent 34th America's Cup Regatta [28].

Establish thresholds of these absolute wind flow levels to determine Required Conditions for use of the Resource prior to impact

A set of absolute minimum Required Conditions for wind flow for a Sailable Day at the Resource relative to this CPSRA Sensor was obtained through a survey of local experts who collectively use the Resource thousands of times per year. These Required Conditions are conservative and reasonable.

Two sets of Required Conditions were considered in the Sailable Day Impact Analysis. One set of Required Conditions included only minimum mean wind speed. The second set included minimum mean wind speed, minimum lull wind speed, and minimum gust wind speed.

These Required Conditions are similar to those used by the 34th America's Cup Regatta in determining minimum acceptable as well as maximum safe racing conditions [29], [28].

> *A Sailable Day is one on which there exists a two-hour window somewhere between the hours of 12pm and 7pm local time containing CPSRA Sensor observations such that 75% of the observations during that two-hour window are Sailable Observations.*
>
> *A Sailable Observation is a CPSRA Sensor observation with a minimum lull wind speed of 10 mph, a minimum mean wind speed of 16 mph, and a minimum gust wind speed of 20 mph and a wind direction either West, West-Northwest, or Northwest.*

Figure 22: Definition of Required Conditions for a Sailable Day

This definition is based on actual historic data, analysis, surveys of the general public who use this resource, and information by expert weather forecasters. It is specific to CPSRA and tied directly to the CPSRA Sensor and its operating parameters. The definition is not transferable to any other sensor or any other sailing site.

Select either a historic set of the data or a projection of future data with which to assess impacts

Three years of historic anemometer CPSRA Sensor data was utilized (years 2011, 2012, and 2012 and months from April through September) [35].

Determine the pre-impact availability of the Resource by applying the Required Conditions to the selected data

Table 2 shows the number of Sailable Days per month and year by applying the Required Conditions to the three-year historic data set.

Determine the post-impact availability of the Resource by applying the relative wind flow changes to the selected data and reapplying the Required Conditions to the modified data

Average impacts of 5% and 10% decrease in mean wind speeds and 5% and 10% increase in wind turbulence intensities[14] were considered as scaling factors to the historic data set. These scaling factors were applied to wind flow data points in the three-year historic data set. The Required Conditions were then reapplied. A sensitivity analysis approach was taken to isolate the impact of different degrees of potential wind changes and different degrees of Required Conditions strictness.

Regarding the selection of 5% and 10% scaling factors, 58% of data points reported in the Analysis for impacts to the Practical Sailing Area that were newly measured to account specifically for the Project show a 5% or greater mean wind speed reduction. Furthermore, the Analysis only measures new impact data points covering less than 25% of the Practical Sailing Area. The uncovered portions of the Practical Sailing Area with no new measurement data points are generally to the West and closer to the Project. According to the Analysis, impacts will be more severe closer to the Project.

This method of scaling historic data and re-applying the Required Conditions to assess impacts to a quantity such as Sailable Days is sanctioned by the reporting of relative wind flow changes in the DEIR. The DEIR states that the projected relative impacts can be applied to any baseline conditions to obtain projected absolute impacts.

Compare the change in pre-impact and post-impact availability of the Resource

Table 3 shows the changes that would have occurred over the past three years under a variety of possible applications of the projected impacts. This method of considering a range of possible impacts is called a sensitivity analysis and is meant to show a range of "best-case" to "worst-case" outcomes. A sensitivity analysis is more appropriate given the uncertainty involved here than projecting a single definitive outcome with no contingency factor as was done in the DEIR.

By considering the most conservative impact scenario of a 5% reduction applied to mean wind speed only, it was found that the number of average annual Sailable Days was reduced by 9%.

By considering a 10% reduction applied to mean wind speed only, a 20% reduction in Sailable Days was found.

By considering the same 5% and 10% wind speed reductions applied to lulls and gusts in addition to mean wind speeds (as is empirically supported by the models detailed in the Appendices to these Comments and by models used to study extreme values as found in [30], [19], [34], [26], [18], [9], and [13]), a reduction in Sailable Days of 22% to 44% respectively was found.

By keeping all data points unchanged except adjusting the lull values so that the lull-mean range was expanded by 5% or 10%, a reduction in Sailable Days of 15% to 16% respectively was found. This method of considering the increase in wind turbulence intensity by a direct proportional scaling of the lull-mean range is supported by models as found in [30], [19], [34], [26], [18], [9], and [13].

[14] For the purposes of these Comments, an increase in wind turbulence intensity from 0.10 to 0.11 is referred to as a 10% increase in wind turbulence intensity, for example.

		Days Sailable	Mean	Lull	Gust	Lull-Gust Range	Lull-Mean Range	Mean-Gust Range
April	2011	12	20	12	28	16	8	8
	2012	14	18	11	25	14	7	7
	2013	20	18	12	24	13	7	6
May	2011	15	20	12	28	16	8	8
	2012	19	19	12	25	13	7	6
	2013	22	19	12	26	14	7	7
June	2011	9	19	12	26	13	7	6
	2012	19	19	12	26	14	7	7
	2013	17	19	12	25	13	6	7
July	2011	13	18	11	23	12	6	5
	2012	10	17	11	22	11	5	5
	2013	12	17	11	23	12	6	6
August	2011	3	17	12	21	9	5	4
	2012	13	17	11	23	11	6	5
	2013	13	18	12	26	14	6	7
September	2011	15	17	11	22	10	6	5
	2012	11	17	11	21	10	6	5
	2013	18	18	12	26	14	6	7
2011		67	19	12	25	13	7	6
2012		86	18	12	24	12	6	6
2013		102	18	12	25	13	6	7
All Years		255	18	12	25	13	7	6

Table 2: Sailable Days Existing Conditions (Base Case)

No adjustment to observed wind speeds. All wind speed values and ranges are averages over the specified time period. *Mean* is the average wind speed during an observation, *lull* is the minimum short-term wind speed during an observation, and *gust* is the maximum short-term wind speed during an observation. Each range is an average difference between the indicated variables during each included observation. The averages include only observations for days that are determined as sailable and within those days, only observations that qualify as sailable within the first two hour sailable window. The threshold for a sailable observation is lull minimum 10, mean minimum 16, and gust minimum 20 along with direction W, WNW, or NW. The threshold for a Sailable Day is a day having at least a single two hour window starting at 12pm and ending at 7pm such that 75% of the observations within the window are sailable. All wind speed values are in miles per hour. Some sums may not reconcile to their constituents due to rounding.

3.3 Significance of Resource Availability Impact

For unique, valuable, and irreplaceable recreational resources, reductions of availability of 10% or more have been considered to be significant under applications of CEQA guidelines.

These Comments make clear that applying such a threshold to relative mean wind speed reductions is nonsense. Impacts to mean wind speed are not the same thing as impacts to availability of the windsurfing Resource. Mean wind speed and windsurfing Resource availability are two different things. Changes to mean wind speed do not necessarily cause proportional changes to windsurfing Resource availability.

However, it is reasonable and meaningful to apply this threshold directly to impacts on actual availability of the Resource based on established Required Conditions as they currently exist.

The Sailable Day quantity defined above adequately measures the availability of the Resource. Projected changes to this quantity directly project the change in availability of the Resource.

The Sailable Day Impact Analysis reported above projects a 9% to 44% decrease in Sailable Days using realistic requirements, analysis methods, and measurements reported in the DEIR.

Based on these findings, it is clear that there is strong potential that the Project as currently described without mitigation would likely have a significant impact on the Resource.

	Average Days Sailable Per Year	Loss of Days Sailable Compared To Existing Conditions
100% of Lull, Mean, Gust Wind Speeds*	**85**	**-**
95% of Lull, Mean, Gust Wind Speeds	68	-17 (-20%)
90% of Lull, Mean, Gust Wind Speeds	48	-37 (-44%)
95% Adjustment to Only Mean Wind Speeds	77	-8 (-9%)
90% Adjustment to Only Mean Wind Speeds	66	-19 (-22%)
5% Increase of Lull-Mean Range	72	-13 (-15%)
10% Increase of Lull-Mean Range	72	-13 (-16%)

Table 3: Sailable Day Impact Analysis Summary

Summary of sensitivity analysis tables showing predicted impact on days sailable from mean wind speed reductions and wind turbulence intensity increases. Existing conditions from sensor observations shown as “100% of Lull, Mean, Gust Wind Speeds*.” “Loss of Days” means average annual loss of Sailable Days over the past three years of data analyzed compared to existing conditions. Numbers above reflect effects of rounding.

These projected reductions in Sailable Days, summarized in Table 3, represent a critical and as yet unmitigated threat to the availability and continued viability of this Resource.