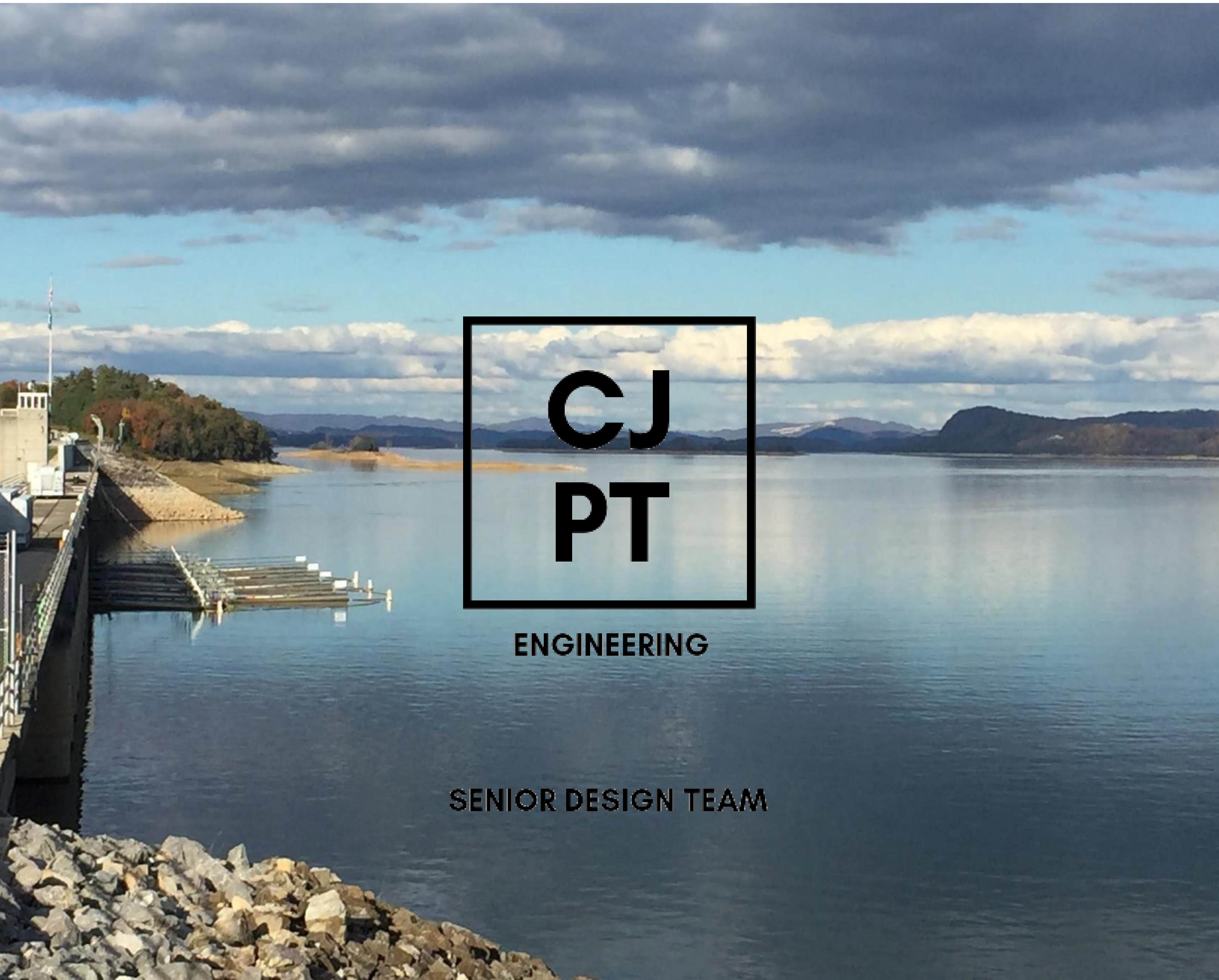
CHELAQUE

TICKLE COLLEGE OF ENGINEERING
THE UNIVERSITY OF TENNESSEE, KNOXVILLE

Morristown TN



CJ PT
ENGINEERING

SENIOR DESIGN TEAM

Acknowledgements

CJPT Engineering would like to thank the Chelaque Estates residents and everyone that participated in making this a successful project. We would also like to thank the Tickle College of Engineering for the support and guidance provided for the project. We would like to acknowledge the following people that supported this project:

David Toll – Marina Chairman Chelaque Estates

Robert Brasington – Marina Associate Chelaque Estates

Curtis M. Jawdy – Lead Hydrologist at TVA

Dr. Chris Wilson- Research Assistant Professor at the University of Tennessee – Knoxville in CEE Department

Dr. Thanos Papanicolaou – Henry Goodrich Chair of Excellence and Professor at the University of Tennessee – Knoxville in CEE Department

Dr. John S. Schwartz – Director of Tennessee Water Resources Research Center and Professor at the University of Tennessee – Knoxville in CEE Department

Michael D. Hogan- PE, Project Manager and Senior Engineer at Lose Design

Dr. Jennifer Retherford – Senior Lecturer at the University of Tennessee – Knoxville in CEE Department

Disclaimer

The following report represents the work compiled by engineering students at the University of Tennessee as part of a senior design project. All work for this project must be reviewed and approved by a licensed engineer before implementing any of the solutions contained within this document.

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1.0 Introduction

This report contains a summary of engineering services rendered for the infrastructure improvements of the Chelaque Estates Marina located on Cherokee Lake in Mooresburg, TN. Chelaque Estates is a lakefront subdivision that maintains a community marina used to house and protect recreational boats, and is managed by the Homeowners Association for the community. The marina is surrounded by a system of floating debris containment booms anchored in place to protect the boats from debris, deter wake, and prevent theft. The debris containment booms are aging, and the elements are deteriorating. The boom system in place needs either an update or a full replacement. To address the need of the marina community, CJPT Engineering performed engineering services to address the aging infrastructure improvements paired with operational improvements for the boom system. The engineering services required included the following: compilation of water flow behavior and traits, characterization of debris, creation of an operator's strategy, and specification of an "off-the-shelf" boom system modified to adapt to the conditions of the marina site.

1.1 Project Background

The boom containment system at Chelaque Estates marina was installed in 1999 and has experienced significant weathering and deterioration due to time. The boom system does not deflect debris away from the marina effectively because the elements have aged and are starting to deteriorate. The operation of the booms requires constant surveillance of Cherokee reservoir water levels and must be manually adjusted by Chelaque Estates residents. Also, the costs for replacing the boom system are estimated at $300,000 ($150,000 per boom), which is uneconomical for the marina at this time. The aging booms are rusting and are a visual eye sore, which negatively impacts the aesthetics of the marina. Aside from aesthetic decay, operational performance has been hindered by excessive debris build ups within the boom containment system. Also, the complexities of frequent manipulation of the orientation of the boom has worn the components and caused cables attached to the booms to snap frequently, which cost $200 to replace. The residents of Chelaque Estates expressed concerns over the effectiveness of the structure; primarily the boom structure and its ability to prevent debris. During the spring months when water levels in the reservoir are increased by the Tennessee Valley Authority, large amounts of debris accumulate in the reservoir and the marina experiences higher levels of trees, medium to small sized limbs, and trash inside the boom system. As water levels increase in the Cherokee reservoir, debris lying on the shoreline (trees, limbs, trash, etc.) is picked up by the rising water and enters the reservoir channel. The debris is carried by the direction of water flow at the surface, which is primarily dictated by the direction of wind, and is making its way past the boom system. The booms are important for protecting the dock infrastructure and the watercrafts housed in the marina from floating debris that has entered the waterway. The operational complexities of the boom system are challenging for the community because the reservoir fluctuates up to 30 feet, and the system requires operations to re-tension the cables for every 2 feet in water level changes. The operations of the current boom system require several hours per week to keep the booms functioning. This is a challenge for the community because it requires volunteers to adjust cables attached to the booms in boats, sometimes in inclement weather, on a weekly basis. Also, repairs to the boom are costly to the community. The cables that support the system break on about a monthly basis and cost the marina approximately $2,400 per year. The community recognizes that the aging debris containment booms need replaced, but a single boom can cost up to $150,000 to replace.

1.2 Project Contact Information

The CJPT Engineering Senior Design Team is comprised of four members as shown in **Figure 1** and identified in **Table 1**. Each member of the team is prepared to graduate in December of 2019 from the University of Tennessee Knoxville with a Bachelor of Science Degree in Civil and Environmental Engineering. The team worked closely with technical mentors and clients of Chelaque Estates (identified in **Table 2)** that assisted along the duration of the project.

Table 1: CJPT Engineering Senior Design Team

NAME	ROLE	EMAIL
Paige Livingston	Team Leader/ Hydrology Lead 1	ahubard@vols.utk.edu
Chase Allsup	Operations Lead	wallsup@vols.utk.edu
Jonathan Payne	Hydrology Lead 2	jpayne45@vols.utk.edu
Talecia Dyson	Fluid Dynamics Lead	tdyson@vols.utk.edu

Table 2: Chelaque Estates Clients and Technical Mentors

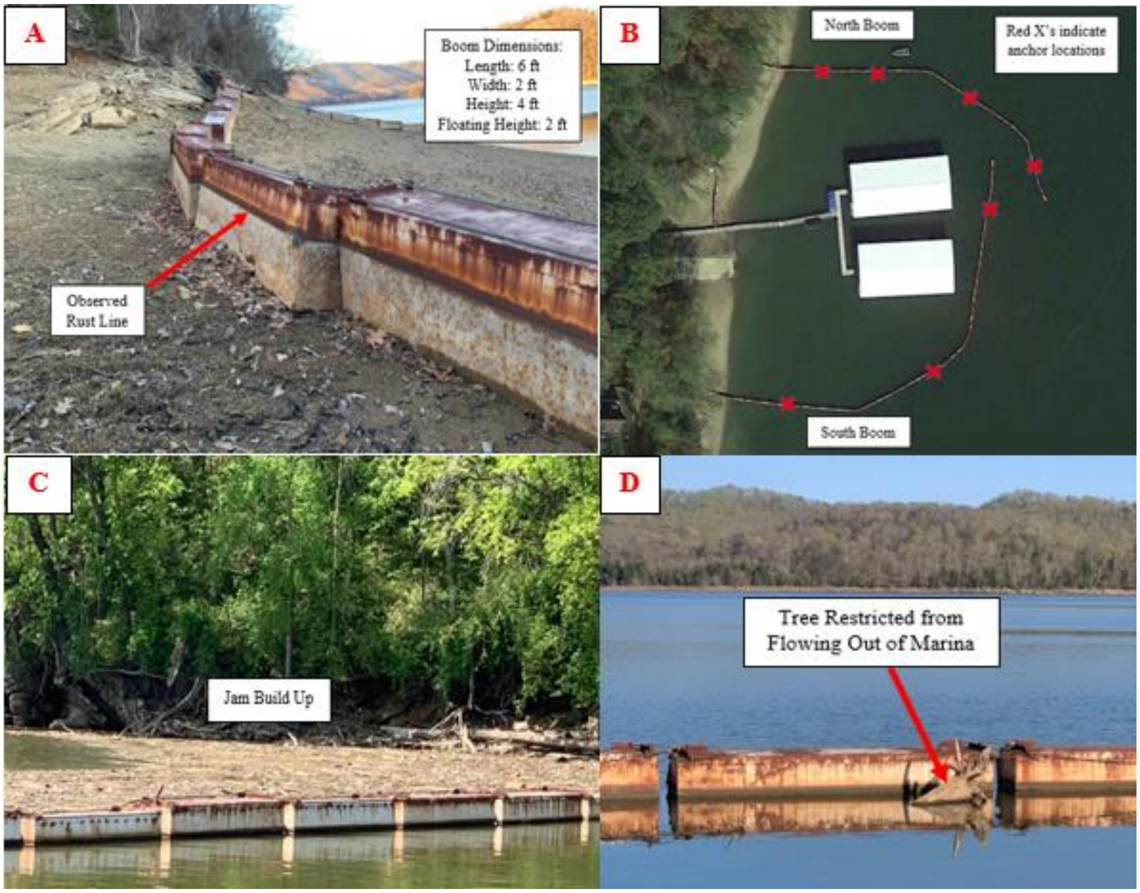
NAME	POSITION	EMAIL
David Toll	Chelaque Estates Marina Chairman	davidt88@yahoo.com
Robert Brasington	Chelaque Estates Marina Associate	rwbrasington@hotmail.com
Dr. Jenny Retherford	Senior Lecturer	jqretherford@utk.edu
Curtis Jawdy	TVA Lead Hydrologist	cmjawdy@tva.gov
Michael D. Hogan	Project Manager and Senior Engineer at Lose Design	mhogan@lose.design

Figure 1: Image of Team and Technical Mentor (shown left to right Talecia Dyson, Paige Livingston, Dr. Jenny Retherford, Chase Allsup, and Jonathan Payne)

1.3 Existing Site Conditions

A project site visit was conducted to observe the age conditions and the operational requirements of the boom system. The north and south debris containment booms displayed evidence of significant aging. The operation requirements to keep the debris containment booms functioning are extensive and require daily attention by Chelaque residents. The orientation of the current boom system exhibited a jam buildup of debris on the outside of the boom. Debris was observed on the shoreline and in the water on the inside of the boom system. Also, the south boom restricted flow of debris flowing downstream out of the marina. The aging debris containment booms are made of metal, concrete and foam. The system is comprised of booms affixed together by cables, all of which display signs of material deterioration. The booms show signs of rusting along the floating water line, shown in **Figure 2A**, at the approximate mid-height of the boom. Cables are connected to the boom with welded attachments, and deterioration was observed at the welded connections. Operations of the system was also observed and further clarified during the site visit. The operations procedure was outlined by Mr. David Toll who described that to keep the cables taut at all times, the booms must be manually adjusted for every 2 feet in water fluctuations. The cables are re-tensioned manually at the seven different anchor points, shown in **Figure 2B**, holding the north and south booms in place with concrete weights. Operation of the system requires manipulation of two debris containment booms currently encompassing the marina. The current operations for the boom system require several adjustments per week and sometimes daily adjustments to keep up with the varying water levels within the reservoir. While in the field, debris build up was observed on the outside of the boom structure, shown in **Figure 2C**. The orientation of the booms to the shoreline prevented debris from flowing past the marina and promoted the jam build up against the boom structure. Debris was also observed within the boom system, shown in **Figure 2D**, during the site visit, and the south boom restricted the debris from flowing out of the marina.

Figure 2: A: Aging Debris Containment Boom with Deteriorating Elements. B: Anchor Point Locations for North and South Boom. C: Jam Build of Debris Against Boom and Shoreline. D: Large Tree on the Inside of the Barrier System on the South Side



2.0 Technical Scope of Work

To address the diminishing functionality issue of the debris containment boom system for the marina, the surface level water velocity behavior was estimated to determine the movement of debris floating in the reservoir. The most prominent factors influencing the surface level water velocity were identified to be wind direction and the effects of water flowing from the John Sevier Water Treatment Plant and the Cherokee Dam. Three years of wind data and water flows (from 2017 to present) were obtained from TVA, and the flow data was compiled and back calculated to the project site to determine the surface level water velocity vectors resulting from dam release flows. The wind speed data was collected from the two dams and the two closest airports to the project site (Bristol Airport and Knoxville Airport). The wind speeds were averaged and compiled to determine if prevalent wind patterns, based on the magnitude of speed and average direction, could be identified. Wind patterns were interpreted by creating a series of wind rose graphs to display the predominant wind direction during different seasons. Then, the surface level water velocity vectors, in relation to wind direction at the project site, were calculated. An operation strategy for the best boom orientation was developed based on the resultant vectors calculated by adding the magnitudes of wind direction vectors with water velocity vectors back calculated from the flows of the two dams. A boom was then selected that fit the operation strategy.

3.0 Surface Water Velocity Behavior

From field observations, it was seen that debris movement in the marina was affected by two forces: wind and water. To understand the movement of the debris near the marina, an engineering analysis of the water velocities and wind speeds were done. Flow rate data from March 2017 to August 2019 from John Sevier Dam was utilized to calculate surface water velocity at the site. The approximate cross-sectional area near John Sevier Dam and the marina were measured using computer software. The flow rate data at John Sevier Dam was divided by the corresponding cross-sectional area to find surface velocity at this upstream location. The volume flow rate equation for continuity was then used to calculate the downstream surface velocity near the marina from the surface velocity upstream at John Sevier Dam. The calculations performed can be found in ***Appendix A***. The surface water velocity over the three-year period measured as very small water velocity vectors. The summation of this data can be found in **Table 3**.

Table 3: Surface Water Velocity Summary Table March 2017- August 2019

Surface Water Velocity at Chelaque Marina (ft/sec)		
Maximum	Minimum	Average
0.111	0.000257	0.013

Tests were performed in the field to verify accuracy of TVA data by gathering water velocity data points from several locations outside and inside of the boom structure. Data was collected once in the Spring and again in the Fall. Surface velocity data, shown in **Figure 3**, was collected by traveling outside of the boom structure on a watercraft and attaching a string to a ball made of composite material that would float in the water. The distance and pathway the ball traveled was recorded over a set interval of time and surface velocity vectors were obtained to compare with calculations made using TVA data. The surface water velocities were calculated, summarized in **Table 4**, and compared with the site velocity conditions calculated using TVA data. The surface velocities from the field data ranged from 0.00-1.48 ft/sec. The average for the field data was slightly higher than seen from the velocities calculated from the TVA data due to wind also playing a role in the movement of the ball. This observation further solidified past observations that the debris movement was affected by the two factors: wind and water. Wind as a lone vector was then analyzed further then compiled with the water velocity data from TVA data to produce a resultant vector.

Figure 3: Gathering Water Velocity Data at Chelaque Estates

Table 4: Water Surface Velocity Data

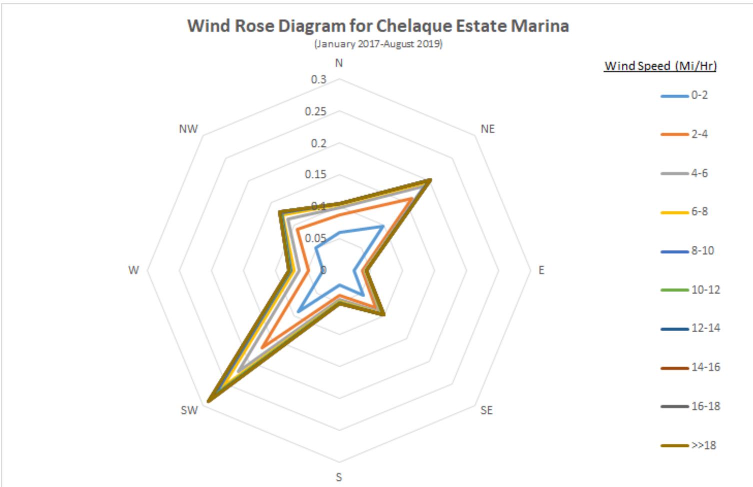
Data Point	Season	Water Surface Velocity (ft/sec)	Location of Data Point	Outside or Inside Boom	Direction of Wind Vector
1	Spring	1.48	North of Boom	Outside	Northwest
2	Spring	0.82	Northeast of Boom	Outside	Northeast
3	Spring	0.68	East of Boom	Outside	West
4	Spring	0.36	South of Boom	Outside	North
5	Spring	0.096	Entrance of Boom	Outside	North
6	Fall	0.48	North of Boom	Inside	West
7	Fall	0.19	Northeast of Boom	Inside	South
8	Fall	0.23	Entrance of Boom	Inside	West
9	Fall	0.14	South of Boom	Inside	North
10	Fall	0.00	Southeast of Boom	Inside	N/A
11	Fall	0.23	North of Boom	Outside	East
12	Fall	0.013	Northeast of Boom	Outside	South
13	Fall	0.054	Entrance of Boom	Outside	North
14	Fall	0.29	Southeast of Boom	Outside	North
15	Fall	0.24	South of Boom	Outside	South
Average:		**0.35**	-	-	-

3.1 Wind Vector Analysis

To understand the direction of water flow at the surface of the reservoir, wind data acquired from TVA for the past three years was compiled and used to create a series of wind rose graphs. 48 wind rose graphs were plotted according to seasons and one additional graph for all three years together. To replicate wind conditions experienced at the marina, TVA data was acquired from four different locations near the marina to calculate an averaged set of wind speeds and directions for the site. Wind rose diagrams were created by assigning a direction to each degree azimuth and creating a pivot table with wind direction, now assigned to a direction on the compass rose, to columns and wind speed to rows. A radar graph was then used to create the visual for the wind rose to be observed.

Initially looking at ***Figure 4,*** there's a slight trend in wind magnitudes greater than 18 MPH going in the southwest direction. Further analysis was conducted on the seasonal diagrams, shown in ***Appendix B,*** to address the possibility of seasonal trends. Observing the wind patterns on a shorter basis, it became apparent that the data varied too greatly by season and an operation strategy cannot be established based on time of year.

Figure 4: Wind Rose for January 2017-August 2019



Through confirmation of field data collection and TVA data, we can conclude that wind is the prevailing factor in movement of debris and water flow patterns. A resultant magnitude and direction can be determined for velocity of the surface water affecting the boom due to combined wind speed and water flow by summing wind and water vectors for each scenario. Sample calculations for resultants can be accessed in ***Appendix B,*** including excel equations utilized. These scenarios are categorized into a critical range where the resultant direction points from south of due east to where it intersects the boom perpendicularly. The travel path of debris resulting from wind and water vectors was verified is the field, shown in **Figure 5**, to primarily travel downstream in the south direction.

Figure 5: Verification of Debris Traveling in Direction of Wind and Water Vectors

4.0 Operation Strategy

The data analyzed indicated that the need for the south boom was not necessary as compared to the need for the north boom. The reservoir primarily experiences downstream flow, and the wind direction travels in the same direction. During the months when the dams are open to increase the water elevation levels, the site can rarely experience upstream flow, but the average wind direction still blows in the downstream direction. In the data collected on-site, the upstream flow was not observed uniformly around the booms, and the water velocities collected were very low and close to stagnant. Most of the debris that is accumulated at the site comes from the shorelines and enters the water during heavy rainfall events or when the water levels rise. The southwest wind is the dominant factor in the direction of debris traveling through the site and will carry the debris past the site once normal conditions resume.

By summing the resultant vectors according to the ranges for Cases 1 through 4, we observed most scenarios are satisfied by the orientations specified in each case. Shown in **Appendix B**, a tally was compiled of the resultant directions lying in the optimal range of the cases. Resultants that do not fall in the specified ranges, but still exhibit southward flow are included as satisfactory. Observing the tally for the three years of data, we see a 1.3:1 ratio of data points that fall within the critical ranges to those that do not; leading to the conclusion that the marina typically experiences downstream flow.

The team recommends that the south boom be removed while the north boom should be replaced and reoriented. Reorientation of the boom shall be based upon weather and wind conditions specified by the resultant wind and water vector scenarios. This allows the boom to optimally deflect debris for several ranges of scenarios. There will be four positioning cases that the boom can be oriented to. Each of which optimally deflects debris for a critical range. These orientations can be achieved by using a reference stake for guidance. The process of the operations for orientation can be found in **Appendix E**. Additionally, the proposed boom will have only one anchor point that will require adjustments for orientation. The proposed option will be more cost effective due to maintenance only being required for the north boom structure at one anchor point.

5.0 Discussion of Final Solution

For a final solution, the positioning of anchors for a new boom system was determined, and a boom system that is feasible for the operation strategy was selected. The boom selected to replace the north boom is a Worthington product called Tuffboom. This boom system in much smaller than the current system and is composed of floating log booms instead of the rectangular concrete boom system. The material is made of a strong UV resistant resin and ranges from 13 to 24 inches in diameter. The Tuffbooms are connected by a heavy-duty internal steel channel, and the spacing between units is never more than 12 inches. The Tuffboom system will include a structural steel debris screen that hangs below the surface at a depth of 2 feet below the boom, which will deflect most of the submerged debris traveling past the site. An estimate of probable cost was calculated, shown in **Appendix C**, for the Tuffboom system selected, and the total cost for materials is $115,547. While a significant cost reduction in replacing the boom system has not been identified, the operating strategy developed now allows Chelaque Estates marina to seek a more economical boom. The operation strategy, shown in **Appendix E**, will allow users of the boom system to orient the boom in a specified orientation based on observations. Observations that will dictate orientation placement are wind direction and the TVA water release schedule.

6.0 REFERENCES

https://webapp.navionics.com/#boating@15&key=klu%7CEtyuzN

https://drive.google.comhttps://webapp.navionics.com/#boating@15&key=klu%7CEtyuzN/drive/folders/0B0v9Sr3Z8JA9NlE1anJfaHUwdXc

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https://www.climate.gov/maps-data/dataset/wind-roses-charts-and-tabular-data

https://www.wcc.nrcs.usda.gov/climate/windrose.html

TVA Shoreline Construction Permits

https://www.tva.gov/Environment/Shoreline-Construction

Appendix A: Water Data

Velocity Calculations For Site Visit on 10-3-19

$V_1 = \frac{116''}{20sec} \cdot \frac{1Ft}{12in} = 0.483\ Ft/sec$

$V_2 = \frac{46.5''}{20sec} \cdot \frac{1Ft}{12in} = 0.194\ Ft/sec$

$V_3 = \frac{41''}{15sec} \cdot \frac{1Ft}{12in} = 0.228\ Ft/sec$

$V_4 = \text{~~Neglible~~} = \frac{34''}{20sec} \cdot \frac{1Ft}{12in} = 0.142\ Ft/sec$

$V_5 =$ Neglible

$V_6 = \frac{46.5in}{17sec} \cdot \frac{1Ft}{12in} = 0.228\ Ft/sec$

$V_7 = \frac{3in}{20secs} \cdot \frac{1Ft}{12in} = 0.0125\ Ft/sec$

$V_8 = \frac{13in}{20sec} \cdot \frac{1Ft}{12in} = 0.0542\ Ft/sec$

$V_9 = \frac{70in}{20sec} \cdot \frac{1Ft}{12in} = 0.292\ Ft/sec$

$V_{10} = \frac{58in}{20sec} \cdot \frac{1Ft}{12in} = 0.242\ Ft/sec$

Water Velocity Calculation

Cross-sectional Area (@ John Sevier Dam) $(A_1) = 8075\ ft^2$

Cross-sectional Area (@ Site) $(A_2) = 424{,}321.6\ ft^2$

$Q = VA \Rightarrow V = Q/A$

sample calculation from excel:

$$V_1 = \frac{3478\ ft^3/s}{8075\ ft^2} = 0.431\ ft/s$$ [Velocity at Dam]

$$A_1 V_1 = A_2 V_2$$

$$(8075)(0.431) = (424{,}321.6)(V_2)$$

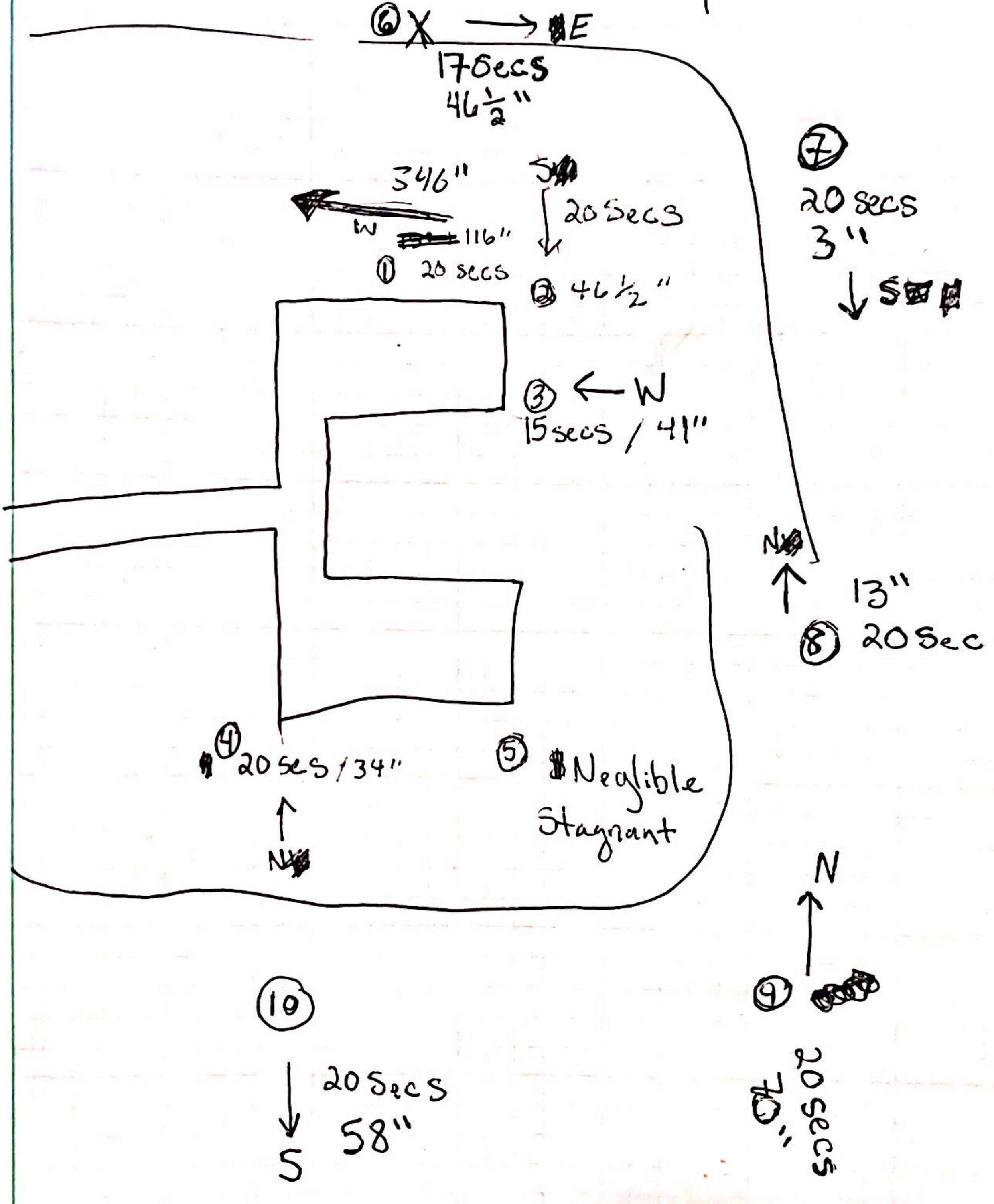
$V_2 = 0.0082\ ft/s$ [Velocity at site]

Site Visit To Chelaque Estates Marina

Date : 10-3-19 Thursday at 5:30pm

Sunny and 93°F

Data Collection 1 : Water Velocity Inside the Boom



80.5 °F 23FT

	A	B	C	D	E
1		Cross Sectional Area (ft^2) @dam=	8075		
2		Cross Sectional Area (ft^2) @site=	424321		
3		QT			
4		(CFS)			
5		Flow			
6		John Sevier Combined Cycle Plant			
7	**Time**	JSST1	**Velocity @Dam (ft/s)**	**Velocity @Site (ft/s)**	
8	42800.75	3478	=B8/$C$1	=C8*$C$1/$C$2	
9	42800.7916666667	3749	=B9/$C$1	=C9*$C$1/$C$2	
10	42800.8333333333	4022	=B10/$C$1	=C10*$C$1/$C$2	
11	42800.875	4294	=B11/$C$1	=C11*$C$1/$C$2	
12	42800.9166666667	4362	=B12/$C$1	=C12*$C$1/$C$2	
13	42800.9583333333	4328	=B13/$C$1	=C13*$C$1/$C$2	
14	42801	4191	=B14/$C$1	=C14*$C$1/$C$2	
15	42801.0416666667	4022	=B15/$C$1	=C15*$C$1/$C$2	
16	42801.0833333333	3852	=B16/$C$1	=C16*$C$1/$C$2	
17	42801.125	3818	=B17/$C$1	=C17*$C$1/$C$2	
18	42801.1666666667	4191	=B18/$C$1	=C18*$C$1/$C$2	
19	42801.2083333333	4820	=B19/$C$1	=C19*$C$1/$C$2	
20	42801.25	5392	=B20/$C$1	=C20*$C$1/$C$2	
21	42801.2916666667	5612	=B21/$C$1	=C21*$C$1/$C$2	
22	42801.3333333333	5480	=B22/$C$1	=C22*$C$1/$C$2	
23	42801.375	5260	=B23/$C$1	=C23*$C$1/$C$2	
24	42801.4166666667	4864	=B24/$C$1	=C24*$C$1/$C$2	

Jawdy, Curtis Michael <cmjawdy@tva.gov>
Thu 3/14/2019 2:39 PM
Allsup, William Chase; Dyson, Talecia Renee; Livingston, Alexa Paige; Payne, Jonathan F

Folks,

I would get the bathymetry here:
https://webapp.navionics.com/#boating@15&key=klu%7CEtyuzN

And the topography here:
https://drive.google.com/drive/folders/0B0v9Sr3Z8JA9NlE1anJfaHUwdXc

Curt Jawdy
TVA
Lead Hydrologist
865-310-4727

...

Jawdy, Curtis Michael <cmjawdy@tva.gov>
Mon 9/9/2019 11:06 AM
Allsup, William Chase; Dyson, Talecia Renee; Livingston, Alexa Paige; Payne, Jonathan F

Cherokee Marina Student De...
2 MB

FullModelTenn.p38.zip
5 MB

2 attachments (7 MB) Download all Save all to OneDrive - University of Tennessee

Folks,

Here are some data for headwater, tailwater and reservoir releases for Cherokee and John Sevier Dams. I have also included a HEC-RAS hydraulic model you should be able to use to examine some bulk flow conditions. I recommend cutting the geometry down to cover the reach just below John Sevier Dam to just above Cherokee Dam. Then, do an unsteady flow run with the observed Cherokee headwater as the downstream boundary and the observed John Sevier releases as the upstream boundary. That should give you an idea of flows.

Cheers,
Curt

...

Velocity Calculations

$V = \frac{d}{t}$

Point 1 → North Side

$t = 21$ secs $d = 31.125$ Ft

$V = \frac{31.125 Ft}{21 sec} = 1.43$ Ft/sec

Point 2 Northeast

$t = 30.5$ secs $d = 25.04$ Ft

$V = \frac{25.04 Ft}{30.5 secs} = 0.82$ Ft

Point 3 West Side

$t = 30.5$ secs $d = 20.7$ Ft

$V = \frac{20.7 Ft}{30.5 secs} = 0.68$ Ft/sec

Point 4 South Side

$t = 24.85$ secs $d = 9.125$ Ft

$V = \frac{9.125 Ft}{24.85 secs} = 0.36$ Ft/sec

Point 5 West Side

$t = 40$ secs $d = 3.875$ Ft

$V = \frac{3.875 Ft}{40 secs} = 0.096$ Ft/sec

Appendix B: Wind Data

Figure 20: Sample calculations for resultant direction of wind and water flow

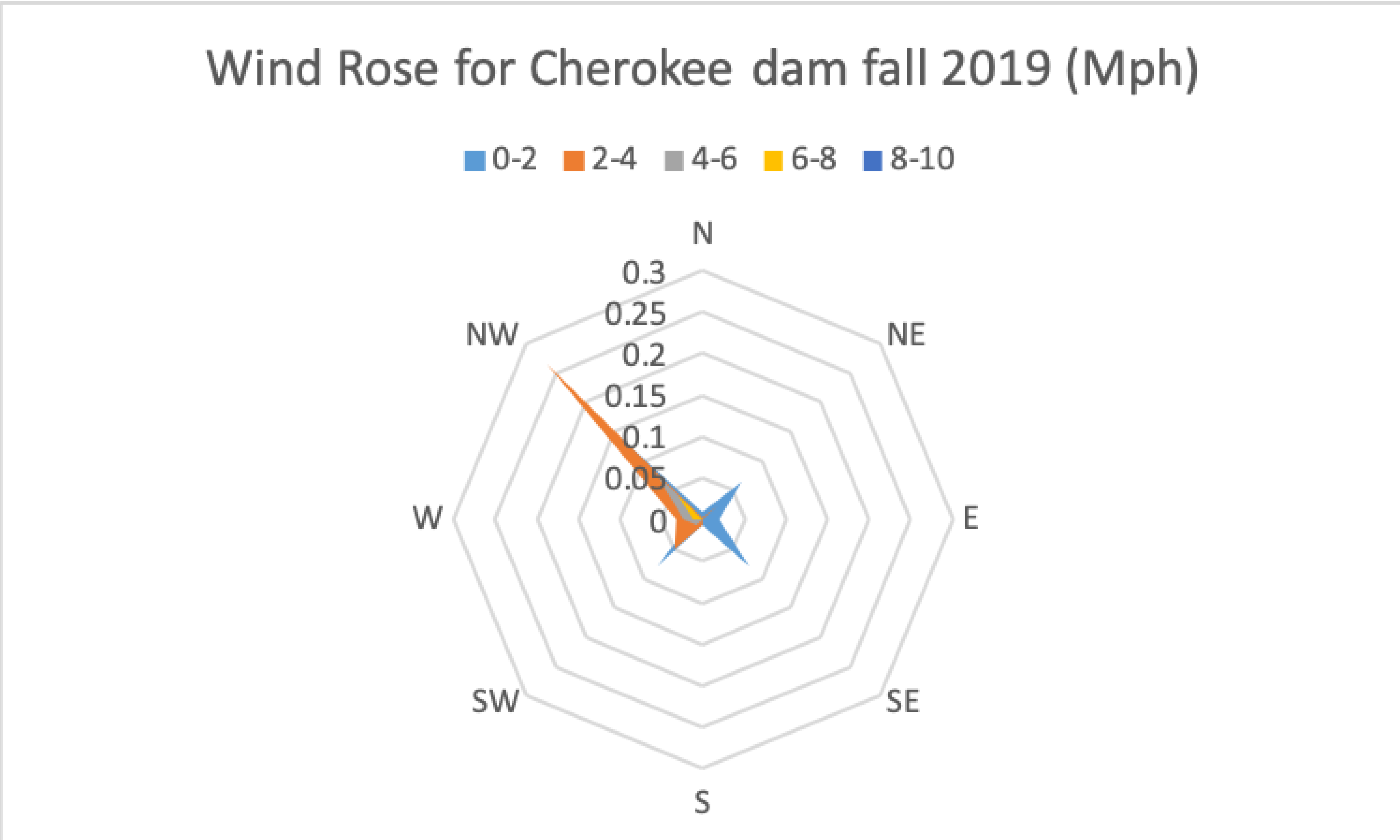
(MI/HR) Windspeed	(DEG) Wind Direction	*exclude this column* Adj Wind Direction	Velocity @Site (ft/s)	Water Direction	WindX	WindY	*no adj made* adj water direction	WaterX	WaterY	Resultant	ResultX	ResultY	Direction
0.1	0.2	0	0.008276753	179.3298942	0.00034907	0.09999939	179.3298942	9.6799E-05	-0.0082762	0.09172429	0.00044586	0.0917232	0.27851111
0.1	0.3	0	0.003869712	179.3298942	0.0005236	0.09999863	179.3298942	4.5257E-05	-0.0038694	0.09613087	0.00056885	0.09612918	0.33904938
0.2	0.4	0	0.002432121	179.3298942	0.00139625	0.19999513	179.3298942	2.8444E-05	-0.002432	0.19756831	0.0014247	0.19756317	0.41317254
0.2	0.3	0	0.040299679	179.3298942	0.00104719	0.19999726	179.3298942	0.00047132	-0.0402969	0.15970756	0.00151851	0.15970034	0.54477992
0.2	0.6	0	0.020899272	179.3298942	0.00209436	0.19998903	179.3298942	0.00024442	-0.0208978	0.17910646	0.00233878	0.17909119	0.74819199
0.3	0.8	0	0.014364125	179.3298942	0.00418865	0.29997076	179.3298942	0.00016799	-0.0143631	0.28564084	0.00435665	0.28560761	0.87391966
0.1	0.8	0	0.005792784	179.3298942	0.00139622	0.09999025	179.3298942	6.7748E-05	-0.0057924	0.09420924	0.00146397	0.09419786	0.89038471
0.2	1	0	0.006914576	179.3298942	0.00349048	0.19996954	179.3298942	8.0868E-05	-0.0069141	0.19308847	0.00357135	0.19305544	1.05979871
0.7	1.1	0	0.019341489	179.3298942	0.01343821	0.699871	179.3298942	0.0002262	-0.0193402	0.680668	0.01366441	0.68053083	1.15029036
2.4	1.3	0	0.003388944	179.3298942	0.0544496	2.39938226	179.3298942	3.9635E-05	-0.0033887	2.39661306	0.05448924	2.39599355	1.30278529
0.7	1.3	0	0.004991504	179.3298942	0.01588113	0.69981983	179.3298942	5.8377E-05	-0.0049912	0.69501147	0.01593951	0.69482866	1.31414632
0.1	1.1	0	0.012811056	179.3298942	0.00191974	0.09998157	179.3298942	0.00014983	-0.0128102	0.08719596	0.00206957	0.08717139	1.36002806
0.1	1.3	0	0.009959441	179.3298942	0.00226873	0.09997426	179.3298942	0.00011648	-0.0099588	0.0900471	0.00238521	0.0900155	1.51785637
0.3	1.5	0	0.002714926	179.3298942	0.00785308	0.2998972	179.3298942	3.1752E-05	-0.0027147	0.29728704	0.00788484	0.29718246	1.5198134
0.2	1.8	0	0.00234728	179.3298942	0.00628215	0.19990131	179.3298942	2.7452E-05	-0.0023471	0.19765493	0.0063096	0.19755419	1.82932501
0.1	1.6	0	0.010760721	179.3298942	0.00279216	0.09996101	179.3298942	0.00012585	-0.01076	0.08924874	0.00291801	0.08920103	1.8736361
0.7	1.9	0	0.00475112	179.3298942	0.02320862	0.69961515	179.3298942	5.5566E-05	-0.0047508	0.69525369	0.02326419	0.69486436	1.91755731
6.2	2	0	0.003626971	179.3298942	0.21637688	6.19622313	179.3298942	4.2418E-05	-0.0036267	6.19637697	0.2164193	6.1925964	2.00156235
0.4	2	0	0.014470177	179.3298942	0.0139598	0.39975633	179.3298942	0.00016923	-0.0144692	0.38554612	0.01412903	0.38528714	2.10017722
1	2.1	0	0.002488682	179.3298942	0.03664371	0.99932839	179.3298942	2.9106E-05	-0.0024885	0.99751423	0.03667281	0.99683988	2.1069084

(MI/HR) Windspeed	(DEG) Wind Direction	*exclude this column* Adj Wind Direction	Velocity @Site (ft/s)	Water Direction	WindX	WindY	*no adj made* adj water direction	WaterX	WaterY	Resultant	ResultX	ResultY	Direction
0.1	0.2	0	0.00827675274143867	=179.3298942	=SIN(PI()*B6/180)*A6	=COS(PI()*B6/180)*A6	=E6	=SIN(PI()*H6/180)*D6	=COS(PI()*H6/180)*D6	=SQRT((I6+F6)^2+(J6+G6)^2)	=I6+F6	=J6+G6	=MOD(360+DEGREES(IMARG
0.1	0.3	0	0.00386971184551318	=179.3298942	=SIN(PI()*B7/180)*A7	=COS(PI()*B7/180)*A7	=E7	=SIN(PI()*H7/180)*D7	=COS(PI()*H7/180)*D7	=SQRT((I7+F7)^2+(J7+G7)^2)	=I7+F7	=J7+G7	=MOD(360+DEGREES(IMARG
0.2	0.4	0	0.00243212096502412	=179.3298942	=SIN(PI()*B8/180)*A8	=COS(PI()*B8/180)*A8	=E8	=SIN(PI()*H8/180)*D8	=COS(PI()*H8/180)*D8	=SQRT((I8+F8)^2+(J8+G8)^2)	=I8+F8	=J8+G8	=MOD(360+DEGREES(IMARG
0.2	0.3	0	0.0402996787809229	=179.3298942	=SIN(PI()*B9/180)*A9	=COS(PI()*B9/180)*A9	=E9	=SIN(PI()*H9/180)*D9	=COS(PI()*H9/180)*D9	=SQRT((I9+F9)^2+(J9+G9)^2)	=I9+F9	=J9+G9	=MOD(360+DEGREES(IMARG
0.2	0.6	0	0.0208992720134049	=179.3298942	=SIN(PI()*B10/180)*A10	=COS(PI()*B10/180)*A10	=E10	=SIN(PI()*H10/180)*D10	=COS(PI()*H10/180)*D10	=SQRT((I10+F10)^2+(J10+G1	=I10+F10	=J10+G10	=MOD(360+DEGREES(IMARG
0.3	0.8	0	0.0143641252730833	=179.3298942	=SIN(PI()*B11/180)*A11	=COS(PI()*B11/180)*A11	=E11	=SIN(PI()*H11/180)*D11	=COS(PI()*H11/180)*D11	=SQRT((I11+F11)^2+(J11+G1	=I11+F11	=J11+G11	=MOD(360+DEGREES(IMARG
0.1	0.8	0	0.00579278423646249	=179.3298942	=SIN(PI()*B12/180)*A12	=COS(PI()*B12/180)*A12	=E12	=SIN(PI()*H12/180)*D12	=COS(PI()*H12/180)*D12	=SQRT((I12+F12)^2+(J12+G1	=I12+F12	=J12+G12	=MOD(360+DEGREES(IMARG
0.2	1	0	0.00691457646451625	=179.3298942	=SIN(PI()*B13/180)*A13	=COS(PI()*B13/180)*A13	=E13	=SIN(PI()*H13/180)*D13	=COS(PI()*H13/180)*D13	=SQRT((I13+F13)^2+(J13+G1	=I13+F13	=J13+G13	=MOD(360+DEGREES(IMARG
0.7	1.1	0	0.0193414891084816	=179.3298942	=SIN(PI()*B14/180)*A14	=COS(PI()*B14/180)*A14	=E14	=SIN(PI()*H14/180)*D14	=COS(PI()*H14/180)*D14	=SQRT((I14+F14)^2+(J14+G1	=I14+F14	=J14+G14	=MOD(360+DEGREES(IMARG
2.4	1.3	0	0.00338894374777586	=179.3298942	=SIN(PI()*B15/180)*A15	=COS(PI()*B15/180)*A15	=E15	=SIN(PI()*H15/180)*D15	=COS(PI()*H15/180)*D15	=SQRT((I15+F15)^2+(J15+G1	=I15+F15	=J15+G15	=MOD(360+DEGREES(IMARG
0.7	1.3	0	0.00499150407356695	=179.3298942	=SIN(PI()*B16/180)*A16	=COS(PI()*B16/180)*A16	=E16	=SIN(PI()*H16/180)*D16	=COS(PI()*H16/180)*D16	=SQRT((I16+F16)^2+(J16+G1	=I16+F16	=J16+G16	=MOD(360+DEGREES(IMARG
0.1	1.1	0	0.0128110557808829	=179.3298942	=SIN(PI()*B17/180)*A17	=COS(PI()*B17/180)*A17	=E17	=SIN(PI()*H17/180)*D17	=COS(PI()*H17/180)*D17	=SQRT((I17+F17)^2+(J17+G1	=I17+F17	=J17+G17	=MOD(360+DEGREES(IMARG
0.1	1.3	0	0.00995944108351932	=179.3298942	=SIN(PI()*B18/180)*A18	=COS(PI()*B18/180)*A18	=E18	=SIN(PI()*H18/180)*D18	=COS(PI()*H18/180)*D18	=SQRT((I18+F18)^2+(J18+G1	=I18+F18	=J18+G18	=MOD(360+DEGREES(IMARG
0.3	1.5	0	0.00271492572839902	=179.3298942	=SIN(PI()*B19/180)*A19	=COS(PI()*B19/180)*A19	=E19	=SIN(PI()*H19/180)*D19	=COS(PI()*H19/180)*D19	=SQRT((I19+F19)^2+(J19+G1	=I19+F19	=J19+G19	=MOD(360+DEGREES(IMARG
0.2	1.8	0	0.00234727953601165	=179.3298942	=SIN(PI()*B20/180)*A20	=COS(PI()*B20/180)*A20	=E20	=SIN(PI()*H20/180)*D20	=COS(PI()*H20/180)*D20	=SQRT((I20+F20)^2+(J20+G2	=I20+F20	=J20+G20	=MOD(360+DEGREES(IMARG
0.1	1.6	0	0.0107607212464149	=179.3298942	=SIN(PI()*B21/180)*A21	=COS(PI()*B21/180)*A21	=E21	=SIN(PI()*H21/180)*D21	=COS(PI()*H21/180)*D21	=SQRT((I21+F21)^2+(J21+G2	=I21+F21	=J21+G21	=MOD(360+DEGREES(IMARG
0.7	1.9	0	0.00475112002469828	=179.3298942	=SIN(PI()*B22/180)*A22	=COS(PI()*B22/180)*A22	=E22	=SIN(PI()*H22/180)*D22	=COS(PI()*H22/180)*D22	=SQRT((I22+F22)^2+(J22+G2	=I22+F22	=J22+G22	=MOD(360+DEGREES(IMARG
6.2	2	0	0.00362697109028306	=179.3298942	=SIN(PI()*B23/180)*A23	=COS(PI()*B23/180)*A23	=E23	=SIN(PI()*H23/180)*D23	=COS(PI()*H23/180)*D23	=SQRT((I23+F23)^2+(J23+G2	=I23+F23	=J23+G23	=MOD(360+DEGREES(IMARG
0.4	2	0	0.0144701770593489	=179.3298942	=SIN(PI()*B24/180)*A24	=COS(PI()*B24/180)*A24	=E24	=SIN(PI()*H24/180)*D24	=COS(PI()*H24/180)*D24	=SQRT((I24+F24)^2+(J24+G2	=I24+F24	=J24+G24	=MOD(360+DEGREES(IMARG
1	2.1	0	0.0024886819176991	=179.3298942	=SIN(PI()*B25/180)*A25	=COS(PI()*B25/180)*A25	=E25	=SIN(PI()*H25/180)*D25	=COS(PI()*H25/180)*D25	=SQRT((I25+F25)^2+(J25+G2	=I25+F25	=J25+G25	=MOD(360+DEGREES(IMARG

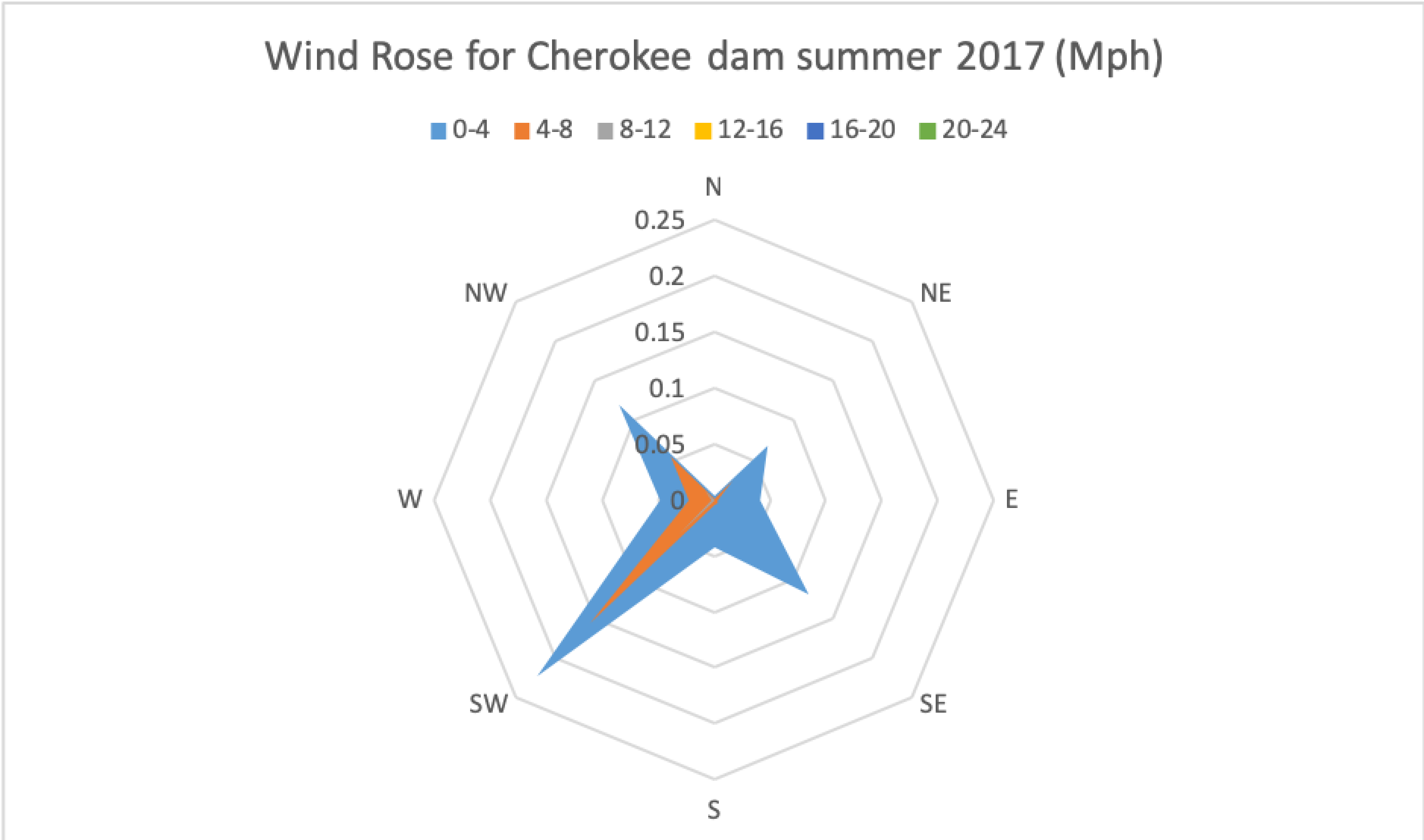
Figure 21: Sum of Resultant Vectors by Case

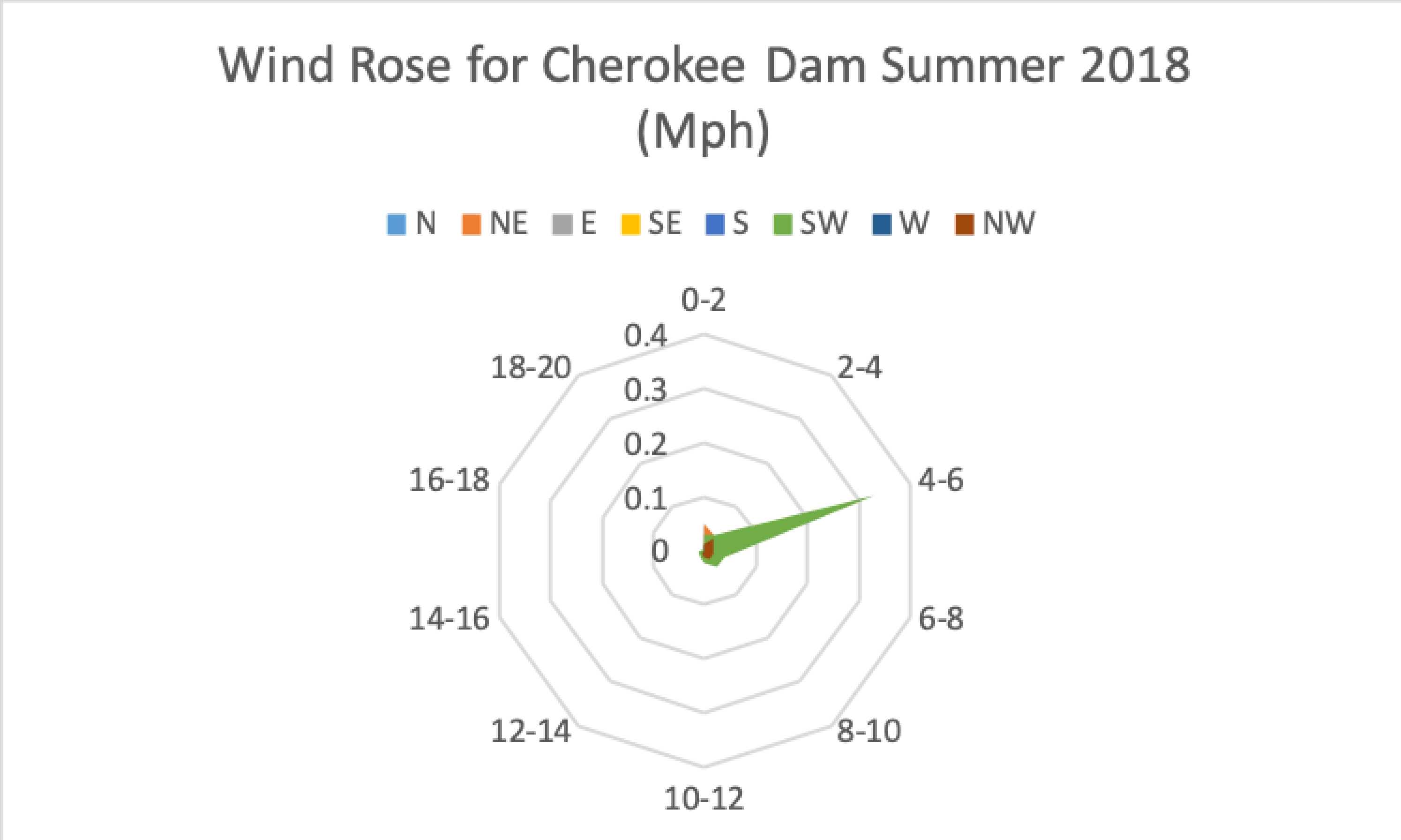
Resultant Vector Count			
CASE 1: (90-203deg)	**CASE 2: (203-209deg)**	**CASE 3: (209-214)**	**CASE 4: (214-219)**
5889	6431	6964	7626

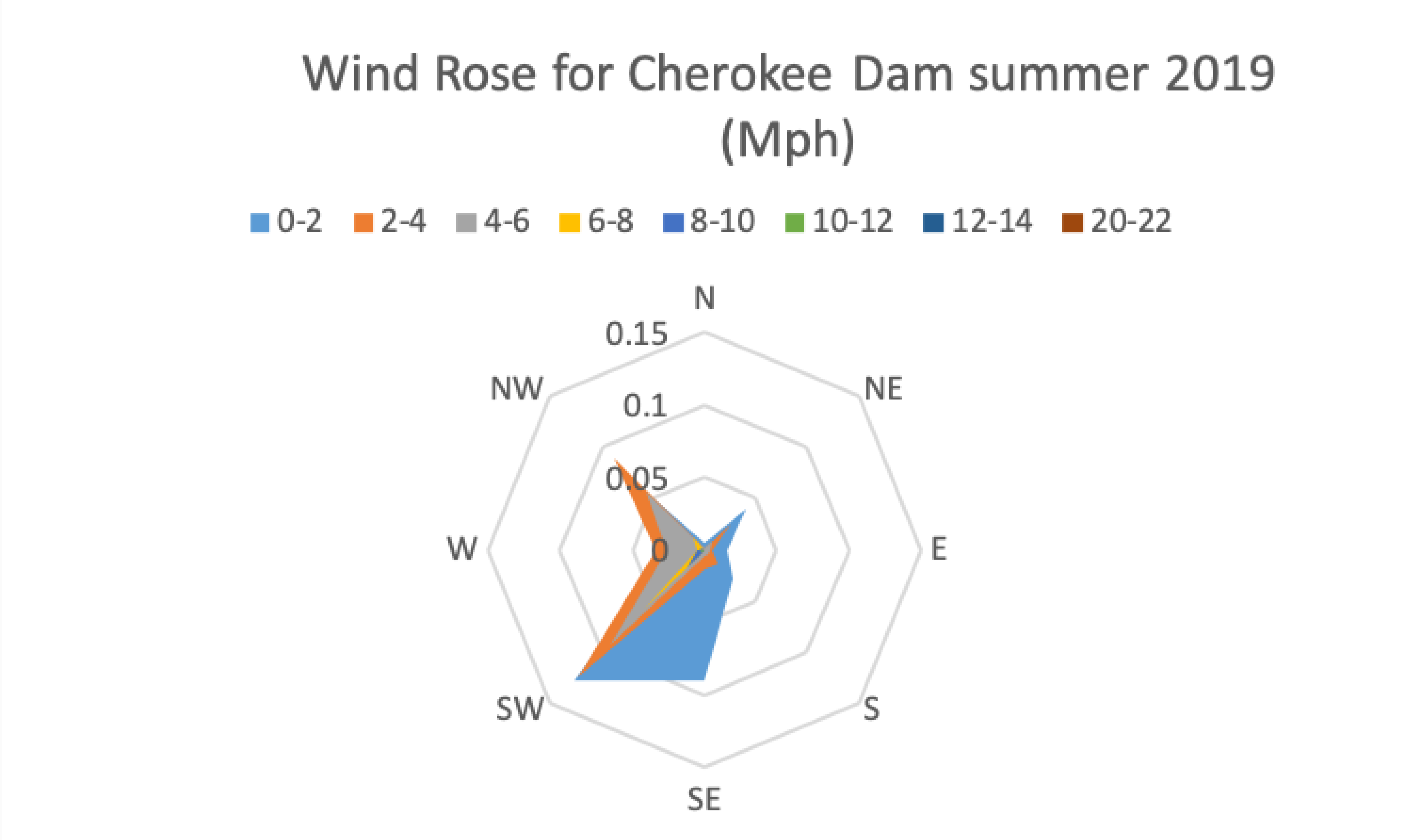
NOT OPTIMAL BUT SATISFACTORY	*NORTHERN FLOW*
CASE 5(220-270deg)	CASE 6(<<90deg or >>270deg)
5253	9946
SCENARIOS SATISFIED BY CASES	*SCENARIOS NOT SATISFIED*
12879	9946



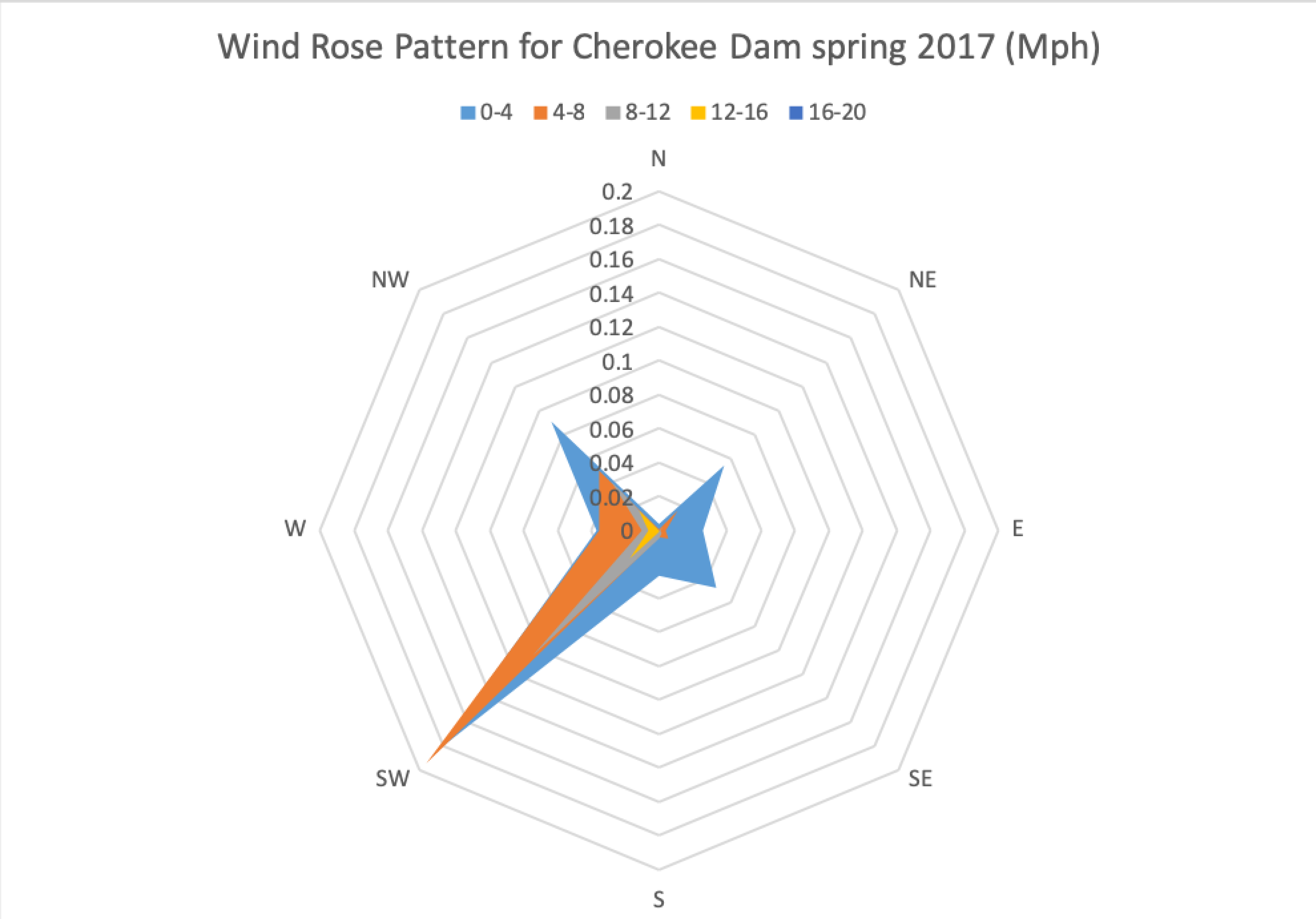
Wind Rose for Cherokee dam fall 2019 (Mph)
0-2
2-4
4-6
6-8
8-10
N
NE
E
SE
S
SW
W
NW
0.3
0.25
0.2
0.15
0.1
0.05
0


Wind Rose for Cherokee dam summer 2017 (Mph)
0-4
4-8
8-12
12-16
16-20
20-24
N
NE
E
SE
S
SW
W
NW
0.25
0.2
0.15
0.1
0.05
0

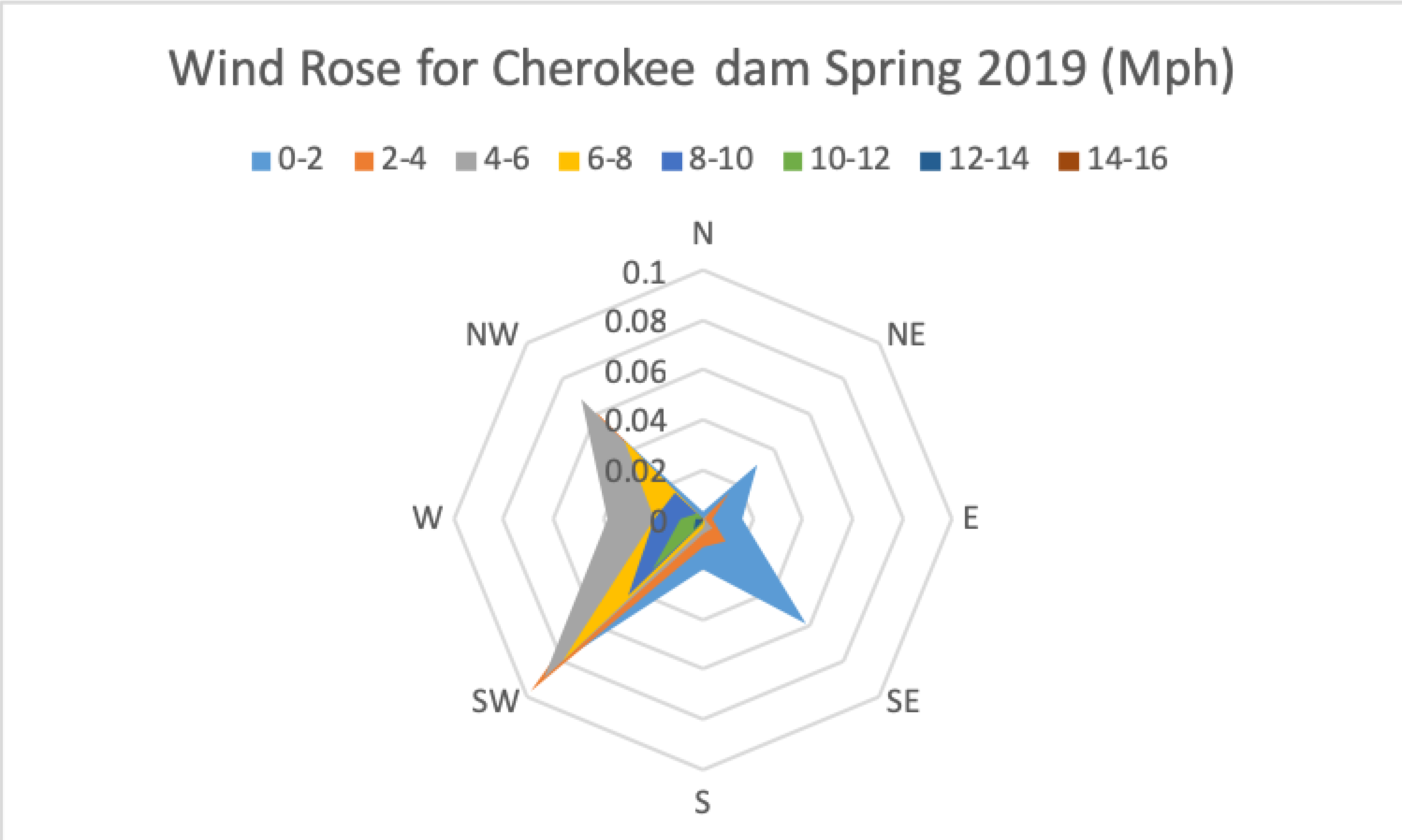

Wind Rose for Cherokee Dam Summer 2018 (Mph)
N
NE
E
SE
S
SW
W
NW
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
18-20
0.4
0.3
0.2
0.1
0



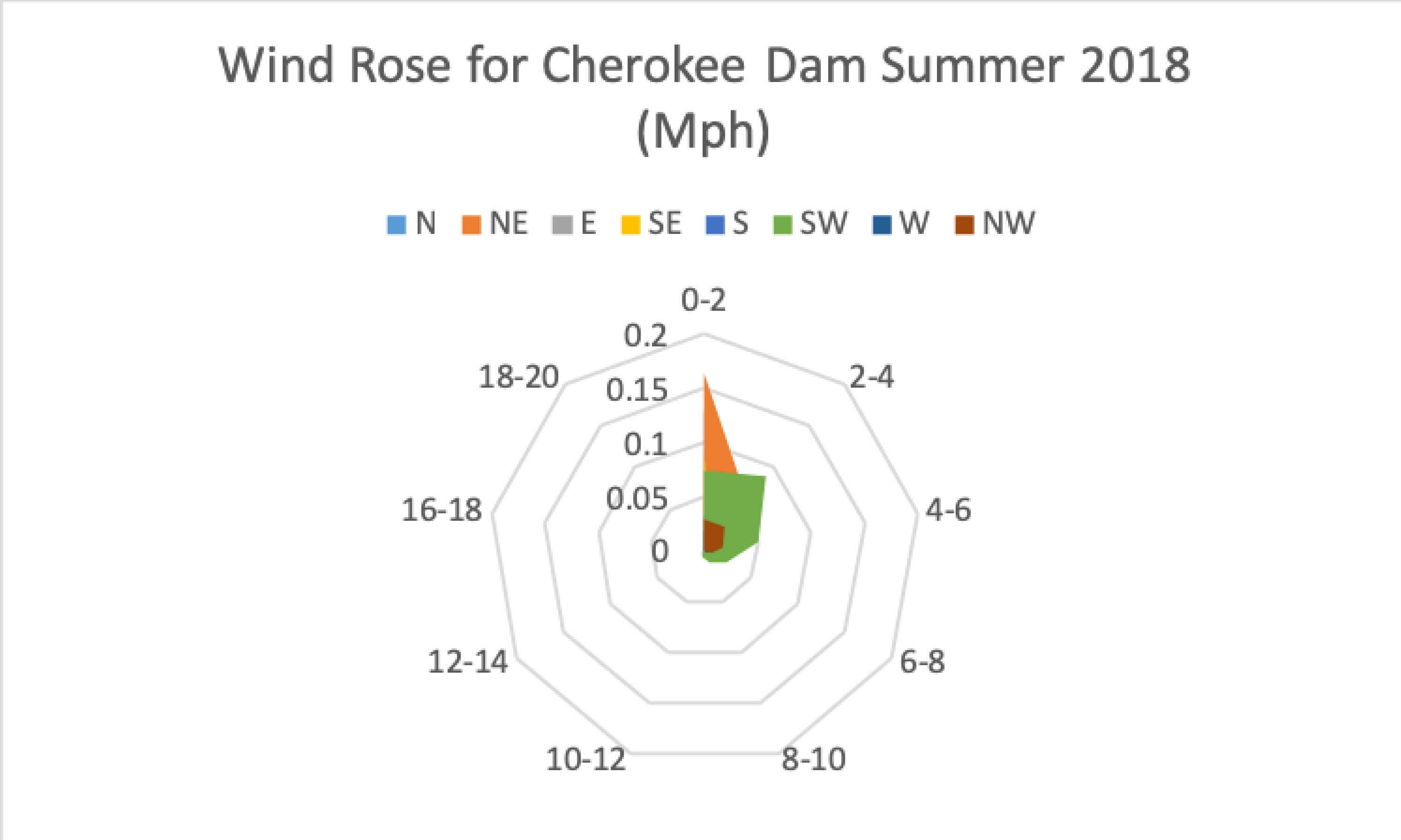
Wind Rose for Cherokee Dam summer 2019 (Mph)
0-2
2-4
4-6
6-8
8-10
10-12
12-14
20-22
N
NE
E
S
SE
SW
W
NW
0.15
0.1
0.05
0



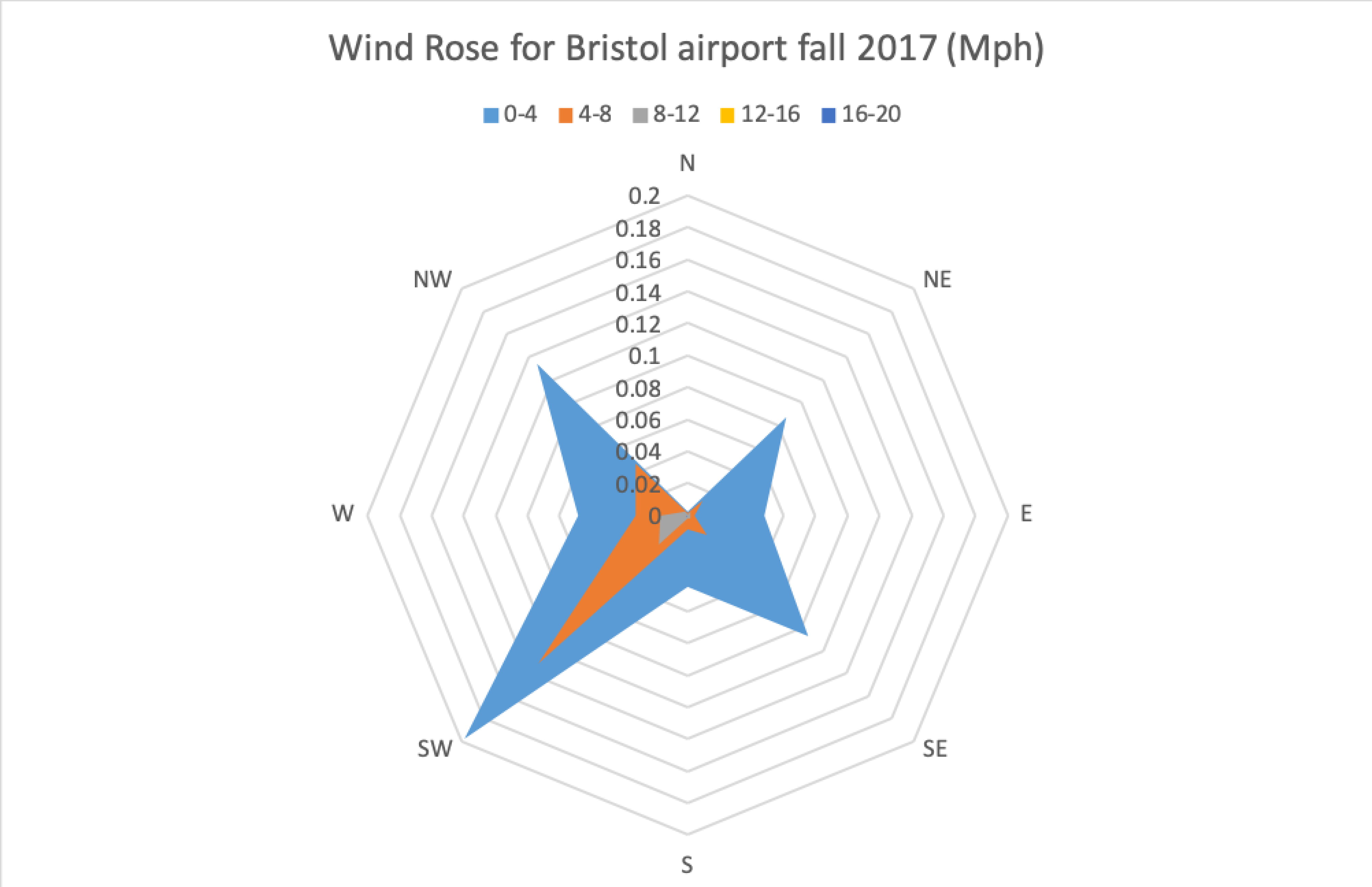
Wind Rose Pattern for Cherokee Dam spring 2017 (Mph)
0-4
4-8
8-12
12-16
16-20
N
NE
E
SE
S
SW
W
NW
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0

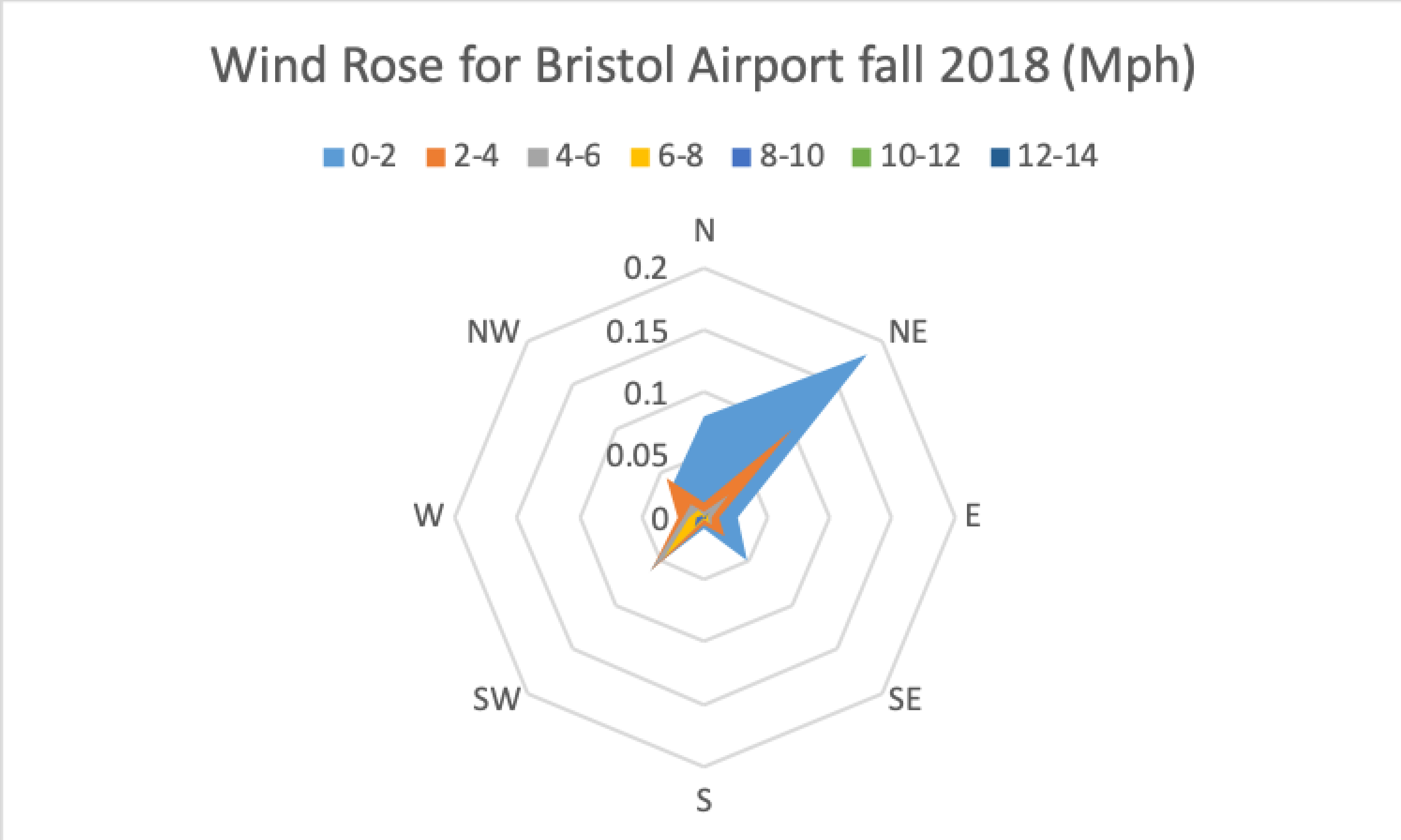


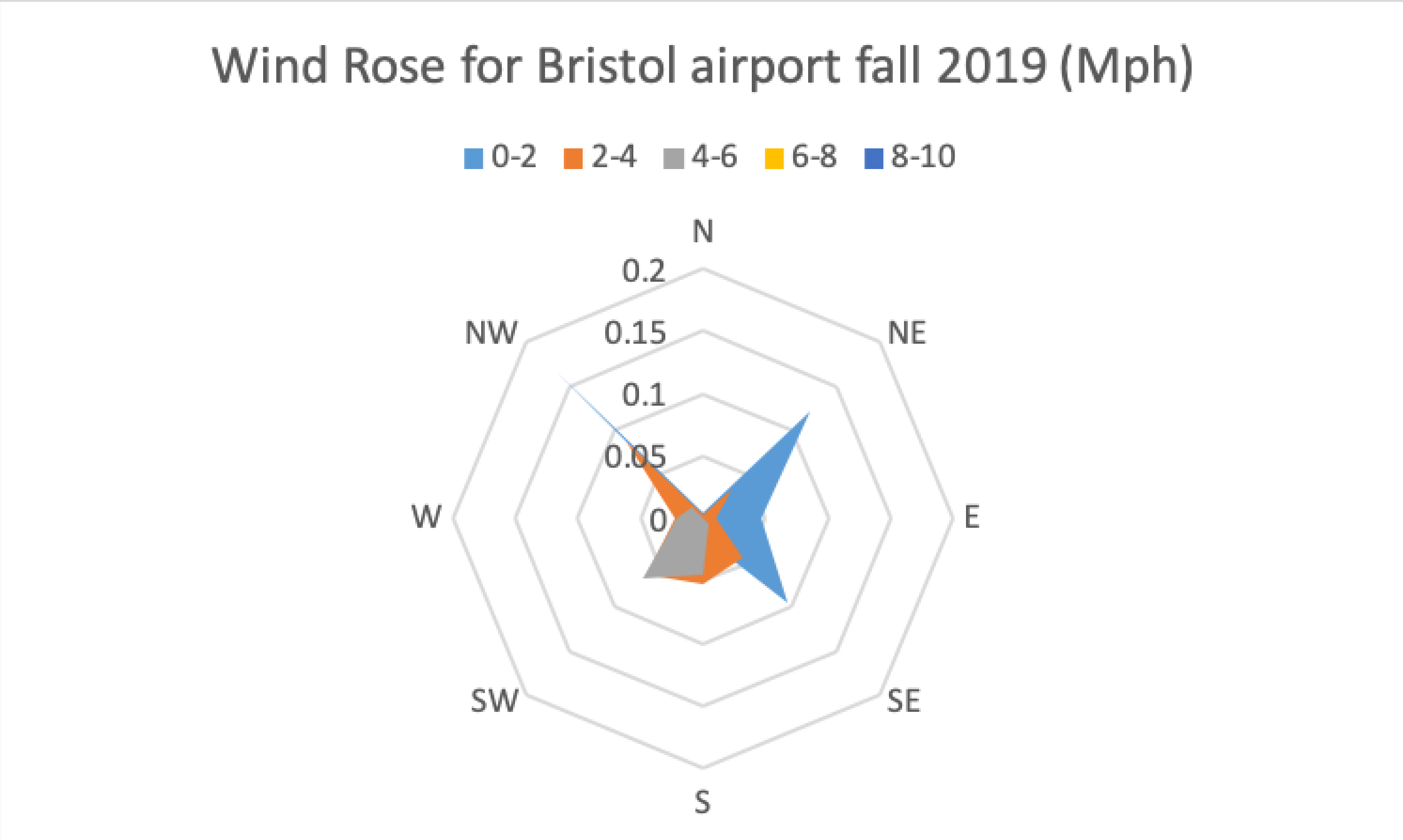
Wind Rose for Cherokee dam Spring 2019 (Mph)
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
N
NE
E
SE
S
SW
W
NW
0.1
0.08
0.06
0.04
0.02
0

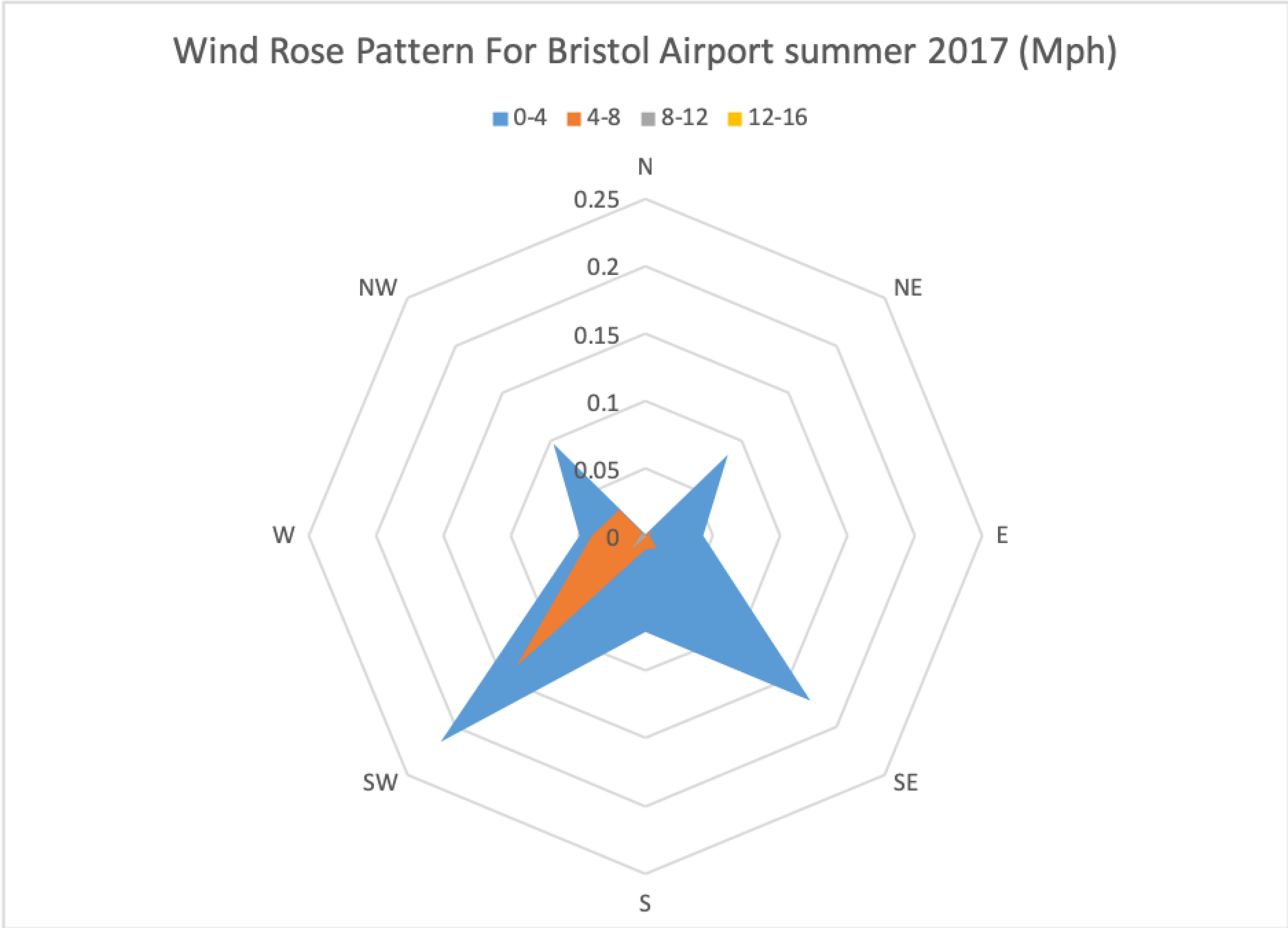


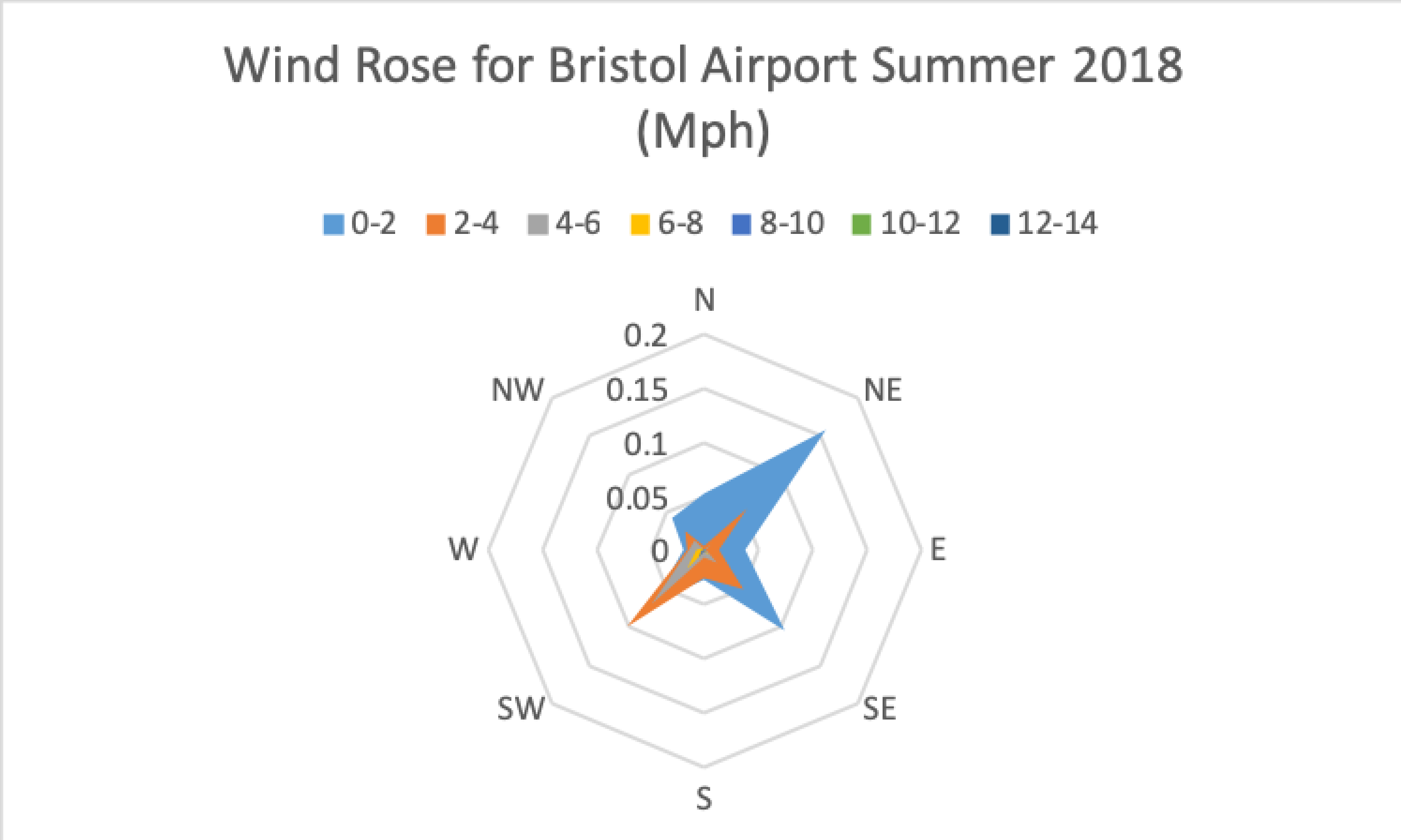
Wind Rose for Cherokee Dam Summer 2018 (Mph)
N
NE
E
SE
S
SW
W
NW
0-2
2-4
4-6
6-8
8-10
10-12
12-14
16-18
18-20
0.2
0.15
0.1
0.05
0

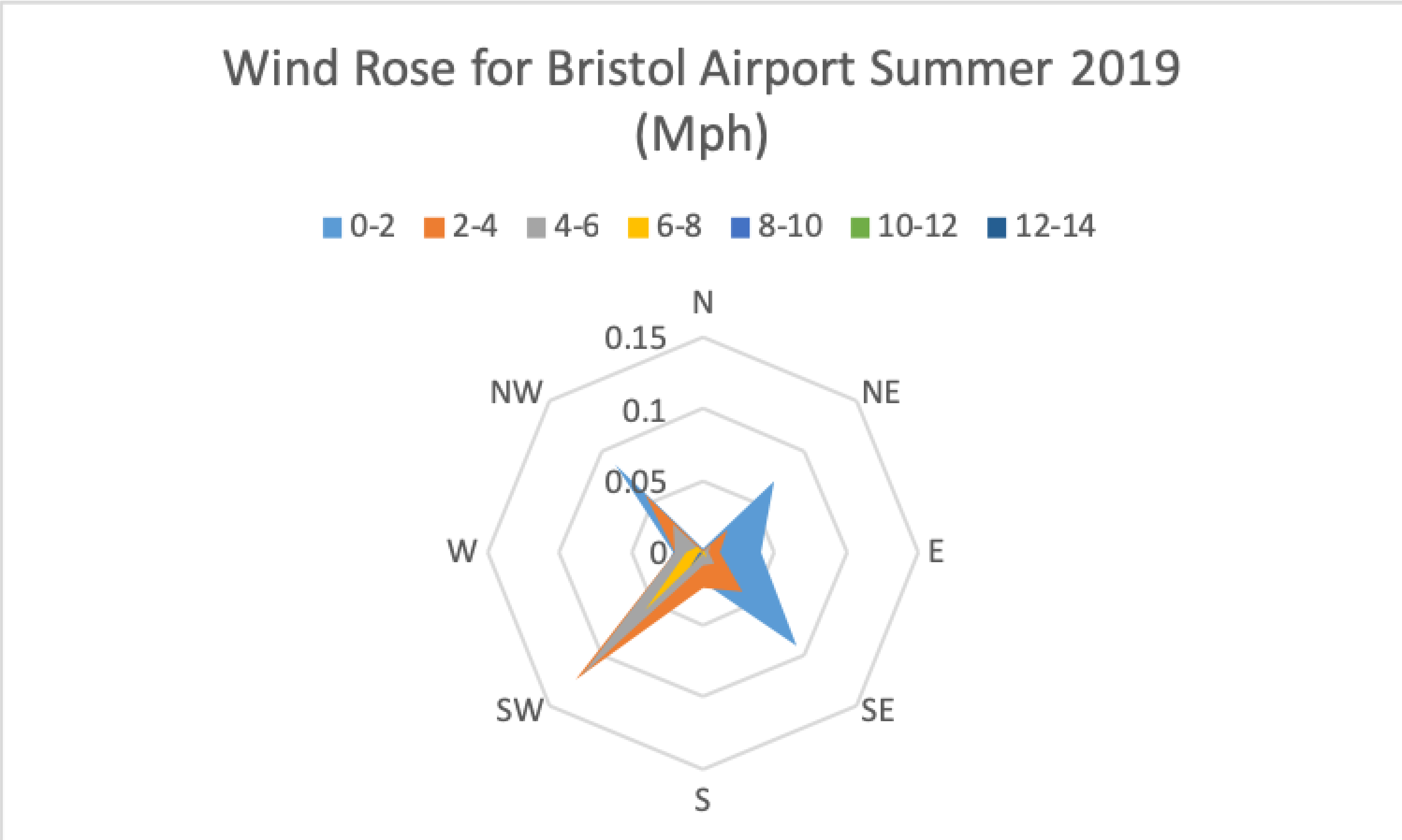

Wind Rose for Bristol airport fall 2017 (Mph)
0-4
4-8
8-12
12-16
16-20
N
NE
E
SE
S
SW
W
NW
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0


Wind Rose for Bristol Airport fall 2018 (Mph)
0-2
2-4
4-6
6-8
8-10
10-12
12-14
N
NE
E
SE
S
SW
W
NW
0.2
0.15
0.1
0.05
0

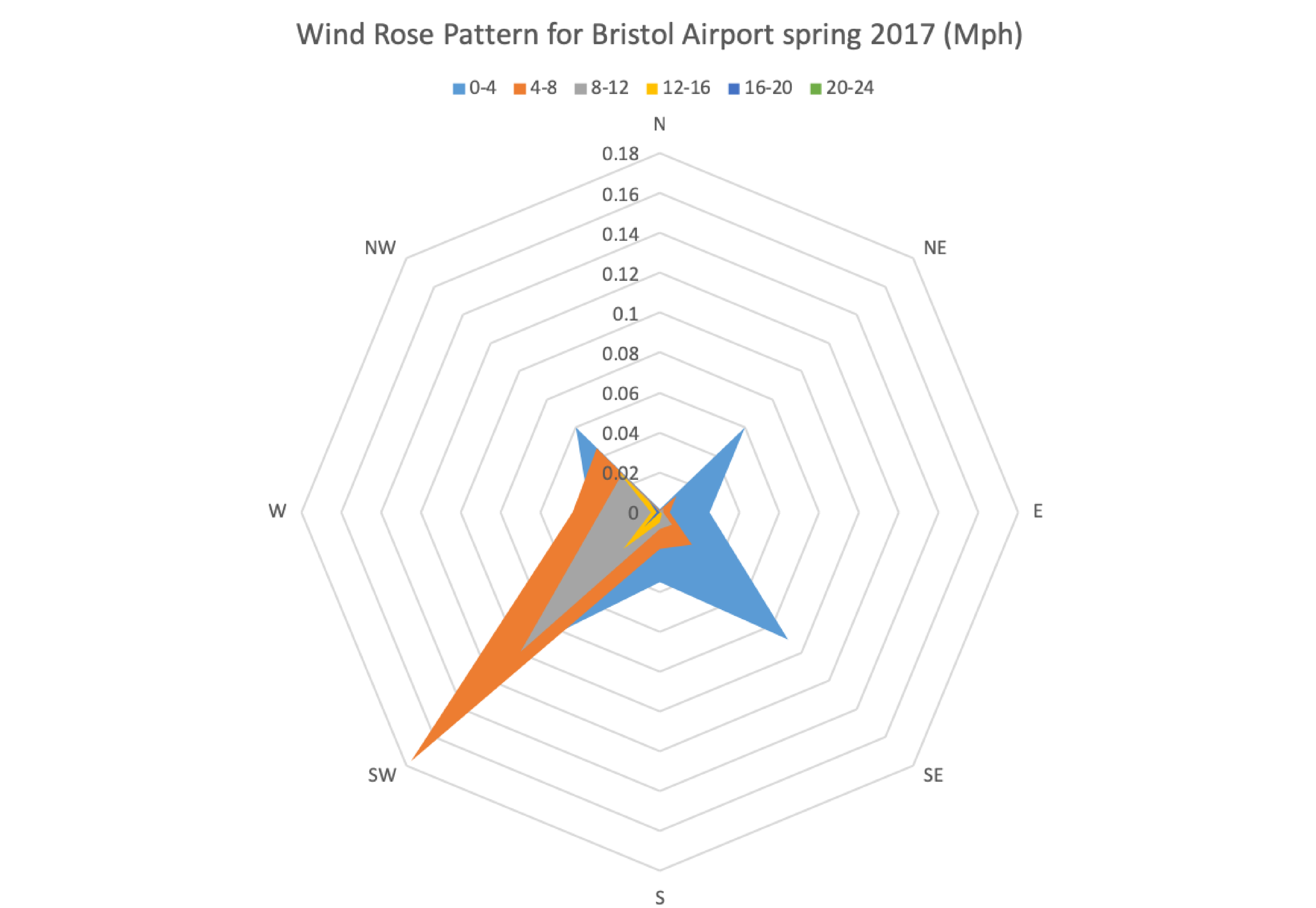

Wind Rose for Bristol airport fall 2019 (Mph)
0-2
2-4
4-6
6-8
8-10
N
NE
E
SE
S
SW
W
NW
0.2
0.15
0.1
0.05
0


Wind Rose Pattern For Bristol Airport summer 2017 (Mph)
0-4
4-8
8-12
12-16
N
NE
E
SE
S
SW
W
NW
0.25
0.2
0.15
0.1
0.05
0

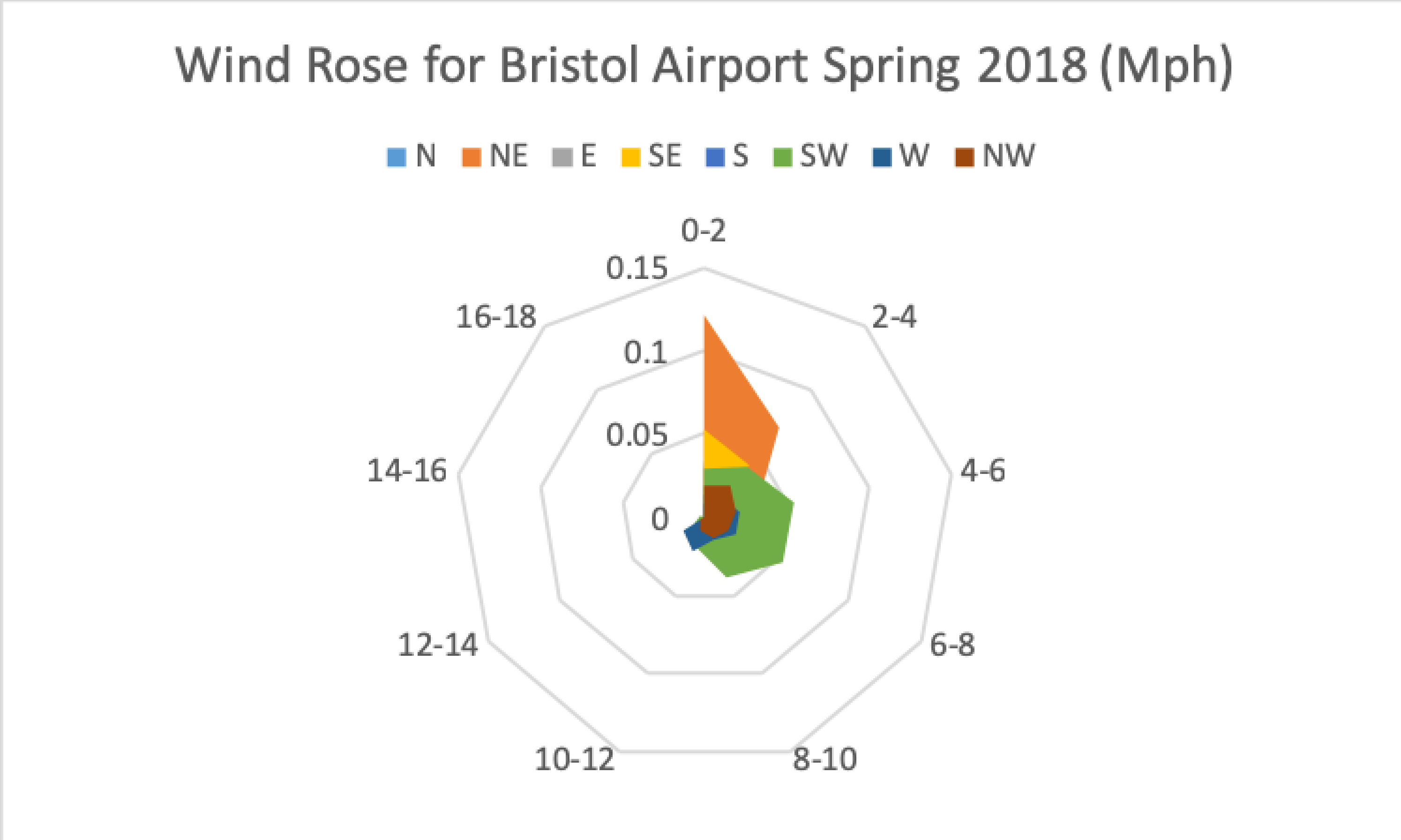

Wind Rose for Bristol Airport Summer 2018 (Mph)
0-2
2-4
4-6
6-8
8-10
10-12
12-14
N
NE
E
SE
S
SW
W
NW
0.2
0.15
0.1
0.05
0



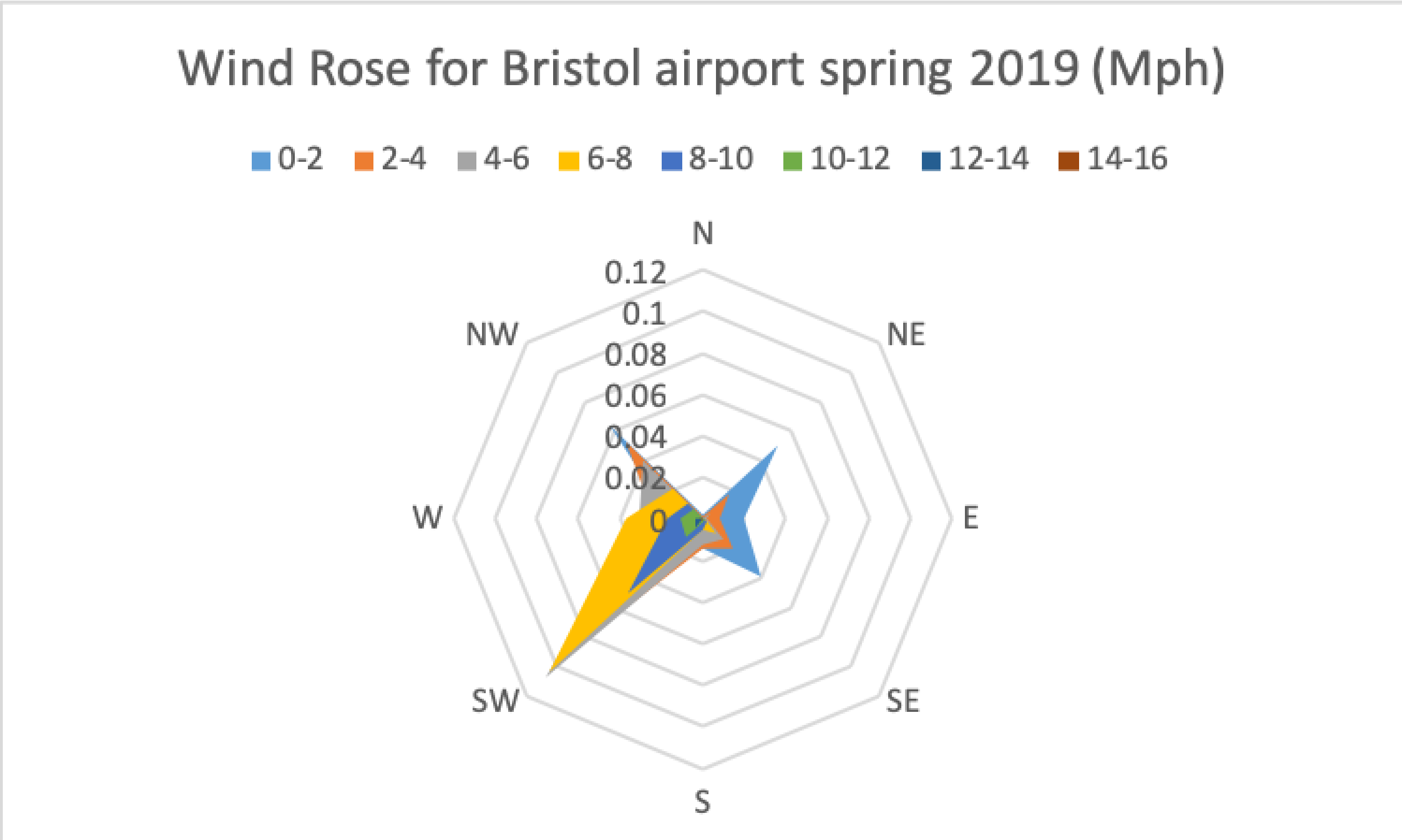
Wind Rose for Bristol Airport Summer 2019 (Mph)
0-2
2-4
4-6
6-8
8-10
10-12
12-14
N
NE
E
SE
S
SW
W
NW
0.15
0.1
0.05
0

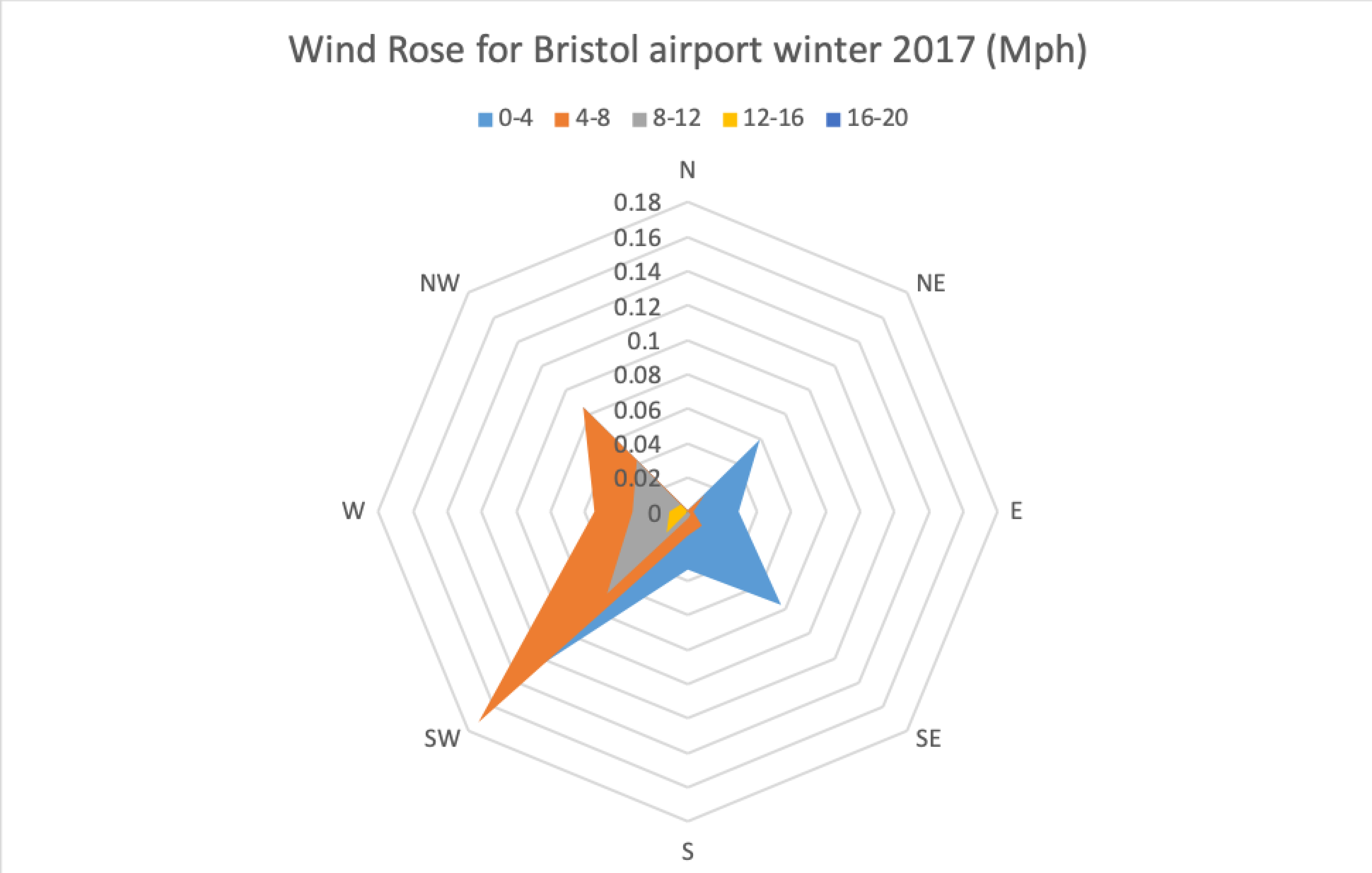


Wind Rose Pattern for Bristol Airport spring 2017 (Mph)
0-4
4-8
8-12
12-16
16-20
20-24
N
NE
E
SE
S
SW
W
NW
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0

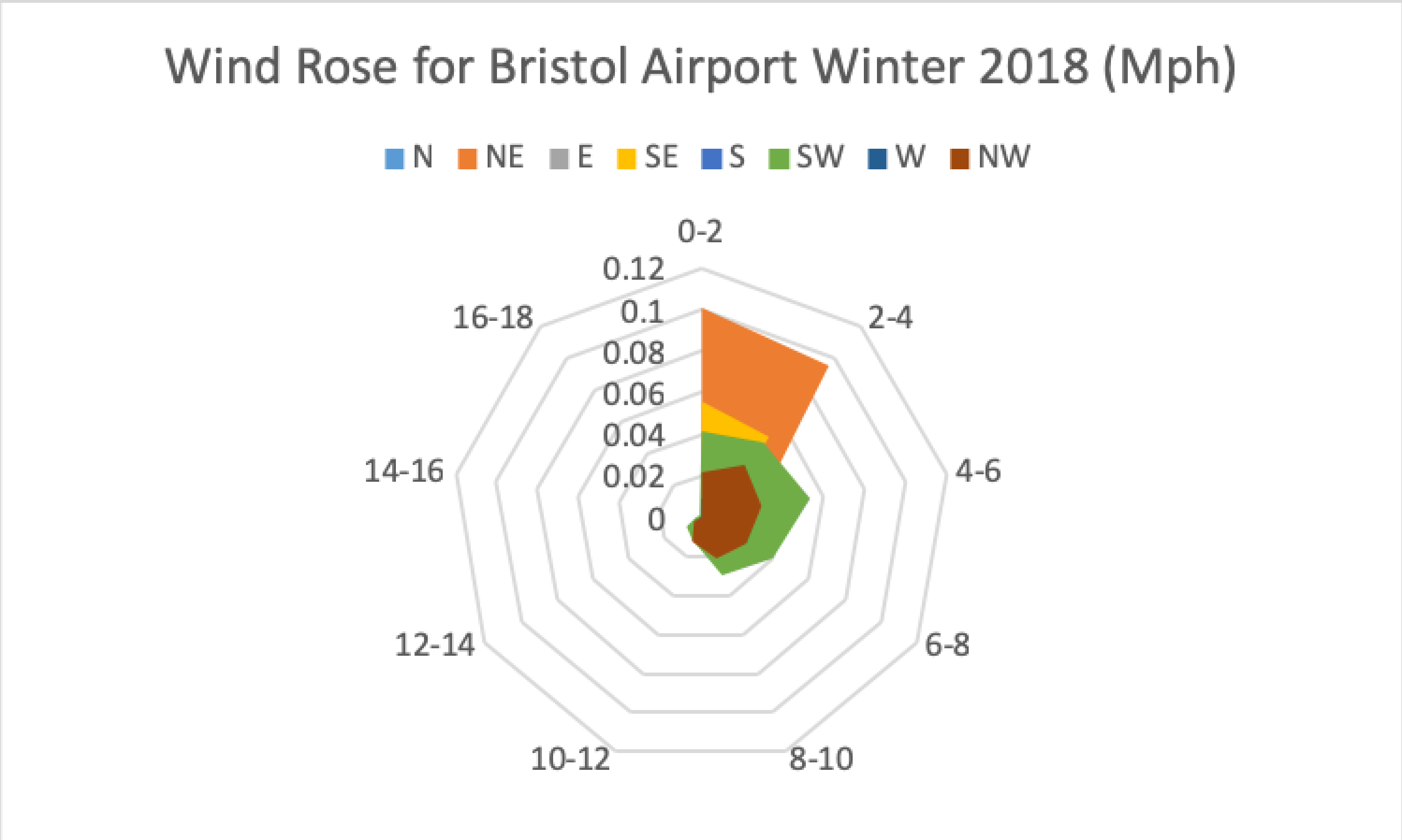


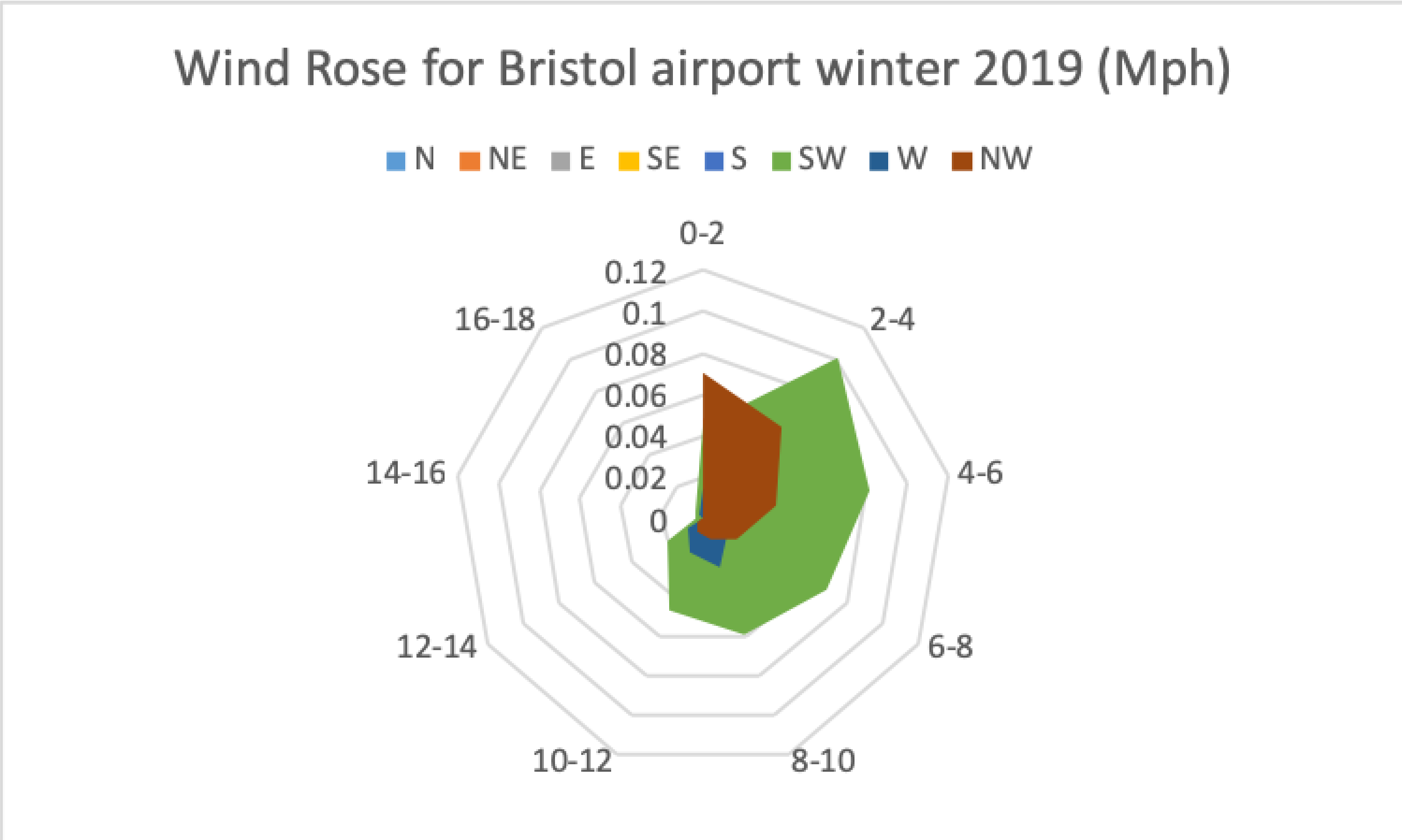
Wind Rose for Bristol Airport Spring 2018 (Mph)
N
NE
E
SE
S
SW
W
NW
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
0.15
0.1
0.05
0


Wind Rose for Bristol airport spring 2019 (Mph)
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
N
NE
E
SE
S
SW
W
NW
0.12
0.1
0.08
0.06
0.04
0.02
0

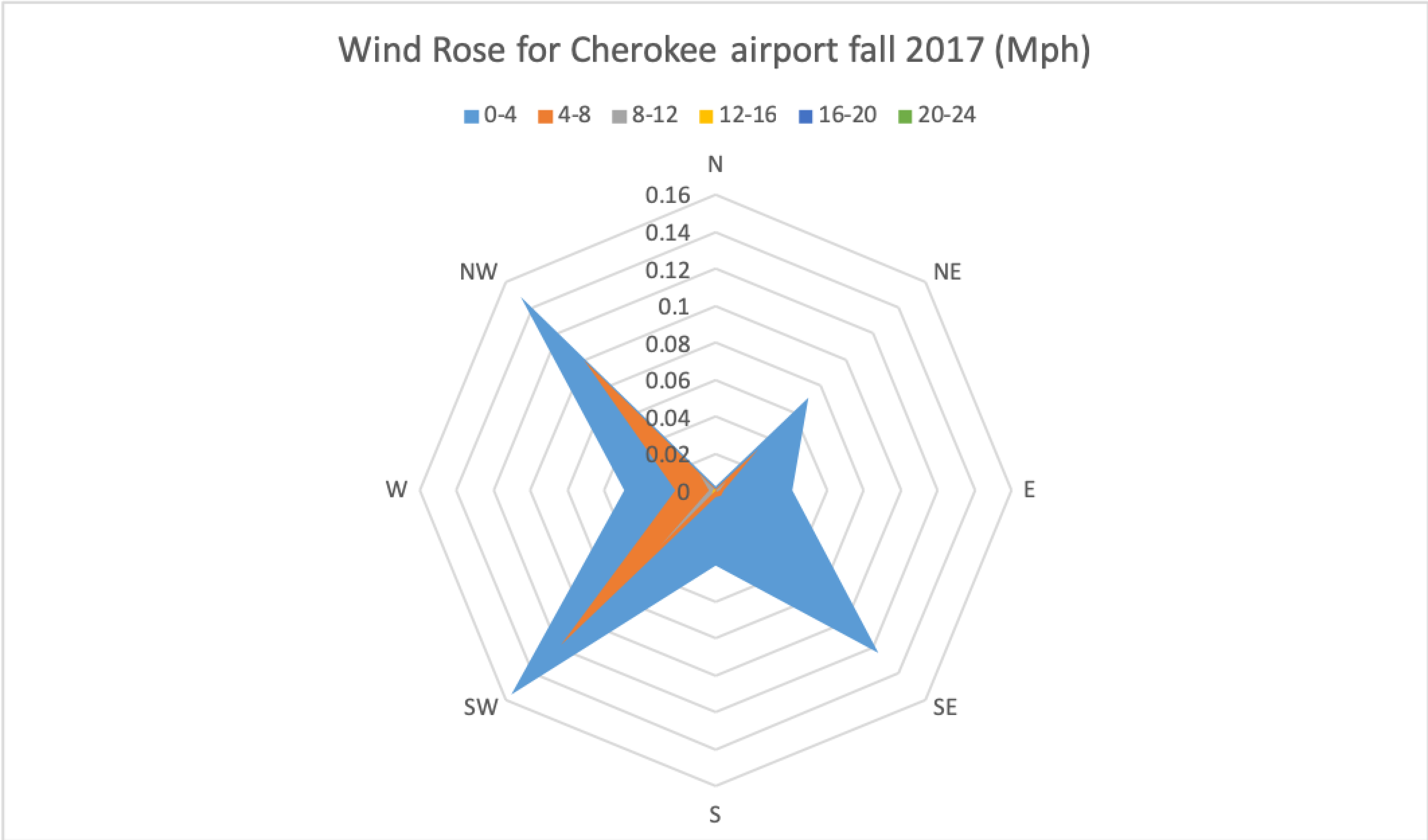


Wind Rose for Bristol airport winter 2017 (Mph)
0-4
4-8
8-12
12-16
16-20
N
NE
E
SE
S
SW
W
NW
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0

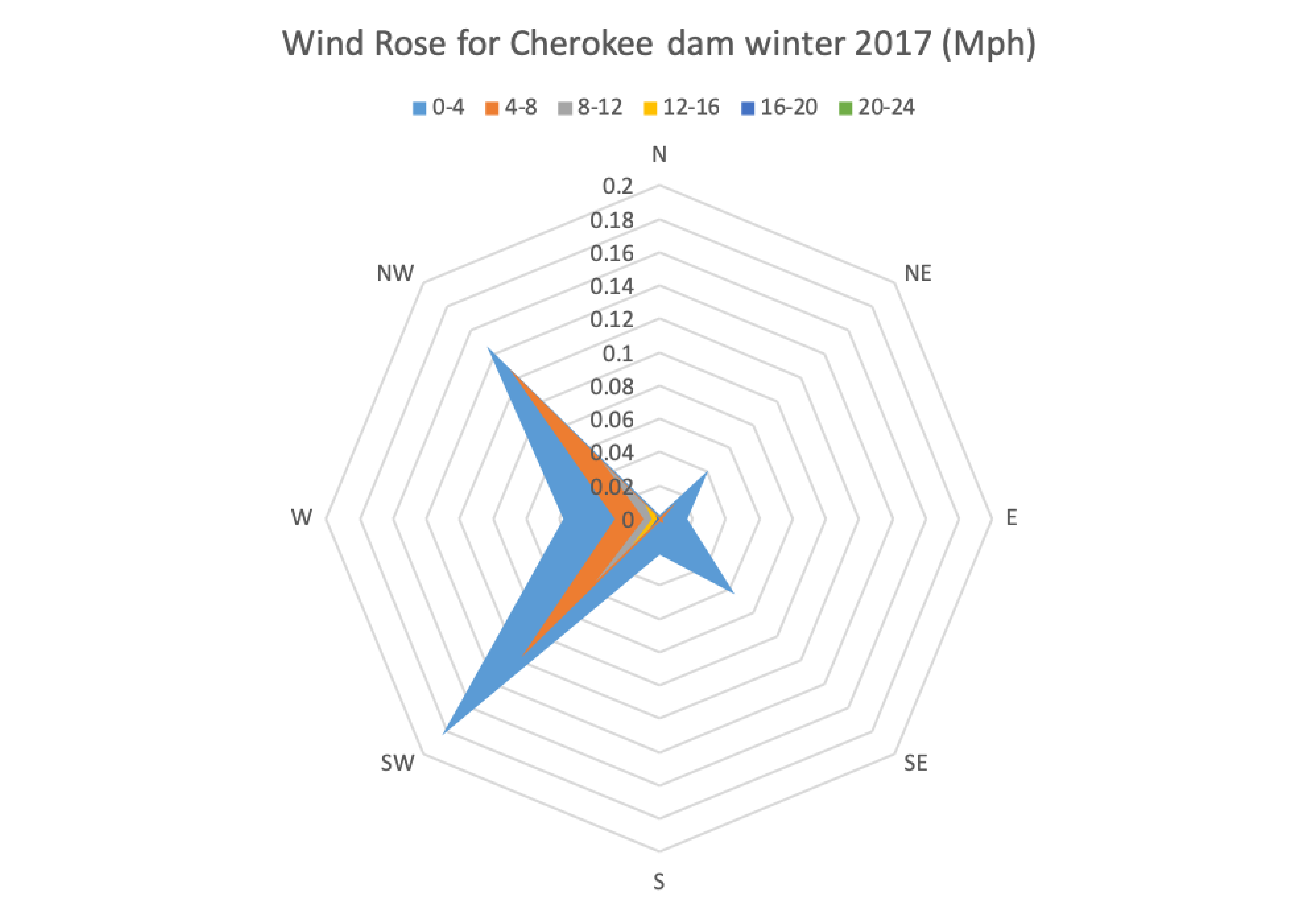

Wind Rose for Bristol Airport Winter 2018 (Mph)
N
NE
E
SE
S
SW
W
NW
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
0.12
0.1
0.08
0.06
0.04
0.02
0



Wind Rose for Bristol airport winter 2019 (Mph)
N
NE
E
SE
S
SW
W
NW
0-2
2-4
4-6
6-8
8-10
10-12
12-14
14-16
16-18
0.12
0.1
0.08
0.06
0.04
0.02
0



Wind Rose for Cherokee airport fall 2017 (Mph)
0-4
4-8
8-12
12-16
16-20
20-24
N
NE
E
SE
S
SW
W
NW
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0



Wind Rose for Cherokee dam winter 2017 (Mph)
0-4
4-8
8-12
12-16
16-20
20-24
N
NE
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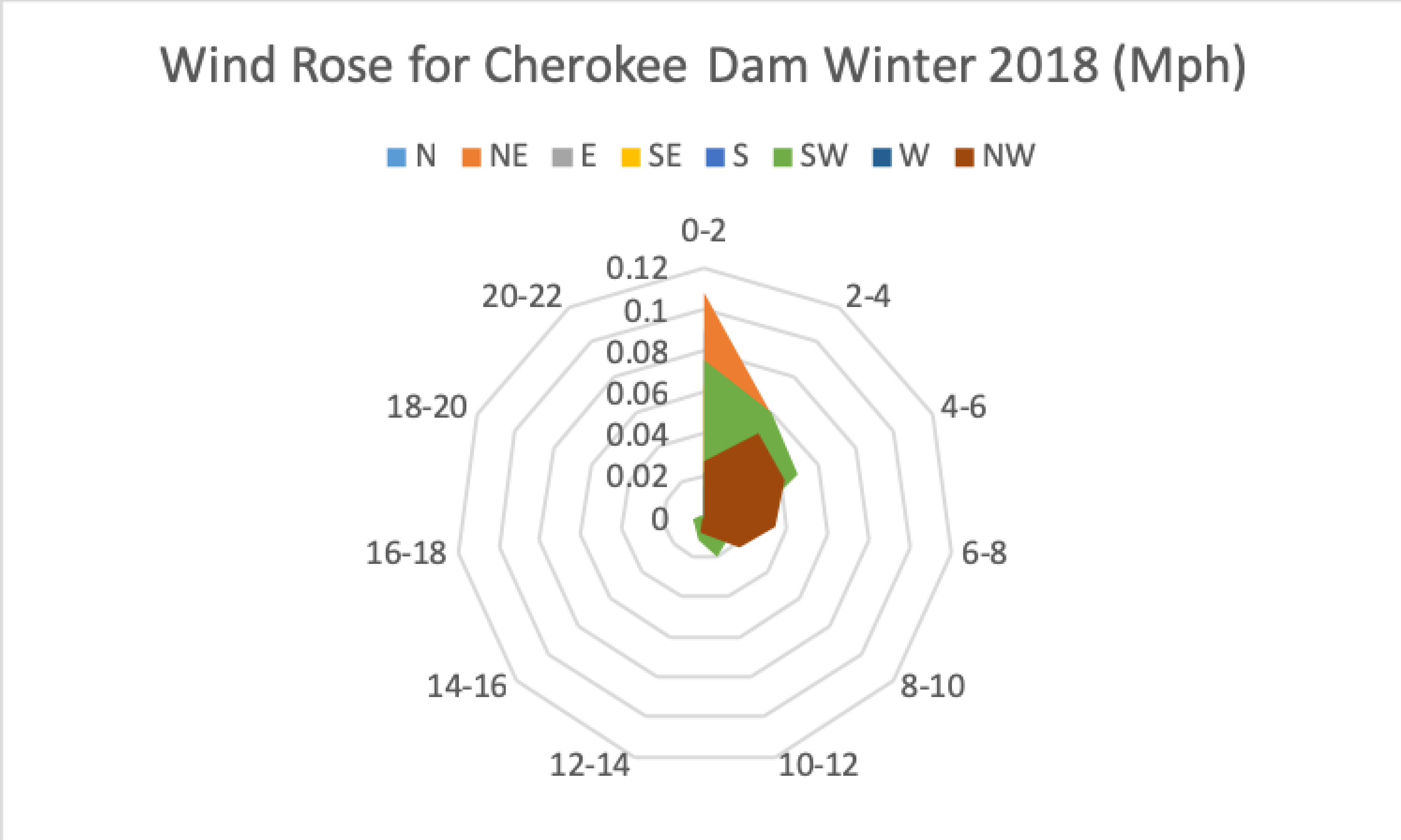

Wind Rose for Cherokee Dam Winter 2018 (Mph)
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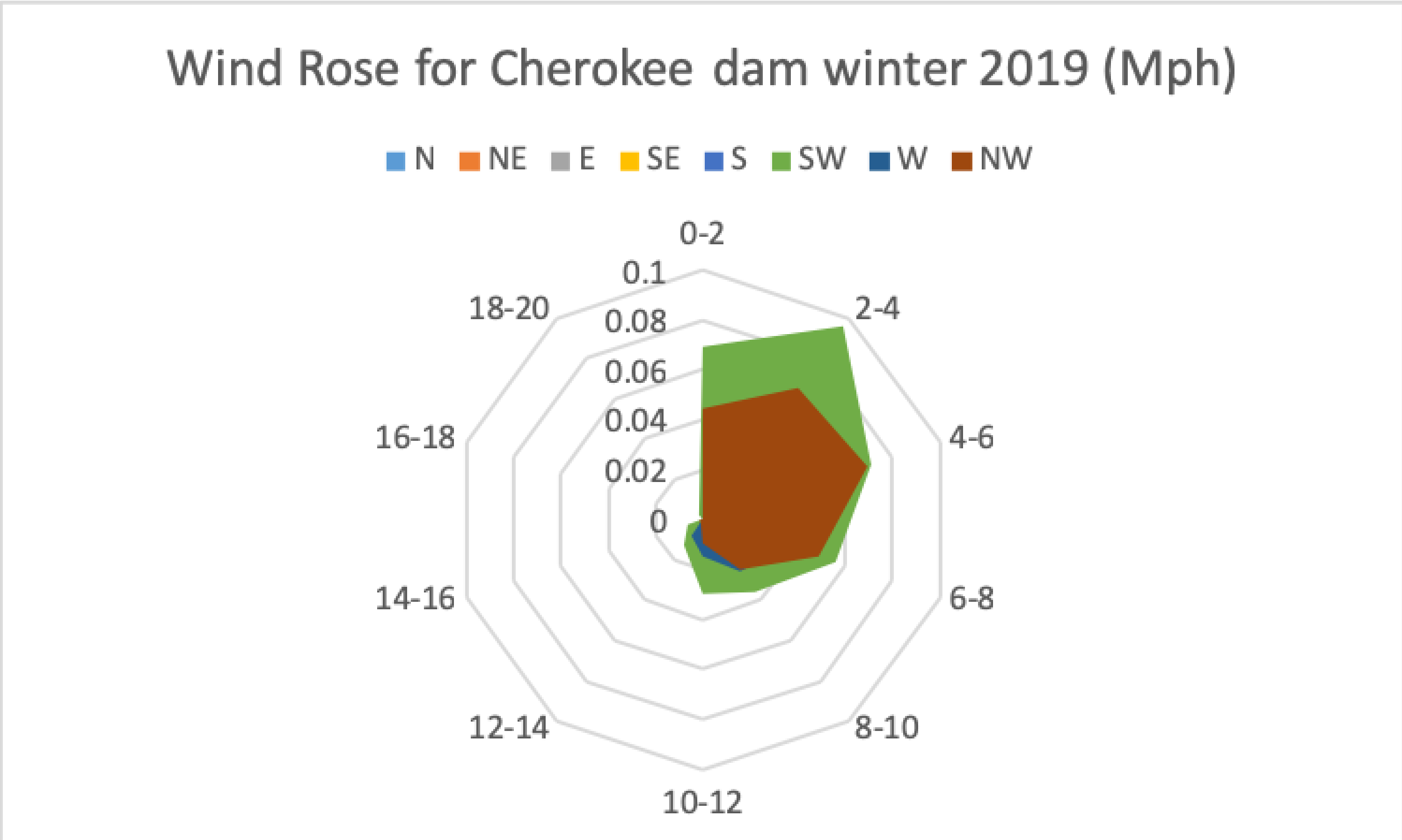
Wind Rose for Cherokee dam winter 2019 (Mph)
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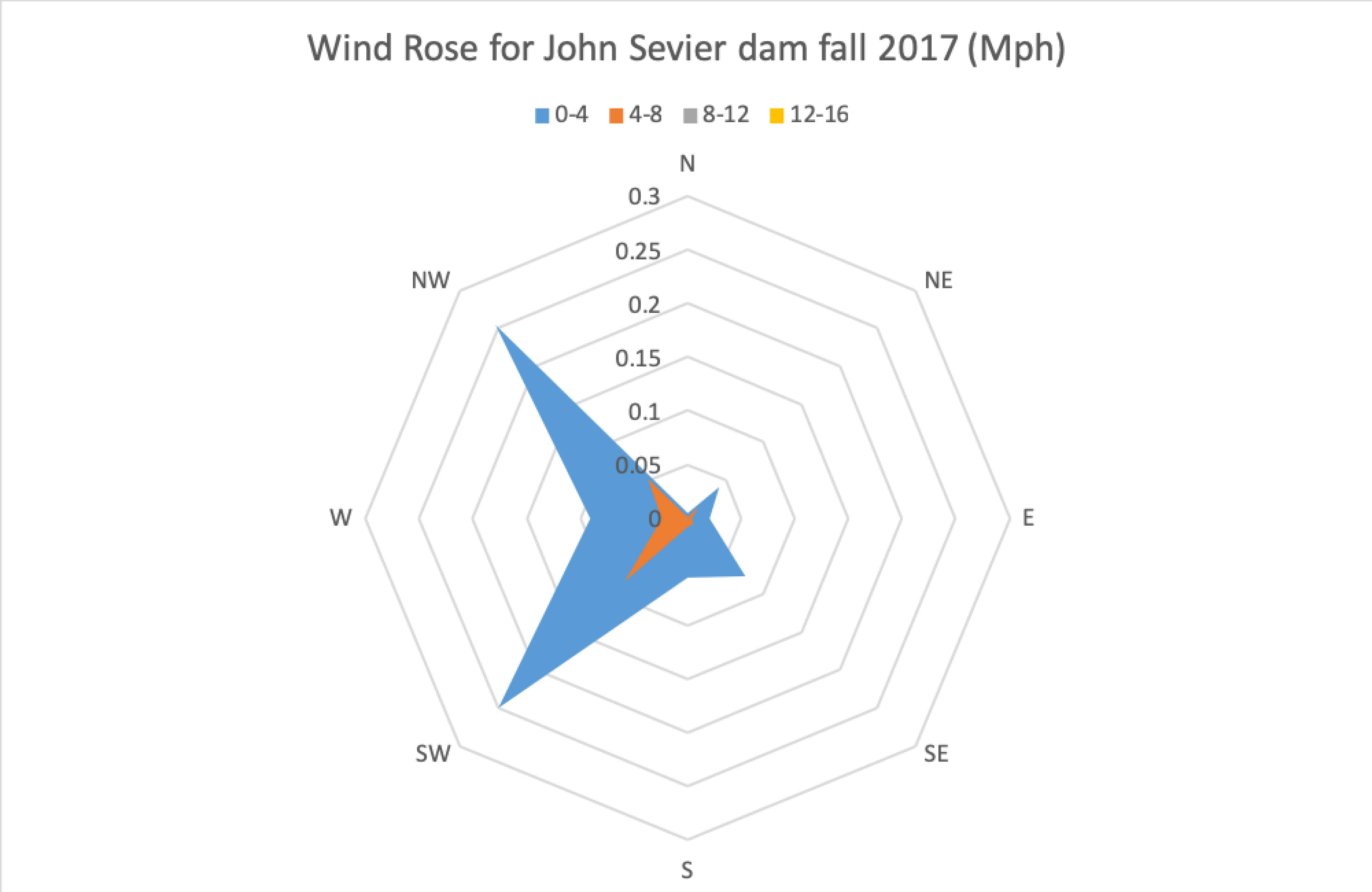
Wind Rose for John Sevier dam fall 2017 (Mph)
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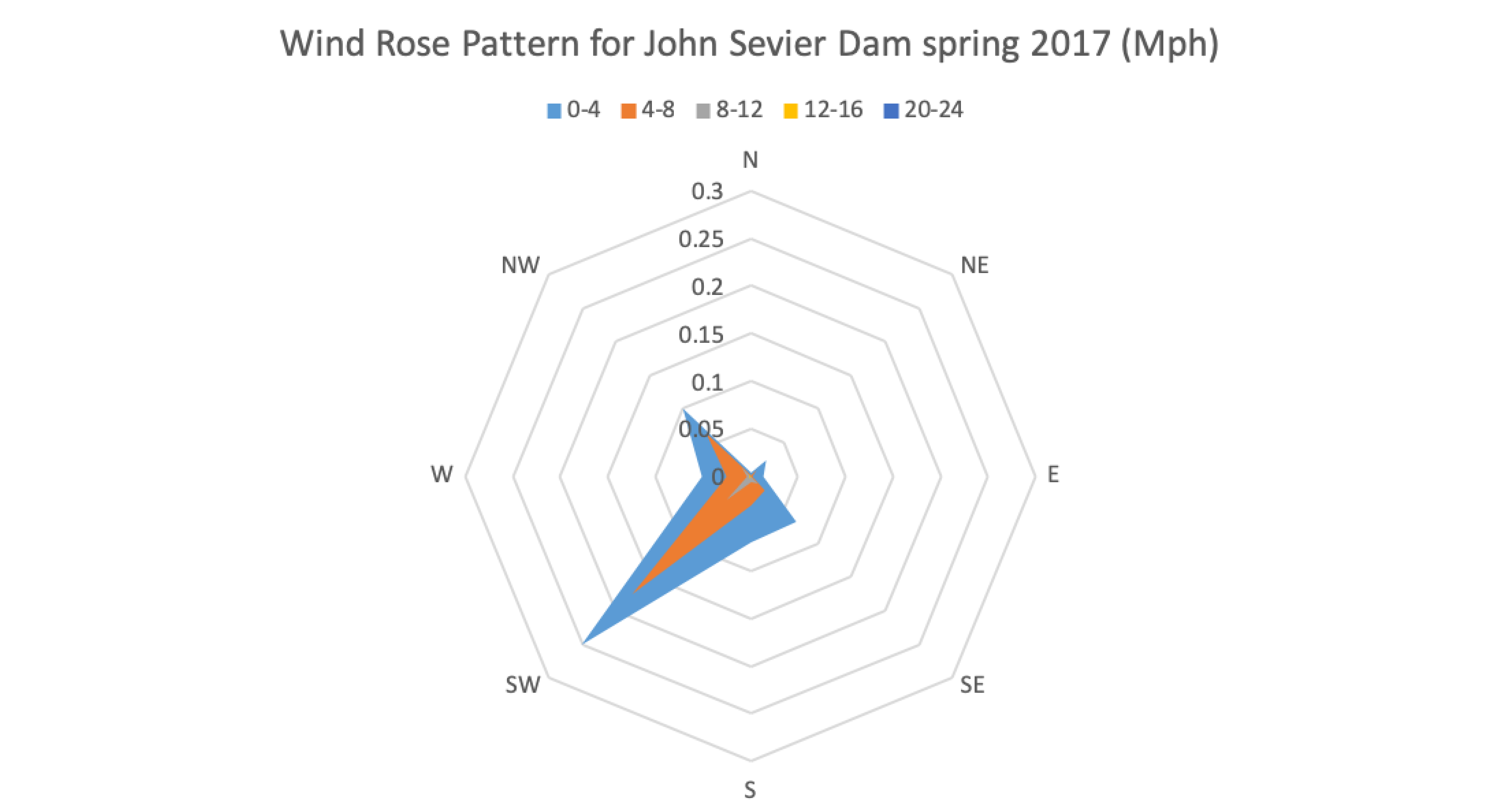
Wind Rose Pattern for John Sevier Dam spring 2017 (Mph)
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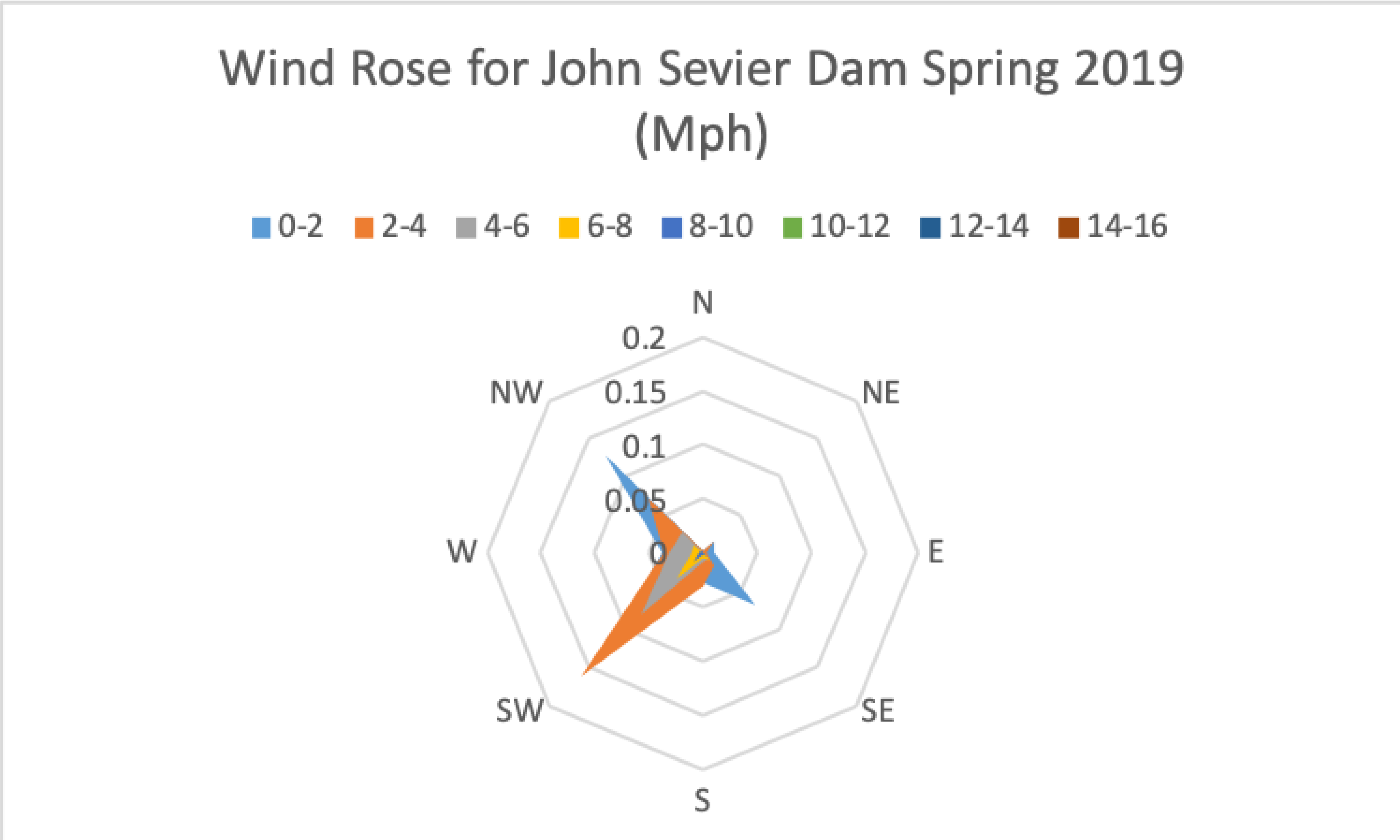
Wind Rose for John Sevier Dam Spring 2019 (Mph)
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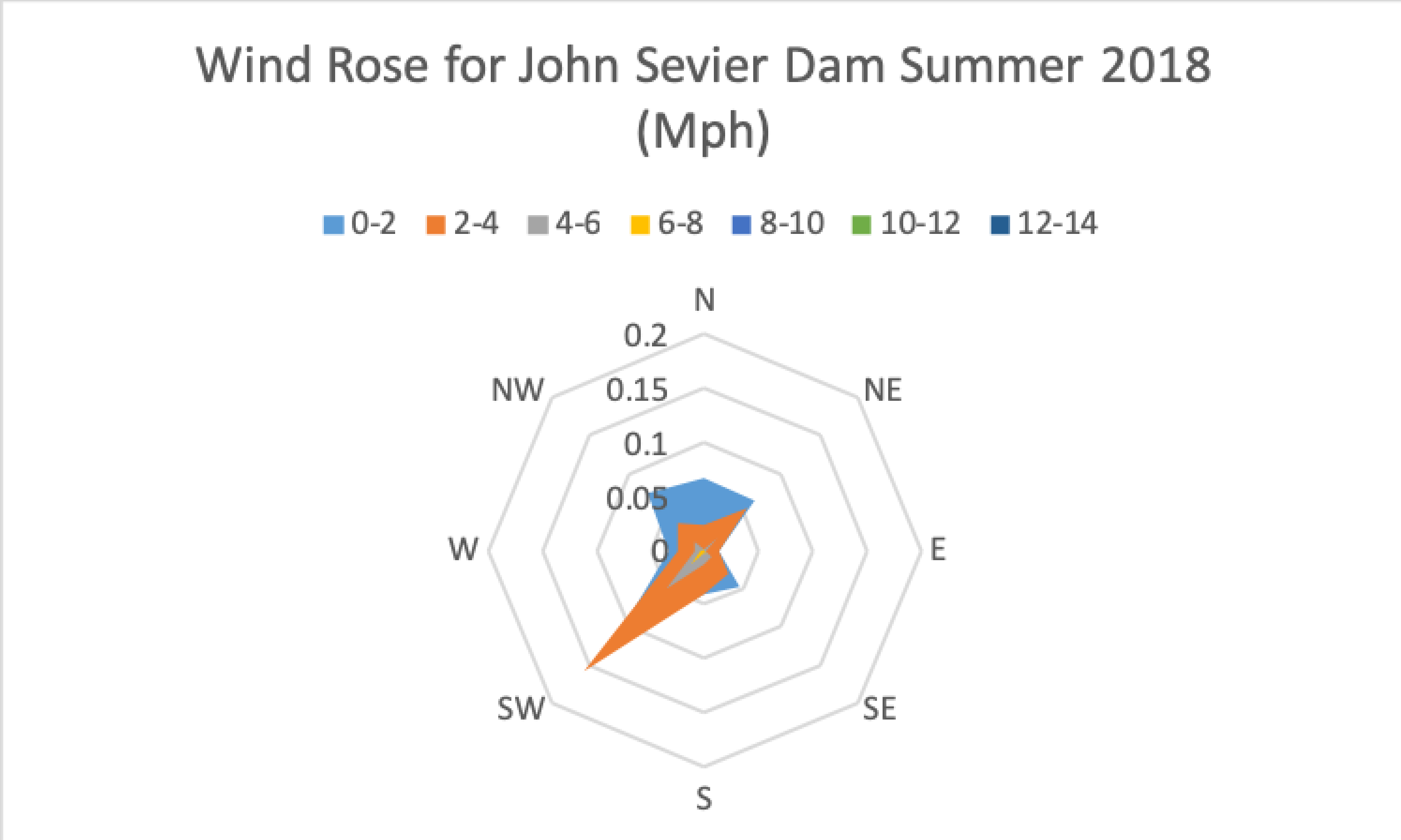
Wind Rose for John Sevier Dam Summer 2018 (Mph)
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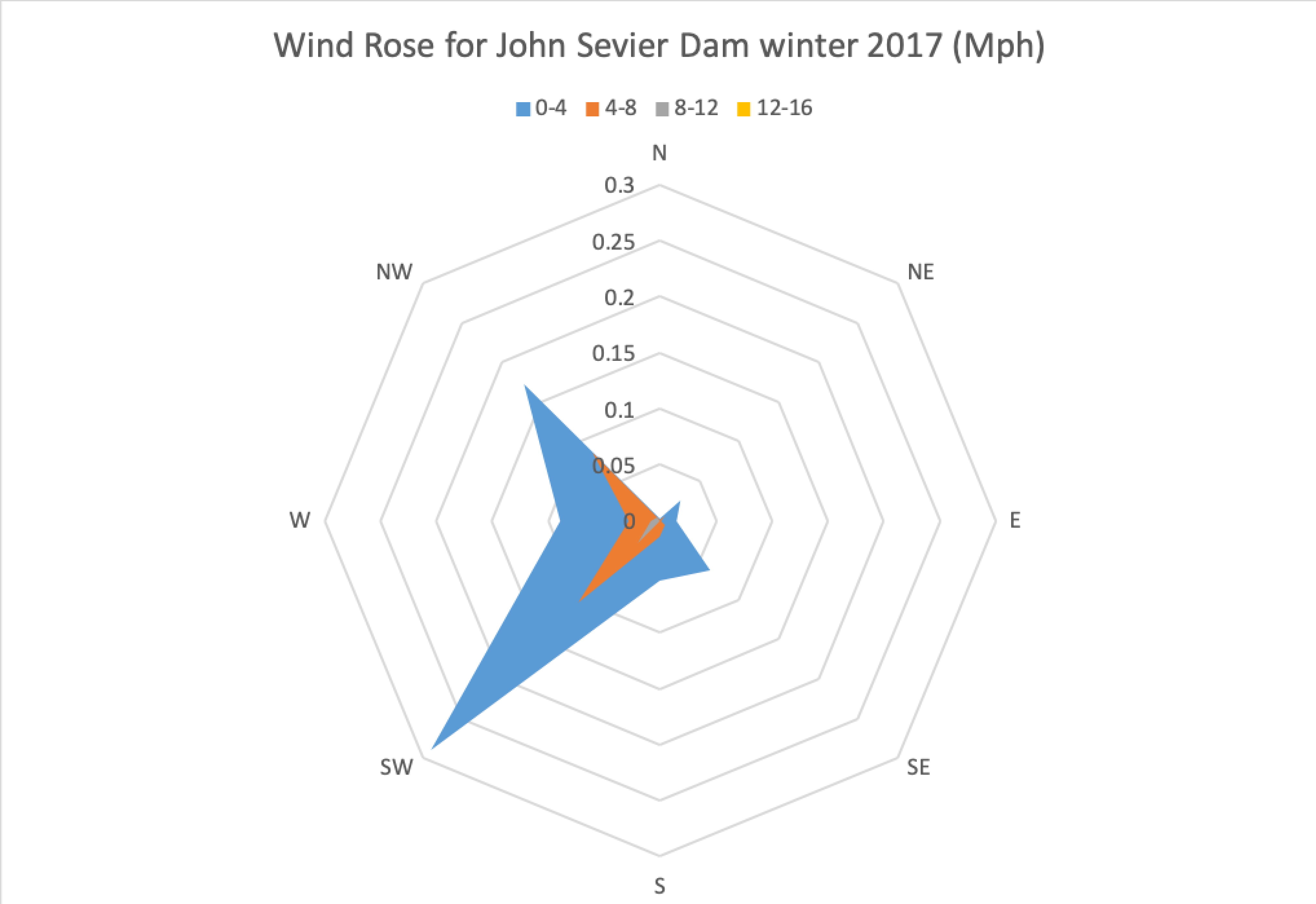

Wind Rose for John Sevier Dam winter 2017 (Mph)
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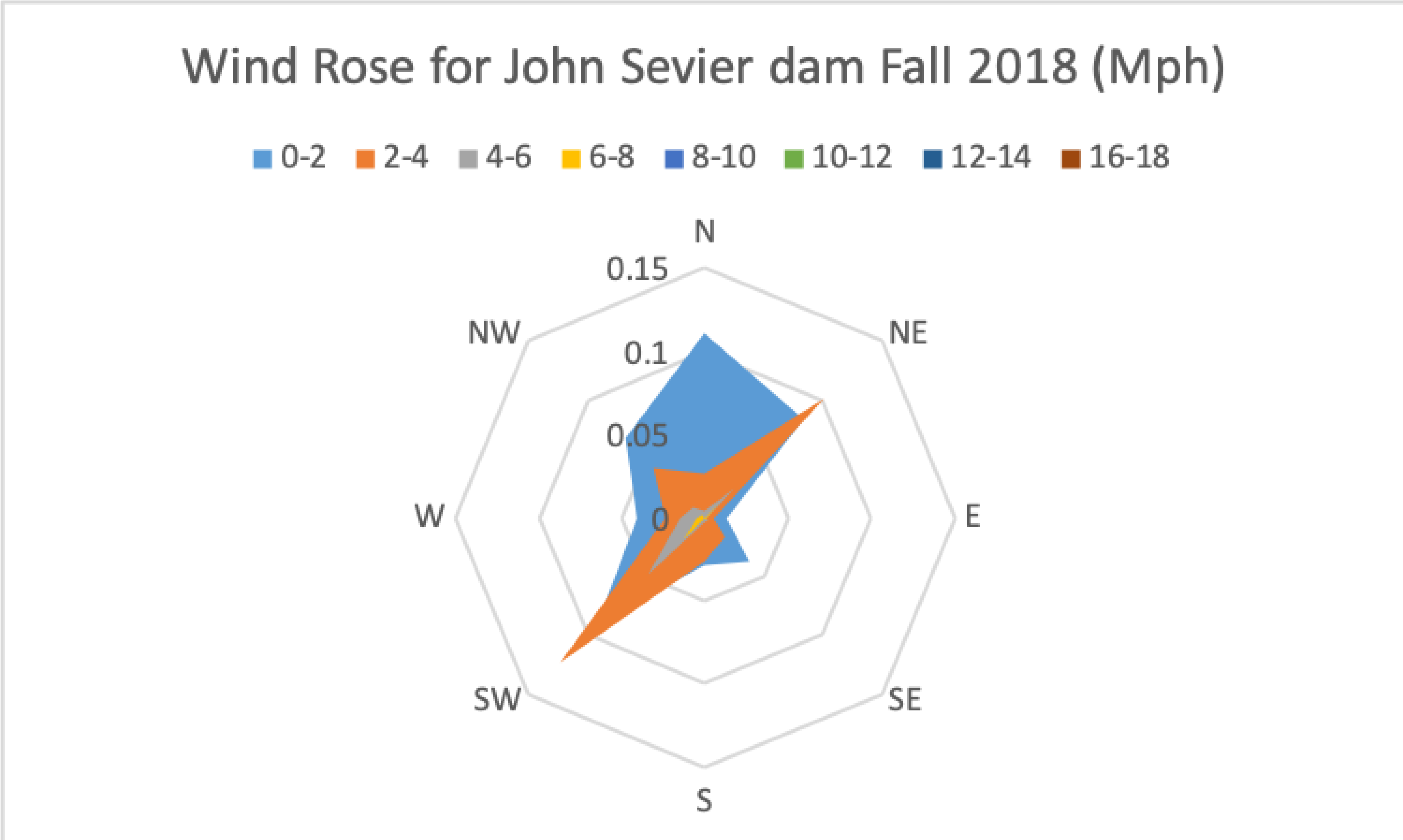
Wind Rose for John Sevier dam Fall 2018 (Mph)
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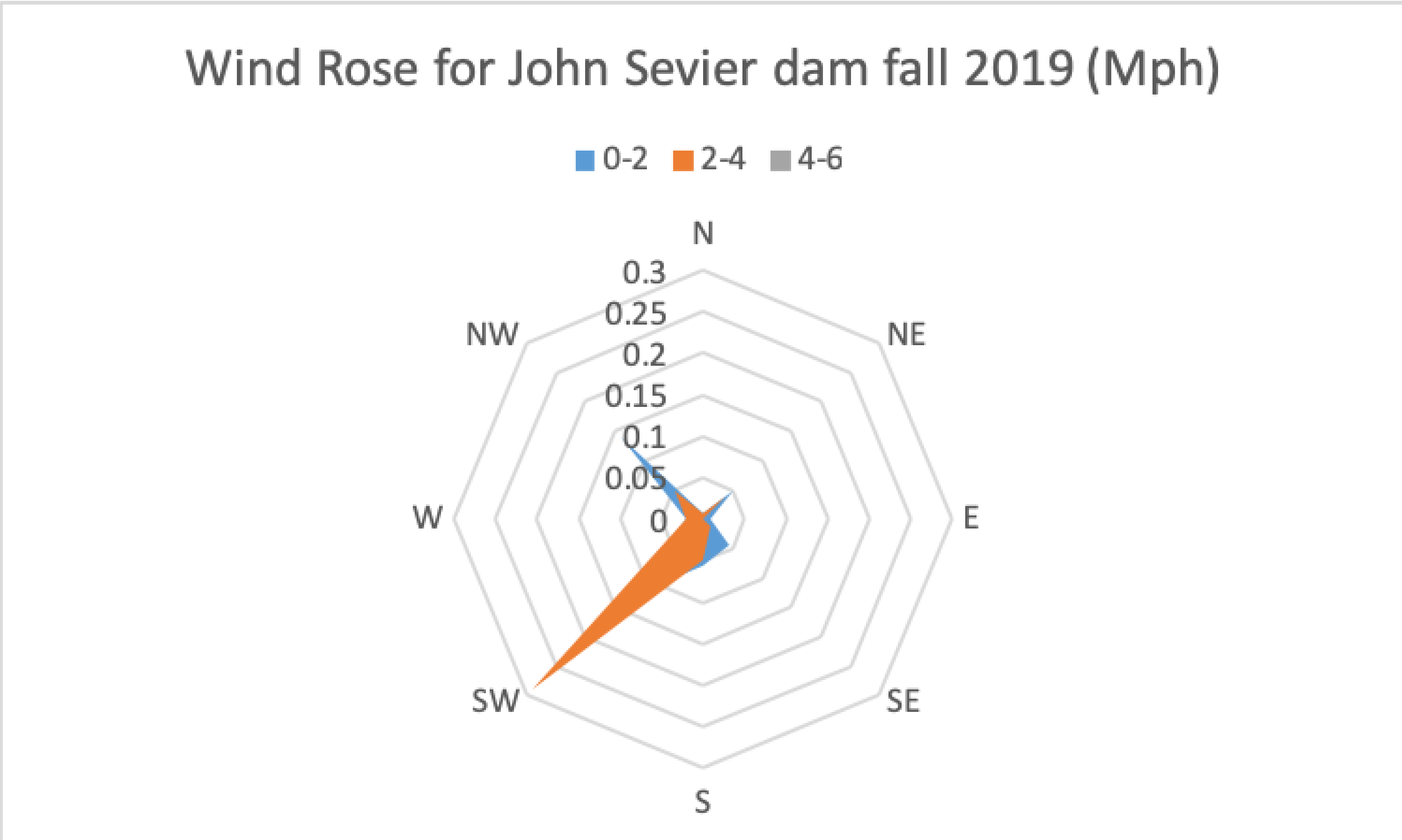
Wind Rose for John Sevier dam fall 2019 (Mph)
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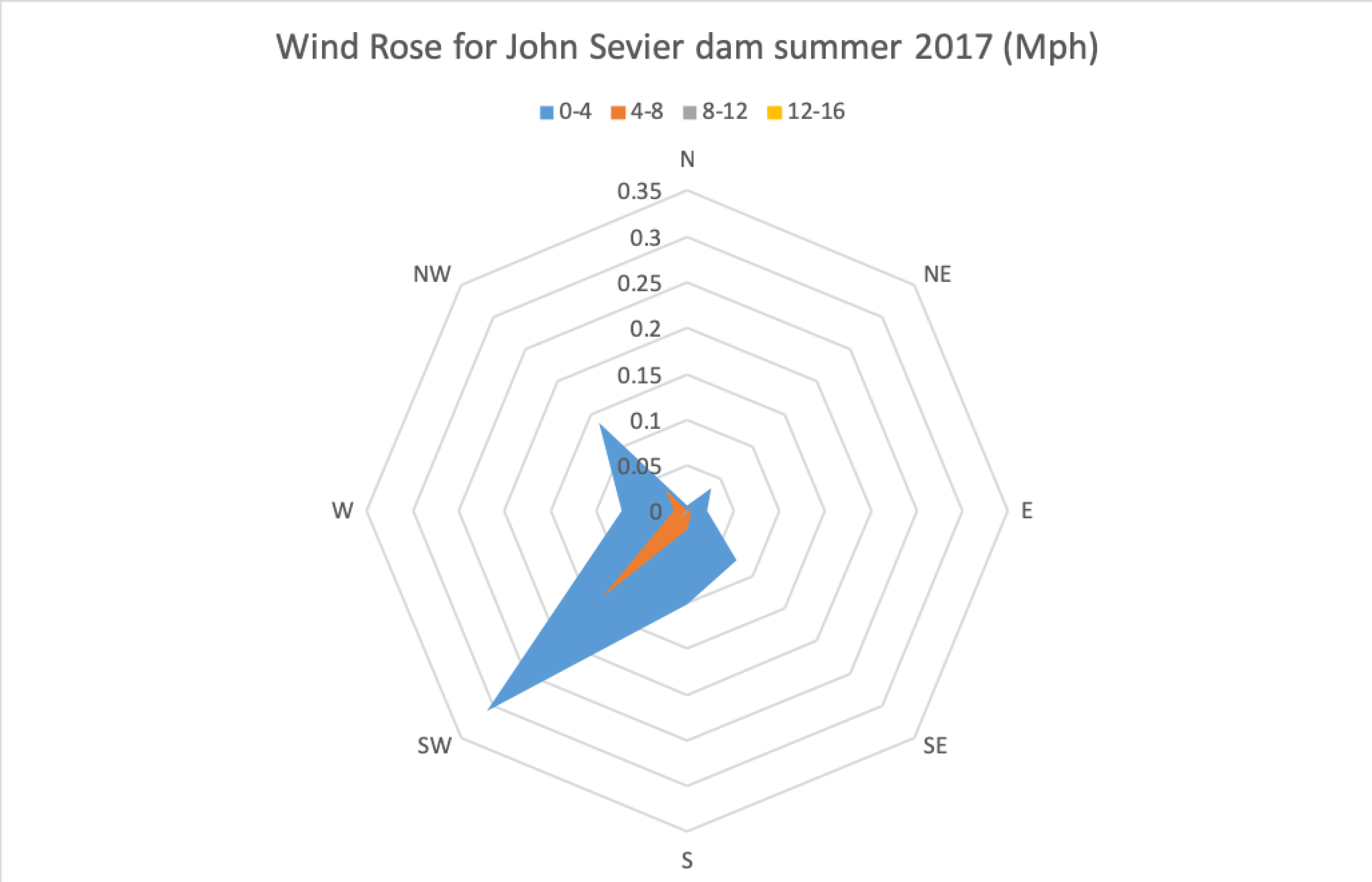
Wind Rose for John Sevier dam summer 2017 (Mph)
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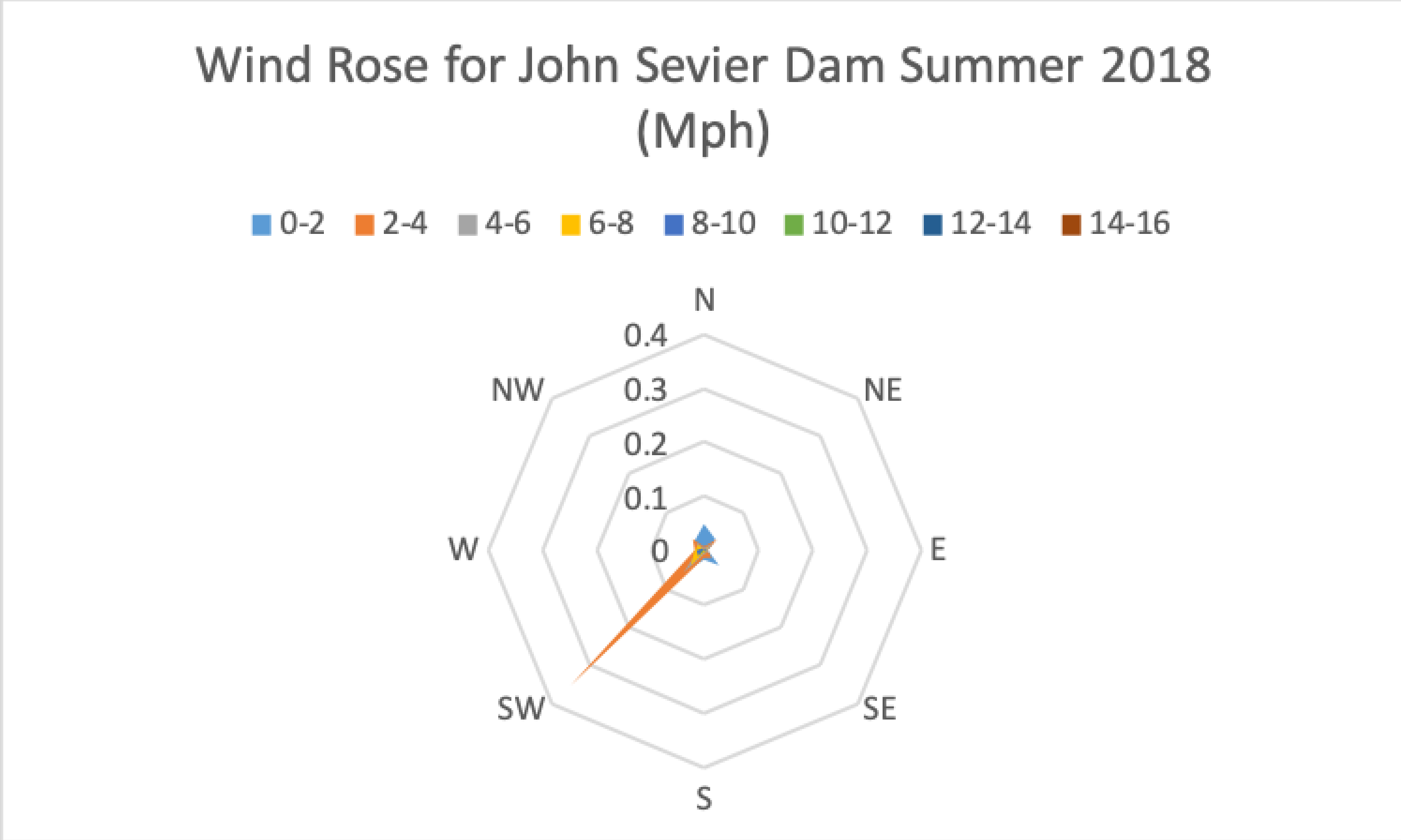
Wind Rose for John Sevier Dam Summer 2018 (Mph)
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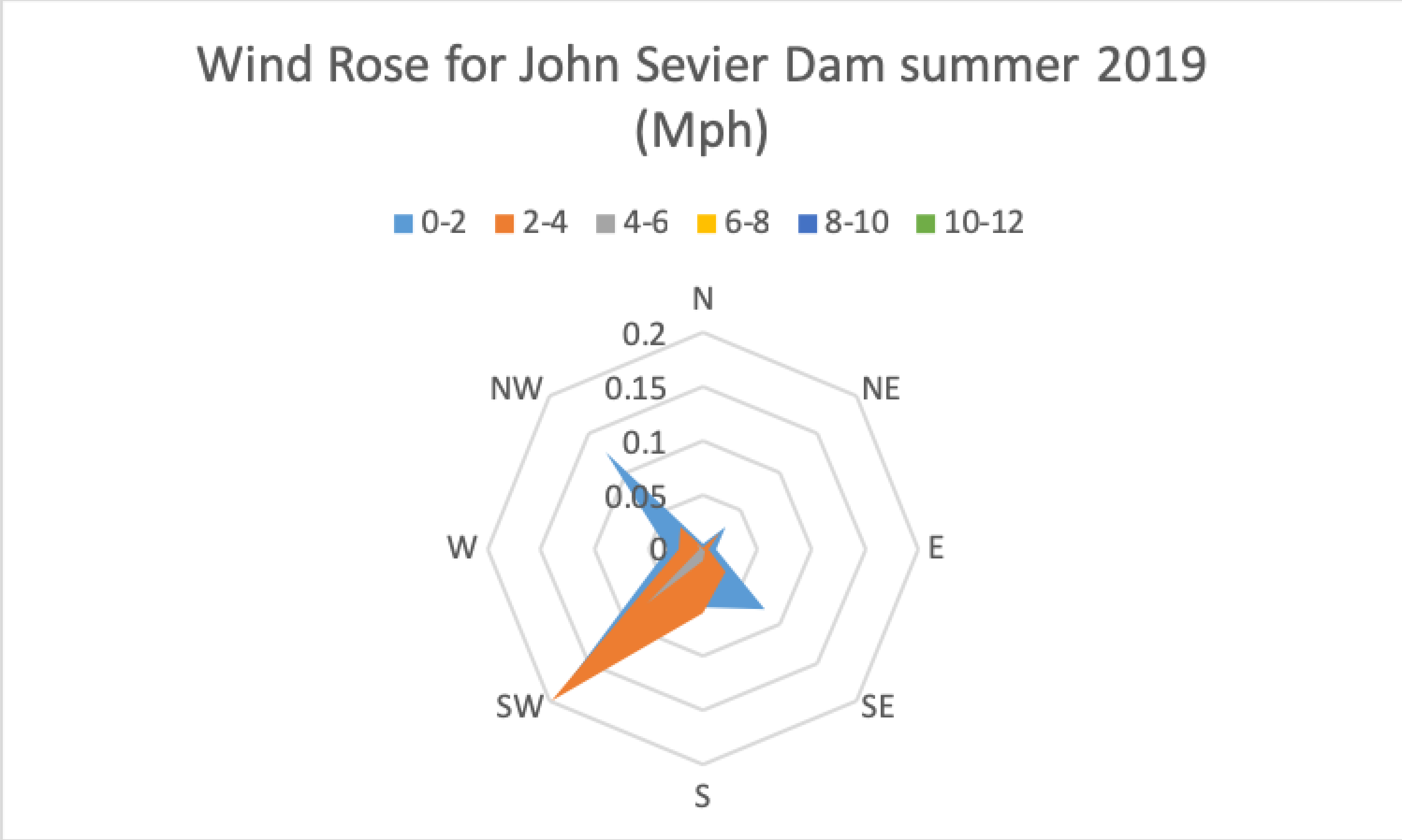
Wind Rose for John Sevier Dam summer 2019 (Mph)
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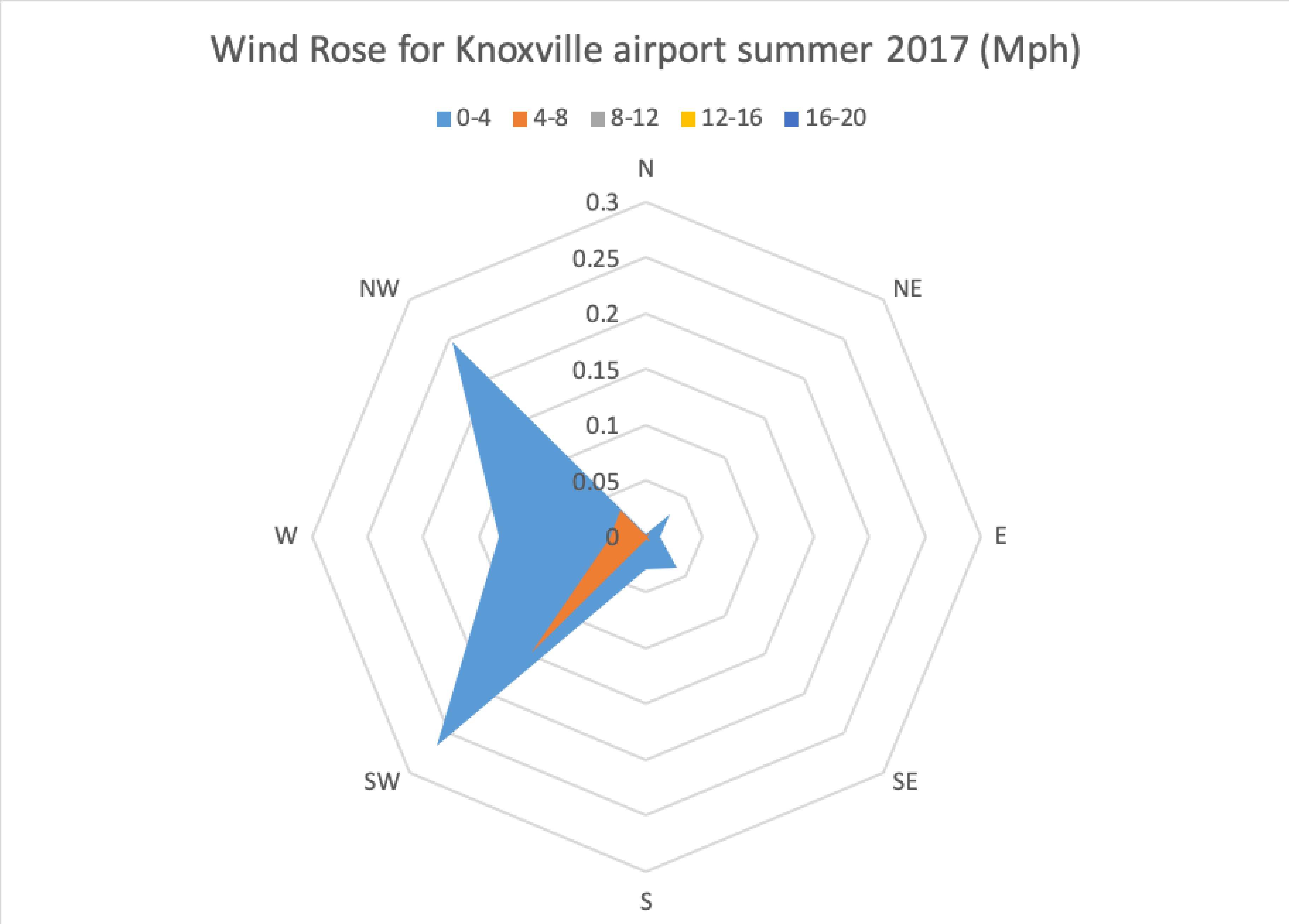

Wind Rose for Knoxville airport summer 2017 (Mph)
0-4
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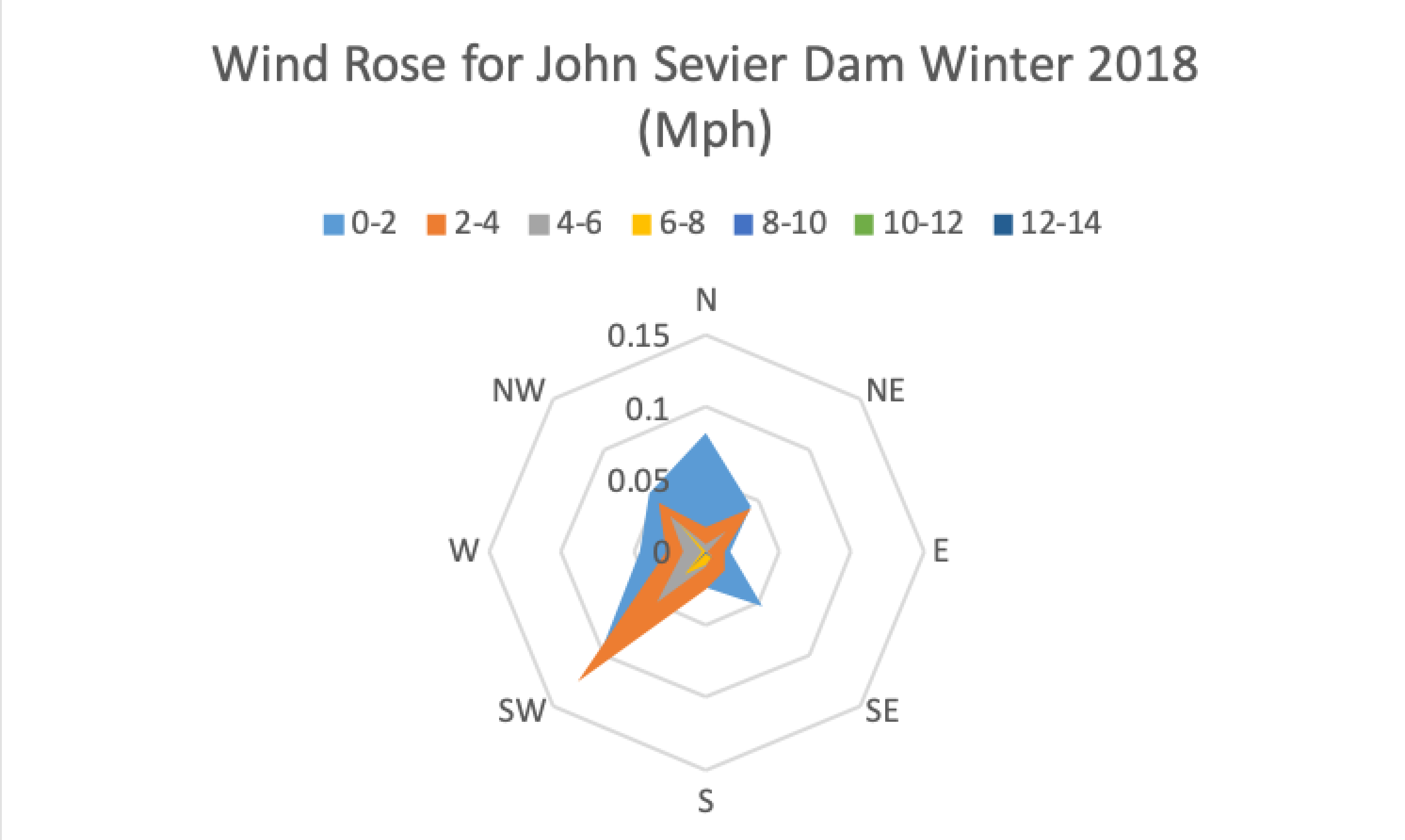
Wind Rose for John Sevier Dam Winter 2018 (Mph)
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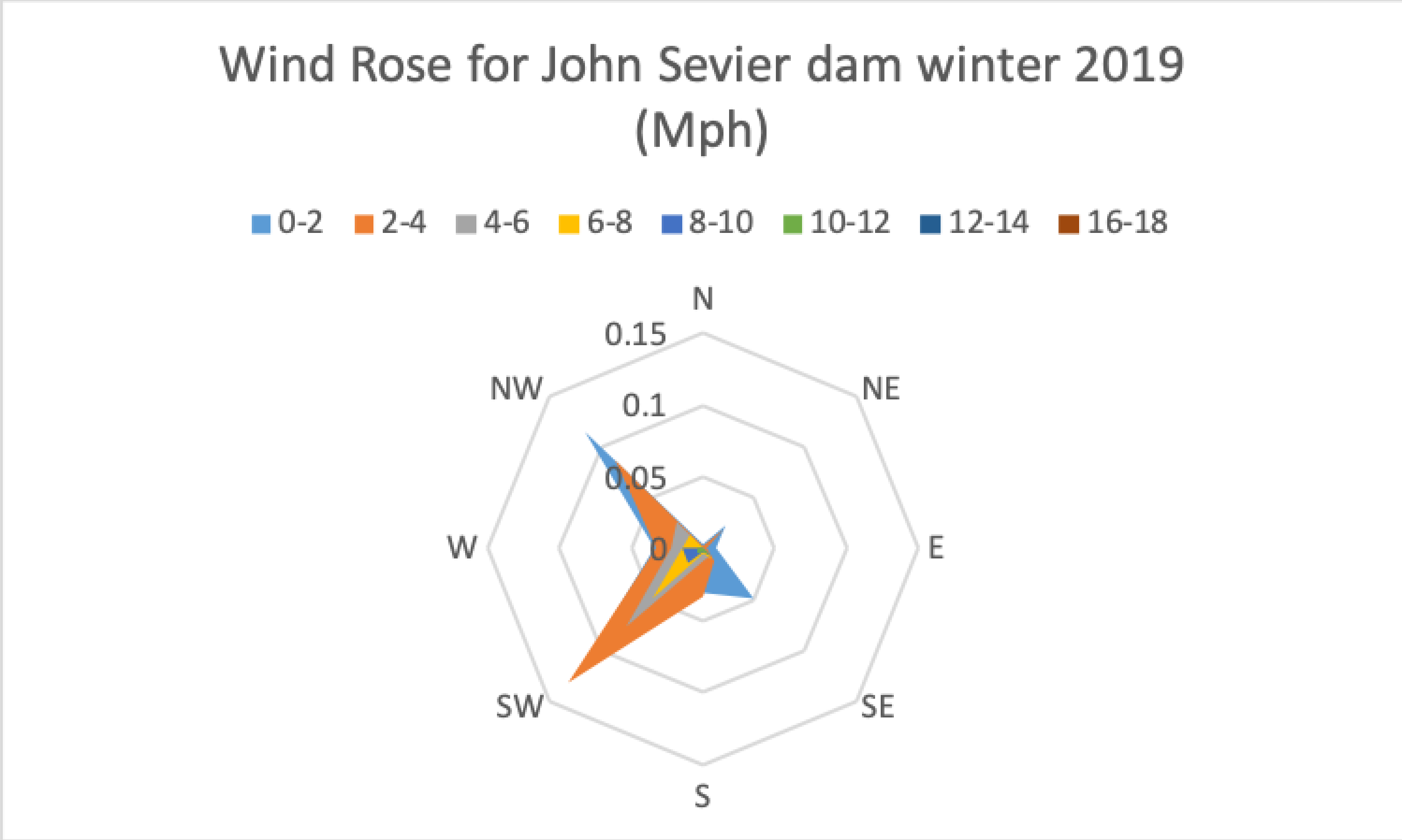

Wind Rose for John Sevier dam winter 2019 (Mph)
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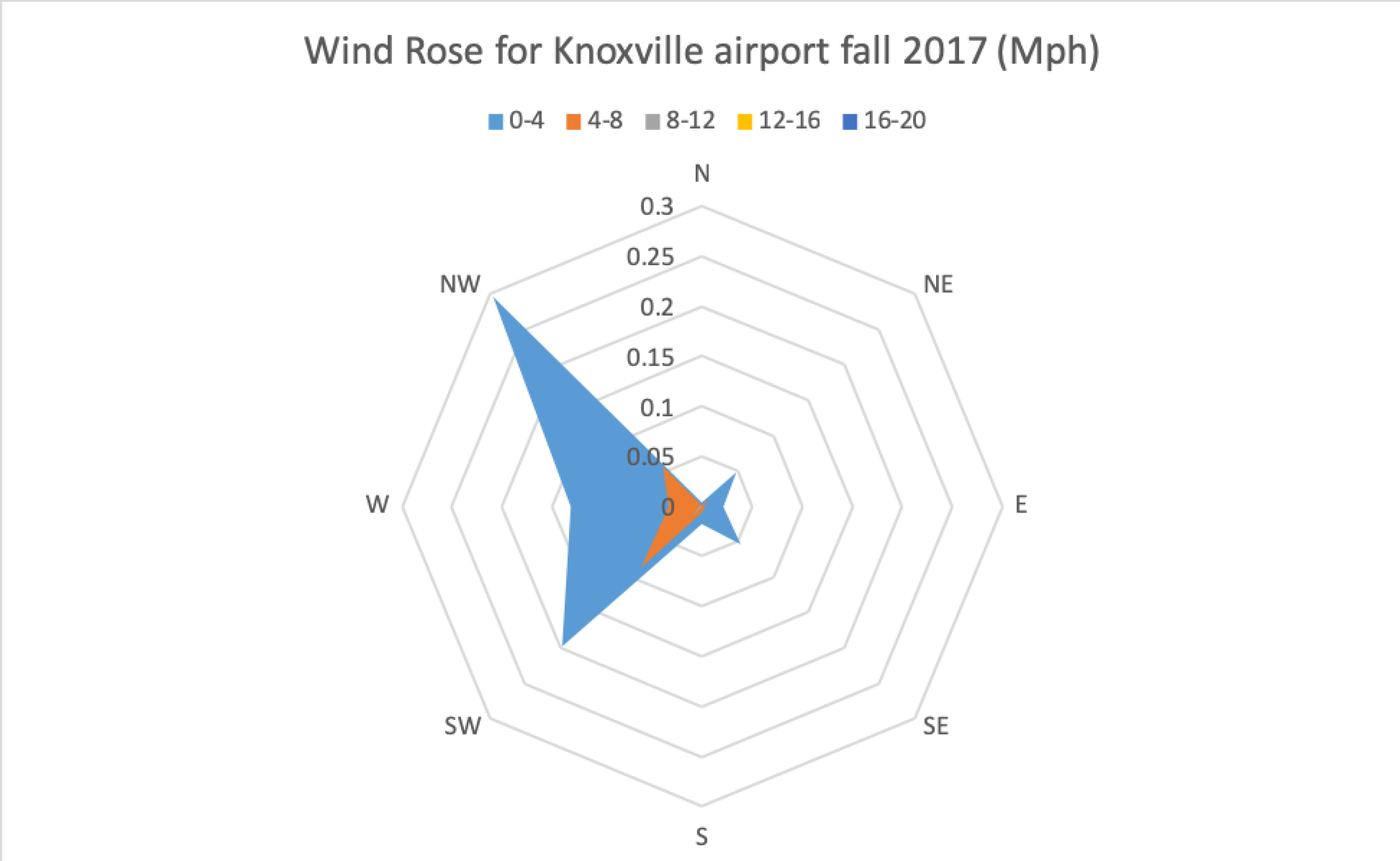

Wind Rose for Knoxville airport fall 2017 (Mph)
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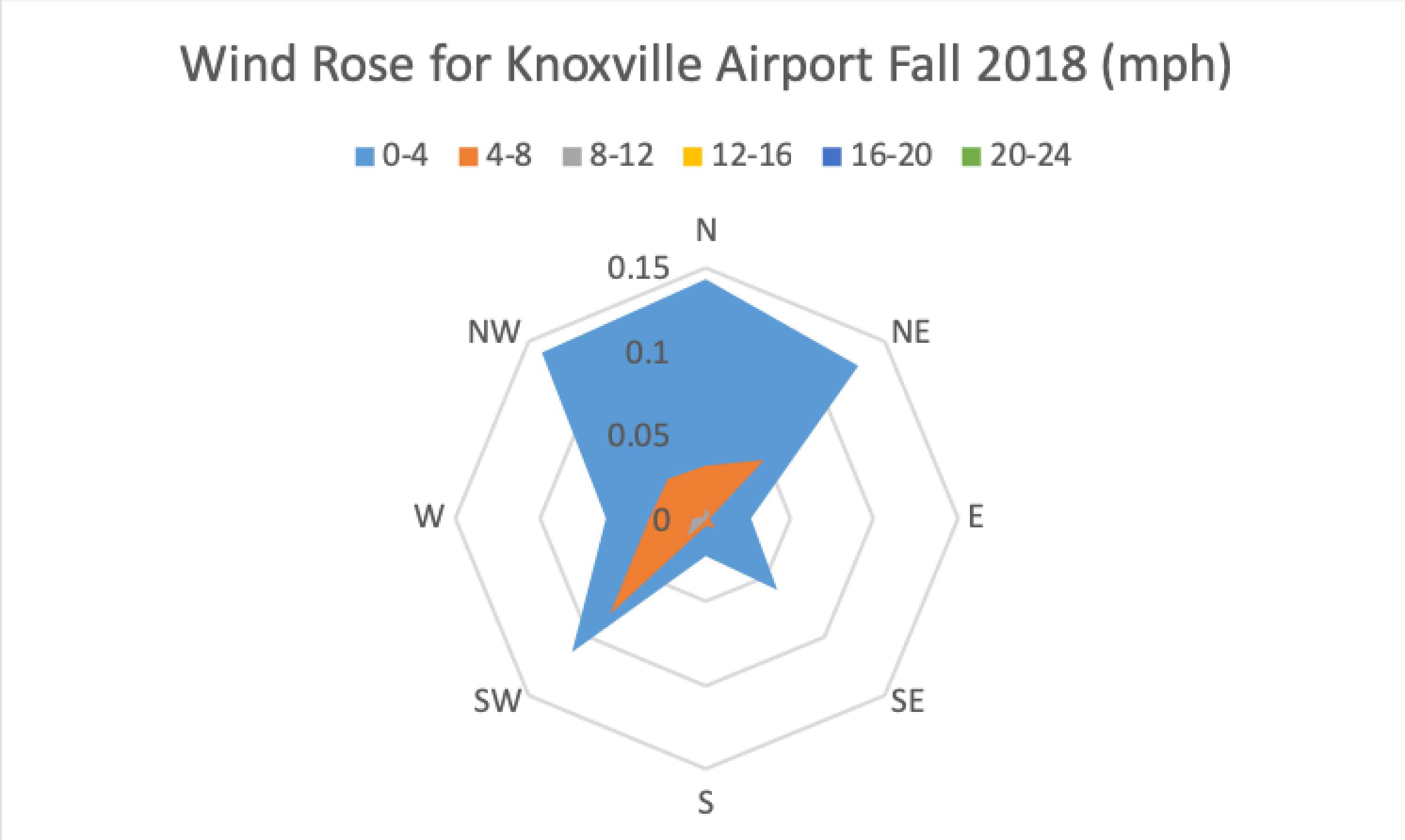
Wind Rose for Knoxville Airport Fall 2018 (mph)
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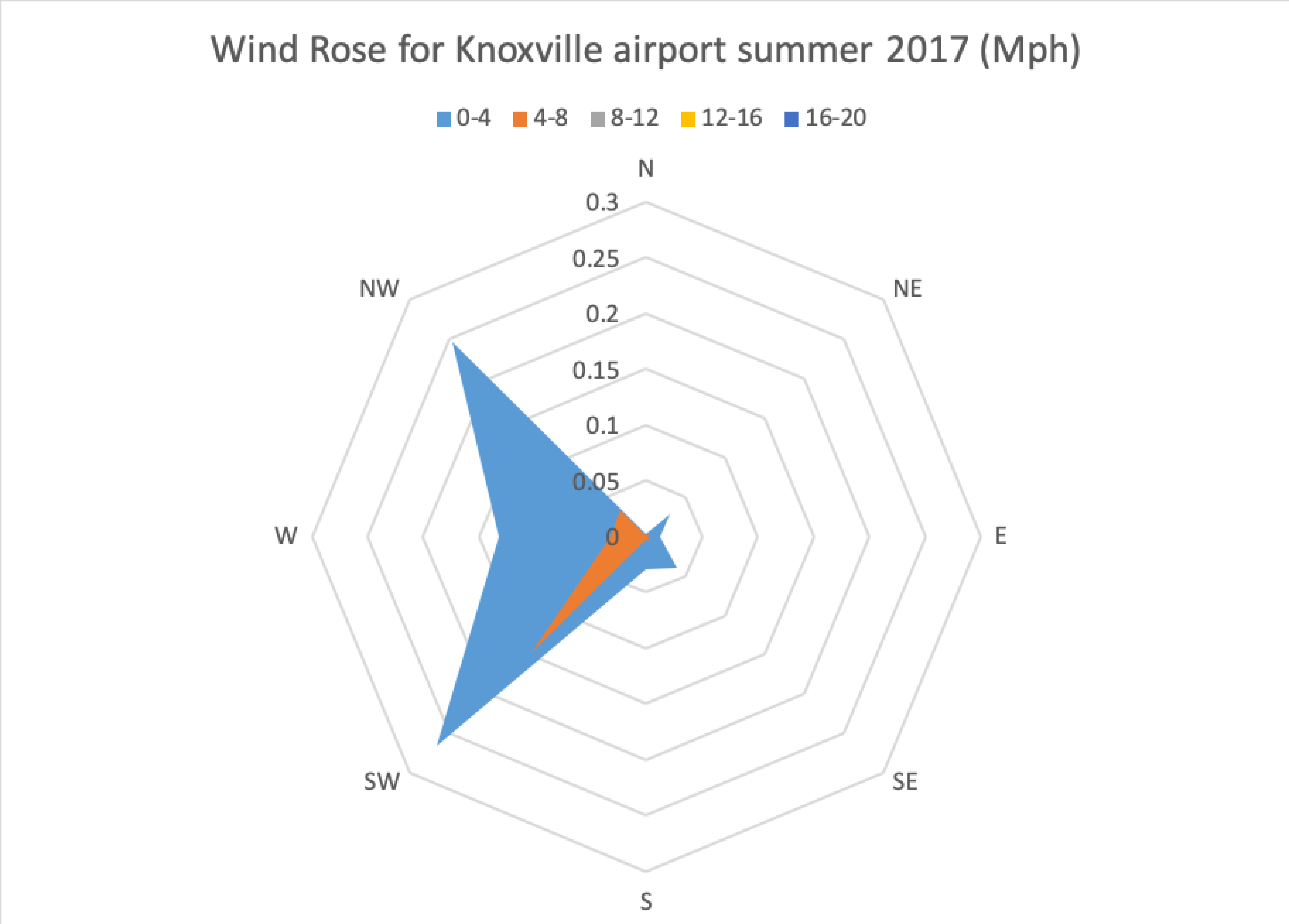

Wind Rose for Knoxville airport summer 2017 (Mph)
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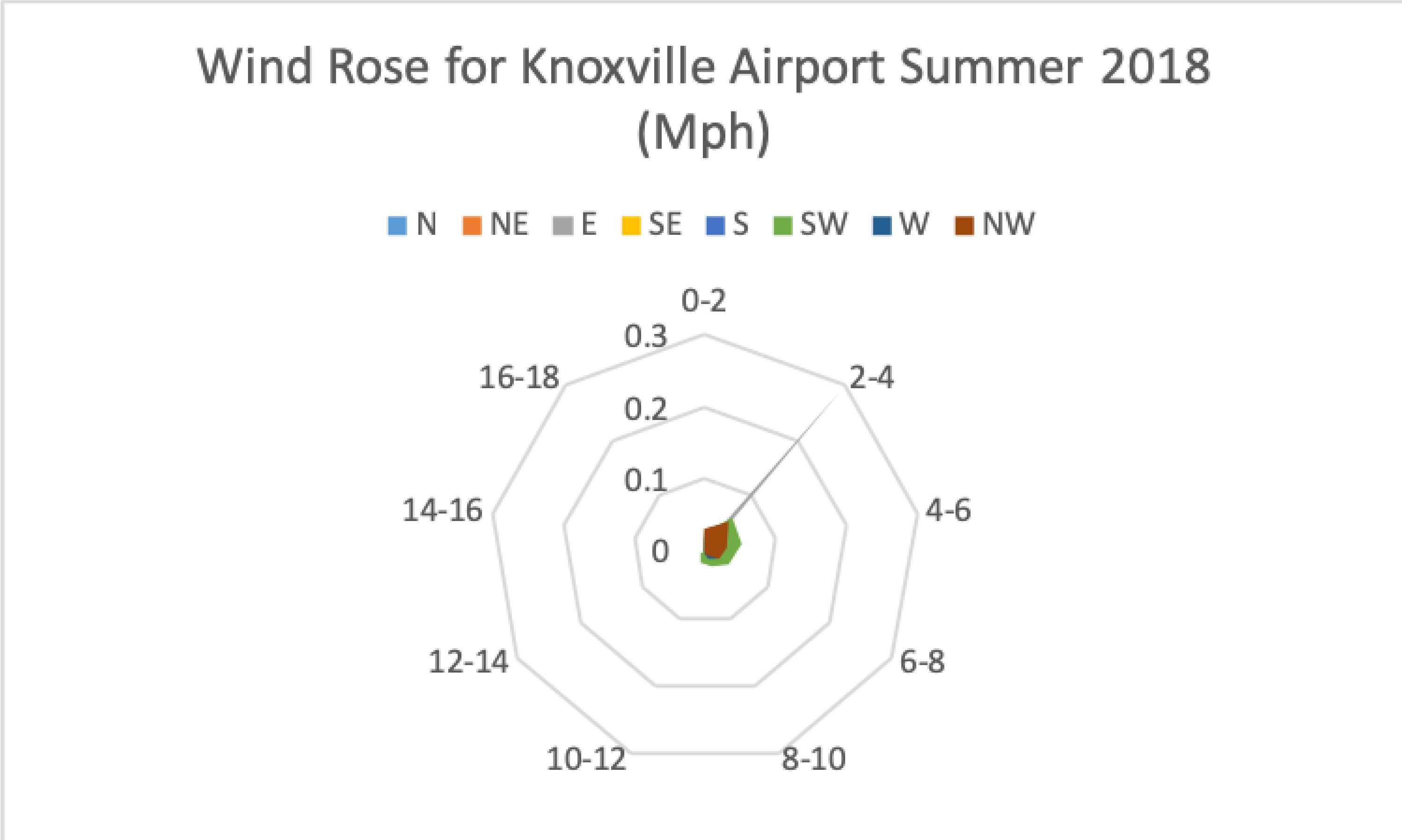
Wind Rose for Knoxville Airport Summer 2018 (Mph)
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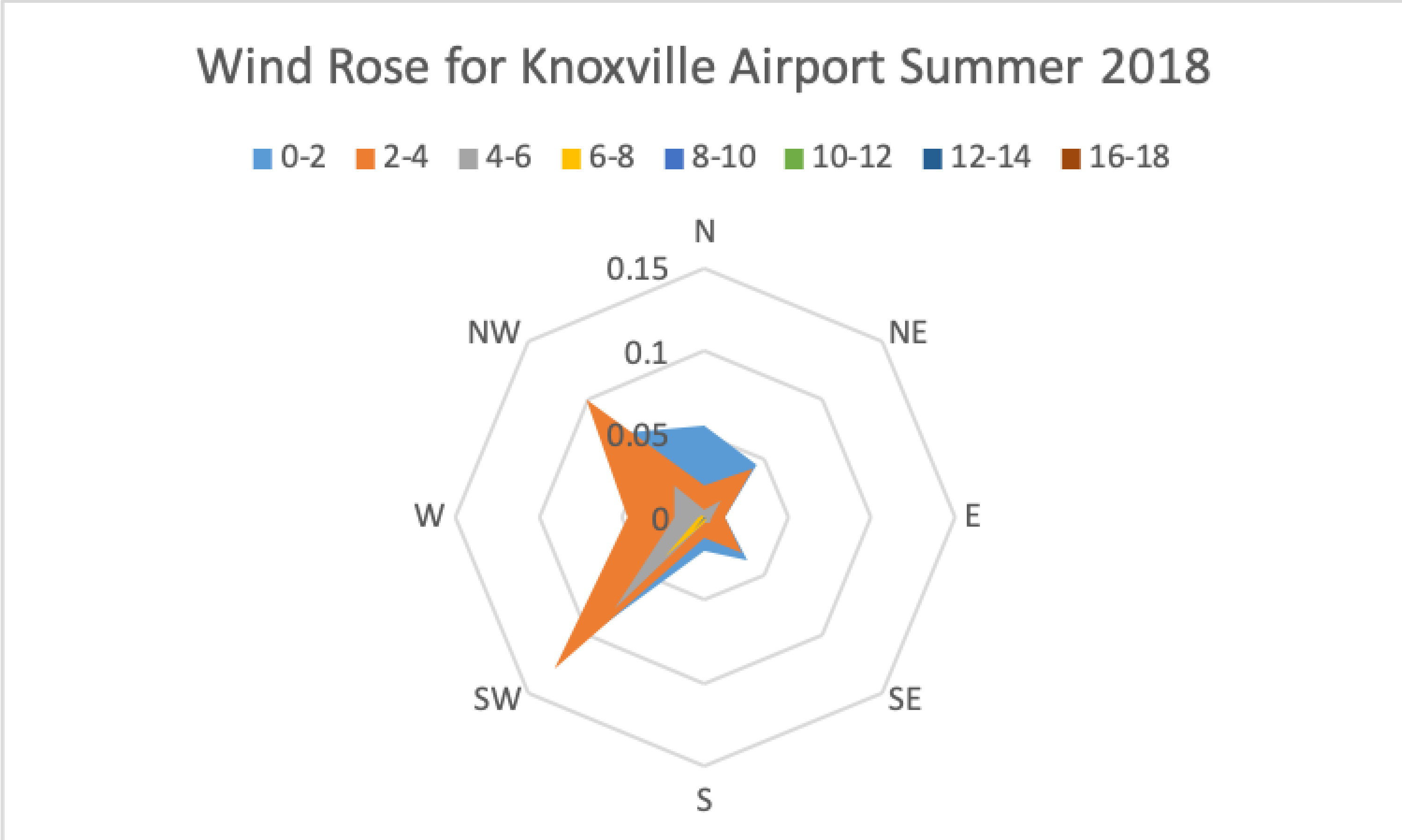
Wind Rose for Knoxville Airport Summer 2018
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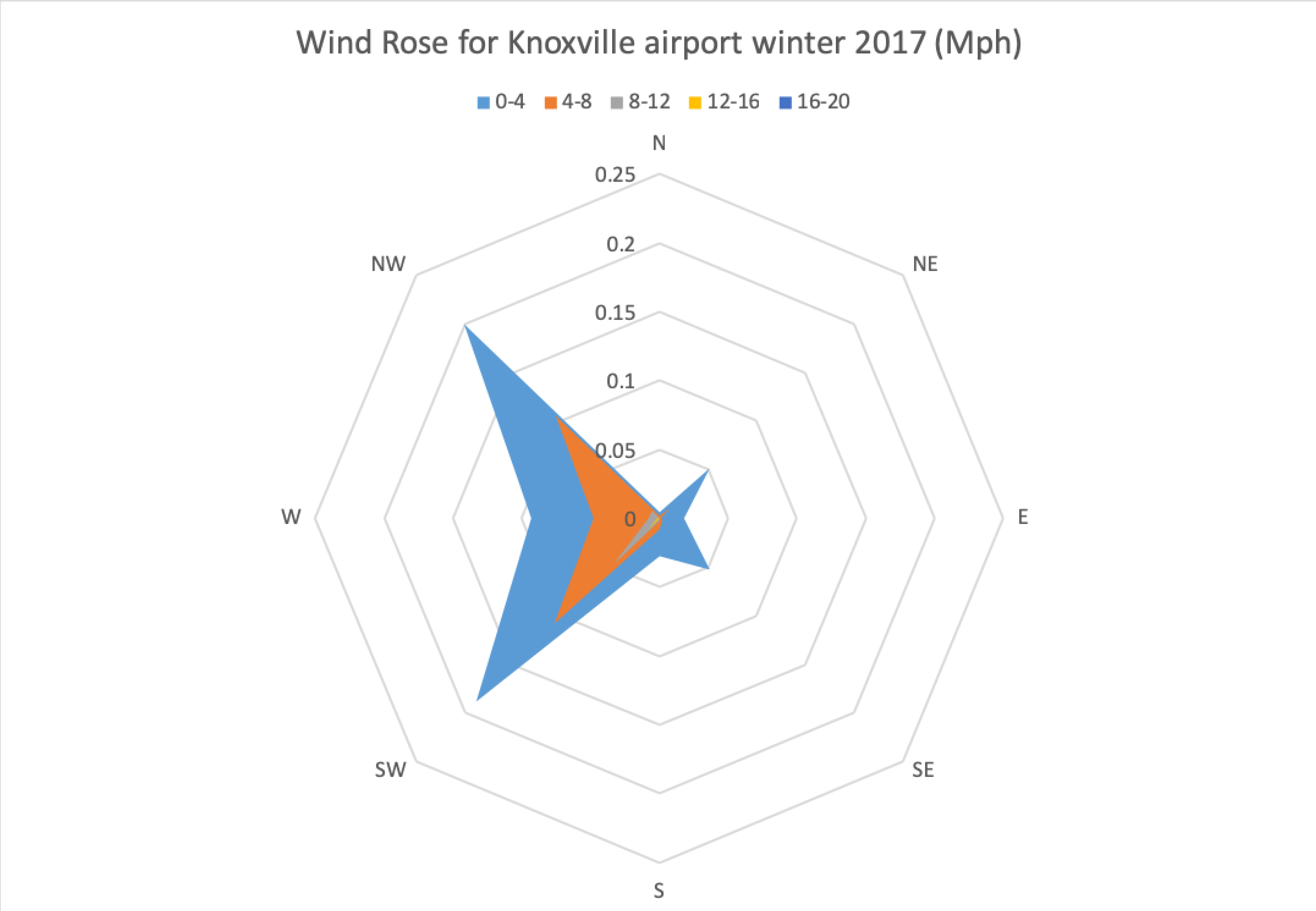
Wind Rose for Knoxville airport winter 2017 (Mph)
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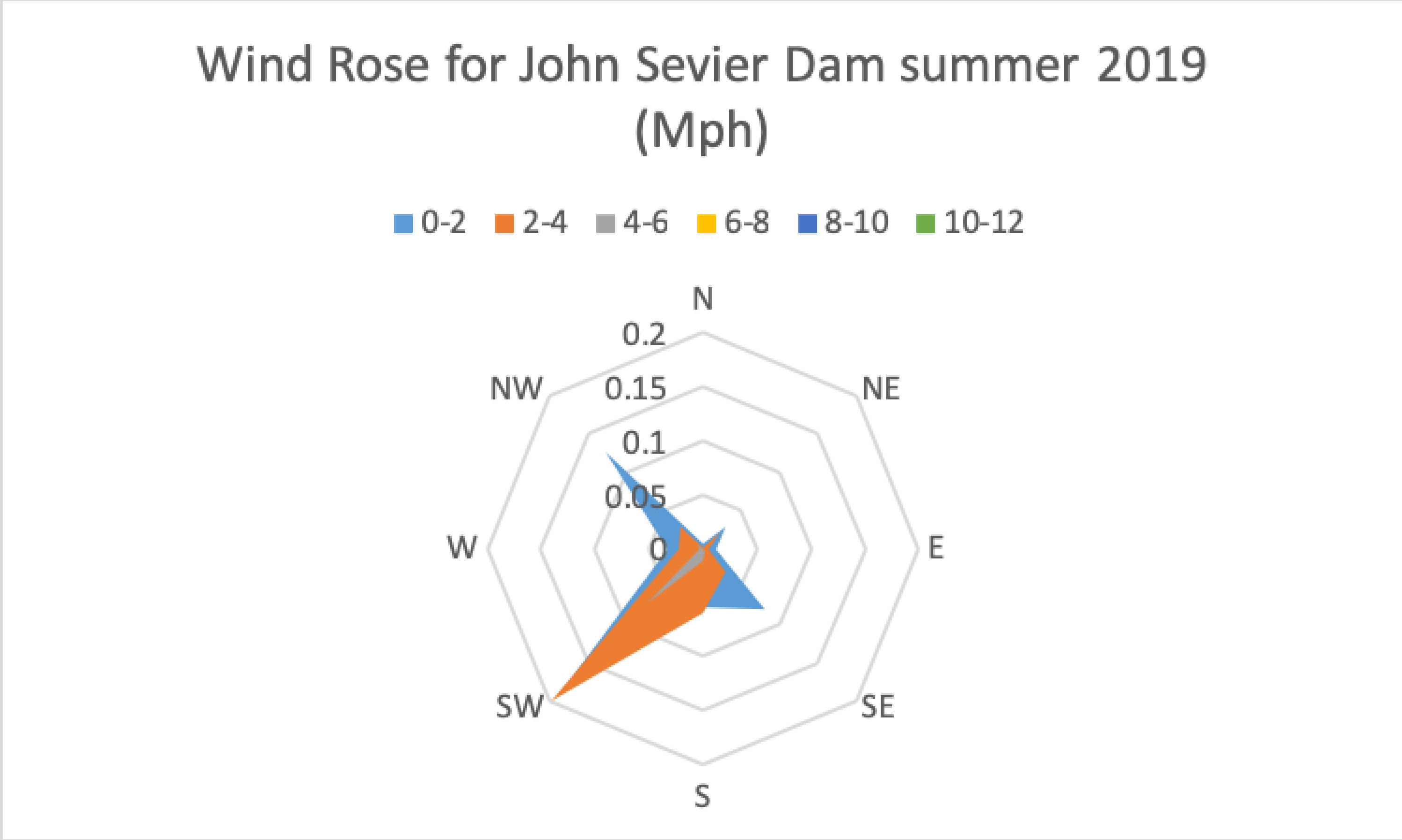
Wind Rose for John Sevier Dam summer 2019 (Mph)
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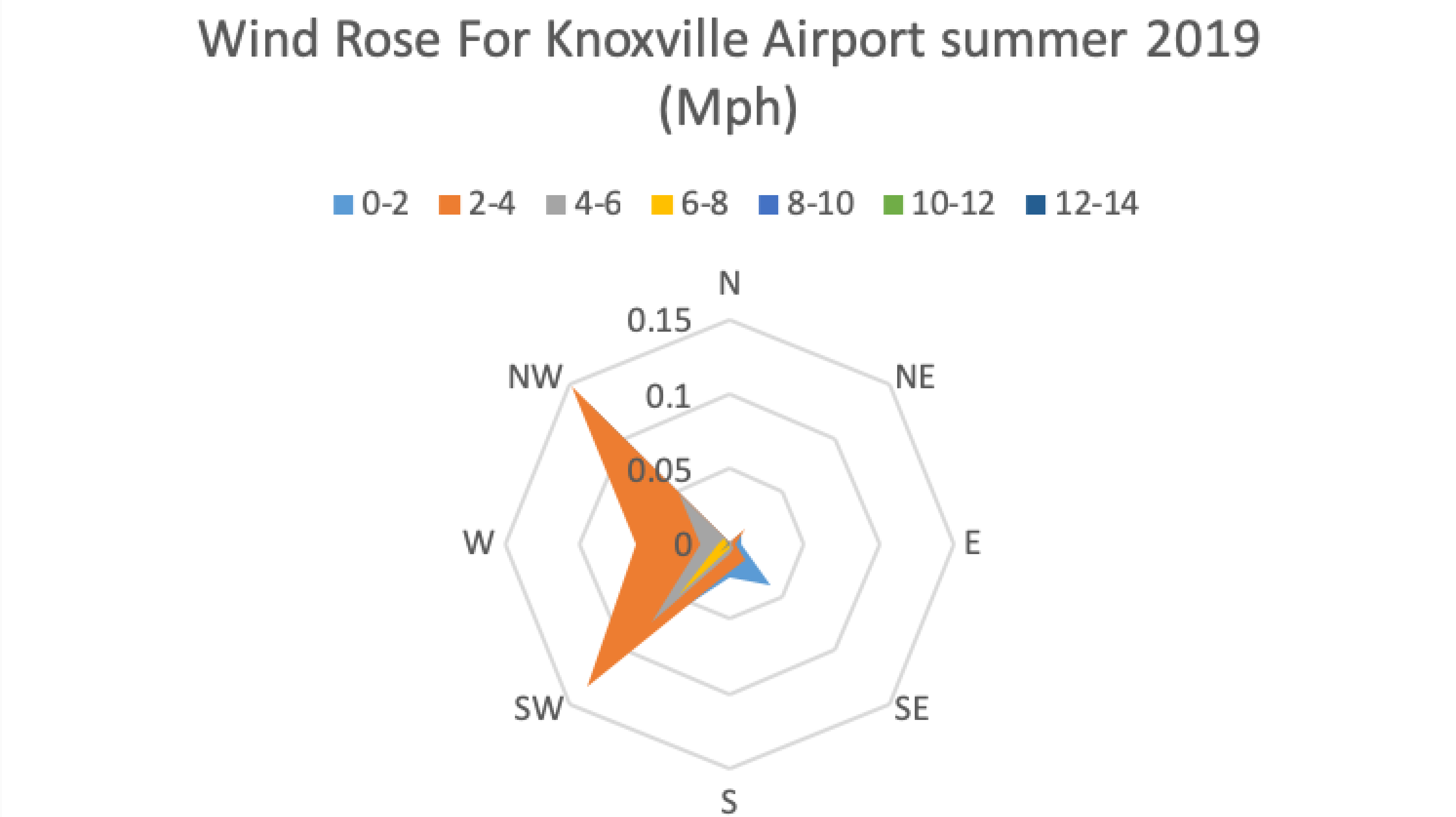
Wind Rose For Knoxville Airport summer 2019 (Mph)
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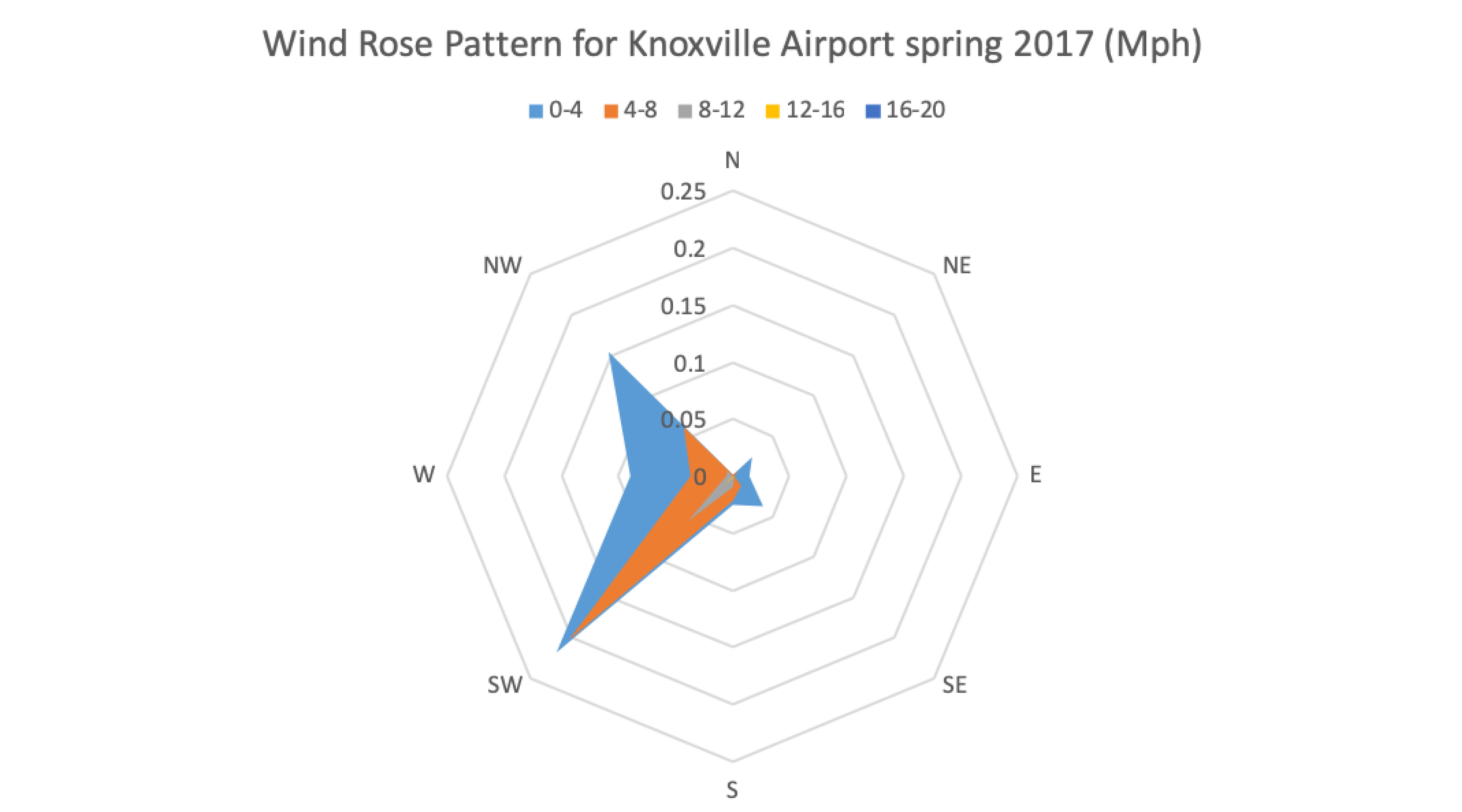

Wind Rose Pattern for Knoxville Airport spring 2017 (Mph)
0-4
4-8
8-12
12-16
16-20
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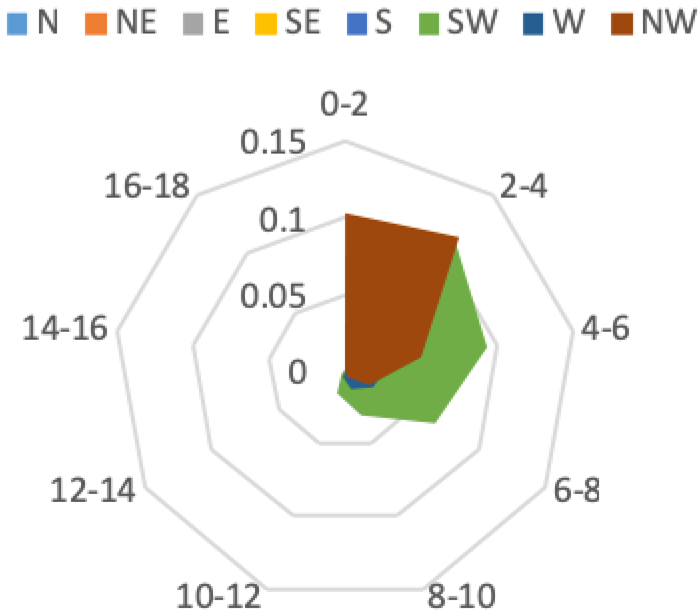
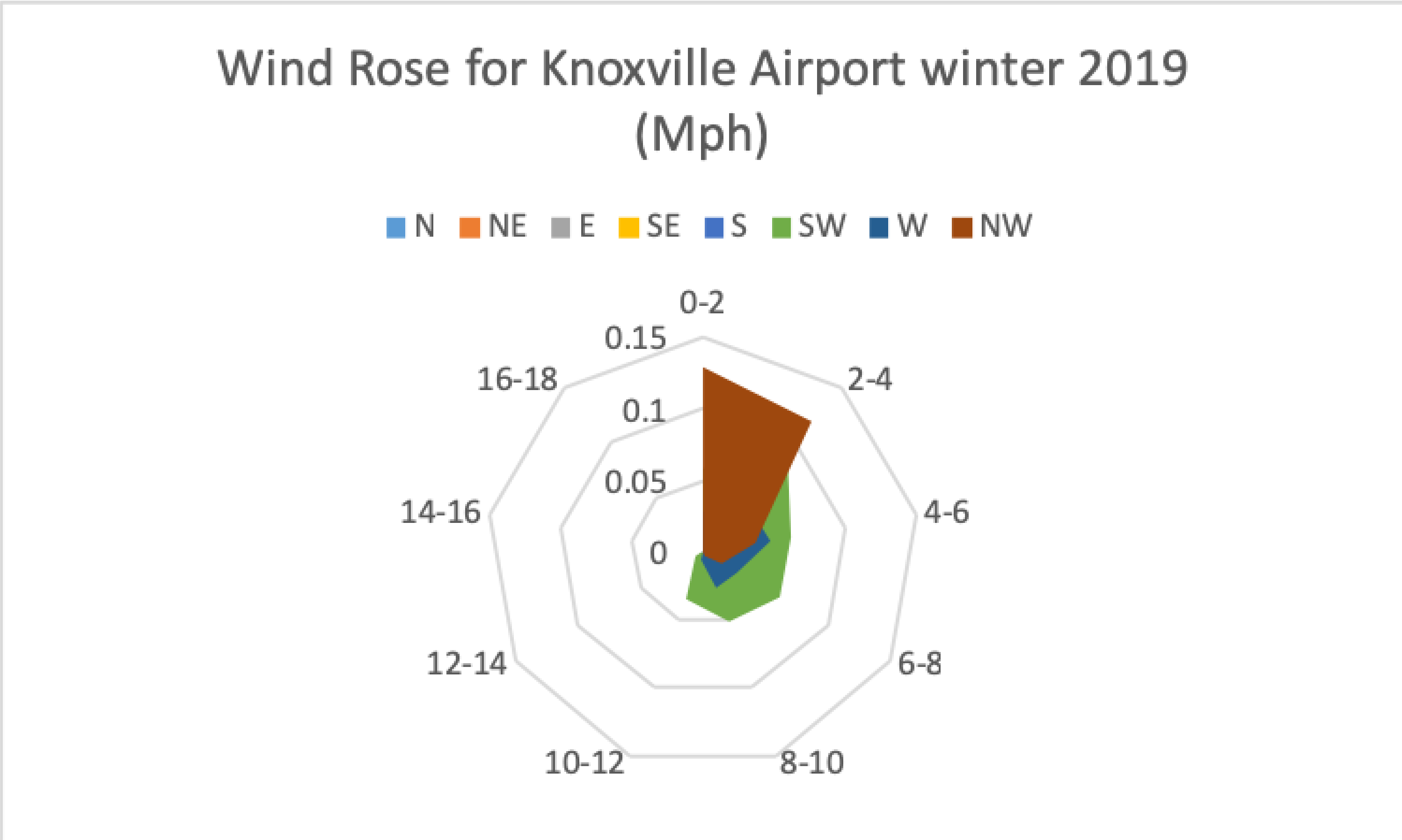
Wind Rose for Knoxville airport spring 2019 (Mph)





Wind Rose for Knoxville Airport winter 2019 (Mph)
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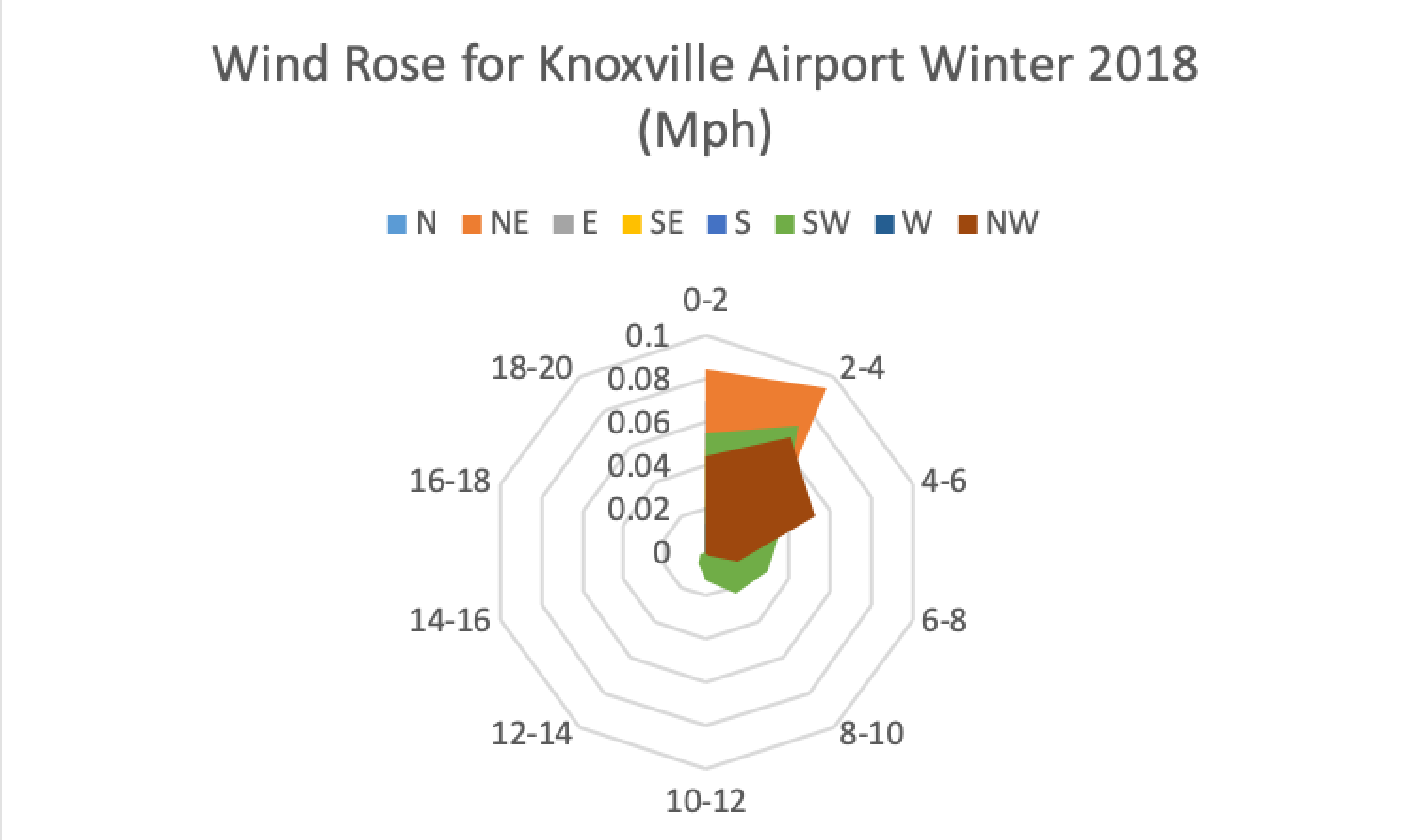
Wind Rose for Knoxville Airport Winter 2018 (Mph)
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Appendix C: Estimate of Cost Documents

Total Boom Length	600	ft
Boom Section Lengths	10	ft
Spacing Between Boom Section	0.9	ft
How Many Boom Sections	55	
How Many Boom Connection Points	53	

Estimation of Probable Cost for Materials				
Part Description	**Price per Part**	**Quantity Needed**	**Total Cost**	**Discount**
1/2" Shackle to Anchor	5.3	5	26.5	0%
Debris Screen (TUFFBOOM), 24" Depth	552.28	55	27945.368	8%
10 Foot TUFFBOOM Sections	609.03	55	33441.247	10%
Bottom Plate for Debris Screen	45.41	55	2372.6725	5%
Bottom Plate for TUFFBOOM	30.59	55	1598.3275	5%
2 Hinged Links at Each Connection Point	9.5	106	1007	0%
Debris Screen Connection Chain	7.7	53	408.1	0%
Debris Screen Connection Chain Quick Link	2.8	53	148.4	0%
10' Internal Steel Channel Sections	122.5	55	6737.5	0%
On-Site Consultation Service	1960	Per Day	1960	0%
Assembly for Debris Screens	637.2	55	31541.4	10%
2x2x2' Concrete Anchors	50	5	250	0%
1 3/4" Cable to Boom	200	1	200	0%
3x3x3' Concrete Anchor	80	1	80	0%
Winches	200	7	1400	0%
Dock Fender Chain (per foot)	42.87	150	6430.5	0%
		Total Cost of Materials	**115547.015**	

WORTHINGTON
Waterway Barriers

GENERAL SERVICES ADMINISTRATION
FEDERAL SUPPLY SERVICE

AUTHORIZED FEDERAL SUPPLY SCHEDULE PRICE LIST

On-line access to contract ordering information, terms and conditions, up-to-date pricing, and the option to create an electronic delivery order are available through GSA Advantage!, a menu-driven database system. The INTERNET address GSA *Advantage!* is: GSAAdvantage.gov.

Schedule: 084
Total Solutions for Law Enforcement and Security

FSC Group 1945
SIN 260-12, 260-98, 260-99

Contract Number: GS-07F-0069M
Modification No.: PA-0033, March 10, 2017

For more information on ordering from Federal Supply Schedules click on the FSS Schedules button at fss.gsa.gov.

Contract Period:

Worthington Products, LLC
3405 Kuemerle Ave NE
Canton, Ohio 44705

tuffboom.com
800-899-2977 / 330-452-7400 (Phone)
330-452-7495 (Fax)

CONTRACT ADMINISTRATOR: Paul Meeks
gsasales@tuffboom.com

SMALL BUSINESS (NAICS: 326121, 326140)

CUSTOMER INFORMATION:

1a: Table of Awarded SPECIAL ITEM NUMBERS (SINs)

SIN	Product Description
260-12	Floating Marine Barriers and Booms, Floats, Perimeter Floats, and Moorings - Includes parts and accessories
260-98	Ancillary Services - Includes, but is not limited to installation of Boat Modification Packages, Training and Consultation
260-99	Introduction of New Products and Services Items Directly Related to Marine Equipment

1b: Lowest priced model number and price:

SIN	Product Description	Part Number	Price
260-12	Galvanizing Charge	Galv Charge	0.90

1c: Hourly Rates: Not Applicable

2: Maximum Order:

SIN 260-12	$300,000
SIN 260-98	$315,000
SIN 260-99	$100,000

A delivery order that exceeds the maximum order may be placed under the schedule contract in accordance with FAR 8.404. *If the "best value" selection places your order above the Maximum Order, identified in this catalog/price list, you have an opportunity to obtain a better schedule contract price. Before placing your order, contact the aforementioned contractor for a better price. The contractor may (1) offer a new price for this requirement (2) offer the lowest price available under this contract or (3) decline the order. A delivery order that exceeds the maximum order may be placed under the schedule contract in accordance with FAR 8.404.

3: Minimum Order: $25.00

4: Geographic Coverage (delivery area): 48 Contiguous states, Alaska, Hawaii, Puerto Rico and Washington D.C..

5: Points of Production: Harding County, Ohio / Stark County, Ohio

6: Discount from List Prices: Prices shown herein are net prices (discounts and IFF added)

7: Quantity Discounts: Discounts shown on attached price table

8: Prompt Payment Terms: 2%/10, Net 30

9a: Government purchase cards accepted at or below the micro-purchase threshold. Yes

9b: Government purchase cards accepted above the micro-purchase threshold. Yes

10: Foreign Items: Anchor shackle body (excl. bolt, nut, cotter) manufactured in China

CUSTOMER INFORMATION:

11a: Time of Delivery: 7-days to 120 days dependent on stock and special modifications

11b: Expedited Delivery: Available. Contact Worthington for details

11c: Overnight and 2-Day Delivery: Available on some items. Contact Worthington for details

11d: Urgent Requirements: Contact Worthington for details

12: FOB Point: FOB Origin, Canton, Ohio (Freight prepaid and added to invoice)

13a: Ordering address:

Worthington Products, LLC
3405 Kuemerle Ave NE
Canton, OH 44705

Attn: Paul Meeks
Tel: 800-899-2977 / 330-452-7400
Fax: 330-452-7495
gsasales@tuffboom.com

13b: Ordering Procedures: For supplies and services, the ordering procedures, information on Blanket Purchase Agreements (BPAs), and a sample BPA can be found at the GSA/FSS Schedule homepage (fss.gsa.gov/schedules).

14: Payment Address:

Worthington Products, LLC
3405 Kuemerle Ave NE
Canton, Ohio 44705

15: Warranty Provision: 90-days from date of shipment

16: Export Packing Charges: Not Applicable

17: Terms and conditions of Government purchase card acceptance (any thresholds above the micro-purchase level.): Not Applicable

18: Terms and conditions of rental, maintenance, and repair: Not Applicable

19: Terms and conditions of installation: Not Applicable

20: Terms and conditions of repair parts: Not Applicable

20a: Terms and conditions for any other services: Not Applicable

21: List Service and Distribution Points: Not Applicable

22: List of participating dealers: Not Applicable

23: Preventative maintenance: Not Applicable

24a: Special attributes: Not Applicable

24b: Section 508 Compliance for EIT: N/A

CUSTOMER INFORMATION:

25: DUNS Number: 00-761-2927
TIN: 31-155-7455
CAGE Code: 1VX20

26: Registered in Central Contractor Registration Database (CCR): Registration valid until 4/10/2013

27: Uncompensated Overtime: Not Applicable

End.

FUN FACTS:

We are helping to make America strong. Our high quality Made in the USA barriers are now found in more than 59 countries since 2000.

Our largest project was in Brazil where we shipped more 485 standard 40-foot ocean containers of MADE IN AMERICA barriers to a new hydroelectric plant in Brazil.

We are very proud of our 2017 shipment of TUFFCAT Security Barriers to the US Army for placement upstream & downstream of all bridges in the "Green Zone" in Iraq to protect against terrorist attack.

We make floating barriers walls called fish guidance system that have demonstrated great results in guiding young salmon away from dams and turbines as they migrate downstream.

In 2017, we introduced several NEW products including a larger diameter TUFFBOOM & BoatBuster floats, new sign floats and we patented several new designs that make the booms more reliable and longer lasting.

Our international sales people each rack up more than 100,000 airline miles, often before June of each year…ouch, those are some sore rear ends….. And they still can't qualify for an upgrade on Delta Airlines. Go figure!

Our official warehouse cat is a friendly white cat we saved from the Humane Society. Her name is "Warehouse Kitty".

If it is a nice day in April, we can be found out on the water offering FREE inspections of boom lines to our local Corps of Engineers clients. They are free because we are looking for any excuse we can find to get out of the office and on the water. And, yes, there may be a fishing line or two dangling from our boats.

WPI Part No.	Description	GSA Price	UOM	SIN	Discount
Anchor Plate - 12x100	Anchor Plate 18x100	735.00	ea	260-12	0
CS-100	Anchor Shackle - 1"	61.30	ea	260-12	0
CS-1/2" Safety Shackle	Anchor Shackle - 1/2"	5.30	ea	260-12	0
CS-150 Galv	Anchor Shackle - 1-1/2"	257.30	ea	260-12	0
CS-125 Galv	Anchor Shackle - 1-1/4"	151.90	ea	260-12	0
CS-3/4" Safety (2016)	Anchor Shackle - 3/4"	48.80	ea	260-12	0
LHD Barrier Assy	BB Sign Float Assy (Complete)	1,903.90	ea	260-12	0.05
SCA - Lug Plate	BB-20 End Connector Lug Plates	139.65	ea	260-12	0.05
S11058-Dresden Front Screen	BB-20 Lower Debris Screen 3ft depth	3,307.50	ea	260-12	0
S11058-MainHozWalkway	BB-20 Walking Barrier Upper Platform	13,475.00	ea	260-12	0
Boat Passage Beam 12ft	Boat Passage Beam - 12 ft	3,920.00	ea	260-12	0
BBA-S /100 (2014)	BoatBuster Assembly Complete	1,552.49	ea	260-12	0.05
BPFA-Boat Passage WP13042	BoatBuster Boat Passage L/R Floating Assemblies	3,613.80	ea	260-12	0
BBA - Float Collar	BoatBuster Float Collar Slide Assembly Complete	7,477.40	ea	260-12	0
BBMA-IL S (2016)	BoatBuster In-Line Mooring Buoy, Complete Assembly	3,456.39	ea	260-12	0.05
BBMA-ML S (2016)	BoatBuster Multi-Line Mooring Buoy, Complete Assembly	3,264.20	ea	260-12	0.05
BB36.48 /O	BoatBuster Replacement 1/2 Shell	509.60	ea	260-12	0
npm	BoatBuster-20 - Additional Screen per foot of depth	490.00	ft	260-12	0
WP13021-Goshen BB20A	BoatBuster-20 Debris Barrier, Standard Design w/ Outriggers, Complete.	7,840.00	ea	260-12	0
npm	BoatBuster-20 Extreme Debris Barrier, 10 foot frontal screens, complete assembly	25,284.00	ea	260-12	0
npm	BoatBuster-20 Extreme Debris Barrier, 5 foot frontal screens, complete assembly	18,720.50	ea	260-12	0
WP16009 - BB20-LD Frame	BoatBuster-20 L/D complete assembly, designed for 2 floats	6,338.20	ea	260-12	0
0	BoatBuster-20 L/D w/ outriggers, complete assembly, designed 2 floats	7,403.90	ea	260-12	0
BBBG-WP13001	BoatGate - BoatBuster	14,700.00	ea	260-12	0
BP-58 SCR G	Bottom Plate - Debris Screen - TUFFBOOM	45.41	ea	260-12	0.05
BP-16003-28/SCR/G	Bottom Plate - Debris Screens - TUFFBOOM - 2017	58.80	ea	260-12	0
BP-58 RG	Bottom Plate - Riser Post - TUFFBOOM	59.38	ea	260-12	0.05
BP-58 G	Bottom Plate - TUFFBOOM	30.59	ea	260-12	0.05
BP-16003-28/G	Bottom Plate - TUFFBOOM - 2017	49.00	ea	260-12	0
Chain - DFC-1"	Chain - DFC-1" Dock Fender Chain, GR80	67.62	ft	260-12	0.08
Chain - DFC-3/4"	Chain - DFC-3/4" Dock Fender Chain, GR80	42.87	ft	260-12	0.08

SCR - Chain	Debris Screen connection chain	7.70	ea	260-12	0
SCR - Quick Link	Debris Screen connection chain quick link	2.80	ea	260-12	0
SCR-12/2011	Debris Screen(TUFFBOOM), 12" Depth, HDG	486.86	ea	260-12	0.08
SCR-24/2011	Debris Screen(TUFFBOOM), 24" Depth, HDG	552.28	ea	260-12	0.08
SCR-36/2011	Debris Screen(TUFFBOOM), 36" Depth, HDG	577.02	ea	260-12	0.08
SCR-48/2011	Debris Screen(TUFFBOOM), 48" Depth, HDG	633.42	ea	260-12	0.08
Deflector Plate	Deflector Plates - Half-Round - TUFFBOOM	28.20	ea	260-12	0
Design/Engineering	Engineering/Design	205.34	Hour	260-12	0.08
galv charge	Galvanizing Charge	0.90	lb	260-12	0
Deflector Plate Mount Bracket	Guide Rail for URE Deflector Panel (ea)	33.82	set	260-12	0.05
Int Channel - HDG	Internal Steel Channel HDG	122.50	ea	260-12	0
WP16001 - Kayak Frame	Kayak Gate - 32" opening max.	673.80	ea	260-12	0
RP32 - Light	Lightpost, 2" dia x 32" long	61.30	ea	260-12	0
MIG - Artwork	MIG Graphics - Artwork Fee	2,850.00	l/s	260-12	0.05
MIG - Special	MIG Graphics - Custom	46.08	ea	260-12	0.05
MIG - Setup	MIG Graphics - Mold Setup Charge	380.00	LS	260-12	0.05
MIG - DAKA	MIG Graphics - Standard Stock Graphics	48.50	ea	260-12	0
Site Services	On-Site Consultation Service	1,960.00	Per day	260-12	0
Reflective Film - Red 2"	Reflective Tape - 2" wide, Red	2.20	ft	260-12	0
Reflective Film - Red 6"	Reflective Tape - 6" wide, Red	3.50	ft	260-12	0
RP-32FG	Riser Post, 2" dia, 32" long	69.90	ea	260-12	0
SCB-32/2011	SCB-32/2011 Extra Wide Sign Frame	3,552.50	ea	260-12	0
SCB-32/2011	SCB-32/2011 frame	1,041.30	ea	260-12	0
SCB-32/2011-Post	SCB-32/2011 Post Assembly w/ Rubber Pad	192.40	ea	260-12	0
SCB-32/2011-Post	SCB-32/2011 Sign Posts	192.40	ea	260-12	0
WP14011 - SliBeam Vernon	Slide Beam - W12 x 72 x 20ft, 4 lugs, HDG	4,165.00	ea	260-12	0
WP14039 - SliBeam	Slide Beam - W12 x 96 x 20ft, 4 lugs, HDG	6,125.00	ea	260-12	0
WP14011 - SliBeam Piv Plt	Slide Beam Pivot Plate (W14011)	698.30	ea	260-12	0
WP14011 - SliBeam Stop Plt	Slide Beam Stop Plate (WP14039)	306.30	ea	260-12	0
Light - 1NM Amber	Solar Marine Lantern - 1NM	363.09	ea	260-12	0.05
Light - 2NM	Solar Marine Lantern - 2NM	754.60	ea	260-12	0
TBA-S /58G	TUFFBOOM Assembly	609.03	ea	260-12	1 to 240 @ 10%, 241 to 360 @ 15%
TBA-S /58SCRG	TUFFBOOM Assembly for Debris Screens	637.20	ea	260-12	1 to 240 @ 10%, 241 to 360 @ 15%

TBA-S /DP/58G	TUFFBOOM Assembly w/ Deflector Plate Guides	643.05	ea	260-12	1 to 240 @ 10%, 241 to 360 @ 15%
TBA-S /DP/58SCRG	TUFFBOOM Assembly w/ Deflector Plate Guides for Debris Screens	671.22	ea	260-12	1 to 240 @ 10%, 241 to 360 @ 15%
Color Surcharge	TUFFBOOM COLOR Setup	400.00	LS	260-12	0
TUFF-16 S	TUFFBOOM Replacement Float	542.61	ea	260-12	1 to 240 @ 10%, 241 to 360 @ 15%
RB1362W	TUFFBUOY - 13" Regulatory Buoy	307.61	ea	260-12	0.05
RB961W	TUFFBUOY - 9" Regulatory Buoy	182.88	ea	260-12	0.05
FCCB-1428W	TUFFBUOY - Float Collar Can Buoy w/ External ballast	565.25	ea	260-12	0.05
FWFCCB-1428W	TUFFBUOY - Float Collar Can Buoy w/ eye in front	448.88	ea	260-12	0.05
SWFCCB-1428W	TUFFBUOY - Float Collar Can Buoy w/ eye on bottom	448.88	ea	260-12	0.05
T1318/PT-O	TUFFBUOY, 13"diax18"long/ Shape: Oval/ Internals: 1/2" dia PVC Pipe	108.11	ea	260-12	0.05
T1318/SE-O	TUFFBUOY, 13"diax18"long/ Shape: Oval/ Internals: 1/2" rod w/ Swivel Eye	121.41	ea	260-12	0.05
T1830/PT-O	TUFFBUOY, 18"diax30"long/ Shape: Oval/ Internals: 1" dia galv pipe	157.99	ea	260-12	0.05
T1830/SE-O	TUFFBUOY, 18"diax30"long/ Shape: Oval/ Internals: 5/8" rod w/ Swivel Eye	166.25	ea	260-12	0.05
T2436/PT-O	TUFFBUOY, 24"diax36"long/ Shape: Oval/ Internals: 1" dia galv pipe	307.61	ea	260-12	0.05
T2436/SE-O	TUFFBUOY, 24"diax36"long/ Shape: Oval/ Internals: 3/4" rod w/ Swivel Eye	307.61	ea	260-12	0.05
T2445/PT-O	TUFFBUOY, 24"diax45"long/ Shape: Oval/ Internals: 1" dia galv pipe	422.28	ea	260-12	0.05
T2445/SE-O	TUFFBUOY, 24"diax45"long/ Shape: Oval/ Internals: 3/4" rod w/ Swivel Eye	432.25	ea	260-12	0.05
T1313/SE-O	TUFFBUOY, Dia: 13"/ Shape: Round/ Internals: 1/2" dia Rod w/ Swivel Eye	88.16	ea	260-12	0.05
T1313/PT-O	TUFFBUOY, Dia: 13"/ Shape: Round/ Internals: PVC Pipe	68.21	ea	260-12	0.05
T1818/SE-O	TUFFBUOY, Dia: 18"/ Shape: Round/ Internals: 5/8" dia Rod w/ Swivel Eye	133.00	ea	260-12	0.05
T1818/PT-O	TUFFBUOY, Dia: 18"/ Shape: Round/ Internals: dia 1" galv pipe	113.05	ea	260-12	0.05
T2424/SE-O	TUFFBUOY, Dia: 24"/ Shape: Round/ Internals: 5/8" dia Rod w/ Swivel Eye	199.50	ea	260-12	0.05
T2424/PT-O	TUFFBUOY, Dia: 24"/ Shape: Round/ Internals: dia 1" galv pipe	196.18	ea	260-12	0.05
TUFF-10 S	TUFFCAT 10ft Float	951.19	ea	260-12	0.02
TUFF-5 S	TUFFCAT 5ft Float	590.84	ea	260-12	0.02
Def Panel - URE - 20.25 ORG	URE TUFFBOOM Deflector Panel	33.12	ea	260-12	0.1
WL-3/4 (2015)	Weldless Link - TUFFBOOM - 2015 Design	9.50	ea	260-12	0
WL - 3/4 HDG	Weldless Master Link - 3/4" HDG	60.70	ea	260-12	0

NOTES:

1. GSA Price shown represents the list price less any GSA discounts for a quantity of one (1) plus the IFF fee.
2. Quantity discounts, if any, are shown in this column.
3. Surcharges are variable and are based on the current steel charges in effect at the time of order.

Worthington | TUFFBOOM

TUFFBOOM barriers have been the choice of dam operators worldwide for controlling surface debris and satisfying regulatory guidelines for public safety. These 10' (3m) modular units link together to form unlimited length boom lines. Our patented Zero Gap deflector system eliminates the gap between units. For Public Safety, we've redesigned our connections to assure that the spacing between units is never more than 12". Accessories include high visibility mold-in graphics, hanging debris skirts, boat gates, solar lights and more.

TUFFBOOM is made from thick-walled, UV resistant resin. Each boom includes a high load bearing internal steel channel through which all boom-to-boom connections are bolted. Each boom is fully filled with closed-cell foam making these booms are truly unsinkable.

Whether your goal is to stop a 50' (15m) long tree or keep boaters a safe distance from your dam, the solution is simple. The solution is TUFFBOOM.

Worthington | TUFFBOOM

Features (At-A-Glance)

- Heavy-wall impact resistant polyethylene with max. UV resistance.
- Unsinkable solid internal core of non-water absorbing foam fill. Maintains buoyancy even when punctured.
- High load bearing internal steel channel provides strength and ballast, resists horizontal and vertical loads.
- TUFFBolt Hardware for superior connection integrity.
- Zero Gap built in design between units.
- Connections designed for continuous motion and heavy loads.
- Mold-in Graphics™ with standard or customized warnings.
- Exceptional debris load capacity.
- Available in International Orange, Safety Yellow, Log Boom Brown, Forest Green, Black, White, Red, Navy Gray, Sand Tan.
- High Visibility, high buoyancy for maximum freeboard visibility.
- Anchor components designed to site specific conditions.
- Assembles easily with little or no equipment required.
- Thousands of units installed worldwide with proven results.

Quick Specifications

Diameter:
16” (40.6 cm)

Single Float Length:
120 in (3.05m)

Center-Center Length:
136 in (3.45m)

Weight (dry):
141 lbs. (64 kg)

Buoyancy:
700 lbs. (317 kg)

Freeboard:
12” (30.5 cm)

Design Strength:
47 kips

Spacing Between Units:
11” (27.9 cm)






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GSA Contract Holder

Worthington | **TUFF**Bolt Shackles

Of all components in your boom line, the shackle, and more specifically the shackle bolt, nut and cotter pin is the "glue" that holds the boom line together. We've spent the past 15-years evaluating and researching boom line performance in all conditions. The result of this dedication to perfection is our TUFFBolt shackle.

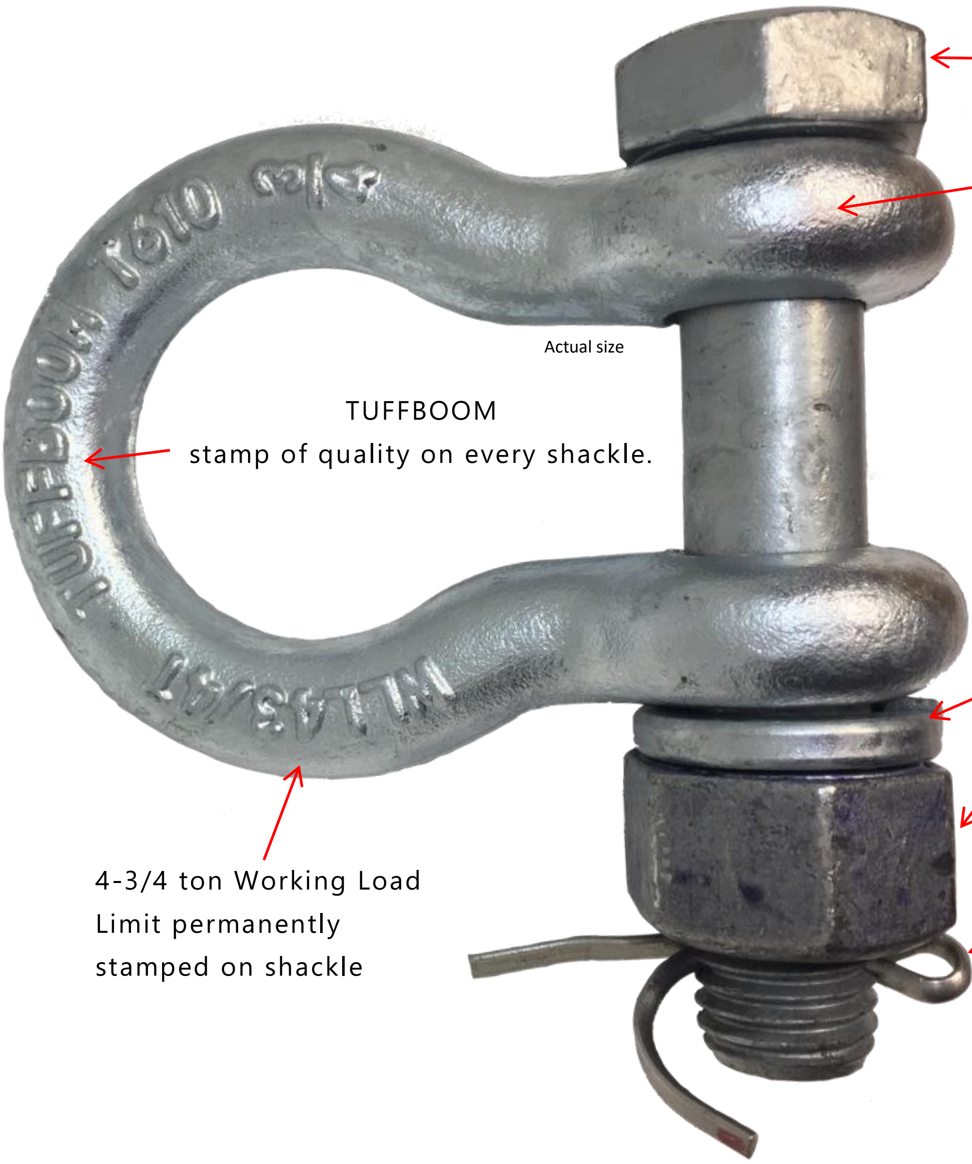
Why do all other brands use loose fitting tiny nuts and zinc-coated cotter pins? They are all designed for lifting and rigging applications. They were not designed to be permanently immersed in water for years at a time.

The zinc cotter pins corrode sometimes in as little as 3-months allowing the undersized and loose fitting nut to fall off the bolt pin. The result: your boom line breaks apart.

Only TUFFBolt shackles are designed specifically for long term boom applications. When you want the best shackle for the application, demand TUFFBolt. No other shackles can compare.

Worthington | **TUFF**Bolt Shackles

Features (At-A-Glance)



TUFFBOLT - made for boom applications

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GSA Contract Holder

Worthington | TUFFBOOM Maintenance

TUFFBOOM barriers are designed to require a minimal amount of attention after installation. However, they are subjected to unpredictable weather and water events that warrant periodic inspection of critical connections to assure integrity of the boom line. The following guidelines serve as general suggestions for annual maintenance/inspection

Inspection Item	30-day post Install	Fall Inspection	Spring Inspection	Annual Inspection	3-Year Inspection
Interboom Conenctions					
Shackle Bolts & Nuts	P	P	P		P
Cotter Pins	P	P	P	P	P
Bottom Plates	V	V	V	V	P
Debris Screen Connections					
3/4" Bolts/Nuts	P	P	P		P
Scheen Chain/Links	P	P	P		P
Mooring Buoys, In-water & Shoreline Anchors					
Anchor Rope/Cable	P	V	V	P	P
Anchor Shackles	P	V	V	P	P
Anchors	V	V	V	V	P
Mooring Buoys	V	V	V	V	P

"P" = Physical hands-on inspection. "V" = Visual Inspection.

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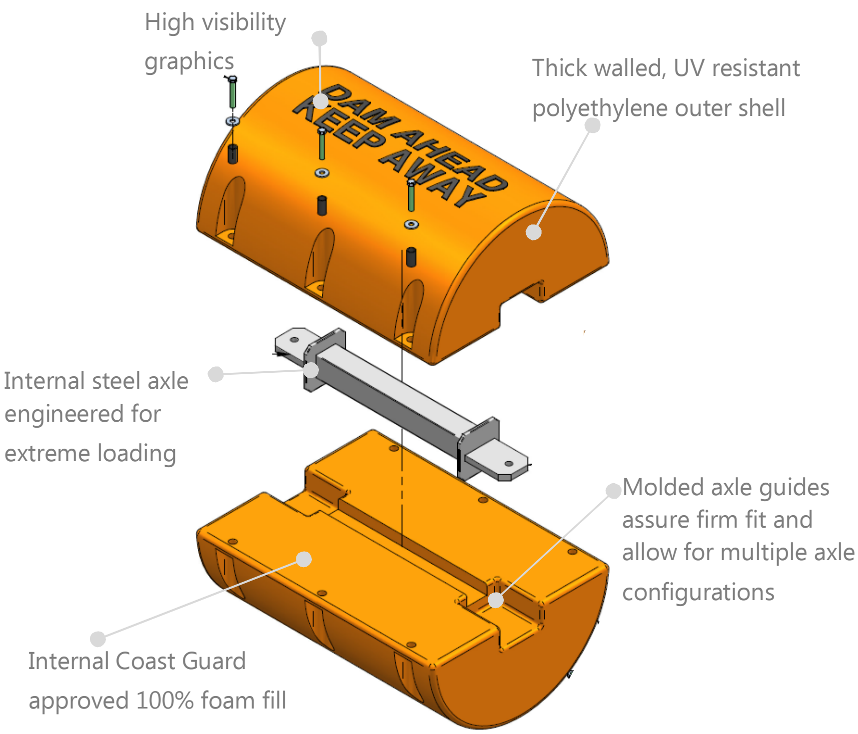
- Inter-boom Connections:
    - Shackle Bolt Nuts: Objective: Make sure each bolt has a hex head nut firmly affixed in place. This can be done via a simple visual inspection or by feeling for the nut with your hands.
    - Cotter Pin: Objective: Each shackle bolt should have a cotter pin secured in place with both legs of the cotter pin properly bent backwards. The cotter pin is a thinner piece of steel and even with galvanizing; it will corrode faster depending on water types. This is a critical item that should be inspected frequently. Local water conditions will determine the longevity of the cotter pins. We recommend at a minimum, the cotter pins be replaced every 2-years unless local conditions require more frequent replacement.
    - Bottom Plate: Looking for signs of excessive wear on bottom plate shackle bolt holes. Looking for holes that are oblong and no longer circular. If hole is oblong with less than 1/2'" steel between the edge of the hole and the end of the bottom plate, then the plate should be replaced.
- Debris Screen Connections:
    - Dia ¾" bolt/nut connection between screen and bottom plate: Objective, each screen should have a bolt and nut both screen ends. Check the bolt for visible wear and check for lose or missing nuts. Replace as needed.
    - Screen chain and quick link: Check for missing or worn chain and quick links. Replace as necessary.
- Mooring Buoys, In-Water Anchors, Shoreline Anchors:
    - Anchor Rope/Cable: Check for signs of fraying, corrosion, wear or other outward signs of damage. Replace repair as necessary.
    - Anchor Shackles: Check for wear and missing nuts and cotter pins. Replace as necessary.
    - Anchors: If an underwater visual inspection is not possible for in-water anchors, visually confirm the position of the boom lien and mooring buoys. If excessive sag or if the boom line appears out of position, this may be an indication that anchors have moved or anchor lines has broken.

Special Inspections: After any unusual weather/rain event in which the boom line experiences high wave, wind or flow action, it is suggested to conduct the above visual inspections to assure no connecting hardware is damaged or missing. Check position of anchor line buoys to determine if anchors have shifted position. If anchors have moved it may be necessary to reposition the anchors to the correct location.

The above are suggestions only and are based on generalized past experiences. Each location presents its own unique set of operational conditions. Inspection/Maintenance schedules should be adjusted by site personnel based on observations and local site conditions.

Worthington | BOATBUSTER



BoatBuster is an engineered, barrel style waterway barrier used primarily as a Public Safety Boat Barrier and for mid-level security. The custom half-shell design permits multiple site-specific configurations. Securely situated between each half-shell unit is a high strength structural steel axle able to accommodate a wide range of load scenarios and movement.

Each foam-filled unit is impact-resistant, unsinkable, highly visible, and highly buoyant; allowing the BoatBuster units to be used in a variety of environments.

BoatBuster's tough construction, engineered axle, and high strength connections make it ideal for use in fast flowing and turbulent waters such as in the tailrace of dams and spillways as well as across large bodies of water, where high visibility and a capacity to stand up to strong winds and waves is a must.

Worthington | BOATBUSTER

Features (At-A-Glance)

- Heavy-wall impact resistant polyethylene with max. UV resistance.
- Unsinkable solid core of Coast Guard certified non-water absorbing foam fill.
- Engineered Internal Steel axles with multiple connection possibilities.
- Grade 80 alloy chain connections between units.
- Half-shell design allows in-situ replacement of damaged float units.
- Designed for continuous motion and heavy loads.
- Mold-in Graphics™ with standard or customized warnings.
- Available in International Orange, Safety Yellow, White, Red or with customized colors.
- High freeboard for Excellent Visibility.
- Designed for year-round installations. No need to remove in ice.
- Boat gates, boat/kayak passages, marine lighting, shoreline connection plates are easily incorporated into the boom line.

Quick Specifications

Diameter:
36 in / 91.4 cm

Length:
48 in / 122 cm

Buoyancy:
1,800 lbs. / 816 kg

Weight (fully assembled):
225 lbs. / 102 kg

Colors:
Orange, Yellow, Red, White, Green, Brown

Load Capacity:
Varies with Components

Graphics:
Mold-On Millennium graphics

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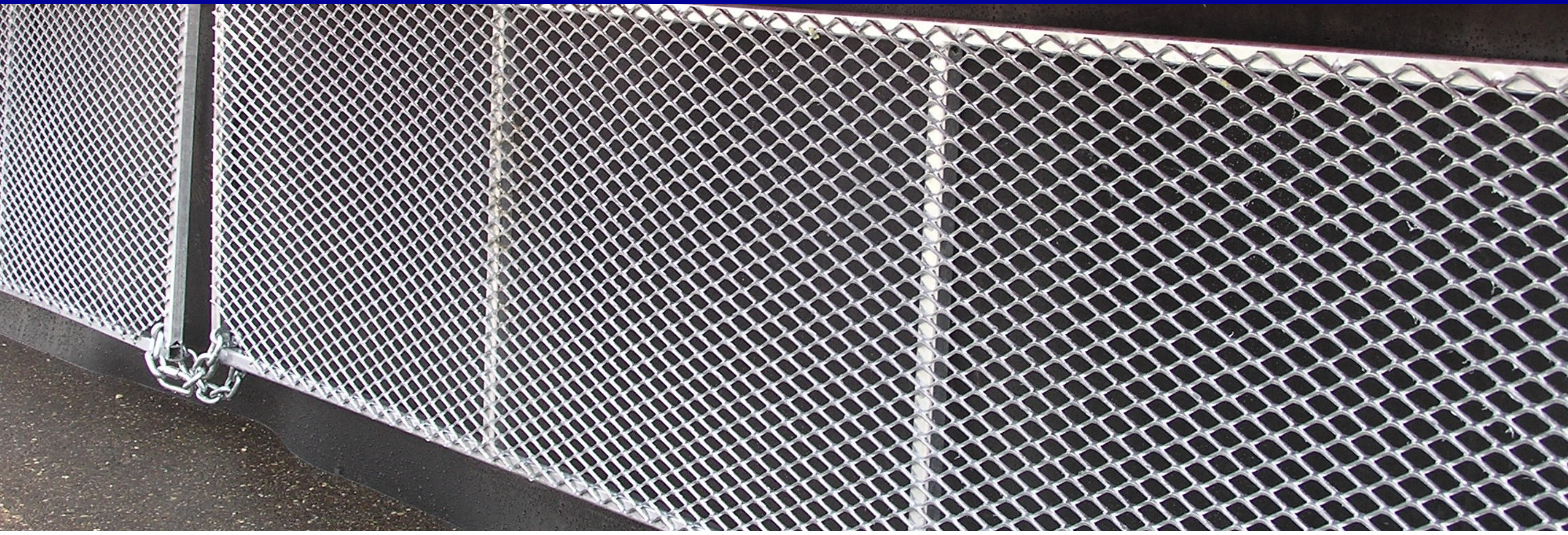
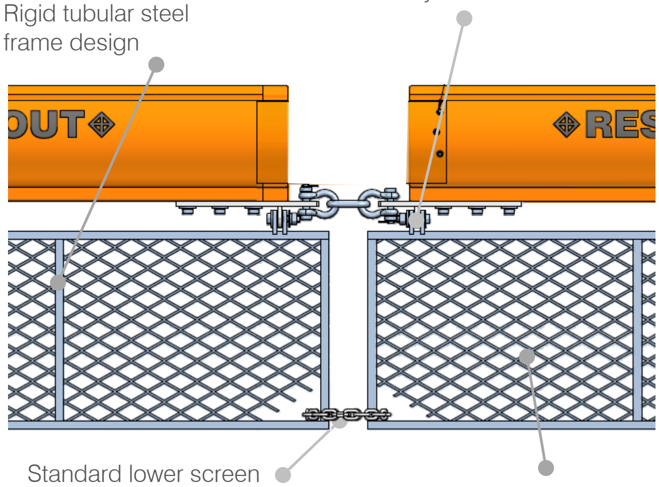
GSA Contract Holder

Worthington | Debris Screens





TUFFBOOM Debris Screens are the perfect compliment to your TUFFBOOM debris barrier for when you need to capture more than just surface debris and trash. Each screen is engineered to fit perfectly to TUFFBOOM barriers. Debris screens are designed to resist loading while also permitting freedom of movement as the booms move about in the water.

TUFFBOOM Debris Screens are fabricated from structural steel tubing and include horizontal and vertical supports to assure adequate debris loading capacity. Standard debris screens include a heavy metal mesh screen material designed for 100% blockage. Alternate screen facing materials from rubber, solid panels to wood are also available.

Worthington has designed its debris screens for long term immersion in tough application conditions. From the high strength hinged connections to the boom and the lower inter-unit chain connections, no detail has been overlooked.

When you need to catch sub-surface debris, the solution is simple. The solution is a TUFFBOOM Debris Screen.

Worthington | Debris Screens

Features (At-A-Glance)

- Tubular steel frame construction.
- Galvanized Steel (standard) or stainless steel option.
- Choice of screen facing material.
    - 3/4” Expanded Metal Mesh (Standard).
    - Multi-ply industrial rubber belting.
    - Perforated steel plate.
    - Treated lumber planking.
- Lower connection chain.
- Depth options from 12” to 48” (31cm to 122cm).
- Exceptional debris load capacity.
- Assembles easily with little or no equipment required.
- Tens of Thousands of units installed worldwide with proven results.

Quick Specifications

Length:
130” (3.3 m)

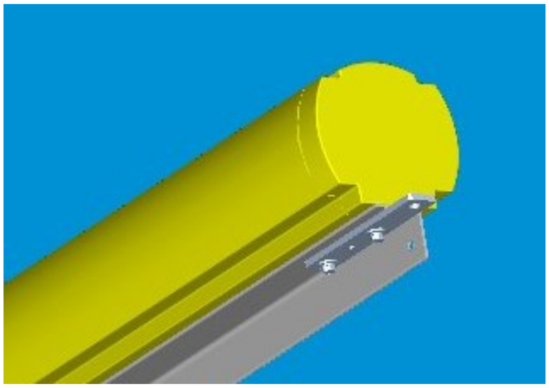
Depth:
12”, 24”, 36”, 48”
(31cm, 62cm, 92cm, 122cm)

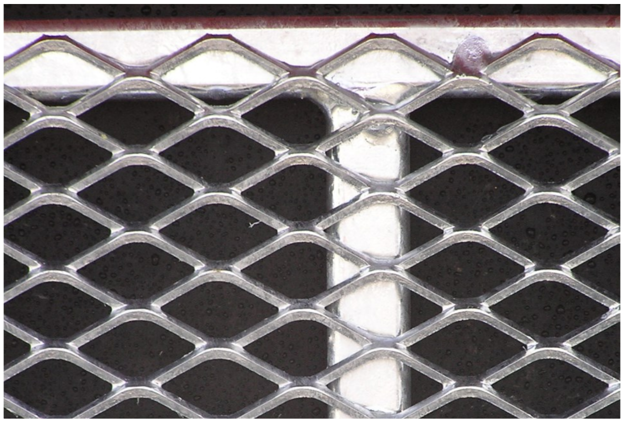
Weight:
90 to 110 lbs. (41 to 50 kg)

Finish:
Hot Dip Galvanized or Stainless

Connection to Boom:
2 Hinge connection points





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GSA Contract Holder

Site Design
Services

WORTHINGTON
Waterway Barriers

Services **(A-la-Carte)**

General Boom Line Tension Calculations
Anchor Design with Load Calculations
Detailed Project Plans

Site Design Services

Designed to meet your project requirements

Worthington offers multiple levels of site design services tailored to meet your on-site needs and capabilities. Our services are structured so that you can decide how much, or how little, engineering and design support you require to get your boom project up and running.

Level 1

Boom Tension Calculations

Used by clients who need just a little extra information so they can design anchorages themselves.

Complete load calculations for a single boom line based on data provided by the client. No site visit occurs. Design notes/calcs not included.

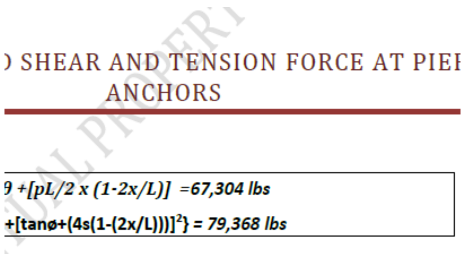
Boom layout drawing, provided by client, with reaction loads at anchor points indicated.

WPI stamped product drawings for existing product line only, does not include drawings for new product line or revisions to existing. Engineers stamp confirms products are engineered to resist a specified tensile load from a set of typical environmental conditions.

Client is responsible to confirm the environmental parameters meet their site specific codes and regulations.

Level 2

Anchor Design with Loads


) SHEAR AND TENSION FORCE AT PIE
ANCHORS

9 +[pL/2 x (1-2x/L)] =67,304 lbs

+[tanø+(4s(1-(2x/L)))]^{2}} = 79,368 lbs

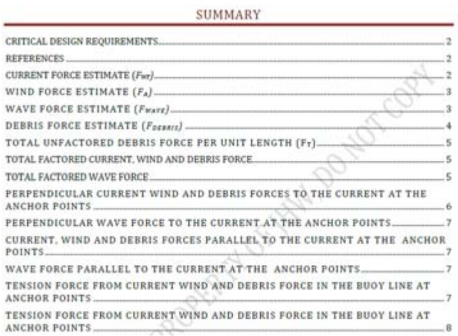
Level 1 service PLUS Worthington provides:

Suggested anchor drawings for soil type as specified by client including suggested connection hardware (client to confirm and approve design meets local site conditions, codes, regulations)

The engineering company remains responsible to ensure the in-situ soil or rock characteristics and/or concrete meets the design requirements specified in Worthington's documentation.

Level 3

Detailed Project Plans


SUMMARY

The "Detailed Project Plan" fully encompasses the design of the barrier system, anchorages, moorings, and individual components.

A Worthington engineer will visit your site for an evaluation, gather data, evaluate existing site drawings, and consult on the general boom line layout and primary components.

Based on data gathered by this site visit and information provided by the client and/or his engineering consultant, Worthington will produce a detailed project design that includes calculations, drawings and layouts. In most regions of the USA and Canada, these drawings can be stamped by a professional engineer registered within that state or province.

For more complete information on the range of Site design services offered by Worthington, please contact a Worthington support representative.

Design services provided by Worthington's engineering/design affiliate Revelostoke Design Services of Winnipeg, MB (Canada)

WORTHINGTON
Waterway Barriers

Worthington | SafetyFloats

Worthington has more than 15-years experience designing boom systems in over 58-countries. We've learned what works and what fails. We use that experience to design products that outperform and outlast anything else on the market.

Our SafetyFloats are designed for use upstream of overflow weirs on rivers where a safety barrier system that will not collect debris is needed or where spans between floats are longer. Worthington's safety floats provide more than 1,600 lbs of buoyancy to safely support the weight of a stranded swimmer or boater until rescue arrives. Our rounded bottom edges are designed to prevent the collection of debris by allowing trees and other floatables to smoothly pass underneath.

Cable connections between booms are high enough above water so that most debris will simply float on downstream. The cables are positioned so any swimmer, canoeist or kayaker can easily grab hold when in distress.

Features (At-A-Glance)

- High Visibility double sided nylon signs with standard or custom warning message.
- Retro reflective tape along top horizontal pipe.
- Weighs less than 230 lbs
- Over 1,600 lbs buoyancy
- Non-sinkable marine grade, Coast Guard approved, foam fill.
- Optional solar power marine light with mounts
- All steel components hot dipped galvanized or stainless steel.
- Can be connected in-line or individually anchored.

August 20, 2019

DRAFT

Chelaque Marina Meeting (August 2019)

Attendees: D. Toll, M. Bourne, G. Mace, J. Tedeschi, D. Margozzi, J. Howells, D. Bodary, R. Ryan, R. Clark and R. Workman.

NEXT STEPS

- Budget – plan to place ~1/2 of annual budget in to marina reserve funds each year. Submit 2020 Marina Budget by Sept 30, 2010. Primary new project for 2019/2020 is upgrade marina lighting with LEDs.
- 2020 Marina Covered Slip Fee – Work to recommend to BoD by Oct. 14 the 2020/2021 annual fee taking in to consideration as many Chelaque lot and home owners as possible.
- Marina Slip Expansion – Wait list of 3 with 2 on for over 1 year. Also not having covered slips available significantly effects marketability of most all houses/lots being sold in Chelaque. Work with Chelaque and TVA to increase number of covered slips and docking areas where possible.
- Long term Slip Usage and Wait List – Currently wait list prioritized on a first come basis. Consider other wait list/slip rental criteria for optimizing wait list, Including: priority for Chelaque residents; slip lottery rotation system; and inland lots owners priority over water front owners.
- Trash Booms – keep South and North Booms as long as possible. Plan to replace North trash booms and not South booms due primarily to costs (i.e., ~+$100K for just South or North booms).
- Reduce need for marina and slip access by expanding trailer/boat parking and also expanding the community parking for trailer storage.
- Work with UT Civil Engineering team to assess debris flow, trash boom optimization, marina efficiency, etc.. A September kickoff meeting is planned at Chelaque.
- Lack of cable adjusters. May need to contract out part of year for cable adjustments.
- Jon Boat – Attempt to move out of slip and make available for use. Recommend to build marina roof overhang so as not to need to bail out boat.
- Complete a long-term marina plan.

MEETING SUMMARY

Approximate 2019 Marina Budget Update

Income: 39 slip rentals (accounting for Jon-boat) @ 400 each/yr giving $15,600/yr Income.

Item	Total CY 2019	Current Spending	Balance Available Aug
Cables and Trash Booms	6024	298	5726
Marina Projects	5500	4100	1400
Maintenance - Electrical	720	720	0 (known expenses)
Maintenance – Porta Pottie Waste	1080	1080	0 (known expense)
Maintenance - Repair	1200	510	690
Marina Property Taxes	1076	1076	0
Total	15600	7784	$7816

Marina Reserve Balance July. 31, 2019 $47,428 (Not all 2019 expenses submitted)

Marina Projects 2019 _Update

1) Security and camera update $4100

Significant upgrade going to digital with WIFI, 2 more cameras for 6 in total, having 3+ times improvements in capabilities (resolution and night time viewing). Has 2 plus weeks of data storage.

2) Upgrade (& repair) marina lighting (LED). Initial estimate for LED lighting down middle of North slips and South Slips with 8 motion/night lights postpone for next year and obtain more estimates.

2019 Slip Rental – 39 rented slips. Three on wait list. Keeping 1-slip for Jon-Boat. See below about efforts to move Jon boat out so we can rent one more slip.

2019 Marina Updates and Issues

1) Trash Boom/Debris Flow Update
    a. Temporary removal of South trash booms last spring cancelled due to complexity and timing.
    b. Several experts (i.e., Includes Lifetime Docks, All-Seasons, Kirby Construction & U. Tenn) not needed to replace South booms for debris flow. Recommend to keep as long as possible (debris and security).
        i. Cost for South Boom replacement around $75K-$175K.
        ii. Concern for security if South Trash Boom removed (removes the only entry).
        iii. New camera system, including new cameras pointing towards South slips (still may add 2 more).
        iv. Losing the South boom in addition to debris flow influx changes and reduced marina security will also increase wakes.
        v. Overall consensus from group was to keep the current South Trash booms as long as possible but not to replace due to costs. In contrast to the North boom where upkeep and replacement are of high priority.
    c. Possible long-term plan to save for North boom upkeep and replacement

i. Costs may be ~+$100K for North boom only (Tuff Boom and others)
ii. Long Term Recommendation – If necessary, to maintain North Booms use South booms components.
iii. Rough estimate of 5-years expected for South booms and 10 years for North Booms. Likely a function of storms more than time. Also aesthetics is a factor.
iv. Extend current North boom to reduce effect from wakes and debris flow.
v. Recommend to contact TVA to find out about trash boom replacement process (DT action item)
vi. Not feasible to paint, refurbish or upkeep in a major way current booms (Lifetime Docks, Kirby Construction & All Seasons)

2) U. Tenn & Chelaque Project (Spring and Fall-2019 Semesters)
   a. Spring (1 credit hr/person) and Fall (3 credit hr/person) 2019 work by 4 UT Senior Civil Engineering students and a professor (J. Rehterford).
   b. Examining debris flow and possible marina improvements
   c. Preliminary conclusions 1) on debris flow and reduction, 2) trash boom planning, marina upgrades, 3) bridge to marina ramp helpful, 4) etc..
   d. Plan on Chelaque Meeting in September at our Pavilion. Would like as many from Chelaque to attend.
3) Cable adjustments
   a. Lack of monthly adjusters. Many had to double-duty
      i. Current marina chairman responsibility for 3 months in 2017/2018 and 4 months in 2018/2019.
      ii. Legacy Bay contracting out their adjustments for cables.
   b. Most all adjusters are helping to maintain and repair booms (wire ropes, clamps, etc.)
   c. No cables broken since July 2018.
   d. Suggestion to lower 2020/2021 marina slip fee (or provide partial refund) if help with marina related activities including adjusting cables. Also a suggestion to make it a requirement for slip users to assist with marina upkeep. Currently Chelaque HoA does not plan to compensate Chelaque residents.
4) Jon Boat - Move Jon boat out of slip in to an adjacent covered extension. Looking for estimates.
5) Chelaque Marina slip and non-slip area expansion
   a. TVA rule 100 ft of shoreline for 1000 sq ft of marina space.
   b. Grandfathered in at about 300’ shoreline with current 17,000 sq ft marina.
   c. Need ~1400 more sq ft to be in compliance, before any requests for more slips.
      i. If a new marina in Chelaque, then do not need to make-up deficit
   d. One estimate (Life Time Docks) ~$150K for 10 new slips to be to parallel to North slips.
      i. Back end of new slips may act as a trash boom.
   e. Also could add 4-8 slips to end of S & N slips (perpendicular)
   f. Consider extending current marina roof out to provide protection for more boats. Similar to Jon boat plan but for other areas.
   g. TVA indicated we likely could get Water Rights from non-contiguous marina lots to count towards shoreline requirements.

h. Started looking in to acquiring water rights for a fee. May be best option is to waive Chelaque HoA fee for a period of time. We will target those on deep coves and steep lots initially.
i. Our uncovered dock areas are free. Future may have to pay. Then need to provide electrical access, fenders, etc..
j. We are primarily in a stage to gather data and information to make an informed decision on slip and marina improvements.

6) Reduce Chelaque community needs for marina access.
   a. Add parking area with cover for trailered boats by Pavilion (i.e., extend lot backwards or develop area behind Port-A-Potty). Consider having a fee for storage and access.
   b. Expand parking within the community for trailer storage
7) 2020 Marina Covered Slip Rental Fee Recommendation
   a. $400/yr for last 3 years
   b. 3 on Wait List with 2 on for over 1-year.
   c. Currently there are several slips with rarely used boats.
   d. Selling price of Chelaque properties maybe significantly reduced (time and amount) from not having available slips.
      i. Leeper email indicating a possible $50,000 loss in sales for their home due to the marina being full.
      ii. Feedback from realtors Amy Schrader and Erin Davis indicate a strong need for Chelaque to have available marina slips
   e. Recently 2-3 homes built per year. Many undeveloped lots may result in higher rate
   f. Recent marina spending from last 5-years is to spend approximately ½ and other ½ going in to savings for long term costs (marina and booms). Slow way to add to marina reserve.
   g. Other nearby slip rates (Fall Creek $1320-$1440/yr or covered slip with 1 yr lease), CardNal Cove $750/yr, with 1 yr lease, Cedar Hill $1380/yr covered slip with 1 year lease, (Lakeside and German Creek Marinas ~$1300-$1500/year). Non-covered slip fees from $650-$850/yr. Life Time Docks in Norris Lake charge ~$2100/year for covered slips.
      i. Legacy Bay free and not yet at full capacity (LB President said would need to have a passed vote to implement fees).
      ii. Our marina has non-covered areas that are free.
         1. Long term to consider having fees for non-covered areas as we get more crowded.
   h. Since we have a 'Wait List' and likely impacting the quality of life for all Chelaque lot and home owners important to represent much of community as possible on any decision for a slip fee increase.
   i. Lively discussion on cover slip fee for 2020. Some at meeting at $700 or higher while others wanting to keep at $400/year (or minor increase to $425). DT plans to solicit more from the Chelaque community.
   j. Recommendation to do more planning for trash boom replacement and slip expansion before an increase of over $25. Others pointed out even a modest increase would make

little progress towards the expensive but tentative plans for replacement trash booms (~ more than +$100K) and slip expansion (~$50K - $250K).

k. Large potential costs for increasing the number of slip may require a special assessment.

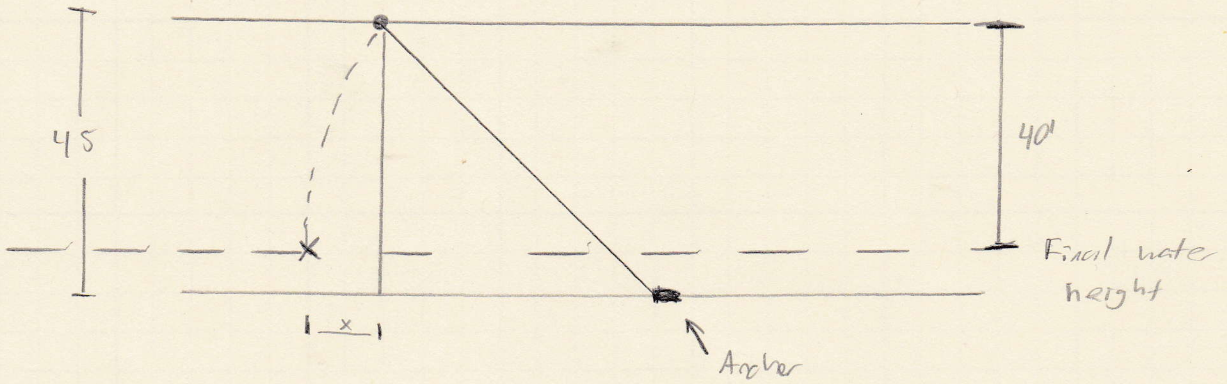
8) Long-Term Slip Usage & Wait List
   a. Currently we have a wait list ranked by time registered.
      i. Chelaque can now provide pro-rated slip refunds when have a wait list.
   b. Discussion that many boats in slips are not used much and would be nice to rent to those who use the slips more. Several said would be difficult to actually enforce.
   c. Implement a rotation system with lottery (? time scale of few weeks or yearly). Similar to Legacy Bay.
   d. Many of group at meeting recommended to limit or prioritize in favor of Chelaque residents over non-residents (i.e., lot owners with no dwelling).
      i. Many non-built lot owners feel their HoA fees are not directly providing any benefits and losing marina access makes worse.
   e. A recommendation to consider higher priority for residents on inland lots over those with water front.
   f. Several recommend to keep our current system for wait list based on first request date only with no other changes.
      i. We allow lifts in slips. Is it unfair to potentially move out those who paid the high cost for a lift?
9) New Chelaque HoA and Marina insurance with Erie
   a. Marina suggestions includes: Electrical, emergency ladders (?), throw rings, shepherd's hook, fire extinguisher, non-slip surfaces, lighting and limited access.
   b. Most controversial – Fuel never be carried across deck. RB – suggested having a refueling area only.
10) 2019 Marina Activities completed to date
   a. Twice year (Fall & Spring) litter and wood/debris clean-ups.
   b. Marina update and cleaning – Re-attach North side loose side rails, replace P-Molding, Power Wash Marina
      i. Any other action/improvement contact Marina Committee and help plan.
   c. Ongoing trash boom cables and clamp repairs by cable adjusters.
11) Future Marina Improvements (in addition to enhance lighting, see above)
   a. Reconfigure marina slips by rotating 90^0 (R. Brasington) to reduce need for booms.
      i. Rotation of slips may be a long term solution that reduces debris effects to boats and remove need for trash booms.
      ii. This would likely require new anchors and cables (All Seasons an Kirby Construction indicated would be more problems than and benefits.
   b. Assess individual slip protectors from debris.
   c. Fish cleaning station, kayak holder, etc.
12) Outline of Long-term Planning, including
   - Develop a long term plan
      - Trash Booms, repair as long as possible, with plans to replace North Boom when necessary.

- Marina Slips – expand existing marina considering various options note above.
- Add bridge to Marina ramp (~$10K). Allow debris to flow down reservoir and escape marina. Especially useful if South booms are removed.
- Other: security, lighting, electrical, parking, etc.

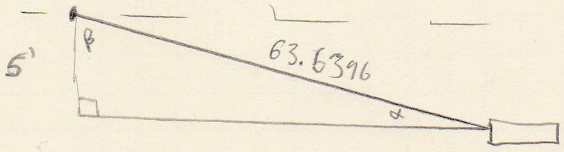
13) Volunteers needed for any Sub-committees such as on Long Term Trash Booms and Slip Expansion

Appendix D: Anchoring Positioning

Chase Allsup | Anchor 5 @ 45'



$\sqrt{45^2 + 45^2} = 63.6396$



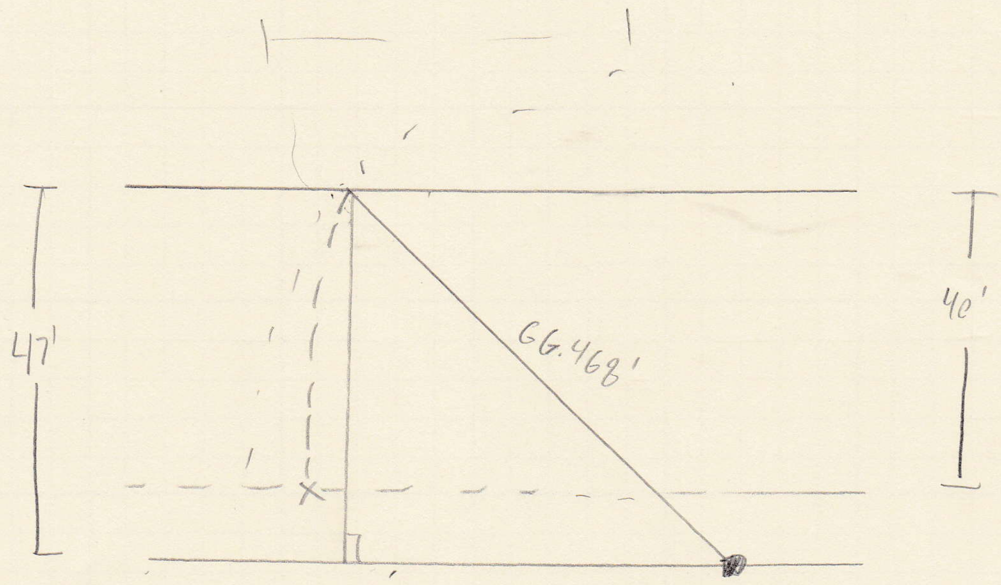
$\sqrt{63.6396^2 - 5^2} =$

$5^2 + B^2 = 63.6396^2$

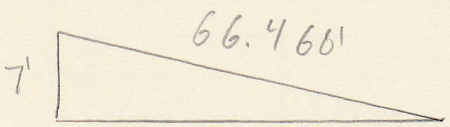
$B = 63.4429 \quad -45 \quad = \quad 18.4429$

y displacement = 18.4429'

Chase Allsup | Anchor 6 @ 47'



$\sqrt{47^2 + 47^2} = 66.468'$



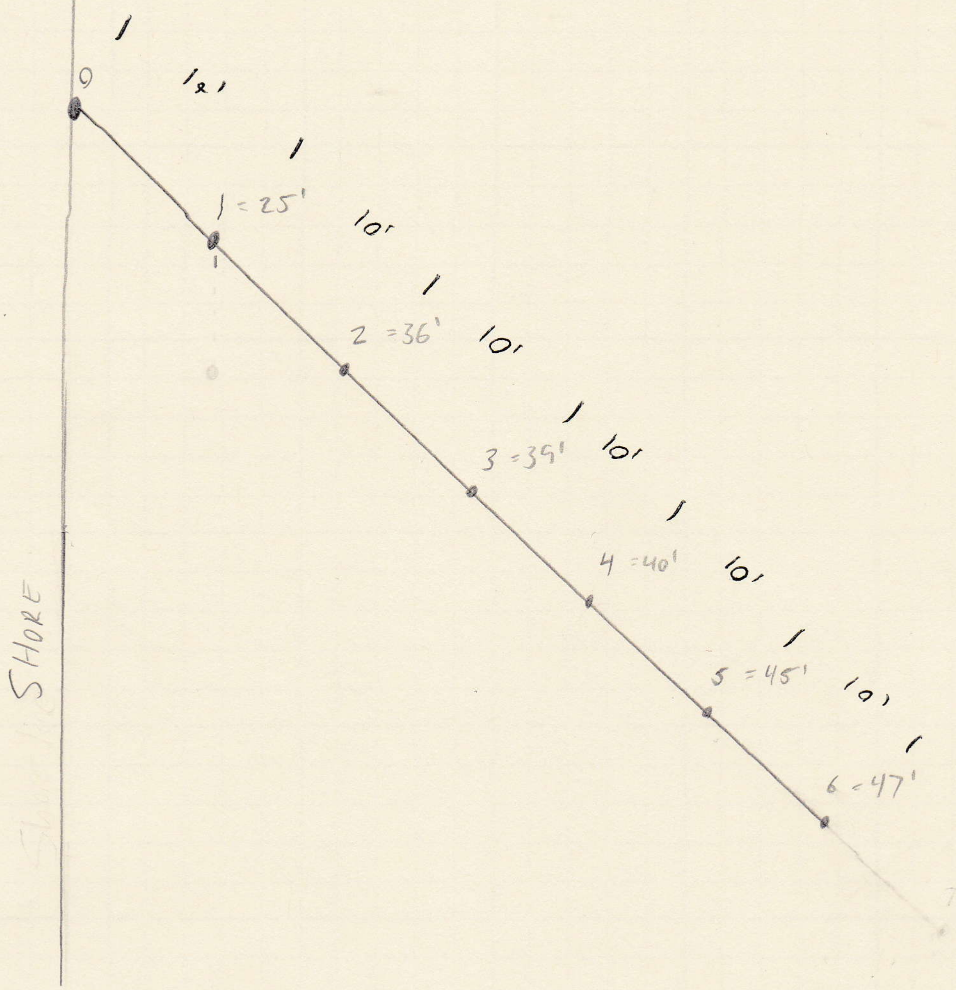
$\sqrt{66.468^2 - 7^2} = 66.0984 - 47$

Y displacement = 19.0984' ↓

11/7/2019	Anchor Positioning	Chelaque Estates

High Water conditions

Low water = -40'



Anchor Design | 12/1/19 | Chase Allsup

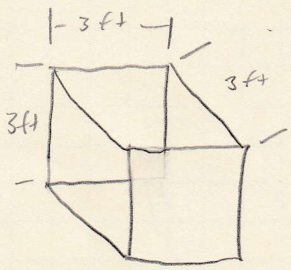
Needed capacity 3650 lbs

$3650 \cdot 1.2 = 4380$ lbs

4000 lbs / 145 lb/ft³ = 27.583 ft³

$3^3 = 27$ ft³

27 ft³ · 145 lb/ft³ = 3915 lbs per anchor at detail C



2 Anchors, Total weight = **7830 lbs**

3 FT

5 internal anchors

3650 total load

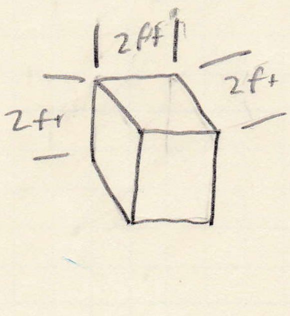
3650 / 5 = 730 lbs

$730 \cdot 1.2 = 876$ lbs

876 lbs / 145 lb/ft³ = 6.04 ft³

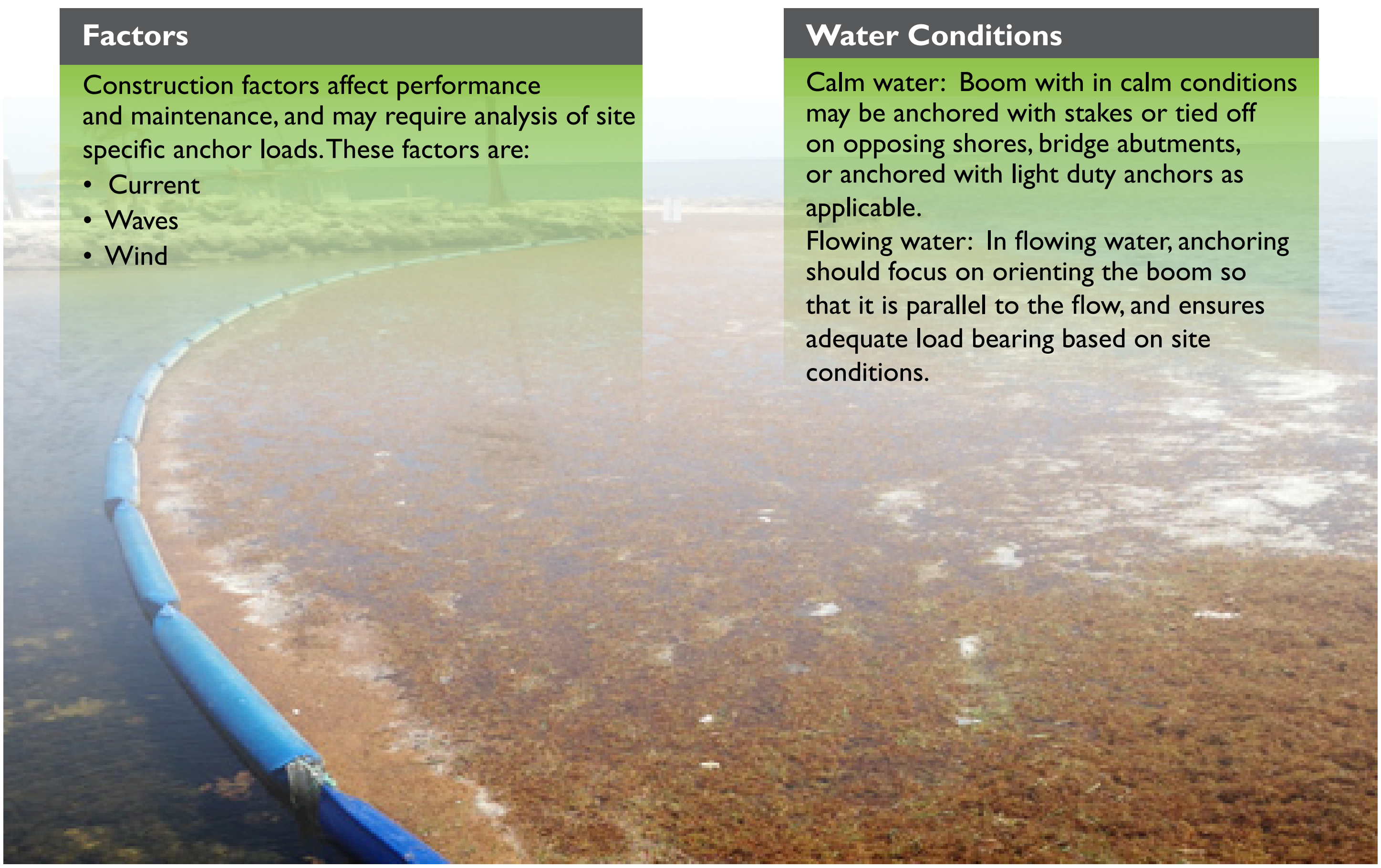
$\sqrt[3]{6.04 \text{ ft}^3} = 1.82$ ft

≈ 2 ft



Boom Anchoring
Applications & Configurations

One of the most important factors in determining the effectiveness of boom is the deployment and proper anchoring to bear against hydraulic loads. Your GEI representative can discuss safe load conditions based on performance criteria and site-specific conditions at the deployment location. Performance, effectiveness and maintenance parameters require confirmation of your specified anchoring plan.



Factors

Construction factors affect performance and maintenance, and may require analysis of site specific anchor loads. These factors are:

- Current
- Waves
- Wind

Water Conditions

Calm water: Boom with in calm conditions may be anchored with stakes or tied off on opposing shores, bridge abutments, or anchored with light duty anchors as applicable.

Flowing water: In flowing water, anchoring should focus on orienting the boom so that it is parallel to the flow, and ensures adequate load bearing based on site conditions.

Deployment

In general, if there is no current and little to no wind, anchors may be set after the boom is towed into position. Otherwise, it is recommended that anchors are deployed before moving the barrier from the staging area, and that each anchor line is attached to a buoy for easy retrieval. Each section of floating boom may contain anchor points (with an anchor symbol) that are located on each connector and optionally at center location(s).

Boom Anchoring
Applications & Configurations

Types of Anchors

We have several anchor types available that we recommend based on site-specific conditions.

Concrete Anchors

Concrete anchors rely on friction or suction, but since concrete loses 50% of its weight in water, concrete blocks or barriers are typically up to 2,000 lbs. Concrete anchors range in sizes, styles, and weights.

Fluke Anchor

Fluke-style, "navy" or "mushroom" anchors are readily available, and inexpensive. They require firm silt, mud, or sand bottoms. Bottoms with a "crust" or rocky floor may not be suitabe for this type of anchor.

Earth Anchor

Must be driven in with available accessories through several feet of soil. This anchor is lightweight, stable, corrosion resistant, and an excellent option for both shoreline anchoring. If under water anchors are being used, the max depth without divers is 10 feet.

*Alternate anchors available at an additional cost include: navy, mushroom, grapnel, plow/CQR, Richter

Dual Anchoring

Orienting the boom in tidal or other conditions subjected to loading from either side, may require anchoring from both directions so that wind or current change does not compromise the loading, or boom configuration.

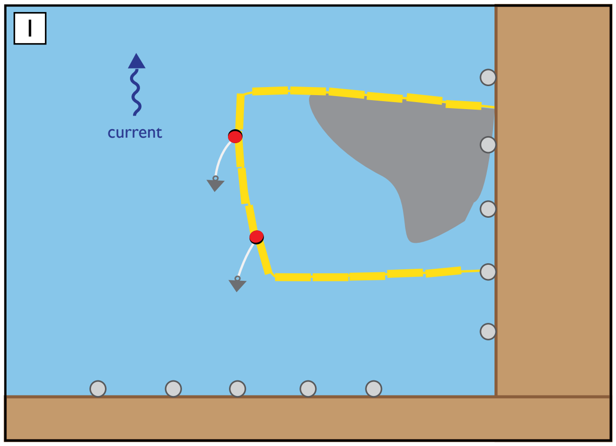
Boom Configuration

Prior to deployment, an anchoring plan should be developed based on hydraulic load, velocity, flow, and location of particulates or debris that would impact the performance of the barrier. The following illustrations elaborate on boom configurations. Oil booms, trash booms, debris booms, and turbidity curtains, may follow similar configurations. Your GEI representative will help determine the right solution based on your project specifications.

Boom may be wound into reels and stored for easy access, and rapid deployment. The tow bridle is a floating boom accessory designed to aid the deployment process. Equipped to safely tow the curtain into position, these bridles feature a small flotation device and two attachment points to help distribute weight evenly across the boom. Depending on the size of the boom, this towing equipment is available in small, medium, large and heavy duty model options.

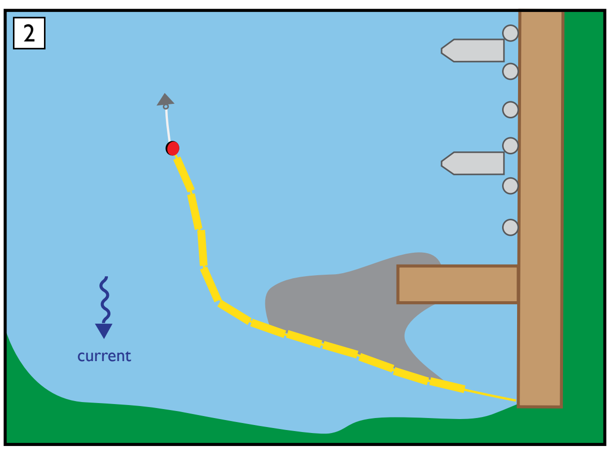
Boom Anchoring
Applications & Configurations

The following are examples of effective boom configurations. The type of configuration depends on your site specifications. Our illustrations depict: containment, deflection, and exclusion.



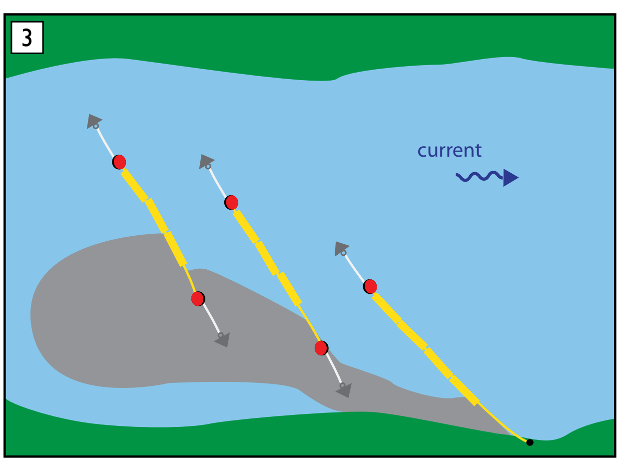
Containment

Figure 1 illustrates containment boom configuration. This type of anchoring method takes place when there is floating debris or spilled contaminant during calm weather, along with minimal current movement (no greater than 0.75 knots). A spill is contained by orienting boom across a waterway perpendicular to the path of the spill. Containment boom may also be used to encircle floating oil or debris so it can be collected and recovered at a specific location (such as a grounded barge, a vessel at the dockside, or a vehicle on shore). This configuration has 2 anchor points on the shoreline pier, and 2 anchor points underwater.



Deflection

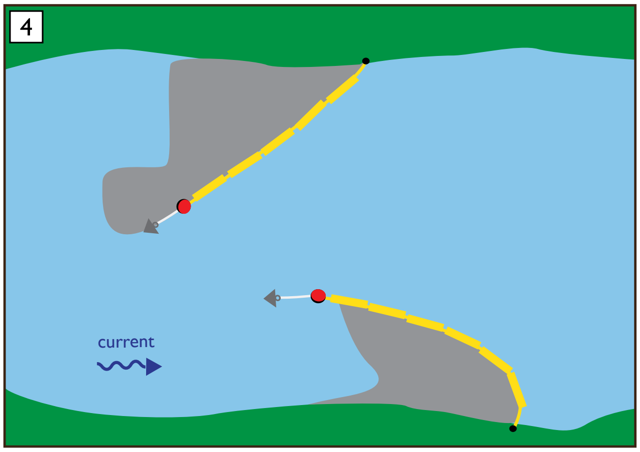
A deflection boom, as shown in figure 2, is a protective boom strategy used to intercept, deflect, or move floating trash or debirs towards a recovery site. This method is utilized when a stronger current is present. Entrapment may occur when the boom is placed perpendicular to a current of more than 0.75 knots. To increase the effectiveness of boom in such conditions, it must be placed at an angle. Orienting the boom in this way deflects the oil spill or floating debris towards the shoreline where current may be less severe. This configuration has one anchor point on the shore, and one in the water.



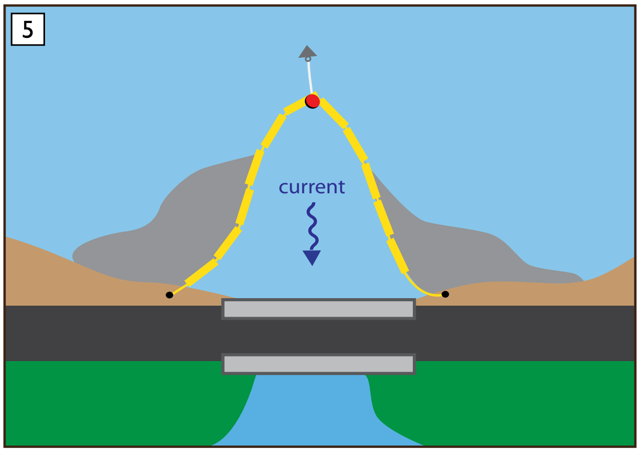
Other Types of Deflection: Cascade

As displayed in figure 3, boom is usually deployed in this configuration when a single boom is not sufficient because of fast currents or because it may be necessary to leave access for marine traffic. Additional anchor points are required to maintain this orientation as compared to single boom configuration.

Boom Anchoring
Applications & Configurations



Other Types of Deflection: Staggered Chevron
Oriented in areas with strong currents, the open chevron configuration displayed in figure 4 is used to divert spills or floating debris to two or more recovery areas. Booms are anchored separately mid-stream, with one anchor point upstream or down-stream of the other, so that boat traffic may pass.



Exclusion
Figure 5 displays an exclusion boom configuration (or closed chevron), used as a measure to protect sensitive areas such as marshlands and water intakes, from spills, floating trash, debris, or seaweed. This method requires the area to be completely encased by boom, forming a protective barrier. Accordingly, a combination of exclusion and containment boom may be used to protect water intakes. Ideal for low current areas, this techinque requires two shoreline anchor points, with one anchor in the center to create the point. Water outflow from a river or stream may assist in maintaining boom orientation.

For more complete information on GEI Works products and solutions, visit us on the Web at www.geiworks.com.

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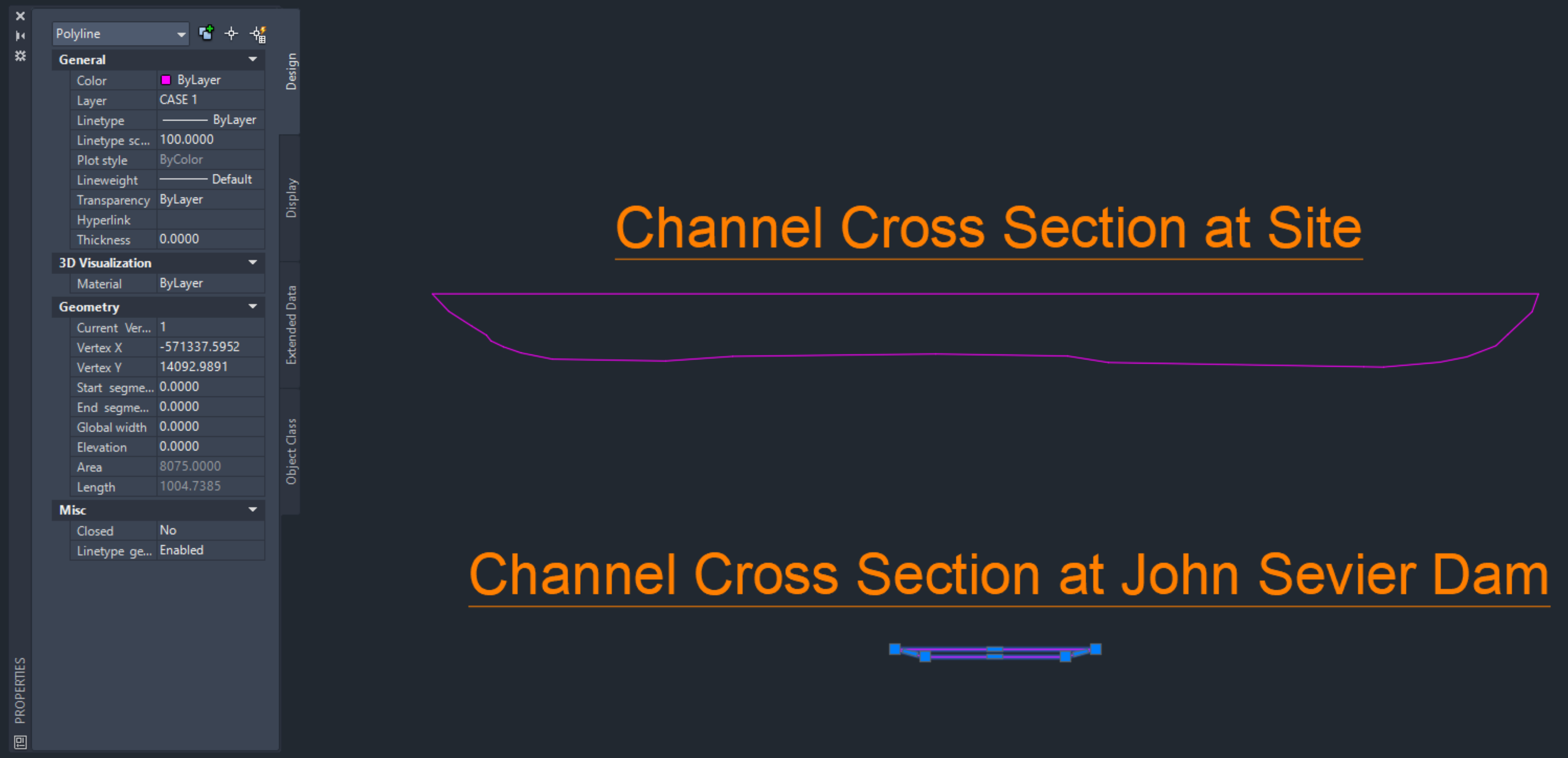
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Hyperlink
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Material ByLayer
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Vertex Y 14092.9891
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End segme... 0.0000
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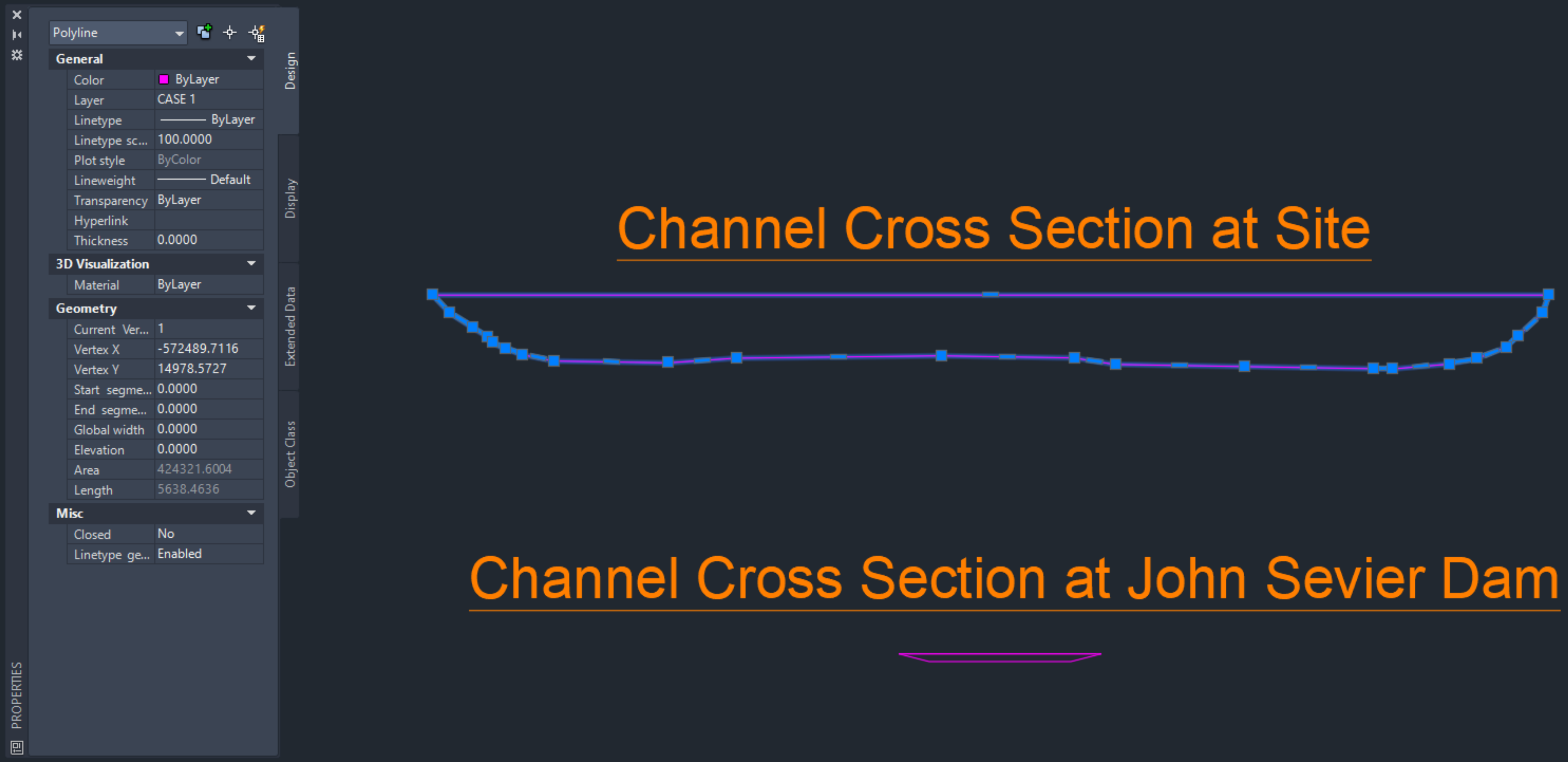
Display
Extended Data
Object Class
PROPERTIES
Channel Cross Section at Site
Channel Cross Section at John Sevier Dam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Vertex Y 14978.5727
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End segme... 0.0000
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Design
Display
Extended Data
Object Class
PROPERTIES
Channel Cross Section at Site
Channel Cross Section at John Sevier Dam

Chase Allsup	11/2019	Cross-Section Area

$A_1 = 8{,}075\ ft^2$ @ Dam

V_1 = Water Velocity @ Dam

$A_2 = 424{,}321.6\ ft^2$ @ site

V_2 = Velocity at site

$A_1 V_1 = A_2 V_2$

$Q_1 = V_1 A_1$

$8{,}075\ (0.262\ ft/sec) = 424{,}321.6\ ft^2\ (V_2)$

$V_2 = 0.005557\ ft/sec$

≈ 0

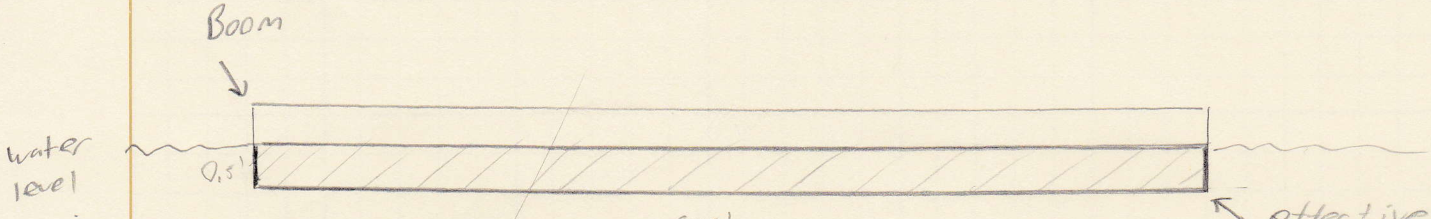
Drag on Boom

$$F_D = C_D A_p \left(\frac{\rho V^2}{2}\right) \rightarrow (1.15)(300\ ft^2)\left(\frac{(1)(1.6936\ ft/sec)^2}{2}\right)$$

$= 494.778$ lb ≈ 495 lbs

$C_D = 1.15$

$= 0.825$ lb/ft



$A_p = (0.5)(600') = 300\ ft^2$ $\qquad \rho = 1$

V = 0.292 FT/sec @ wind of 4mph

MAX → 23.2 mph

$$\frac{23.2\ mph}{X} = \frac{4\ mph}{0.292\ FT/sec}$$

@ 23.2mph $X = 1.6936$ FT/sec Max water velocity at surface

peak gust @ 63 mph

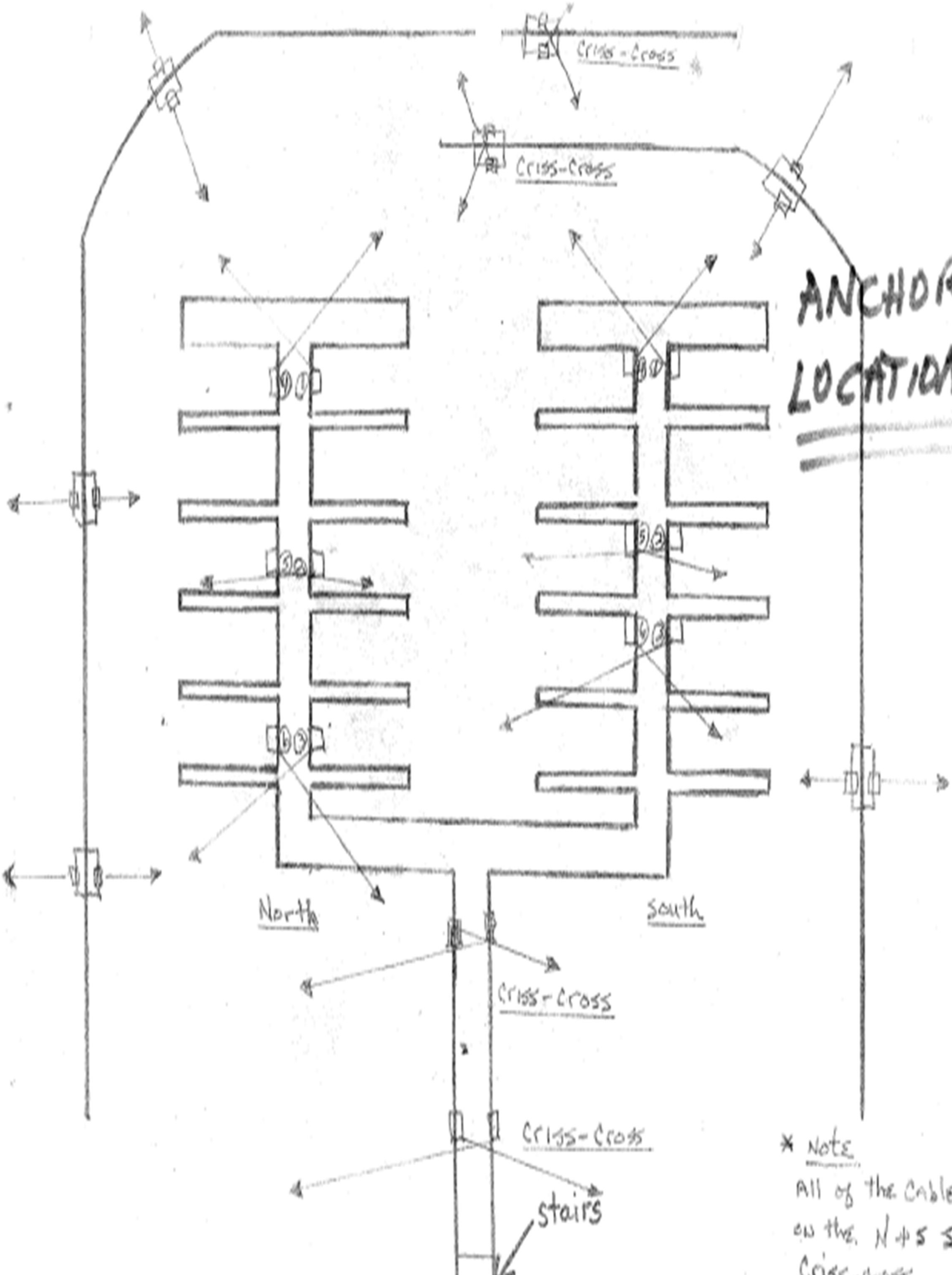
$$\frac{63\ mph}{X} = \frac{4\ mph}{0.292\ FT/sec}$$

$x = 4.599 \rightarrow 4.6$ FT/se

$$(1.15)(300\ fT^2)\left(\frac{(1)(4.6)^2}{2}\right) = 3650\ lbs$$

3050 / 600' $= 6.08$ lb / ft

ANCHOR LOCATIONS



* Note
All of the Cables on the N + S Slips Criss-cross

Chase Allsup | Tension on Cable

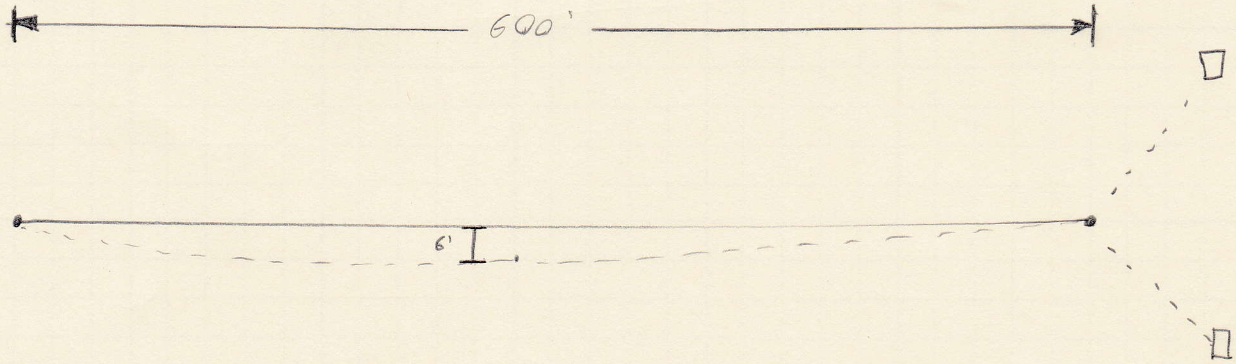
@ anchor 6

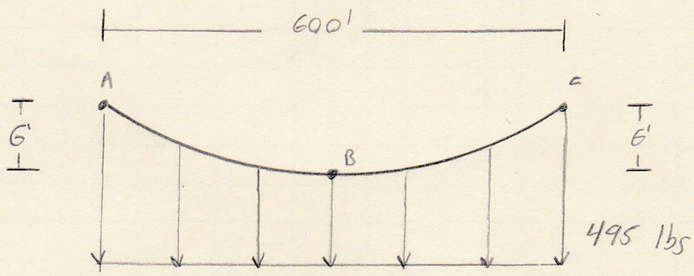
Tension on Cable

1% deflection
$= 600'(0.01)$
$= 6'$

$F_0 = 495$ lbs @ 23.3 mph $= 0.825$ lb/ft

$= 3650$ lbs @ 63 mph $= 6.08$ lb/ft





$y = \frac{W_0}{2F_H} x^2 \rightarrow \frac{6.08 \text{ lb}}{2 F_H} x^2$

$6' = \frac{3.04}{F_H} x^2$

$F_H = 0.5066\, x'^2$

$F_H = 0.5066\, x'^2$

$= 0.5066\,(300)^2 = 45{,}594$ lbs

$6 = \frac{3.04}{F_H}\left[-(600' - x')\right]^2$

$6 = \frac{3.04}{0.5066 x'^2}\left(-(600 - x')\right)^2$

$x' = 300$ ft

$\frac{dy}{dx} = \frac{6.08}{45{,}594} x = 0.000133\, x$

point A

$x = -(600 - 300) = -300'$

$\tan \theta_A = \left.\frac{dy}{dx}\right|_{x=-300\text{ ft}}$

$0.000133\,(-300) = -0.04°$

$T_A = \frac{F_H}{\cos \theta_A} \rightarrow \frac{45{,}594}{\cos(-0.04°)}$

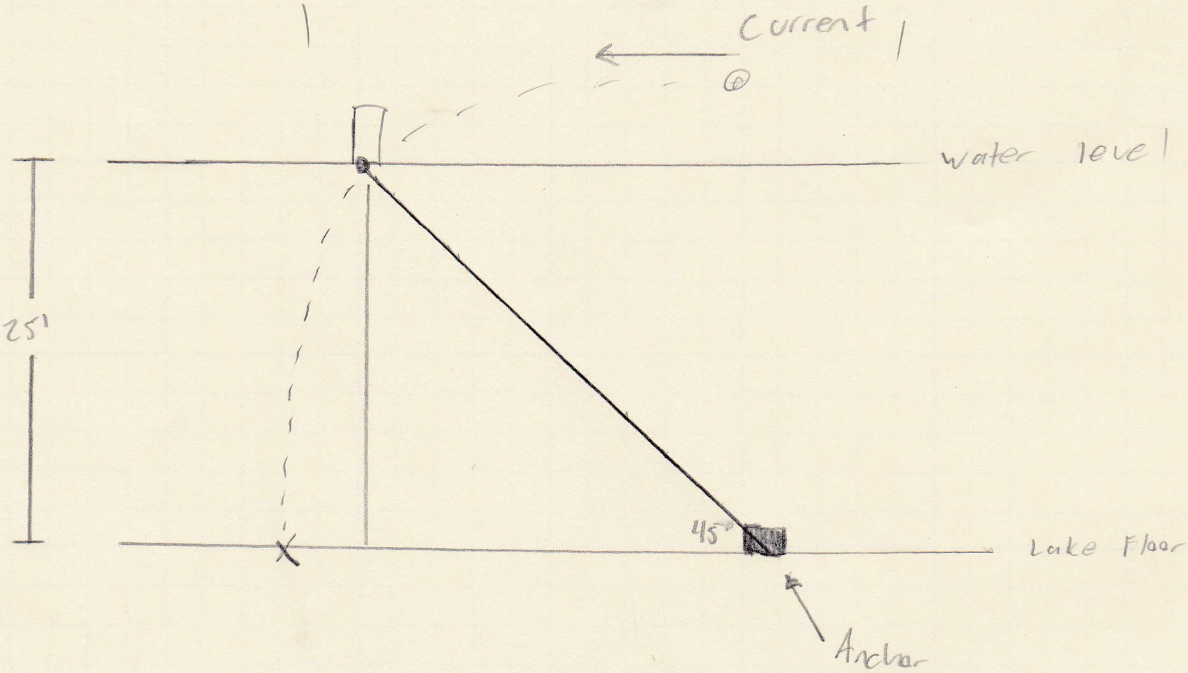
$\approx 45{,}594$ lbs

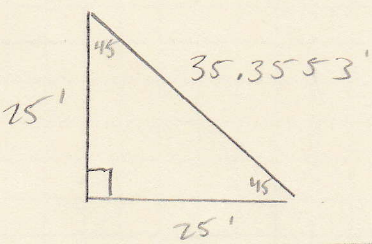
$T_A = T_B = T_C$

per table choose $1\,\frac{3}{4}$" diameter cable

11/7/2019	Anchor 1 @ 25'	Chase Allsup

SIDE VIEW



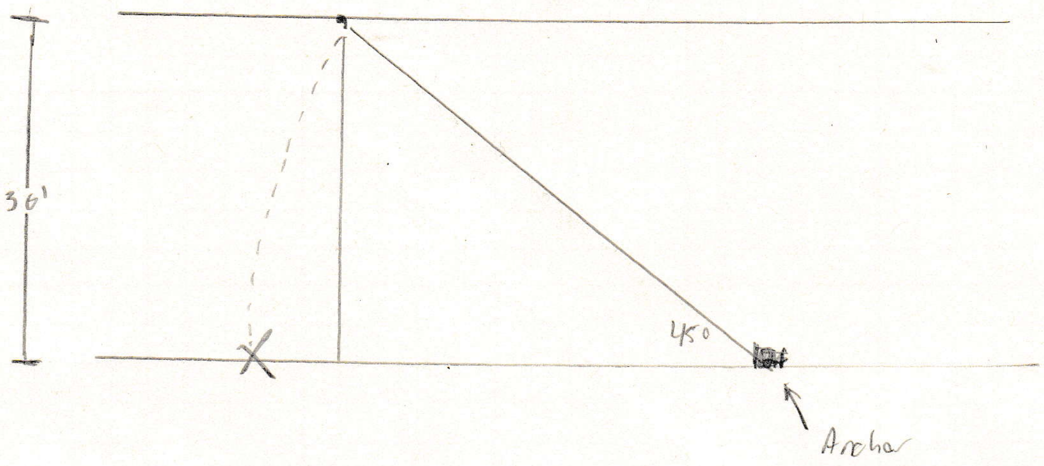


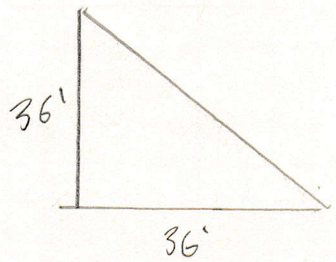
$\sqrt{25^2 + 25^2} = 35.3553'$

$35.3553' - 25' = 10.3553$

Y displacement = 10.35' ↓

11/7/2019	Anchor 2@ 36'	Chase Allsup



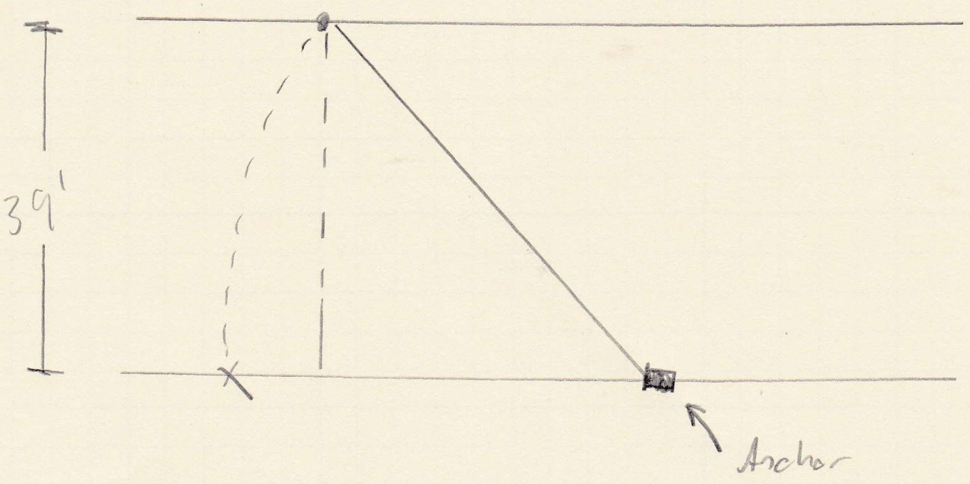


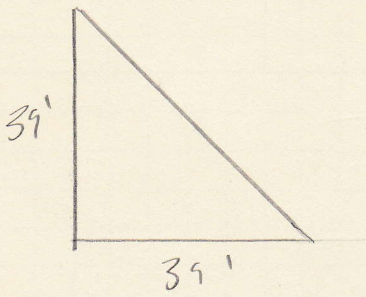
$\sqrt{36' + 36'} = 50.91'$

$50.91 - 36 = 14.91$

y displacement = 14.91'

11/7/2019 | Anchor 3 @ 39' | Chase Allsup



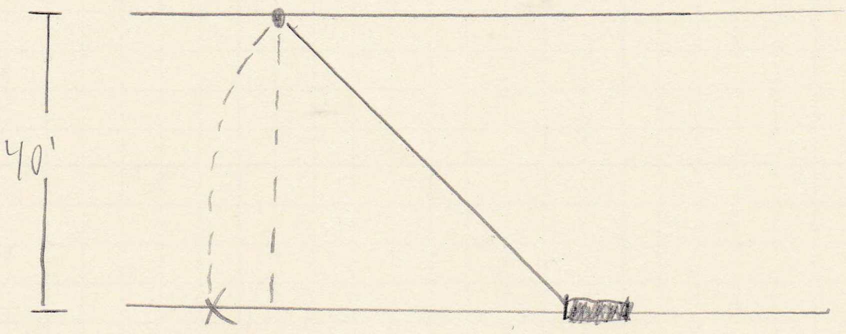


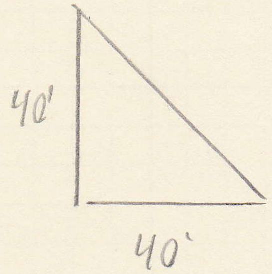
$\sqrt{39^2+39^2} = 55.15'$

$55.15 - 39 = 16.15'$

y displacement = 16.15'

11/7/2019	Anchor 4@ 40'	Chase Allsup



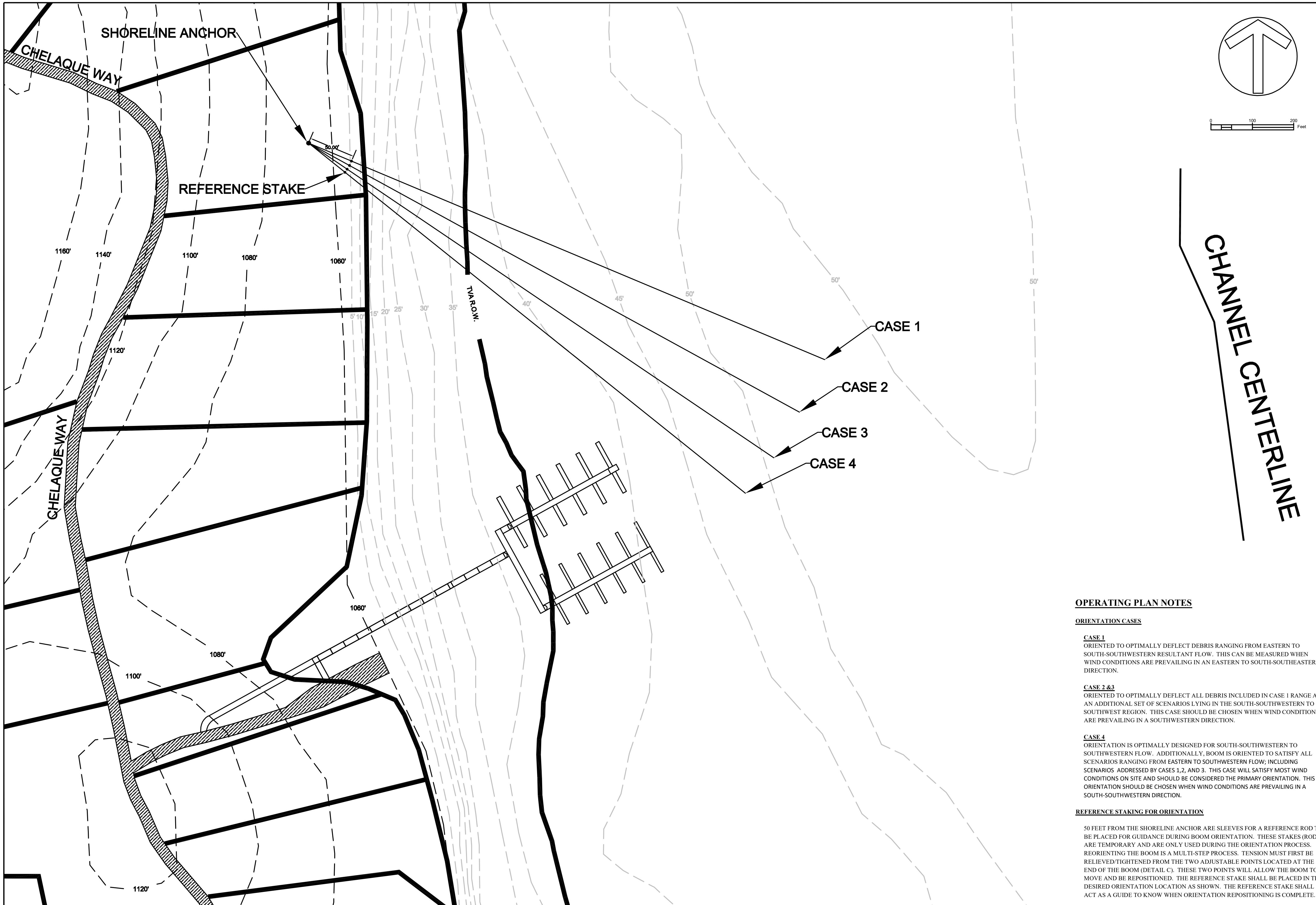


$\sqrt{40^2 + 40^2} = 56.56$

$56.56 - 40 = 16.56'$

y displacement = 16.56'

Appendix E: Operating Plan



OPERATING PLAN NOTES

ORIENTATION CASES

CASE 1
ORIENTED TO OPTIMALLY DEFLECT DEBRIS RANGING FROM EASTERN TO SOUTH-SOUTHWESTERN RESULTANT FLOW. THIS CAN BE MEASURED WHEN WIND CONDITIONS ARE PREVAILING IN AN EASTERN TO SOUTH-SOUTHEASTERN DIRECTION.

CASE 2 &3
ORIENTED TO OPTIMALLY DEFLECT ALL DEBRIS INCLUDED IN CASE 1 RANGE AND AN ADDITIONAL SET OF SCENARIOS LYING IN THE SOUTH-SOUTHWESTERN TO SOUTHWEST REGION. THIS CASE SHOULD BE CHOSEN WHEN WIND CONDITIONS ARE PREVAILING IN A SOUTHWESTERN DIRECTION.

CASE 4
ORIENTATION IS OPTIMALLY DESIGNED FOR SOUTH-SOUTHWESTERN TO SOUTHWESTERN FLOW. ADDITIONALLY, BOOM IS ORIENTED TO SATISFY ALL SCENARIOS RANGING FROM EASTERN TO SOUTHWESTERN FLOW; INCLUDING SCENARIOS ADDRESSED BY CASES 1,2, AND 3. THIS CASE WILL SATISFY MOST WIND CONDITIONS ON SITE AND SHOULD BE CONSIDERED THE PRIMARY ORIENTATION. THIS ORIENTATION SHOULD BE CHOSEN WHEN WIND CONDITIONS ARE PREVAILING IN A SOUTH-SOUTHWESTERN DIRECTION.

REFERENCE STAKING FOR ORIENTATION

50 FEET FROM THE SHORELINE ANCHOR ARE SLEEVES FOR A REFERENCE ROD TO BE PLACED FOR GUIDANCE DURING BOOM ORIENTATION. THESE STAKES (RODS) ARE TEMPORARY AND ARE ONLY USED DURING THE ORIENTATION PROCESS. REORIENTING THE BOOM IS A MULTI-STEP PROCESS. TENSION MUST FIRST BE RELIEVED/TIGHTENED FROM THE TWO ADJUSTABLE POINTS LOCATED AT THE END OF THE BOOM (DETAIL C). THESE TWO POINTS WILL ALLOW THE BOOM TO MOVE AND BE REPOSITIONED. THE REFERENCE STAKE SHALL BE PLACED IN THE DESIRED ORIENTATION LOCATION AS SHOWN. THE REFERENCE STAKE SHALL ACT AS A GUIDE TO KNOW WHEN ORIENTATION REPOSITIONING IS COMPLETE.

CJ PT
ENGINEERING

SENIOR DESIGN: MARINA IMPROVEMENTS AT CHELAQUE ESTATES

NOT FOR CONSTRUCTION PURPOSES

THE UNIVERSITY OF TENNESSEE - KNOXVILLE
MARINA IMPROVEMENTS AT CHELAQUE ESTATES
HAMBLEN COUNTY - MORRISTOWN, TENNESSEE

OPERATING PLAN

DATE: 12/2/2019

SCALE 1":100'

SHEET NO: C4.10

UTK Event Descriptions

Date of Attendance: ***11/4/2019*** ***Hours:1***

Event Title: ***ASCE General Body Meeting***

Event Host (person, company, professional society etc.): ***ASCE, Rembco Geotechnical Contractors***

Brief Description of Event: ***Rembco came to UT to speak during our bi-weekly ASCE General Body Meeting. We spoke about professional licensure, providing quality service and management in the field of a geotechnical contactor.***

Reference Information (website, location of event, etc.): ***JDT 405***

UTK Event Descriptions

Date of Attendance: ***11/27/2019*** ***Hours:1.75***

Event Title: ***FE Exam Review: Mathematics (2018.08.29)***

Event Host (person, company, professional society etc.): ***Gregory Michaelson, Marshall University***

Brief Description of Event: ***20 review problems over the mathematics portion of the FE exam. Reviewed algebra, trigonometry, calculus, alternate coordinate systems, area between curves, logarithmic functions and matrix algebra.***

Reference Information (website, location of event, etc.): ***https://www.youtube.com/watch?v=LJYy2tAaKQM&list=PLCV9OyAY5K-V-bki_dxxq_uVpyIoyIJ8P***

UTK Event Descriptions

Date of Attendance: ***11/27/2019*** ***Hours:1.25***

Event Title: ***FE Exam Review: Probability/Statistics, Computational Tools (2018.09.05)***

Event Host (person, company, professional society etc.): ***Gregory Michaelson, Marshall University***

Brief Description of Event: ***13 review problems over the Probability/Statistics and Computational Tools portion of the FE exam. Reviewed estimations of data sets, linear regression plots, probability from a standard deviation and from a fair dice/coin.***

Reference Information (website, location of event, etc.):
https://www.youtube.com/watch?v=qwYtq6CzPfg&list=PLCV9OyAY5K-V-bki_dxxq_uVpyIoyIJ8P&index=2

UTK Event Descriptions

Date of Attendance: ***11/27/2019*** ***Hours:1.25***

Event Title: ***FE Exam Review: Engineering Economics (2018.09.12)***

Event Host (person, company, professional society etc.): ***Gregory Michaelson, Marshall University***

Brief Description of Event: ***7 review problems over the Engineering Econ portion of the FE exam. Reviewed depreciation of equipment, calculating lump sums, payment calculations and deposit and interest amounts over a term.***

Reference Information (website, location of event, etc.):
https://www.youtube.com/watch?v=GUbf0Mz04k4&list=PLCV9OyAY5K-V-bki_dxxq_uVpyIoyIJ8P&index=3

UTK Event Descriptions

Date of Attendance: ***11/28/2019*** ***Hours:1***

Event Title: ***FE Exam Review: Statics/Dynamics (2018.09.19)***

Event Host (person, company, professional society etc.): ***Gregory Michaelson, Marshall University***

Brief Description of Event: ***7 review problems over the Statics portion and part of the Dynamics portion of the FE exam. Reviewed the basic principles of statics (fx,fy,m = 0) and the basic principle of dynamics (f=ma).***

Reference Information (website, location of event, etc.):
https://www.youtube.com/watch?v=PNDjGIBIUJU&list=PLCV9OyAY5K-V-bki_dxxq_uVpyIoyIJ8P&index=4

UTK Event Descriptions

Date of Attendance: ***11/28/2019*** ***Hours:1.5***

Event Title: ***FE Exam Review: Dynamics/Ethics (2018.09.26)***

Event Host (person, company, professional society etc.): ***Gregory Michaelson, Marshall University***

Brief Description of Event: ***The continued the dynamics portion from the previous lecture with 3 more problems discussing displacements and collisions. 5 review problems over the Ethics portion of the FE exam. Reviewed ethical dilemmas that an engineer can face during practice. It also identifies what is and what is not an ethical violation.***

Reference Information (website, location of event, etc.):
https://www.youtube.com/watch?v=FB9sHi7FkKc&list=PLCV9OyAY5K-V-bki_dxxq_uVpyIoyIJ8P&index=5

UTK Event Descriptions

Date of Attendance: ***11/28/2019*** ***Hours:1.5***

Event Title: ***FE Exam Review: Structural Analysis (2018.10.03)***

Event Host (person, company, professional society etc.): ***Gregory Michaelson, Marshall University***

Brief Description of Event: ***5 examples on structural analysis covered in the FE exam. Reviewed truss analysis, axial forces, live loads, dead loads, factored loads, maximum shear, maximum moment and vertical and horizontal deflection.***

Reference Information (website, location of event, etc.):
https://www.youtube.com/watch?v=wkkp3UCHpBk&list=PLCV9OyAY5K-V-bki_dxxq_uVpyIoyIJ8P&index=6

UTK Event Descriptions

Date of Attendance: ***12/1/2019*** ***Hours:1***

Event Title: ***Concrete Innovations***

Event Host (person, company, professional society etc.): ***Lionel Lemay, PE, SE, LEED AP. Executive Vice President, Structures and Sustainability, National Ready Mixed Concrete Association.***

Brief Description of Event: ***The course "Concrete Innovations" teaches the advancements in modern day concrete applications. These methods include bendable concrete, self-cleaning concrete, concrete than can self-repair and recover better from excessive loads, the use of self-consolidating concrete, reinforcing with graphene and reducing the carbon footprint.***

Reference Information (website, location of event, etc.): https://csengineermag.com/concrete-innovations/

UTK Tally Form

Please use the following form to maintain record of your UTK progress throughout the semester. Note that some UTK events will require a Certificate of Attendance; specifically events outside the scheduled course meeting time. Please consult Dr. J with questions regarding reporting of UTKs.

Date	Duration (Hours)	Title of Event	Satisfy Online/Tutorial Credit? (Y/N)	Satisfy Sustainability Credit? (Y/N)	Certificate of Attendance? (Y/N)
11/4	1	ASCE General Body Meeting	N	N	Y
11/27	1.75	FE Exam Review: Mathematics	Y	N	N
11/27	1.25	FE Exam Review: Probability/Statistics, Computational Tools	Y	N	N
11/27	1.25	FE Exam Review: Engineering Econ	Y	N	N
11/28	1	FE Exam Review: Statics/Dynamics	Y	N	N
11/28	1.5	FE Exam Review: Dynamics/Ethics	Y	N	N
11/28	1.5	FE Exam Review: Structural Analysis	Y	N	N
12/1	1	Concrete Innovations	Y	Y	Y

civil + structural
ENGINEER

CERTIFICATE OF COMPLETION

This is to certify that

Chase Allsup

participated in

Concrete Innovations

ZG082019CS

1 PDH

Richard Massey
Editor-in-Chief, Civil + Structural Engineer, Zweig Group

Beth Brooks
Director of Sales, Zweig Group

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GREENCE
www.greence.com

CERTIFICATE
OF COMPLETION

Jonathan Payne

The above named recipient successfully completed a registered education program.

Designing with Metal

Online Course

Completed On **12/04/2019**

Awarded Credit Information

1 AAA Structured Learning Hour
1 AIA HSW/LU CE Hour
1 AIBD CE Hour
1 GBCI General Hour for LEED Professionals
1 OAA Structured Learning Hour
1 SAA Core Learning Hour

AIA Course #: **GBE05A**
GBCI Course ID: **0920019720**

Your Membership Information

No AIA Member # Provided
No AIBD Member # Provided
No GBCI Member # Provided

CONTINUING EDUCATION AIA

Credit Provided By:
GreenCE, Inc | AIA Provider: K167
education@greence.com | 800-248-6364

EDUCATION PARTNER

civil + structural ENGINEER

CERTIFICATE OF COMPLETION

This is to certify that

Jonathan Payne

participated in

Advantages of Today's Tension Fabric Structures

ZG09082016CS

Date

1 PDH

Richard Massey

Editor-in-Chief, Civil + Structural Engineer, Zweig Group

Beth Brooks

Director of Sales, Zweig Group

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civil + structural
ENGINEER

CERTIFICATE OF COMPLETION

This is to certify that

Jonathan Payne

participated in

Concrete Innovations

ZG082019CS

1 PDH

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Editor-in-Chief, Civil + Structural Engineer, Zweig Group

Beth Brooks
Director of Sales, Zweig Group

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civil + structural
ENGINEER

CERTIFICATE OF COMPLETION

This is to certify that

Jonathan Payne

participated in

Un-complicating the Stabilization Selection Process

ZG11062019CS

Date

1 PDH

Richard Massey
Editor-in-Chief, Civil + Structural Engineer, Zweig Group

Beth Brooks
Director of Sales, Zweig Group

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civil + structural
ENGINEER

CERTIFICATE OF COMPLETION

This is to certify that

Jonathan Payne

participated in

Properly Specifying Steel Joists

ZG10012019CS

Date

1 PDH

Richard Massey
Editor-in-Chief, Civil + Structural Engineer, Zweig Group

Beth Brooks
Director of Sales, Zweig Group

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CERTIFICATE
OF COMPLETION

Jonathan Payne

The above named recipient successfully completed a registered education program.

Concrete Tile Roofing: The World's Most Sustainable and Energy Efficient Roof...

Online Course

Completed On **12/04/2019**

Awarded Credit Information

1 AAA Structured Learning Hour
1 AIA HSW/LU CE Hour
1 AIBD CE Hour
1 GBCI General Hour for LEED Professionals
1 OAA Structured Learning Hour
1 SAA Core Learning Hour

AIA Course #: **GEA07A**
GBCI Course ID: **0920019626**

Your Membership Information

No AIA Member # Provided
No AIBD Member # Provided
No GBCI Member # Provided

Credit Provided By:
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education@greence.com | 800-248-6364

CONTINUING EDUCATION AIA

EDUCATION PARTNER

GREENCE
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CERTIFICATE
OF COMPLETION

Jonathan Payne

The above named recipient successfully completed a registered education program.

Modular Beauty: Low Impact Development and Permeable Pavers

Online Course

Completed On **12/04/2019**

Awarded Credit Information

1 AAA Structured Learning Hour
1 AIA HSW/LU CE Hour
1 AIBD CE Hour
1 GBCI General Hour for LEED Professionals
1 OAA Structured Learning Hour
1 SAA Core Learning Hour

AIA Course #: **GTG32A**
GBCI Course ID: **0920015153**

Your Membership Information

No AIA Member # Provided
No AIBD Member # Provided
No GBCI Member # Provided

Credit Provided By:
GreenCE, Inc | AIA Provider: K167
education@greence.com | 800-248-6364

CONTINUING EDUCATION AIA

EDUCATION PARTNER

UTK Event Descriptions

Date of Attendance: ***12/03/19*** Hours: ***1***

Event Title: ***Advantages of Today's Tension Fabric Structures***

Event Host (person, company, professional society etc.): ***CSEngineeringmag***

Brief Description of Event: ***Discusses benefits and advantages of using Fabric Structures for commercial use as opposed to traditional steel structures. Fabric structure advantages include green building practices, easily customizable, cost-efficient and sustainable.***

Reference Information (website, location of event, etc.):
https://csengineermag.com/advantages-of-todays-tension-fabric-structures/

UTK Event Descriptions

Date of Attendance: ***12/01/19*** Hours: ***2***

Event Title: ***FE Exam Review: Mathematics***

Event Host (person, company, professional society etc.): ***Gregory Michaelson, Marshall University***

Brief Description of Event: ***20 problem review of Mathematics principles addressed on the FE Final. In addition, there's a review of the relevant equations given to you on the exam and methods of solving problems using them.***

Reference Information (website, location of event, etc.):
https://www.youtube.com/watch?v=LJYy2tAaKQM&list=PLCV9OyAY5K-V-bki_dxxq_uVpyIoyIJ8P

UTK Event Descriptions

Date of Attendance: ***12/01/19*** Hours: ***2***

Event Title: ***FE Exam Review: Structural Design***

Event Host (person, company, professional society etc.): ***Gregory Michaelson, Marshall University***

Brief Description of Event: ***6 Problem review for Structural Design principles seen on the FE Exam. Begins with Beam (moment/shear) and Column analysis/design for Reinforced concrete members and moves onto Beam/Column/Tension member analysis and design for Structural Steel.***

Reference Information (website, location of event, etc.): ***https://www.youtube.com/watch?v=SGZD1OBr-8A&list=PLCV9OyAY5K-V-bki_dxxq_uVpyIoyIJ8P&index=7&frags=pl%2Cwn***

UTK Event Descriptions

Date of Attendance: ***12/04/19*** Hours: ***1***

Event Title: ***Modular Beauty: Low Impact Development and Permeable Pavers***

Event Host (person, company, professional society etc.): ***GreenCE***

Brief Description of Event: ***Discusses the benefits of Low-Impact-Design (LID) stormwater management through plastic grid pavers. Plastic grids are designed for sub-base water detention and prove to be more cost-effective than traditional pavement while also maintaining adequate stormwater management function. Additionally, pavers are constructed entirely from recycled waste product.***

Reference Information (website, location of event, etc.):
https://www.greence.com/Free_Courses/Modular-Beauty-Low-Impact

UTK Event Descriptions

Date of Attendance: ***12/04/19*** Hours: ***1***

Event Title: ***Concrete Tiling: The World's Most Energy Efficient Roof System***

Event Host (person, company, professional society etc.): ***GreenCE***

Brief Description of Event: ***Argues the fact that concrete tiling is the most ductile and versatile material to be used for roofing. Application of tiles can be seen in areas that experience extreme high temperatures (i.e. Sunbelt region). In addition to zero waste construction process, the tiles are partially composed of recycled materials. Overall, concrete tiles prove as a suitable replacement for traditional roofing (metal, wood, or asphalt).***

Reference Information (website, location of event, etc.):
https://www.greence.com/Free_Courses/Concrete-Tile-Roofing

UTK Event Descriptions

Date of Attendance: ***12/03/19*** Hours: ***1***

Event Title: ***Concrete Innovations***

Event Host (person, company, professional society etc.): ***By Lionel Lemay, PE, SE, LEED AP. Executive Vice President, Structures and Sustainability, National Ready Mixed Concrete Association***

Brief Description of Event: ***"Concrete Innovations" talks about recent advancements in the concrete manufacturing process and improvements made in performance of concrete mixes. Seeking out stronger and more ductile concrete new technologies are experimented with to develop a superior product. Implementation of bendable concrete, self-cleaning concrete, and the addition of carbonation to reduce the carbon footprint of the process.***

Reference Information (website, location of event, etc.): ***https://csengineermag.com/concrete-innovations/***

UTK Event Descriptions

Date of Attendance: ***12/04/19*** Hours: ***1***

Event Title: ***Designing With Metal***

Event Host (person, company, professional society etc.): ***GreenCE***

Brief Description of Event: ***Discusses the benefits in sustainability when using metal for roofing and cladding materials. Different finishes are recommended for the material per the application scenario (i.e. power coating, corrosion resistant primer, and hot dip or in-line galvanized). Additionally, through life cycle cost analysis, the material has proven to reduce heat island effects and overall cost and use of materials over time.***

Reference Information (website, location of event, etc.):
https://www.greence.com/Free_Courses/Designing-Metal

UTK Event Descriptions

Date of Attendance: ***12/03/19*** Hours: ***1***

Event Title: ***Uncomplicating the Stabilization Selection Process***

Event Host (person, company, professional society etc.): ***CSEngineermag***

Brief Description of Event: ***Discusses selection of Turf Reinforcement Mats (TRMs) for bank stabilization through analysis of various hydraulic parameters. Variables such as soil density/volume, Root depth, and light penetration are accounted for when designing for soil stabilization. Additional benefits of utilizing earth anchors are expressed for controlling hydraulic retention and sediment loss when applied to the TRMs.***

Reference Information (website, location of event, etc.): ***https://csengineermag.com/un-complicating-the-stabilization-selection-process/***

UTK Event Descriptions

Date of Attendance: ***12/03/19*** Hours: ***1***

Event Title: ***Properly Specifying Steel Joists***

Event Host (person, company, professional society etc.): ***CSEngineermag***

Brief Description of Event: ***Expresses the economical application of open web steel joists in construction of roofing and floor sections. The lecture guided the reader to proper design of steel joist sections through the use of specific codes/requirements compiled by the Steel Joist Institute.***

Reference Information (website, location of event, etc.): ***https://csengineermag.com/properly-specifying-steel-joists/***

UTK Tally Form: Jonathan Payne

Please use the following form to maintain record of your UTK progress throughout the semester. Note that some UTK events will require a Certificate of Attendance; specifically events outside the scheduled course meeting time. Please consult Dr. J with questions regarding reporting of UTKs.

Date	Duration (Hours)	Title of Event	Satisfy Online/Tutorial Credit? (Y/N)	Satisfy Sustainability Credit? (Y/N)	Certificate of Attendance? (Y/N)
12/1	1.5	FE Exam Review: Mathematics	Y	N	N
12/1	2	FE Exam Review: Structural Design	Y	N	N
12/3	1	Advantages of Today's Tension Fabric Structures	Y	N	Y
12/3	1	Uncomplicating the Stabilization Selection Process	Y	Y	Y
12/3	1	Concrete Innovations	Y	Y	Y
12/3	1	Properly Specifying Steel Joints	Y	Y	Y
12/4	1	Modular Beauty: Low Impact Development and Permeable Pavers	Y	N	Y
12/4	1	Designing With Metal	Y	Y	Y
12/4	1	Concrete Tile Roofing: The World's Most Sustainable and Energy Efficient Roo	Y	Y	Y

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CERTIFICATE
OF COMPLETION

Alexa Livingston

The above named recipient successfully completed a registered education program.

FSC-Certified Wood in Construction and Green Building

Online Course

Completed On **11/15/2019**

Awarded Credit Information

1 AAA Structured Learning Hour
1 AIA HSW/LU CE Hour
1 AIBD CE Hour
1 GBCI General Hour for LEED Professionals
1 OAA Structured Learning Hour
1 SAA Core Learning Hour

AIA Course #: **GFS06B**
GBCI Course ID: **0920019128**

Your Membership Information

No AIA Member # Provided
No AIBD Member # Provided
No GBCI Member # Provided

Credit Provided By:
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CONTINUING EDUCATION AIA

EDUCATION PARTNER

civil + structural ENGINEER

CERTIFICATE OF COMPLETION

This is to certify that

Paige Livingston

participated in

Protect Soil Slopes & Walls with GEOWEB® 3D Soil Confinement

ZG10152019CS

11-1-19

1 PDH

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Beth Brooks
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ENGINEER

CERTIFICATE OF COMPLETION

This is to certify that

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participated in

Diverging Diamond Interchange (DDI) Coming to a Highway Near You: An Insightful Solution to Your DDI Design

ZG021919

11-8-19

1 PDH

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Beth Brooks
Director of Sales, Zweig Group

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civil + structural
ENGINEER

CERTIFICATE OF COMPLETION

This is to certify that

Paige Livingston

participated in

Properly Specifying Steel Joists

ZG10012019CS
11-1-19
1 PDH

Richard Massey
Editor-in-Chief, Civil + Structural Engineer, Zweig Group

Beth Brooks
Director of Sales, Zweig Group

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CERTIFICATE
OF COMPLETION

Alexa Livingston

The above named recipient successfully completed a registered education program.

Commercial Design with Structural Insulated Panels

Online Course

Completed On **11/15/2019**

Awarded Credit Information

1 AAA Structured Learning Hour
1 AIA HSW/LU CE Hour
1 AIBD CE Hour
1 GBCI General Hour for LEED Professionals
1 OAA Structured Learning Hour
1 SAA Core Learning Hour

AIA Course #: **GSI06C**
GBCI Course ID: **0920015956**

Your Membership Information

No AIA Member # Provided
No AIBD Member # Provided
No GBCI Member # Provided

CONTINUING EDUCATION AIA

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education@greence.com | 800-248-6364

EDUCATION PARTNER

civil + structural ENGINEER

CERTIFICATE OF COMPLETION

This is to certify that

Paige Livingston

participated in

Presto Geosystems Managing Stormwater through LID & GI

ZG053019

11-8-19

1 PDH

Richard Massey

Editor-in-Chief, Civil + Structural Engineer, Zweig Group

Beth Brooks

Director of Sales, Zweig Group

Zweig Group is an Approved Provider by the AIA, ACEC, and SMPS.

civil + structural ENGINEER

CERTIFICATE OF COMPLETION

This is to certify that

Your Name Here

participated in

The Value of Intelligent 3D Bridge BIM in Transportation Projects

ZG101116CS

Date

1 PDH

Richard Massey

Editor-in-Chief, Civil + Structural Engineer, Zweig Group

Beth Brooks

Director of Sales, Zweig Group

Zweig Group is an Approved Provider by the AIA, ACEC, and SMPS.

GREENCE
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CERTIFICATE
OF COMPLETION

Alexa Livingston

The above named recipient successfully completed a registered education program.

Concrete Tile Roofing: The World's Most Sustainable and Energy Efficient Roof...

Online Course

Completed On **11/13/2019**

Awarded Credit Information

1 AAA Structured Learning Hour
1 AIA HSW/LU CE Hour
1 AIBD CE Hour
1 GBCI General Hour for LEED Professionals
1 OAA Structured Learning Hour
1 SAA Core Learning Hour

AIA Course #: **GEA07A**
GBCI Course ID: **0920019626**

Your Membership Information

No AIA Member # Provided
No AIBD Member # Provided
No GBCI Member # Provided

Credit Provided By:
GreenCE, Inc | AIA Provider: K167
education@greence.com | 800-248-6364

CONTINUING EDUCATION AIA

EDUCATION PARTNER

civil + structural
ENGINEER

CERTIFICATE OF COMPLETION

This is to certify that

Paige Livingston

participated in

Erosion & Sediment Control on Linear Utility Projects

ZG08162019CS

11-8-19

1 PDH

Richard Massey

Editor-in-Chief, Civil + Structural Engineer, Zweig Group

Beth Brooks

Director of Sales, Zweig Group

Zweig Group is an Approved Provider by the AIA, ACEC, and SMPS.

Name: Paige Livingston

UTK Tally Form

Please use the following form to maintain record of your UTK progress throughout the semester. Note that some UTK events will require a Certificate of Attendance; specifically events outside the scheduled course meeting time. Please consult Dr. J with questions regarding reporting of UTKs.

Date	Duration (Hours)	Title of Event	Satisfy Online/Tutorial Credit? (Y/N)	Satisfy Sustainability Credit? (Y/N)	Certificate of Attendance? (Y/N)
11-1-19	1	Protect Soil Slopes & Walls with GEOWEB	N	N	Y
11-1-19	1	Properly Specifying Steel Joists	N	N	Y
11-8-19	1	Erosion and Sediment Control on Linear Utility Projects	N	N	Y
11-8-19	1	Managing Stormwater through LID & GI	N	N	Y
11-8-19	2	Diverging Diamond Interchange	N	N	Y
11-13-19	1	Concrete Tile Roofing: The World's Most Sustainable	N	Y	Y
		and Energy Efficient Roof System			
11-~~13~~ 15-19	1	FSC-Certified Wood in Construction and Green Building	N	Y	Y
11-15-19	1	Commercial Design with Structural Insulated Panel	N	Y	Y
12-4-19	1	The Value of Intelligent 3D Bridge BIM			
		in Transportation Projects	Y	N	Y

Semester & Year: Fall 2019

UTK Event Descriptions

Date of Attendance: 12-4-19 Hours: 58 Minutes

Event Title: Concrete Tile Roofing: The Value of Intelligent 3D Bridge BIM in Transportation Projects

Event Host (person, company, professional society etc.): The webinar is sponsored by Bentley, moderated by Bob Drake, and presented by Raul Amaya, Andre Tousignant, and Dennis Fontenot.

Brief Description of Event: This webinar talks about using intelligent 3D BIM processes in transportation projects, specifically bridge projects. BIM has several benefits in the construction industry such as increasing communication, identifying issues early, increasing productivity, reducing project time, and improving safety. One of the most notable benefits is being able to identify conflicts on construction projects early and resolve them virtually before they arise in the field, which can cause delays and higher construction costs. My concentrations are transportation and construction management, and this course addresses elements that I will likely encounter in my career. I also am interested in BIM as it is gaining popularity in the construction industry.

Reference Information (website, location of event, etc.):

https://csengineermag.com/value-intelligent-3d-bridge-bim-transportation-projects/

UTK Event Descriptions

Date of Attendance: 11-13-19 Hours: 1 Hour

Event Title: Concrete Tile Roofing: The World's Most Sustainable and Energy Efficient Roof System

Event Host (person, company, professional society etc.): The webinar was sponsored by Eagle Roofing Products.

Brief Description of Event: This webinar talks about the sustainability and energy efficient attributes of concrete tile roofing. It talks in depth about the zero-waste manufacturing process, the life cycle cost, installation process and the performance as compared to temporary asphalt shingle roofing.

Reference Information (website, location of event, etc.):

https://www.greence.com/Free_Courses/Concrete-Tile-Roofing

UTK Event Descriptions

Date of Attendance: 11-8-19 Hours: 1 Hour and 18 Minutes

Event Title: Erosion and Sediment Control on Linear Utility Projects

Event Host (person, company, professional society etc.): Host is Beth Brooks (Director of Civil and Structural Engineer Media). Speaker is Ted Sherrod. Webinar is sponsored by SOX Erosion Solutions, Propex Geosolutions and Carolina Hydrologic.

Brief Description of Event: This webinar talks about innovative design features for erosion, sediment and turbidity control for linear utility projects. Ted Sherrod speaks about design of control measures for pipeline utility projects and developing stormwater management plans for private and public sectors.

Reference Information (website, location of event, etc.):

https://csengineermag.com/erosion-sediment-control-on-linear-utility-projects/

UTK Event Descriptions

Date of Attendance: 11-15-19 Hours: 50 Minutes

Event Title: FSC- Certified Wood in Construction and Green Building

Event Host (person, company, professional society etc.): This webinar was hosted by the Forest Stewardship Council (FSC).

Brief Description of Event: This webinar talks about how Forest Stewardship Council (FSC) products are a crucial conservation tool for global forest conservation. It also talks about how they integrate with broader green building standards.

Reference Information (website, location of event, etc.):
https://www.greence.com/Free_Courses/FSC-Certified-Wood

UTK Event Descriptions

Date of Attendance: 11-8-19 Hours:2 Hour and 20 Minutes

Event Title: Diverging Diamond Interchange (DDI)

Event Host (person, company, professional society etc.): Webinar is sponsored by TRANSOFT Solutions. Presenter in Hannah Khosravi who is a designer for TRANSOFT Solutions.

Brief Description of Event: The speaker talks about how more highways are shifting more towards DDIs. She expresses how well-designed DDI projects can improve safety, reduce traffic delays, and save costs over traditional interchanges.

Reference Information (website, location of event, etc.):

https://csengineermag.com/diverging-diamond-interchange-ddi/

UTK Event Descriptions

Date of Attendance: 11-8-19 Hours: 1 Hour and 9 Minutes

Event Title: Presto Geosystems Managing Stormwater Through LID & GI

Event Host (person, company, professional society etc.): Webinar is sponsored by Presto Geosystems. Presentation is moderated by Beth Brooks. Speaker is Sam Justice, a PE Design Engineer for Presto Geosystems.

Brief Description of Event: The presentation talked about Low Impact Development (LID) and Green Infrastructure (GI) that can work with the water cycle and help keep stormwater under control. Specifically the speaker presents on porous pavements and the benefits they can have on reducing the size of above ground detention ponds along with other benefits such as protecting again erosion and overflow concerns.

Reference Information (website, location of event, etc.):

https://csengineermag.com/presto-geosystems-managing-stormwater-through-lid-gi/

UTK Event Descriptions

Date of Attendance: 11-15-19 Hours: 1 Hour 5 Minutes

Event Title: Commercial Design with Structural Insulated Panels

Event Host (person, company, professional society etc.): This webinar was sponsored by the Structural Insulated Panel Association, and Al Cob was the host.

Brief Description of Event: This webinar discusses the benefits of structural insulated panels (SIPs) in the commercial building industry. Benefits addressed include energy savings, waste minimization and better indoor air quality.

Reference Information (website, location of event, etc.):

https://www.greence.com/Free_Courses/Commercial-Design

UTK Event Descriptions

Date of Attendance: 11-1-19 Hours: 53 Minutes

Event Title: Protect Soil Slopes and Walls with GEOWEB 3D Soil Confinement

Event Host (person, company, professional society etc.): Zweig Group and GEOSYSTEMS hosted the presentation and Sam Justice was the speaker.

Brief Description of Event: The event was hosted by a geotechnical engineer that was speaking about the causes of slope surface erosion and how it can lead to slope failure. The presentation included information on a system called GEOWEB that can protect against erosive forces for slopes and walls on projects.

Reference Information (website, location of event, etc.):

https://csengineermag.com/protect-soil-slopes-walls-with-geoweb-3d-soil-confinement/

UTK Event Descriptions

Date of Attendance: 11-1-19 Hours: 1 Hour 12 Minutes

Event Title: Properly Specifying Steel Joists

Event Host (person, company, professional society etc.): The event was hosted by Steel Joist Institute (SJI) and the speakers were Keith Juedermann and Tim Holtermann.

Brief Description of Event: The event was talking about open web steel joists relating to the structural design and specifying process. The presentation talked about the current codes and specifications that apply to steel joist construction along with practical guidance on how to properly specify steel joists.

Reference Information (website, location of event, etc.):

https://csengineermag.com/properly-specifying-steel-joists/

GreenCE
www.greence.com

CERTIFICATE
OF COMPLETION

Talecia Dyson

The above named recipient successfully completed a registered education program.

FSC-Certified Wood in Construction and Green Building

Online Course

Completed On **12/05/2019**

Awarded Credit Information

1 AAA Structured Learning Hour
1 AIA HSW/LU CE Hour
1 AIBD CE Hour
1 GBCI General Hour for LEED Professionals
1 OAA Structured Learning Hour
1 SAA Core Learning Hour

AIA Course #: **GFS06B**
GBCI Course ID: **0920019128**

Your Membership Information

No AIA Member # Provided
No AIBD Member # Provided
No GBCI Member # Provided

Credit Provided By:
GreenCE, Inc | AIA Provider: K167
education@greence.com | 800-248-6364

CONTINUING EDUCATION AIA

EDUCATION PARTNER

GREENCE
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CERTIFICATE
OF COMPLETION

Talecia Dyson

The above named recipient successfully completed a registered education program.

Walking the Talk: The Importance of Sustainable Manufacturing

Online Course

Completed On **12/04/2019**

Awarded Credit Information

1 AAA Structured Learning Hour
1 AIA HSW/LU CE Hour
1 AIBD CE Hour
1 GBCI General Hour for LEED Professionals
1 IDCEC CEU
1 OAA Structured Learning Hour
1 SAA Core Learning Hour

AIA Course #: **GTO22D**
GBCI Course ID: **0920017961**
IDCEC Course #: **107975-P1**

Your Membership Information

No AIA Member # Provided
No AIBD Member # Provided
No GBCI Member # Provided
No IDCEC Member # Provided

Credit Provided By:
GreenCE, Inc | AIA Provider: K167
education@greence.com | 800-248-6364

CONTINUING EDUCATION AIA

USGBC EDUCATION PARTNER

UTK Event Descriptions

Date of Attendance: ***12/05/19*** Hours: ***1***

Event Title: ***Concrete Innovations***

Event Host (person, company, professional society etc.): ***Civil + Structural Engineer***

Brief Description of Event: ***This article talks about the evolution of concrete as a material including how new products, manufacturing methods and research are developing innovative concretes to meet new challenges.***

Reference Information (website, location of event, etc.): https://csengineermag.com/concrete-innovations/

UTK Event Descriptions

Date of Attendance: ***12/05/19*** Hours: ***1***

Event Title: ***Walking the Talk: The Importance of Sustainable Manufacturing***

Event Host (person, company, professional society etc.): ***Greence***

Brief Description of Event: ***This article explores how sustainable manufacturing currently helps to reduce negative environmental impacts and solve critical issues facing the health of the planet.***

Reference Information (website, location of event, etc.):
https://www.greence.com/Free_Courses/Walking-Talk-Importance

UTK Event Descriptions

Date of Attendance: ***12/05/19*** Hours: ***1***

Event Title: ***FSC-Certified Wood in Construction and Green Building***

Event Host (person, company, professional society etc.): ***Greence***

Brief Description of Event: ***This online seminar identifies the tools, strategies, and resources that building professionals can use to encourage market transformation and sustainability of the forest products industry. This includes benefits in the environment as well as benefits to the built environment for the end users.***

Reference Information (website, location of event, etc.):
https://www.greence.com/Free_Courses/FSC-Certified-Wood

CE 400: Senior Design, Fall 2019, Chelaque Marina, Talecia Dyson

UTK Tally Form

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Date	Duration (Hours)	Title of Event	Satisfy Online/Tutorial Credit? (Y/N)	Satisfy Sustainability Credit? (Y/N)	Certificate of Attendance? (Y/N)
8/28	2	NSBE General Body Meeting	N	N	Y
9/11	2	NSBE General Body Meeting	N	N	Y
10/15	1.5	EMPOWER Women in Engineering Meeting	N	N	Y
11/20	1.5	NSBE General Body Meeting	N	N	Y
12/4	1	Walking the Talk: The Importance of Sustainable Manufacturing	Y	Y	Y
12/5	1	Concrete Innovations	Y	N	Y
12/5	1	FSC-Certified Wood in Construction and Green Building	Y	Y	Y

 Semester & Year: ____________________

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18	Summer Break	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18
Everyone																																					
Weekly Team Meeting, Thursday 2:00 PM		PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD																			
Site Visit				PD																																	
Kickoff Meeting				PD																																	
Public Forum 1									PD																												
Public Forum 2													PD																								
Poster Showcase Event																		PD																		CD	
Weekly Team Meeting, Thursday 3:00 PM																																					
By Weekly Client Meetings Thursday 3:00 PM																								DD		DD		DD		CD		CD		CD			
Reconvene with Stakeholders Meeting																					DD	DD															
Project Progress Meeting																										DD	DD										
Host Final Client Meeting																																		CD	CD		
Paige Livingston	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**	**Week 7**	**Week 8**	**Week 9**	**Week 10**	**Week 11**	**Week 12**	**Week 13**	**Week 14**	**Week 15**	**Week 16**	**Week 17**	**Week 18**																			
Team Task Management		PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD		DD	DD	DD	DD	DD	DD	DD	DD	DD	CD	CD	CD	CD	CD	CD	CD	CD	
Coordiation with Team/Mentor/Clients		PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD		DD	DD	DD	DD	DD	DD	DD	DD	DD	CD	CD	CD	CD	CD	CD	CD	CD	
Introduction/Scope of Work			PD	PD	PD																																
Create Report Template				PD	PD																																
Write and Edit Technical Scope of Work					PD	PD																															
Research TVA Water Levels						PD	PD																														
Research Automated Adjustable Anchoring System							PD	PD	PD																												
Water Fluctuation/New Design Calculations								PD	PD	PD	PD	PD																									
Project Cost Estimation Calculations									PD	PD	PD	PD																									
Determine Cost-Effective Solution											PD	PD	PD	PD																							
Report Writing				PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD					DD	DD	DD	DD	DD	DD	DD	CD	CD	CD	CD	CD	CD	CD		
Hydraulic Data Collection and Analysis																							DD	DD	DD	DD	DD	DD	CD	CD	CD	CD	CD	CD	CD		
Chase Allsup	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**	**Week 7**	**Week 8**	**Week 9**	**Week 10**	**Week 11**	**Week 12**	**Week 13**	**Week 14**	**Week 15**	**Week 16**	**Week 17**	**Week 18**																			
Introduction/Scope of Work			PD	PD	PD																																
Write and Edit Introduction				PD	PD																																
Drafting						PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD					DD	DD	DD	DD	DD	DD	DD	CD	CD	CD	CD	CD	CD	CD		
Mentoring						PD																															
Report Writing				PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD					DD	DD	DD	DD	DD	DD	DD	CD	CD	CD	CD	CD	CD	CD		
Design Work						PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD							DD	DD	DD	DD	DD	CD	CD	CD	CD	CD	CD	CD		
Talecia Dyson	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**	**Week 7**	**Week 8**	**Week 9**	**Week 10**	**Week 11**	**Week 12**	**Week 13**	**Week 14**	**Week 15**	**Week 16**	**Week 17**	**Week 18**																			
Introduction/Scope of Work			PD	PD	PD																																
Write and Edit Purpose					PD	PD																															
Research on Preliminary Cost Analysis						PD	PD																														
Research on Material Selection for Boom Structure						PD	PD	PD																													
Work on Prediction Model							PD	PD	PD																												
Design Work								PD	PD	PD	PD															DD	DD	DD	CD								
Report Writing				PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD						DD	DD	DD	DD	DD	DD	DD	CD	CD	CD	CD	CD	CD	CD		
Setup Working Schedule w/Clients																																					
Jonathon Payne	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**	**Week 7**	**Week 8**	**Week 9**	**Week 10**	**Week 11**	**Week 12**	**Week 13**	**Week 14**	**Week 15**	**Week 16**	**Week 17**	**Week 18**																			
Introduction/Scope of Work			PD	PD	PD																																
Write and Edit Purpose					PD	PD																															
Research on Hydrological Analysis					PD	PD	PD	PD														DD	DD	DD	DD												
Determine Prediction Modeling (Software vs Physical Built Model)						PD	PD	PD	PD																												
Work on Prediction Model							PD	PD	PD	PD	PD											DD	DD	DD	DD	DD	DD	DD									
Design Work								PD	PD	PD	PD											DD	DD	DD	DD	DD	DD	DD									
Determine New Design Solutions										PD	PD	PD																									
Estimate Cost of New Design Solutions												PD	PD																								
Report Writing				PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD	PD					DD	DD	DD	DD	DD	DD	DD	CD	CD	CD	CD	CD	CD	CD		