Appendix B
Moveable Bridge Lift Analysis Report

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HARDESTY & HANOVER, LLP

ENGINEERING

ERIE CANAL HARBOR DEVELOPMENT CORPORATION

Buffalo Harbor Bridge

MOVABLE BRIDGE LIFT ANALYSIS

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FINAL REPORT

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I. EXECUTIVE SUMMARY

The purpose of this study is to assess the effect of the closed position vertical clearance of a proposed Buffalo Harbor movable bridge will have on marine traffic. The study takes data gathered from a variety of sources, some historic and some anecdotal, and analyzes it with respect to the proposed alignments and movable bridge types. The scope of the assessment is not intended to be so broad as to arrive at a single recommended solution. Conversely however, it is intended to be broad enough to potentially eliminate certain combinations of alignment location, bridge type and/or channel clearance.

The data considered includes roughly 2 years of draw-tenders logs from the Michigan Avenue and Ohio Street Bridges, information from stakeholders meetings, telephone conversations with businesses adjacent to the Buffalo River and Buffalo Ship Canal and fleet operators who service them.

The general conclusion is that any proposed movable bridge in the project study area should attempt to attain a minimum closed position vertical clearance of 18′ above standard water datum. Closed position vertical clearances of 20′ will clear approximately 50% of the typical vessels. Clearances above 20′ begin to show diminishing returns; that is, the incremental change in the number of vessels that will be able to pass beneath the bridge without requiring an opening will be small with each added foot of clearance, until reaching approximately 48′ of clearance above which only the largest occasional vessels will require an opening.

II. DATA GATHERING

In order to compile sufficient data to draw well informed conclusions and recommendations, several sources were utilized to gather the data within the project study limits. Existing draw logs were reviewed for the existing Michigan Avenue and Ohio Street Bridges to provide a look at current usage of the Buffalo River. The Michigan Avenue Bridge is a vertical lift bridge that carries Michigan Avenue over the Buffalo River and the Ohio Street Bridge is a vertical lift bridge that carries Ohio Street over the Buffalo River. The period reviewed of the existing draw logs for the Michigan Avenue Bridge was December 17, 2005 to April 27, 2009, and the period reviewed of the existing draw logs for the Ohio Street Bridge was December 22, 2005 to April 27, 2009. In addition to providing current usage patterns, this data also provided a look into what times of day were seeing the heaviest volumes of vessel traffic and therefore would see the most openings. These draw logs provided a record of the time of day the span was lifted, the name of the vessel the span was being lifted for, the time of day the span was lifted, how many additional barges were either being pushed or tugged, and whether the span was lifted to its full opening or only partially.

Current Coast Guard regulations also reflect the peak travel times for vessels throughout the year. From March 22 through December 15, both the Michigan Avenue Bridge and the Ohio Street Bridge must be opened within 20 minutes of the request being made from the vessel operator to the draw tender. Alternatively, from December 16 through March 21, four hours of advance notice must be given in order for the bridge to lift. The Coast Guard also places restrictions on the hours of the day during which the bridge need not be lifted based on vehicular traffic conditions[1]. However, this consideration is beyond the scope of this report. These issues will be discussed in future traffic analysis within the Draft Environmental Impact Statement.

One major piece of information not provided by these draw logs was height of vessels. This information was necessary in order to determine the optimal height for closed position of the proposed bridge over Buffalo River. In order to compile this data, a variety of methods were used to correlate vessels to lift height requirements including visual observation from marine traffic counts (explained below), contacting vessel owners directly, and contacting marina operators for anecdotal information.

Marine traffic counts were performed using visual observation and recording of marine and pedestrian traffic on three dates which were selected to provide a typical cross-section of usage patterns during peak periods. These selected dates were Tuesday, July 13, 2009 from noon until 9:00 PM, Wednesday, July 14, 2009 from noon until 9:00 PM, and Saturday, July 18, 2009 from 9:00 AM until 5:00 PM. Data was collected from the mainland side of Erie Street so as to be able to view vessel traffic coming out of and going in to both the city ship canal and the Buffalo River. During these periods, vessels were counted and, whenever possible, identified by name and had their estimated vertical clearance recorded. Also noted was the time of day and the direction the vessel was headed, eastbound or westbound.

[1] Coast Guard DHS, §117.773, pg. 593 – App B

Involved parties were contacted via telephone to obtain pertinent information, such as vessel heights and the projected frequencies of vessels leaving and returning. The data was collected and correlated with the quantitative data obtained in the previously described draw logs and marine traffic counts. Commercial businesses and marinas were contacted to determine their level of involvement as well as how their respective entities would be affected by the proposed construction of a new movable span over the Buffalo River. Topics discussed included total number of slips and boats at each marina, average vessel sizes and peak times of day for vessel activity. The following is a list of those contacted:

Agency	Contact Name	Telephone #/Email	Date Contacted
First Buffalo River Marina	Carol Harrison	(716) 854-0020	July 23, 2009
RCR Yachts	Rich Lenard	(716) 856-6314	July 30, 2009
General Mills	Dave Tincher	(716)857-3700	July 30, 2009
Luedtke Engineering Co.	Paul Luedtke	(231) 352-9631	July 31, 2009
Miss Buffalo II	Mike Hayhurst	(716) 856-6696	September 17, 2009
Great Lakes Towing	Rob Ocasio	(216) 621-4854	September 17, 2009
China Light Yacht Club	Stephen Krzeinski	(716)632-4762	November 2, 2009
Seven Seas Sailing Club	Bill Zimmerman	(716)880-5154	November 2. 2009
Buffalo Harbor Sail Club	Craig Wittmann	(716)844-3621	November 2, 2009
Erie Basin Marina	Julie Wolasz	Eriebasinmarina@verizon.net	November 2, 2009
LaFarge	Robert Haefner	Rob.haefner@lafarge-na.com	September 22, 2009

All of the data gathered through the aforementioned methods was quantified and analyzed to produce an informed recommendation and conclusion as to the optimal location, type, and closed vertical clearance of the proposed bridge. Data collection was limited due to the scope of the project, but sufficient data was collected to generate a concise an informed product.

III. DATA ANALYSIS

During the analysis period covered by the existing draw logs there were 717 recorded lifts for the Michigan Avenue Bridge and 625 lifts for the Ohio Street Bridge. This number of lifts does not accurate reflect the volume of traffic under the raised span because there were several occasions where two or three boats passed under the span at the same time which increases the total number of openings as counted per vessel. There were 41 unique vessels that were recorded for either bridge, 14 of which were tug boats. In addition to the 41 unique vessels, maintenance vessels, and other miscellaneous vessels (unnamed tugs and cranes with barges and scows as well as a few sailboats) were also recorded as requiring openings during the monitored time frame. Lists of the vessels that required an opening at the existing bridges and the number of openings per vessel, are as follows:

NUMBER OF VESSELS REQUIRING OPENINGS AT OHIO ST. (12/05-04/09)	
Vessel Name	**Number of Openings**
Tug Washington	197
Tug Kurt Luedtke	187
Tug New Jersey	63
Miscellaneous	62
English River	52
Miss Buffalo II	48
Henry C. Jackson	34
Maintenance	29
Fire Boat Cotter	22
American Fortitude	8
Iglehart	7
R.V. Seneca	6
Saginaw	6
Barbara Andre	6
Tug Gregory Bush	5
Westwind	4
Tug Joanne	4
Alpena	4
Aquarius	4
Tug Jaclyn	3
Tug Bush	3
Derrick	3
Grand Lady	2
Cuyahoga	2
Tug Madelin	2
Cheraw	2
Tug Gretchen	2
R.V. Mudpuppy	1
Jonclaire and Breaker	1
TOTAL	**753**

NUMBER OF VESSELS REQUIRING OPENINGS AT MICHIGAN AVE. (12/05-04/09)	
Vessel Name	**Number of Openings**
Tug Washington	213
Tug Kurt Luedtke	175
English River	107
Tug New Jersey	66
Miscellaneous	63
Fire Boat Cotter	49
Miss Buffalo II	47
Henry C. Jackson	33
Westwind	33
Maintenance	29
Iglehart	11
American Fortitude	9
Tug Joanne	9
Tug Samuel Champlain	9
Integrity	8
Alpena	8
R.V. Seneca	7
Innovation	7
Saginaw	6
Tug Gregory Busch	5
Tug Jaclyn	5
Barbara Andre	4
Aquarius	4
Tug Ostlander	4
Tug Bush	3
Derrick	2
Grand Lady	2
Cuyahoga	2
Tug Madelin	2
Cheraw	2
R.V. Mudpuppy	2
Nina	2
Cornelius	2
Tug Gretchen	1
Jonclaire and Breaker	1
St. Barbara	1
Moondance	1
Tug Otto	1
Tug Ohio	1
Rebecca Lynn	1
Mawmee	1
TOTAL	938

Certain assumptions had to be made in order to interpret the data and to draw informed conclusions. Of the industrial properties along the City Ship Canal, the General Mills operation on Kelly Island and Sand Products Corp. on the Outer Harbor are the predominant feature in the area. However, it should be noted that the operations of RCR Yachts and First Buffalo River Marina in the Outer Harbor Area as well as various other businesses along the river and ship canal are no less important. Information and input was gathered from them via telephone interview as well as through the marine traffic counts. According to representatives from General Mills, based on current usage and their own projections, they anticipate a limited number of large vessels annually that require access to the berthing areas adjacent to South Michigan Avenue. This figure may be revised either up or down depending on the economy and other unforeseeable factors. General Mills has stated that they expect operations at this facility to potentially increase based on the vehicular and marine access afforded this facility.

For purposes of this assessment, Buffalo Harbor will be considered the area bounded by the confluence of the Buffalo River and the Buffalo City Ship Canal. This would place its geographical limits between the tip of Kelly Island and the tip of the Outer Harbor Peninsula (former USCG Station/lighthouse). This harbor is also marked as a turning basin on navigation maps. Confined within this area are some facilities and businesses of note. The Naval Museum at Pearl Street does not account for a great number of vessel traffic. However, this facility must be accommodated to prevent any proposed restriction to navigation in the Harbor. The decommissioned USS The Sullivans (DD-537) is currently berthed there and used as a museum. At 376.5 feet, the consideration for this vessel isn't merely its vertical clearance, its length must comfortably fit within the width limits of the navigable waterway should it ever need to leave its berth for maintenance or other purposes. Because it is an extremely long ship, it has a wide turning radius and this would need to clear any potential piers. In addition to the USS The Sullivans, this area is also home to the USS Little Rock CLG4 at 610 feet long and the USS Croaker SSK246 at 311 feet long. These constraints must be taken into consideration when determining pier placement and bridge type selection for a potential crossing at either Erie or Main Streets.

First Buffalo River Marina currently maintains 152 slips, 80% of which are occupied (approximately 120 total boats). Of that 80%, 75% are sailboats which require increased vertical clearance (approximately 90 boats). It is assumed based on information from the marina that the typical mast height for most sailboats is approximately equal to the size of the vessel. The average size for a vessel in this marina is 35 feet. About 75% of the sailboats are in the 30 foot range, 15% are in the 20 foot range, and 10% are in the 40 foot range. Therefore, the majority of tall vessels in the marina are in the 30 foot height range. Peak departure periods from First Buffalo River Marina into Lake Erie occur on Wednesdays from 5:00 PM to 6:00 PM and continue through the evening due to the regattas that occur on this day. Also, all day on weekends is a peak departure period for the marina.

RCR Yachts currently maintains 125 slips, 90% of which are occupied (approximately 110 total boats). Of that 90%, 98% are sailboats which require increased vertical clearance (approximately 108). The average vessel size at this marina is 34 feet with a majority of boats in the 20 to 35 foot range. A smaller portion of boats are in the 40 to

45 foot range. According to RCR Yachts, the typical mast height for most boats in their marina is about 40 feet and most boats would need about 50 feet of clearance to comfortably depart the marina into Lake Erie. The peak departure periods are Tuesday and Wednesday between 5:00 PM and 6:00 PM due to the regattas, and the marina also sees additional periods of increased vessel volume between 5:00 PM and sundown weekdays and all day on the weekends. Also noted was the fact that in the spring and the fall, some larger transient boats in excess of 60 and 70 feet pass through the facility and would need to be accommodated. There are approximately 6 to 12 boats of this height observed per season.

From additional phone conversations, information was provided for a few of the commercial vessels that utilize that Buffalo Harbor. Ultimately, the information collected served to verify the theory that recreational vessels account for the vast majority of the harbor traffic. The Miss Buffalo II is 19 feet high and 90 feet long. A typical trip on the Miss Buffalo II involves the tour boat making a U-turn in the turning basin that takes approximately ten minutes to complete. Only about six trips per year continue up the Buffalo River and pass under the existing Michigan Avenue and Ohio Street Bridges. The SS Alpena is 83 feet tall. The Washington Tug is 20 feet tall and travels down the Buffalo River once every two weeks towing the English River, whose height is unknown due to conflicting information. However, it can be assumed that the English River is at least 36 feet tall based on the information acquired. The New Jersey Tug is 20 feet tall and travels down the Buffalo River once a month towing the Herbert C. Jackson, which is 37 feet tall. The Ohio Tug is 30 feet tall, but travels down the Buffalo River less than five times a year. The Tug Samuel de Champlain tows the barge Innovation, which is 80 feet tall. The Tug GL Ostrander tows the barge Integrity which is 92 feet tall. Even though the tugs are only 20 feet tall, their necessary clearance is controlled by the height of the vessel they are towing, which is almost twice as tall as the tug itself.

The data provided in the lift logs only included time of opening, number of parcels the vessel was either pushing or pulling, and if the lift was a partial lift or a full lift. From that data, almost every vessel had at least one partial lift, and the ones that did not, had less than five recorded lifts. Two conclusions can be drawn from this. Either, the parcel was what required the full opening of the lift since the vessel has also been recorded clearing a partial opening or the bridge was lifted to full opening at point without regard to how much clearance the vessel actually needed. The minimum clearance of the Michigan Avenue Bridge at Mile 1.34 of the Buffalo River is 20 feet and the minimum clearance of the Ohio Street Bridge at Mile 2.10 is 18 feet. For the purposes of this report, all powerboats are assumed to have a height of 18 feet or less, and therefore not require an opening at the existing Ohio Street and Michigan Avenue Bridges. This is assumed to be true since there were no powerboats recorded in the lift logs provided for those two bridges. The regulated vertical clearance requirement for a bridge in the open position over the Buffalo River and the City Ship Canal, as well as the provided open clearance of the existing Michigan Avenue, Ohio Street, and Skyway Bridges is 100 feet. Consequently, the provided vertical clearance of any new bridge in the open position over these waterways should be 100 feet at a minimum. Lift log data and recent actual marine traffic counts show that no tall vessels (powerboats excluded) were observed at a height of less than 27 feet. Therefore, all tall vessels will be assumed to require at least

30 feet of clearance for a bridge in the closed position. If this closed position vertical clearance cannot be provided, a bridge opening will be required.

For this report, the term "peak period" will refer to the hours of greatest vessel traffic during the months of July and August. This is based on the lift logs for the existing Michigan Avenue and Ohio Street Bridges as well as telephone conversations with marinas in the surrounding area. For weekdays, this peak period occurs from 5:00 PM to 9:00 PM, with volume being heaviest on Tuesdays and Wednesdays due to the regattas that take place those days during the summer months. For weekend days, this period is considered to be all day, which is assumed to be from 9:00 AM to 5:00 PM. Therefore, the volumes calculated below for the peak periods, assumed to be the worst case scenario, are for a single day in July or August, with that day being either a regatta day or a weekend day.

Based on the data provided by the marinas, it is assumed that 50% of boats leave the marina on the weekends and regatta days. On the weekend, vessels will be traveling in an out of the harbor all day so it is difficult to predict an average number of vessels per opening. Therefore, weekend usage will be expressed in the number of vessels that would require an opening. That translates to 54 boats leaving and returning to RCR Yachts resulting in 108 vessels requiring openings. Similarly, First Buffalo River Marina would require openings for 90 boats during anticipated periods of peak activity. The actual opening frequency will be a function of the USCG regulations established for this crossing based on their normal approval process.

From the data provided from the lift logs, the following averages can be obtained regarding commercial vessel usage of Buffalo River:

		# of Days Observed	# of Total Lifts	Ave. # Lifts/Day
Michigan Avenue	Weekday	135	198	1.467
	Weekend	53	80	1.509
Ohio Street	Weekday	135	184	1.363
	Weekend	53	81	1.528

All of these averages can be rounded up to two openings per day during the peak period for both the Michigan Avenue and Ohio Street crossings, weekend day and weekday. This also demonstrates that the vast majority of the volume is going to come from the marinas downriver particularly during their specified peak hours.

As seen in the preceding paragraphs, there is a substantial quantity of sailboats and other tall recreational vessels that would require an opening in order to travel into and out of Buffalo Harbor. Such a large number of openings is impractical. Therefore, during anticipated periods of peak activity, lifts could be scheduled so that boaters and vehicle operators would know when the position of the bridge would be least desirable for them to travel either over or under it, and they would be able to plan accordingly. In the event of an extreme weather event which would require boaters to return to their marina for shelter, the bridge can be opened for a prolonged period of time to quickly allow vessels through, as there are alternate routes off the island for vehicles.

IV. BRIDGE CLEARANCE AND LIFT FREQUENCY ANALYSIS

Based on the data collected during marine traffic counts, a typical cross section of vessel volume was determined for the weekday and weekend peak period for vessel types and vessel heights. These are reflected in the following graphs:

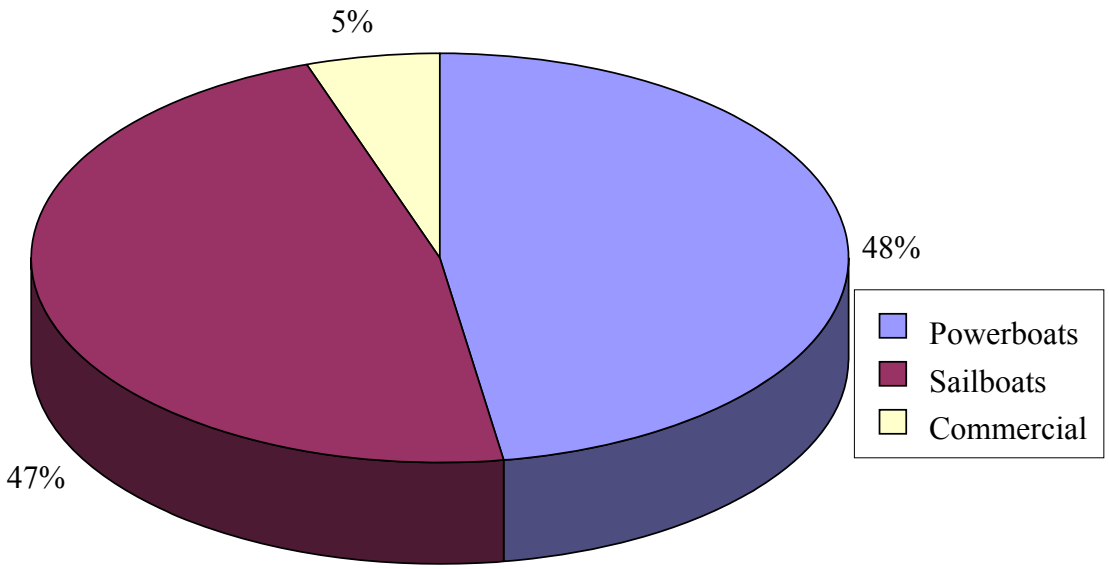

Figure 1 - Weekday Peak Usage by Vessel Type

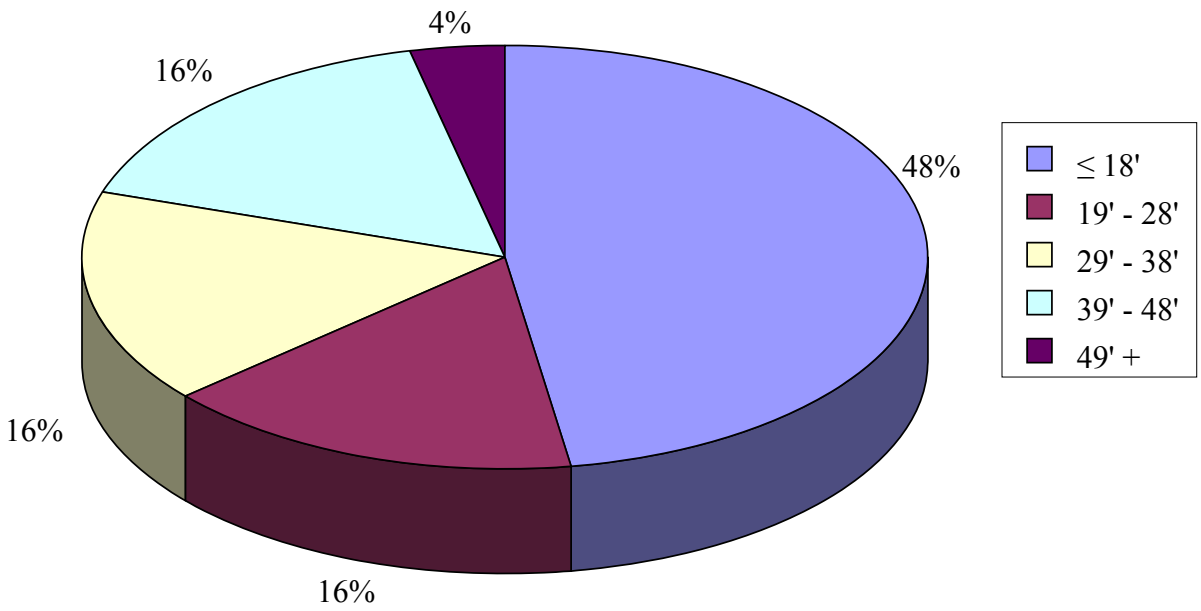

Figure 2 - Weekday Peak Usage by Vessel Height

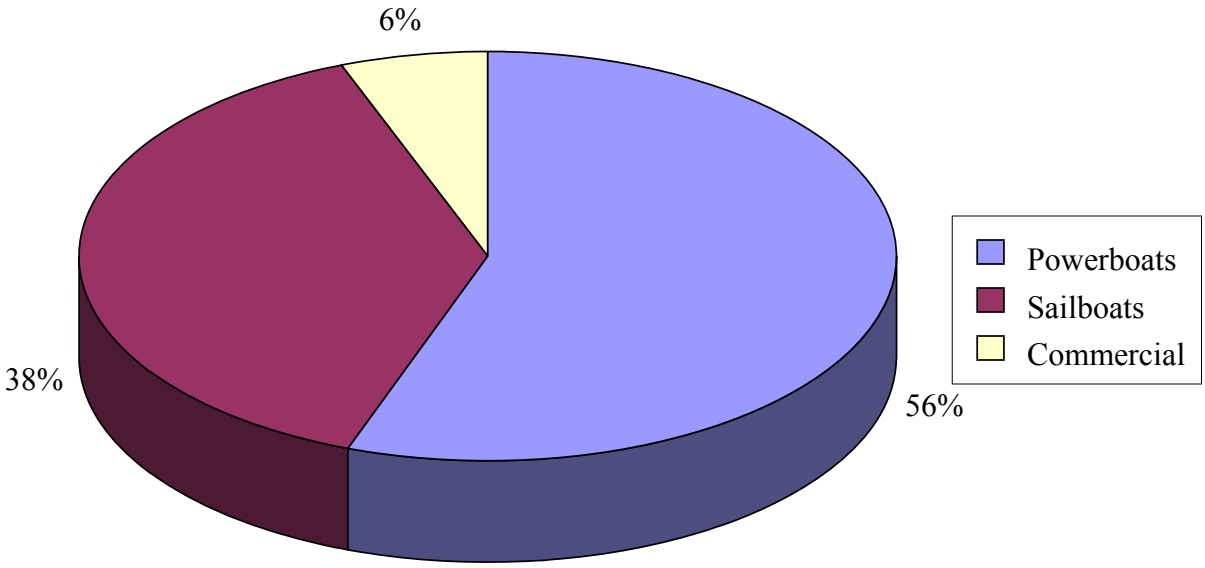

Figure 3 - Weekend Peak Usage by Vessel Type

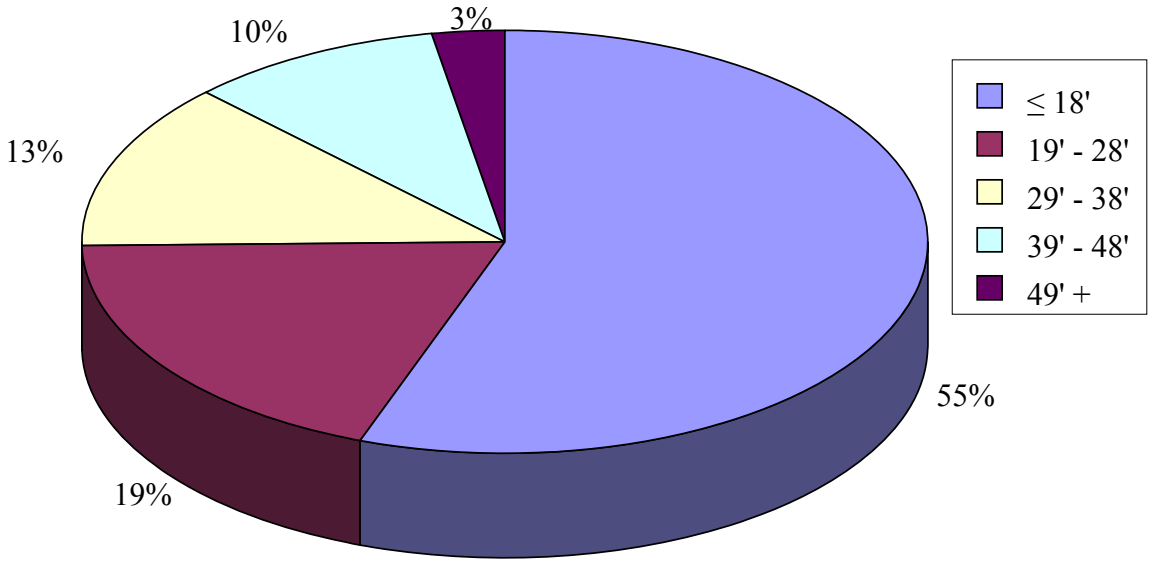

Figure 4 - Weekend Peak Usage by Vessel Height

As seen from the preceding pie charts, approximately half of all boats that travel out to the lake on a weekday and weekend peak period are powerboats, and therefore, under 18 feet in height. This requires no opening of a bridge that has a closed clearance of 18 feet. It is also seen that sailboats make up the remaining majority of vessels that travel out to the lake during the weekend and weekday peak periods. The majority of the sailboats are between 19 feet and 48 feet on both the weekdays and the weekends. On the weekends, approximately half are between 19 feet and 48 feet, while on the weekdays, the sailboat height is evenly distributed between 19 and 48 feet.

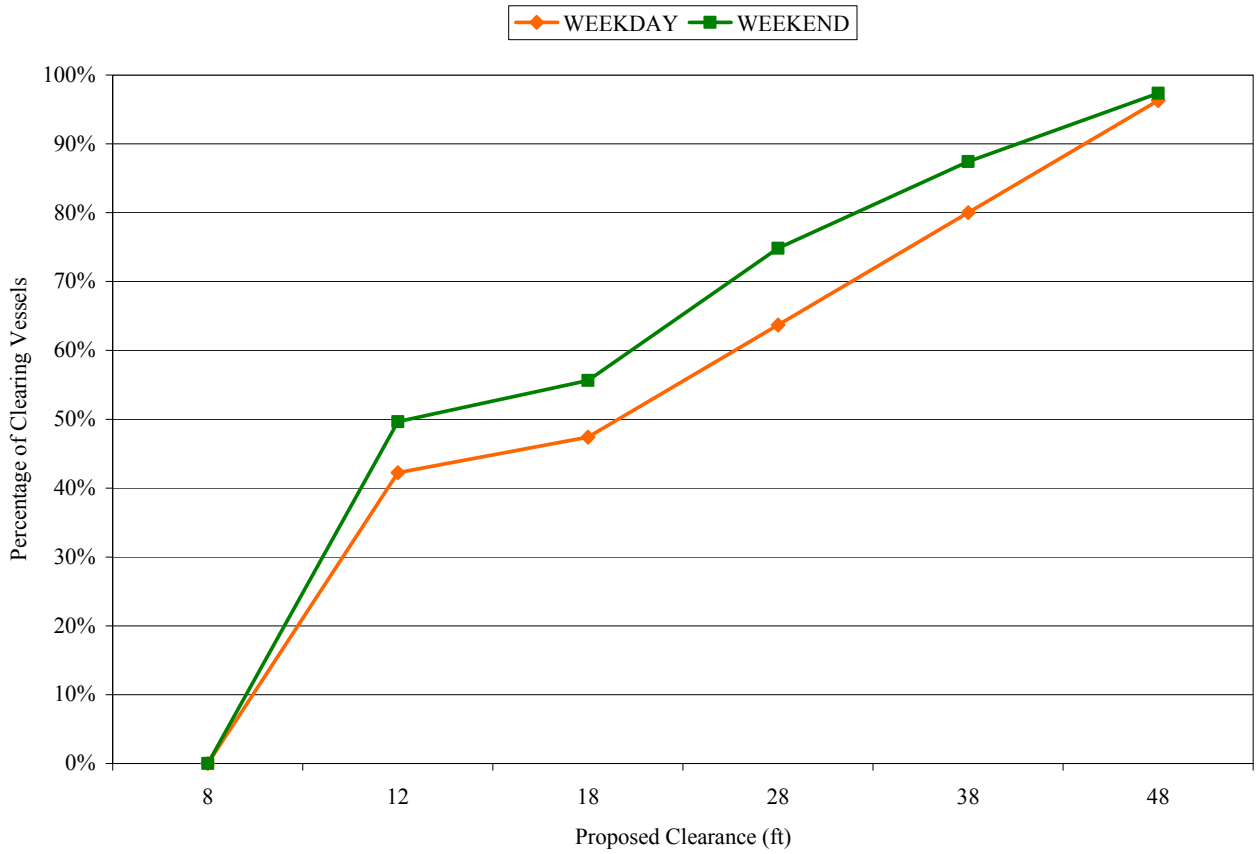

Figure 5 - Percentage of Vessels Clearing Proposed Closed Clearance

As seen from the above graph, roughly half of all vessels can comfortably navigate under a proposed bridge with a clearance of 18 to 20 feet without requiring an opening. Construction of a span with a clearance much higher than this will have diminishing gains, for several reasons. First, the additional percentage of vessels that can pass under the bridge in the closed position decreases linearly after 18 feet. Therefore, there is little additional positive impact to boaters for closed spans over 18 to 20 feet. Secondly, due to structure depth requirements, constraints on the piers due to geological makeup, engineering geometric considerations and potential environmental impact, it is not feasible to construct a bridge which will accommodate even a small percentage of sailboats without a lift.

Among the alternatives considered for the Buffalo Harbor Bridge project, there are four proposed bridge alignment locations being considered. Vessel traffic at each location will differ depending on location and consequently each location will have a differing number of projected bridge openings. Based on the data collected, and for the purposes of projecting usage, an 18 foot closed bridge clearance will be assumed and therefore will not require an opening for 50% of the vessel traffic going into and out of the Buffalo Harbor.

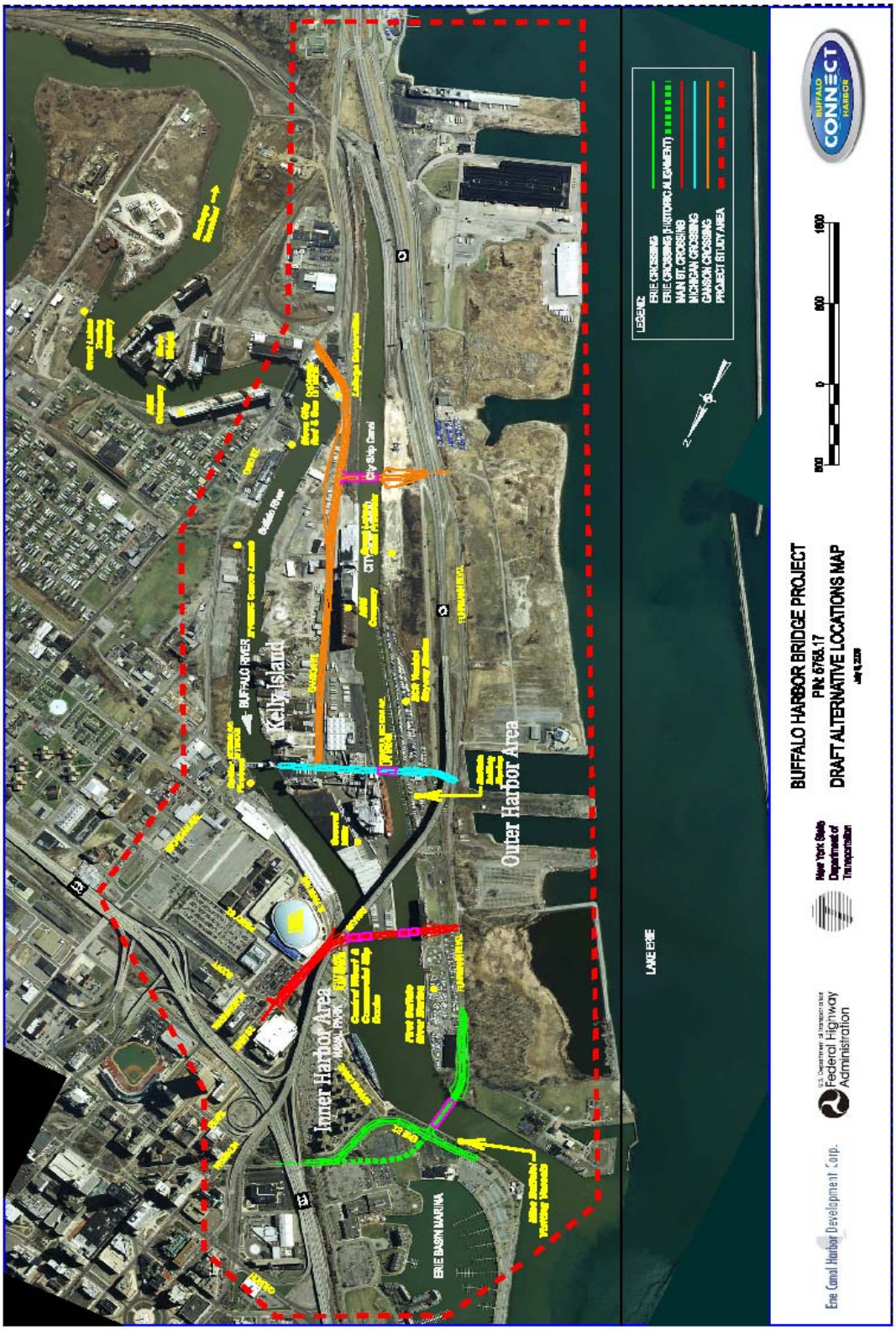

Figure 6 - Alternative Locations Map

General

All structure lengths are gross approximations for the purposes of this assessment and do not indicate any selected or preferred structure lengths or waterway clearances. It is anticipated that all movable bridge piers and fenders would be placed outside of the navigable channels of the Buffalo River and the City Ship Canal.

South Michigan Avenue

The proposed South Michigan Avenue alternative would utilize the existing Michigan Avenue Lift Bridge to carry traffic onto and across Kelly Island along South Michigan Avenue. Then the proposed bridge would carry traffic approximately 125 feet across the City Ship Canal onto the Outer Harbor Area. First Buffalo River Marina would not be affected by this bridge, as it is located north of its proposed location. This bridge would not see much recreational traffic aside from those vessels that are berthed in the RCR Yachts Marina which is just south of the proposed location of the bridge. The bridge would need to accommodate their volume, as well as any traffic seen by the General Mills Plant on Kelly Island, whose dock is due south of this proposed location. Any other traffic would be minimal, as the City Ship Canal comes to a termination not much further downstream. The projected usage for this alignment would be 108 vessels requiring an opening for a peak period weekend and 11 openings for a peak period weekday.

Ganson Street

The proposed Ganson Street alternative would carry traffic approximately 125 feet across the City Ship Canal from Kelly Island to the outer harbor approximately 3000 feet south of Michigan Avenue and approximately 800 feet north of the southerly navigation limit of the Canal. This alignment is south of both First Buffalo River Marina and RCR Yachts as well as the General Mills Plant, resulting in virtually no vessel traffic needing access to points south. No data was gathered to suggest that any vessels currently travel or will travel to points south of this alignment therefore, no potential openings are projected. However, a movable bridge is required since the alignment is over Federal navigable waterway and its construction cannot preclude the future use of this waterway.

Main Street

The proposed Main Street alternative would carry traffic 200 feet across the Buffalo River, and then 125 feet across the City Ship Canal via Main Street to the Outer Harbor Area. This crossing would be perpendicular to the waterway (as opposed to the Buffalo Skyway, which would share a similar origin point, but crosses the waterway at a skew). This alignment would accommodate vessel traffic going into and out of both the City Ship Canal and the Buffalo River as it is located at the mouth of both of these waterways. First Buffalo River Marina is still just north of this alignment and would not be affected by the proposed crossing. However, RCR Yachts, the General Mills Plant, and all commercial and recreational traffic using the Buffalo River and the City Ship canal south

of this alignment would have to pass under this proposed location. The frequency of lifts for the Buffalo River span at this location would be similar to current lifts at Michigan and Ohio. From data provided in the lift logs of the existing Michigan Avenue and Ohio Street Bridges, the projected number of openings for the Buffalo River span would be two openings on a peak period weekday or weekend day. However, the projected usage for the City Ship Canal span of this alignment would be 108 vessels requiring an opening on a peak period weekend day or 11 openings on a peak period weekday, due to the location of the marinas and the fact that they account for the vast majority of all vessel traffic to the lake.

Erie Street

The Erie Street alignment would be the proposed alignment furthest to the north, and by far the alignment that would need to accommodate the most vessel traffic. It takes traffic 325 feet* from Erie Street across Buffalo Harbor to the Outer Harbor Area. With few exceptions such as Miss Buffalo, which is moored north of the Erie alignment and may not always require an opening, it would see all vessel traffic entering the Harbor, including vessels traveling down Buffalo River and the City Ship Canal as well as both of the marinas on the Outer Harbor Area, the General Mills Plant, and other larger lake freighters. The projected usage for this alignment would be 200 vessels requiring an opening on a peak period weekend day or 20 openings on a peak period weekday.

V. MOVABLE BRIDGE TYPE CONSIDERATIONS

Movable spans are required in bridges crossing navigable waterways to permit passage of vessels that would otherwise be blocked by insufficient vertical clearance of the structure in the closed position. There are several types of movable spans that are in frequent use today, and a variety of other types that are no longer constructed or constructed on an occasional basis. While serving the same overall purpose, each type has positive and negative attributes. A variety of factors must be weighed against these attributes in determining what the proper type of bridge is for a particular location.

Generally speaking, the criteria to be evaluated for this study include the provision that any movable bridge must provide adequate clearance in the open position so as to not exclude marine traffic that could now utilize the Buffalo River or the City Ship Canal. This can be achieved by providing either an unlimited vertical clearance, or a clearance of no less than 105 feet while in the open position.

Vertical Lift Bridges

Vertical lift bridges are trademarked by a span that rises vertically and remains parallel with the deck. In the closed position, the span is suspended by wire ropes from high towers and counterbalanced. The span is raised and lowered using supporting end cables attached to drums in the towers on each side of the bridge. Hydraulics can also be used to raise and lower the span. The major disadvantage of a vertical lift bridge is the limited clearance that it provides. Vertical clearance is limited by the height of the towers, which could possibly prevent some vessels from passing below. Under these circumstances, the maximum vertical clearance of a lifted span could be no less than that already achieved by the Buffalo Skyway, which is around 100 feet. Vertical lift bridges provide the ability to be twinned, meaning that an identical bridge can be placed directly next to the existing one in order to provide greater capacity.

Bascule Bridges

The movable span of a bascule bridge essentially pivots around a fixed axis with the span balanced by a counterweight. Comprised of either one leaf or two, when open, their main advantage is their ability to provide unlimited vertical clearance without necessitating additional room to operate (like a swing bridge does). The counterweights provide a significant mechanical advantage and therefore require a reduced amount of energy to lift the span. There are generally two types of bascule bridges, the trunnion type and the rolling lift type. In the trunnion type, the center of rotation remains fixed and is at or close to the center of gravity of the rotating part. In the rolling lift type the center of rotation continually changes and the center of gravity of the rotating part moves in a horizontal line, which results in shifting the application of load on the pier. When the bridge is in the open position, it must also be designed to resist the wind load which may also require larger machinery than is required to merely operate the span. Also, if a counterweight pit is required, this could result in additional cost and maintenance. A bascule bridge also provides the ability to be twinned, similar to the vertical lift bridge.

Swing Bridges

The swing span is supported by a rim bearing or a center bearing at or near the span's center, and the span pivots horizontally to open. A major advantage to this type of movable is the unlimited clearance it provides, however, a major disadvantage is that more space is required in order for the bridge to operate due to the space needed for the span to rotate open. Another advantage is that no counterweight is required, which greatly reduces the total weight of the bridge. The center pier divides the channel into two parts, decreasing the potential for vessel collision. However, the center pier provides a hazard for vessel collision and must be fortified to prevent damage to the pier and therefore the structure. The center pier also decreases the width of the channel. Also, when the span is open, the ends are no longer supported and the span must support itself, operating as a balanced double cantilever. This may cause additional members to be added to the design in order to increase stiffness. Unlike the vertical lift and bascule bridges, the swing bridge cannot be twinned to provide greater capacity.

VI. CONCLUSIONS

Two items need to be discussed when considering the ideal situation for this projected alignment based on current and projected vessel traffic. The volume of vessel traffic that the bridge is going to see that is going to require it to open is one, and the type of bridge to be constructed based on the vertical and horizontal needs of the vessel traffic is the other. The two are dependent on one another and careful consideration of the given data can result in an ideal alignment that is suitable for both vessel and vehicular traffic. The scope of this report only pertains to the considerations given to vessel traffic.

It is readily apparent from the data analysis that if each vessel is going to require its own lift on demand, during peak vessel traffic hours, the movable portion of the span of any alignment excluding Ganson Street would open very frequently, and probably more often than is practical. For the purposes of this conclusion, it will be assumed that Ganson Street will not open at all, because from the data given it currently sees no vessel traffic. This conclusion will focus on the other three crossing locations, Main, Erie, and Michigan. Any crossing at Erie Street will open with the most frequency as it sees all vessel traffic going into and out of the Harbor. Main and Michigan will open with the same frequency if each vessel is requiring an individual opening. The number of openings can be decreased by specifying opening times during peak vessel traffic periods, which would allow several boats to pass under the span during one opening. In the case of Erie Street, these openings would likely have to be longer or more frequent than those at Michigan and Main.

The typical operating time of a movable span is approximately eight to ten minutes. This time period includes one minute for the gates to lower and the locks to disengage, 90 seconds for the span to fully open, three to five minutes for vessel traffic to clear, 90 seconds for the span to fully close, and another minute for gates to raise and the locks to engage. Therefore, if the bridge is opened at scheduled intervals of every half an hour, during a peak weekday period, the bridge would be open one third of the time. This is a significant period of time for vessel operators to utilize the bridge opening.

Concerning bridge type, a swing swan would not be practical at the Michigan, Main, or Ganson alignments, as their channel widths are already too narrow to permit the addition of a center pier for the span to pivot about. At the Main Street alternative, the potential exists to place the pier on Kelly Island, which would not affect the existing 200 foot wide Buffalo River or the existing 125 foot wide City Ship Canal. However, this is not practical because the General Mills plant's operations fall within the zone where the span would need to turn when open. In addition, an extensive fender system would be necessary in order to protect the other end of the open span from errant vessels. While a swing span would be possible at Erie Street, it would be ill-advised. The channel is currently approximately 400 feet wide. Adding a center pier would divide the channel into two navigable waterways that are each less than 200 feet. Additionally, the span would need room to turn, and given that this alignment is at a bend in the waterway called out on navigation maps as a turning basin, this may or may not be possible. However, a large bobtail swing with a pier on or toward the outer harbor side may be a potential option. Unlike a typical swing bridge, the pivot pier is not centered under the

movable span but rather closer to one side, thus making the arms of the span projecting away from the pier asymmetrical. In this case, a pier placed closer to the outer harbor side would allow for a larger navigable channel and may also address the issue of not having enough room to turn due to the bend in the waterway.

All four locations would be ideal for either single or double leaf bascules or vertical lifts. The advantage to constructing a single leaf bascule would be its unlimited clearance. A double leaf bascule would allow for longer spans and therefore wider channels, while keeping pit piers shallower at the same time. Conversely, the issue with the vertical lift is its limited vertical clearance when in the open position. When open, the clear height of the vertical lift must be identical to that of the Buffalo Skyway, which is about 100 feet. This would require the total height of the towers to be equal to the clearance required plus the structure depth, plus an additional 20 to 30 feet, resulting in towers around 150 feet tall.

APPENDIX A

PHONE & EMAIL CORRESPONDENCE

1501 BROADWAY
NEW YORK, NY 10036
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ny@hardesty-hanover.com

TELEPHONE MEMO **PROJECT:** 2584

DATE: Thursday, July 30, 2009

SPOKE WITH: Rich Lenard – Director of Sales – RCR Yachts

PHONE NO.: 1-716-856-6314

RE: Navigation Traffic – Proposed Buffalo Outer Harbor Bridge

I spoke with Rick Lenard, Director of Sales for RCR Yachts regarding marine traffic into and out of his facilities. Rick offered the following information:

Total Number of Slips at marina - 125
% Occupied – 90% (approximately 110 boats)
% Sail Boats – 98% (only 2 power boats out of 110)

Vessel Size – 34 foot average with majority of boats in the 20 to 35 foot range. Some boats are 40 to 45 foot range
Vessel Height – Typical mast height for most boats is on the order of 40 feet. Rick noted that most boats would clear 50 feet

Peak Departure period – Tuesday and Wednesday (regatta days) between 5:00 and 6:00 pm

Additional periods of traffic: Other weekdays between 5:00 pm and dark and weekends all day

Rick also noted that in the spring and fall that some larger transient boats in excess of 60 ft / 70ft pass through his facility. Rick estimated approximately 6 to 12 boats of this height are observed per season

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TELEPHONE MEMO **PROJECT:** 2584

DATE: Thursday, July 23, 2009

SPOKE WITH: Carol – Receptionist for First Buffalo River Marine

PHONE NO.: 1-716-854-0020

RE: Navigation Traffic – Proposed Buffalo Outer Harbor Bridge

I spoke with Carol, receptionist for First Buffalo River Marine regarding marine traffic into and out of her facilities. Carol offered the following information:

Total Number of Slips at marina - 152
% Occupied – 80% (approximately 120 total boats)
% Sail Boats – 75% (approximately 90 sail boats)

Vessel Size – 35 foot average. Approximately 75% of sail boats are 30 foot range, 15% in the 20 foot range and 10% in the 40 foot range
Vessel Height – Typical mast height for most boats is approximately equal to vessel size. Carol mentioned the majority of vessels are in the 30 foot height range

Peak Departure period – Wednesday (regatta days) between 5:00 and 6:00 pm through the evening

Additional periods of traffic: weekends all day

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TELEPHONE MEMO **PROJECT:** 2584

DATE: Thursday, September 17, 2009

SPOKE WITH: Mike Hayhurst – Miss Buffalo II

PHONE NO.: 1-716-856-6696

RE: Navigation Traffic – Proposed Buffalo Outer Harbor Bridge

I spoke with Mike Hayhurst regarding marine traffic into and out of his facilities. Mike offered the following information:

Height of Miss Buffalo II: 19 feet
Length of Miss Buffalo II: 90 feet

The Miss Buffalo II makes a U-turn in turning basin that takes 10 minutes approximately three times a day. Only six trips a year travel beyond the turning basin and continue down the Buffalo River.

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TELEPHONE MEMO **PROJECT:** 2584

DATE: Thursday, September 17, 2009

SPOKE WITH: Rob Ocasio – Operations, Great Lakes Towing

PHONE NO.: 1-216-621-4854

RE: Navigation Traffic – Proposed Buffalo Outer Harbor Bridge

I spoke with Rob, an employee in the operations department of Great Lakes Towing regarding marine traffic into and out of his facilities. Rob offered the following information:

Great Lakes Towing maintains the following tugs (proceeded by their height) and they operate with the following frequency down the Buffalo River and under the existing Ohio Street and Michigan Avenue bridges:

Washington Tug (20 feet) – once every two weeks
New Jersey Tug (20 feet) – one every month
Ohio Tug (30 feet) – less than five times per year

The Washington Tug tows the English River, which is 36 feet tall. The New Jersey Tug tows the Herbert C. Jackson, which is 37 feet tall.

Fw: navigation data requested

Brian Mileo to: Kathleen Ann Munson, Tom Duffy 09/22/2009 02:03 PM

Show Details

----- Forwarded by Brian Mileo/Hardesty_Hanover on 09/22/2009 02:03 PM -----

From:	Rob.Haefner@lafarge-na.com
To:	bmileo@hardesty-hanover.com
Date:	09/22/2009 02:00 PM
Subject:	Re: navigation data requested

Brain,

This the list of the vessel that visit the Buffalo Terminal and there measurements. There are no set day's or time's that the ships deliver to the terminal. The frequency of travel on the Buffalo River varies from year to year. We have received about 18- 29 trips a year, occurrences in or out would be 36-58. Are ships don't use the City Ship Canal. If you need any other information just Email or call.

English River - length = 404 ft, beam = 60 ft, height = 82 ft
JAW Iglehart - layup status
SS Alpena - length = 520 ft, beam = 67 ft, height = 83 ft
tug Samuel de Champlain/ barge Innovation - length = 537 ft, beam = 70 ft, height = 80 ft
tug G.L. Ostrander / barge Integrity - length = 544 ft, beam 70 ft, height = 92 ft

Thank you
Robert

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		bmileo@hardesty-h
		anover.com
		09/15/2009 12:43
		PM
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| |
| To: rob.haefner@lafarge-na.com
| |
| cc:
| |
| Subject: navigation data requested
|

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Rob,

As per our discussion yesterday, on behalf of the Erie Canal Harbor Development Corporation (ECHDC), I am seeking to obtain navigation data for vessel traffic on the Buffalo River and the City Ship Canal near the Buffalo Outer Harbor. This data is to be utilized in a forthcoming navigation study to determine the most practical alternative for the proposed Buffalo Outer Harbor Bridge Project.

During recent meetings involving the City of Buffalo, The NYS Department of Transportation, and the ECHDC, Lafarge Corporation was mentioned as one of the local corporations located along the Buffalo River. Some of the following vessels were named as potentially being owned / utilized by Lafarge:

English River
JAW Iglehart
Alpena
Tug Samuel Champlain
Integrity
Innovation
Herbert C. Jackson

If possible, could you please provide the following information:

- Confirm if the above vessels are utilized by or utilize the Lafarge facility
- Name any other vessels which may be utilized by or utilize the Lafarge facility
- Provide vessel height and length
- list frequency of travel on the Buffalo River and/or the City Ship Canal (in and out counting as separate occurrences)
- list which days and times are typically most traveled

On behalf of the ECHDC, I appreciate your assistance with providing this information.

Sincerely,

Brian J. Mileo, PE
Associate

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APPENDIX B

U.S. COAST GUARD REGULATIONS

NEW YORK

§ 117.769 Black Rock Canal.

The draws of the Ferry Street bridge, mile 2.6, and Canadian National Railway bridge, mile 3.8, both at Buffalo, shall operate as follows:

(a) From April 15 through November 30, the draws shall open on signal. However, between the hours of 12 midnight and 8 a.m., seven days a week, no bridge tender is required to be in attendance at the bridges and the draws shall open on signal if notice is given to the owners at least two hours in advance of a vessel's intended time of passage through the draws.

(b) From December 1 through April 14, no bridge tender is required to be in attendance at the bridges and the draws shall open on signal if notice is given to the owners at least four hours in advance of a vessel's time of intended passage through the draws.

[CGD09–94–008, 59 FR 50167, Oct. 3, 1994]

§ 117.771 Bronx River.

(a) The draw of the Bruckner Boulevard Bridge, mile 1.1, at the Bronx, New York, shall open on signal if at least a two-hour advance notice is given to the New York City Department of Transportation (NYCDOT) Radio Hotline, or the NYCDOT Bridge Operations Office. From 7 a.m. to 9 a.m. and 4 p.m. to 6 p.m., Monday through Friday, the bridge need not be opened for the passage of vessels.

(b) The draw of the Conrail Bridge, mile 1.6 at the Bronx, New York, need not be opened for the passage of vessels.

(c) The owners of the Bruckner Boulevard Bridge, mile 1.1, and the Conrail Bridge, mile 1.6, both at the Bronx, New York, shall provide and keep in good legible condition two clearance gauges designed, installed and maintained in accordance with the provisions of § 118.160 of this chapter.

[CGD01–97–018, 62 FR 54385, Oct. 20, 1997, as amended by CGD01–99–070, 65 FR 45718, July 25, 2000]

§ 117.773 Buffalo River.

(a) The draw of the Michigan Avenue bridge, mile 1.3, at Buffalo, shall operate as follows:

(1) From March 22 through December 15, the draw shall open within 20 minutes of signal. However, the draw need not open from 7:30 a.m. to 9 a.m., and from 4 p.m. to 5:45 p.m., Monday through Saturday.

(2) From December 16 through March 21, the draw shall open on signal if notice is given at least 4 hours in advance of a vessel's time of intended passage through the draw.

(b) The draw of the Ohio Street bridge, mile 2.1, at Buffalo, shall operate as follows:

(1) From March 22 through December 15, the draw shall open on signal within 20 minutes after a request is made to the Michigan Avenue draw tender. However, the draw need not open from 7:30 a.m. to 9 a.m., and from 4 p.m. to 5:45 p.m., Monday through Saturday.

(2) From December 16 through March 21, the draw shall open on signal if notice is given at least 4 hours in advance of a vessel's time of intended passage through the draw.

(3) In addition to the standard signals required for requesting the bridge to open, the owners of this bridge shall maintain and monitor a marine radiotelephone for use by the Michigan Avenue draw tender for receiving requests for opening the Ohio Street bridge. The drawtender shall maintain communications with any transiting vessel until the vessel has cleared both the Ohio Street and Michigan Avenue draws.

(c) The draws of the CSX Transportation railroad bridges, miles 4.02 and 4.39, both at Buffalo, shall open on signal if notice is given at least 4 hours in advance of a vessel's time of intended passage through the draws.

(d) The South Park Avenue bridge, mile 5.3, at Buffalo, shall open on signal if notice is given at least 4 hours in advance of a vessel's time of intended passage through the draw. However, the draw need not open from 7 a.m. to 8:30 a.m., and from 4:30 p.m. to 6 p.m., Monday through Saturday.

(e) The periods when the bridges need not open on signal prescribed in paragraphs (a)(1), (b)(1), and (d) in this section shall not be effective on Sundays, and on New Year's Day, Memorial Day,

Fourth of July, Labor Day, Thanksgiving Day, Christmas Day, or days observed in lieu of any of these under State law.