Conversion of Great Lakes Bulk Vessels to LNG:

Evaluation of a Potential Fuel Terminal

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Prepared for the Connecticut Maritime Association
January 2013

I would like to express the utmost gratitude to Lead Operator, Mr. Rodney Graham from Calumet Superior, LLC., Duluth Marine Terminal, Great Lakes Maritime Research Institute for the help and support of this report. I am also grateful to my teacher, Dr. Richard Stewart, who assisted me in completing it.

Most marine fuels are residual fuels, which is the low-grade oil product that remains after the distillation of crude oil. After the petroleum crisis in 1973, the quality of residual oil declined. Companies had improved their refining technologies to exact the maximum quantity of refined products (Buckley 189). As a result, the consistency of contaminants such as sulfur, the substance that causes negative health effects and environmental threats, has increased. To improve on air quality and protect public health from the toxic emission, the United States and Canada submitted a joint proposal to the International Maritime Organization to designate an Emission Control Area (ECA), a certain area of United States and Canadian coastal waters including the Great Lakes. (EPA 1-1). The ships sailing within the ECAs have to reduce their emission of sulfur oxide (SO), nitrogen oxide (NOx), and fine particulate matter (PM2.5) (EPA 1). To meet the ECA standard, the ships either have to (1) install scrubbers, (2) use low sulfur content fuel, (3) a combination of (1) and (2), or (4) use a clean fuel, such as natural gas.

Our research team is composed of Hiroko Tada, the principle investigator, Julia Haeder, who contributed to the writing survey letter, and Dr. Stewart as an advisor. The Great Lakes Maritime Research Institute (GLMRI) has been funded by the U.S. Maritime Administration to explore the potential of shifting suitable Great Lake ships to using natural gas as a fuel in preparation for the vessels need to meet the requirements of the North American Emission Control Area (ECA). Initial GLMRI research indicates that Liquified Natural Gas would most likely be the type of natural gas fuel used by Great Lakes vessels. In order to use LNG as a vessels' fuel, it is essential to develop a supply chain for LNG in the Great Lakes region. Without a stable availability of LNG, it is difficult for shipowners to convert to LNG. GLMRI has cataloged the current fueling locations used by Great Lakes vessels and, as part of the research process, is evaluating the potential to modify the existing fuel terminals to provide LNG.

Duluth, Minnesota and Superior, Wisconsin (the Twin Ports) is the largest port on the Great Lakes and in the top twenty of the United States. Over 1,200 vessels a year call at the port, and it has been a fuel stop for over one hundred years. Initial GLMRI research has indicated that there are sufficient natural gas supply lines coming to the region to supply a gas liquefaction plant. Within 250 miles of the port there are multiple markets for LNG including trucking, rail, mining, transit, and agriculture as well as shipping. It is important for suppliers know there is enough demand to justify building a natural gas liquefaction plant.

Our research team was tasked with identifying the current fuel consumption for ships fueling in the Twin Ports and to examine the existing fueling terminal. The data gathered will assist in determining fueling options and what size liquefaction plants would be appropriate for this region. This paper is the report on the research conducted to determine marine fuel consumption and the potential to use the current terminal for LNG.

Survey Methodology

Research from *Greenwood's Guide to Great Lakes Shipping 2009* and Duluth Seaway Port Authority: Ms. Adele Yorde indicated that the two companies, Liquid Transport Inc. and Calumet Superior, LLC., Duluth Marine Terminal (Calumet), are the major fuel suppliers in the Duluth / Superior area, (Greenwood's. 19.5). To obtain fuel consumption data, a survey was sent to each company.

In order to send a survey form and letter, we investigated quantitative research methodology to learn how to compose a concise survey form. It is critical to prepare detailed questions in order to gain information without confusion from respondents. Our survey draft was reviewed by Dr. Stewart. After discussion with him, and research into the types of fuel used by ship, it was revised to be more precise.

At first we decided to send the surveys by email. As our survey form was made using Excel, we thought it was not convenient for respondents to fill out a survey form by hand. However, Dr. Stewart gave us advice that sending our letters by snail mail will catch the respondent's attention better than email. We installed our Excel survey form (see Appendix I Survey Instrument) into a Great Lake Maritime Research Institute flash drive and sent it with a cover letter by snail mail. On December 5, 2012, we sent survey letters (See Appendix I) to Liquid Transport, Inc., 101 Hwy. 61E. Esko, MN 55377, and Calumet, 1400 Port Terminal Dr. P.O. Box 16171, Duluth, MN.

We received responses from Calumet, but did not receive any reply from Liquid Transport, Inc. On December 7, 2012, I received a phone call from from Calumet, saying that they were willing to give us a facility tour. I scheduled the facility tour for the research team and Dr. Stewart on December 18, 2012 at approximately at 13:30 at Calumet Superior, LLC., Duluth Marine Terminal.

With the advice of Dr. Stewart, I prepared beforehand a list of questions to ask at the tour. Dr. Stewart also gave me advice to compose questions. (See Appendix II). Calumet did not fill out the survey form which was sent with the letter, but in return was willing to give us a facility tour, along with a discussion.

M/V Paul R. Tregurtha

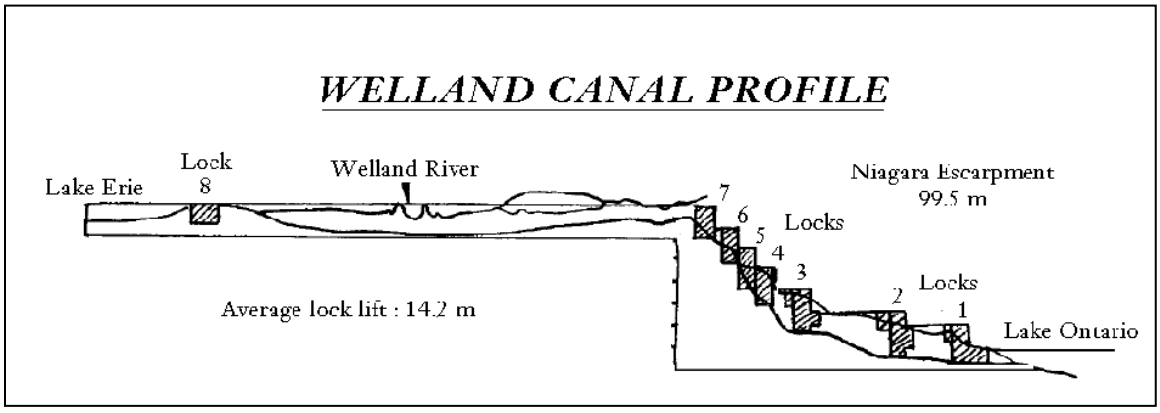
While on the tour the research team had an opportunity to observe the bunkering operation for *M/V Paul R. Tregurtha* at the Calumet facility tour. The following is a description of a Great Lakes bulk carrier.

M/V Paul R. Tregurtha is a Great Lakes-based bulk carrier and the largest vessel on the Great Lakes. She is 1,013 feet (309m) lengthwise with a beam of 105 feet (32m); her carrying capacity of Taconite pellets is up to 68,000 gross tons. She was built in 1981 by American Ships Building Company yard in Lorain, Ohio, first named *M/V William J. Delancey*. In 1990, her name was changed to *M/V Paul R. Tregurtha* in honor of Interlake Steam Company's Vice Chairman of the Board (The Interlake Steam Company).

M/V Paul R. Tregurtha is equipped with main engines made by a German company, Maschinenbau Kiel GmbH (Mak). According to the Interlake Steam Company, the engine horsepower is 17,120 bhp. This is the third season that the ship has operated with the MaK engines. The vessel was re-powered in the winter of 2009 to 2010 during winter lay-up. In a conversation with the research team, the vessel's Chief Engineer, Mr. Rick Laksonen, said that the ship burns 9,700 U.S. gallons (36,718.49 liters) of IFO a day on average when they are underway. He also mentioned that in the winter the ship loads fuel in Duluth every trip in case the vessel would not be able to stop at a fueling dock because of ice. In the summer they load fuel less frequently.

Due to its length and beam, *the M/V Paul R. Tregurtha* cannot sail into Lake Ontario. According to the St. Lawrence Seaway Management Corporation "The Welland Canal Section of the St. Lawrence Seaway", vessels more than 225.5m (740 feet) long, or 23.8m (78feet) wide cannot travel through the Seaway locks (11). The St. Lawrence Seaway Management Corporation mentions in their "The Welland Canal Section of the St. Lawrence Seaway", that there are eight locks between Lake Erie and Lake Ontario (See Figure 1). This means that the *M/V Paul R. Tregurtha* cannot leave the Great Lakes.

Figure 1: Welland Canal Profile



Source: The St. Lawrence Seaway Management Corporation, Corporation "The Welland Canal Section of the St. Lawrence Seaway" (2003 7)

Observing Bunkering Operations at Calumet Fuel Terminal Duluth, MN

The detailed facility schedule on December 18, 2012 :

- 13:00 - Left University of Wisconsin-Superior.
- 13:20 - Arrived at the Calumet Superior, LLC., Duluth Marine Terminal
  - Observe arrival docking of the vessel: *M/V Paul R. Tregurtha*
  - Pass security and sign in
  - The research team was given a safety briefing and put on safety equipment

Observed the following:

- Red Bravo flag (B-flag) was up.

  B-flag is a red colored flag from one of the International Marine Signal Flags, and it means a ship is engaged in loading or discharging hazardous material.

  The B-flag image from International Code of Signals
- The ship and the shore communication were established
- The hoses were connected to the ship's manifold. Two hoses were hoisted using a shore crane with saddles to support the hoses and prevent them from twisting or kinking. The hoses went from the terminal's piping system to the ship's fuel manifold. A six inch diameter hose was used for diesel fuel and an eight inch hose for Intermediate Fuel Oil (IFO).

- 13:30 – Bunkering started
  - When the bunkering started we had to move to the general area for safety issues.
  - Mr. Graham ensured all valves were correct, and after approval from the vessel, he then started supplying diesel oil slowly. When he made certain that all was in good order with the diesel he then set up and started providing IFO-280 (#6 oil).
  - During the bunkering operation, Mr. Graham was constantly checking for any leak, and that proper back pressure was maintained.
  - Calumet supplied blended diesel fuel, Number 2 Diesel Oil (#2 oil) for 6,000 U.S. gallons (22,712.47 liters) and 55,000 U.S. gallons (20,8197.65 liters) #6 oil to *M/V Paul R. Tregurtha*.
  - During the operation, Mr. Graham took the samples of diesel oil and #6 oil. Sampling is conducted to confirm the fuel specifications are correct for the vessel. If the fuel is the wrong kind, it might cause problems such as fire while the sailing due to overheating the engine. Excessive expansion due to heating might also cause spillage. The sample container "sealed carefully labeled with the name of the ship, the name of the supplier, date of delivery, exact time of day, and the number of the container's seal" (Buckeley 190). Mr. Graham took #6 oil samples for the ship and for Calumet, and one #2 oil sample for the ship. He mentioned that Calumet would not keep a #2 fuel sample, because they only have one #2 tank at their facility.
  - U. S. Coast Guard (USCG) arrived for an inspection of the fueling operations.
    The USCG talked both ship's chief engineer, Mr. Rick Laksonen and Calumet manager, Mr. Graham, then went on the ship for an inspection.
    There were two people from the ship monitoring the fuel transfer operation; one ship crew member staying by the manifold, and the other ship crew member, which was the chief engineer, on the dock.
- 14:00 – Finished bunkering #2 oil to the ship
  - The #2 Diesel oil valve was shut down, then air was blown into the hoses to force the remaining diesel in the hose into the ship's tank.
  - It took approximately 30 minutes to load 6,000 U.S. gallons (22712.47 liters) of #2 oil to the ship, which is 200 U.S. gallons (757.08 liters) per minute (6,000 gallons/30 minutes = 200 gallons/minute).
- 14:25 – Finished bunkering #6 oil to the ship
  - The #6 was loaded at a 157 Fahrenheit (72 Centigrade) because of the #6 oil's high viscosity so it has to be heated in order to flow through the hose. The outside temperature

was about 23.9 F˚. Calumet supplied 55,000 U.S. gallons (20,8197.65 liters) of the #6 oil to the ship, and Mr. Graham mentioned that the loading rate was 1,200 U.S. gallons (4,542.49 liters) per minute.

  - Shut down the #6 fuel. The remaining #6 oil in the pipeline was reversed to the Calumet tank. The pipe has a breathing valve in order to bring air into the pipes to avoid collapse.
  - Mr. Graham gave the #6 fuel sample with ship paper work and pumping ticket which issued from pumping metering station to the ship's chief engineer.

- Disconnected hoses from ships
  - Shut down every system in the facility and check for leaks.
- Authorized the ship to leave
- 15:00 – Facility tour and discussion
- Sulfur Testing
- 15:27 – Returned to UWS

***M/V Paul R. Tregurtha* Chief Engineer: Mr. Rick Laksonen**

Mr. Laksonen said they used to go to the fuel terminal that had the lowest fuel price before the ECA. However, since ECA was activated on August 1, 2012, the ship's main concern has shifted to sulfur content. Their biggest concern now is who has the lowest sulfur content fuel. To meet the ECA, Mr. Laksonen said he thought that the ship may use natural gas instead of installing scrubbers. If the ship stayed with IFO and installed scrubbers it will take long time to pay back on the scrubbers. Also, using the scrubbers brings up the issue of disposal of hazardous waste material. The scrubber is an exhaust gas purification system (Blikom 100). The advantage of installing scrubbers is that the initial capital costs are less than changing ship's engines' to LNG and installing LNG tanks. Also, with scrubbers, ships are able to use Heavy Fuel Oil (HFO) in the future (Bilkom 59). Mr. Laksonen pointed out the disadvantage of scrubber technology: the waste material generated from the scrubbers is an environmental threat. Moreover, the TEN-T report, "North European LNG Infrastructure Project" mentions that the capital investments in the scrubber and infrastructure for scrubber waste disposing in ports are also disadvantages of implementing the scrubber technology (Bilkom 59).

Tour of Calumet Fuel Terminal

Calumet Bunkering Hoses

Calumet has three different dimensions of hoses; six inches, four inches, and three inches. They used two different dimension hoses for the *M/V Paul R. Tregurtha* bunkering operation. One is the six inch hose for Number 6 Oil (#6), also called the Intermediate Fuel Oil (IFO 280), and the other one is for

diesel hose. Each hose has a bonding cable inside of them, which prevent sparks caused by static electricity. The bonding cable equalizes the electric charges before they develop sufficient amount of electric charge to produce static sparks (*Aviation Fuel Handling Handbook* 16). It is very important to control electrostatic charges in order to reduce the risk of fire or explosion caused by the sparks.

The Pumps

Calumet has four different pumps. Three of them are located inside their facility: the pumps for pumping the heavy fuel, diesel fuel, and pumps for blending the diesel fuel into heavy fuel. The fourth pump is for pumping fuel for the ships' bow thruster. This pump is located at the far end of the facility. Photo 1 shows the building of the fourth pump. The bow thruster is a device which is built into the bow of a ship to assist in maneuvering when docking or turning in a small harbor (Alderton 29). The purpose of the bow thruster is to provide lateral movement of the ship which is difficult and/or cannot be achieved only by turning the ships' screw and helm. Vessels that do not have a bow thruster require tugboat assistance when they dock or when turning. Using a tugboat is costly and requires time to arrange. Having a bow thruster reduces these times and costs. (Need citation). Depending on the bow thruster, they require diesel or electricity for their engine. The fourth pump at Calumet is used to pump the fuel to the bow thruster engine without the need to shift the ship.

Photo 1: Building for the Bow Thruster Pump

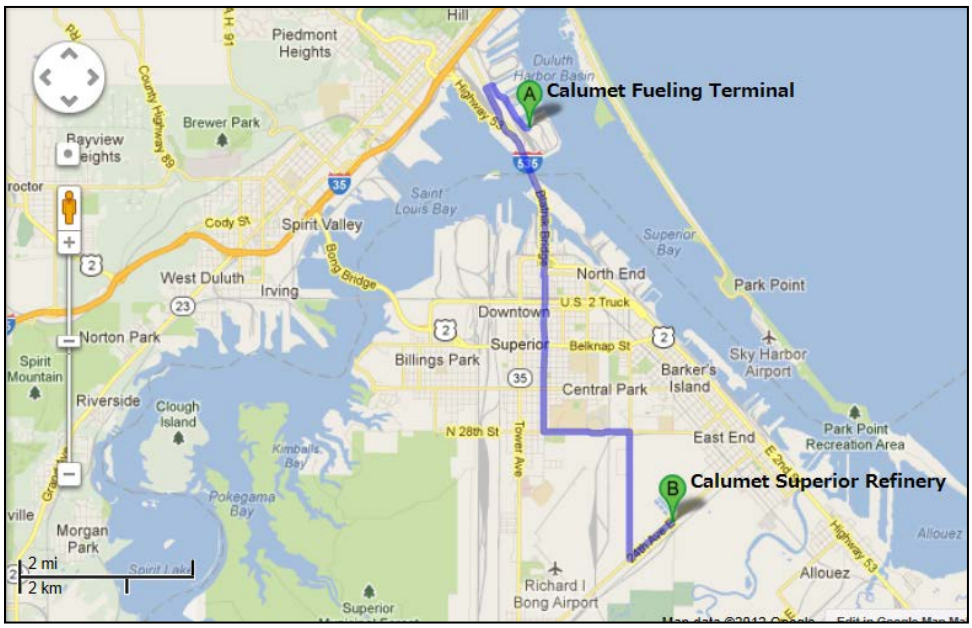
Source: Dr. Stewart, Richard. "P1210077". 2012. JPEG image

Calumet's Current Fuel Supply

Calumet obtains its fuel from the Calumet Refinery located in Superior, Wisconsin. The refinery obtains its crude oil from Canadian wells that arrives at the refinery by pipelines. Calumet terminal does not have a pipeline to transport their fuel at their terminal. The refined products are shipped to the Calumet fuel terminal by truck. The Jeff Foster trucking company delivers most of the fuel to the fueling terminal from the refinery. A diesel delivery truck and a heavy fuel delivery truck can unload their fuel at the same time since Calumet expanded their truck terminal two years ago.

One of the advantages to Calumet is having a refinery closer to fueling terminal. Calumet refinery is located in Superior, 2407 Stinson Avenue. According to the Google Map, the approximate distance from the Calumet fueling terminal to the Superior refinery is 7.9 miles (See Map 1). One of the more expensive transportation modes is motor carrier. Having a refinery close to the fueling terminal enables Calumet to keep transportation cost low.

Map 1: Refinery location to fuel terminal



Source: Google Map

Low Sulfur Content Fuel

Sulfur dioxide (SO_2) is a toxic gas, a member of sulfur oxide (SO), and is produced from burning fuels containing sulfur, such as coal or oil (EPA 3-3). Also, when the fuel burns at a high temperature, it generates nitrogen dioxide (NO_x). These SO_2 and NO_x are the major precursors of acid rain (EPA 3-3). Sulfur dioxide is also a major substance of fine particulate soot and causes negative health effects.

The sulfur content of fuel differs by the crude oil and the refining process. Calumet tests for viscosity, gravity, and sulfur contamination at the terminal. Calumet terminal is not responsible for refining the lower sulfur content fuel, but the refinery has to meet the requirements. The refinery certifies the fuel before leaves the plant.

Density

Density is a measurement used to calculate the quantity of fuel delivered. Three important reasons for the density or specific gravity of fuel is listed below (Ewart 4):

1. Operation of centrifuges that clean the fuel of particulate matter (Ewart 4).
2. Density enables calculations to be made about the volume of space required to store a given weight of oil or conversely to discover the weight oil resulting from the sounding of a tank (Ewart 4).
3. Density is measured in expressing quantities of oil purchased or use in terms that can be readily understood (Ewart 4).

Also, density is an indication of the ignition quality of the fuel within a certain product class, particularly for the low-viscosity IFOs (Vermeire 10).

Viscosity

Viscosity is a measurement of the liquid's resistance to flow. Viscosity is affected by temperature, and sales contracts usually specify that viscosity shall be calculated at 50˚ Celsius (Buckley 191).

In the conversation with the research team, Mr. Graham mentioned the heaviest fuel that the ships have recently been taking is Bunker C (#6 oil), the ratio is 380-ish by steamboat, and it is stored in the tank 401.

Flash Point

Flash point is the temperature at which the vapors of a fuel ignite when exposed to a flame (Ewart 7). The minimum flash point temperature of shipboard residual fuels has been set 60˚C (140˚F) by the United States Coast Guard.

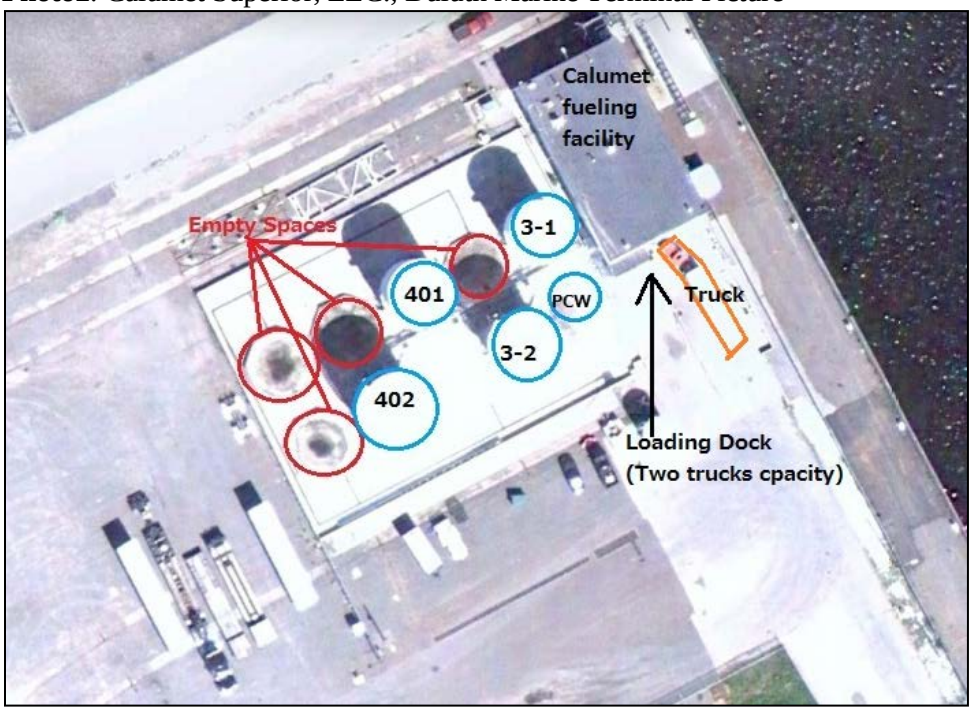
The Storage Tanks and Capacities

Calumet has four tanks at their terminal. Photo 2 is the photo from Google Earth showing each storage tank location, empty spaces, and truck loading dock. Photo 3 is the storage tank, taken by Dr. Stewart. The tank number 3-1 is for the #2 oil with a capacity of 3,000 barrels (42 gallons per barrel, 405

tons) tank. They usually store 116,000 U.S. gallons (439,107.77 liters). The tank number 3-2 is for IFO 320 and has the same capacity as 3-1 tank. Next to tank 3-2, there is a small tank to store the Petroleum contaminated water (PCW). The other two tanks are number 401 and 402. Both of these store 4,000 barrels (540 tons) of Number 6 oil, which is also called Bunker C oil.

With the exception for the diesel PWC tanks, each tank has three lines. The suction line used to pump to the ship, the fill line used for filling the fuel into the tanks from the trucks, and the return line. The return line makes the fuel loop around the building which allows for uniform temperature inside of tanks in order to be able to load the fuel aboard the vessel.

Photo2: Calumet Superior, LLC., Duluth Marine Terminal Picture



- 3-1: Number 2 Oil
- 3-2: IFO 320
- PCW: Petroleum Contaminated Water
- 401: Blended IFO 320
- 402: Blended IFO 320

Source: Google Earth

Photo 3: Calumet Superior, LLC., Duluth Marine Terminal Storage Tanks

Source: Dr. Stewart, Richard. "P1210078". 2012. JPEG image

Possibility for LNG Storage Tanks

In the tank storage area, there are four empty spaces to build additional tanks. Calumet could build new storage tanks for LNG at their terminal using these empty areas. In the conversation with the research team, Mr. Graham indicated that the empty space between 3-1 and 401 are too close to build a new tank; however, the back three empty spaces are available.

It is easier for ships to fuel at Calumet than go to a newly built facility because Calumet has received approval by the U.S. Coast Guard (USCG) for bunkering operation. The main issue LNG storage tanks are the USCG has not issued the regulations regarding LNG with building. After the regulation is revealed, Calumet may not build new tanks using their empty space that was mentioned above. However, Mr. Graham indicated in discussion with the research team that Calumet leases their land through Duluth Seaway Port Authority. If Calumet needs more space to build new storage tanks for LNG and comply with the regulation, they could lease additional space from the Port Authority. Photo 4 shows additional possible empty spaces to build new facilities.

Photo 4: Additional Potential Storage Tank Location

Source: Google Earth

The Competitor

In the discussion with the research team, Mr. Graham mentioned that Calumet Superior, the LLC Marine terminal does not have competitors at the upper lake. At Two Harbors, Minnesota, there is a fuel terminal, but they are fueling Canadian flag ships. This terminal purchases fuel from the Calumet refinery because of the Calumet is the only refinery in the Wisconsin.

Discussion of Fuel Consumption

Mr. Graham calculated the data below for the research team:

The first year the Calumet opened was in November of the 1998-1999 season. As of December 18, 2012, when we visited Calumet terminal, Mr. Graham did not have the data for the 2011-2012 season as the season was not yet complete. During the winter time when the ships stop operation, Calumet Terminal does maintenance on their facility.

The total sold fuel gallon in thirteen seasons is about 245 million U.S. gallons, and the average per year is 18.8 million U.S. gallons per year. Calumet sold approximately 40% #2 oil over the last three seasons combined. They also sold 60% #6 oil over the last three seasons combined not including the 2011-2012 season.

Three seasons' detailed information is below:

2006 – 2007 Season

- Number 2 Oil: 10,270,881 U.S. gallons, which is 39.5% of the total fuel that Calumet sold
- Number 6 Oil: 15, 605, 330 U.S. gallons, which is 60.5% of the total fuel that Calumet sold
- Total: 25,876,211 U.S. gallons

2007 – 2008 Season

- Number 2 Oil: 7.686,173 U.S. gallons, which is 32% of the total fuel that Calumet sold
- Number 6 Oil: 16,304,659 U.S. gallons, which is 68% of the total fuel that Calumet sold
- Total: 23,990,832 U.S. gallons

2010 – 2011 Season

- Number 2 Oil: 8,817,750 U.S. gallons, which is 38.5% of the total fuel that Calumet sold
- Number 6 Oil: 14,086,623 U.S. gallons, which is 61.5% of the total fuel that Calumet sold
- Total: 22,904,373 U.S. gallons

Conversion to LNG

According to the U.S. Department of Energy, one gallon of #2 oil (Diesel) has 113% of the energy of one gallon of gasoline. Whereas, one gallon of LNG has 64% of the energy of one gallon of gasoline. LNG has less energy than diesel oil so that the ships burn LNG faster than diesel. This means when ships use LNG as a fuel, they have to fuel greater amounts of LNG than they fuel with currently.

To calculate how much LNG will be needed to replace the current fuel with LNG, we first need to convert each IFO's into British Thermal Units (BTU). BTU is the amount of the heat energy requires to raise the temperature of one pound (lbs) of water by one degree Fahrenheit (F˚). By using BTU we are able to compare different fuels into a common unit of measurement based on the energy content of each fuel.

As stated in the previous section, over a thirteen year period Calumet sells 7,520,000 U.S. gallons per average year for #2 oil (40% of average selling of 18.8 million per year), and 11,280,000 U.S gallons of #6 oil per average year (60% of average selling of 188 million per year).

According to the U.S. Department of Energy, #2 oil energy content (in LHV, lower heating value, which is close to the actual energy yield) is 128, 450 BTU per U.S. gallon, and LNG has 74,720 BTU per gallon. For #6 oil, Bartok mentions in his "Approximate Heating Value of Common Fuels", it has

153,200 BTU per U.S. gallon. Therefore, the 7,520,000 U. S. gallons of #2 oil are equivalent to approximately 955 Billion BTU. Also, 11,280,000 U.S. gallons of #6 oil have approximately 1,728 Trillion BTU. Therefore, if vessels use LNG as a fuel, Calumet will need to supply approximately 30.7 million gallons of LNG per average year (1 gallon of LNG = 87,600 BTU in LHV).

Conclusion

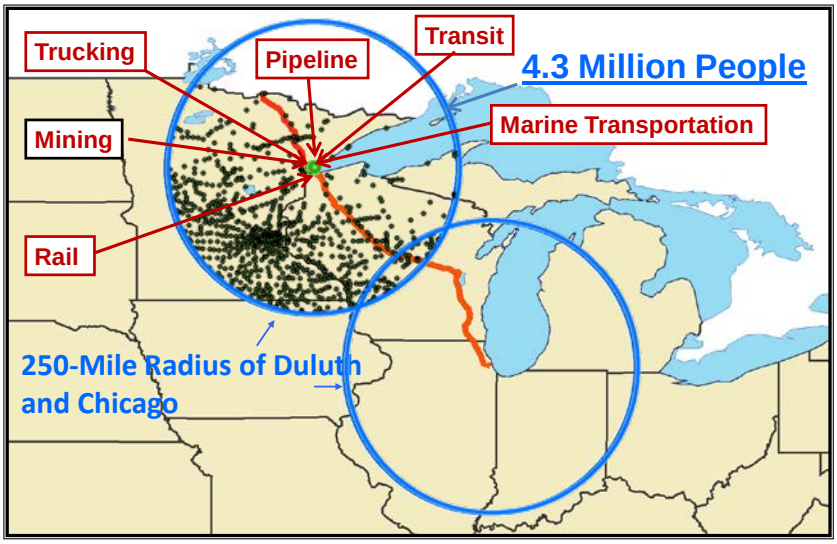
In this report, we discussed the potential of shifting suitable Great Lakes carriers to using Natural Gas, specifically Liquified Natural Gas (LNG) as a fuel to meet the requirement of the North American Emission Control Area.

Visiting Calumet Superior, LLC., Duluth Marine Terminal (Calumet), the team observed that there are potential spaces to build LNG storage tanks in their existing fuel storage tank area. Moreover, Calumet could negotiate with their landowner, Duluth Seaway Port Authority, to expand their site if needed.

The advantages of building LNG storage tanks for fuel bunkering are (1) Calumet has already been approved by the USCG for bunkering operation, (2) Calumet is the largest U.S.fuel supplier in the head of the Lakes area, and (3) Calumet has empty areas to build new LNG storage tanks.

In addition, the development of LNG terminals in the Duluth / Superior region shows that there are synergies between the build-up of an LNG terminal infrastructure and industrial use. Map 2 shows Twin Port LNG terminal marketing region. There are multiple potential markets for LNG. Within 250 miles, this region has a market of 4.3 million people. The transportation hub includes four class one railroads, largest dry bulk port in U.S., trucking, and mining, transit and agriculture as well as shipping.

Map 2: Twin Ports LNG Terminal Marketing Region



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Appendix I

Survey Instrument

Table 1 Duluth/ Superior

Calumet — Measurement in US Gallons

Ship Type	Number of Transfer Operations Annually	Annual #2 /Bunker A (Gallon)	Annual #6 /Bunker C (Gallon)	Annual Bio Diesel (Gallon)	Annual Gasoline (Gallon)	Annual IFO-180 (Gallon)	Annual HFO/380 (Gallon)	Annual MDO (Gallon)	Annual MGO (Gallon)	Other: Please Specify (Gallon)	Maximum Amount in a Single Transfer
U.S. Flag											
Canadian Flag											
Foreign Flag											
Government Vessels											
Fuel Delivered to Other Ports											Fuel Delivered to Other Ports
Two Harbor, MN											
Silvey Bay, MN											
Ashland, WI											

* other: Please mention what type of fuel in gallons (Assume API 60 degrees Fahrenheit) .

Note: I your measurements are in liters we will convert

Revision 12/3/12

Great Lakes Maritime Research Institute

A University of Wisconsin - Superior and University of Minnesota Duluth Consortium

Appendix II

Questions for Calumet

- Who is your competitor in this region?
- Who is your competitor in the upper lake and lower lake?
- Who are your suppliers for each different type of fuel?
- How do you bring the different types of fuels to your terminal?

Low sulfur content fuel

- Can you supply low sulfur content (EPA- ECA) fuel to ships?
    - Sulfur limit in Fuel (% m/m)
      Effective from 1 January 2012: 1.0 %
      1 January 2015: 0.1 %

- Who are your suppliers for lower sulfur content fuel?
- How much low sulfur content fuel will you be able to supply?
- Do you have competitors to supply lower content sulfur fuel in the upper lake/ lower lake?

Because of the Emission Control Area regulation, the shipowners are considering shifting their fuel to LNG,

- Have you ever thought about supplying LNG from your terminal?

If yes,

- Where will you get the LNG for your terminal?
    - Peak Shaving
- How would LNG be brought to your terminal?
- Do you have room for LNG Storage tanks
    - Conversion numbers:
- What modifications would be needed to your terminal to fuel ships with LNG

Who are your customers for LNG?