North Carolina State Ports Authority 2024 PIDP Grant

Benefit-Cost Analysis Methodology and Findings

Report
May 2024

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1.0 PROJECT OVERVIEW

1.1 Introduction and Project Overview

The Port of Morehead City (the Port), located four miles off the Atlantic Ocean, offers breakbulk, bulk, and Roll-on/Roll-off transportation with nine berths, on-dock rail, a 225,000-ton capacity warehouse and extended open storage facilities. The North Carolina State Ports Authority (the Authority) oversees the Port of Morehead City in addition to two other facilities and boasts the highest truck gate and crane productivity in North America. The Port is served by Norfolk Southern and has modest rail car storage capacity, though limited by the geographic nature of Morehead City.

The Port of Morehead City serves as a domestic export terminal for PCS Phosphate Company, Inc. (commonly known as Nutrien), the world's largest provider of potash, which is primarily used as an agricultural fertilizer. Nutrien is the highest-volume tenant at the Port of Morehead City, which supports the collection of over $9 billion annually in local and county tax revenue (July 2020 – June 2021, North Carolina Ports Economic Impact Study). Nutrien ships a variety of cargo, including but not limited to potash, dry fertilizer, and acid, from its facility in Aurora, North Carolina, 57 nautical miles to the north.

The barge berths Nutrien currently uses at the Port's Phosphoric Acid Terminal (the Terminal) are in such poor state of repair that they are no longer safe to use. A Stability Analysis conducted in 2022 indicated the bulkhead has reached the end of its useful life and repairs would not be adequate to restore safe operating conditions. The East Barge Berths have been officially removed from service consistent with the recommendations of this analysis. As a result, Nutrien is currently using one of the Port's other berths,

Figure 1. The project scope includes reconstruction of the Phosphoric Acid Terminal North and East Barge Berths to restore state of good repair, safe working conditions, and full berthing capacity.

Berth 1, to both unload liquid acid barges and load liquid acid ships for export. This requires one barge to fully unload before another can leave the production facility, increases barge unloading time by over 50%, and a barge can no longer be unloaded while an export ship is loading, significantly increasing operational costs and reducing throughput. Dry barges are still being unloaded at the terminal's North Barge Berths at reduced capacity – however, due to stability concerns, the North Barge Berths must be removed from service as well by 2027, at which time Nutrien's dry cargo could no longer travel by barge to the Port's Phosphoric Acid Terminal for export and would need to be diverted to other modes. The use of other berths to accommodate Nutrien's operations also increases congestion at the port and delays other tenants' vessels.

The North Carolina State Ports Authority, with the full support of Nutrien as demonstrated in the Memorandum of Understanding submitted with this application, seeks grant funding for the ***Modernization and Revitalization of Barge Berths*** project (the Project) to facilitate the continued productivity and operational safety of the Port, regional employment, and export of agricultural commodities to support the global food supply chain. The project will construct new sheet pile bulkheads in front of the existing bulkheads at the North, East, and South Berths (the South Berth does not accept cargo and functions as a stabilizing wall) to extend the anticipated service life by 50 years. The project also includes installing a new anchorage system, concrete cap, fenders, and mooring hardware to enhance barge berth stability.

Without the project, the movement of liquid cargo must travel to another berth south of the Newport River Bridge (US 70) as shown in Figure 2 on the following page, which requires a skilled pilot and fair weather to navigate. Additionally, unloading at Berth 1 means the purpose-built infrastructure and equipment currently housed at the Phosphoric Acid Terminal cannot be used, reducing efficiency and increasing operating costs. Dry cargo, beginning in the year 2028, is assumed to be diverted to truck and possibly rail. Freight transport by both these modes is less safe than barge, requires greater operational costs, and produces more emissions and pollution. The cost-effective ratios produced under several scenarios in this analysis, even while not accounting for all the operational inefficiencies the Port and Nutrien would incur in a No-Build Scenario, demonstrates the significant value of this project to the Port, Morehead City and Carteret County tax bases, workforce in Aurora, North Carolina, and global food production system.

Due to constraints on rail capacity at the Port, a scenario involving modal diversion by rail could accommodate a maximum weekly service of six additional specialty railcars (approximately 8.5% of Nutrien's total dry cargo throughput). Given its small scale, it is likely that Norfolk Southern would charge a high rate to provide this service that may not be cost-effective as compared to transport entirely

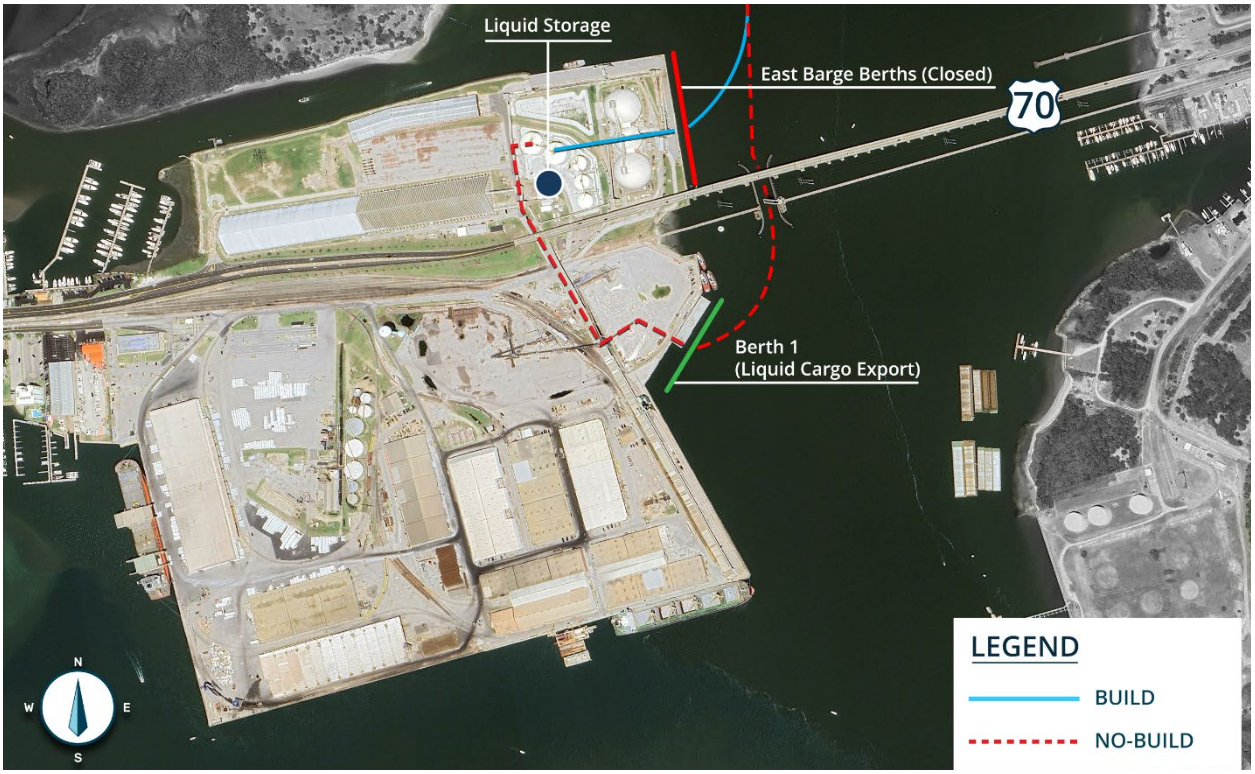

Figure 2. With the East Barge Berths closed, liquid barges must navigate to Berth 1 beneath the Newport River Bridge, which requires a skilled pilot and fair weather. Liquid cargo must travel a longer distance to be unloaded, use inefficient temporary equipment at Berth 1, and there is no capacity to stage more than one barge for unloading at a time nor load an export ship while barges are unloading.

by truck. Given these uncertainties, this BCA provides one scenario that assumes the maximum amount (8.5%) of diversion by rail with the remainder (91.5%) by truck, and a second scenario that assumes all (100%) dry cargo is diverted to truck. The updated value of emissions for freight rail movements in the most recent USDOT BCA Guidance increases the project's cost-effectiveness when rail diversion is included, despite the assumption of a very conservative rail route that assumes a fairly high average speed and does not include stops at any switching yards between the production facility and the Port (not accounting for the associated additional hauling, idling, and dwell time/delay.)

The project addressing these challenges will be performed in a rural Area of Persistent Poverty and Historically Disadvantaged Community of North Carolina and provides significant regional economic benefit by supporting the retention of over 2,250 jobs and the export of nearly 800,000 tons of cargo annually through the Port to support global food production.

2.0 COST ASSESSMENT

Contracted engineers estimated the total capital costs the project will require, which are shown in the table below. The opinion of probable construction cost, which can be found on the following page, is based on a 90% level of design detail and defined by the US Army Corps of Engineers as a Class 3 cost opinion. Cost data was derived from publicly available NCDOT information, nearby recent marine construction projects of similar scope, and cost book databases. As such, a 10 percent contingency was assumed as well as 10 percent of project costs for mobilization. The Authority proposes to complete all NEPA and design work separately from the project.

Annual operations and maintenance costs for the reconstructed barge berths were estimated at $77,000 in the year 2028, which is the first year the barge berths will be in service. The cost accounts for pressure washing, minor crack repairs, and general maintenance of the 61,000 sq. ft. berth area. These costs are accounted for as a disbenefit, consistent with 2024 Benefit Cost Analysis Guidance. Operations and maintenance costs for the bulkhead are not included in the No-Build Scenario where the barge berths fail and are removed from service, as the 2022 Stability Analysis Report indicated the bulkhead has reached the end of its useful life and repairs would not be adequate to restore safe operating conditions.

The project would reduce the annual operations and maintenance costs for Berth 1 because in the Build Scenario, Nutrien's approximately 22 barges per month would unload at the East Barge Berth. Future annual operations and maintenance costs for Berth 1 were determined by approximating its size relative to the barge berths this project would reconstruct.

As vehicle and railcar depreciation were included in the USDOT provided values for miles/hours traveled by truck and rail, the depreciation of Nutrien's barge fleet was also accounted for using real data. These costs – approximately $15 million each for four (4) dry barges and three (3) liquid barges with an estimated service life of 30 years – are accounted for in both the dry and liquid operational expenses in the Build Scenario.

ENGINEERING COST ESTIMATE FOR NUTRIEN BARGE BERTHS BULKHEAD REPLACMENT

Capital Construction Costs	Quantity and Unit	Total Cost (Undiscounted)
Furnish Steel Sheet Pile	965 TON	$2,895,000
Install Steel Sheet Pile	603 EA	$1,206,000
Flowable Fill	2,100 CY	$210,000
Furnish and Install Concrete Cap	1,820 CY	$4,095,000
Repair Existing Pile Cap	1500 LF	$600,000
Remove and Reinstall UHMW-PE Fenders	1,285 LF	$771,00
Replacement of NE Corner Wheel Fender Assembly	1 LS	$55,017
Refurbish Existing Bollards	22 EA	$27,500
Remove and Reinstall Bull Rail	1,154 LF	$115,400
New Bull Rail	196 LF	$39,200
Furnish & Install Soil Anchors	120 EA	$4,800,000
Soil Anchor Testing	8 EA	$120,000
Excavation & Backfill	900 CY	$108,000
Asphalt Paving/Patching	110 SY	$16,500
Remove and Reinstall Riprap at NE Corner	30 CY	$3,000
Furnish & Install Riprap at SE Corner	150 CY	$27,000
Furnish HP18 King Pile	72 TON	$180,000
Install HP18 King Pile	12 EA	$78,000
Furnish and Install PC Conc Panels	120 CY	$300,000
Furnish & Install Tie Rods at SE Corner	6 EA	$45,000
Furnish & Install Concrete Deadman and Tunnel Closure	30 CY	$36,000
SE Corner Concrete Tunnel Demo	30 CY	$12,000
Total Project Construction Cost		**$15,739,616**
Contractor Mobilization	+10%	$1,573,962
Contingency	+10%	$1,573,962
Total Project Cost ($2025)		**$18,887,540**

3.0 NET BENEFITS ASSESSMENT

The net benefit assessment provides a conservative estimate of the economic value of the outcomes expected from and associated with the project. The net benefit assessment was conducted based on the 2024 USDOT Benefit-Cost Analysis Guidance for Discretionary Grant Programs (December 2023).

3.1 Model Scenarios and Assumptions

The Benefit-Cost Analysis (BCA) for this project involves three scenarios:

- The Build Scenario, which is reflective of optimized operations at the Port's Phosphoric Acid Terminal for both dry and liquid cargo with construction of the project;
- The No-Build Scenario for liquid cargo, which must be unloaded, stored, and reloaded for export at the same berth further south of the terminal (as opposed to maintaining continuous operations); and
- The No-Build Scenario for dry cargo, which has reduced operations at the North Barge Berths until an assumed failure date of 2027, at which time cargo would be diverted to other modes due to limited waterway capacity at the Port.

<u>Build Scenario: Dry and Liquid Cargo</u>

The Build Scenario includes the reconstruction of barge berths at the Phosphoric Acid Terminal. Contracted engineers estimate the reconstruction will begin in late 2025 following final design, environmental review, and permitting, and take 18-21 months to complete including schedule contingency, with operations at the reconstructed barge berths to commence by 2028. Barges would continue to utilize the 57-nautical-mile route shown in Figure 1 in white, with a travel time of approximately nine hours (informed by Nutrien's current operations).

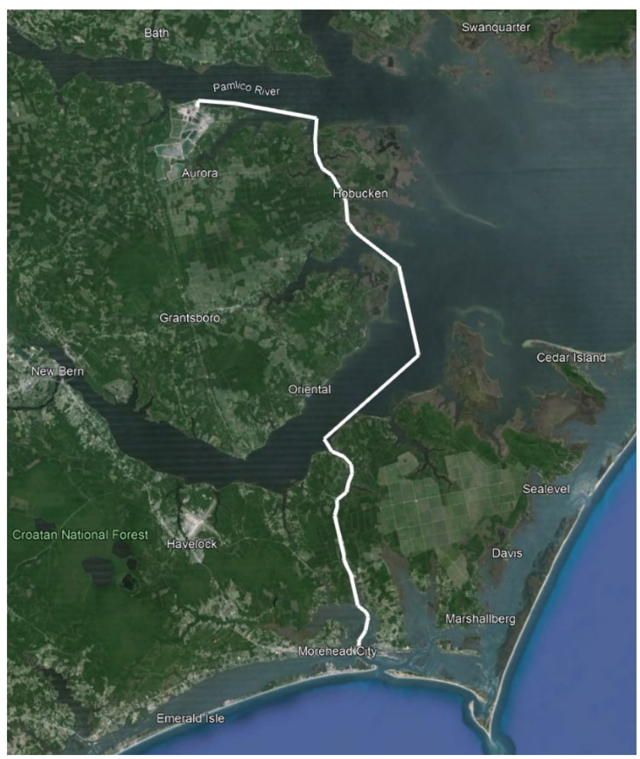

Figure 3. Current and Build route for barges from Nutrien's Aurora production facility to the Port of Morehead City.

The East Barge Berths will be restored to a state of good repair, allowing one liquid barge to stage along the northern portion of the barge berth while another is unloading. Crews can use specialized equipment intended for safe and efficient unloading, such as booster pumps connected to grid power. An approximate loading time of six (6) hours per liquid barge is assumed, with one hour to move barges once one has been unloaded (informed by Nutrien's operations data prior to the barge berth closures). The North Barge Berths will also be restored to a state of good repair, allowing the continued transport of dry cargo by barge as opposed to overland by road and rail.

Other assumptions used for barge transport under the Build Scenario include:

- A crew of six (6), including one captain/pilot, with labor values monetized using the recommended hourly values for locomotive operators and engineers, respectively;
- Average liquid barge capacity of 1,650 tons and dry barge capacity of 3,000 tons;
- For the purposes of calculating barge depreciation, an average capital cost of $15 million was assumed per barge with a useful life of approximately 30 years, informed by industry averages and data collected from Nutrien's fleet; and
- An average liquid cargo value of $474 per metric ton, based on key published actual value data for the blended components, to calculate supply chain savings from faster barge unloading and turnaround times.

<u>No-Build Scenario: Liquid Cargo</u>

In the No-Build Scenario, which assumes the proposed improvements would not occur, the East Barge Berths continue to remain unusable due to poor condition and safety concerns. Nutrien would continue to utilize Berth 1 at the Port, which is located south of the Newport River Bridge and requires pilots to navigate a narrow passage, to both unload barges and load export vessels. "Threading this needle" requires additional time and is not possible in all weather conditions. While this was not accounted for in the BCA, in calendar year 2023, Nutrien experienced four days in which high winds prevented barges from traveling under US 70 for more than a day.

Because Berth 1 was not designed for unloading this type of cargo, Nutrien must use a mobile generator, forklift, and additional equipment to equip hoses, which results in an additional three (3) hours of unloading (as well as rental expenses and emissions, which were not included due to being a transfer payment and difficult to quantify, respectively). Additionally, the energy to move the liquid cargo to the storage tanks at the Phosphoric Acid Terminal comes from the barge pumps, which deteriorates those vessel elements at a much more rapid pace than standard use. The liquid cargo is also pumped a much farther distance from Berth 1, approximately 1,900 feet, as compared to under 500 feet in the Build Scenario. Without a safe place to tie off, barges cannot leave the Nutrien-Aurora facility until they have confirmation that the barge ahead of them has finished unloading. Therefore, without the ability to berth two barges at once, Nutrien experiences delays of approximately one day between barges, where this difference would be just one hour in the Build Scenario.

No-Build Scenario: Dry Cargo

The same May 2022 Stability Analysis conducted on the Port's Phosphoric Acid Terminal that recommended closing the East Barge Berths, advises the North Barge Berths have also reached the end of their service life with failure anticipated at any time within five years – for the purposes of the BCA, a conservative failure date for the North Barge Berths of 2027 is assumed. Failure at the South Berth would also stop operations at the North Barge Berths because it functions as a protective wall. Due to the large volume of liquid barges that would already be traveling the narrow passage under the Newport River Bridge and unloading at Berth 1, along with all other Port tenants on a first-come, first-serve basis, it will not be possible to continue transporting dry cargo by barge after the North Barge Berths' failure. Diversion to another port was not assumed due to the significant cost invested in purpose-built liquid and dry storage and loading and unloading systems at the Port of Morehead City's Terminal – the cost to rebuild this essential operational infrastructure adjacent to sufficient berthing capacity in a state of good repair elsewhere would dwarf the costs of the Project or assumed modal diversion in the No-Build Scenario. All trips are assumed to be roundtrip.

Diversion of Dry Cargo by Truck

With US 70 providing the only vehicular access to the Port, trucks have the option of routes entering the Port from both the east and west. Google Maps was used to determine approximate routes, distances, and travel times. It is assumed that trucks would take the fastest route, which is highlighted in darker blue in Figure 2, taking NC 306 and NC 55 to US 70 and traveling through Morehead City, entering the Port from the west. This route measures approximately 70.4 miles with a projected travel time of 1.5 hours. (Note: This projected travel time ranges from 85 minutes at minimum to a maximum of 120 minutes during peak hours, with 90 minutes appearing the most common projected travel time.) The 60-mile route shown continuing south on NC 306 to NC 101 is not feasible as it requires using a ferry to cross the Neuse River. The alternate route shown using NC 43 to the north requires more time and distance. Any utilization of this alternate route by trucks, which could be induced by extreme weather conditions, incidents at the NC 55 bridge across the Neuse River, or any number of human or natural-caused incidents, would result in additional benefits beyond what was calculated in this BCA. Monetized benefits for diversion to truck include operating savings (fuel costs, depreciation, truck lease or purchase payments, maintenance, insurance, permits/licenses and tires), travel time savings for commercial vehicle operators, reduced congestion, reduced noise pollution, reduced pavement deterioration, enhanced safety, and emissions reduction.

An additional 20 minutes per trip, 40 minutes roundtrip, is included to account for entering/exiting the Aurora facility and the Port, informed by the time required for current operations. In the No-Build scenario, truck traffic at the Port will increase significantly (26,000-30,000 additional annual truck trips), which would likely increase entry/exit times due to congestion, resulting in additional truck operating and personnel time, as well as delay for Nutrien's cargo and all other goods at the Port traveling by truck. These costs beyond the standard 20-minute entry/exit time assumed per trip are not monetized and would only improve the cost-effectiveness of the project. The BCA does not account for the capital costs in loading and other required equipment investments to make these operations possible. To accommodate the diverted tonnage, approximately 25 trucks would be needed to make two daily trips each during the workweek.

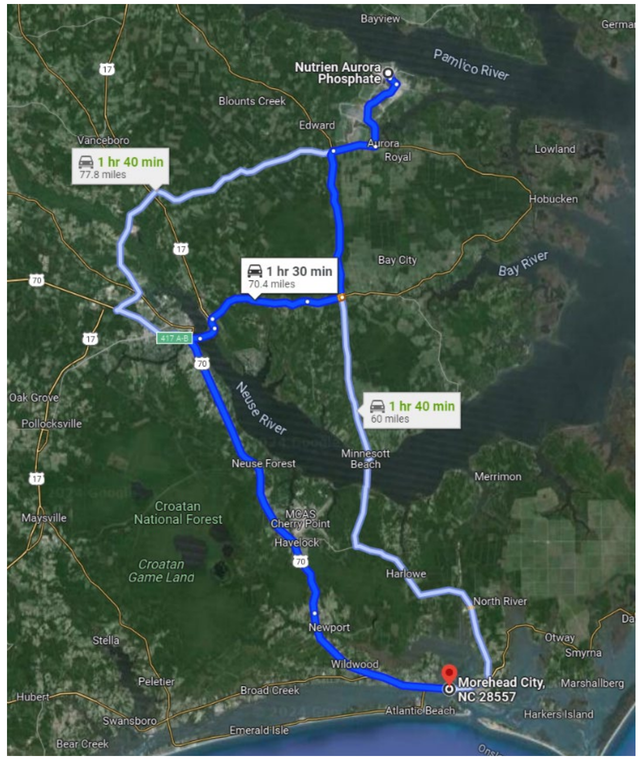

Figure 4. Assumed diversion route by truck, using the quickest route and traveling at off-peak times. (Google Maps)

Diversion of Dry Cargo by Rail

Rail capacity at the Port, including at the Phosphoric Acid Terminal, is limited by geographic constraints. A maximum of six (6) cars can be pushed into the terminal for unloading at once. As a conservative approach, this BCA uses the shortest potential rail route between Aurora and the Port, a distance of 102 miles as shown in Figure 3. Average speeds were collected for various at-grade crossings along this route using Federal Railroad Administration (FRA) crossing inventory data. The "typical speed range over crossing" observed was most commonly 15-25 miles per hour, with a few crossings ranging from 5-15 and 25-35 miles per hour. As such, an average speed of 25 miles per hour was assumed to offer a conservative estimate of benefits based on hours of freight train hauling. A conservative estimate of 15 minutes switching time was accounted for at both the Aurora facility and the Port, for a combined 30 minutes of switching per trip (1 hour roundtrip), which comprises the rail idling time accounted for in this BCA. It is unlikely the cargo would travel directly from Aurora to the Port, especially given the very small scale of rail service that could be used. These transfers would require additional crew time to move the cargo between serving yards (likely including additional time lost to crew changes) as well as additional train movement, which would consume more fuel; result in more wear on the locomotive, railcars, and track; and generate additional emissions. While the likelihood of this cargo stopping at one or more railyards is very high, no additional stops were assumed for this BCA. Any benefits derived from additional switching activities would only increase the project's cost effectiveness.

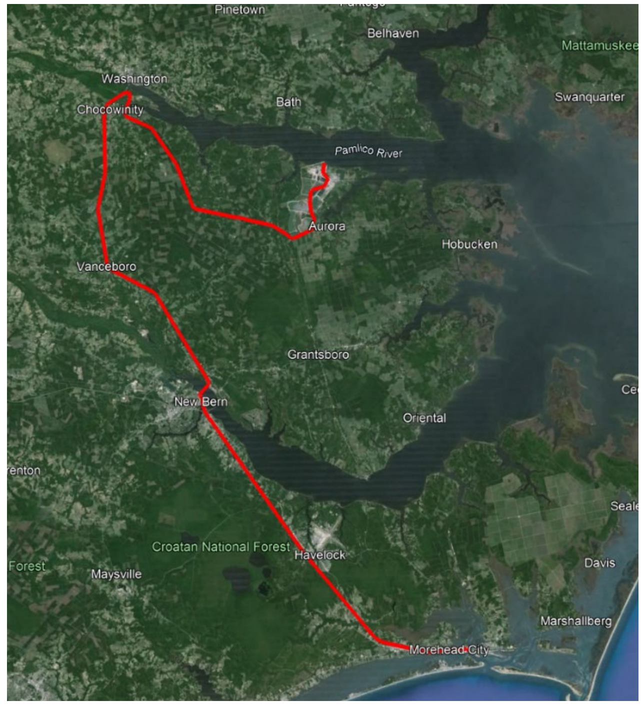

Figure 5. Assumed diversion route by rail, using the shortest distance route. (Serviced by Norfolk Southern)

Given the very small scale of this potential rail service, it is likely that Norfolk Southern would charge a high relative rate, perhaps exceeding the cost of transport by truck. Though this analysis utilizes the emissions values provided in the 2024 USDOT BCA Guidance per hour of train hauling and idling, these values are likely representative of a much larger volume of cargo per train. Given these uncertainties, the model produces two No-Build Scenarios for Dry Cargo:

1) Combined Rail & Truck Modal Diversion – This scenario assumes the maximum amount of cargo that could, would be diverted by rail (1 weekly trip of six (6) railcars with an approximate 100 tons per railcar, accommodating approximately 8.5% of dry cargo) and the remainder of tonnage would be accommodated by trucks (258 trucks weekly with an approximate 25 tons per truck, approximately 91.5% of dry cargo).

2) Truck-Only Modal Diversion – This scenario assumes rail service is not feasible and all dry cargo would be diverted to trucks (282 trucks weekly with an approximate 25 tons per truck).

3.2 Benefits Estimation

To maintain a conservative estimate, this BCA evaluated the following benefits from the ***Modernization and Revitalization of Barge Berths*** project:

- Avoided liquid barge depreciation costs by restoring barge access to the East Barge Berths with more efficient, purpose-built unloading infrastructure, alleviating the need to use barge pumps;
- Avoided vessel congestion (reflected as annual avoided ship charter rates);
- Supply chain savings, calculated as the value of avoided liquid cargo delay by restoring barge access to the East Barge Berths with more efficient unloading infrastructure and the ability to stage barges by berthing two barges simultaneously;
- Reduced operations and maintenance costs for Berth 1 (increased productivity at Berth 1, which the project would make possible, was not monetized in this BCA);
- Avoided truck operating costs (fuel cost, truck/trailer lease or purchase payments, repair and maintenance, truck insurance premiums, permits and licenses, and tires) and operator travel time savings, and pavement wear by preventing modal diversion to truck;
- Avoided train operating costs (fuel cost, depreciation, and labor) by preventing modal diversion to rail (under the No-Build Scenario inclusive of rail diversion);
- Reduced safety risk from avoided vehicle and rail miles traveled (as resulting crash reduction);
- External highway use savings including reduced congestion and noise from avoided truck miles traveled;
- Reduction in emissions as a result of avoided truck and rail miles traveled; and
- Residual value of the reconstructed barge berths at the end of the 20-year operations period.

Each of these benefits is described in more detail in the following sections, including the present value (in $2022) of total benefits over the 20-year project lifecycle. The scenarios and assumptions described above are reflected in the attached BCA Spreadsheet Model. Other details related to BCA values and sources are also found in the workbook, primarily in the Inputs & Parameters tab. Costs and benefits in the BCA are expressed in constant dollars discounted to the year 2022 (year zero for discounting). All monetary values are discounted using a 3.1 percent discount rate, with the exception of carbon emissions, which are discounted at 2.0 percent.

3.2.1 Avoided Liquid Barge Depreciation Costs

Using the barge pumps as a primary power source for unloading liquid bulk at Berth 1 will reduce their useful life. Barges are very expensive, with an industry standard price of approximately $15 million for a typical barge. The typical barge in Nutrien's fleet has a 30-year average service life. It is assumed that use of the pumps for an additional six to nine hours per trip decreases this average service life to 25 years in the No-Build Scenario. These accelerated depreciation costs were accounted for three (3) liquid barges, generating nearly $3.8 million in total discounted benefits over the analysis period.

3.2.2 Avoided Vessel Delay

In the No-Build Scenario, Nutrien must use Berth 1 to accommodate loading and unloading for liquid barge in addition to export ship operations, significantly increasing barge traffic traveling under the narrow Newport River Bridge (US 70) marine passage. Given the port's nine berths outside of the Phosphoric Acid Terminal, this results in an 11% capacity reduction for other tenants' operations with an average delay of one day per vessel when accounting for 22 barges per month that each take one working day to unload. This analysis uses a five-year average of vessel count at the Port and publicly available industry data for multipurpose (bulk and breakbulk) vessel charter rate. This estimate is conservative as it does not account for the downstream supply chain consequences of other tenants' delayed cargo nor the additional emissions that would be incurred during the additional vessel dwell time. The project results in nearly $1.6 million of total discounted benefits over the analysis period.

3.2.3 Supply Chain Savings (Avoided Liquid Cargo Delay)

A primary benefit to the liquid cargo in the Build scenario is supply chain savings, which are valued at over $1.3 million in total discounted benefits over the analysis period. With the reconstructed East Barge Berths in the Build Scenario that allow two barges to berth at once, it will take approximately one hour to stage a new barge for unloading. However, in the No-Build Scenario, Nutrien is limited to operating with one barge at a time at Berth 1. Due to many uncertainties in the supply chain, the arrival of a new barge cannot be immediately timed with the departure of an unloaded barge and without a safe place for the new barge to berth while Berth 1 is in use, these barges must wait for confirmation of Berth 1's near availability before departing the Aurora facility. Informed by recent delays, as the No-Build Scenario reflects Nutrien's current liquid cargo operations, the average turnaround time between barges is 24 hours. This increased handling time results in significant delays in getting Nutrien's liquid cargo to market, primarily because it now takes much longer to accumulate the volume of stored liquid acid necessary to load a ship for export, and also because Berth 1 is also used for these ships. In the Build Scenario, Nutrien can unload one barge and have another staged at the East Barge Berths while loading a ship for export; in the No-Build Scenario, all three activities are mutually exclusive. Nutrien would likely need to purchase or lease additional liquid barges for its fleet to maintain current production and export levels without the project (these costs are not included in the BCA).

The cost of liquid cargo delay was estimated based on the average value of a barge, using a price of $474 per metric ton (confidential business information) and average liquid barge capacity of 1,650 metric tons, both provided from Nutrien's operational data. An assumed 20 percent annual interest rate was added, prorated for the additional days of delay, to reflect the time value of private sector capital, as well as production losses, loss of reputation/brand loyalty and other factors that comprise supply chain delay.

This markup is also intended to capture the additional operating costs associated with unloading liquid barges at Berth 1, which are not included as an additional benefit to avoid double counting. The unloading time at Berth 1 is approximately nine hours, as compared to a maximum of six at the East Barge Berth, which would realize both labor and operational savings in the Build Scenario.

3.2.4 Reduced Berth 1 Operations and Maintenance Costs

By restoring the full barge berthing capacity of the Phosphoric Acid Terminal, liquid barges will no longer need to use Berth 1 – to facilitate Nutrien's operations, the O&M costs at Berth 1 will decrease (while O&M costs for the North and East Barge Berth will resume). This results in an estimated $243,000 of total discounted O&M savings for liquid barge berths over the analysis period. As mentioned, O&M costs for Berth 1 were determined as a percentage of the project's O&M costs proportional to berth length. It is assumed that these costs for Berth 1 increase 50 percent under the No-Build Scenario as the tonnage generated by the additional barge traffic equates to the approximate monthly tonnage that would be exported from the berth in the Build scenario. Reducing Nutrien's usage of Berth 1 will also allow the Authority to put it to other productive use. To avoid double counting, the benefits of the Authority regaining capacity at Berth 1 are not monetized in this BCA.

3.2.5 Avoided Truck Operating Costs

Depending on the No-Build Dry Cargo scenario, continued export by barge would save an estimated 37.8 million truck miles and over 983,000 truck hours (41.3 million truck miles and over 1 million truck hours assuming 100% truck diversion) over the 20-year analysis period. The avoidance of over 37.8 million vehicle miles traveled over the lifecycle of the project results in:

- Truck vehicle operations and maintenance cost savings of $31.5 million ($34.5 million assuming 100% truck diversion) in total discounted benefits over the lifecycle of the project, using recommended monetized values for commercial trucks provided in Table A-4 of the 2024 USDOT Benefit Cost Analysis Guidance;

- Truck operator travel time savings of $22.7 million ($24.8 million assuming 100% truck diversion) in total discounted benefits over the lifecycle of the project, using recommended monetized values for commercial truck drivers provided in Table A-2 of the 2024 USDOT Benefit Cost Analysis Guidance and accounting for one operator per truck taking the shortest available route and accounting for 20 minutes of unloading time; and

- Roadway maintenance cost savings of over $1.1 million (over $1.3 million assuming 100% truck diversion) in total discounted benefits over the lifecycle of the project.

Highway maintenance costs fluctuate based on the types and amount of traffic handled each year. By reducing heavy truck traffic, the project has an incremental reduction in the required roadway maintenance. Pavement wear reduction was estimated based on the FHWA Comprehensive Truck Size and Weight Study, updated in 2009, using values specific to truck traffic per vehicle mile traveled. This figure from 2009 was updated to $2022 using the inflation adjustment values provided in Table A-7 of the 2024 USDOT Benefit Cost Analysis Guidance.

3.2.6 Avoided Rail Operating Costs

Under the No-Build Scenario that includes diversion by rail, continued export by barge would save an estimated 212,000 rail miles traveled, as well over 1,040 hours of idling and 8,400 hours of hauling, over the 20-year analysis period. Trips are assumed to occur weekly including six railcars per trip. The avoidance of these rail miles and freight train hauling/idling hours over the lifecycle of the project results in train operating cost savings of $4.3 million in total discounted benefits over the lifecycle of the project, using recommended monetized values for train operating costs provided in Table A-5 of the 2024 USDOT Benefit Cost Analysis Guidance. Assuming 30 minutes of unloading time per railcar with two locomotive engineers generates an additional $211,000 in total discounted benefits.

As mentioned in the Scenario Overview, these monetized benefits are a very conservative account. If rail service were cost-effective, it is likely there would be one or more stops at switching yards, resulting in additional fuel consumption; personnel time and handling fees; and wear on locomotives, railcars, and track; in addition to cargo delay upwards of 48 hours. No capital costs to accommodate rail loading at the Nutrien-Aurora facility were included in this analysis.

3.2.7 Safety Benefits

Avoiding total truck and rail miles results in an avoidance of both fatal and non-fatal crashes including property damage. The value of such safety benefits was estimated based on the recommended monetized values provided in the 2024 Benefit Cost Analysis Guidance. Based on the avoidance of 37.8 million truck miles over the lifecycle of the project in the multimodal diversion scenario, there is a total truck crash reduction safety benefit of over $517,000 in total discounted benefits over the lifecycle of the project. Based on the potential avoidance of over 212,000 rail miles traveled over the lifecycle of the project, there is a total rail crash reduction safety benefit of over $34,000 in total discounted benefits over the lifecycle of the project. Therefore, assuming diversion to both rail and truck and accounting for minimal safety impacts of the Build Scenario, the project provides over $508,000 in total discounted safety benefits over the lifecycle of the project. Under the 100% diversion to truck scenario, the project provides over $521,000 in total discounted safety benefits over the same period.

3.2.8 Avoided External Highway Use Benefits

By avoiding total truck miles traveled, the project will also reduce noise pollution and roadway congestion. The value of these external highway use costs (congestion and noise) was estimated based on the recommended monetized values provided in the 2024 Benefit Cost Analysis Guidance Table A-14. Based on the avoidance of 37.8 million truck miles over the lifecycle of the project in the split diversion scenario, there is a total avoided highway use benefit of over $6.1 million in total discounted benefits over the lifecycle of the project. Under the 100% diversion to truck scenario, the project provides $6.7 million in total discounted avoided highway use benefits over the same period.

3.2.9 Reduction in CO_2 and Other Emissions

Avoiding truck miles and rail operating hours both provide emissions benefits as part of the project. The environmental impact of carbon dioxide (CO_2) and other pollutants has been accounted for using the recommended value in 2024 Benefit Cost Analysis Guidance Table A-14 for buses and trucks, with CO_2 discounted at 2.0 percent and other pollutants discounted at 3.1 percent. Based on the avoidance of over 37.8 million truck miles and 212,000 rail miles traveled over the lifecycle of the project, there is an emissions benefit of over $20.2 million in total discounted benefits over the lifecycle of the project. Under the 100% diversion to truck scenario, the project provides over $7.0 million in total truck emissions benefits over the same period.

The emissions benefits for rail were calculated using the recommended values in 2024 Benefit Cost Analysis Guidance Table A-5 for hauling and idling freight trains, with CO_2 discounted at 2.0 percent and other pollutants discounted at 3.1 percent. As mentioned in the Scenarios overview, the project conservatively assumes just over four hours of hauling time per trip from the Aurora production facility to the Port (eight hours roundtrip), as well as only 30 minutes of switching time each time the train arrives or departs Aurora or the Port, for a combined idle time of one hour per trip.

This methodology for calculating the emissions benefits of freight rail produces an interesting outcome for the two scenarios of modal shift: the scenario with some diversion by rail produces a greater emissions reduction benefit per ton of diverted cargo than the scenario solely diverting freight to truck. This outcome is a result of the low volume of cargo the Port could potentially accommodate by rail, a lack of economy of scale: the locomotive must travel the full route – generating significant emissions all the while – while moving a relatively small share of the cargo the Project would accommodate.

3.2.10 Residual Value

The BCA calculations assume that at the end of the 20-year model period, the reconstructed barge berths would retain some residual value. Based on the Capital Costs listed in section 2, the capital cost of the barge berth is estimated to be approximately $18.9 million in $2025-2027 year-of-expenditure dollars. Conservatively assuming a total useful life of 50 years for the bulkhead and a linear depreciation over the project lifecycle, this represents an estimated $5.3 million in total discounted residual value.

4.0 BENEFIT-COST RATIO AND NET PRESENT VALUE

The table below presents the summarized results of the BCA. The analysis uses a 3.1 percent discount rate for all costs and benefits, except for carbon emissions which are discounted at 2.0 percent. Values presented are in 2022 dollars. Results yield a benefit-cost ratio (BCR) of 3.53 for the project with diversion of dry cargo to both truck and rail, or a BCR of 2.84 with 100% diversion of dry cargo to truck. Several likely project benefits have been omitted from this analysis including the inefficiency of dry cargo operations with only one barge berthing at the North Barge Berths until they are assumed to fail in 2027; additional delays, emissions, and operational expenses likely from stops at railyards and increased truck congestion within the Port; increased emissions and downstream supply chain impacts resulting from vessel congestion; weather-related delay for liquid barges traveling under the Newport River Bridge; and any potential recovery and restoration costs that would be incurred if the failed bulkhead broke off and entered the waterway. As such, these results represent a conservative estimate of the BCR and net present value, and the inclusion of any of these benefits would increase both values.

SUMMARY BENEFIT-COST ANALYSIS RESULTS TABLE (2022 DOLLARS) – TRUCK AND RAIL DIVERSION OF DRY CARGO

	PRESENT VALUE
Discounted Benefits	
Liquid Barge Depreciation Savings	$ 3,796,212
Avoided Vessel Congestion	$ 1,599,454
Liquid Barge Berth Cost Savings	$ 1,350,073
Liquid Cargo Supply Chain Savings	$ 243,590
Personnel Time Savings	$ 14,506,079
Truck/Freight Train Operating	$ 6,868,827
Safety Benefits	$ 508,408
Avoided External Highway Use	$ 6,167,010
Avoided Emissions	$ 20,278,922
Dry Barge Berth O&M Costs	($ 487,181)
Residual Value	$ 5,282,749
Total Discounted Benefits	**$ 61,309,302**
Discounted Costs	
Build Capital Costs	$ 17,450,878
Total Discounted Costs	**$ 17,450,878**
Benefit-Cost Ratio	**3.53**
Net Present Value	**$ 44,069,645**

SUMMARY BENEFIT-COST ANALYSIS RESULTS TABLE (2022 DOLLARS) – 100% TRUCK DIVERSION OF DRY CARGO

	PRESENT VALUE
Discounted Benefits	
Liquid Barge Depreciation Savings	$ 3,796,212
Avoided Vessel Congestion	$ 1,599,454
Liquid Barge Berth Cost Savings	$ 1,350,073
Liquid Cargo Supply Chain Savings	$ 243,590
Personnel Time Savings	$ 16,622,240
Truck/Freight Train Operating	$ 5,509,723
Safety Benefits	$ 521,861
Avoided External Highway Use	$ 6,740,686
Avoided Emissions	$ 7,042,745
Dry Barge Berth O&M Costs	($ 487,181)
Residual Value	$ 5,282,749
Total Discounted Benefits	**$ 49,528,488**
Discounted Costs	
Build Capital Costs	$ 17,450,878
Total Discounted Costs	**$ 17,450,878**
Benefit-Cost Ratio	**2.84**
Net Present Value	**$ 32,077,610**

ATTACHMENT 1 - BENEFIT-COST ANALYSIS SPREADSHEET MODEL

The Excel BCA Spreadsheet Model supporting this report is a separate attachment.

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