DuPont Technical Assessment on

U.S. Army Newport (Indiana) Project

Executive Summary

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TRANSPORTATION SAFETY ASSESSMENT AND RISK MANAGEMENT PLAN

Statement of Purpose

DuPont has performed a thorough transportation safety assessment, considering these critical transportation factors:

1. Hazards of the wastewater material
2. Design requirements of the transportation equipment
3. Features of various transportation route
4. Transportation risks

There would be no transportation of VX nerve agent. If the Army awards the contract to DuPont, wastewater (Newport Caustic Hydrolysate, or NCH) will be transported from Newport, Indiana, to the DuPont SET facility in Deepwater, New Jersey. The NCH wastewater will be certified as having no detectable levels of nerve agent present, using the state of the art analytical techniques.

Methodology

This transportation safety assessment was consistent with existing methodologies developed or used by various government agencies, including the U.S. Department of Transportation's Risk Management Self-Evaluation Framework (RMSEF), and the Guidelines for Chemical Transportation Risk Analysis published by the Center for Chemical Process Safety.

VRiskMap, a commercially available Geographic Information System offered by Visual Risk Technologies (Nashville, TN), was used in the evaluation of various transportation route options.

Key Findings

- The wastewater (NCH) does not pose any unique or new concerns in transportation. NCH is a medium-hazard material, defined as Corrosive, Packing Group II, by the U.S. Department of Transportation (DOT). Several household products, including drain and oven cleaners, are classified similarly (or at a higher hazard level).
- The transportation equipment to be used for this project meet or exceed DOT requirements.
  - Tank trucks are built to the American Society of Mechanical Engineers (ASME) standards and have a higher Maximum Allowable Working Pressure (MAWP) than required by DOT. This means that they are more robust than is required, having a thicker wall on the container, which would provide additional protection during an accident.
  - DOT specifies many important features of the tanks, including material of construction, thickness of material, pressure relief systems, emergency valve shut-off, and accident damage protection for valves and other fittings. The tanks to be used for transportation meet or exceed these requirements.
- All transportation options have equivalent and low chances of accident or release.
  - Less than one accident and significantly less than one release would be statistically predicted with loaded tank trucks over the *entire* project. There is roughly a 1 in 3,000 chance of a truck accident per trip or a 1 in 13,000 chance of a release of product per trip.
- The transportation of NCH poses only a moderate hazard to emergency responders and other persons in the immediate vicinity of the spill (range of 30-50 yards), and is very unlikely to have wide-reaching effects on population or the environment. Overall, the potential consequences from a spill are low and do not differ from other potential spills of other commercially transported, corrosive materials.

Conclusions

- The wastewater being transported for this project does not pose any unique or new concerns in transportation. The risks along all of the identified routes are very low to populations, employees, emergency response personnel, and the environment due to transport of NCH. (see Figures 1 and 2)

- The routes, carriers, and transportation equipment were carefully selected to even further reduce that risk, and result in a very low chance of an accident or a release of material.
- In order to further assure safe shipment of the material, DuPont's risk management plan includes:
  - Thorough safety qualification of carriers and selection of the best in industry, qualifications which must be maintained over the entire shipping campaign
  - Dedicated fleet of drivers and equipment for transportation
  - Team drivers to reduce transit time and layover, and provide added security
  - Global Positioning Systems (GPS) in every truck for communication and security
  - Late-model, high-quality equipment
  - Speed governors to restrict maximum travel speed
  - Trailers built to ASME boiler code standards

DuPont's Preferred Route

The identified preferred route, (No. 1 in the chart below):

- utilizes the most interstate highways – enhancing its statistical safety ratio
- minimizes travel over waterways – enhancing the water "exposure" metric
- is the most efficient in coordinating emergency response capabilities among DuPont responders and appropriate state and local responders

In the event of weather, traffic or other issues affecting the preferred route, an alternative route has been identified (No. 2 in the chart below) based on several comparable criteria.

Public comments and input on the transportation routes are available as part of the current public comment process and at the upcoming public information sessions.

Figure 1: Map of Four Potential Highway Routes

#3
#4
#2
#1

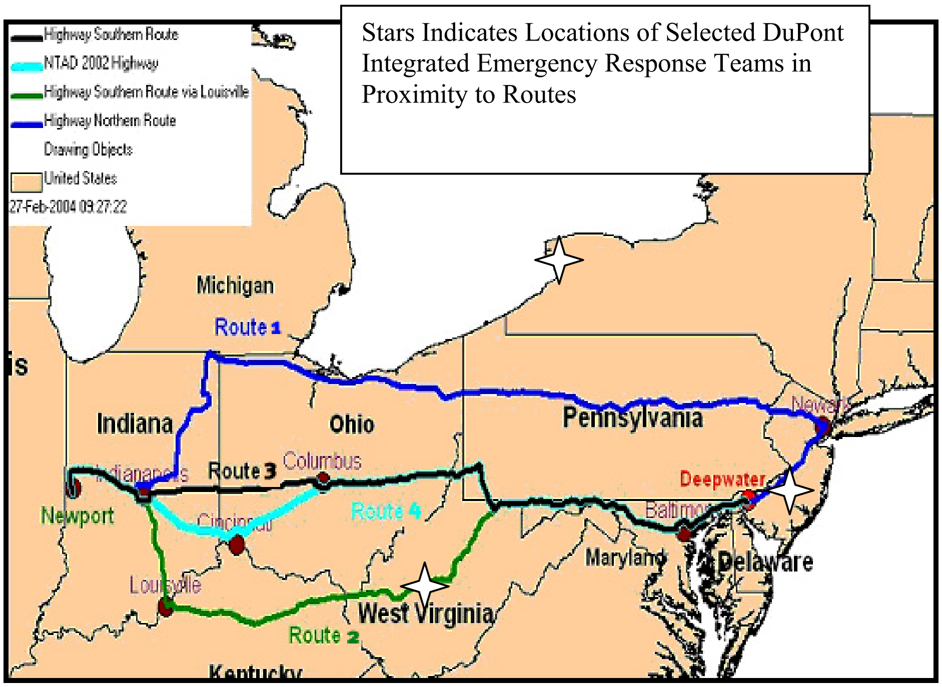
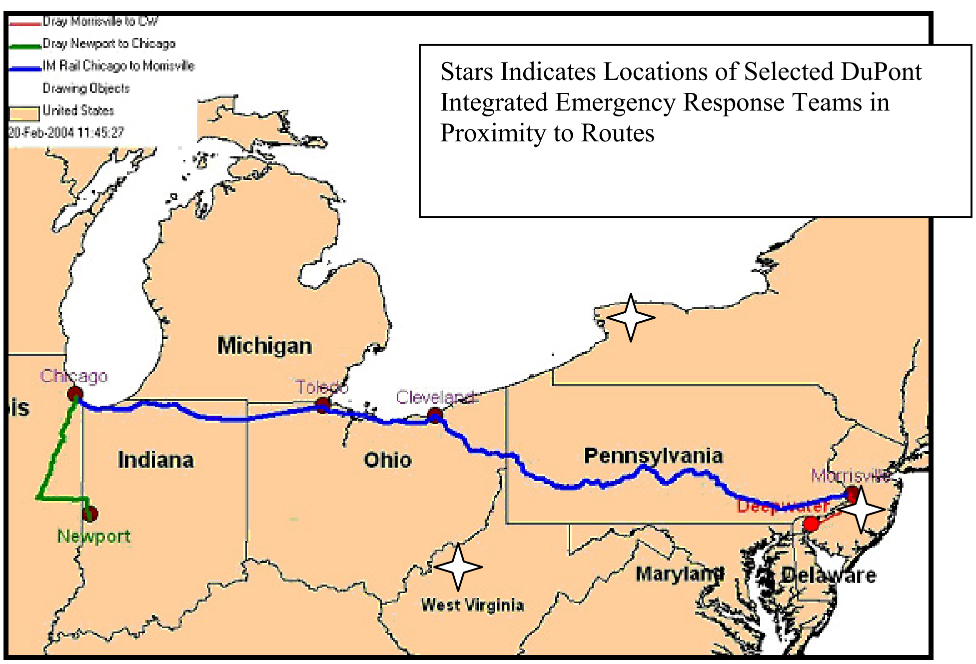


Figure 2: Map of Potential Highway-Rail Intermodal Route (#5)



TREATABILITY STUDY

Statement of Purpose

The objective of this study was to determine if the SET Wastewater Treatment Plant (WWTP) at the Chambers Works site (Deepwater, NJ) could effectively treat Newport (Indiana) Caustic Hydrolysate (NCH) at the U.S. Army's anticipated generation rate. Currently, the SET facility treats approximately 15 million gallons of wastewater per day. The approximate production rate of NCH is anticipated to be one to two truckloads (a total of 3,000 to 7,000 gallons) per day.

The study evaluated both pretreatment through chemical oxidation as well as biotreatment utilizing the patented PACT® process (Powdered Activated Carbon Treatment with activated sludge).

In the study, three general criteria for the effective treatment of NCH were used:

- Ability to meet SET WWTP operational requirements
- Ability to maintain control of wastewater and sludge odors
- Ability to assure permit compliance

Methodology

Pretreatment by chemical oxidation was conducted to evaluate dosages and operating conditions. A biotreatability study was conducted using continuously fed Eckenfelder-type PACT® bioreactors.

Over the history of the SET WWTP, DuPont has demonstrated the suitability of this scale of testing to screen wastewaters for acceptance. Eckenfelder-type reactors have been used by DuPont to design several of its wastewater treatment systems currently in operation. The bioreactors were operated to simulate the conditions at the WWTP using actual wastewater and activated sludge under plant process conditions. Several wastewater parameters were monitored in the influent and effluent to each bioreactor including dissolved organic carbon (DOC), biochemical oxygen demand (BOD), chemical oxygen demand (COD), ethyl methyl-phosphonic acid (EMPA), methylphosphonic acid (MPA), and other parameters. Reactor conditions such as pH, temperature and mixed liquor suspended solids (MLSS) were monitored and controlled at levels similar to those maintained in the full-scale SET WWTP.

Key Findings

Key findings of the treatability study include:

- The DuPont WWTP can effectively treat the stated volume (3,000 to 7,000 gallons per day) of NCH generated at the Newport (Indiana) site. In addition, the bioreactor system operated within normal SET WWTP operating conditions at a NCH production rate of up to 10,000 gallons per day.
- Pretreatment by chemical oxidation was effective in odor control. Odor intensity results were indistinguishable between the wastewater and sludge in the control and those from the test streams.
- Chemical oxidation pretreatment destroys the thiolamine, but has limited effect on EMPA and MPA. Biotreatment will convert a substantial portion of EMPA to MPA while overall treatment of MPA will be limited. EMPA and MPA at the estimated levels are not toxic to aquatic organisms in the Delaware River and Estuary.
- Following biotreatment at the WWTP, no other organic components or degradation products of the NCH were identified in the bioreactor effluent.
- Solid residues generated from the treatment of NCH will be placed in DuPont's on-site RCRA permitted subtitle "C" landfill, not in public landfills
- The study demonstrated that key permit parameters such as BOD_5, percent BOD removal and Whole Effluent Toxicity for the WWTP would be met during the treatment of the NCH.
- Modeling of the physical parameters indicates that no atmospheric emissions of MPA, EMPA or thiolamine would result from the treatment of NCH.

Conclusions

This treatability study conclusively demonstrates that all three major success criteria can be met and the SET WWTP can safely and effectively treat the NCH.

SCREENING LEVEL ENVIRONMENTAL RISK ASSESSMENT

Statement of Purpose

The objective of this review is a screening level environmental risk assessment for the effluent discharge to the Delaware River and Estuary resulting from the waste treatment of Newport (Indiana) Caustic Hydrolysate (NCH) by the DuPont Secure Environmental Treatment (SET) wastewater treatment plant (WWTP) located at Deepwater, New Jersey. This assessment evaluated the environmental exposure pathways and screening level risk to ecological receptor species in the Delaware River and Estuary.

Methodology

U.S. EPA risk assessment guidance was used in the development of this assessment (U.S. EPA 1997). Screening level exposure and hazard characterizations were developed for EMPA and MPA, the principal constituents of the SET WWTP effluent that result from the treatment of NCH. These exposure and hazard characterization data were then used to develop risk quotients that were evaluated to assess risk to the receptor species.

The following information was considered in this process:

- Physical/chemical properties of EMPA and MPA
- Estimated effluent concentrations for EMPA and MPA from the study of NCH treatability (Reich et al. 2004)
- Physical mixing properties for the SET WWTP effluent discharge in the Delaware River
- Experimental and modeled aquatic toxicity data for EMPA and MPA using representative, sensitive aquatic species

Findings

- The primary environmental exposure pathway for MPA and EMPA is surface water. Based on their physical-chemical properties, EMPA and MPA are not volatile (no airborne exposure) and do not bioaccumulate (do not build up in organisms or the food chain).
- Phosphonic acids are present in the environment from naturally occurring and industrial sources.

- EMPA and MPA at anticipated discharge concentrations are not toxic to aquatic organisms in the Delaware River and Estuary.
- In surface water, EMPA will naturally biodegrade into MPA and ethanol. The low levels of ethanol released will be used as a food source by microorganisms and will not pose a hazard to the environment.
- Biological processes will eventually biodegrade MPA to inorganic phosphate and methane.
- Based on the low concentrations of MPA and the limited bioavailability of its phosphorus content, no significant addition of phosphorus will occur in the estuary. Any utilization of the phosphorus in MPA as a nutrient for plant growth is likely to occur in phosphorus-limited areas of the open ocean.

Conclusion

The screening level risk assessment indicates that discharge of effluent from the treatment of NCH by the SET WWTP will have no adverse effect on the environment.

Toxicology Assessment of Health Hazards

Statement of Purpose

A toxicology assessment was conducted to evaluate the potential human health hazards and risk relevant to transportation of NCH from Newport, Indiana to Deepwater, New Jersey and subsequent treatment at the DuPont Secure Environmental Treatment (SET) wastewater treatment plant (WWTP) located at Deepwater, New Jersey.

Methodology

The wastewater (NCH) is a water-based mixture containing 80% water and the following compounds: diisopropylamino ethylthiolate (thiolamine), sodium ethyl methylphosphonate, sodium hydroxide, sodium methyl phosphonate, ethanol, diisopropylamino ethyl disulfide and diisopropylamine.

All currently available information on the NCH mixture physical properties, exposure scenarios, toxicity and regulatory standards were evaluated and used to assess the human health hazard/risk potential of NCH during transportation. The NCH toxicological assessment was conducted on the complete NCH mixture.

One of the NCH components, thiolamine, is in the mercaptan chemical family and has an odor, which can be detected at very low concentrations. However, thiolamine will be completely destroyed during treatment at the SET facility. A toxicological assessment was conducted for the residual methylphosphonic acid (MPA) and ethyl methylphosphonic acid (EMPA) expected to remain following NCH treatment at the SET facility.

Additional toxicity testing and modeling were conducted to complement the available information in the MPA and EMPA toxicity databases. The assessment included the following activities.

- Reviewed U.S. Army reports related to the composition, chemical and toxicological properties of NCH
- Comprehensively searched Toxline, Medline, Toxnet and Scifinder 2004 databases for toxicity information on NCH components, including MPA and EMPA and similar compounds

- Reviewed the American Industrial Hygiene Association (AIHA) Emergency Response Planning Guides (ERPGs) for sodium hydroxide, the component of NCH which drives the toxicity considerations
- Conducted dermal toxicity tests on NCH required for DOT corrosivity classification
- Conducted predictive toxicity and metabolism modeling of EMPA and MPA using METEOR, DEREK and TOPKAT programs
- Conducted acute oral toxicity tests on MPA and EMPA

Key Findings

- NCH is a water-based liquid with very low vapor pressure. Using DOT definitions, NCH is not a poison or acutely toxic material, but it is considered to be a corrosive material due to the presence of sodium hydroxide (pH 12-14).
- NCH presents no unique physical or chemical hazards as compared to other corrosive sodium hydroxide (lye) waste materials.
- Dermal and eye exposure to NCH liquid and inhalation of NCH droplets are the most relevant exposure considerations for people in the immediate vicinity of a NCH release, such as those involved in emergency response or clean up activities.
- Predictive toxicity models were uninformative, but metabolism modeling indicated that MPA and EMPA are not metabolized in humans.
- Based on acute oral toxicity tests, MPA and EMPA had approximately the same order of acute toxicity as table salt.

Conclusion

An assessment of NCH hazard information led to the conclusion that NCH, although a corrosive mixture, can be safely transported and treated at the DuPont SET facility. Additionally, the toxicity testing, exposure information, predictive modeling and literature searches support the conclusion that MPA and EMPA present a low risk of toxicity to humans.

OVERALL CONCLUSION OF DUPONT TECHNICAL ASSESSMENT ON U.S. ARMY NEWPORT (INDIANA) PROJECT

The four assessments, which were reviewed by several independent scientists including the Virginia Institute of Marine Sciences, Virginia Polytechnic Institute and the U.S. Centers for Disease Control and Prevention – conclude that the wastewater from the U.S. Army's Newport, Indiana site can be safely transported, managed as a corrosive material, effectively treated at the DuPont SET facility and disposed of under permits with both U.S. EPA and the New Jersey Department of Environmental Protection without adverse impact on the environment.

TRANSPORTATION SAFETY ASSESSMENT AND RISK MANAGEMENT PLAN

SHIPMENTS OF NEWPORT (INDIANA) CAUSTIC HYDROLYSATE (NCH) NEWPORT IN TO DEEPWATER NJ

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TRANSPORTATION SAFETY ASSESSMENT AND RISK MANAGEMENT PLAN
Shipments of Newport (Indiana) Caustic Hydrolysate (NCH)
Newport IN to Deepwater NJ
February 2004

OVERVIEW

DuPont has performed, as part of this project, a thorough transportation safety assessment. In this assessment, critical safety factors are identified and evaluated, and a plan to effectively manage the risks associated with transportation of the Newport (Indiana) Caustic Hydrolysate (NCH) is presented.

COMPONENTS OF ASSESSMENT:

- Identification of NCH composition
- Description of expected behavior upon release and potential consequences to human health, the environment, or property
- Determination of shipping requirements under U.S. Department of Transportation Regulations
  - Material classification
  - Allowable equipment specifications
- Recommendation for preferred equipment specification(s) for NCH shipments
- Putting NCH shipments in perspective
- Risk-based evaluation of potential modes and routes, and identification of preferred route(s), including consideration of:
  - Distance/transit time
  - Infrastructure (road or rail) characteristics
  - Estimated frequency of accidents and releases
  - Population centers and densities along route
  - Other sensitive locations along route (population or environmental)
  - Location of DuPont Integrated Emergency Response teams
- Emergency response coverage
- Specification of additional operational measures to help ensure safe and secure transport

RESULTS OF ASSESSMENT

Identification of NCH Composition

The Newport Caustic Hydrolysate (NCH) is the caustic wastewater resulting from the chemical destruction of the liquid nerve agent VX by mixing it with a solution of sodium hydroxide at elevated temperatures. The VX is completely destroyed during this process and cannot be reformed. The NCH must not contain any detectable amounts of VX prior to shipment, based on a chemical analysis method with a detection limit of 20 μg/L (parts per billion). The caustic hydrolysis reaction significantly reduces the toxicity of the resulting mixture with the result that the human health and ecological hazards associated with transportation of the NCH are analogous (similar) to those for other caustic materials, such as sodium hydroxide.

Composition of the hydrolysate will vary slightly depending on the amount of agent initially loaded into the neutralization process, but in all cases the NCH produced will contain no detectable amounts of VX. The Newport Chemical Agent Disposal Facility (NECDF) plans to operate using an 8 – 16 % mass loading of agent for the reaction mass into the NECDF destruction reactor. At this 8 – 16 weight % formation, the resulting NCH will be a solution of water (80 - 85%) and sodium hydroxide (3 - 5%, CAS# 1310-75-2), containing small amounts (approximately 10%) of breakdown products. These percentages may vary somewhat depending on the percent agent loading used.

The breakdown products in the NCH that will be subject to additional treatment at DuPont Secure Environmental Treatment (SET) will include sodium salts of ethyl methyl phosphonic acid (EMPA, 3 - 8%, CAS# 1832-53-7) and methyl phosphonic acid (MPA, <1%, CAS# 993-13-5), diisopropylamino ethylthiolate (thiolamine, 5 -11%, CAS# 5842-07-9), ethanol and other organics (<1%).

The vapor pressure of NCH is very low, essentially negligible (approximately 0.02 psig). A low vapor pressure means that hazardous fumes or vapors will not be present above the material, or carried by air.

Description of Expected Behavior upon Release and Potential Consequences to Human Health, the Environment, or Property

Because of the presence of residual sodium hydroxide, the solution will have a high pH (12 – 14), which will make NCH caustic. Caustic materials may cause burns if contact occurs with the skin or eyes, can cause gastrointestinal damage if ingested, and can also cause burning and respiratory damage if inhaled. However, since NCH does not produce vapor or fumes above the liquid, it will not pose an inhalation hazard unless aerosolized (sprayed). While NCH has an unpleasant (skunky) odor due to the presence of thiolamine, the odor is not hazardous. Humans can detect this odor at extremely low concentrations. None of the breakdown products have toxic or other harmful properties. NCH is not flammable.

In a release of NCH, the caustic hazard would exist for persons who came in direct contact with the material, and would not be expected to extend to areas remote from the release. The potential health hazard of NCH is directly related to its corrosive nature and is similar to the hazard associated with industrial or common household caustic solutions containing sodium or potassium hydroxide (also known as lye). For example, many drain and oven cleaners contain concentrations of these caustic materials that are equal to or greater than that found in NCH. Consumers of these products are warned to avoid direct contact with these materials, but they may be in the same room with them.

As an environmental hazard, NCH is again is similar to sodium hydroxide or other caustic solutions. Vegetation may be burned due to the caustic nature. Spills into water may kill fish in the concentrated area due to the increase in pH until mixing has occurred. Sodium hydroxide solution is not classified as a marine pollutant by the U.S. Department of Transportation (DOT).

Toxicity Related Emergency Response Guidelines for NCH

The American Industrial Hygiene Association (AIHA) has established Emergency Response Planning Guidelines (ERPGs) for sodium hydroxide. The ERPGs are designed to protect the general public from the consequences of a one-hour exposure to airborne sodium hydroxide following an accidental release. Nearly all individuals could be exposed for one-hour to airborne sodium hydroxide concentrations of 5 mg/m^3 or less without experiencing a permanent or serious health effect (ERPG-2). Additionally, the AIHA has established an ERPG-3 of 50 mg/m^3 for sodium hydroxide. The ERPG-3 is the maximum airborne sodium hydroxide concentration at which nearly all people could be exposed for one-hour without experiencing life-threatening effects.

Emergency Response Guidebook (ERG2000)

The Emergency Response Guidebook (ERG2000) was developed as a joint effort by the U.S. Department of Transportation with equivalent agencies in Canada and Mexico, for use by firefighters, police, and other emergency services personnel who may be the first to arrive at the scene of a transportation incident involving a hazardous material. It assists first responders in quickly identifying the specific or generic classification of the material(s) involved in the incident, and recommends actions to protect themselves and the general public during this initial response phase of the incident.

For sodium hydroxide solution, as well as for the proper DOT name for NCH (discussed below), the guide suggests that emergency responders isolate the spill or leak area immediately for at least 80 to 160 feet in all directions, and keep unauthorized persons clear of the scene. Advice to keep upwind of the spill and out of low lying areas is also given, which is standard for any spill emergency response.

Determination of Shipping Requirements under U.S. Department of Transportation Regulations

The U.S. Department of Transportation (DOT) determines what materials are considered hazardous for transportation purposes, and establishes regulations for the safe shipment of these hazardous materials. The DOT regulations governing hazardous materials transportation are published in the Code of Federal Regulations (CFR), specifically 49 CFR 100 – 180. One of the first steps in determining if and how a hazardous material can be transported is to establish its DOT proper shipping name, hazard classification, and shipping description.

Material Classification

NCH has been tested according to DOT regulations, and has been classified as a corrosive material (Hazard Class 8). No explosive, flammable, or toxic properties have been identified through extensive testing.

The proper shipping name and description for NCH under DOT regulations is:

> Waste Corrosive Liquid, Basic Organic, n.o.s. 8, UN3267, PG II, RQ (Sodium Hydroxide)

Since there is not a specific listing for NECDF NCH in the DOT hazardous materials table, a "not otherwise specified," or "n.o.s." description is used. The number 8 depicts the Hazard Class, and UN3267 is the number associated with this shipping name. It is used to identify the material contained in the transport package, as well as a reference to find emergency response guidebook information (discussed earlier). The Packing Group (or PG) is a relative indication of the degree of hazard associated with the material. PG I indicates a high degree of hazard, PG II a lesser degree, and PG There were not remarkable variation in the environmental metrics across the various routes, PG III a minor degree. In this case, NCH has a medium degree of corrosivity to human tissue, based on tests prescribed by the DOT.

"Sodium hydroxide" in parentheses denotes that this is the primary chemical leading to the designation of this material as a Class 8, or corrosive, material. The RQ notation preceding it means that sodium hydroxide has been designated a hazardous substance and is present at or above the reportable quantity of 1000 pounds (equivalent to 2% by weight in solution).

DOT Packaging Requirements

NCH is permitted by DOT to be shipped in bulk packages by highway and rail. It is also permitted in non-bulk packages by highway, rail, water, and air, but since the proposed shipments will be in bulk packages, only those requirements will be covered. *The use of bulk packaging, such as in tank trucks or ISO tanks, will greatly reduce the number of trips required to transport the total volume of NCH that will be produced at NECDF.*

DOT has specified several bulk transportation packages that may be used to transport this material. These containers include tank cars for rail, tank trucks (also called cargo tanks) for highway, and portable or "ISO" tanks that can be transported by rail, highway, or marine modes.

The type of tank truck considered in this report is a tank permanently mounted onto a steel support frame that runs the length of the trailer, commonly known as semitrailer. Attached to the support frame are the fifth-wheel (for connection to the tractor), landing gear (which allow the trailer to stand alone without the tractor), running gear (suspension, axles, tires, etc.) and rear-end protection. A portable or "ISO" tank is not permanently attached to a transport vehicle, but is enclosed in a frame used for lifting and securing the unit onto the truck chassis or intermodal rail car. This configuration is typically used when the mode of transport changes along the trip – for example, truck to rail to truck. (The NECDF does not have direct rail service, therefore the rail tank car option will not be considered in this report. However, rail transport by ISO tank from Chicago is evaluated.)

<u>DOT Allowable Tank Trucks</u>

DOT allows NCH and similarly classified corrosive materials to be shipped in the following commonly used DOT Specification cargo tanks: MC 307, DOT 407, MC 312, and DOT 412[1]. The MC and DOT series (such as MC 307 and DOT 407) are quite similar, but the DOT series represent the most current designs for new construction. For construction of any DOT Specification tanks (which includes both

[1] An MC 330 or MC 331 is also allowed, but these tanks are generally built for compressed gases and are not ideally suited for NCH transport.

the MC and DOT series), DOT specifies many important features, including material of construction, minimum thickness of material, types of pressure relief systems, emergency valve shut-off, and accident damage protection for valves and other fittings, external piping, etc. DOT also specifies requirements for the periodic inspection and testing of these tanks.

MC 307 and DOT 407 tanks are generally used to carry flammable liquids and mild corrosives, and must have a maximum allowable working pressure (MAWP) of at least 25 psig. MC 312 and DOT 412 tanks are generally used to carry corrosive, poisonous, or high density liquids. The required MAWP is based on the vapor pressure of the product being carried (or the maximum pressure in the tank during loading or unloading, if higher), and can range from as low as 5 psig to over 100 psig – most are at least 25 psig. For NCH, a very low pressure tank would be permitted by DOT, since the vapor pressure of the material is negligible and pressure assisted loading or unloading will not be used.

MC 312 and DOT 412 tanks are often “custom built” in terms of features such as MAWP, capacity, valving, etc. for specific products or loading/unloading needs. For example, a DOT 412 used to carry a high density liquid might be sized smaller than one used for lighter materials.

Depending on the thickness of the tank, all of the specifications discussed above may use circumferential reinforcement in order to strengthen the tank. These are often in the form of “stiffening rings” added to the tank shell.

Cargo tanks used to transport Class 8, Packing Group I and II materials, must meet certain pressure relief requirements, and also be equipped with stop-valves to allow the flow of product to be stopped quickly (within 30 seconds) and remotely during an emergency during loading or unloading.

A common trailer used to transport hazardous waste liquids is the “vacuum trailer.” This trailer can be built to the MC 307/DOT 407 or MC 312/ DOT 412 specifications discussed above. These tanks must have an MAWP of at least 25 psig, and an external (vacuum) pressure rating of 15 psig. To be used as a vacuum trailer, a tank must be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code. (ASME is the American Society of Mechanical Engineers, an internationally recognized standard setting organization.).

Vacuum trailers are used widely in the waste transport area because the vacuum can be used to "suck" materials into the trailer. Vacuum loading will not be used at NECDF. However, the design of the vacuum trailer makes it slightly more robust than a non-vacuum trailer of the same MAWP.

DOT Allowable Portable (ISO) Tanks

DOT allows NCH and similarly classified corrosive materials to be shipped in the following commonly used portable tanks: DOT Specification 51, Specification IM 101 and IM 102, and UN (United Nations) Specification T11 or higher[2]. These tanks are quite similar, but the UN tanks represent the most current designs for new construction.

The T11 code indicates that the ISO tank must have a test pressure of 87 psig. The test pressure is 1.5 times the MAWP, therefore the T11 code requires a tank with an MAWP of 58 psig.

However, as with tank trucks, the specific design, MAWP, and features of an ISO tank usually vary with the product characteristics and loading/unloading requirements. DOT regulations allow the use of an ISO tank with a test pressure of 58 psig if calculations based on vapor pressure indicate that the material does not require a higher pressure tank. For NCH, which has a very low (essentially negligible) vapor pressure, an ISO tank with an MAWP of approximately 38 psig is therefore authorized.

There are similar requirements for pressure relief systems and shut-off devices for ISO tanks as for tank trucks.

Recommended Tank Truck and ISO Specifications for NCH Service

In addition to meeting all regulatory requirements, DuPont will specify that tank trucks or ISO tanks used for the highway transport of NCH be constructed of Type 316L stainless steel[3], and have an MAWP of *at least* 35 psig (38 psig for ISO tanks). Vacuum trailers such as described earlier, with an MAWP of at least 35 psig, would exceed minimum regulatory requirements for NCH, and offer flexibility in loading and unloading.

The minimum specification for ISO tanks to be shipped by rail is currently being evaluated by DuPont.

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[2] DOT Specification 56, 57, and 60 are also authorized, but these tanks are no longer commonly used
[3] Steel corrosion tests performed on NCH show that it is compatible with both stainless and carbon steel. Very low corrosion rates were found with either type. However, for appearance and ease of maintenance, 316L stainless steel is preferred.

All ISO tanks must be mounted in a full, not beam frame. Full frame construction offers more support and protection than the beam design.

NCH weighs approximately 9.2 pounds per gallon. Tanks should have a capacity of 4000 – 5500 gallons, which would allow approximately 35,000 to 48,000 lbs. of NCH to be loaded per tank (assuming a 5% outage)[4]. Tanks that are nearly full by volume are more stable during transport, as they are less susceptible to the effects of product surging during stops, starts, and turns than are partially filled tanks.

Bottom outlet valves shall be equipped with remotely actuated internal valves in addition to the external valve. The internal valve shall be protected from damage due to external forces by use of a shear section or sacrificial device.

Tank trucks shall be equipped with "air ride" suspension to reduce stresses on the tank during transport.

ISO tanks shall be transported on the highway by "low-boy" or tank type chassis only to lower the center of gravity and improve stability. ISO tanks to be transported by rail shall be by Container on Flat Car (COFC) service only. The tanks, flatcars, and support/securement systems must conform to the requirements of the Association of American Railroads (AAR), Specifications M-1002 (AAR 600) and M-943.

Putting NCH Shipments in Perspective

The activity of transporting chemicals, including waste materials, has an excellent safety record in the United States. The DOT estimates that over 800,000 shipments of regulated hazardous materials are made *daily* in the United States. This is almost 300 million shipments annually, of over 3 billion tons of hazardous materials. The majority of shipments (approximately 94%, or over 750,000 shipments daily) are made by truck.

In 2002 (the latest complete reporting year), 483 serious incidents involving hazardous materials transported by all modes were reported to DOT, as required by regulation.[5]

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[4] An outage of 1% is permitted by DOT regulations; however, a 5% outage is preferred as a safety margin.
[5] A serious incident is one which DOT has defined as involving:

- a fatality or major injury due to the release of a hazardous material
- closure of a major transportation artery due to the release of a hazardous material or exposure to fire
- evacuation of 25 or more persons due to the release of a hazardous material or exposure to fire;
- release of over 119 gallons (or 882 pounds) of a hazardous material
- release of over 11.9 gallons (or 88.2 pounds) of a severe marine pollutant
- release of radioactive materials from Type B packaging
- alteration of an aircraft flight plan or operation

Therefore, approximately 0.00016% of the estimated hazardous shipments made in 2003 resulted in a serious incident. Of these 483 incidents, 391 involved highway transportation (0.00014% of all estimated highway shipments).

Of the 800,000 daily hazardous materials shipments, over 300,000 are estimated to involve petroleum products such as gasoline, home heating oil, and propane (over 99% delivered by truck). Deliveries of flammable petroleum products commonly take place in the midst of both urban and rural population centers, to gasoline stations as well as to individual homes and businesses. Over the past 10 years, the majority of fatalities (ranging from 4 – 16 per year) from hazardous materials transportation have been as a result of accidents or loading/unloading operations involving petroleum products. Additionally, the MC 306 and DOT 406 tanks generally used to carry flammable liquids, such as gasoline, have a very low maximum allowable working pressure (MAWP). They are commonly constructed of aluminum alloy, which is lighter in weight but lesser in strength than carbon or stainless steel.

NCH does not pose any unique or new concerns in transportation. It is regulated no differently that the tens of thousands of shipments made annually in the United States of other bulk corrosive liquids with similar characteristics. From a transportation risk management standpoint, NCH is a medium hazard material (due to its caustic nature) that ordinarily would not be subjected to detailed analysis or the implementation of safety or security measures beyond the basic regulatory requirements for transport. However, DuPont has performed a rigorous review of potential options for the mode, equipment, route, and additional risk reduction measures in order to assure that the transport of NCH will meet the highest standards of safety.

Risk-based Evaluation of Potential Modes and Routes

When developing a risk-management plan for a chemical shipment, including evaluation of alternative modes and routes, a risk-based approach is desirable. Risk associated with a transportation operation is a function of three major components: the expected frequency of accidents, the probability that the container breaches during the accident, and the expected consequences of a release of material due to the breach.[6]

[6] There are also releases that may occur due to non-accident causes, for example, a malfunctioning valve that leaks product. However, for most liquid materials such as NCH, the expected amount of such a release is quite small compared to a puncture of the tank or other damage that might occur due to accident forces. Therefore, in this analysis, only accident-caused releases are considered.

The factors considered main contributors to each of these three risk components are described in more detail below, to aid in understanding of the analysis process. In italics after each section is a discussion of these factors as they apply to the NCH shipments, and of DuPont's approach to managing each risk component.

Factors that influence the accident rate include:

- **Distance and Number of Trips**
  Accident rates are generally expressed as the number of accidents per million miles. In general, the longer a route, and the more trips made, the higher the total chance of having an accident, since more total miles are traveled. Related to these factors is the transit time of the trip. The fewer layovers or stops in rail terminals ("yard dwells"), the less time spent the shipment spends in the public sector.
- **Quality of the Road or Rail Infrastructure**
  Better maintained roads or rail track, such as those found on the Interstate highway system or on a railroad's "mainline" are likely to result in lower accident rates than county or state roads, or lesser utilized rail track. For example, non-highway road (i.e. those that do not have limited access and dividers separating the directional flow of traffic) often have intersections that may controlled by signal lights or stop signs, rail crossings that may not be protected by warning lights and devices (such as automatic barrier gates), and may be closer to the residential neighborhoods.
- **Performance of the Transportation Carrier**
  Truck and rail carriers must each report their accident rate per million miles according to DOT definitions of a recordable accident. These definitions vary by mode, but generally a recordable accident is one with more resulting damage than the typical "fender-bender." These recordable accidents are the ones of interest in risk analysis, because they may contain sufficient energy to cause damage to the transport tank.
- **Equipment Condition**
  Equipment that is properly maintained is less likely to fail during transit, resulting in an accident. Critical activities include not only the periodic inspection and testing of hazardous material tanks required by the DOT, but day-to-inspection and maintenance of all components of the transport unit (tires, brakes, etc.)

DuPont has focused on options that reduce the distance of the trip while still routing on only the best quality roads. (A detailed analysis of potential routes is presented in a later section.) Limited access, divided highways will be used to the greatest extent possible for highway shipments, and mainline track maintained to high FRA Class Track standards for rail shipments. The number of trips will depend on the concentration of the

NCH produced by NECDF and the size of the tank container used. DuPont proposes that tanks in the 4,000 – 5,500 gallon range be used. The transit time of the trip will be reduced by using team drivers for highway shipments, thereby eliminating the need for a layover, or *for rail by using express intermodal service.*

DuPont only uses truck carriers for hazardous materials shipments that have passed a detailed safety fitness examination. Out of the thousands of bulk truck carriers serving the United States, we have contracted with a very limited number (less than 30) who are approved to haul hazardous materials on behalf of DuPont. Since NCH is a waste material, we have pre-qualified two bulk truck carriers from our approved list that specialize in transporting hazardous waste products. Both of these carriers have an excellent safety record (very low DOT recordable accident rates) and very favorable DOT safety ratings. These high qualifications must be maintained throughout the entire shipping campaign. Drivers must meet experience requirements and pass a rigorous background check prior to be accepted for employment. Both companies have extensive training programs, both pre-employment and ongoing. Additionally, both companies have late-model, high-quality equipment, including both tractors and trailers, maintained to high standards.

For rail shipments, DuPont has contracts with all major (Class I) railroads in the United States and Canada, and many smaller railroads as well. All Class I railroads are members of the American Chemistry Council's Responsible Care program, and as such are held to high standards of performance. The selected railroad for the intermodal option would, as a result, have one of the best safety records in that industry.

All equipment used to transport NCH, including tractors and tank equipment, will be thoroughly inspected prior to loading and shipment. Shipment will not be permitted unless the equipment is fully functional, meets all regulatory requirements, and is in excellent condition.

Factors that influence the release probability if an accident occurs include:

- **Accident Characteristics and Forces**
  When and where an accident occurs, and what happens during it (such as collision, rollover, etc.), is generally not very predictable. It is important to understand that most accidents involving hazardous material shipments *do not* result in a spill. For example, a DOT recordable truck accident may occur that requires the equipment to be towed away because of damage to the tractor, but the accident may not have involved the tank trailer at all. Likewise, a train derailment typically involves some, but not all, cars derailing.

- Since DOT generally only collects hazardous materials incident data when there has been a release of product (i.e. the "failures"), but not the "successes" where an accident occurred with no release of product, it is difficult to accurately predict the release probability of a particular container should it be involved in a serious accident.

- **Design of the Transport Equipment**
  Many features of the equipment, such as design code, thickness of the shell, valve protection, etc. can affect the chance that it will be damaged and release product during an accident.
- **Securement Procedures**
  The loading and securement practices used by the shipper and the receiver (when sending back the unloaded container) can affect the chance that a release will occur en-route, whether due to an accident or not.
- **Operating Conditions**
  Operating conditions - such as the speed at which an accident occurs – can affect the chance that the container will be damaged and release product during an accident.

DuPont has conducted an evaluation of potential equipment options for both tank trucks and portable (ISO) tanks, and made recommendations (discussed earlier).

Detailed securement procedures will be developed to reduce any potential for leaks to occur en-route.

The pre-qualified truck carriers both have speed governors on their tractors to restrict the maximum speed, and have other compliance monitoring programs in place to ensure that legal road speed limits are not exceeded.

Factors that influence the consequences of a release include:

- **Hazards of the Material**
  The predicted consequences of a release will depend heavily on the hazards of the material.
- **Properties and Behavior of the Material**
  Hazardous materials that have the ability to travel a distance from the scene of an accident, such as dispersion of a toxic gas, are generally expected to produce more consequences to the surrounding population than a material that has little vapor pressure.
- **Spill Size**
  Spill size is generally affected by both the impact forces in an accident

(which can vary with mode, speed, and accident characteristics), as well as the design features of the container. As discussed earlier concerning the probability of a release, it is very difficult to predict the amount of material that might spill in an accident.

- **Meteorological Conditions, Terrain Features, etc.**
  Depending on when and where an incident occurs, the consequences may be quite different. Across a long route, both meteorological conditions and terrain are expected to change, sometimes dramatically.
- **Population or Other Receptors in the Vicinity of the Release**
  This factor is related to the hazards of the material.
- **Speed and Effectiveness of Emergency Response**

DuPont has thoroughly evaluated the hazards of NCH. As discussed earlier, the product is most similar to a sodium hydroxide solution, and its hazardous characteristic is that it is caustic and therefore can cause burns. Adverse consequences from a spill will be restricted to the immediate area. Because NCH has virtually no vapor pressure, it will not transfer into the air and therefore does not pose an inhalation hazard. The potential health hazard of NCH is directly related to its corrosive nature and is similar to the hazard associated with common household or industrial caustic solutions.

It is not flammable and therefore does not pose a fire hazard.

As an environmental hazard, it again is similar to sodium hydroxide solution. Vegetation may be burned due to the caustic nature. Spills into water may kill fish in the concentrated area due to the increase in pH until mixing has occurred. Sodium hydroxide solution is not classified as a marine pollutant by DOT.

DuPont has considered, as part of the routing analysis, the potential exposure to people or the environment. As will be discussed later, the risk of an accident with or without a release of NCH is very low. Likewise, NCH may pose moderate hazard to persons immediately in the vicinity of a spill, but is very unlikely to have wide-reaching effects. Overall the expected impacted area and consequences due to a spill are low and no different than those from spills of other caustic materials.

In the unlikely event of a release of NCH during transportation, the speed and effectiveness of emergency response actions can be critical in minimizing the consequences of the event. DuPont has an extensive program –known as our Integrated Emergency Response (IER) Plan - for assessing and responding to any off-site incidents that may occur in transportation. We are one of the few chemical manufacturing companies in industry that has highly trained in-house emergency response *teams, each with response vehicles fully stocked with state of the art equipment, available to respond to emergencies 24/7. DuPont's Belle, WV production facility is the location of the 24-hour Emergency Response Center; 6 other fully equipped teams are located across the United States. Details of this program, and how it will be applied to the NECDF shipments, are provided in a later section of this report.*

Application of Risk Principles to Route Analysis

The principles discussed above were used to assess routes for the proposed transport of NCH from Newport, Indiana to DuPont's treatment facility in Deepwater, NJ. There are sometimes trade-offs between different risk functions, however, some general principles that were applied in the evaluation were to:

- Reduce the number of trips
- Reduce the length of the trip and transit time
- Reduce the potential for accidents by using the highest quality road or track (for road, limited access, divided highway; for rail, mainline track maintained to Class 4 or higher)
- Reduce the potential for population exposure, heavy traffic density, and congestion by using bypasses around population centers whenever possible
- Reduce exposure to streams, rivers, reservoirs, and other water bodies to the extent possible
- Consider the speed of emergency response should an incident occur

The 4 most logical highway routes, utilizing limited access, divided highway to the greatest extent, were identified and analyzed. Additionally, an intermodal rail service from Chicago, Illinois to Morrisville, Pennsylvania was analyzed, along with the associated truck movements (drays) to move the ISO tanks to and from the intermodal rail terminals. VRiskMap, a commercially available Geographic Information System offered by Visual Risk Technologies (Nashville, TN), was used to generate routes and produce associated data.

Highway routes that would be restricted to hazardous materials shipments, such as through tunnels, were not considered. As an example, use of the Pennsylvania Turnpike was excluded.

A tank size of 5000 gallons was used for all analyses, which would result in approximately 758 trips for NCH produced using an 8% loading rate, and 359 trips for a 16% loading rate. At this time, the number of shipments that will be made per day or week is not known, but is expected to be up to two per day.

A summary comparison of the 4 truck routes is shown in Table 1, with details on the routes in Tables 2 – 5. A summary of the intermodal truck-rail route is shown in Table 6. Figures 1 and 2 display the highway and rail routes, respectively. Table 7 presents a summary comparison of the five routes in terms of mileage and estimated transit time. The shortest highway route is Route #3, so it was used for comparison to other routes. Route #4 is approximately 4% longer, route #2 is 15% longer, and Route #1 is 30% longer. Route #5 is the highway-rail intermodal rate, and is the longest (40% longer than Route #3). Estimated transit times for the direct highway routes are based on an average speed of 45 miles per hour. The transit time for the highway-rail intermodal rate is influenced by 3 factors: the highway moves to and from the rail terminals, the delays anticipated at the rail terminals when dropping off or picking up a container, and the rail transit itself. It is estimated that the intermodal option will take at least twice the time from pickup at NECDF to delivery at DuPont's SET facility as will highway route #3.

Tables 8 and 9 present estimates on the number of statistically expected accidents for the entire project duration, based on the loading rate used, for the highway and rail options[7]. These figures represent the number of accidents expected due to the highway or rail movement itself, not due to the presence of hazardous materials. Calculations are based on the round-trip mileage for each route.[8] Actual accident rates for the two pre-qualified truck carriers and the railroad carrier were obtained and used in these calculations.

Of the two truck carriers, the higher rate of 0.36 accidents per million miles was used, in order to provide a conservative (high) estimate. This rate was based on over 5 million miles of travel in 2003. It should be noted that this rate is far lower than would be expected for large truck operations in general,[9] and is due to the excellent safety programs, including driver selection, required of DuPont approved carriers.

For rail, the railroad carrier's 2003 mainline accident rate of 1.06 accidents per million train miles was used. The majority of the track from Chicago to Morrisville is mainline track. Express intermodal service bypasses yard stops and train configuration changes, which could increase the accident rate.

[7] It is important to note that these predictions, and others made in this report, are not guarantees, but are calculated estimates that are most useful for making relative comparisons between the various options.
[8] Since up to 2 ISO tanks might be shipped per train, the number of trips required (for the rail portion only), and therefore the expected number of accidents, could be halved. However, since the number of shipments per day has not yet been established, the analysis was performed assuming the full number of trips with 1 ISO tank per train.
[9] Estimates vary, but up to 2 accidents per million miles have been proposed for large truck operations.

For highway, the additional fatalities and injuries that might be expected as a result of the movement across each route are also presented in Table 8. For rail, since the train would be operated regardless of NECDF shipments, additional fatalities and injuries resulting from train accidents are not calculated.

For all routes, highway and rail, it can be seen that the chance of an accident over the course of the NECDF shipments, with either a loaded or empty container, is very small. Far less than one fatality or injury for any of the highway routes would be expected**, and these estimates represent the result of the accident, not of any NCH release.** For example, for the longest highway route (#4), only one-tenth of an injury and less than one one-hundredth of a fatality would be expected for the highest number of trips. Put another way, there is less than a 1 in 1,000 chance of an accident per trip and less than a 1 in 130,000 chance of a fatality due to an accident (not due to NCH) per trip. To put these numbers in perspective, over 130 fatal accidents occurred in Delaware during 2003, and from January 1st through February 17th, already 15 fatal accidents have occurred.

As noted above, Tables 8 and 9 do not involve the presence or absence of hazardous materials, but are used to estimate any added burden on society due to the mere occurrence of the NECDF shipments. Tables 10 and 11 analyze the chance of having an accident with a loaded trailer or ISO tank of NCH, and the chance that the tank would release some or all of its contents as a result of that accident. Since only loaded trailers are of interest, one-way mileage is used in the estimates.

For the direct highway shipments, a release probability (assuming that the trailer is involved in an accident) of 20% is used. Accurate data to predict release probabilities are not available, and would depend on the exact container being used, but 20% is felt to be a very conservative estimate, based on historical data and the design of the equipment. For rail shipments, the impact forces during a derailment can be much higher than expected for highway accidents, and therefore the release probability was increased to 40%. This again is a very conservative estimate that is likely to over-estimate the chance of a release.

The number of accidents or releases expected with a loaded tank of NCH by any route is seen to be very low, again well below 1 accident or release expected over the entire number of shipments. With a loaded tank truck, for example, there is roughly a 1 in 3,000 chance of an accident per trip or a 1 in 13,000 chance of a release of product per trip, using the highest estimates. These are very low odds of a problem during shipment of NCH.

Table 12 presents a summary comparison of all routes, and Table 13 presents the percent difference for each factor as compared to the base comparison routes. Included in these tables are population counts within a 1/2 mile corridor along the route, and two environmental metrics – the number of times the route crosses a stream (or river), a lake, or a reservoir, as well as the total mileage of each route that is within 1/10 of a mile (on either side of the route) of one of these bodies of water.

For the direct highway routes, population in a one-half mile corridor around the route was roughly equivalent for the 3 "Southern" routes. For the "Northern" truck route (#1), the population was somewhat higher (29%) than the baseline route #4, due primarily to travel through Northern New Jersey. For the highway-rail intermodal route, the population was over twice (216%) of that for route #4. This is primarily due to the very dense population in the Chicago and Cleveland areas. These population figures do not mean that this many persons would be injured, evacuated, or otherwise affected by a release during transport. They are simply used to make relative comparisons between the routes.

With the exception that Route #1 (the Northern highway route) had significantly fewer water crossings or miles in close proximity to water, there were not remarkable variation in the environmental metrics across the various routes.

Summary of Route Analysis

All of the direct highway options use high quality, limited access, divided highway for the entire route (except for the 23 miles on State Route 63 in Indiana used to access the Interstate system from the NECDF). While the various options differ in some characteristics, they all result in a very low chance (less than one) of an accident or release over the *entire duration* of the NECDF shipments. Given the extremely low chance of an accident or release, combined with the low expected consequences of a spill to either persons or the environment, all routes would be considered acceptable for transport of this material.

The rail intermodal route is the longest in terms of miles and transit time, has the largest potential population exposure, and involves the most handling. The ISO tanks would need to be loaded onto a truck chassis at NECDF, unloaded unto a train flat car in Chicago, and loaded back onto a truck chassis at Morrisville. Additional handling provides some opportunity for additional accidents, but this is difficult to quantify and is expected to be low. Overall, the expected number of accidents or releases, and the expected consequences of a release, are still very low for the intermodal option.

Additionally, all of the evaluated routes are in reasonable proximity to several of DuPont's Integrated Emergency Response (IER) teams. including those located in Belle, WV, Parkersburg, WV, Niagara Falls, NY, Edgemoor, DE, and Deepwater, NJ., providing excellent emergency response coverage.

DuPont teams will be available to provide guidance to local emergency responders as well as to assist on-scene as needed. Most local hazardous material emergency response teams are capable and equipped to respond to incidents involving corrosive materials. As noted later, a detailed emergency response plan will be developed and shared with individual states along the route, including outreach to local responders.

Emergency Response Coverage

Primary emergency response coverage for the NCH shipments will be provided under DuPont's Integrated Emergency Response Plan (IERP). As described earlier, DuPont has an extensive program for assessing and responding to any off-site incidents that may occur in transportation. The function of this program is to assist with off-site chemical emergencies where DuPont knowledge, personnel, and experience can be rapidly deployed to the emergency scene. The IERP structure allows DuPont to respond with over 100 OSHA qualified technicians, a mobile Command Center, and state of the art response equipment (capping kits, transfer pumps, hand tools, protective equipment, etc).

The Emergency Response Center (ERC) and IER team in Belle, WV, and the Chambers Works IER team in Deepwater, NJ, will be the regional response service centers supporting the shipments of NCH. The following outlines the DuPont Emergency Response process:

- Notification
  - Truck carrier, railroad, or local emergency official notifies CHEMTREC of an incident (accident, spill, etc.) involving an NCH shipment[10]
  - CHEMTREC notifies DuPont ERC in Belle, WV, triggering the DuPont response
  - ERC notifies SET Chambers Works operations
  - ERC contacts the External Affairs Emergency Communication Coordinator for communications support

[10] CHEMTREC is a service of the American Chemistry Council where callers can report incidents and request assistance. Upon such a call, CHEMTREC retrieves the MSDS and notifies the shipper of the incident. The toll-free CHEMTREC number will be listed as the emergency response contact on all shipping documents. The NCH Material Safety Data Sheet (MSDS), Waste Characterization Profile Sheet (WCPS), and shipper contact information will be provided to CHEMTREC.

- Responsibility
  - Once notified, SET Chambers Works operations personnel ensure that an appropriate response to the incident occurs, following a formal written emergency response plan.
- Early Contact
  - SET Chambers Works personnel will contact responsible people at the scene, carrier/rail representatives, and local emergency response leaders. The purpose of this contact is to ensure understanding of the incident, provide initial information and advice, and arrange for continual contact with scene.
- Coordination and Implementation of the Response
  - ERC personnel will assist in the coordination and implementation of the response as the situation requires. Appropriate on-scene advisors and response teams will be deployed as necessary.

Specification of Additional Operational Measures to Help Ensure Safe and Secure Transport

DuPont will require several additional operational measures that will further increase the safety and security of these shipments. Some of these have been mentioned earlier in the report, but are added again here for emphasis.

- Team drivers will be used for direct highway shipments. Use of team drivers will expedite the shipment by preventing (or reducing) layovers, and will provide a security benefit in that the truck will not be left unattended during routine stops. Additionally, in the case of an accident or other problem en-route, the two drivers will be able to coordinate activities for more effective action.
- Drivers and equipment – tractors, trailers, ISO tanks, and chassis - will be dedicated to this project. Drivers will be trained in the characteristics and hazards of the material, as well as in the emergency response communication and management procedures. An adequate number of drivers will be trained so that if additional coverage is necessary (due to illness, vacation, etc.), replacement drivers will be readily available.
- Trucks being used to transport NCH will be equipped with cell phones as well as two-way Global Positioning Systems (GPS). Both methods will allow the drivers to keep in close communication with the company dispatchers. GPS will also allow the location of the unit to be tracked.

- Tank trucks and ISO tanks will be sized such that they can be shipped nearly full (5 – 10% outage). Tanks that are filled 50 - 75% full are more susceptible to surge forces during starting, stopping, or turning.
- Bottom outlet valves shall be equipped with remotely actuated internal valves in addition to the external valve. The internal valve shall be protected from damage due to external forces by use of a shear section or sacrificial device.
- ISO tanks shipped by highway will be transported only on low-boy (tank) chassis.
- For ISO tanks to be shipped by rail, an upgraded construction specification will be considered.
- Detailed procedures and checklists will be used for loading and unloading.
- Seals will be applied to both loaded and empty (residue) trailers prior to shipment.
- A detailed emergency response plan will be developed, including plans for emergency communication as well as recommended spill mitigation procedures and personal protective equipment (PPE). This plan will be discussed and shared with carrier personnel, states along the selected route(s), and, to the extent possible, larger municipal hazardous material teams along the selected route(s). Additionally, a process to keep contact information up-to-date will be designed and implemented
    - Drivers for the two pre-qualified truck carriers will be trained to OSHA 29 CFR 1910.120 emergency response standards, to at least the First Responder Awareness Level.
    - Drivers will receive detailed instruction in what actions to take if there is a spill of NCH while en-route, and be trained to the OSHA level required to take that action
    - Trucks will be equipped with all of the necessary PPE for actions expected of the driver to be performed safely.

Conclusions

Based on this transportation safety assessment, NCH does not pose any unique or new concerns in transportation. No nerve agent will be transported since all nerve agent will be destroyed at NECDF and transformed into caustic wastewater. The hazard of NCH – its corrosive nature – is similar to many other materials shipped daily in the U.S. and throughout the world. The chance of having an accident or release during the entire course of the NCH shipments is very low. The hazards from a spill would be restricted to the immediate area. The potential routes, carriers, transportation equipment, and additional safety measures were carefully selected to even further reduce that risk. NCH can be shipped safely, securely, and with very minimal risk to the public or the environment.

TABLES

Table 1: Summary Comparison of Four Evaluated Highway Routes from NECDF, Newport, Indiana, to DuPont SET facility, Deepwater, New Jersey[11]

Route Attribute	Route #3	Route #4	Route #2	Route #1
One-way mileage	782.65	813.84	899.25	1015.23
Distance traveled in each state:				
Indiana	184.49	190.69	214.40	294.88
Ohio	230.64	255.63	0	237.08
Pennsylvania	54.65	54.65	0	310.87
Kentucky	0	0	189.93	0
West Virginia	57.64	57.64	239.69	0
Maryland	237.95	237.95	237.95	0
Delaware	16.28	16.28	16.28	0
New Jersey	1.00	1.00	1.00	172.40
Total population within ½ mile of route	371,701	368,801	371,826	475,112
Total population within 1/2 mile of route by state:				
Indiana	82,563	67,364	87,033	79,385
Ohio	103,162	115,461	0	98,790
Pennsylvania	15,663	15,663	0	31,192
Kentucky	0	0	57,003	0
West Virginia	18,664	18,664	76,141	0
Maryland	133,956	133,956	133,956	0
Delaware	17,607	17,607	17,607	0
New Jersey	86	86	86	265,745

[11] Population estimates presented in this table are from the 2000 Census data.

Table 2: Route #3 Directions		
Road Name	**Direction**	**Miles**
Indiana State Road 63	North	23.42
Interstate 74	East	69.08
Interstate 465 (Bypass around Indianapolis)	South East	25.10
Interstate 70	East	159.90
Interstate 270 (Bypass around Columbus)	South East	20.84
Interstate 70	East	148.53
Interstate 79	South	48.79
Interstate 68	East	111.86
Interstate 70	East	90.91
Interstate 695 (Bypass around Baltimore)	North East	21.44
Interstate 95	North East	55.68
Interstate 295	North East	7.10
Total Mileage		782.65

Table 3: Route #4 Directions		
Road	**Direction**	**Miles**
Indiana State Road 63	North	23.42
Interstate 74	East	69.08
Interstate 465 (Bypass around Indianapolis)	South East	20.25
Interstate 74	South East	83.82
Interstate 275 (Bypass around Cincinnati)	North East	24.18
Interstate 71	North East	84.28
Interstate 270	East	24.5
Interstate 70	East	148.53
Interstate 79	South	48.79
Interstate 68	East	111.86
Interstate 70	East	90.91
Interstate 695 (Bypass around Baltimore)	North East	21.44
Interstate 95	North East	55.68
Interstate 295	North East	7.10
Total Mileage		813.84

Table 4: Route #2 Directions		
Road	**Direction**	**Miles**
Indiana State Road 63	North	23.42
Interstate 74	East	69.08
Interstate 465 (Bypass around Indianapolis)	South East	15.76
Interstate 65	South	106.81
Interstate 71	North East	6.08
Interstate 264	South East	3.98
Interstate 64	East	237.87
Interstate 77	East	1.94
Interstate 79	North East	147.32
Interstate 68	East	111.86
Interstate 70	East	90.91
Interstate 695 (Bypass around Baltimore)	North East	21.44
Interstate 95	North East	55.68
Interstate 295	North East	7.10
Total Mileage		827.96

Table 5: Route #1 Directions		
Road	**Direction**	**Miles**
Indiana State Road 63	North	23.42
Interstate 74	East	69.08
Interstate 465 (Bypass around Indianapolis)	North East	20.72
Interstate 69	North	96.53
Interstate 469 (Bypass around Fort Wayne)	North	31.11
Interstate 69	North	40.83
Interstate 80 (Ohio Turnpike)	East	607.56
Interstate 280	East	17.0
Interstate 95 (New Jersey Turnpike)	South	108.39
New Jersey State Road 140	West	0.59
Total Mileage		1015.23

Table 6: Summary Report of Evaluated Truck-Rail Intermodal Route (Route #5) from NECDF, Newport, Indiana, to DuPont SET facility, Deepwater, New Jersey[12]

Route Attribute	*Dray* NECDF to Chicago, IL	*Rail* Chicago, IL to Morrisville, PA	*Dray* Morrisville, PA to Deepwater, NJ	*Total*
One-way mileage	67.22	834.04	196.39	1097.66
Distance traveled in each state:				
Illinois	168.73	9.60	0	178.33
Indiana	27.67	152.59	0	180.26
Ohio	0	261.37	0	261.37
Pennsylvania	0	410.48	10.12	420.6
New Jersey	0	0	57.10	57.1
Total population within ½ mile of route	160,836	939,519	63,391	1,163,746
Total population within 1/2 mile of route by state:				
Illinois	159,972	88,596	0	248,568
Indiana	864	133,143	0	134,007
Ohio	0	263,589	0	263,589
Pennsylvania	0	454,191	18,591	472,782
New Jersey	0	0	44,800	44,800

[12] Population estimates presented in this table are from the 2000 Census data.

Table 7: Expected Transit Times and Percent Differences between Route #3 (Shortest Duration Comparison Route) and Other Routes				
Route	**One-Way Mileage**		**Expected Transit Time (hours)[13]**	
Route #3	**782.65**		**17**	
Route #4	**813.84**	**+4%**	**18**	**+6%**
Route #2	**899.25**	**+15%**	**20**	**+18%**
Route #1	**1015.23**	**+30%**	**23**	**+35%**
Route #5	**1097.66**	**+40%**	**33**	**+94%**

[13] For direct highway transport, estimated time was calculated assuming an average speed of 45 mph. For Route 5, the railroad estimates 26 hours for the Chicago to Morrisville intermodal service. The estimated time for the highway (dray) moves was based on an average speed of 45 mph; added to this was 2 hours spent at each intermodal terminal to drop off or pick up the container. These are considered minimum estimates, and are presented for relative comparison.

Figure 1: Map of Four Potential Highway Routes

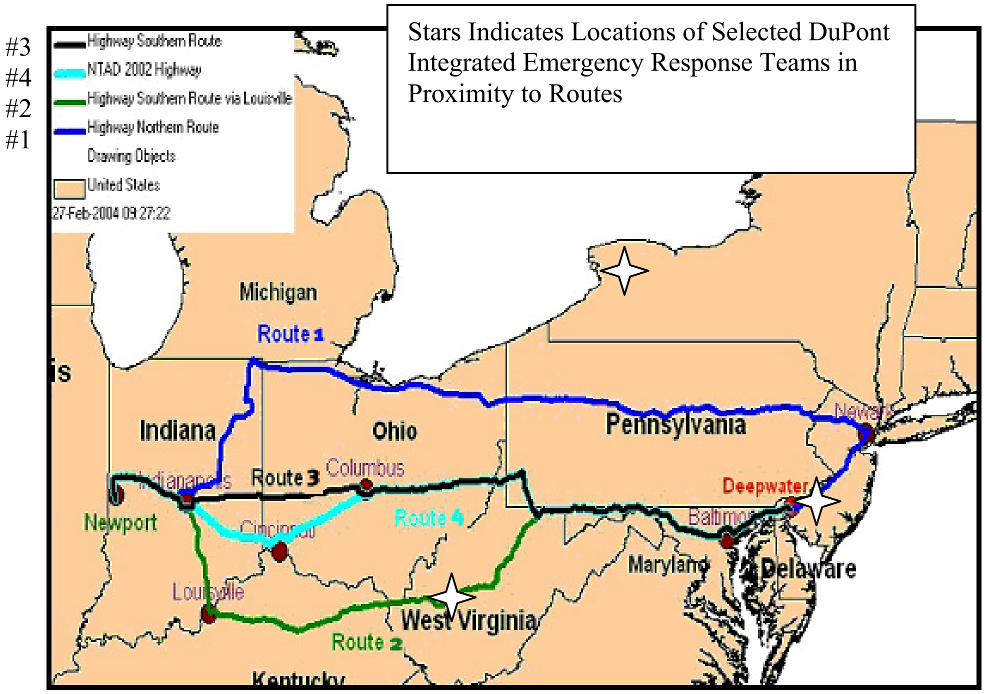

Figure 2: Map of Potential Highway-Rail Intermodal Route (#5)

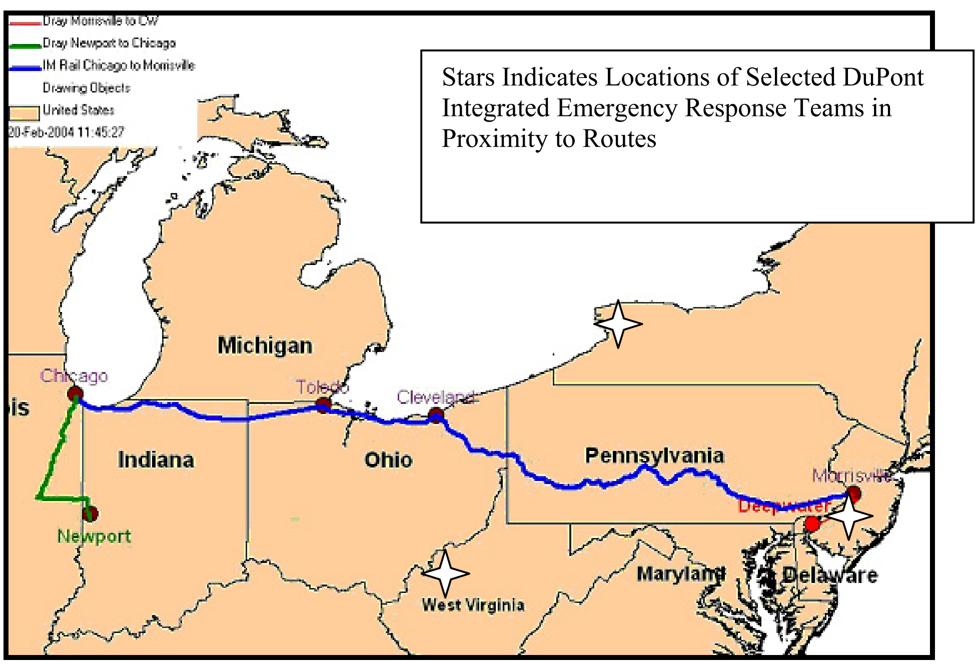

Table 8: Statistically Expected Accidents During the Highway Transport of NCH from NECDF, Newport, Indiana, to DuPont SET, Deepwater, NJ

Neutralization Loading Rate	Quantity of NCH Generated (gallons)	Number of Trips Required[14]	One-Way Mileage	Accident Rate per Million Miles[15]	Expected Number of:		
					Accidents for Both Loaded and Empty Trips	Fatalities Due to Crash[16] (Round Trip)	Injuries Due to Crash[3] (Round Trip)
Route #3:							
8%	3,600,000	758	782.65	0.36	0.43	0.0043	0.0903
16%	1,800,000	379			0.21	0.0021	0.0441
Route #4							
8%	3,600,000	758	813.84	0.36	0.44	0.0044	0.0924
16%	1,800,000	379			0.22	0.0022	0.0462
Route #2							
8%	3,600,000	758	899.25	0.36	0.49	0.0049	0.1029
16%	1,800,000	379			0.24	0.0024	0.0504
Route #1							
8%	3,600,000	758	1015.23	0.36	0.55	0.0055	0.1155
16%	1,800,000	379			0.28	0.0028	0.0588

[14] Assuming 5,000 gallon tank and 5% outage.
[15] Actual DOT recordable accident rates were collected from the two pre-qualified truck carriers. The accident rate per million miles for the carrier with the higher rate was chosen for analysis, in order to be conservative.
[16] The DOT estimates that approximately 1% of all large truck crashes involve at least one fatality, and approximately 21% result in at least one injury. These estimate are not related to the presence or absence of hazardous materials. It simply estimates the added number of fatalities or injuries due to the actual operation of the truck across this route, either loaded or empty.

Table 9: Statistically Expected Accidents During the Intermodal Transport of NCH from NECDF, Newport, Indiana, to DuPont SET, Deepwater, NJ (Route #5)

Neutralization Loading Rate	Quantity of NCH Generated (gallons)	Number of Trips Required[17]	One-Way Mileage	Accident Rate per Million Miles	Expected Number of:			
					Accidents for Both Loaded and Empty Trips		Fatalities Due to Crash (Round Trip)[18]	Injuries Due to Crash (Round Trip)
Highway Dray Newport to Chicago								
8%	3,600,000	758	196.39	0.36[19]	0.11		0.0011	0.0231
16%	1,800,000	379			0.05		0.0005	0.0105
Highway Dray Morrisville to Deepwater								
8%	3,600,000	758	67.22	0.36[3]	0.04		0.0004	0.0084
16%	1,800,000	379			0.02		0.0002	0.0042
Rail Transport Chicago to Morrisville								
8%	3,600,000	758[20]	834.05	1.06[21]	1.34	(*Mainline Train Derailments*)	Not Applicable[22]	
16%	1,800,000	379			0.67			
Total								
8%	3,600,000	758	1097.66	Not Applicable	1.49		0.0015	0.0315
16%	1,800,000	379			0.74		0.0007	0.0147

[17] Assuming 5,000 gallon tank and 5% outage.

[18] The DOT estimates that approximately 1% of all large truck crashes involve at least one fatality, and approximately 21% result in at least one injury. These estimate are not related to the presence or absence of hazardous materials. It simply estimates the added number of fatalities or injuries due to the actual operation of the truck across this route, either loaded or empty.

[19] Actual DOT recordable accident rates were collected from the two pre-qualified truck carriers. The accident rate per million miles for the carrier with the higher rate was chosen for analysis, in order to be conservative.

[20] If two ISO tanks are shipped per train, the number of trips and therefore the expected number of train accidents would be halved.

[21] Data represents the railroad's train derailment rate on mainline track, for Jan. through Nov. 2003. Since the majority of the intermodal service track is mainline, this rate is applied to the entire mileage. The chance of any particular car on the train derailing would be a fraction of this rate.

[22] Fatalities or injuries to the public due to mainline train derailments are not recorded by DOT, but are expected to be quite rare. Most fatalities or injuries to the public associated with freight train movements are due to accidents at highway-rail crossings. Because the railroad carrier would operate this intermodal train regardless of the presence of any NCH containers on board, there are no additional fatalities or injuries expected due to NCH shipments.

Table 10: Statistically Expected Releases During the Highway Transport of NCH from NECDF, Newport, Indiana, to DuPont SET, Deepwater, NJ						
Neutralization Loading Rate	**Quantity of NCH Generated (gallons)**	**Number of Trips Required[23]**	**One-Way Mileage**	**Accident Rate per Million Miles[24]**	**Accidents Expected for Total Loaded Trips**	**Releases Expected for Total Loaded Trips[25]**
Route #3:						
8%	**3,600,000**	**758**	**782.65**	**0.36**	**0.21**	**0.0420**
16%	**1,800,000**	**379**			**0.11**	**0.0220**
Route #4						
8%	**3,600,000**	**758**	**813.84**	**0.36**	**0.22**	**0.0440**
16%	**1,800,000**	**379**			**0.11**	**0.0220**
Route #2						
8%	**3,600,000**	**758**	**899.25**	**0.36**	**0.25**	**0.0500**
16%	**1,800,000**	**379**			**0.12**	**0.0240**
Route #1						
8%	**3,600,000**	**758**	**1015.23**	**0.36**	**0.28**	**0.0560**
16%	**1,800,000**	**379**			**0.14**	**0.0280**

[23] Assuming 5,000 gallon tank and 5% outage.
[24] Actual DOT recordable accident rates were collected from the two pre-qualified truck carriers. The accident rate per million miles for the carrier with the higher rate was chosen for analysis, in order to be conservative.
[25] Detailed release probabilities for tank trucks or ISO tanks shipped by highway are not available. However, a conservative estimate based on previous studies and unpublished data is that 20% of highway accidents involving tank trucks or ISO tanks of similar design to those proposed for the movement of NCH would result in a spill of some size (large or small).

Table 11: Statistically Expected Releases During the Intermodal Transport of NCH from NECDF, Newport, Indiana, to DuPont SET, Deepwater, NJ (Route #5)

Neutralization Loading Rate	Quantity of NCH Generated (gallons)	Number of Trips Required[26]	One-Way Mileage	Accident Rate per Million Miles[27 28]	Accidents Expected for Total Loaded Trips[29]	Releases Expected for Total Loaded Trips[4 30 31]
Highway Dray Newport to Chicago						
8%	3,600,000	758	196.39	0.36	0.0536	0.0107
16%	1,800,000	379			0.0268	0.0054
Highway Dray Morrisville to Deepwater						
8%	3,600,000	758	67.22	0.36	0.0183	0.0037
16%	1,800,000	379			0.0092	0.0018
Rail Transport Chicago to Morrisville						
8%	3,600,000	758	834.05	0.16	0.1011	0.0404
16%	1,800,000	379			0.0506	0.0202
Total						
8%	3,600,000	758	1097.66	0.36 Truck 0.16 Rail	0.1730	0.0548
16%	1,800,000	379			0.0866	0.0274

[26] Assuming 5,000 gallon tank and 5% outage.
[27] Actual DOT recordable accident rates were collected from the two pre-qualified truck carriers. The accident rate per million miles for the carrier with the higher rate was chosen for analysis, in order to be conservative.
[28] Based on historical data, approximately 15% of the cars involved in a mainline rain accident are expected to be involved. Therefore 15% percent of the railroad's mainline train derailment rate of 1.06 per million miles was used to estimate the chance of an NCH container derailing (0.16 cars derailments per million car miles).
[29] If two ISO tanks are shipped per train, the number of trips and therefore the expected number of accidents (for the rail portion only) would be halved, but the car derailment probability per million car miles would be doubled. Therefore shipment of two tanks per train would not change the expected number of releases over all shipments.
[30] Detailed release probabilities for tank trucks or ISO tanks shipped by highway are not available. However, a conservative estimate based on previous studies and unpublished data is that 20% of highway accidents involving tank trucks or ISO tanks of similar design to those proposed for the movement of NCH would result in a spill of some size (large or small).
[31] Detailed release probabilities for ISO tanks shipped by rail are not available. However, the forces in a train derailment are expected to be greater than those in a highway accident. Therefore, the expected release probability of a spill of some size (large or small) was doubled to 40%. This assumes that the ISO tank specification used for rail is equivalent to that used for highway.

Table 12: Summary Table of Route Options

Neutralization Loading Rate	Number of Trips Required[32]	One-Way Mileage	Accidents Expected for Total Loaded Trips	Releases Expected for Total Loaded Trips[33 34 35]	Population Within 1/2 Mile of Route	Stream, Lake, or Reservoir Crossing	Water "Exposure" Metric (Miles)
Route #3							
8%	758	782.65	0.21	0.0420	371,701	166	38.80
16%	379		0.11	0.0220			
Route #4							
8%	758	813.84	0.22	0.0440	368,801	169	37.54
16%	379		0.11	0.0220			
Route #2							
8%	758	899.25	0.25	0.0500	371,826	217	44.83
16%	379		0.12	0.0240			
Route #1							
8%	758	1015.23	0.28	0.0560	475,112	124	15.68
16%	379		0.14	0.0280			
Route #5							
8%	758	1097.66	0.17	0.0548	1,163,746	273	44.79
16%	379		0.09	0.0274			

[32] Assuming 5,000 gallon tank and 5% outage.
[33] Detailed release probabilities for tank trucks or ISO tanks shipped by highway are not available. However, a conservative estimate based on previous studies and unpublished data is that 20% of highway accidents involving tank trucks or ISO tanks of similar design to those proposed for the movement of NCH would result in a spill of some size (large or small).
[34] Detailed release probabilities for ISO tanks shipped by rail are not available. However, the forces in a train derailment are expected to be greater than those in a highway accident. Therefore, the expected release probability of a spill of some size (large or small) was doubled to 40%. This assumes that the ISO tank specification used for rail is equivalent to that used for highway.
[35] If two ISO tanks are shipped per train, the number of trips and therefore the expected number of accidents (for the rail portion of route #5 only) would be halved, but the car derailment probability per million car miles would be doubled. Therefore shipment of two tanks per train would not change the expected number of releases over all shipments.

Table 13: Percent Differences between Routes Versus Baseline Comparison Criteria [36]

Route	One-Way Mileage		Accidents Expected for Total Loaded Trips		Releases Expected for Total Loaded Trips[37 38]		Population Within 1/2 Mile of Route		Stream, Lake, or Reservoir Crossing		Water "Exposure" Metric (Miles)[39]	
Route #3	782.65		0.21	+21%	0.0420		371,701	+.01%	166	+33%	38.80	+147%
Route #4	813.84	+4%	0.22	+27%	0.0440	+5%	368,801		169	+36%	37.54	+139%
Route #2	899.25	+15%	0.25	+45%	0.0500	+19%	371,826	+.01%	217	+75%	44.83	+186%
Route #1	1015.23	+30%	0.28	+62%	0.0560	+33%	475,112	+29%	124		15.68	
Route #5	1097.66	+40%	0.173		0.0548	+30%	1,163,746	+216%	273	+120%	44.79	+185%

[36] Using 8% neutralization loading rate.
[37] Detailed release probabilities for tank trucks or ISO tanks shipped by highway are not available. However, a conservative estimate based on previous studies and unpublished data is that 20% of highway accidents involving tank trucks or ISO tanks of similar design to those proposed for the movement of NCH would result in a spill of some size (large or small).
[38] Detailed release probabilities for ISO tanks shipped by rail are not available. However, the forces in a train derailment are expected to be greater than those in a highway accident. Therefore, the expected release probability of a spill of some size (large or small) was doubled to 40%. This assumes that the ISO tank specification used for rail is equivalent to that used for highway.
[39] The water exposure metric measures the total length of the route where a water body (stream/river, lake, and/or reservoir) is present within a 0.2 mile corridor of the route (i.e. 0.1 mile on either side of route). Direct crossing of the water body is not necessary.