2. METHODOLOGY

The methodology for this study involved five major tasks: (1) comprehensive literature review; (2) data solicitation and compilation; (3) dataset development; (4) analysis; and (5) reporting.

2.1 Literature Review

A literature review was conducted to examine the available data, published reports, plans, regulations, and guidance relating to hazardous materials transportation and storage statewide. Appendix D contains a complete list of all literature reviewed for this study.

2.2 Data Solicitation and Compilation

The first step in compiling the data required to conduct this study was to generate a list of agency and industry contacts that might be able to provide datasets or other information for use in completing this study. In total, 135 individuals and organizations were identified as potential information sources to support the completion of this Hazardous Materials Commodity Flow Study.

Contact and information requests took the form of phone calls, emails and Freedom of Information Act Requests (Appendix B). Of the 135 potential information sources identified, approximately 76% were successfully contacted; of those successfully contacted, approximately 67% were responsive, providing some data that was of use to the development of this study. Of those parties that responded to information requests, nine respondents provided the majority of the data for this report. Table 2-1 summarizes the key data sources, and Appendix C provides a complete list of the potential information sources contacted and their responsiveness.

Table 2-1. Summary of Key Data Sources

Information Source	Data Provided	Comments
Carlile Transportation Systems	Hazardous material shipments for 2005 through 2009 totaling over 88,000 lines of data (highway, marine and air).	Data included hazardous materials shipped via highway, marine and air modes.
Alaska West Express	Hazardous Material Traffic Analysis for 2009.	Useful report that contributed to the development of this study.
Alaska Railroad Corporation	Hazardous material shipments for 2007 through 2009. The dataset included information for movement of over 160,000 railcar hazardous material units.	To control the number of discreet line item entries, shipments were grouped and volumes shipped determined.
U.S. Coast Guard[14]	Facility and Vessel hazardous material	Much of the data was incomplete lacking

[14] It should be noted that the response from the United States Coast Guard (Headquarters response to the Freedom of Information Act Request dated March 22, 2010) was incomplete and did not address the information requested. As noted above, spill data extracted from the Marine Information Safety and Law Enforcement System (MISLE) database was provided in lieu of any hazardous materials facility specific or vessel transportation information. While somewhat useful, the response did not address what was requested.

Information Source	Data Provided	Comments
	release data for 2005 through 2009, over 1200 entries.	dates, or was below the 1 barrel threshold and therefore was not included in the dataset.
U.S. Coast Guard Marine Safety Unit Valdez	Facility information for six (6) facilities including geo-spatial data and commodities stored.	Data useful in helping validate completeness of Tier Two Report data.
U.S. Coast Guard Sector Anchorage	Facility information for 296 facilities including geo-spatial data and commodities stored.	Data useful in helping validate completeness of Tier Two Report data.
Totem Ocean Trailer Express	Marine shipping information (total volume shipped) for U.S. Coast Guard regulated commodities for 2007 through 2009 (chlorine only).	Data useful as it addressed what appeared to be a significant gap/difference in EHS commodities shipped from the 2005 report.
Air Cargo Carrier[15]	Total hazardous material shipments for 2007 through 2009, over 13,000 data entries.	This carrier is one of 22 carriers (cargo and passenger) that operate out of Anchorage.
Environmental Protection Agency	Tier Two Facility data for 2008 including over 4,000 entries covering commodities stored within the State.	Data useful in helping validate completeness of shipping information.

2.3 Dataset Development

The Hazardous Material Commodity Flow Study Dataset analyzed in this report began as more than 100,000 entries, had significant gaps in data completeness, and varied greatly in format and detail. In many cases, line entries were missing UN/NA Identification numbers, CAS Numbers, Hazard Classifications, and/or a definitive Hazardous Material Name. To the extent possible, these gaps were filled using the on-line CAMEO database[16] and Material Safety Data Sheets (MSDS).

One of the primary challenges with evaluating and compiling the dataset included the inability to effectively provide comprehensive data quality assurance/quality control (QA/QC). While QA/QC measures were implemented throughout the period of this study, questions of data integrity came up that were difficult, if not impossible, to validate. In one case, a several order of magnitude jump in the volume of a particular hazard class shipment was observed between 2007 and 2008, and then a near equivalent drop was observed between 2008 and 2009. Given the size of this jump and subsequent reduction, this entry was suspected to be a data entry error on the part of the information source. Unfortunately, lacking the cognizant company's ability to trace back through hundreds of thousands of shipping records, there was no confident method to adjust or validate the data entry. As such, these issues were noted as appropriate.

[15] Air Carrier preferred to not be identified for proprietary business concerns.
[16] http://cameochemicals.noaa.gov/search/simple

Once the dataset had been supplemented, it was scoped down to control data quality and allow for comparative analysis:

- Data from the years 2007, 2008, and 2009 were selected to ensure there was consistent coverage between the various data sources; all other years were excluded from the dataset. Entries without date information were also eliminated from the dataset.[17]
- The dataset was scoped to only include those items that met a minimum volume threshold value, which was set at 1 barrel (42 gallons, or 351 pounds) for all HS substances.[18] EHS chemicals were all retained in the dataset regardless of volume.
- Like entries of hazardous material commodities being transported via the same mode and between the same origin and destination cities within the same timeframe (e.g. same year) were combined and a single total volume shipped was determined[19] to limit the number of discreet line item entries. For example, three shipments of HC 3.0 (Flammable Liquid Materials) commodities with UN ID Number 1267 (Petroleum Crude Oil), transported via the highway from Anchorage to Fairbanks in 2008 would be combined into a single entry totaling the volumes of all three entries.
- Fixed facility information was removed from the dataset (although retained for inclusion in this report).

The conversion of the hazardous materials commodity flow data from an Excel spreadsheet into an ACCESS Database enabled simplified data entry, data query, report generation, and data maintenance. Future studies could build upon this database to enable analysis across larger year classes. Figure 2-1 shows an example of a data record from the ACCESS Database.[20] Appendix A contains a table with the complete data set.

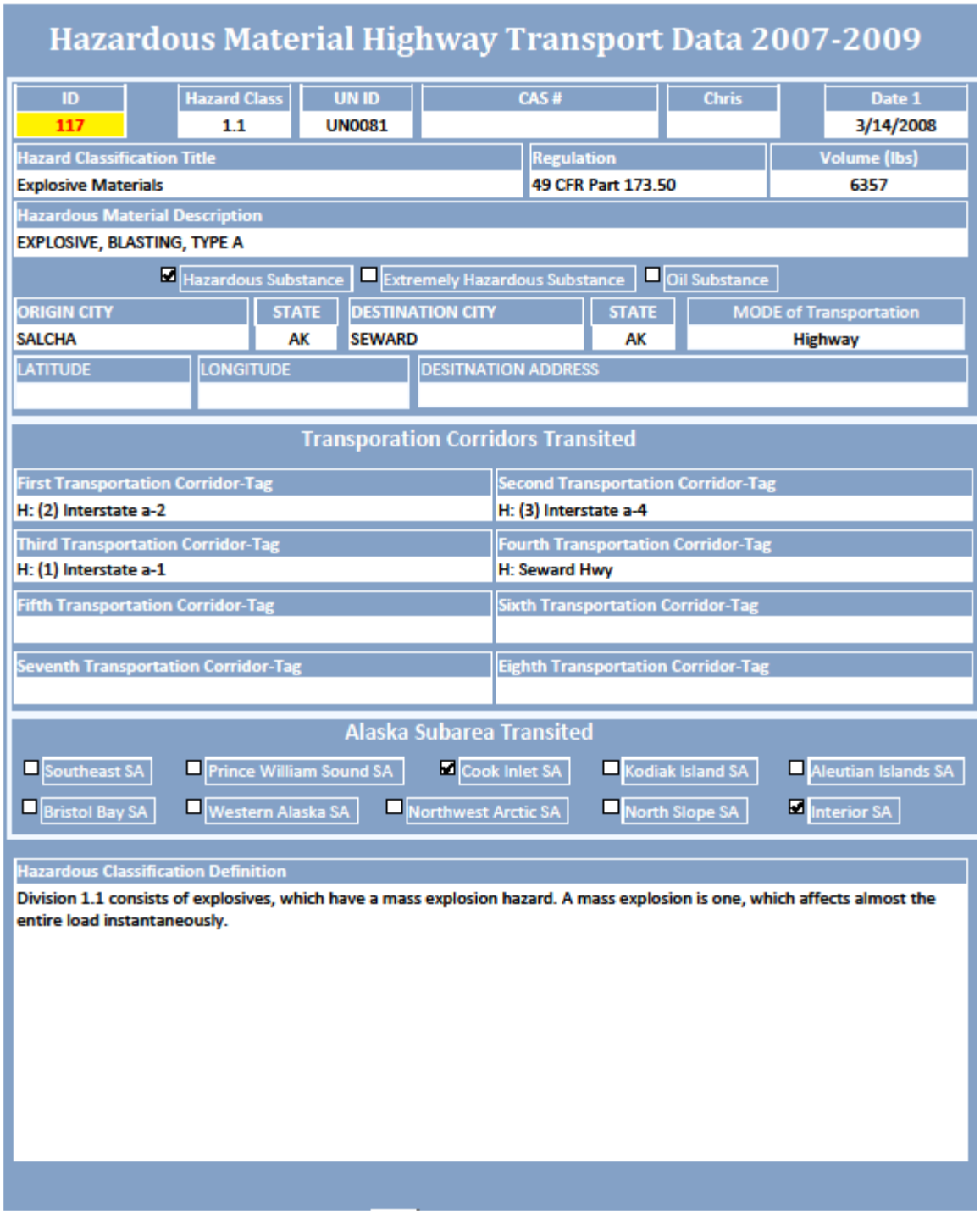
[17] These entries were primarily incomplete spill data received from the USCG MISLE database and were typically single distinct spills of minimal volumes.

[18] The weight of 1 gallon of water was used to calculate the weight threshold for the equivalent of 1 barrel of commodity shipped – 8.35 pounds/gallon of water. Any commodity, with the exception of EHS, under this volume threshold was removed from the dataset.

[19] This scoping step combined similar shipments. As a result, the final analysis focuses primarily on volume shipped versus total number of actual shipments.

[20] A full copy of the database was provided to ADEC as a deliverable for this project.

Figure 2-1. Example of data record from ACCESS Database



Hazardous Material Highway Transport Data 2007-2009

ID	Hazard Class	UN ID	CAS #	Chris	Date 1
117	1.1	UN0081			3/14/2008

Hazard Classification Title	Regulation	Volume (lbs)
Explosive Materials	49 CFR Part 173.50	6357

Hazardous Material Description: EXPLOSIVE, BLASTING, TYPE A

☑ Hazardous Substance ☐ Extremely Hazardous Substance ☐ Oil Substance

ORIGIN CITY	STATE	DESTINATION CITY	STATE	MODE of Transportation
SALCHA	AK	SEWARD	AK	Highway

LATITUDE	LONGITUDE	DESITNATION ADDRESS

Transporation Corridors Transited

First Transportation Corridor-Tag	Second Transportation Corridor-Tag
H: (2) Interstate a-2	H: (3) Interstate a-4
Third Transportation Corridor-Tag	**Fourth Transportation Corridor-Tag**
H: (1) Interstate a-1	H: Seward Hwy
Fifth Transportation Corridor-Tag	**Sixth Transportation Corridor-Tag**
Seventh Transportation Corridor-Tag	**Eighth Transportation Corridor-Tag**

Alaska Subarea Transited

☐ Southeast SA ☐ Prince William Sound SA ☑ Cook Inlet SA ☐ Kodiak Island SA ☐ Aleutian Islands SA

☐ Bristol Bay SA ☐ Western Alaska SA ☐ Northwest Arctic SA ☐ North Slope SA ☑ Interior SA

Hazardous Classification Definition

Division 1.1 consists of explosives, which have a mass explosion hazard. A mass explosion is one, which affects almost the entire load instantaneously.

2.3.1 Assumptions

For hazardous materials that were shipped by rail, there are multiple methods for shipment. As the data received from the Alaska Railroad provided the number of 'containers' or 'tank cars' shipped in a given year to a specified location, some assumptions had to be made to convert these total number of shipments to volumes. These assumptions were:

- That general break-bulk commodities (e.g. sodium cyanide, gas materials) were transported in 20-foot containers. A loaded 20 foot container weight of 48,000 pounds was used for these commodity shipments;
- That flammable liquids were shipped in General Service Tank Cars. A loaded volume of 23,000 gallons was used and verified by Alaska Railroad;
- That corrosive materials, as validated by the Alaska Railroad, were generally shipped in smaller cars, approximately 15,000-gallon tank cars. The volume was converted to pounds using a conversion of 15 lbs/gallon;
- That ammonium nitrate was shipped in covered hopper type cars. A loaded volume of 203,000 pounds was used and verified by Alaska Railroad; and
- That radioactive materials, as validated by the Alaska Railroad, were shipped in 65-foot gondolas weighing 250,000 pounds.
- That military shipment of ammunition entering Valdez from the lower 48 twice a year and being trucked to Anchorage and Fairbanks averaged between 47 and 302 20-foot containers per shipment and included Hazard Class 1.0 (Explosive Materials) commodities with hazard class divisions 1.1 (mass explosion hazard), 1.2 (projection hazard), 1.3 (fire and minor blast and/or projection hazards) and 1.4 (minor explosion hazard).[21] In order to develop an estimated volume, the following assumptions were made:
    - A single 20-foot container loaded weight was estimated at 48,000 pounds;
    - The average number of containers per shipment was set at 200. While slightly higher than the true average, this number was selected to be slightly conservative in the estimate.
    - Half of each shipment went to Anchorage, and half went to Fairbanks.
    - There were 100 containers each year (50/shipment) for each hazard class 1.1, 1.2, 1.3 and 1.4 explosives.
- For hazardous materials shipped via air, only the total number of shipments was provided for specific destinations. To enable further analysis, two key assumptions were applied to the air cargo data:
    - The volume of hazardous materials shipments ranged between 1 and 5000 pounds per shipment based on the cargo capacity of the aircraft utilized; and

[21] 6/2/10 Phone call with Mr. Bob Meno, Service Deployment & Distribution Command Military Munitions move coordinator.

- The number of shipments of the specific hazardous material commodities was distributed evenly across the total number of shipments to a given destination.

For air shipments, a simple algorithm was developed that distributed an average weight category equally across the total number of shipments to a given destination (e.g. it was assumed that there were the same number of shipments that averaged 500 pounds as those that averaged 4500 pounds). Within each weight category, the five (5) general commodities were spread over the weight category such that lower weight commodities dominated the lower two weight categories (500 and 1500 pounds) while the higher weight commodities dominated the upper three weight categories (2500, 3500 and 4500). The average weight category distribution is displayed below in Table 2-2. For the purposes of this example, the number of shipments to destination 'Q' is 100 (therefore 20 shipments per weight category), and there are 5 commodities that may be shipped to this location.[22]

Table 2-2. Air Cargo Average Weight Category Distribution

Q	Air Cargo Weight & Commodity Hazard Class Distribution Algorithm					
Ship-ments	Cargo A	Cargo B	Cargo C	Cargo D	Cargo E	Weight Cat.[23]
20	.3*20*500	.3*20*500	.3*20*500	.05*20*500	.05*20*500	500
20	.3*20*1500	.3*20*1500	.3*20*1500	.05*20*1500	.05*20*1500	1500
20	.05*20*2500	.05*20*2500	.05*20*2500	.425*20*2500	.425*20*2500	2500
20	.05*20*3500	.05*20*3500	.05*20*3500	.425*20*3500	.425*20*3500	3500
20	.05*20*4500	.05*20*4500	.05*20*4500	.425*20*4500	.425*20*4500	4500

2.4 Analysis

Once reduced through scoping, the dataset was analyzed to consider trends by transportation mode, hazardous materials class by volume, and Potential Impacted Subarea.

2.4.1 Transportation Mode

Five transportation modes were considered in this study: air, rail, highway, marine, and pipeline. The analysis of transportation modes captured multiple transportation routes.

Initially, 119 transportation routes were identified to describe the route a particular commodity transited during shipment from origin to destination. Unique identifiers represented a code

[22] The assumptions and hazard class category distributions that resulted in a volume of a particular hazardous materials commodity moving from point A to point B are for reporting consistency and to provide an indication of relative volumes of hazardous materials cargos.

[23] An average weight was selected for each weight category: 500 for 1-1000, 1500 for 1000 to 2000, etc. Using both a Uniform and Parabolic distribution of weights, the average centers in on the mid points for each respective range, http://www.statisticalengineering.com/index.html.

identifying the mode of transportation, and the route and/or origin/destination locations. Table 2-3 provides examples of the transportation mode identifiers.

Table 2-3. Summary of Transportation Mode Identifiers

Transportation Mode	Route Identifier	Meaning
Air	A: Anchorage-Galena	The commodity was shipped via aircraft from Anchorage to Galena.
Air	Backhaul Anchorage	The commodity was shipped via aircraft from various locations back to Anchorage.
Highway	H: (1) Interstate A-1	The commodity transited Interstate A-1 during shipment.
	H: Anchorage Local	The commodity was shipped within the greater Anchorage area, but specific destinations were undetermined.
Marine	M: Cook Inlet	The commodity transited Cook Inlet during shipment.
Pipeline	P: North Slope – Valdez	The commodity was shipped from the North Slope to Valdez via the Trans-Alaska pipeline.
Rail	R: Whittier-Portage	The commodity was shipped via the Whittier to Portage segment of the Alaska Rail Road.

The marine corridor identifiers were developed utilizing multiple sources including the Alaska Marine Highway routes and the Aleutian Islands Vessel Traffic Survey (Nuka Research and Planning Group, 2005), and geographic reference points. The marine corridor naming convention identified an actual marine route (M: Inside Passage), a waterway that was transited (M: Cook Inlet), a destination port (M: Seward), or a destination Subarea (M: North Slope).

For the purposes of this study, the maximum number of segments for any particular route was limited to eight (8) and primarily identified only the major transportation routes (city to city rather than point to point) as specific addresses were not available for the majority of commodities. In scenarios where the origination and destination cities were the same (e.g. Anchorage), and no additional route information was available, a 'local' identifier was assigned (e.g. H: Anchorage Local indicates that the commodity was transported between undetermined locations in the Anchorage area via highway/roadway; see Table 2-3).

2.4.2 Hazardous Materials Class

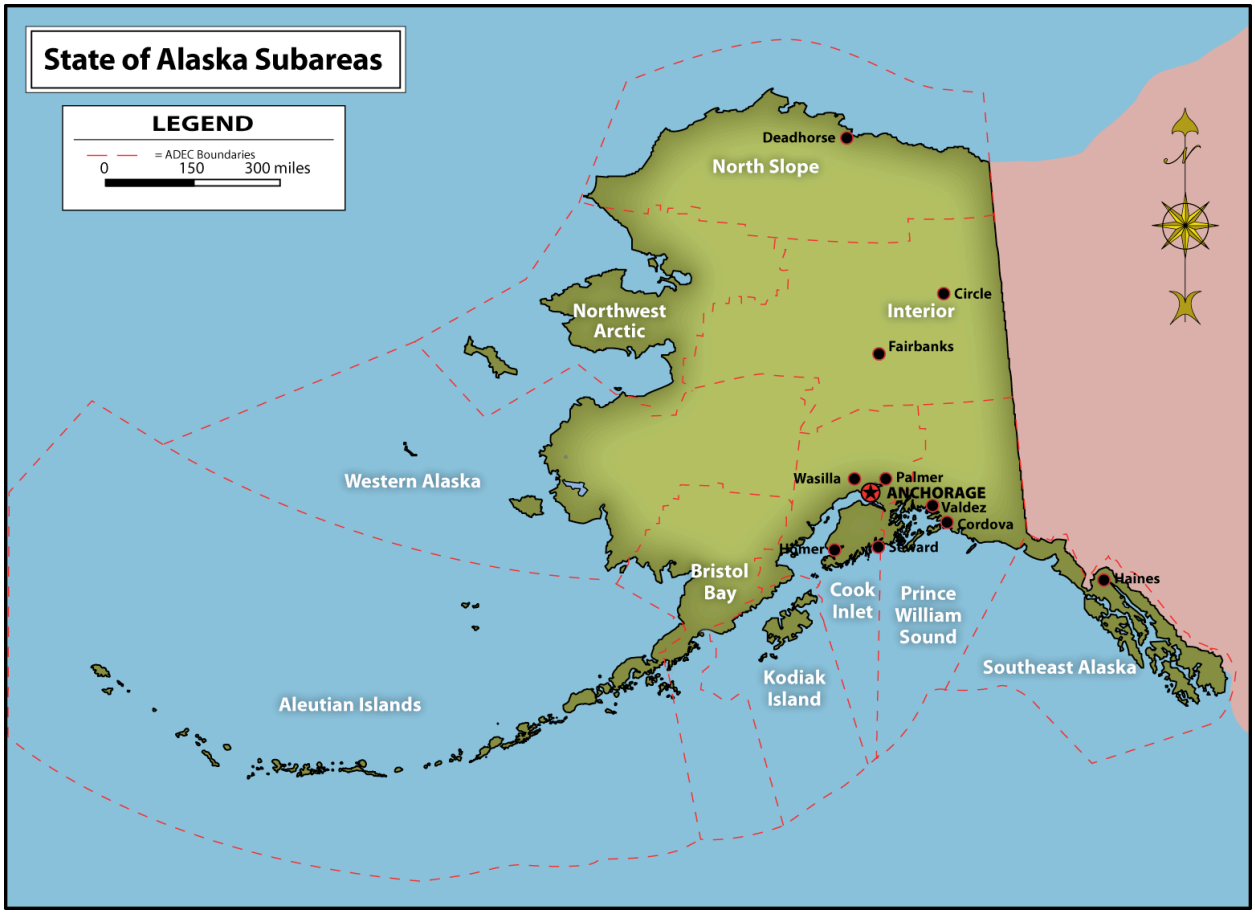
The transportation of hazardous materials statewide was analyzed by type of hazardous material (class) transported by year, volume, and number of shipments, to identify statewide trends. Commodities were grouped by hazard class and by year shipped and evaluated by total volume shipped statewide. Additionally, the total numbers of shipments were compared by hazard class for each year evaluated in this study.

2.4.3 Potentially Impacted Subarea

There are ten Subareas in Alaska for the purpose of oil and hazardous materials spill response planning: Southeast Alaska, Prince William Sound, Cook Inlet, Kodiak Island, Aleutians, Bristol Bay, Western Alaska, Northwest Arctic, North Slope and Interior Alaska (Figure 2-2). The initial determination of Potentially Impacted Subarea was made based on the origination and destination cities noting that this was not necessarily complete and that it would have to be further defined as the actual transportation routes were identified.

Once transportation routes were identified, Potentially Impacted Subareas were further defined to capture those Subareas transited between origin and destination. For air cargo transportation, only the origination and destination subareas were identified since the greatest potential likelihood of a hazardous material incident resides at the origin and destination locations.

Figure 2-2. Alaska Subareas



2.5 Reporting

Interim and final reporting on the data included three progress reports on data compilation and scoping and this final report.[24]

[24] Interim reports were submitted to ADEC on 4/15/10, 5/14/10, and 6/30/10.