TRANSPORTATION AND INFRASTRUCTURE REQUIREMENTS
FOR A
RENEWABLE FUELS STANDARD

Downstream Alternatives Inc.

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TRANSPORTATION AND INFRASTRUCTURE REQUIREMENTS FOR A RENEWABLE FUELS STANDARD

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Executive Summary

The U.S. Department of Energy's (DOE) Biomass Program is responsible for major planning and analysis to ensure consistency of various program objectives with the Energy Policy Act (EPACT). Oak Ridge National Laboratory (ORNL) is supporting the DOE Biomass Program in the analysis of current and future ethanol demand for the transportation fuels market.

The DOE is interested in the logistics of, and any constraints associated with, ethanol industry expansion because it is engaged in research and development work on cellulosic ethanol development. Understanding the infrastructure development necessary for an expanded ethanol industry is an important part of this work. Downstream Alternatives Inc. (DAI) was retained to provide technical expertise specifically related to ethanol transportation, distribution, and marketing issues.

This analysis is part of a series of project deliverables prepared for ORNL under Subcontract No. 4500010570. The purpose of this analysis was to assess the increased infrastructure needs and transportation requirements for the increased ethanol production and use that would result from a "Renewable Fuels Standard" (RFS).

At the time this work was initiated, the most likely RFS structure was the requirement contained in U.S. Senate Bill S.517 (Daschle) (1). Consequently, the premises for this work were based largely on S.517. Since initiation of this work, S.517 has become an amendment to House of Representatives Bill H.R.4. Since legislation had not been finalized at the time this work was undertaken, changes to various elements of the RFS could occur. Various changes could alter the geographic locations in which refiners would choose to blend ethanol as part of their RFS compliance strategy. Consequently, the approach in this analysis is to develop "boundary cases".

At the extremes of the many possible outcomes are two scenarios. In one scenario, refiners do not need to use ethanol for Reformulated Gasoline (RFG) compliance and would therefore direct ethanol usage to conventional gasoline (CG) markets. Given CG usage patterns and the low freight costs for ethanol shipments to PADDs† II(U.S. Midwest) and III (U.S. Gulf Coast) from PADD II ethanol plants, this would concentrate ethanol use in PADDs II and III where a great deal of ethanol blending

† Petroleum Administration for Defense District (PADD). A map depicting the states in each PADD is provided in Appendix E.

infrastructure already exists. The combination of low capital investment and low freight rates for these markets would yield the lowest cost, least difficult, scenario.

In the other scenario, refiners would need to use ethanol for RFG compliance, resulting in much greater use of ethanol in PADDs I (U.S. East Coast) and V (U.S. West Coast). These are not traditional ethanol markets and would necessitate more infrastructure investments for tanks, rail spurs, and blending equipment. Also freight rates would be higher to ship ethanol from the ethanol plants in PADD II to the outlying PADDs. These combined factors would therefore yield the most expensive and most difficult scenario.

The adoption or exclusion of various requirements in RFS legislation, variations in ethanol prices and future developments in refinery processes could result in scenarios that lie somewhere between these two cases. Consequently these two scenarios have been selected as boundary cases since they would provide least cost/least difficulty and highest cost/highest difficulty cases, from a logistics standpoint.

The projections in this study are a representation of what might happen given the specific premises, assumptions, and methodologies used. Real world data were used as a starting point. Such information includes historic gasoline/ethanol blend sales, current ethanol production, and actual terminal locations. However, the actual projections for where new ethanol production would be located and where future ethanol sales increases would develop are highly dependent on the premises, assumptions, and methodologies used. Many developments that will shape the future of the ethanol industry cannot be anticipated with certainty. No study is made of the specific impact that certain issues may have on the supply and demand of ethanol. This study is focused on logistic issues, concentrating primarily on transportation and storage demand resulting from the RFS proposed in S.517.

Both the scenarios studied assume that the RFS volume requirements are as follows:

Calendar year	Applicable volume of renewable fuel (in billions of gallons)
2004	2.3
2005	2.6
2006	2.9
2007	3.2
2008	3.5
2009	3.9
2010	4.3
2011	4.7
2012	5.0

For each of the scenarios studied, three dates are analyzed. These include 2004 (representing the first year of the RFS), 2007 (representing the first year when MTBE is banned), and 2012 (the year when the maximum volume, on a percentage market share basis, is required).

In Scenario #1, refiners would use ethanol for RFG production, resulting in much greater use of ethanol in PADDs I and V. These are not traditional ethanol markets and would necessitate more infrastructure investments for tanks, rail spurs, and blending equipment. Also, freight rates would be higher to ship ethanol from the ethanol plants in PADD II to the outlying PADDs. Further, in this scenario it is assumed that 65% of the ethanol is used in a six-month period and 35% in the other, commonly referred to in this study as the 65/35 seasonal split. These combined factors would therefore yield the most expensive and most difficult scenario.

In this scenario, we start with the baseline of existing ethanol sales from year 2000. Year 2000 was used as the baseline because it is the most recent year for which ethanol volumes by state are available.

In Scenario #2, refiners do not need to use ethanol for RFG production and would therefore direct ethanol usage to CG markets. Given CG usage patterns and the low freight costs for ethanol shipments to PADDs II and III from PADD II ethanol plants, this would concentrate ethanol use in PADDs II and III, where a great deal of ethanol blending infrastructure already exists. The combination of low capital investment and low freight rates for these markets would yield the lowest cost, least difficult, scenario.

In this scenario, we also start with existing year 2000 baseline volumes. New ethanol volumes are directed first into PADD II and then into PADD III. To optimize utilization of facilities, there will be a more uniform seasonal distribution of ethanol. The following tables list the new ethanol volume for each study year and for each PADD.

Table ES-1 New Ethanol Volume by PADD - Scenario #1 (bgy)

PADD	Base	New Volume 2004	New Volume 2007	New Volume 2012	New Volume Total	Total Base + New Volume
I	0.111	0.390	0.299	0.800	1.489	1.600
II	1.071	0.313	0.116	0.300	0.729	1.800
III	0.083	-	0.182	0.235	0.417	0.500
IV	0.065	-	-	0.035	0.035	0.100
V	0.146	0.154	0.300	0.400	0.854	1.000
Total	1.476	0.857	0.897	1.770	3.524	5.000

Table ES-2 New Ethanol Volume by PADD - Scenario #2 (bgy)

PADD	Base	New Volume 2004	New Volume 2007	New Volume 2012	New Volume Total	Total Base + New Volume
I	0.111	-	-	-	-	0.111
II	1.071	0.924	0.683	0.522	2.129	3.200
III	0.083	-	0.117	1.243	1.360	1.443
IV	0.065	-	-	0.035	0.035	0.100
V	0.146	-	-	-	-	0.146
Total	1.476	0.924	0.800	1.800	3.524	5.000

Looking at the differences in volume between the scenarios, it can be seen that by year 2012 in Scenario #1, a total of 1.489 bgy more ethanol is distributed in PADD I than in Scenario #2. Similarly, in Scenario #1, 0.854 bgy more ethanol is distributed in PADD V than in Scenario #2. Conversely Scenario #2 ethanol volumes are higher in PADDs II and III, 1.4 bgy and 0.943 bgy respectively. These figures are recapped in the following table.

Table ES-3 New Ethanol Volume Comparison - Year 2012
(bgy)

PADD	Scenario #1	Scenario #2	Difference
I	1.489	0.000	1.489 (1)
II	0.729	2.129	1.405 (2)
III	0.417	1.360	0.943 (2)
IV	0.035	0.035	0 -
V	0.854	0.000	0.854 (1)
Total	3.524	3.524	--

() Number in parentheses indicates Scenario number in which the higher volume difference occurs

With a different distribution profile in each scenario, it is apparent that some costs† will vary, especially freight. Using the cumulative new ethanol volumes by year 2012, key findings from the analysis include:

- The number of terminals converted will be similar in either scenario, although Scenario #1 will require more total storage capacity as covered in the next table.

† For a discussion of various cost calculations, see Section 1.1.4 Methodology & Additional Assumptions and also Appendix C.

Table ES-4 Terminal Profile Comparison

	Servicing Terminals	Number with Ethanol	Number of Tanks Converted/Installed	Total Storage Added - bbl (gal)
Scenario #1	557	333	215	4,715 MB (198,030,000)
Scenario #2	535	367	213	3,280 MB (137,760,000)

Similarly, Scenario #1 requires the installation of more rail spurs and conversion of a greater number of retail outlets. The number of blending systems installed and miscellaneous contingency expenses (for terminal conversions) are similar. These items are compared in the following table.

Table ES-5 Terminal Equipment and Retail Conversion Comparison

	Blending Systems	Rail Spurs	Misc. Contingency	Retail Units
Scenario #1	216	31	216	53,627
Scenario #2	229	18	229	45,296

- When compared on an amortized basis per gallon of ethanol, the total investment for terminal equipment and retail conversions is nearly the same for the two scenarios, $0.0066 in Scenario #1 and $0.0060 in Scenario #2, as listed in the following table.

Table ES-6 Terminal and Retail Investment Cost Comparison (000)

	Tank Conversion	New Tanks	Blending Systems	Rail Spurs	Misc. Contingency	Retail	Total	Amortized Cost Per Gallon of Ethanol
Scenario #1	$1,885	$35,000	$64,800	$11,000	$4,320	$31,639	$148,649	$0.0066
Scenario #2	$1,245	$27,725	$68,700	$6,390	$4,580	$26,725	$135,365	$0.0060

- The seasonal ethanol split (i.e., 65% in one six month period, 35% in the other) in Scenario #1 results in terminal and retail investments increasing by a factor of 1.3 (30% higher than what would be necessary were ethanol use balanced over the year. If Scenario #1 utilized the 50/50 split of Scenario #2, amortized costs would be approximately $0.0051 per ethanol gallon. This would be lower that Scenario #2 and results from the higher volumes and fewer terminal conversions necessary to serve the higher population centers in PADDs I and V. This analysis does not include any costs incurred by the ethanol producers to store excess production during the slower sales period in the 65/35% seasonal split used in Scenario #1. Since ethanol production is relatively constant on a month to month basis, it would be necessary to build or lease tanks to store excess production during the low demand six month period for later sales in the higher demand six month period. Costs for tank construction and/or leases, as well as any carrying costs for storing inventory for extended periods would be incurred by the ethanol producer and presumably reflected in the price of the ethanol.

- The major differences between the scenarios are in transportation equipment requirements and freight costs. Scenario #1 would require the use of 6.5 small Jones Act Vessels where as Scenario #2 requires none. Barge requirements are higher in Scenario #1 with 185.5 barges required, compared to only 41.9 barges in Scenario #2. Rail requirements are also higher in Scenario #1 with 3,990 rail cars required compared to 1,820 for Scenario #2. Truck requirements are lower for Scenario #1 because of less ethanol shipped by truck and more by other modes. Scenario #1 would require the equivalent of 261 tractor/trailer rigs while Scenario #2 would require 315. These figures are recapped in the following table.

Table ES-7 Transportation Profile Comparison

For New Ethanol Volume

	Scenario #1		**Scenario #2**	
Cargoes	**Annual Shipments**	**Annual Equipment Requirement**	**Annual Shipments**	**Annual Equipment Requirement**
Shipping	82.9	6.5	n/a	n/a
Barge	3,407	185.5	199	41.9
Rail	59,791	3,990	43,700	1,820
Truck	158,450	261	244,625	315

- In Scenario #1, additional annual barge cargoes would equate to 4.7 million short tons equating to 0.75% of total tonnage moved on the inland waterways in 1998. In Scenario #2 additional barge shipments equate to 0.399 million short tons or 0.064% of total tonnage moved on the inland waterways in 1998.

- In Scenario #1, additional annual rail car shipments would reach 59,791 cargoes. This represents only 3.9% of the total tank cars loaded on the Class I railroads in 1999 and only 0.27% of all car loadings. In Scenario #2, addition rail car shipments will reach 43,700 annual cargoes representing 2.84% of total tank cars loaded in 1999 and only 0.2% of all cars loaded.

- In Scenario #1 a total of 158,450 truck shipments per year are needed. In Scenario #2 the annual truck shipments total 244,265 loads. This only results in an increase of 260 to 315 more trucks (or truck equivalents) being on the road.

.• Freight costs will comprise the majority of cost differences between the two scenarios. Freight cost for new ethanol volume for Scenario #1 averages $0.1049 per gallon while Scenario #2 freight costs average only $0.0577 per gallon of new ethanol volume, as seen in the following table.

Table ES-8 Freight Cost Comparison - New Ethanol Volume

	Total Freight Charges (000)	Average per Gallon
Scenario #1	$369,800	$0.1049
Scenario #2	$203,427	$0.0577

• In Scenario #1, combining amortized terminal and retail investments with annual freight costs results in $0.1115 per gallon of new ethanol volume. In Scenario #2 these investments equate to $0.0637 per gallon of new ethanol volume or $0.0478 per gallon of ethanol less than Scenario #1. This comparison is provided in the following table.

Table ES-9 Per Gallon Cost Comparison Between Scenarios

	Amortized Investment per Gallon	Freight Cost per Gallon	Total
Scenario #1	$0.0066	$0.1049	$0.1115
Scenario #2	$0.0060	$0.0577	$0.0637
Difference	$0.0006	$0.0472	$0.0478

• The costs for transportation and distribution of ethanol, then average $0.00637 per gallon of gasoline ethanol blend in Scenario #2, the lower boundary/least difficult scenario and $0.01115 per gallon of gasoline ethanol blend in Scenario #1, the upper boundary/more difficult scenario. This is based on 10v% ethanol blends except in California where the blend ratio is assumed to be 5.7v%.

- Scenario #2 results in the transportation and distribution costs being $0.00478 per gallon of gasoline ethanol blend lower than Scenario #1.

- With combined transportation and storage cost differences between the scenarios of less than one half cent per gallon of gasoline ethanol blend, refinery operations and economics may play a greater role in the decision of where to use ethanol, at least in the long term. Refiner decisions will, of course, be made on differences between their actual costs.

- It is not likely that the resulting market, after implementation of the RFS, will follow the path of either scenario but will lie somewhere between the two. However, since the scenarios studied represent upper and lower boundaries, the average transportation and distribution costs per gallon of gasoline ethanol blend will be between $0.00637 and $0.01115 per gallon.

Executive Summary Specific References

1. S.517 Senate Energy Bill - Daschle

Executive Summary General References

None

Section 1

Background & Introduction

1.0 Background & Introduction

The U.S. Department of Energy's (DOE) Biomass Program is responsible for major planning and analysis to ensure consistency of various program objectives with the Energy Policy Act (EPACT). Oak Ridge National Laboratory (ORNL) is supporting the DOE Biomass Program in the analysis of current and future ethanol demand for the transportation fuels market. Downstream Alternatives, Inc. (DAI) was retained to provide technical expertise specifically related to ethanol transportation, distribution, and marketing issues.

The DOE is interested in the logistics of, and any constraints associated with, ethanol industry expansion because it is engaged in research and development work on cellulosic ethanol development. Understanding the infrastructure development necessary for an expanded ethanol industry is an important part of this work.

This analysis is part of a series of project deliverables prepared for ORNL under Subcontract No. 4500010570. Other previously completed important project deliverables under this subcontract are listed in the references for this section (1,2). Note that numbers in parentheses indicate references listed at the end of each report section.

The purpose of this analysis was to assess the increased infrastructure needs and transportation requirements for the increased ethanol production and use that would result from a "Renewable Fuels Standard" (RFS).

At the time this work was initiated, the most likely RFS structure was the requirement contained in U.S. Senate Bill S.517 (Daschle) (3) (which is now an amendment to House of Representatives Bill H.R.4). Consequently, the premises for this work were based largely on S.517. While S.517 appears to be the most likely vehicle for a RFS, the possibility remains that certain aspects of the legislation would change. For instance, earlier versions of proposed RFS legislation included such items as rescinding the 1.0 pound per square inch (psi) vapor pressure exemption for summer grade conventional gasoline (CG) east of the Mississippi River, and including a Distillation Index maximum of 1200 on all gasoline. Likewise the date of the ban on methyl tertiary butyl ether (MTBE) could be changed, or the provision for banking and trading RFS credits could be modified. All of the aforementioned items could affect the volumes of ethanol used in different geographic areas. Likewise, a number of refinery operational factors may impact how a refiner/blender chooses to comply with any RFS requirement. Examples here would include the potential for importing reformulated gasoline (RFG) and various blendstocks to balance refinery runs, expansion of alkylate production, and future development of new or improved process catalysts that could improve yields of blendstock components that are desirable for use in RFG.

Seasonal differences in ethanol prices and/or ethanol pricing patterns could also play a role in how decisions are made. The aforementioned items will all enter the decision making process on where the refining industry, and even individual refiner/blenders, will choose to sell gasoline ethanol blends. These items are discussed in greater detail in Appendix B.

At the extremes of the many possible outcomes are two scenarios. In one scenario, refiners do not need to use ethanol for RFG compliance and would therefore direct ethanol usage to CG markets. Given CG usage patterns and the low freight costs for ethanol shipments, this would concentrate ethanol use in PADDs† II (U.S. Midwest) and III (U.S. Gulf Coast) where a great deal of ethanol blending infrastructure already exists. The combination of low capital investment and low freight rates for these markets would yield the lowest cost, least difficult, scenario.

In the other scenario, refiners would need to use ethanol for RFG compliance, resulting in much greater use of ethanol in PADDs I (U.S. East Coast) and V (U.S. West Coast). These are not traditional ethanol markets and would necessitate more infrastructure investments for tanks, rail spurs, and blending equipment. Also freight rates would be higher to ship ethanol from the ethanol plants in PADD II to the outlying PADDs. These combined factors would therefore yield the most expensive and most difficult scenario.

The adoption or exclusion of the various aforementioned requirements in RFS legislation, variations in ethanol prices and future developments in refinery processes could result in scenarios that lie somewhere between these two cases. Consequently these two scenarios have been selected as boundary cases since they would provide least cost/least difficulty and highest cost/highest difficulty cases, from a logistics standpoint.

Prior to initiation of this study, a premise document [4] was developed for these two study cases. This premise document is included as Appendix A.

The two scenarios analyzed are discussed in more detail in the following sections.

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† Petroleum Administration for Defense District (PADD). A map depicting the states in each PADD is provided in Appendix E.

1.1 Scenarios Studied

Given the current legislative focus, the analytical approach for both scenarios is based on certain provisions of S.517 which:

1. Specifies the RFS requirement (a volume formula is used for years after 2012):

Calendar year	Applicable volume of renewable fuel (billion gallons per year)
2004	2.3
2005	2.6
2006	2.9
2007	3.2
2008	3.5
2009	3.9
2010	4.3
2011	4.7
2012	5.0

2. Provides for the generation of credits by any person that refines, blends, distributes or imports gasoline that contains a quantity of renewable fuel that is greater than the quantity required.

3. Ensures that 35 percent or more of the quantity of the renewable fuels requirement is used during each of two specified seasons of six months each.

4. Allows repeal of the 1 psi Reid vapor pressure (RVP) waiver for CG blended with 10 percent ethanol, given supporting documentation from the Governor of a State, that the RVP waiver will increase emissions that contribute to air pollution in any area in the State.

5. Prohibits the use of MTBE, not later than 4 years after the date of enactment.
   NOTE: Since this work was initiated, the MTBE ban was modified allowing states to opt out of the ban at the governor's request. However, it was not included in the premises underlying this study.

6. Eliminates the oxygen content requirement for RFG.

7. Maintains Toxic Air Pollutant emission reductions for RFG at 1999-2000 baseline levels.

8. Consolidates the Volatile Organic Compound (VOC) emissions specification for RFG to the more stringent requirement for southern RFG.

9. Contains provisions for additional opt-in areas under the RFG program.

For each of the scenarios studied, three dates are analyzed. These include 2004 (representing the first year of the RFS), 2007 (representing the first year when MTBE is banned), and 2012 (the year when the maximum volume, on a percentage market share basis, is required).

1.1.1 Scenario #1 - High Cost/High Difficulty Boundary Case

In Scenario #1, refiners would use ethanol for RFG production, resulting in much greater use of ethanol in PADDs I and V. These are not traditional ethanol markets and would necessitate more infrastructure investments for tanks, rail spurs, and blending equipment. Also freight rates would be higher to ship ethanol from the ethanol plants in PADD II to the outlying PADDs. These combined factors would therefore yield the most expensive and most difficult scenario.

In this scenario, we start with the baseline of existing ethanol sales from year 2000 and use three date points in the RFS schedule, 2004, 2007, 2012. Most new ethanol volume would be directed into PADD I and PADD V. Year 2000 was used as the baseline because it is the most recent year for which ethanol volume data by state are available. The incremental volumes by PADD and year studied are listed in the following table.

Table 1-1 Scenario #1 - High Cost/High Difficulty Boundary Case Ethanol Use (bgy)

PADD	Base	2004	2007	2012
I	0.111	0.501	0.800	1.600
II	1.071	1.384	1.500	1.800
III	0.083	0.083	0.265	0.500
IV	0.065	0.065	0.065	0.100
V	0.146	0.300	0.600	1.000
Total	1.476	2.333	3.230	5.000

For Scenario #1, it is premised that:

1. The more stringent VOC requirement for summer RFG, and the optional repeal of the RVP waiver for summer CG, drive the maximum allowable seasonal use of renewables into the winter season. [Note: Summer volatility specifications in these premises are different from the premises and, therefore, the seasonal ethanol demand patterns in the OFD-sponsored report on *Ethanol Demand in United States Regional Production of Oxygenate-Limited Gasoline* (Hadder 2000).] (5)

2. Over time, regional RFG-CG price differentials will become increasingly attractive for transport of ethanol produced in PADD II to the more distant RFG markets. In PADD V, there could be repeti-

tions of recent markets situations. For example, RFG (PADD V)-CG (PADD II) differential prices in the winter of 2000 were as high as 25 cents per gallon(6). DAI (2) estimates that freight costs and amortized infrastructure costs for ethanol shipped from PADD II to PADD V would be about 14 cents per gallon. [Note: The maximum requirement for ethanol in PADD II winter RFG is satisfied in these premises (7).]

3. The value, and required volumes, of ethanol in RFG will increase over time due to additional RFG opt-ins and due to the need for a clean replacement for MTBE. For example, refiners supplying PADD I are premised to need increasing volumes of ethanol in RFG for compliance with Toxic Air Pollutant regulations.

4. The RFS volume requirements drive the increasing use of ethanol in RFG over time. The mandated renewable volume is increasing faster than the RFG volume, and ethanol percentages are increasing as shown in a possible winter season outcome for PADDs I and V:

Table 1 -2 Scenario #1 - High Cost/High Difficulty Boundary Case
Winter Ethanol Use
(bgy)

PADD	Base	2004	2007	2012
I	-	0.3	0.5	1.0
V	-	0.2	0.4	0.7

Table 1-3 Scenario #1 - High Cost/High Difficulty Boundary Case
Ethanol in Winter RFG (average percent)

PADD	Base	2004	2007	2012
I	-	3.6	5.5	9.9
V	-	2.6	4.9	7.4

5. At the combinations of ethanol concentrations implied by the above table(8), we premise that refiner/blenders will produce RFG in compliance with Federal and California specifications for emissions of NOx and Toxic Air Pollutants (see the Phase 3 CARBOB Predictive Model (9), for example).

6. RFS credits are traded as necessary for refiners to achieve RFS compliance on a national scale.

1.1.2 Scenario #2 - Low Cost/Low Difficulty Boundary Case

In Scenario #2, it is premised that refiners do not need to use ethanol for RFG production and would therefore direct ethanol usage to CG markets. Given CG usage patterns and the low freight costs for ethanol shipments, this would concentrate ethanol use in PADDs II and III, where a great deal of ethanol blending infrastructure already exists. The combination of low capital investment and low freight rates for these markets would yield the lowest cost, least difficult, scenario.

In this scenario, we also start with existing baseline volumes (year 2000) and use the three date points of 2004, 2007, 2012. In this scenario, new ethanol volumes are directed first into PADD II and then into PADD III. Note that for year 2004 and 2007, premise volumes differ slightly (less than 0.1 bgy) from Scenario #1. To optimize utilization of facilities, there will be a more uniform seasonal distribution of ethanol.

Table 1-4 Scenario #2 - Low Cost/Low Difficulty Boundary Case (bgy)

PADD	Base	2004	2007	2012
I	0.111	0.111	0.111	0.111
II	1.071	1.995	2.678	3.200
III	0.083	0.083	0.200	1.443
IV	0.065	0.065	0.065	0.100
V	0.146	0.146	0.146	0.146
Total	1.476	2.400	3.200	5.000

In both scenarios actual volumes vary slightly from the original premise document due to existing sales in each PADD.

1.1.3 Additional Premises Applicable to Both Scenarios

1. Ethanol Production: Ethanol production will consist of existing plants, plants under construction or expansion, and hypothetical plants. Since S.517 only requires 5 billion gallons per year of renewable production in 2012 (the most distant date point in this study), it will be assumed that all hypothetical plants will be grain based and located in PADD II. Only domestic production is used for RFS compliance.

2. Biodiesel Portion: Since we are using boundary cases, no calculations will be made for biodiesel. It should be noted that biodiesel can be used for RFS compliance and any biodiesel used would reduce the demand for ethanol by a corresponding amount. However, biodiesel is not expected to reach significant volumes by 2012.

3. Gasoline Demand Increases: Since S.517 uses an actual RFS in gallons, it is not necessary to determine the actual demand increase for gasoline. However, it may be necessary to make some assumptions about demand increase if the gasoline ethanol blend market share approaches 100 percent in an area. For purposes of market assessment, the Federal Highway Administration's state-specific gasoline volumes will be used. Any projected gasoline demand increase employed in this work will be based on DOE projections.(10)

4. CO Non-attainment Areas: It will be assumed that all CO non-attainment areas (except Los Angeles) utilizing an oxyfuel program will come into compliance in 2004 but will utilize oxyfuel for one more year (i.e., 2005) for maintenance of the State Implementation Plan (SIP). It will be assumed that Los Angeles achieves compliance in 2010 with no continuation for SIP maintenance.

5. ETBE: No ethyl tertiary butyl ether will be used.

6. RFG VOC: All RFG must comply with the southern RFG requirement for emissions of VOCs.

7. Compliance Averaging and Credit Trading: Premises will be consistent with provisions of S.517.

8. Seasonal Ethanol Use: Some observers believe that credit trading will result in greater seasonal use of ethanol (i.e., more use in summer than winter or vice versa). This would result in greater seasonal storage necessitating more tanks for ethanol inventory. Additionally, if some areas do not utilize ethanol year round, then more areas would need to handle ethanol to achieve required volume levels. An important unknown here is that, rather than incur seasonal storage costs, ethanol producers may chose to discount ethanol prices to eliminate or minimize seasonal use, i.e., promote year round blending. Scenario #2 will assume a 50/50 seasonal split. Scenario #1 will assume a 65/35 seasonal volume split, but will also note the infrastructure requirements that could develop should a 50/50seasonal split develop.

1.1.4 Methodology and Additional Assumptions

In order to develop a logistic and freight analysis, it is necessary to make certain additional assumptions which include the following:

1. Many of the assumptions with regards to terminal equipment costs, investment amortization, and other aspects of this work rely on Downstream Alternatives Inc. recently completed study *"Infrastructure Requirements for an Expanded Ethanol Industry"* (January 15, 2002). For historic reference, readers may wish to review certain sections of this report, which can be accessed via the Internet at www.afdc.gov/pdfs/6235.pdf. The report format utilized here also follows a similar pattern to the above referenced report.

2. Plant Placement: (Section 2) All new plants, which are in PADD II, are placed in areas with major corn production. No feasibility studies were conducted and exact locations of plants could vary slightly. However, this would not alter the logistics involved in any major way. The production levels were developed to exceed the RFS requirement by a small amount since it is not reasonable to assume that the entire industry would operate at 100% of nameplate capacity.

3. Ethanol Use by PADD and Time Frame: (Section 3) The preliminary ethanol volume use for each PADD was developed to fit the premised scenarios by PADD and time frame for each year studied. Then for each year studied, specific markets were developed within each PADD. Total gasoline volumes were checked to insure that ethanol volumes did not exceed the potential market at the designated blend levels. In California, the ethanol blend level is assumed to be 5.7 v% and a blend level of 10.0 v% is assumed in all other areas. For each scenario, equipment demands and associated costs for each year studied are presented on an incremental volume basis, i.e., 2004 represents required infrastructure and costs over the baseline, 2007 over 2004, and 2012 over 2007. The three study year points are then combined to assess total requirements for the volume increase from the baseline to year 2012 requirement.

4. Scenario Development/Analysis: (Sections 4 and 5) Ethanol volumes were assigned to the most likely markets based on the applicable premises for each scenario. Next the number of servicing terminals were determined as well as those already offering ethanol. Then, the number of terminals required to handle the premised ethanol volumes (considering the number of servicing terminals) was developed. Estimates were made of terminals that might already handle ethanol, as well as those that might be able to handle ethanol in existing tankage (with or without modification). Note that inventory turnover plays a major role in determining tank requirements. Inventory turns are different by PADD. Generally, it is assumed that due to the greater distance, PADDs I and V will turn inventory twice per month (24 times per year) while PADD II will turn inventory 3 times per month (36 times per year) due to its close proximity to

plants and generally smaller tankage. The cost of tank conversions, new tanks and blending systems (2 per terminal) is then calculated, as is the cost of adding rail spurs and miscellaneous costs. Finally, the cost of retail conversions is calculated. These costs are all totaled in a recap and then amortized to provide a comparable matrix by PADD. Finally, an estimate is made of the amount of ethanol shipped by product mode (i.e., ship, barge, rail, truck, and combinations thereof). Composite freight rates, considering these collective transportation modes are developed and freight costs, and average freight costs per gallon, are calculated for each PADD, and in total. Based on established turnaround times for shipments, an estimate of increased needs for ships, barges, rail cars, and transport trucks is also made.

5. Staging Tanks: Staging tankage, i.e., tanks in New Orleans that receive product by barge and then ship to PADDs I and V are not included as required investments. Existing tankage can be leased for this purpose or throughput agreements can be arranged. The throughput costs, generally assumed to be $0.01 per gallon ($0.42 per barrel) or less are included in the freight cost since they are an integral part of an intermodal shipment expense.

6. Seasonal Split: In Scenario #1, it is assumed that 65% of the ethanol will be used in one six -month period of the year with the remainder being used in the other six-month period. This leads to a greater need for more storage capacity than in a seasonally balanced scenario. Consequently, more terminals handle ethanol, and more tanks, blending systems and rail spurs, etc., are needed. Likewise, a greater number of retail outlets would need to handle ethanol. The seasonal split also leads to a greater need for transportation equipment during the higher use season. For Scenario #1, all terminal, retail, and transportation equipment needs have been increased by a factor of 1.3 to reflect these demands. The seasonal split factor was developed by calculating the additional tankage and retail outlets required to move 65% of volume in a six month period, compared to a normal 50% of volume per six month period. As an example, if a terminal were moving 600 mbbl per year with no seasonal split (and assuming one turn per month) approximately 50 mbbl of storage capacity would be required. However if 65% of the volume

is throughput in six months (i.e., 390 mbbl) the storage requirement for one turn per month is 65 mbbl or 1.3 times greater. While the storage capacity may not be totally utilized in the off season, it is assumed that tank leases would be required to be on an annual basis. Similar calculations apply at the retail level.

7. Composite Freight Rates: To assess total freight cost, composite freight rates were developed. Rail rates were developed by averaging the rail rate from major producers to the destination markets. Ship rates, when applicable, were developed by averaging the freight rate of ethanol plants (with barge shipping capabilities) to ship ethanol to the New Orleans area and then by ship to the destination markets. The ship rate includes the throughput/storage fees for staging product in tankage prior to loading the ship. For truck rates, the rates were developed based on an average of plants, or hub terminals, of origin as applicable, to destination terminals. The rates for the various delivery modes were then weighted by their representative volumes to yield a composite freight rate for each PADD.

8. Average Retail Unit Volume: To estimate the number of retail stations required to meet premised ethanol volumes, the average retail unit volume by PADD was taken from *"Infrastructure Requirements for an Expanded Fuel Ethanol Industry"*(2). These figures were derived by taking the total gasoline volume for each PADD from Federal Highway Administration (FHA) reports (11), which is then divided by the number of retail gasoline outlets (from the National Petroleum News)(12) to get the average per unit volume. These numbers are rounded upward slightly because, in most cases, ethanol would be blended in metropolitan areas, and also because there will likely be some per unit volume increase in future years. Based on the blend ratio of ethanol (5.7v% in California, 10v% elsewhere), the average annual ethanol use per retail outlet is determined for each PADD. The premised volumes are divided by the average ethanol use per retail unit to estimate the total number of retail outlets required for the premised ethanol volumes for each PADD. In the case of Scenario #1, premised volumes are increased by a factor of 1.3 to reflect the higher retail outlet count necessary for a 65/35 seasonal split scenario. The average historic retail outlet

volumes, in gallons per year, calculated for each PADD are as follows:

PADD I 742,523

PADD II 717,477

PADD III 533,867

PADD IV 721,798

PADD V 1,155,442

9. Cost Estimates/Amortization: As noted earlier, cost estimates for terminal equipment and retail conversion as well as the method for amortization were taken from *"Infrastructure Requirements for an Expanded Fuel Ethanol Industry"*. A recap of these items is covered in Appendix C. All costs for terminal and retail modifications, as well as freight expenses, are in constant year 2000 dollars (i.e., costs have not been adjusted for any inflation that may occur prior to the year in which the investment costs or other expenses are incurred).

10. Operating Costs: It should be noted that there could be very modest increases in operating costs for some terminals to handle ethanol. Storage and load out of ethanol would basically be similar to gasoline so operating costs (utilities, personnel, etc.) should be the same. One possible area of increased operating expense may be for product receipt, especially for pipeline terminals. Pipeline terminals receive their gasoline by pipeline which is fairly automated. However, ethanol would be delivered by rail or truck and could therefore necessitate more manpower to spot and unload rail cars or handle truck deliveries. Any such costs would depend on the current operational parameters of the terminal, the volume of ethanol received and the mode of ethanol delivery. Consequently, these costs cannot be accurately estimated and are not included here, but are likely to be on the order of hundredths of cents per gallon. One additional operating cost would be that in a seasonal use split scenario, some stations/retail outlets would presumably convert in and out of ethanol and would therefore incur conversion expenses annually. These costs are relatively minor, on a cents per gallon of blended fuel basis, and are omitted here.

11. Ethanol Shipment Costs: Shipments of ethanol will result in transportion costs somewhat higher than those for gasoline. This is because ethanol will not be routinely shipped by pipeline (2) but instead by barge, rail, truck, and in some cases, by ship. These additional costs are most pronounced in Scenario #1 due to the greater shipping distances involved. Likewise, shipments of new ethanol volumes will require some increase in transportation equipment. Again, this is more pronounced in Scenario #1.

12. Transportation Equipment Demands: The demand for transportation equipment is calculated by taking the annual volume shipped divided by the volume of that shipment mode to yield annual shipments by mode. This is divided by 12 to yield monthly shipments. Total monthly shipments are divided by the number of turnarounds (one complete round trip) expected for that type of shipping equipment, over the distance and route traversed. This yields an equipment equivalent. In Scenario #1 the equipment equivalent is increased by the factor 1.3 to compensate for the 65/35% seasonal demand split.

13. This analysis does not include any costs incurred by the ethanol producers to store excess production during the slower sales period in the 65/35% seasonal split used in Scenario #1. Since ethanol production is relatively constant on a month to month basis, it would be necessary to build or lease tanks to store excess production during the low demand six month period for later sales in the higher demand six month period. Costs for tank construction and/or leases, as well as any carrying costs for storing inventory for extended periods would be incurred by the ethanol producer and presumably reflected in the price of the ethanol.

14. Note that a “Glossary of Commonly Used Terms and Acronyms” is included as Appendix D.

Section 1 - Background & Introduction: Specific References

1. Downstream Alternatives Inc. (DAI). 2000. *The Current Fuel Ethanol Industry Transportation, Marketing, Distribution, and Technical Considerations*, Phase I, Task 2 Project Deliverable Report, Oak Ridge National Laboratory, Ethanol Project, Subcontract No. 4500010570, South Bend, IN 46680-2587, May 15,
http://www.ott.doe.gov/biofuels/database.html

2. Downstream Alternatives Inc. (DAI). 2002. *Infrastructure Requirements for an Expanded Fuel Ethanol Industry*, Phase II Project Deliverable Report, Oak Ridge National Laboratory, Ethanol Project, Subcontract No. 4500010570, South Bend, IN 46680-2587, January 15, http://www.afdc.doe.gov/pdfs/6235.pdf

3. S.517 (Daschle), Sec.819. *Renewable Content of Motor Fuel*.

4. Downstream Alternatives Inc. (DAI). 2002. *Assumptions and Premises for Phase III Task 1 Deliverable for Studies on Ethanol Logistics Issues*, Submitted to Oak Ridge National Laboratory, Ethanol Project, Subcontract No. 4500010570, South Bend, IN 46680-2587, March 14.

5. Hadder, G.R. 2000. *Ethanol Demand in United States Regional Production of Oxygenate-Limited Gasoline*, ORNL/TM-2000/165, Oak Ridge National Laboratory, Oak Ridge, TN 37831, August.

6. U.S. Department of Energy (DOE). 2001b. Energy Information Administration. *Petroleum Marketing Annual*, DOE/EIA-0380(00), Washington, DC.

7. U.S. Environmental Protection Agency (EPA). 2001. "Revised PADD Data," tables provided by John Weihrauch to G.R. Hadder.

8. U.S. Department of Energy (DOE), Energy Information Administration. 2001c. *Petroleum Supply Annual 2000 Volume 1*, DOE/EIA-0340(00)/l, Washington, DC, http://www.eia.doe.gov/oil_gas/petroleum/data_publications/petroleum_supply_annual/psa_volume1/psa_volume1.html

9. California Air Resources Board (CARB). 2001. *California Gasoline Program Procedures Documents, Predictive Models, and CARBOB Model*, December 27, http://www.arb.ca.gov/cbg/premodel/Ph3CARBOBPMFlat011602.xls

10. U.S. Department of Energy (DOE), Energy Information Administration. 2001a. *Annual Energy Outlook 2002 with Projections to 2020*, DOE/EIA-0383(2002), Washington, DC, December 21, http://www.eia.doe.gov/oiaf/aeo99/aeo99tables/aeo99b.pdf

11. Federal Highway Administration (FHA). 1999. Monthly gasoline reported by state, 1998, from *Monthly Motor Fuel Reported by State*, December.

12. National Petroleum News. 2001. *NPN Market Facts*, July.

Section 1 - Background & Introduction: General References

None

Section 2

Ethanol Production for Scenarios #1 and #2

2.0 Ethanol Production for Scenarios #1 and #2

The premises and assumptions for plant locations are the same for both Scenario #1 and #2.

2.1 2002 Baseline Ethanol Production

We start with a baseline of existing plants and plants under construction as of 2002. The following table lists those plants.

Table 2-1 PADD II BY STATE - 2002
TOTAL ALL PLANTS + UNDER CONSTRUCTION

Plant	Location	Annual Volume Production Capacity (mmgy)
IA		
Archer Daniels Midland	Cedar Rapids, IA	450.0*
Archer Daniels Midland	Clinton, IA	
Cargill, Inc.	Eddyville, IA	35.0
Grain Processing Corp.	Muscatine, IA	10.0
Manildra Energy Corp.	Hamburg, IA	8.0
Permeate Refining	Hopkinton, IA	1.5
Siouxland Energy & Livestock Coop	Sioux Center, IA	14.0
Sunrise Energy	Blairstown, IA	7.0
Little Sioux Corn Processors, LLC	Marcus, IA	40.0
Midwest Grain Processors	Lakota, IA	45.0
Northeast Iowa Ethanol, LLC	Earlville, IA	15.0
Pine Lake Corn Processors, LLC	Steamboat Rock, IA	15.0
Quad-County Corn Processors	Galva, IA	18.0
Tall Corn Ethanol, LLC	Coon Rapids, IA	40.0
Total IA		**698.5**
IL		
Archer Daniels Midland	Decatur, IL	500.0*
Archer Daniels Midland	Peoria, IL	
Midwest Grain	Pekin, IL	65.0
Williams Bio-Energy	Pekin, IL	100.0
Adkins Energy, LLC	Lena, IL	40.0
Total IL		**705.0**

Table 2-1 continued

Plant	Location	Annual Volume Production Capacity (mmgy)
IN		
New Energy Corp.	South Bend, IN	85.0
Total IN		**85.0**
KS		
ESE Alcohol Inc.	Leoti, KS	1.5
High Plains Corp.	Colwich, KS	20.0
Midwest Grain	Atchison, KS	25.0
Reeve Agri-Energy	Garden City, KS	12.0
U.S. Energy Partners, LLC	Russell, KS	25.0
Total KS		**83.5**
KY		
U.S. Liquids	Louisville, KY	4.0
Total KY		**4.0**
MI		
Michigan Ethanol, LLC	Caro, MI	40.0
Total MI		**40.0**
MN		
Agri-Energy, LLC	Luverne, MN	21.0
Al-Corn Clean Fuel	Claremont, MN	18.0
Central MN Ethanol Coop	Little Falls, MN	19.0
Chippewa Valley Ethanol Co.	Benson, MN	21.0
Corn Plus	Winnebago, MN	44.0
DENCO, LLC	Morris, MN	20.0
Ethanol2000, LLP	Bingham Lake, MN	30.0
Exol Inc.	Albert Lea, MN	38.0
Gopher State Ethanol	St. Paul, MN	15.0
Heartland Corn Products	Winthrop, MN	35.0
Land O' Lakes	Melrose, MN	2.6
Minnesota Corn Processors	Marshall, MN	40.0
Minnesota Energy	Buffalo Lake, MN	18.0
Pro-Corn, LLC	Preston, MN	22.0
Total MN		**343.6**

Table 2-1 continued

Plant	Location	Annual Volume Production Capacity (mmgy)
MO		
Golden Triangle Energy, LLC	Craig, MO	20.0
Northeast MO Grain Processors	Macon, MO	21.0
Total MO		**41.0**
ND		
Alchem Ltd. LLLP	Grafton, ND	10.5
Archer Daniels Midland	Wallhalla, ND	28.0
Total ND		**38.5**
NE		
AGP	Hastings, NE	52.0
Cargill, Inc.	Blair, NE	75.0
Chief Ethanol	Hastings, NE	62.0
High Plains Corp.	York, NE	50.0
Minnesota Corn Processors	Columbus, NE	100.0
Sutherland Associates	Sutherland, NE	15.0
Williams Bio-Energy	Aurora, NE	35.0
Husker Ag Processing	Plainview, NE	20.0
Total NE		**409.0**
OH		
Total OH		**0.0**
OK		
Total OK		**0.0**
SD		
Broin Companies	Scotland, SD	9.0
Dakota Ethanol, LLC	Wentworth, SD	45.0
Heartland Grain Fuels, LP	Aberdeen, SD	8.0
Heartland Grain Fuels, LP	Huron, SD	14.0
Glacial Lakes Energy, LLC	Watertown, SD	40.0
Northern Lights Ethanol, LLC	Milbank, SD	40.0
Tri-State Ethanol Co., LLC	Rosholt, SD	14.0
Total SD		**170.0**

Table 2-1 continued

Plant	Location	Annual Volume Production Capacity (mmgy)
TN		
A.E. Staley	Loudon, TN	60
Total TN		**60**
WI		
Plover Ethanol	Plover, WI	5.0
ACE Ethanol	Stanley, WI	15.0
Badger State Ethanol, LLC	Monroe, WI	40.0
Spring Green Ethanol	Spring Green, WI	0.7
Total WI		**60.7**
Grand total PADD II (2002)		**2738.8**
	(other PADDS)	**41.2**
		2780.0

Source: Renewable Fuels Association, "Growing Homeland Security - Ethanol Industry Outlook 2002"

*total state capacity for company

2.2 2004 Ethanol Production

For calendar year 2004, the RFS requirement is 2.3 bgy. Since baseline production capacity already exceeds this amount by over 0.4 bgy, we assume no additional new production is brought on line by the beginning of year 2004. Historically, ethanol production capacity (nameplate) has generally exceeded actual production (operational rate) by 0.2 to 0.4 bgy in most calendar years.

2.3 2007 Ethanol Production

For calendar year 2007, the RFS requirement is 3.2 bgy. Nameplate capacity would need to be slightly higher because it is unreasonable to assume that the entire industry can run at 100% of name-plate capacity. Consequently we have raised total nameplate capacity to 3.405 bgy which allows for a 94% operational rate. This was done by assuming some plant expansion and the addition of 15 new plants in PADD II. Expansions and new plant placements were derived from *"Infrastructure Requirements for an Expanded Fuel Ethanol Industry"*. These expansions and additions for 2007 are covered in the following table.

Table 2-2 PADD II BY STATE - 2007 U.S. Fuel Ethanol Production Capacity + Theoretical Plants Added

Plant	Location	Additional Annual Production Capacity 2007 (mmgy)	Production Total Capacity by 2007 (mmgy)
IA			
Cargill, Inc.*	Eddyville, IA	10.0	
Proposed plant	Des Moines, IA	15.0	
Proposed plant	Spenser, IA	40.0	
Theoretical plant	Burlington, IA	35.0	
Total IA		**100.0**	**798.5**
IL			
Midwest Grain*	Pekin, IL	15.0	
Williams Bio-Energy*	Pekin, IL	20.0	
Proposed plant	Cascade, IL	100.0	
Theoretical plant	Mt. Carmel, IL	50.0	
Total IL		**185.0**	**890 .0**
IN			
Theoretical plant	Indianapolis, IN	50.0	
Total IN		**50.0**	**135 .0**
KS			
High Plains Corp.*	Colwich, KS	10.0	
Midwest Grain*	Atchison, KS	10.0	
Proposed plant	Pratte, KS	15.0	
Total KS		**35.0**	**118.5**
KY			
Total KY		**0.0**	**4 .0**
MI			
Proposed plant	Lansing, MI	40.0	
Total MI		**40.0**	**80.0**
MN			
Proposed plant	St. Paul, MN	30.0	
Total MN		**30.0**	**373.6**

Table 2-2 continued

Plant	Location	Additional Annual Production Capacity 2007 (mmgy)	Production Total Capacity by 2007 (mmgy)
MO			
Proposed plant	Cape Girardeau, MO	30.0	
Total MO		**30.0**	**71 .0**
ND			
Total ND		**0.0**	**38.5**
NE			
AGP*	Hastings, NE	15.0	
Cargill, Inc.*	Blair, NE	10.0	
Chief Ethanol*	Hastings, NE	10.0	
High Plains Corp.*	York, NE	10.0	
Williams Bio-Energy*	Aurora, NE	5.0	
Proposed plant	Neely, NE	15.0	
Total NE		**65.0**	**474 .0**
OH			
Total OH		**0.0**	**0 .0**
OK			
Total OK		**0.0**	**0.0**
SD			
Proposed plant	Milbank, SD	40.0	
Proposed plant	Platte, SD	15.0	
Proposed plant	Rosholt, SD	15.0	
Total SD		**70.0**	**240.0**
TN			
Total TN		**0.0**	**60.0**
WI			
Proposed plant	Lacrosse, WI	20.0	
Total WI		**20.0**	**80.7**
Grand Total (PADD II) 2007		**3363.8**	**3363.8**
	(other PADDs)	**41.2**	
		3405.0	

New volume from expansion at existing plants (2007)	**115.0**	**(10 plants)**
New volume from new proposed/theoretical plants (2007)	**510.0**	**(15 plants)**
Total new production	**625.0**	

*Expansion at existing plant

2.4 2012 Ethanol Production

For calendar year 2012 the RFS requirement is 5.0 bgy. As with the 2007 requirement above, we have assumed a slightly higher nameplate capacity would be required to reach the RFS requirement. Nameplate ethanol production capacity has been raised to 5.235 bgy for year 2012. Production increases were achieved by adding theoretical plants in PADD II. As was the case for 2007, placement of new theoretical plants was derived from "*Infrastructure Requirements for an Expanded Fuel Ethanol Industry*". The following table covers the plant additions for 2012.

Table 2-3 Padd II By State - 2012 U.S. Fuel Ethanol Production Capacity + Theoretical Plants Added

Plant	Location	Additional Annual Production Capacity 2012 (mmgy)	Production Total Capacity by 2012 (mmgy)
IA			
Theoretical plant	Davenport, IA	30.0	
Theoretical plant	Des Moines, IA	50.0	
Theoretical plant	Waterloo, IA	30.0	
Theoretical plant	Mason City, IA	50.0	
Total IA		**160.0**	**958.5**
IL			
Theoretical plant	Quincy, IL	50.0	
Theoretical plant	Chicago, IL	50.0	
Total IL		**100.0**	**990.0**
IN			
Theoretical plant	Lafayette, IN	50.0	
Theoretical plant	Terre Haute, IN	50.0	
Total IN		**100.0**	**235.0**
KS			
Theoretical plant	Salinas, KS	50.0	
Theoretical plant	Topeka, KS	50.0	
Theoretical plant	Witchita, KS	50.0	
Total KS		**150.0**	**268.5**

Table 2-3 continued

Plant	Location	Additional Annual Production Capacity 2012 (mmgy)	Production Total Capacity by 2012 (mmgy)
KY			
Theoretical plant	Louisville, KY	50.0	
Theoretical plant	Bowling Green, KY	50.0	
Total KY		**100.0**	**104.0**
MI			
Theoretical plant	Jackson, MI	45.0	
Theoretical plant	Kalamazoo, MI	50.0	
Total MI		**95.0**	**175.0**
MN			
Theoretical plant	Mankato, MN	30.0	
Theoretical plant	St. Paul, MN	40.0	
Total MN		**70.0**	**443.6**
MO			
Theoretical plant	Caruthersville, MO	40.0	
Theoretical plant	St. Louis, MO	150.0	
Theoretical plant	Jefferson City, MO	50.0	
Theoretical plant	St. Louis, MO	50.0	
Theoretical plant	Springfield, MO	40.0	
Total MO		**330.0**	**401.0**
ND			
Theoretical plant	Bismarck, ND	30.0	
Theoretical plant	Fargo, ND	17.0	
Theoretical plant	Grand Forks, ND	30.0	
Total ND		**77.0**	**115.5**
NE			
Theoretical plant	Sioux City, NE	33.4	
Theoretical plant	Auburn, NE	50.0	
Theoretical plant	Omaha, NE	50.0	
Theoretical plant	Lincoln, NE	50.0	
Total NE		**183.4**	**657.4**

Table 2-3 continued

Plant	Location	Additional Annual Production Capacity 2012 (mmgy)	Production Total Capacity by 2012 (mmgy)
OH			
Theoretical plant	Columbus, OH	50.0	
Theoretical plant	Toledo, OH	40.0	
Theoretical plant	Cincinnati, OH	50.0	
Theoretical plant	Mansfield, OH	50.0	
Total OH		**190.0**	**190.0**
OK			
Theoretical plant	Oklahoma City, OK	25.0	
Theoretical plant	Tulsa, OK	20.0	
Total OK		**45.0**	**45.0**
SD			
Theoretical plant	Rapid City, SD	20.0	
Theoretical plant	Sioux Falls, SD	30.0	
Total SD		**50.0**	**290.0**
TN			
Theoretical plant	Memphis, TN	50.0	
Theoretical plant	Nashville, TN	40.0	
Total TN		**90.0**	**150.0**
WI			
Theoretical plant	Madison, WI	50.0	
Theoretical plant	Milwaukee, WI	40.0	
Total WI		**90.0**	**170.7**
Grand Total (PADD II) 2012		**5194.2**	**5194.2**
	(other PADDs)	**41.2**	
		5235.4	
New volume from expansion at existing plants (2012)		**0.0**	**(0 plants)**
New volume from new proposed/theoretical plants (2012)		**1,830.4**	**(41 plants)**
Total new production		**1,830.4**	

Section 2 - Ethanol Production for Scenarios #1 and #2: Specific References

None

Section 2 - Ethanol Production for Scenarios #1 and #2: General References

1. Downstream Alternatives Inc. (DAI). 2002. *Infrastructure Requirements for an Expanded Fuel Ethanol Industry*, Phase II Project Deliverable Report, Oak Ridge National Laboratory, Ethanol Project, Subcontract No. 4500010570, South Bend, IN 46680-2587, January 15, http://www.afdc.doe.gov/pdfs/6235.pdf

2. Renewable Fuels Association (RFA). 2002. *Growing Homeland Energy Security - Ethanol Industry Outlook 2002*, Washington, DC.

Section 3

Ethanol Use by PADD & Time Frame

Scenario #1 & Scenario #2

3.0 Ethanol Use by PADD & Time Frame Scenario #1 & Scenario #2

3.1 Ethanol Use by PADD & Time Frame - Scenario #1

For Scenario #1 it is assumed that the ethanol used in the baseline years continues to be used in the same area for year 2004 because certain areas would continue to use ethanol in oxygenated fuel programs for their carbon monoxide (CO) non-attainment programs. It is assumed that areas come into compliance in 2004 but continue to use ethanol for one additional year as part of their State Implementation Plan (SIP) maintenance. Los Angeles would not come into CO compliance until 2010, but the same level of oxygenate would continue to be used for RFG compliance. The breakdown of ethanol use by PADD for Scenario #1 is covered in the following table.

Table 3-1 Scenario #1 - High Cost/High Difficulty Boundary Case Ethanol Use (bgy)

PADD	Base	2004	2007	2012
I	0.111	0.501	0.800	1.600
II	1.071	1.384	1.500	1.800
III	0.083	0.083	0.265	0.500
IV	0.065	0.065	0.065	0.100
V	0.146	0.300	0.600	1.000
Total	1.476	2.333	3.230	5.000

In order to properly assess the infrastructure requirements and freight costs, it is necessary to assess where, in each PADD, new ethanol use is likely to occur. In this scenario a significant amount of ethanol is used in RFG in PADDs I and V. So new ethanol use in these PADDs is directed to areas with RFG programs. The first step is determining where the majority of current ethanol production is being directed. To do this, Federal Highway Administration (FHA) data on ethanol use by state are used.(1) FHA data are used because it is the only source that breaks down ethanol use by state. Year 2000 figures are used for the baseline. This will tend to underestimate actual current use by approximately

0.3 bgy. From that starting point it is possible to project increased ethanol use by PADD and then project where the ethanol would be used. The following tables cover new ethanol use and projected markets in each of the years studied.

Table 3-2 New Ethanol Use Scenario #1 - 2004
(bgy)

PADD	New Ethanol Volume	Projected Use Area/Volumes
I	0.390	New York, 0.300; Philadelphia, 0.040; Hartford, 0.050
II	0.313	Illinois, Indiana, Ohio, 0.313
III	0.000	-
IV	0.000	-
V	0.154	Los Angeles, 0.154
Total	0.857	

Table 3-3 New Ethanol Use Scenario #1 - 2007
(bgy)

PADD	New Ethanol Volume	Projected Use Area/Volumes
I	0.299	New York, 0.200; Philadelphia, 0.040; Baltimore/DC, 0.059
II	0.116	Kansas, Michigan, Missouri, 0.116
III	0.182	Arkansas, Mississippi, Texas, 0.182
IV	0.000	-
V	0.300	Los Angeles 0.096; San Francisco, 0.100; San Diego, 0.034; Sacramento, 0.02; California other, 0.05
Total	0.897	

Table 3-4 New Ethanol Use Scenario #1 - 2012
(bgy)

PADD	New Ethanol Volume	Projected Use Area/Volumes
I	0.800	New York, 0.290; Philadelphia, 0.120; Baltimore/DC, 0.190; Boston, 0.200
II	0.300	Nebraska, Kansas, Ohio, Wisconsin, 0.300
III	0.235	Arkansas, Mississippi, Texas, 0.235
IV	0.035	Colorado, Utah, 0.035
V	0.400	Los Angeles 0.050; San Francisco 0.028; San Diego, 0.017; Sacramento, 0.010; other California 0.061; Phoenix, 0.10; Seattle/Washington State, 0.134
Total	1.770	

3.2 Ethanol Use by PADD & Time Frame - Scenario #2

The same assumption with regards to CO non-attainment areas is made for Scenario #2. The breakdown of ethanol use by PADD for Scenario #2 is covered in the following table.

Table 3-5 Scenario #2 - Low Cost/Low Difficulty Boundary Case
(bgy)

PADD	Base	2004	2007	2012
I	0.111	0.111	0.111	0.111
II	1.071	1.995	2.678	3.200
III	0.083	0.083	0.200	1.443
IV	0.065	0.065	0.065	0.100
V	0.146	0.146	0.146	0.146
Total	1.476	2.400	3.200	5.000

Again, in order to properly assess the infrastructure requirements and freight costs, it is necessary to assess where in each PADD the new ethanol use would occur. In Scenario #2 it is assumed that new ethanol volume is distributed to the markets closest to the production points, i.e., PADDs II and III. As with Scenario #1, the starting point is to determine baseline ethanol use and then determine where new ethanol volumes would be directed. Note that there are slight variations in total volumes compared to Scenario #1. Projected ethanol use, by area, for each year studied is covered in the following tables.

Table 3-6 New Ethanol Use Scenario #2 - 2004
(bgy)

PADD	New Ethanol Volume	Projected Use Area/Volumes
I	0.000	
II	0.924	Illinois, Iowa, Indiana, Missouri, Nebraska, Kansas, 0.924
III	0.000	-
IV	0.000	-
V	0.000	
Total	0.924	

Table 3-7 New Ethanol Use Scenario #2 - 2007
(bgy)

PADD	New Ethanol Volume	Projected Use Area/Volumes
I	0.000	
II	0.683	Illinois, Iowa, Indiana, Missouri, Nebraska, Kansas, Wisconsin, 0.683
III	0.117	Arkansas, Mississippi, Texas, 0.117
IV	0.000	-
V	0.000	
Total	0.800	

Table 3-8 New Ethanol Use Scenario #2 - 2012
(bgy)

PADD	New Ethanol Volume	Projected Use Area/Volumes
I	0.000	
II	0.522	Ohio, Michigan, Kentucky, Tennessee, Oklahoma, Minnesota, North Dakota, South Dakota, 0.522
III	1.243	Arkansas, Texas, Louisiana, Mississippi, 1.243
IV	0.035	Colorado, 0.035
V	0.000	
Total	1.800	

Section 3 - Ethanol Use by PADD & Time Frame Scenario #1 & Scenario #2: Specific References

1. Federal Highway Administration (FHA). 1999. Monthly gasoline reported by state, 1998, from *Monthly Motor Fuel Reported by State*, December.

Section 3 - Ethanol Use by PADD & Time Frame Scenario #1 & Scenario #2: General References

2. Downstream Alternatives Inc. (DAI). 2002. *Infrastructure Requirements for an Expanded Fuel Ethanol Industry*, Phase II Project Deliverable Report, Oak Ridge National Laboratory, Ethanol Project, Subcontract No. 4500010570, South Bend, IN 46680-2587, January 15, http://www.afdc.doe.gov/pdfs/6235.pdf

3. Downstream Alternatives Inc. (DAI). 2002. *Assumptions and Premises for Phase III Task 1 Deliverable for Studies on Ethanol Logistics Issues*, Submitted to Oak Ridge National Laboratory, Ethanol Project, Subcontract No. 4500010570, South Bend, IN 46680-2587, March 14.

Section 4

Scenario #1

4.0 Scenario #1

As noted in Section 1.1.4 "Methodology and Additional Assumptions", this work follows a similar format to the recently completed report *"Infrastructure Requirements for an Expanded Ethanol Industry"*. The preliminary terminal analysis for that report is used, as are cost estimates for new tanks, tank conversions, rail spurs, blending systems, and retail unit conversion expense. In all years analyzed, Scenario #1 assumes a 65/35% seasonal split, i.e. 65% of ethanol is sold over one six-month period of the year and 35% in the other six months of the year. Consequently, for calculating tankage requirements and retail unit conversion costs, we have increased the numbers by a factor of 1.3. This is done because if more ethanol is sold in one seasonal period, a greater number of terminals and retail outlets would need to carry ethanol blends than would be necessary if the volumes were equally spread over the calendar. Also, demand for transportation equipment would increase due to seasonal use patterns.

4.1 Scenario #1 - Year 2004

In Scenario #1 for year 2004, the increased ethanol use is 0.857 bgy. Costs associated with this volume increase are covered in the following sections.

4.1.1 Scenario #1 - Year 2004 Terminal & Retail Equipment Requirements & Cost

We start by determining the number of servicing terminals for each targeted market area (and related ethanol volumes) and how many presently are indicated to already have ethanol. The preliminary estimate for tankage is then made. There are a total of 232 terminals in the target markets, of which 38 are already listed in terminal atlases as having ethanol storage available. This information is included in the following table.

Table 4-1 Scenario #1 - Year 2004 - Preliminary Tank Requirement Estimate

PADD	Area	New Ethanol Volume (bgy)	No. of Servicing Terminals	No. with Ethanol	Estimated New Tankage Requirement
I	Hartford CT	0.05	2	0	2 x 25m
	New York NY	0.3	33	1	16 x 25m
	Philadelphia PA	0.04	12	0	6 x 25m
II	IL/IN/OH	0.313	149	37	15 x 5m
					20 x 10m
V	Los Angeles CA	0.154	36	0	12 x 25m
					1 x 50m
					1 x 100m
Totals		0.857	232	38	15 - 5m
					20 - 10m
					36 - 25m
					1 - 50m
					1 - 100m

73 tanks totaling 1,325 M barrels of capacity

Notes: **Current Estimated Gasoline Volume (bgy)**

Hartford CT	0.52
New York NY	9.17
Philadelphia PA	2.72
IL/IN/OH	13.45
Los Angeles CA	7.01
Total	32.87

Source for city/MSA volume: Infrastructure Requirements for an Expanded Ethanol Industry, Downstream Alternatives Inc., January 15, 2002

Source for State gasoline volume: Monthly Gasoline Report by State - 2000, Table MF-33GA, Federal Highway Administration

As can be seen in the table, the new ethanol volume for 2004 in Scenario #1 is 0.857 bgy and there are 232 terminals servicing the target markets. It is estimated that a total of 73 tanks totaling 1,325 MB (55,650,000 gallons) would be required. At 24 inventory turns per year this would be sufficient to handle 1.3 bgy compared to the factored equivalent of 1.11 bgy (0.857 bgy x 1.3).

Because the information available in terminal atlases does not always indicate ethanol storage availability, an estimate is made of terminals that may already handle ethanol but that are not listed as such in terminal atlases. The number of existing tanks that could be used without major conversion is then estimated, as is the number of existing tanks that could be used with conversion modifications (e.g., addition of floating internal covers or fixed roof). The remaining tank requirement is assumed to represent the number of new tanks required. A breakdown of the aforementioned categories is covered in the following table.

Table 4-2 Scenario #1 - Year 2004 - Revised Tank Requirement Estimate

PADD	Area	Tank Size (bbls)	No. of Tanks	Estimated Already In Use	Estimated use without Conversion	Estimated Use With Conversion	New Tanks Required
I	Hartford CT	25m	2	0	0	1	1
	New York NY	25m	16	1	3	2	10
	Philadelphia PA	25m	6	0	1	1	4
II	IL/IN/OH	5m	15	2	1	2	10
		10m	20	2	3	3	12
V	Los Angeles CA	25m	12	8	0	0	4
		50m	1	1	0	0	0
		100m	1	1	0	0	0
Totals			73	15	8	9	41

As the previous table indicates, it is estimated that at least 15 terminals are already handling ethanol. This is primarily due to the number of terminals in California that have already installed such capabilities (1, 2, 3, 4, 5). It is further estimated that at least 8 tanks, in PADDs I and II, could be used without major conversion, and 9 tanks could be used after necessary conversion. A total of 41 new tanks would need to be installed. The conversion costs for the 9 tanks converted is estimated at $360,000 as covered in the following table.

Table 4-3 Scenario #1 - Year 2004 - Cost Estimate for Tank Conversion

PADD	Total No. of Conversions	Tank Size (bbls)	Total Cost Tanks (000)
I	4	25m	$240
II	2	5m	$30
	3	10m	$90
V	0	-	-
Totals	9	-	$360

New tanks would cost $8,250,000 as covered by PADD in the following table.

Table 4-4 Scenario #1 - Year 2004 - Cost Estimate for New Tanks

PADD	Tanks Required	Tank Size (bbls)	Cost Per Steel barrel	Total Cost (000)
I	15	25m	$12	$4,500
II	10	5m	$15	$750
	12	10m	$15	$1,800
V	4	25m	$12	$1,200
Totals	41	-	-	$8,250

It is assumed that all terminals that will be newly converted to ethanol would require new blending systems. This includes all terminal categories except those estimated to already have ethanol. A total of 58 terminals would need to install such blending systems at a total cost of $17,400,000 as covered in the next table.

Table 4-5 Scenario #1 - Year 2004 - Cost Estimate for Blending Systems

PADD	No. of Units Required	Cost Each	Total Cost (000)
I	23	@ $300M	$6,900
II	31	@ $300M	$9,300
V	4	@ $300M	$1,200
Totals	58	@ $300M	$17,400

We have also estimated that at least 7 terminals would need to install rail spurs to handle increased delivery by rail car. The estimated cost for rail spur additions is $2,485,000 and is covered in the next table.

Table 4-6 Scenario #1 - Year 2004 - Cost Estimate for Rail Spur Installation

PADD	No. of Units Required	Cost Each	Total Cost (000)
I	5	@ $355M	$1,775
II	2	@ $355M	$710
V	-	@ $355M	$0
Totals	7	@ $355M	$2,485

Finally we are assuming that all terminals newly converted to ethanol could have unforeseen miscellaneous expenses such as piping modifications or loading rack modifications. We have provided a contingency expense of $20,000 for each such terminal. The 58 terminals in this category would then require $1,160,000 as covered in the following table.

Table 4-7 Scenario #1 - Year 2004 - Miscellaneous Contingency Cost Estimate

PADD	No. of Terminals	Cost estimated	Total Cost (000)
I	23	@ $20M	$460
II	31	@ $20M	$620
V	4	@ $20M	$80
Totals	58	@ $20M	$1,160

Finally there are also expenses in converting retail stations to ethanol use. Because ethanol is directed to the highly populated metropolitan RFG areas, in PADD I it is assumed the average retail outlet volume is 1,000,000 gallons per unit year. Similarly, in PADD II average retail unit volume is assumed to be 850,000 gallons per year. Finally, in PADD V, average retail unit volume is assumed to be 1,200,000 gallons per year. The various retail volume calculations to determine the number of retail units for the premised ethanol volumes are covered in the following table.

Table 4-8 Scenario #1 - Year 2004 - Calculations for Number of Required New Retail Units Handling Ethanol

PADD I 1,000,000 gallons per unit annually = 100,000 gallons of ethanol annually
0.39 bgy ethanol x 1.3 = 0.507 bgy equivalent ÷ 100,000 gallons = 5070 units

PADD II 850,000 gallons per unit annually = 85,000 gallons of ethanol annually
0.313 bgy ethanol x 1.3 = 0.4069 bgy equivalent ÷ 85,000 gallons = 4,787 units

PADD V (Los Angeles) 1.2 million gallons per unit annually = 68,400 gallons of ethanol annually
0.154 bgy ethanol x 1.3 = 0.2002 bgy equivalent ÷ 64,800 gallons = 3,090 units

The premised volumes for 2004 would require a total of 12,783 retail units to convert to ethanol blends at an estimated cost of $7,638,000. These units are recapped by PADD in the table below.

Table 4-9 Scenario #1 - Year 2004 - Retail Unit Conversions and Costs

PADD	No. of Units	Cost per Unit estimated	Total Cost (000)
I	5,070	@ $590	$2,991
II	4,787	@ $590	$,824
V	3,090	@ $590	$1,823
Totals	12,947	@ $590	$7,638

Table 4-10 covers the required investments for each category by PADD. In addition, the volume requirements are calculated and costs are amortized.

The combined costs of preparing for the incremental ethanol volume of year 2004 is $37,293,000, at a total amortized cost of $0.0068 per gallon of ethanol or under $0.00068 per gallon of gasoline/ ethanol blend.

For PADD I, total costs are $16,866,000 or $0.0067 per gallon of ethanol on an amortized basis. For PADD II, total costs are $16,124,000 or $0.0080 per gallon of ethanol on an amortized basis. For PADD V, total costs are $4,303,000 or $0.0044 per gallon of ethanol on an amortized basis. The lower costs in PADD V are a reflection of the investments that have already been made in preparation for the MTBE ban, which would have necessitated ethanol use by January 1, 2003 had Governor Davis not extended the deadline. (1,2,3,4,5)

Table 4-10 Scenario #1 - Year 2004 - Total Estimated Capital Investment for Terminal Improvements & Retail Conversions for E-10/E-5.7

	New ethanol Volume (bgy)	Cost of Tank Conversion (000)	Cost of New Tanks (000)	Cost of Blending Systems (000)	Modification for Rail Receipt (000)	Contingency (000)	Retail Conversions (000)	Total (000)	Amortized cost per gallon
PADD I	0.390	$240	$4,500	$6,900	$1,775	$460	$2,991	$16,866	$0.0067
PADD II	0.313	$120	$2,550	$9,300	$710	$620	$2,824	$16,124	$0.0080
PADD V	0.154	$0	$1,200	$1,200	$0	$80	$1,823	$4,303	$0.0044
TOTALS	0.857	$360	$8,250	$17,400	$2,485	$1160	$7,638	$37,293	$0.0068

4.1.2 Scenario #1 - Year 2004 Freight Costs and Transportation Equipment Requirements

In year 2004, the increased ethanol volumes are relatively low. This combined with the premised 65/35% seasonal split will likely lead to a preference for rail shipments. We have estimated that of the 0.39 bgy ethanol shipped to PADD I, 0.14 bgy would move by ship from the Gulf Coast (after being barged there from the Midwest), while 0.25 bgy would move by rail. Since not all terminals have rail receipt capability, we have also assumed that 0.078 bgy of the ethanol, equating to 20 percent of the PADD I incremental ethanol volume, would need to be redistributed from "hub terminals". Most of this would be by truck, but some small amount could move by barge.

In PADD II, barges and rail cars would move only small ethanol volumes, 0.05 bgy by each mode, due to proximity to plants. This will encourage the use of low working inventory requiring less tank capacity and, in turn, transport truck deliveries. Truck deliveries in PADD II are estimated at 0.213 bgy. No redistribution from hub terminals is necessary in PADD II due to the numerous points of supply availability.

In PADD V we estimate that 0.07 bgy of ethanol would move by ship and 0.084 bgy by rail. Of this amount, an estimated 0.046 bgy (30%) would need to be redistributed by truck.

Total shipments by mode for each PADD (for both interPADD and intra-PADD movements if applicable) are recapped in the following table.

Table 4-11 Scenario #1 - Year 2004 - Projected Transportation Modes (bgy)

PADD	Total Volume	Projected Transportation Modes				Redistribution from Hub Terminal
		Ship	Barge	Rail	Truck	
I	0.390	0.140	--	0.250	--	0.078
II	0.313	--	0.050	0.050	0.213	--
V	0.154	0.070	--	0.084	--	0.046
Totals	0.857	0.210	0.050	0.384	0.213	0.124

The composite freight rates and resulting total freight charges by PADD, for both initial shipments and redistribution shipments, as well as an average resulting freight per gallon of ethanol, are covered in the following table.

Table 4-12 Scenario #1 - Year 2004 - Transportation Costs

	Primary Shipments		Redistribution Shipments		Total	Average
PADD	Composite Freight Rate per Gallon	Total Freight Cost (000)	Composite Redistribution Freight Rate per Gallon	Total Redistribution Cost (000)	Freight Cost (000)	Freight Costs per Gallon
I	$0.11	$42,900	$0.025	$1,950	$44,850	$0.115
II	$0.035	$10,955	n/a		$10,955	$0.035
V	$0.14	$21,560	$0.025	$1,150	$22,710	$0.1475
Totals		$75,415		$3,100	$78,515	$0.0916

Total freight charges for the 0.857 bgy incremental ethanol volume are $78,515,000 averaging $0.0916 per gallon of ethanol. For PADD I the average freight rate is $0.115 per gallon, for PADD II it is $0.035, and for PADD V it is $0.1475 per gallon.

Although the increased demand on transportation capabilities is relatively small in year 2004, it is discussed here so that each year studied represents only the demand for the associated incremental ethanol volume.

The following table provides calculations for movements by ship.

Table 4-13 Scenario #1 - Year 2004 - Ship Requirements

PADD	Volume (bgy)	Annual Shipments	Monthly Shipments	Monthly Turnarounds	No. of Shipping Equivalent
I	0.14	13.33	1.1	2	0.55
II	-	-	-	-	-
V	0.07	6.67	0.55	0.9	0.61
Total	0.21	20	1.65		1.16

1.16 ships (250 mb capacity) x 1.3 seasonal factor = 1.5 equivalent ships required

(NOTE: 1 shipment = 250 mb (10.5 million gallons))

In 2004 total ship equivalents, after applying the 1.3 seasonal split factor, would be 1.5 ships.

Barge shipments are comprised of shipments within PADD II as well as shipments to New Orleans for staging and subsequent shipment to PADDs I and V. This would require 618 barge movements per year (52 per month) and equates to 26 barges in service. After applying the 1.3 seasonal factor, an estimated 33.8 barges of 10 MB capacity (or 11 barges of 30 MB) would be needed. These calculations are covered in the following table.

Table 4-14 Scenario #1 - Year 2004 - Barge Requirements

PADD	Volume (bgy)	Annual Shipments	Monthly Shipments	Monthly Turnarounds	No. of Barges Required
I	0.14	333	28	2	14
II	0.05	119	10	2	5
V	0.07	166	14	2	7
Total	0.26	618	52		26

26 barges (10 MB capacity) x 1.3 seasonal factor = 33.8 barges of 10 MB capacity or 11 barges of 30 MB capacity

Rail car shipments are directly from PADD II to PADDs I and V, as well as some small volumes moved within PADD II. Total rail car loadings are 12,799 cars averaging 1,065 monthly. It is assumed that some shipments to PADDs I and V would be by unit train and this is factored into the turn around time. This yields a demand of 687 rail cars which, after applying the 1.3 seasonal factor, equates to a need for 893 rail cars. These calculations are covered in the following table.

Table 4-15 Scenario #1 - Year 2004 - Rail Car Requirements

PADD	Volume (bgy)	Annual Shipments	Monthly Shipments	Monthly Turnarounds	No. of Cars Required
I	0.25	8,333	694	1.5	463
II	0.05	1,666	138	2	69
V	0.084	2,800	233	1.5	155
Total	0.384	12,799	1,065	-	687

687 rail cars x 1.3 seasonal factor = 893 equivalent rail cars required

Finally, there are volumes shipped by truck. This includes the majority of product shipped within PADD II. In addition, some product shipped by other modes will go to "hub terminals" with 20% to 30% of total volume requiring redistribution by truck. The estimated volumes of 0.337 bgy moving by truck would require 42,125 transport truck deliveries, an average of 3,511 per month. An equivalent of nearly 4 turns per truck day, for 23 days per month, is assumed in PADDs I and V due to short hauling distances. For PADD II deliveries are hauled over greater distances and the turns have been lowered to 60 per truck month. The resulting truck equivalent derived is 51 trucks. After applying the 1.3 seasonal adjustment factor, this equates to 66.3 transport trucks. These calculations are covered in the following table.

Table 4-16 Scenario #1 - Year 2004 - Transport Truck Requirements

PADD	Volume (bgy)	Annual Shipments	Monthly Shipments	Monthly Turnarounds	Equivalent Transport Requirement
I	0.078	9,750	813	90	9
II	0.213	26,625	2,219	60	37
V	0.046	5,750	479	90	5
Total	0.337	42,125	3,511	-	51

51 transport truck equivalent x 1.3 seasonal factor = 66.3 transport truck equivalent

4.2 Scenario #1 - Year 2007

In Scenario #1, for year 2007, the increased ethanol use (over year 2004) is 0.897 bgy. Costs associated with the volume increase are covered in the following sections.

4.2.1 Scenario #1 - Year 2007 Terminal and Retail Equipment Requirements & Costs

We start by determining the number of terminals required for each targeted market area (and related ethanol volume increase). The total number of terminals in the servicing markets increases to 479 terminals. Of these, 130 would already have ethanol. This consists of the 111 ethanol terminals from year 2004 (38 existing plus 73 added) plus 19 existing ethanol terminals in new market areas. The preliminary estimate for tankage is then made. This information is included in the following table.

Table 4-17 Scenario #1 - Year 2007 - Preliminary Tank Requirement Estimate

PADD	Area	New Ethanol Volume (bgy)	No. of Servicing Terminals	No. with Ethanol (2004)	Estimated New Tankage Requirement for 2007
I	Hartford CT	0.0	2	2	-
	New York NY	0.2	33	17	10 x 25m
	Philadelphia PA	0.04	12	6	1 x 25m
	*Baltimore/DC	0.059	12	0	6 x 25m
II	IL/IN/OH *KS/MI/MO	0.116	222	84	5 x 5m 8 x 10m
III	*AR/MS/TX	0.182	121	5	5 x 5m 10 x 10m 4 x 25m
V	Los Angeles CA	0.096	36	14	2 x 10m 6 x 25m
	*San Francisco	0.100	19	2	4 x 10m 4 x 25m
	*San Diego	0.034	8	0	3 x 10m 1 x 25m
	*Sacrmento	0.02	6	0	4 x 10m
	*Other	0.05	8	0	4 x 10m 2 x 25m
Totals		0.897	479	130	10 - 5m 35- 10m 34- 25m

79 tanks totaling 1250m barrels of capacity

Notes:

	Current Estimated Gasoline Volume (bgy)	
I	Hartford CT	0.52
	New York NY	9.17
	Philadelphia PA	2.72
II	IL/IN/OH/KS/MI/MO	23.02
V	Los Angeles CA	7.01
	Baltimore/DC	3.34
	AR/MS/TX	13.67
	San Francisco	3.0
	San Diego	1.23
	Sacramento	0.76
	Other	0.76
	Total	65.20

Source for city/MSA volume: Infrastructure Requirements for an Expanded Ethanol Industry, Downstream Alternatives Inc., January 15, 2002

Source for State gasoline volume: Monthly Gasoline Report by State - 2000, Table MF-33GA, Federal Highway Administration

(* New market areas for 2007)

As can be seen in the table, the new ethanol volume for 2007 in Scenario #1 is 0.897 bgy and there are now 479 terminals servicing these expanded markets, an increase of 247 terminals over 2004. It is estimated that a total of 79 tanks totaling 1,250 MB (52,500,000 gallons) would be required. At 24 inventory turns per year this would be sufficient to handle 1.26 bgy compared to the factored equivalent of 1.17 bgy (0.897 bgy x 1.3).

Because the information available in terminal atlases does not always indicate ethanol storage availability, an estimate is made of terminals that may already handle ethanol but that are not listed as such in terminal atlases. The number of existing tanks that could be used without major conversion is then estimated, as is the number of existing tanks that could be used with conversion modifications (e.g., addition of floating internal covers or fixed roof). The remaining tank requirement is assumed to represent the number of new tanks required. A breakdown of the aforementioned categories is covered in the following table.

Table 4-18 Scenario #1 - Year 2007 - Revised Tank Requirement Estimate

PADD	Area	Tank Size (bbls)	No. of Tanks	Estimated Already In Use	Estimated use without Conversion	Estimated Use With Conversion	New Tanks Required
I	New York NY	25m	10	0	2	2	6
	Philadelphia PA	25m	1	0	1	0	0
	Baltimore/DC	25m	6	1	1	1	3
II	KS/MI/MO	5m	5	2	0	1	2
		10m	8	3	2	2	1
III	AR/MS/TX	5m	5	2	0	0	3
		10m	10	2	1	1	6
		25m	4	1	-	1	2
V	Los Angeles CA	10m	2	0	0	1	1
		25m	6	0	0	3	3
	San Francisco CA	10m	4	2	0	0	2
		25m	4	1	0	1	2
	San Diego CA	10m	3	0	0	0	3
		25m	1	0	0	1	0
	Sacramento CA	10m	4	0	0	1	3
	Other	10m	4	0	0	2	2
		25m	2	0	0	0	2
Totals			79	14	7	17	41

As the previous table indicates, it is estimated that at least 14 terminals are already handling ethanol, or have tanks to do so. This is primarily due to the number of terminals in PADDs II and III that have already installed such capabilities. It is further estimated that at least 7 tanks could be used without major conversion, and 17 tanks could be used after necessary conversion. A total of 41 new tanks would need to be installed. The conversion costs for the 17 converted tanks is estimated at $765,000 as covered in the following table.

Table 4-19 Scenario #1 - Year 2007 - Cost Estimate for Tank Conversion

PADD	Total No. of Conversions	Tank Size (bbls)	Total Cost Tanks (000)
I	3	25m	$180
II	1	5m	$15
	2	10m	$60
III	1	10m	$30
	1	25m	$60
V	4	10m	$120
	5	25m	$300
Totals	17	-	$765

New tanks would cost $8,475,000 as covered by PADD in the following table.

Table 4-20 Scenario #1 - Year 2007 - Cost Estimate for New Tanks

PADD	Tanks Required	Tank Size (bbls)	Cost Per Steel barrel	Total Cost (000)
I	9	25m	$12	$2,700
II	2	5m	$15	$150
	1	10m	$15	$150
III	3	5m	$15	$225
	6	10m	$15	$900
	2	25m	$12	$600
V	11	10m	$15	$1,650
	7	25m	$12	$2,100
Totals	41	-	-	$8,475

It is assumed that all terminals that will be newly converted to ethanol would require new blending systems. This includes all terminal categories except those estimated to already have ethanol. A total of 65 terminals would need to install such blending systems at a total cost of $19,500,000 as covered in the next table.

Table 4-21 Scenario #1 - Year 2007 - Cost Estimate for Blending Systems

PADD	No. of Units Required	Cost Each	Total Cost (000)
I	16	@ $300M	$4,800
II	8	@ $300M	$2,400
III	14	@ $300M	$4,200
V	27	@ $300M	$8,100
Totals	65	@ $300M	$19,500

We have also estimated that at least 12 terminals would need to install rail spurs to handle increased delivery by rail car. The estimated cost for rail spur additions is $4,260,000 and is covered in the next table.

Table 4-22 Scenario #1 - Year 2007 - Cost Estimate for Rail Spur Installation

PADD	No. of Units Required	Cost Each	Total Cost (000)
I	3	@ $355M	$1,065
II	2	@ $355M	$710
III	3	@ $355M	$1,065
V	4	@ $355M	$1,420
Totals	12	@ $355M	$4,260

Finally, we are assuming that all terminals newly converted to ethanol could have unforeseen miscellaneous expenses such as piping modifications or loading rack modifications. We have provided a contingency expense of $20,000 for each such terminal. The 65 terminals in this category would then require $1,300,000 as covered in the following table.

Table 4-23 Scenario #1 - Year 2007 - Miscellaneous Contingency Cost Estimate

PADD	No. of Terminals	Cost estimated	Total Cost (000)
I	16	@ $20M	$320
II	8	@ $20M	$160
III	14	@ $20M	$280
V	27	@ $20M	$540
Totals	65	@ $20M	$1,300

Finally, there are also expenses in converting retail stations to ethanol use. In PADD I, it is assumed the average retail outlet volume is 1,000,000 gallons per unit year. In PADD II average retail unit volume is assumed to be 850,000 gallons per year. In PADD III average annual retail unit volume is assumed to be 700,000 gallons. In PADD V, annual retail volume of 1,200,000 gallons is assumed. The various retail volume calculations to determine the number of retail units required for the premised ethanol volumes are covered in the following table.

Table 4-24 Scenario #1 - Year 2007 - Calculations for Number of Required New Retail Units Handling Ethanol
PADD I 1,000,000 gallons per unit annually = 100,000 gallons of ethanol annually 0.299 bgy ethanol x 1.3 = 0.389 bgy equivalent ÷ 100,000 gallons = 3887 units
PADD II 850,000 gallons per unit annually = 85,000 gallons of ethanol annually 0.116 bgy ethanol x 1.3 = 0.1508 bgy equivalent ÷ 85,000 gallons = 1,774 units
PADD III 700,000 gallons per unit annually = 70,000 gallons of ethanol annually 0.182 bgy ethanol x 1.3 = 0.2366 bgy equivalent ÷ 70,000 gallons = 3,380 units
PADD V (Los Angeles) 1.2 million gallons per unit annually = 68,400 gallons of ethanol annually 0.300 bgy ethanol x 1.3 = 0.3900 bgy equivalent ÷ 64,800 gallons = 6,018 units

The premised volumes for 2007 would require a total of 15,059 retail units to convert to ethanol blends, at an estimated cost of $8,885,000. These units are recapped by PADD in the following table.

Table 4-25 Scenario #1 - Year 2007 - Retail Unit Conversions and Costs

PADD	No. of Units	Cost per Unit estimated	Total Cost (000)
I	3,887	@ $590	$2,293
II	1,774	@ $590	$1,047
III	3,380	@ $590	$1,994
V	6,018	@ $590	$3,551
Totals	15,059	@ $590	$8,885

Table 4-26 covers the required investments for each category by PADD. In addition, the volume requirements are calculated and costs are amortized.

The combined estimated costs of preparing for 2007 of the RFS is $43,185,000, at a total amortized cost of $0.0075 per gallon of ethanol, or under $0.00075 per gallon of gasoline/ethanol blend.

For PADD I, total costs are $11,358,000 or $0.0059 per gallon of ethanol on an amortized basis. For PADD II total estimated costs are $4,692,000 or $0.0063 per gallon of ethanol on an amortized basis. PADD III's estimated costs are $9,354,000 or $0.008 per gallon of ethanol on an amortized basis. For PADD V, total costs are $17,781,000 or $0.0092 per gallon of ethanol on an amortized basis.

Table 4-26 Scenario #1 - Year 2007 - Total Estimated Capital Investment for Terminal Improvements & Retail Conversions for E-10/E-5.7

	New ethanol Volume (bgy)	Cost of Tank Conversion (000)	Cost of New Tanks (000)	Cost of Blending Systems (000)	Modification for Rail Receipt (000)	Contingency (000)	Retail Conversions (000)	Total (000)	Amortized cost per gallon
PADD I	0.299	$180	$2,700	$4,800	$1,065	$320	$2,293	$11,358	$0.0059
PADD II	0.116	$75	$300	$2,400	$710	$160	$1,047	$4,692	$0.0063
PADD III	0.182	$90	$1,725	$4,200	$1,065	$280	$1,994	$9,354	$0.0080
PADD V	0.300	$420	$3,750	$8,100	$1,420	$540	$3,551	$17,781	$0.0092
TOTALS	0.897	$765	$8,475	$19,500	$4,260	$1,300	$8,885	$43,185	$0.0075

4.2.2 Scenario #1 - Year 2007 Freight Costs and Transportation Equipment Requirements

In year 2007, the increased ethanol volumes are similar to 2004. This combined with the premised 65/35% seasonal split and retirement of OPA90† compliant Jones Act†† vessels will likely lead to a preference for rail shipments. We have estimated that of the 0.299 bgy ethanol shipped to PADD I, 0.105 bgy would move by ship from the Gulf Coast (after being barged there from the Midwest), while 0.194 bgy would move by rail. Since not all terminals have rail receipt capability, we have also assumed that 0.060 bgy of the ethanol, equating to 20% of PADD I ethanol volume, would need to be redistributed from "hub terminals". Most of this would be by truck although some small amount could move by barge.

In PADD II the small ethanol volume increase of 0.116 bgy would move solely by truck. No redistribution from hub terminals is necessary in PADD II due to the numerous points of supply availability.

In PADD III, 0.182 bgy of ethanol would be moved by a combination of barge and rail. Shipments to Mississippi and Arkansas would be by barge, supplemented by rail, while Texas shipments would be exclusively by rail. It is estimated that 0.06 bgy of product would be shipped by barge with the remaining 0.122 bgy shipped by rail. Some portion of the product shipped by barge and rail would need to be redistributed by truck. It is estimated that 0.055 bgy would need to be redistributed by truck.

In PADD V, we estimate that 0.105 bgy of ethanol would move by ship and 0.195 bgy by rail. Of this amount, an estimated 0.090 bgy (30%) would need to be redistributed by truck.

Total shipments by mode for each PADD are recapped in the following table.

† For a discussion of OPA90, see glossary in Appendix D.
†† For a discussion of Jones Act , see glossary in Appendix D

Table 4-27 Scenario #1 - Year 2007 - Projected Transportation Modes (bgy)						
PADD	**Total Volume**	**Projected Transportation Modes**				**Redistribution from Hub Terminal**
		Ship	**Barge**	**Rail**	**Truck**	
I	0.299	0.105	--	0.194	--	0.060
II	0.116	--	--	--	0.116	--
III	0.182	--	0.060	0.122	--	0.055
V	0.300	0.105	--	0.195	--	0.090
Totals	0.897	0.210	0.060	0.511	0.116	0.205

The composite freight rates and resulting total freight charges by PADD, for both initial shipments and redistribution shipments, as well as an average resulting freight cost per gallon of ethanol, are covered in the following table.

Table 4-28 Scenario #1 - Year 2007 - Transportation Costs

	Primary Shipments		Redistribution Shipments		Total	Average
PADD	**Composite Freight Rate per Gallon**	**Total Freight Cost (000)**	**Composite Redistribution Freight Rate per Gallon**	**Total Redistribution Cost (000)**	**Freight Cost (000)**	**Freight Costs per Gallon**
I	$0.110	$32,890	$0.025	$1,500	$34,390	$0.1150
II	$0.035	$4,060	n/a		$4,060	$0.0350
III	$0.080	$14,560	$0.025	$1,375	$15,935	$0.0880
V	$0.140	$42,000	$0.025	$2,250	$44,250	$0.1475
Totals		$93,510		$5,125	$98,635	$0.1100

Total freight charges for the 0.897 bgy incremental ethanol volume in 2007 are $98,635,000 averaging $0.110 per gallon of ethanol. For PADD I the average freight rate is $0.115 per gallon, for PADD II it is $0.035, for PADD III it is $0.088, and for PADD V it is $0.1475 per gallon.

Again, the increased demand on transportation capabilities is relatively small in year 2007, but is discussed here so that each year studied represents only the demand for the associated incremental ethanol volume. This provides the ability to assess the collective demand, spread over the RFS implementation period.

The following table provides calculations for movement by ship.

Table 4-29 Scenario #1 - Year 2007 - Ship Requirements

PADD	Volume (bgy)	Annual Shipments	Monthly Shipments	Monthly Turnarounds	Annual Ship Equivalent
I	0.105	10.0	0.83	2	0.42
II	-	-	-	-	-
III	-	-	-	-	-
V	0.105	10.0	0.83	0.9	0.92
Total	0.210	20.0	1.66		1.34

1.34 ships (250 mb capacity) x 1.3 seasonal factor = 1.74 equivalent ships required
(NOTE: 1 shipment = 250 mb (10.5 million gallons))

In 2007 total ship equivalents required would be 1.74 ships.

Barge shipments are comprised of shipments to PADD III as well as shipments to New Orleans for staging and subsequent shipment to PADDs I and V. This would require 643 barge movements per year (54 per month) and equates to 27 barges in service. After applying the 1.3 seasonal factor, an estimated 35.1 barges of 10 MB capacity (or 12 barges of 30 MB) would be needed. These calculations are covered in the following table.

Table 4-30 Scenario #1 - Year 2007 - Barge Requirements

PADD	Volume (bgy)	Annual Shipments	Monthly Shipments	Monthly Turnarounds	No. of Barges Required
I	0.105	250	21	2	10.5
II	0.000	-	-	2	0.0
III	0.060	143	12	2	6.0
V	0.105	250	21	2	10.5
Total	0.270	643	54		27.0

27 barges (10 MB capacity) x 1.3 seasonal factor = 35.1 barges of 10 MB capacity or 12 barges of 30 MB capacity

Rail car shipments are directly from PADD II to PADDs I, III, and V. Total rail car loadings are 17,032 cars averaging 1,418 monthly. It is assumed that some shipments to PADDs I and V would be by unit train and this is factored into the turnaround time. This yields a demand for 918 rail cars which, after applying the 1.3 seasonal factor, equates to a need for 1,193 rail cars. These calculations are covered in the following table.

Table 4-31 Scenario #1 - Year 2007 - Rail Car Requirements

PADD	Volume (bgy)	Annual Shipments	Monthly Shipments	Monthly Turnarounds	No. of Cars Required
I	0.194	6,466	538	1.5	359
II	-	-	-	2	-
III	0.122	4,066	338	1.7	198
V	0.195	6,500	542	1.5	361
Total	0.511	17,032	1,418	-	918

918 rail cars x 1.3 seasonal factor = 1,193 equivalent rail cars required

Finally, there are volumes shipped by truck. This includes all of the 2007 incremental ethanol volume shipped within PADD II. In addition, some product shipped to PADDs I, III, and V, by other modes, will go to "hub terminals" with 20% to 30% of total volume requiring redistribution by truck. The estimated volumes of 0.321 bgy moving by truck would require 40,125 transport truck deliveries, an average of 3,344 per month. An equivalent of nearly 4 turns per truck day, for 23 days per month, in PADDs I and V is assumed due to short hauling distances. For PADD II deliveries are hauled over greater distances and the turns have been lowered to 60 per truck month. The resulting truck equivalent derived is 47 trucks. After applying the 1.3 seasonal adjustment factor, this equates to 61.1 transport trucks. These calculations are covered in the following table.

Table 4-32 Scenario #1 - Year 2007 - Transport Truck Requirements

PADD	Volume (bgy)	Annual Shipments	Monthly Shipments	Monthly Turnarounds	Equivalent Transport Requirement
I	0.060	7,500	625	90	7
II	0.116	14,500	1,208	60	20
III	0.055	6,875	573	60	10
V	0.090	11,250	938	90	10
Total	0.321	40,125	3,344	-	47

47 transport truck equivalent x 1.3 seasonal factor = 61.1 transport truck equivalent

4.3 Scenario #1 - Year 2012

In Scenario #1, for year 2012, the increased ethanol use (over year 2007) is 1.77 bgy. Costs associated with the volume increase are covered in the following sections.

4.3.1 Scenario #1 - Year 2012 Terminal and Retail Equipment Requirements & Costs

We start by determining the number of terminals required for each targeted market area (and related ethanol volumes increase). The total number of terminals in the servicing markets increases to 577 terminals. Of these, 229 would already have ethanol storage in place. These consist of the 209 terminals that offered ethanol in year 2007 plus 20 ethanol terminals from newly added market areas. The preliminary estimate for tankage is then made. This information is included in the following table.

Table 4-33 Scenario #1 - Year 2012 - Preliminary Tank Requirement Estimate

PADD	Area	New Ethanol Volume (bgy)	No. of Servicing Terminals	No. with Ethanol (2007)	Estimated New Tankage Requirement for 2012
I	Hartford CT	0.00	2	2	-
	New York NY	0.290	33	27	6 x 50m
	Philadelphia PA	0.120	12	7	5 x 25m
	Baltimore/DC	0.190	12	6	2 x 25m 4 x 50m
	*Boston	0.200	8	2	3 x 25m 3 x 50m
II	IL/IN/OH/KS/MI/MO *NE/WI	0.300	270	106	10 x 10m 6 x 25m
III	AR/MS/TX	0.235	121	24	7 x 5m 10 x 10m 7 x 25m
IV	*CO/UT	0.035	15	2	2 x 25m
V	Los Angeles CA	0.050	36	22	4 x 25m
	San Francisco	0.028	19	10	4 x 5m 2 x 10m
	San Diego	0.017	8	4	2 x 5m 2 x 10m
	Sacramento	0.010	6	4	2 x 5m
	Other	0.061	13	6	7 x 10m 4 x 25m
	*Phoenix	0.100	6	2	4x 25m
	*Seattle/other WA	0.134	16	5	2 x 5m 2 x 10m 2 x 25m 2 x 50m
Totals		1.770	577	229	17 - 5m 33- 10m 39- 25m 15 - 50m

104 tanks totaling 2140m barrels of capacity

*New market areas for 2012

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Table 4-33 continued

Notes: **Current Estimated Gasoline Volume (bgy)**

I	Hartford CT	0.52	V	Los Angeles CA	7.01
				San Francisco	3.0
	New York NY	9.17		San Diego	1.23
				Sacramento	0.76
	Philadelphia PA	2.72		Other CA	0.76
	Boston MA	2.57		Phoenix	1.30
	Baltimore/DC	3.34		Seattle/WA other	2.70
II	IL/IN/OH/KS/MI/MO NE/WI	26.39			
				Total	78.22
III	AR/MS/TX	13.67			
IV	Colorado/Utah	3.08			

Source for city/MSA volume: Infrastructure Requirements for an Expanded Ethanol Industry, Downstream Alternatives Inc., January 15, 2002

Source for State gasoline volume: Monthly Gasoline Report by State - 2000, Table MF-33GA, Federal Highway Administration

As can be seen in the table, the new ethanol volume for 2012 in Scenario #1 is 1.77 bgy and there are now 577 terminals servicing these expanded markets, an increase of 98 terminals over 2007. It is estimated that a total of 104 additional tanks totaling 2,140 MB (89,880,000 gallons) would be required. At an average of 24 inventory turns per year this would be sufficient to handle 2.16 bgy compared to the factored equivalent of 2.301 bgy (1.77 bgy x 1.3).

Because the information available in terminal atlases does not always indicate ethanol storage availability, an estimate is made of terminals that may already handle ethanol but that are not listed as such in terminal atlases. The number of existing tanks that could be used without major conversion is then estimated, as is the number of existing tanks that could be used with conversion modifications (e.g., addition of floating internal covers or fixed roof). The remaining tank requirement is assumed to represent the number of new tanks required. A breakdown of the aforementioned categories is covered in the following table.

Table 4-34 Scenario #1 - Year 2012 - Revised Tank Requirement Estimate

PADD	Area	Tank Size (bbls)	No. of Tanks	Estimated Already In Use	Estimated use without Conversion	Estimated Use With Conversion	New Tanks Required
I	New York NY	50m	6	0	1	1	4
	Philadelphia PA	25m	5	0	0	0	5
	Baltimore/DC	25m	2	0	0	1	1
		50m	4	0	0	2	2
	Boston MA	25m	3	0	1	0	2
		50m	3	0	0	0	3
II	IL/IN/OH/KS/MI/	10m	10	4	1	0	5
	MO/NE/WI	25m	6	2	0	1	3
III	AR/MS/TX	5m	7	0	0	0	7
		10m	10	2	0	0	8
		25m	7	0	1	1	5
IV	CO/UT	25m	2	1	0	0	1
V	Los Angeles CA	25m	4	0	0	0	4
	San Francisco CA	5m	4	0	0	0	4
		10m	2	0	0	0	2
	San Diego CA	5m	2	0	0	0	2
		10m	2	0	0	0	2
	Sacramento CA	5m	2	0	0	0	2
	Other	10m	7	2	0	0	5
		25m	4	0	0	1	3
	Phoenix, AZ	25m	4	0	0	1	3
	Seattle/other WA	5m	2	0	0	0	2
		10m	2	0	0	0	2
		25m	2	0	0	1	1
		50m	2	0	0	1	1
Totals			104	11	4	10	79

As the previous table indicates, it is estimated that at least 11 terminals are already handling ethanol or have tanks to do so. This is primarily due to the number of terminals in the PADD II and III market expansion areas that have ethanol capabilities. It is further estimated that at least 4 tanks could be used without major conversion, and 10 tanks could be used after necessary conversion. A total of 79 new tanks would need to be installed. The conversion costs for the 10 tanks converted is estimated at $760,000 as covered in the following table.

Table 4-35 Scenario #1 - Year 2012 - Cost Estimate for Tank Conversion

PADD	Total No. of Conversions	Tank Size (bbls)	Total Cost Tanks (000)
I	1	25m	$60
	3	50m	$300
II	1	25m	$60
III	1	25m	$60
IV	0	--	--
V	3	25m	$180
	1	50m	$100
Totals	10	-	$760

New tanks would cost $18,275,000 as covered by PADD in the following table.

Table 4-36 Scenario #1 - Year 2012 - Cost Estimate for New Tanks

PADD	Tanks Required	Tank Size (bbls)	Cost Per Steel barrel	Total Cost (000)
I	8	25m	$12	$2,400
	9	50m	$10	$4,500
II	5	10m	$15	$750
	3	25m	$12	$900
III	7	5m	$15	$525
	8	10m	$15	$1,200
	5	25m	$12	$1,500
IV	1	25m	$12	$300
V	10	5m	$15	$750
	11	10m	$15	$1,650
	11	25m	$12	$3,300
	1	50m	$10	$500
Totals	79	-	-	$18,275

It is assumed that all terminals that will be newly converted to ethanol would require new blending systems. This includes all terminal categories except those estimated to already have ethanol. A total of 93 terminals would need to install such blending systems at a total cost of $27,900,000 as covered in the next table.

Table 4-37 Scenario #1 - Year 2012 - Cost Estimate for Blending Systems

PADD	No. of Units Required	Cost Each	Total Cost (000)
I	23	@ $300m	$6,900
II	10	@ $300m	$3,000
III	22	@ $300m	$6,600
IV	1	@ $300m	$300
V	37	@ $300m	$11,100
Totals	93	@ $300m	$27,900

We have also estimated that at least 12 terminals would need to install rail spurs to handle increased delivery by rail car. The estimated cost for rail spur additions is $4,260,000 and is covered in the next table.

Table 4-38 Scenario #1 - Year 2012 - Cost Estimate for Rail Spur Installation

PADD	No. of Units Required	Cost Each	Total Cost (000)
I	3	@ $355m	$1,065
II	2	@ $355m	$710
III	3	@ $355m	$1,065
IV	1	@ $355m	$355
V	3	@ $355m	$1,065
Totals	12	@ $355m	$4,260

We are assuming that all terminals newly converted to ethanol could have unforeseen miscellaneous expenses such as piping modifications or loading rack modifications. We have provided a contingency expense of $20,000 for each such terminal. The 93 terminals in this category would then require $1,860,000 as covered in the following table.

Table 4-39 Scenario #1 - Year 2012 - Miscellaneous Contingency Cost Estimate

PADD	No. of Terminals	Cost estimated	Total Cost (000)
I	23	@ $20M	$460
II	10	@ $20M	$200
III	22	@ $20M	$440
IV	1	@ $20M	$20
V	37	@ $20M	$740
Totals	93	@ $20M	$1,860

Finally, there are also expenses in converting retail stations to ethanol use. In PADD I average retail unit volume is assumed to be 1,000,000 gallons per unit year. In PADD II average retail unit volume is assumed to be 850,000 gallons per unit year. In PADD III average retail unit volume is assumed to be 700,000 gallons annually. For PADD IV, average retail unit volume is assumed to be 800,000 gallons per year. In PADD V, average retail unit volume is assumed to be 1,200,000 gallons per year. The various retail volume calculations to determine the number of retail units for the premised ethanol volumes are covered in the following table.

Table 4-40 Scenario #1 - Year 2012 - Calculations for Number of Required New Retail Units Handling Ethanol

PADD I 1,000,000 gallons per unit annually = 100,000 gallons of ethanol annually
0.800 bgy ethanol x 1.3 = 1.04 bgy equivalent ÷ 100,000 gallons = 10,400 units

PADD II 850,000 gallons per unit annually = 85,000 gallons of ethanol annually
0.300 bgy ethanol x 1.3 = 0.390 bgy equivalent ÷ 85,000 gallons = 4,588 units

PADD III 700,000 gallons per unit annually = 70,000 gallons of ethanol annually
0.235 bgy ethanol x 1.3 = 0.2366 bgy equivalent ÷ 70,000 gallons = 4,364 units

PADD IV 800,000 gallons per unit annually = 80,000 gallons of ethanol annually
0.035 bgy ethanol x 1.3 = 0.0455 bgy equivalent ÷ 80,000 gallons = 568 units

PADD V 1.2 million gallons per unit annually = 68,400 gallons of ethanol annually in California
120,000 gallons elsewhere
(CA) 0.166 bgy ethanol x 1.3 = 0.2158 bgy equivalent ÷ 64,800 gallons = 3,330 units
(Other) .234 bgy ethanol x 1.3 = 0.3042bgy equivalent ÷ 120,000 gallons = 2,535 units

The premised volumes for 2012 would require a total of 25,785 retail units to convert to ethanol blends at an estimated cost of $15,213,000. These units are recapped by PADD in the following table.

Table 4-41 Scenario #1 - Year 2012 - Retail Unit Conversions and Costs

PADD	No. of Units	Cost per Unit estimated	Total Cost ($000)
I	10,400	@ $590	$6,136
II	4,588	@ $590	$2,707
III	4,364	@ $590	$2,575
IV	568	@ $590	$335
V	5,865	@ $590	$3,460
Totals	25,785	@ $590	$15,213

Table 4-42 covers the required investments for each category by PADD. In addition, the volume requirements are calculated and costs are amortized.

The combined estimated cost of preparing for year 2012 of the RFS is $68,268,000, at a total amortized cost of $0.0060 per gallon of ethanol or under $0.00060 per gallon of gasoline/ethanol blend.

For PADD I, total costs are $21,821,000 or $0.0043 per gallon of ethanol on an amortized basis. For PADD II total estimated costs are $8,327,000 or $0.0043 per gallon of ethanol on an amortized basis. PADD III's estimated costs are $13,965,000 or $0.0093 per gallon of ethanol on an amortized basis. In PADD IV total costs are $1,310,000 at an amortized cost of $0.0058 per gallon. For PADD V, total costs are $22,845,000 or $0.0089 per gallon of ethanol on an amortized basis.

Table 4-42 Scenario #1 - Year 2012 - Total Estimated Capital Investment for Terminal Improvements & Retail Conversions for E-10/E-5.7

	New ethanol Volume (bgy)	Cost of Tank Conversion (000)	Cost of New Tanks (000)	Cost of Blending Systems (000)	Modification for Rail Receipt (000)	Contingency (000)	Retail Conversions (000)	Total (000)	Amortized cost per gallon
PADD I	0.800	$360	$6,900	$6,900	$1,065	$460	$6,136	$21,821	$0.0043
PADD II	0.300	$60	$1,650	$3,000	$710	$200	$2,707	$8,327	$0.0043
PADD III	0.235	$60	$3,225	$6,600	$1,065	$440	$2,575	$13,965	$0.0093
PADD IV	0.035	$0	$300	$300	$355	$20	$335	$1,310	$0.0058
PADD V	0.400	$280	$6,200	$11,100	$1,065	$740	$3,460	$22,845	$0.0089
TOTALS	1.770	$760	$18,275	$27,900	$4,260	$1,860	$15,213	$68,268	$0.0060

4.3.2 Scenario #1 - Year 2012 Freight Costs and Transportation Equipment Requirements

In year 2012, the increased ethanol volumes amount to 1.77 bgy compared to year 2007. This combined with the premised 65/35% seasonal split and retirement of OPA90 compliant Jones Act vessels will likely lead to a continued preference for rail shipments. We have estimated that of the 0.800 bgy ethanol shipped to PADD I, 0.300 bgy would move by ship from the Gulf Coast (after being barged there from the Midwest), while 0.500 bgy would move by rail. Since not all terminals have rail receipt capability, we have also assumed that 0.160 bgy of the ethanol, equating to 20% of PADD I ethanol volume, would need to be redistributed from "hub terminals". Most of this would be by truck, but some small amount could move by barge.

In PADD II the ethanol volume increase of 0.300 bgy would move by truck, barge, and rail. No redistribution from hub terminals is necessary in PADD II due to the numerous points of supply availability.

In PADD III, the 0.235 bgy would be moved by a combination of barge and rail. Shipments to Mississippi and Arkansas would be by barge, supplemented by rail, while Texas shipments would be exclusively by rail. It is estimated that 0.1512 bgy of product would be shipped by barge with the remaining 0.0838 bgy shipped by rail. Some portion of the product shipped by barge and rail would need to be redistributed by truck. It is estimated that 0.100 bgy would need to be redistributed by truck.

In PADD IV, the additional 0.035 bgy is shipped to Colorado and Utah, all by rail with 0.01 bgy being redistributed by truck.

In PADD V we estimate that 0.150 bgy of ethanol would move by ship and 0.250 bgy by rail. Of this amount, an estimated 0.120 bgy (30%) would need to be redistributed by truck.

Total shipments by mode for each PADD are recapped in the following table.

Table 4-43 Scenario #1 - Year 2012 - Projected Transportation Modes (bgy)						
PADD	Total Volume	Projected Transportation Modes				Redistribution from Hub Terminal
		Ship	Barge	Rail	Truck	
I	0.800	0.300	--	0.500	--	0.160
II	0.300	--	0.0504	0.030	0.2196	--
III	0.235	--	0.1512	0.0838	--	0.100
IV	0.035	--	--	0.035	--	0.010
V	0.400	0.150	--	0.250	--	0.120
Totals	1.770	0.450	0.2016	0.8988	0.2196	0.390

The composite freight rates and resulting total freight charges by PADD, for both initial shipments and redistribution shipments, as well as an average resulting freight rate per gallon of ethanol are covered in the following table. Note that some composite freight rates have increased compared to year 2007. This is simply a reflection of shipments from plants and hub terminals moving a greater distance as the markets are expanded to include terminals at more distant points.

Table 4-44 Scenario #1 - Year 2012 - Transportation Costs

	Primary Shipments		Redistribution Shipments		Total	Average
PADD	**Composite Freight Rate per Gallon**	**Total Freight Cost (000)**	**Composite Redistribution Freight Rate per Gallon**	**Total Redistribution Cost (000)**	**Freight Cost (000)**	**Freight Costs per Gallon**
I	$0.110	$88,000	$0.025	$4,000	$92,000	$0.1150
II	$0.040	$12,000	n/a	-	$12,000	$0.0400
III	$0.085	$19,975	$0.030	$3,000	$22,975	$0.0978
IV	$0.105	$3,675	$0.040	$400	$4,075	$0.1164
V	$0.145	$58,000	$0.030	$3,600	$61,600	$0.1540
Totals		$181,650		$11,000	$192,650	$0.1088

Total freight charges for the 1.77 bgy incremental ethanol volume in 2012 are $192,650,000 averaging $0.1088 per gallon of ethanol. For PADD I the average freight rate is $0.115 per gallon, for PADD II it is $0.040, for PADD III it is $0.0978, for PADD IV it is $0.1164, and for PADD V it is $0.154 per gallon.

The increased demand on transportation capabilities in year 2012 is much greater as it represents a much greater volume increase over 2007 than 2007 did over 2004, or 2004 over the baseline. The following table provides these calculations for movement by ship.

Table 4-45 Scenario #1 - Year 2012 - Ship Requirements

PADD	Volume (bgy)	Annual Shipment	Monthly Shipments	Monthly Turnarounds	No. of Shipping Equivalent
I	0.300	28.6	2.38	2	1.19
II	-	-	-	-	-
III	-	-	-	-	-
IV	-	-	-	-	-
V	0.150	14.3	1.19	0.9	1.32
Total	0.450	42.9	3.57		2.51

2.51ships (250 mb capacity) x 1.3 seasonal factor = 3.26 equivalent ships required (NOTE: 1 shipment = 250 mb [10.5 million gallons])

In 2012, total additional ship equivalents would be 3.26 ships.

Barge shipments are comprised of shipments to PADD II and PADD III, as well as shipments to New Orleans for staging and subsequent shipment to PADDs I and V. This would require 2,146 barge movements per year (178.9 per month) and equates to 89.5 barges in service. After applying the 1.3 seasonal factor, an estimated 116.4 barges of 10 MB capacity (or 38.8 barges of 30 MB) would be needed. These calculations are covered in the following table.

Table 4-46 Scenario #1 - Year 2012 - Barge Requirements

PADD	Volume (bgy)	Annual Shipment	Monthly Shipments	Monthly Turnarounds	No. of Barges Required
I	0.300	714	59.5	2	29.8
II	0.0504	120	10.0	2	5.0
III	0.1512	360	30.0	2	15.0
IV	-	-	-	2	-
V	0.400	952	79.4	2	39.7
Total	0.9016	2,146	178.9		89.5

89.5 barges (10 MB capacity) x 1.3 seasonal factor = 116.4 barges of 10 MB capacity or 38.8 barges of 30 MB capacity

Rail car shipments are directly from PADD II to PADDs I, III, IV, and V, as well as to some destinations within PADD II. Total rail car loadings are 29,960 cars averaging 2,496 monthly. It is assumed that more shipments to PADDs I and V would be by unit train and this is factored into the turnaround time. This yields a demand for 1,464.9 rail cars which, after applying the 1.3 seasonal factor, equates to a need for 1,904 rail cars. These calculations are covered in the following table.

Table 4-47 Scenario #1 - Year 2012 - Rail Car Requirements

PADD	Volume (bgy)	Annual Shipment	Monthly Shipments	Monthly Turnarounds	No. of Cars Required
I	0.500	16,667	1,389	1.7	817.0
II	0.030	1,000	83	2.0	41.7
III	0.0838	2,793	233	1.7	136.9
IV	0.035	1,167	97	1.6	60.8
V	0.250	8,333	694	1.7	408.5
Total	0.8988	29,960	2,496	-	1,464.9

1,464.9 rail cars x 1.3 seasonal factor = 1,904 equivalent rail cars required

Finally, there are volumes shipped by truck. The majority of product in PADD II is shipped by truck. In addition, some product shipped to PADDs I, III, IV, and V, by other modes, will go to "hub terminals" with 20% to 30% or more of total volume requiring redistribution by truck. The estimated volume of 0.6096 bgy moving by truck would require 76,200 transport truck deliveries, an average of 6,351 per month. An equivalent of nearly 4 turns per truck per day for 23 days per month in PADDs I and V is assumed due to short hauling distances. For PADD II deliveries are hauled over greater distances than earlier years and the turns have now been lowered to 50 per truck month. We have also lowered the turnaround times in PADD III to 50 per month and in PADD V to 80 per month to reflect the need to haul product greater distances as the market expands. The resulting truck equivalent derived is 102.4 trucks. After applying the 1.3 seasonal adjustment factor, this equates to 133.1 transport trucks. These calculations are covered in the following table.

Table 4-48 Scenario #1 - Year 2012 - Transport Truck Requirements

PADD	Volume (bgy)	Annual Shipment	Monthly Shipments	Monthly Turnarounds	Equivalent Transport Requirement
I	0.160	20,000	1,667	90	18.5
II	0.2196	27,450	2,288	50	45.8
III	0.100	12,500	1,042	50	20.8
IV	0.010	1,250	104	60	1.7
V	0.120	15,000	1,250	80	15.6
Total	0.6096	76,200	6,351	-	102.4

102.4 transport truck equivalent x 1.3 seasonal factor = 133.1 transport truck equivalent

4.4 Scenario #1 Recap of Equipment & Transportation Requirements

4.4.1 Scenario #1 Investment Requirements Recap

This section contains the three study year points for Scenario #1 to present a total investment cost for the increased ethanol volumes over the total period studied.

By year 2012, the servicing areas in Scenario #1 will encompass 557 terminals of which 333 would offer ethanol. Between the baseline year and year 2012, it is estimated that 215 tanks totaling 4,715 MB (198,030,000 gallons) of capacity would need to be converted or installed. At an average of 24 turns per year this storage would be capable of handling 4.7 bgy of new ethanol volume. New ethanol volume in Scenario #1 is 3.524 bgy and after applying the 1.3 seasonal use split factor, this would equate to 4.58 bgy per year.

It is estimated that 19 terminal tanks could be put into ethanol service without major modification while another 36 tanks could be placed in service with conversion. However, it would be necessary to add 161 new tanks. It would also be necessary to install 216 blending systems and 31 rail spurs. We have also assumed that all 216 terminals newly offering ethanol would incur $20,000 per terminal in miscellaneous expense. Finally, it would be necessary to convert 53,791 retail outlets to ethanol blends.

These figures are recapped in the following table.

Table 4-49 Scenario #1 - Equipment Recap

	Tanks without Conversion	Tanks with Conversion	New Tanks	Blending Systems	Rail Spurs	Misc.	Retail Units
PADD I							
2004	4	4	15	23	5	23	5,070
2007	4	3	9	16	3	16	3,887
2012	2	4	17	23	3	23	10,400
PADD I Totals	**10**	**11**	**41**	**62**	**11**	**62**	**19,357**
PADD II							
2004	4	5	22	31	2	31	4,787
2007	2	3	3	8	2	8	1,774
2012	1	1	8	10	2	10	4,588
PADD II Totals	**7**	**9**	**33**	**49**	**6**	**49**	**11,149**
PADD III							
2004	0	0	0	0	0	0	0
2007	1	2	11	14	3	14	3,380
2012	1	1	20	22	3	22	4,364
PADD III Totals	**2**	**3**	**31**	**36**	**6**	**36**	**7,744**
PADD IV							
2004	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0
2012	0	0	1	1	1	1	568
PADD IV Totals	**0**	**0**	**1**	**1**	**1**	**1**	**568**
PADD V							
2004	0	0	4	4	0	4	3,090
2007	0	9	18	27	4	27	6,018
2012	0	4	33	37	3	37	5,865
PADD V Totals	**0**	**13**	**55**	**68**	**7**	**68**	**14,973**
Totals 2004	**8**	**9**	**41**	**58**	**7**	**58**	**12,947**
Totals 2007	**7**	**17**	**41**	**65**	**12**	**65**	**15,059**
Totals 2012	**4**	**10**	**79**	**93**	**12**	**93**	**25,785**
TOTALS ALL	**19**	**36**	**161**	**216**	**31**	**216**	**53,791**

By the year 2012, total investments for terminal improvements and retail conversions will reach $148,746,000 to accommodate the premised volume increase of 3.524 bgy. This equates to $0.0066 per gallon of ethanol on an amortized basis or slightly less than $0.00066 per gallon of gasoline ethanol blend.

The required investment estimates by category, study year, and PADD are presented in the following table.

Table 4-50 Scenario #1 - Investment Recap

	New ethanol Volume (bgy)	Cost of Tank Conversion (000)	Cost of New Tanks (000)	Cost of Blending Systems (000)	Mod. for Rail Receipt (000)	Contingency (000)	Retail Conversions (000)	Total (000)	Amortized cost per gallon
PADD I									
2004	0.390	$240	$4,500	$6,900	$1,775	$460	$2,991	$16,866	$0.0057
2007	0.299	$180	$2,700	$4,800	$1,065	$320	$2,293	$11,358	$0.0059
2012	0.800	$360	$6,900	$6,900	$1,065	$460	$6,136	$21,821	$0.0043
Total PADD I	**1.489**	**$780**	**14,100**	**$18,600**	**$3,905**	**$1240**	**$11,420**	**$50,045**	**$0.0052**
PADD II									
2004	0.313	$120	$2,550	$9,300	$710	$620	$2,824	$16,124	$0.0080
2007	0.116	$75	$300	$2,400	$710	$160	$1,047	$4,692	$0.0063
2012	0.300	$60	$1,650	$3,000	$710	$200	$2,707	$8,327	$0.0043
Total PADD II	**0.729**	**$255**	**$4,500**	**$14,700**	**$2,130**	**$980**	**$6,578**	**$29,143**	**$0.0062**
PADD III									
2004	-	-	-	-	-	-	-	-	-
2007	0.182	$90	$1,725	$4,200	1,065	$280	$1994	$9,354	$0.008
2012	0.235	$60	$3,225	$6,600	$1,065	$440	$2,575	$13,965	$0.0093
Total PADD III	**0.417**	**$150**	**$4,950**	**$10,800**	**$2,130**	**$720**	**$4,569**	**$23,319**	**$0.0087**
PADD IV									
2004	-	-	-	-	-	-	-	-	
2007	-	-	-	-	-	-	-	-	
2012	0.035	$0	$300	$300	$355	$20	$335	$1,310	$0.0058
Total PADD IV	**0.035**	**$0**	**$300**	**$300**	**$355**	**$20**	**$335**	**$1,310**	**$0.0058**
PADD V									
2004	0.154	$0	$1,200	$1,200	$0	$80	$1,823	$4,303	$0.0044
2007	0.300	$420	$3,750	$8,100	$1,420	$540	$3,551	$17,781	$0.0092
2012	0.400	$280	$6,200	$11,100	$1,065	$740	$3,460	$22,845	$0.0089
Total PADD V	**0.854**	**$700**	**$11,150**	**$20,400**	**$2,485**	**$1,360**	**$8,834**	**$44,929**	**$0.0082**
Totals									
2004	**0.857**	**$360**	**$8,250**	**$17,400**	**$2,485**	**$1,160**	**$7,638**	**$37,293**	**$0.0068**
2007	**0.897**	**$765**	**$8,475**	**$19,500**	**$4,260**	**$1,300**	**$8,885**	**$43,185**	**$0.0075**
2012	**1.770**	**$760**	**$18,275**	**$27,900**	**$4,260**	**$1,860**	**$15,213**	**$68,268**	**$0.0060**
TOTAL ALL	**3.524**	**$1,885**	**$35,000**	**$64,800**	**$11,005**	**$4,320**	**$31,736**	**$148,746**	**$0.0066**

One item that has not been included in equipment costs is the additional storage an ethanol producer would need to store excess seasonal production resulting from the 65/35 seasonal split. For instance, in year 2012 where 5.0 bgy is used, this would result in 3.25 bgy of use in the high demand season and 1.75 bgy in the low season. If it is assumed that ethanol production is relatively constant on a month to month basis, then excess inventory would build to 1.5 billion gallons by the end of the lower volume season.

It is likely that ethanol producers would take various steps to minimize building or leasing tank capacity for this excess volume. Such factors could include:

- Reducing inventories (at plants, terminals, staging tanks) to minimize levels at the end of the high volume season to allow for upcoming excess production. This could reduce storage requirements by as much as 15%.

- Planning regular maintenance turnarounds for the slower season. This could reduce storage needs by 5% of annual capacity or 10% of capacity across the slow season.

- Producers will also utilize their staging tankage to handle some excess production in the slow season. This could handle perhaps another 10% of off season production capacity.

- Producers will also likely use transportation equipment to handle inventories at the end of the slow production season. They would pre-load rail cars and perhaps barges (especially if owned or leased) at the very end of the slow season to ship and rebuild inventories. This might gain another 2% of seasonal storage swing.

- Producers could also utilize pre-delivery/late invoicing to encourage terminal operators to utilize some of their excess storage capacity during the slower season. In this case, producers would ship ethanol not yet needed and agree to invoice the product when needed or used.

- Finally producers would try to lease tankage for temporary storage (e.g., for 3 months during the last half of the slow season) to avoid the capital investment in new tanks. This could offset some of the need for new tankage.

Despite all the above, it is likely that ethanol producers would need to be able to store as much as 60% of the 1.5 billion gallons of slow season production. This could require up to 900 million gallons (21.4 million barrels) of new or recommissioned storage. These costs have not been included in this study. Similarly, the carrying costs of the ethanol producer maintaining such inventories have not been included.

Finally, it is worth mentioning that the 65/35 seasonal split results in terminal and retail investments being increased by a factor of 1.3 (i.e., 30%). If the ethanol volume in Scenario #1 is utilized in a more balanced pattern, the number of terminals and retail units handling ethanol could be reduced resulting in amortized costs being closer to $0.005 per gallon of ethanol. This is a result of the higher volume that could move through fewer terminals, compared to Scenario #1 with the seasonal split or even Scenario #2 without the seasonal split.

4.4.2 Scenario #1 Freight Requirement Recap

This section combines the study year points for Scenario #1 to present a total freight cost and freight equipment requirement for the ethanol volume increase that would occur between the baseline and year 2012, a volume of 3.524 bgy. Total freight costs for the new volume will, by 2012, reach $369,800,000 representing an average freight cost of $0.1049 per gallon of ethanol, or just slightly over $0.01 per gallon of gasoline ethanol blend. In Scenario #1, the highest freight costs are for PADDs I and V owing to both the higher freight rates, and also the higher volumes shipped to these destinations. Freight cost by PADD are covered in the following table.

Table 4-51 Scenario #1 - Freight Cost by PADD Recap

Year	Volume (bgy)	Total Freight Costs PADD I (000)	PADD II (000)	PADD III (000)	PADD IV (000)	PADD V (000)	TOTALS (000)	Average Freight Cost per gallon
2004	0.857	$44,850	$10,955	--	--	$22,710	$78,515	$0.0916
2007	0.897	$34,390	$4,060	$15,935	--	$44,250	$98,635	$0.1100
2012	1.770	$92,000	$12,000	$22,975	$4,075	$61,600	$192,650	$0.1088
Totals	**3.524**	**$171,240**	**$27,015**	**$38,910**	**$4,075**	**$128,560**	**$369,800**	**$0.1049**

By 2012 the ethanol shipments for Scenario #1 would require 82.9 annual ship cargoes which in turn would require the use of the equivalent of 6.5 small vessels. Annual barge shipments will reach 3,407 shipments requiring the use of 185.5 barges (10 MB capacity barges). Annual rail car loadings will reach 59,791 shipments, requiring the use of 3,990 rail cars. Annual truck cargoes will reach 158,450 shipments requiring the use of the equivalent of 261 truck/transport rigs.

These figures are recapped by PADD and study year in the following table.

Table 4-52 Scenario #1 - Freight Shipments by PADD Recap

	PADD I	PADD II	PADD III	PADD IV	PADD V	TOTALS
Annual Ship Cargoes						
2004	13.33				6.67	20.00
2007	10.00				10.00	20.00
2012	28.60				14.30	42.90
Totals	**51.93**		**0.00**	**0.00**	**30.97**	**82.90**
Annual Ship Requirement						
2004	0.55				0.61	1.16/1.50
2007	0.42				0.92	1.34/1.74
2012	1.19				1.32	2.51/3.26
Totals	**2.16**	**0.00**	**0.00**	**0.00**	**2.85**	**5.01/6.50**
Annual Barge Cargoes						
2004	333	119			166	618
2007	250	0	143		250	643
2012	714	120	360		952	2,146
Totals	**1,297**	**239**	**503**	**0**	**1,368**	**3,407**
Annual Barge Requirement						
2004	14.00	5.00			7.00	26/33.80
2007	10.50	0.00	6.00		10.50	27/35.1
2012	29.80	5.00	15.00		39.70	89.5/116.4
Totals	**54.30**	**10.00**	**21.00**	**0.00**	**57.20**	**142.5/185.5**
Annual Rail Cargoes						
2004	8,333	1,666			2,800	12,799
2007	6,466		4,066		6,500	17,032
2012	16,667	1,000	2,793	1,167	8,333	29,960
Totals	**31,466**	**2,666**	**6,859**	**1,167**	**17,633**	**59,791**
Annual Rail Requirement						
2004	463.00	69.00			155.00	687/893
2007	359.00	0.00	198.00		361.00	918/1193
2012	817.00	41.70	136.90	60.80	408.50	1,464.9/1904
Totals	**1,639.00**	**110.70**	**334.90**	**60.80**	**924.50**	**3,069.9/3990**
Annual Truck Cargoes						
2004	9,750	26,625			5,750	42,125
2007	7,500	14,500	6,875		11,250	40,125
2012	20,000	27,450	12,500	1,250	15,000	76,200
Totals	**37,250**	**68,575**	**19,375**	**1,250**	**32,000**	**158,450**
Annual Truck Requirement						
2004	9.00	37.00			5.00	51/66,3
2007	7.00	20.00	10.00		10.00	4,761.1
2012	18.50	45.80	20.80	1.70	15.60	102.4/133.1
Totals	**34.50**	**102.80**	**30.80**	**1.70**	**30.60**	**200.4/261**

NOTE: TWO NUMBERS ARE LISTED IN THE TOTAL COLUMN FOR EQUIPMENT REQUIREMENTS. THE FIRST NUMBER IS THE CALCULATED REQUIREMENT. THE SECOND NUMBER IS THE REQUIREMENT RESULTING FOR THE 65/35 SEASONAL SPLIT, I.E., TIMES THE FACTOR 1.3

Section 4 - Scenario #1 Specific References

1. ST Services, Tony Hoff, Vice President Marketing. 2002. *Getting Ethanol from the Plants to California*, presentation at 2002 National Ethanol Conference, San Diego, CA, February.

2. Renewable Fuels Association (RFA). 2002. *Ethanol Report #160*, Washington DC, May 13.

3. Chevron Texaco, Fred Gorel. 2002. Statement to Associated Press, April.

4. Phillips Petroleum, Rick Johnson. 2002. Statement to the *Bakersfield Californian*, April.

5. Shell Oil Products USA, Cameron Smythe. 2002. Statement to the *Bakersfield Californian*, April.

Section 4 -Scenario #1 General References

1. Downstream Alternatives Inc. (DAI). 2002. *Infrastructure Requirements for an Expanded Fuel Ethanol Industry*, Phase II Project Deliverable Report, Oak Ridge National Laboratory, Ethanol Project, Subcontract No. 4500010570, South Bend, IN 46680-2587, January 15, http://www.afdc.doe.gov/pdfs/6235.pdf

2. Downstream Alternatives Inc. (DAI). 2002. *Assumptions and Premises for Phase III Task 1 Deliverable For Studies on Ethanol Logistics Issues*, Submitted to Oak Ridge National Laboratory, Ethanol Project, Subcontract No. 4500010570, South Bend, IN 46680-2587, March 14.

Section 5

Scenario #2

5.0 Scenario #2

As with Scenario #1, this scenario follows a similar format to that in *"Infrastructure Requirements for an Expanded Fuel Ethanol Industry"*. The preliminary terminal analysis for that report is used, as are cost estimates for various terminal equipment and retail conversions. Unlike Scenario #1, which was meant to provide a high cost/high difficulty upper boundary case, Scenario #2 assumes the ethanol requirements of the RFS are met in a least cost/least difficulty manner, i.e., a lower boundary case. This results in ethanol being used, primarily in CG, in the markets closest to the plants. Also, unlike Scenario #1, ethanol sales are assumed to be balanced throughout the year.

5.1 Scenario #2 - Year 2004

In Scenario #2 for year 2004, the increased ethanol use is 0.924 bgy. Costs associated with this volume increase are covered in the following section.

5.1.1 Scenario #1 - Year 2004 Terminal and Retail Equipment Requirements & Cost

We start by determining the number of servicing terminals for each targeted market area (and related ethanol volumes) and how many are presently indicated to already have ethanol. There are 117 terminals servicing the market areas and of these, 35 already offer ethanol. The preliminary estimate for tankage is then made. This information is included in the following table.

Table 5-1 Scenario #2 - Year 2004 - Preliminary Tank Requirement Estimate

PADD	Area	New Ethanol Volume (bgy)	No. of Servicing Terminals	No. with Ethanol	Estimated New Tankage Requirement
II	IL, IA, IN, MO, NE, KS	0.924	117	35	10 x 5m 30 x 10m 6 x 25m 2 x 50m
Totals		0.924	117	35	10 x 5m 30 x 10m 6 x 25m 2 x 50m

50 tanks totaling 700m barrels of capacity

Notes: **Current Estimated Gasoline Volume (bgy)**

PADD II (applicable states) 15.23 bgy

Source for city/MSA volume: Infrastructure Requirements for an Expanded Ethanol Industry, Downstream Alternatives Inc., January 15, 2002

Source for State gasoline volume: Monthly Gasoline Report by State - 2000, Table MF-33GA, Federal Highway Administration

As can be seen in the table, the new ethanol volume for 2004 in Scenario #2 is 0.924 bgy and there are 117 terminals servicing the market. It is estimated that a total of 50 tanks totaling 700 MB (29,400,000 gallons) would be required. At 36 inventory turns per year this would be sufficient to handle 1.1 bgy compared to the 0.924 bgy volume.

Because the information available in terminal atlases does not always indicate ethanol storage availability, an estimate is made of terminals that may already handle ethanol but that are not listed as such in terminal atlases. The number of existing tanks that could be used without major conversion is then estimated, as is the number of existing tanks that could be used with conversion modifications (e.g., addition of floating internal covers or fixed roof). The remaining tank requirement is assumed to represent the number of new tanks required. A breakdown of the aforementioned categories is covered in the following table.

Table 5-2 Scenario #2 - Year 2004 - Revised Tank Requirement Estimate

PADD	Area	Tank Size (bbls)	No. of Tanks	Estimated Already In Use	Estimated use without Conversion	Estimated Use With Conversion	New Tanks Required
II	IL, IA, IN,	5m	10	3	0	0	7
	MO, NE, KS	10m	30	5	3	2	20
		25m	8	2	1	1	4
		50m	2	0	0	1	1
Totals			50	10	4	4	32

As the previous table indicates, it is estimated that at least 10 additional tanks, each at an individual terminal, are already handling ethanol. This is primarily due to the number of terminals in PADD II that already have ethanol capabilities. It is further estimated that at least 4 tanks, in PADD II, could be used without major conversion, and 4 tanks could be used after necessary conversion. A total of 32 new tanks would need to be installed. The conversion costs for the 4 tanks converted is estimated at $220,000 as covered in the following table.

Table 5-3 Scenario #2 - Year 2004 - Cost Estimate for Tank Conversion

PADD	Total No. of Conversions	Tank Size (bbls)	Total Cost Tanks (000)
II	2	10m	$60
	1	25m	$60
	1	50m	$100
Totals	4	-	$220

New tanks would cost $5,225,000 as covered in the following table.

Table 5-4 Scenario #2 - Year 2004 - Cost Estimate for New Tanks

PADD	Tanks Required	Tank Size (bbls)	Cost Per Steel barrel	Total Cost (000)
II	7	5m	$15	$525
	20	10m	$15	$3,000
	4	25m	$12	$1,200
	1	50m	$10	$500
Totals	32	-	-	$5,225

It is assumed that all terminals that will be newly converted to ethanol would require new blending systems. This includes all terminal categories except those estimated to already have ethanol. A total of 40 terminals would need to install such blending systems at a total cost of $12,000,000 as covered in the next table.

Table 5-5 Scenario #2 - Year 2004 - Cost Estimate for Blending Systems

PADD	No. of Units Required	Cost Each	Total Cost (000)
II	40	@ $300M	$12,000
Totals	40	@ $300M	$12,000

We have also estimated that only 2 terminals would need to install rail spurs to handle increased delivery by rail car. This is due largely to the preference for truck hauling at locations near plants. The estimated cost for rail spur additions is $710,000 and is covered in the next table.

Table 5-6 Scenario #2 - Year 2004 - Cost Estimate for Rail Spur Installation

PADD	No. of Units Required	Cost Each	Total Cost (000)
II	2	@ $355M	$710
Totals	2	@ $355M	$710

Finally we are assuming that all terminals newly converted to ethanol could have unforeseen miscellaneous expenses such as piping modifications or loading rack modifications. We have provided a contingency expense of $20,000 for each such terminal. The 40 terminals would then require $800,000 as covered in the following table.

Table 5-7 Scenario #2 - Year 2004 - Miscellaneous Contingency Cost Estimate

PADD	No. of Terminals	Cost estimated	Total Cost (000)
II	40	@ $20M	$800
Totals	40	@ $20M	$800

Finally there are also expenses in converting retail stations to ethanol use. The retail volume calculations to determine the number of retail units for the premised ethanol volumes are covered in the following table.

Table 5-8 Scenario #2 - Year 2004 - Calculations for Number of Required New Retail Units Handling Ethanol

PADD II 850,000 gallons per unit annually = 85,000 gallons of ethanol annually

0.924 bgy ethanol ÷ 85,000 gallons = 10,870 units

The premised volumes for 2004 would require a total of 10,870 retail units to convert to ethanol blends at an estimated cost of $6,413,000. These costs are recapped in the following table.

Table 5-9 Scenario #2 - Year 2004 - Retail Unit Conversions and Costs

PADD	No. of Units	Cost per Unit estimated	Total Cost (000)
II	10,870	@ $590	$6,413
Totals	10,870	@ $590	$6,413

Table 5-10 covers the required investments for each category by PADD. In addition, the volume requirements are calculated and costs are amortized.

The combined cost of preparing for the first year (i.e., 2004) of the RFS is $25,368,000, at a total amortized cost of $0.0043 per gallon of ethanol or $0.00043 per gallon of gasoline ethanol blend.

Table 5-10 Scenario #2 - Year 2004 - Total Estimated Capital Investment for Terminal Improvements & Retail Conversions for E-10

	New ethanol Volume (bgy)	Cost of Tank Conversion (000)	Cost of New Tanks (000)	Cost of Blending Systems (000)	Modification for Rail Receipt (000)	Contingency (000)	Retail Conversions (000)	Total (000)	Amortized cost per gallon
PADD II	0.924	$220	$5,225	$12,000	$710	$800	$6,413	$25,368	$0.0043
TOTALS	0.924	$220	$5,225	$12,000	$710	$800	$6,413	$25,368	$0.0043

5.1.2 Scenario #2 - Year 2004 Freight Costs and Transportation Equipment Requirements

In year 2004, the increased ethanol volumes are relatively low. A small amount of PADD II ethanol volume would move by barge and rail, 0.084 bgy and 0.060 bgy respectively. Close proximity to plants will encourage the use of low working inventory, requiring less tank capacity and, in turn, transport truck deliveries. Truck deliveries in PADD II are estimated at 0.780 bgy. No redistribution from hub terminals is necessary in PADD II due to the numerous points of supply availability.

Total shipments by mode for PADD II are recapped in the following table.

Table 5-11 Scenario #2 - Year 2004 - Projected Transportation Modes (bgy)

PADD	Total Volume	Projected Transportation Modes				Redistribution from Hub Terminal
		Ship	Barge	Rail	Truck	
II	0.924	--	0.084	0.060	0.780	0.0
Totals	0.924	--	0.084	0.060	0.780	0.0

The composite freight rates and resulting total freight charges for PADD II as well as an average resulting freight cost per gallon of ethanol are covered in the following table.

Table 5-12 Scenario #2 - Year 2004 - Transportation Costs

PADD	Primary Shipments: Composite Freight Rate per Gallon	Primary Shipments: Total Freight Cost (000)	Redistribution Shipments: Composite Redistribution Freight Rate per Gallon	Redistribution Shipments: Total Redistribution Cost (000)	Total Freight Cost (000)	Average Freight Costs per Gallon
II	$0.035	$32,340	n/a	--	$32,340	$0.035
Totals		$32,340	--	--	$32,340	$0.035

Total freight charges for the 0.924 bgy incremental ethanol volume are $32,340,000 averaging $0.035 per gallon of ethanol.

Although the increased demand on transportation capabilities is relatively small in year 2004, it is discussed here so that each year studied represents only the demand for the associated incremental ethanol volume.

Barge shipments are comprised solely of shipments within PADD II. Due to short shipping distances, barges could be turned 4 times per month. This would require 200 barge movements per year (17 per month) and equates to 4.3 barges in service. These calculations are covered in the following table.

Table 5-13 Scenario #2 - Year 2004 - Barge Requirements

PADD	Volume (bgy)	Annual Shipments	Monthly Shipments	Monthly Turnarounds	No. of Barges Required
II	0.084	200	17	4	4.3
Total	0.084	200	17	4	4.3

4.3 barges (10 MB capacity)
or 1.4 barges of 30 MB capacity

Rail car shipments are all within PADD II. Because shipments are not unit trains, only two turns per month are assumed. Total rail car loadings are 2,000 cars annually, averaging 167 monthly. This yields a demand of 83 rail cars. These calculations are covered in the following table.

Table 5-14 Scenario #2 - Year 2004 - Rail Car Requirements

PADD	Volume (bgy)	Annual Shipments	Monthly Shipments	Monthly Turnarounds	No. of Cars Required
II	0.060	2,000	167	2	83
Total	0.060	2,000	167	2	83

Finally, there are volumes shipped by truck. This includes the majority of product shipped within PADD II. The estimated volume of 0.780 bgy moving by truck would require 97,500 transport truck deliveries, an average of 8,125 per month. For PADD II, truck deliveries are sometimes hauled over greater distances so we have estimated only 70 turns per truck month. This results in the need for the equivalent of 116 truck/transport rigs. These calculations are covered in the following table.

Table 5-15 Scenario #2 - Year 2004 - Transport Truck Requirements

PADD	Volume (bgy)	Annual Shipments	Monthly Shipments	Monthly Turnarounds	Equivalent Transport Requirement
II	0.780	97,500	8,125	70	116
Total	0.780	97,500	8,125	70	116

5.2 Scenario #2 - Year 2007

In Scenario #2, for year 2007, the increased ethanol use (over year 2004) is 0.800 bgy. Costs associated with this volume increase are covered in the following sections.

5.2.1 Scenario #2 - Year 2007 Terminal and Retail Equipment Requirements & Costs

We start by determining the number of terminals required for each targeted market area (and related ethanol volumes increase). There are now 244 terminals servicing the target markets. Of these 94 have ethanol. This consists of 35 terminals that had ethanol in 2004 plus the 50 terminals adding ethanol in the 2004 study year. There were an additional 9 terminals with ethanol among those terminals added for year 2007. The preliminary estimate for tankage is then made. This information is included in the following table.

Table 5-16 Scenario #2 - Year 2007 - Preliminary Tank Requirement Estimate

PADD	Area	New Ethanol Volume (bgy)	No. of Servicing Terminals	No. with Ethanol (2004)	Estimated New Tankage Requirement for 2007
II	IL/IN/IA KS/MO/NE/*WI	0.683	147	90	20 x 5m 20 x 10m 8 x 25m
III	*AR/MS/TX	0.117	97	4	5 x 5m 10 x 10m 2 x 25m
Totals		0.800	244	94	25 - 5m 30 - 10m 10 - 25m

65 tanks totaling 675m barrels of capacity

Notes: **Current Estimated Gasoline Volume (bgy)**

PADD II (applicable states)	17.73 bgy
PADD III (applicable states)	13.66 bgy
Total	31.39

*** New market for 2007**

As can be seen in the table, the new ethanol volume for 2007 in Scenario #2 is 0.800 bgy and there are now 244 terminals servicing these expanded markets, an increase of 127 terminals over 2004. It is estimated that a total of 65 tanks totaling 675 MB (28,350,000 gallons) would be required. Terminals in PADD II can operate on 10 days inventory (due to close proximity to plants). Consequently 36 inventory turns per year could be achieved. In PADD III, it is assumed inventory levels will be maintained at slightly higher levels with only 24 turns per year. Based on this we assume an average of 30 inventory turns per year for the total market area. The 675 MB of new storage would then equate to 0.851 bgy versus an actual volume increase of 0.800 bgy.

Because the information available in terminal atlases does not always indicate ethanol storage availability, an estimate is made of terminals that may already handle ethanol but that are not listed as such in terminal atlases. The number of existing tanks that could be used without major conversion is then estimated, as is the number of existing tanks that could be used with conversion modifications (e.g., addition of floating internal covers or fixed roof). The remaining tank requirement is assumed to represent the number of new tanks required. A breakdown of the aforementioned categories is covered in the following table.

Table 5-17 Scenario #2 - Year 2007 - Revised Tank Requirement Estimate

PADD	Area	Tank Size (bbls)	No. of Tanks	Estimated Already In Use	Estimated use without Conversion	Estimated Use With Conversion	New Tanks Required
II	IL/IN/IA	5m	20	5	0	1	14
	KS/MO/NE/*WI	10m	20	6	2	2	10
		25m	8	1	1	2	4
III	*AR/MS/TX	5m	5	2	0	0	3
		10m	10	2	1	1	6
		25m	2	1	0	1	0
Totals			65	17	4	7	37

As the previous table indicates, it is estimated that at least 17 terminals are already handling ethanol, or have tanks to do so. This is primarily due to the number of terminals in PADDs II and III that have already installed such capabilities. It is further estimated that at least 4 tanks could be used without major conversion, and 7 tanks could be used after necessary conversion. A total of 37 new tanks would need to be installed. The conversion costs for the 7 tanks converted is estimated at $285,000 as covered in the following table.

Table 5-18 Scenario #2 - Year 2007 - Cost Estimate for Tank Conversion

PADD	Total No. of Conversions	Tank Size (bbls)	Total Cost Tanks (000)
II	1	5m	$15
	2	10m	$60
	2	25m	$120
III	1	10m	$30
	1	25m	$60
Totals	7	-	$285

New tanks would cost $4,875,000 as covered by PADD in the following table.

Table 5-19 Scenario #2 - Year 2007 - Cost Estimate for New Tanks

PADD	Tanks Required	Tank Size (bbls)	Cost Per Steel barrel	Total Cost (000)
II	14	5m	$15	$1,050
	10	10m	$15	$1,500
	4	25m	$12	$1,200
III	3	5m	$15	$225
	6	10m	$15	$900
Totals	37	-	-	$4,875

It is assumed that all terminals that will be newly converted to ethanol would require new blending systems. This includes all terminal categories except those estimated to already have ethanol. A total of 48 terminals would need to install such blending systems at a total cost of $14,400,000 as covered in the next table.

Table 5-20 Scenario #2 - Year 2007 - Cost Estimate for Blending Systems

PADD	No. of Units Required	Cost Each	Total Cost (000)
II	36	@ $300M	$10,800
III	12	@ $300M	$3,600
Totals	48	@ $300M	$14,400

We have also estimated that at least 6 terminals would need to install rail spurs to handle increased delivery by rail car. The estimated cost for rail spur additions is $2,130,000 and is covered in the next table.

Table 5-21 Scenario #2 - Year 2007 - Cost Estimate for Rail Spur Installation

PADD	No. of Units Required	Cost Each	Total Cost (000)
II	4	@ $355M	$1,420
III	2	@ $355M	$710
Totals	6	@ $355M	$2,130

We are assuming that all terminals newly converted to ethanol could have unforeseen miscellaneous expenses such as piping modifications or loading rack modifications. We have provided a contingency expense of $20,000 for each such terminal. The 48 terminals would then require $960,000 for this category, as covered in the following table.

Table 5-22 Scenario #2 - Year 2007 - Miscellaneous Contingency Cost Estimate

PADD	No. of Terminals	Cost estimated	Total Cost (000)
II	36	@ $20M	$720
III	12	@ $20M	$240
Totals	48	@ $20M	$960

Finally, there are also expenses in converting retail stations to ethanol use. In PADD II average retail unit volume is assumed to be 850,000 gallons per year. In PADD III average retail unit volume is assumed to be 700,000 gallons annually. The various retail volume calculations to determine the number of retail units for the premised ethanol volumes are covered in the following table.

Table 5-23 Scenario #2 - Year 2007 - Calibrations for Number of Required New Retail Units Handling Ethanol

PADD II 850,000 gallons per unit annually = 85,000 gallons of ethanol annually
0.683bgy ethanol ÷ 85,000 gallons = 8,035 units

PADD III 700,000 gallons per unit annually = 70,000 gallons of ethanol annually
0.117 bgy ethanol ÷ 70,000 gallons = 1,671 units

The premised volumes for 2007 would require a total of 9,706 retail units to convert to ethanol blends at an estimated cost of $5,727,000. These units are recapped by PADD in the table below.

Table 5-24 Scenario #2 - Year 2007 - Retail Unit Conversions and Costs

PADD	No. of Units	Cost per Unit estimated	Total Cost (000)
II	8,035	@ $590	$4,741
III	1,671	@ $590	$986
Totals	9,706	@ $590	$5,727

The next table covers the required investments for each category by PADD. In addition, the volume requirements are listed and costs are amortized.

The combined estimated costs of preparing for 2007 of the RFS is $28,377,000, at a total amortized cost of $0.0055 per gallon of ethanol or $0.00055 per gallon of gasoline ethanol blend.

For PADD II total estimated costs are $21,626,000 or $0.0049 per gallon of ethanol on an amortized basis. PADD III's estimated costs are $6,751,000 or $0.009 per gallon of ethanol on an amortized basis.

Table 5-25 Scenario #2 - Year 2007 - Total Estimated Capital Investment for Terminal Improvements & Retail Conversions for E-10

	New ethanol Volume (bgy)	Cost of Tank Conversion (000)	Cost of New Tanks (000)	Cost of Blending Systems (000)	Modification for Rail Receipt (000)	Contingency (000)	Retail Conversions (000)	Total (000)	Amortized cost per gallon
PADD II	0.683	$195	$3,750	$10,800	$1,420	$720	$4,741	$21,626	$0.0049
PADD III	0.117	$90	$1,125	$3,600	$710	$240	$986	$6,751	$0.0090
TOTALS	0.800	$285	$4,875	$14,400	$2,130	$960	$5,727	$28,377	$0.0055

5.2.2 Scenario #2 - Year 2007 Freight Costs and Transportation Equipment Requirements

In year 2007, the increased ethanol volumes are still relatively low. A small amount of PADD II ethanol volume would move by barge and rail, 0.084 bgy and 0.060 bgy respectively. Close proximity to plants will encourage the use of low working inventories, requiring less tank capacity and, in turn, transport truck deliveries. Truck deliveries in PADD II are estimated at 0.539 bgy. Redistribution from hub terminals is necessary for only a very small volume in PADD II due to the numerous points of supply availability. The increased volume in PADD III would be moved by a combination of barge shipments totaling 0.042 bgy and rail totaling 0.075 bgy. Some redistribution is also necessary from hub terminals in PADD III.

Total shipments by mode for PADD II and III are recapped in the following table.

Table 5-26 Scenario #2 - Year 2007 - Projected Transportation Modes (bgy)

PADD	Total Volume	Projected Transportation Modes				Redistribution from Hub Terminal
		Ship	Barge	Rail	Truck	
II	0.683	--	0.084	0.060	0.539	0.02
III	0.117	--	0.042	0.075	--	0.03
Totals	0.800	--	0.126	0.135	0.539	0.05

The composite freight rates and resulting total freight charges for PADD II as well as an average resulting freight cost per gallon of ethanol are covered in the following table.

	Primary Shipments		Redistribution Shipments		Total	Average
PADD	**Composite Freight Rate per Gallon**	**Total Freight Cost (000)**	**Composite Redistribution Freight Rate per Gallon**	**Total Redistribution Cost (000)**	**Freight Cost (000)**	**Freight Costs per Gallon**
II	$0.038	$25,954	$0.015	$300	$26,254	$0.038
III	$0.085	$9,945	$0.02	$600	$10,545	$0.090
Totals		$35,899		$900	$36,799	$0.046

Table 5-27 Scenario #2 - Year 2007 - Transportation Costs

The average freight cost per gallon in PADD II increases slightly compared to year 2004 due to ethanol being distributed to more distant terminals and also some small volumes being redistributed from hub terminals.

Total freight charges for the 0.800 bgy incremental ethanol volume are $36,799,000 averaging $0.046 per gallon of ethanol.

The increased demand on transportation capabilities remains relatively small in year 2007, but it is discussed here so that each year studied represents only the demand for the associated incremental ethanol volume.

Barge shipments are comprised of shipments to PADD III and shipments within PADD II. Barges could be turned 4 times per month in PADD II and 2 times per month in PADD III. This would require 300 barge movements per year (25 per month) and equates to 8.3 barges in service. These calculations are covered in the following table.

Table 5-28 Scenario #2 - Year 2007 - Barge Requirements

PADD	Volume (bgy)	Annual Shipments	Monthly Shipments	Monthly Turnarounds	No. of Barges Required
II	0.084	200	17	4	4.3
III	0.042	100	8	2	4.0
Total	0.126	300	25	-	8.3

8.3 barges (10 MB capacity)
or 2.8 barges (30 MB Capacity)

Rail car shipments will be made both within PADD II, and to PADD III. Because shipments are not unit trains, only two turns per month are assumed. Total rail car loadings are 4,500 cars annually, averaging 375 monthly. This yields a demand of 187 rail cars. These calculations are covered in the following table.

Table 5-29 Scenario #2 - Year 2007 - Rail Car Requirements

PADD	Volume (bgy)	Annual Shipments	Monthly Shipments	Monthly Turnarounds	No. of Cars Required
II	0.060	2,000	167	2	83
III	0.075	2,500	208	2	104
Total	0.135	4,500	375	-	187

Finally, there are volumes shipped by truck. This includes the majority of product shipped within PADD II. In study year 2007, there are also some small volumes redistributed from hub terminals in both PADDs II and III, and these shipments have also been included. The estimated volume of 0.589

bgy moving by truck would require 73,625 annual transport truck deliveries, an average of 6,136 per month. For PADD II, truck deliveries are now hauled over greater distances so we have lowered estimated turnaround times from 70 turns per truck month down to 60 per month. For PADD III, we assume 70 turns per month since truck shipments are short hauls from redistribution terminals. This results in the need for the equivalent of 102 truck/transport rigs. These calculations are covered in the following table.

Table 5-30 Scenario #2 - Year 2007 - Transport Truck Requirements

PADD	Volume (bgy)	Annual Shipments	Monthly Shipments	Monthly Turnarounds	Equivalent Transport Requirement
II	0.559	69,875	5,823	60	97
III	0.030	3,750	313	70	5
Total	0.589	73,625	6,136	-	102

5.3 Scenario #2 - Year 2012

In Scenario #2, for year 2012, the increased ethanol use (over year 2007) is 1.8 bgy. Costs associated with this volume increase are covered in the following sections.

5.3.1 Scenario #2 - Year 2012 Terminal and Retail Equipment Requirements & Costs

We start by determining the number of terminals required for each targeted market area (and related ethanol volume increase). The terminals servicing the designated market areas total 535, of which 203 offer ethanol. The ethanol terminals are comprised of the 94 that were offering ethanol in 2004 plus the 65 added in 2007. Also, among new terminals added to the servicing market, 44 already offered ethanol. The preliminary estimate for tankage is then made. This information is included in the following table.

Table 5-31 Scenario #2 - Year 2012 - Preliminary Tank Requirement Estimate

PADD	Area	New Ethanol Volume (bgy)	No. of Servicing Terminals	No. with Ethanol (2007)	Estimated New Tankage Requirement for 2012
II	IL/IN/IA KS/MO/NE/WI *KY/TN/OK/OH *MI/MN/SD/ND	0.522	401	178	30 x 5m 50 x 10m 5 x 25m 2 x 50m
III	AR/MS/TX *LA	1.243	125	23	20 x 5m 40 x 10m 8 x 25m 6 x 50m
IV	*CO	0.035	9	2	3 x 10m
Totals		1.80	535	203	50 - 5m 93 - 10m 13 - 25m 8 - 50m

164 tanks totaling 1905m barrels of capacity

Notes:

Current Estimated Gasoline Volume (bgy)	
PADD II	38.23 bgy
PADD III (applicable states)	15.99 bgy
PADD IV (Colorado)	2.04 bgy
Total	57.26

*NEW MARKET FOR 2012

As can be seen in the table, the new ethanol volume for 2012 in Scenario #2 is 1.8 bgy and there are now 535 terminals servicing these expanded markets, an increase of 291 terminals over 2007. It is estimated that a total of 164 additional tanks, totaling 1905 MB (80,010,000 gallons) of storage capacity, would be required. Terminals in PADD II can operate on 10 days inventory (due to close proximity to plants). Consequently 36 inventory turns per year could be achieved. In PADDs III and IV, it is assumed inventory levels will be maintained at slightly higher levels with only 24 turns per year. Based on this we assume an average of 28 inventory turns per year across the entire market area. The 1905 MB of new storage would then equate to 2.239 bgy versus an actual volume increase of 1.8 bgy.

The storage capacity added equates to about 25% more than the calculated need. However, this capacity level may be needed due to the ambitious inventory turn assumptions. Additionally with 164 terminals adding tanks, some may simply not be able to receive large quantity shipments (e.g., barges, multiple rail cars) without some level of excess capacity.

Because the information available in terminal atlases does not always indicate ethanol storage availability, an estimate is made of terminals that may already handle ethanol but that are not listed as such in terminal atlases. The number of existing tanks that could be used without major conversion is then estimated, as is the number of existing tanks that could be used with conversion modifications (e.g., addition of floating internal covers or fixed roof). The remaining tank requirement is assumed to represent the number of new tanks required. A breakdown of the aforementioned categories is covered in the following table.

Table 5-32 Scenario #2 - Year 2012 - Revised Tank Requirement Estimate

PADD	Area	Tank Size (bbls)	No. of Tanks	Estimated Already In Use	Estimated use without Conversion	Estimated Use With Conversion	New Tanks Required
II	IL/IN/IA/KS	5m	30	6	0	4	20
	MO/NE/WI	10m	50	10	5	5	30
	*KY/TN/OK/OH	25m	5	1	0	2	2
	*MI/MN/SD/ND	50m	2	0	0	1	1
III	AR/MS/TX/	5m	20	3	0	0	17
	*LA	10m	40	2	2	4	32
		25m	8	0	1	1	6
		50m	6	0	0	1	5
IV	*CO	10m	3	1	0	1	1
Totals			164	23	8	19	114

***New market for 2012**

As the previous table indicates, it is estimated that at least 23 terminals are already handling ethanol, or have tanks to do so. This is primarily due to the number of terminals in PADDs II and III that have already installed such capabilities. It is further estimated that at least 8 tanks could be used without major conversion, and 19 tanks could be used after necessary conversion. A total 114 new tanks would need to be installed. The conversion cost for the 8 tanks converted is estimated at $740,000 as covered in the following table.

Table 5-33 Scenario #2 - Year 2012 - Cost Estimate for Tank Conversion

PADD	Total No. of Conversions	Tank Size (bbls)	Total Cost Tanks (000)
II	4	5m	$60
	5	10m	$150
	2	25m	$120
	1	50m	$100
III	4	10m	$120
	1	25m	$60
	1	50m	$100
IV	1	10m	$30
Totals	19	-	$740

New tanks would cost $17,625,000 as covered by PADD in the following table.

Table 5-34 Scenario #2 - Year 2012 - Cost Estimate for New Tanks

PADD	Tanks Required	Tank Size (bbls)	Cost Per Steel barrel	Total Cost (000)
II	20	5m	$15	$1,500
	30	10m	$15	$4,500
	2	25m	$12	$600
	1	50m	$10	$500
III	17	5m	$15	$1,275
	32	10m	$15	$4,800
	6	25m	$12	$1,800
	5	50m	$10	$2,500
IV	1	10m	$15	$150
Totals	114	-	-	$17,625

It is assumed that all terminals that will be newly converted to ethanol would require new blending systems. This includes all terminal categories except those estimated to already have ethanol. A total of 141 terminals would need to install such blending systems at a total cost of $42,300,000 as covered in the next table.

Table 5-35 Scenario #2 - Year 2012 - Cost Estimate for Blending Systems

PADD	No. of Units Required	Cost Each	Total Cost (000)
II	70	@ $300M	$21,000
III	69	@ $300M	$20,700
IV	2	@ $300M	$600
Totals	141	@ $300M	$42,300

We have also estimated that at least 10 terminals would need to install rail spurs to handle increased delivery by rail car. The estimated cost for rail spur additions is $3,550,000 and is covered in the next table.

Table 5-36 Scenario #2 - Year 2012 - Cost Estimate for Rail Spur Installation

PADD	No. of Units Required	Cost Each	Total Cost (000)
II	4	@ $355M	$1,420
III	5	@ $355M	$1,775
IV	1	@ $355M	$355
Totals	10	@ $355M	$3,550

We are assuming that all terminals newly converted to ethanol could have unforeseen miscellaneous expenses such as piping modifications or loading rack modifications. We have provided a contingency expense of $20,000 for each such terminal. The 141 terminals would then require $2,820,000 for this category, as covered in the following table.

Table 5-37 Scenario #2 - Year 2012 - Miscellaneous Contingency Cost Estimate

PADD	No. of Terminals	Cost estimated	Total Cost (000)
II	70	@ $20M	$1,400
III	69	@ $20M	$1,380
IV	2	@ $20M	$40
Totals	141	@ $20M	$2,820

Finally, there are also expenses in converting retail stations to ethanol use. In PADD II average retail unit volume for 2012 is lowered, from previous scenario years, to 800,000 gallons per year to reflect the addition of more rural markets. In PADD III average retail unit volume is assumed to be 700,000 gallons annually. In PADD IV average retail unit volume is assumed to be 800,000 gallons annually. The various retail volume calculations to determine the number of retail units for the premised ethanol volumes are covered in the following table.

Table 5-38 Scenario #2 - Year 2012 - Calculations for Number of Required New Retail Units Handling Ethanol

PADD II 800,000 gallons per unit annually = 80,000 gallons of ethanol annually
0.522 ethanol ÷ 80,000 gallons = 6,525 units

PADD III 700,000 gallons per unit annually = 70,000 gallons of ethanol annually
1.243 bgy ethanol ÷ 70,000 gallons = 17,757 units

PADD IV 800,000 gallons per unit annually = 80,000 gallons of ethanol annually
0.035 bgy ethanol ÷ 80,000 gallons = 438 units

The premised ethanol volumes for 2012 would require a total of 24,720 retail units to convert to ethanol blends at an estimated cost of $14,585,000. These units are recapped by PADD in the table below.

Table 5-39 Scenario #2 - Year 2012 - Retail Unit Conversions and Costs

PADD	No. of Units	Cost per Unit estimated	Total Cost (000)
II	6,525	@ $590	$3,850
III	17,757	@ $590	$10,477
IV	438	@ $590	$258
Totals	24,720	@ $590	$14,585

Table 5-40 covers the required investments for each category by PADD. In addition, the volume requirements are listed and costs are amortized.

The combined estimated cost of preparing for 2012 of the RFS is $81,620,000, a total amortized cost of $0.0071 per gallon of ethanol, or $0.00071 per gallon of gasoline ethanol blend.

For PADD II total estimated costs are $35,200,000 or $0.011 per gallon of ethanol on an amortized basis. PADD III's estimated costs are $44,987,000 or $0.0056 per gallon of ethanol on an amortized basis. PADD IV's estimated costs are $1,433,000 or $0.0064 per gallon of ethanol on an amortized basis.

Table 5-40 Scenario #2 - Year 2012 - Total Estimated Capital Investment for Terminal Improvements & Retail Conversions for E-10

	New ethanol Volume (bgy)	Cost of Tank Conversion (000)	Cost of New Tanks (000)	Cost of Blending Systems (000)	Modification for Rail Receipt (000)	Contingency (000)	Retail Conversions (000)	Total (000)	Amortized cost per gallon
PADD II	0.522	$430	$7,100	$21,000	$1,420	$1,400	$3,850	$35,200	$0.0110
PADD III	1.243	$280	$10,375	$20,700	$1,775	$1,380	$10,477	$44,987	$0.0056
PADD IV	0.035	$30	$150	$600	$355	$40	$258	$1,433	$0.0064
TOTALS	1.800	$740	$17,625	$42,300	$3,550	$2,820	$14,585	$81,620	$0.0071

5.3.2 Scenario #2 - Year 2012 Freight Costs and Transportation Equipment Requirements

In year 2012, the increased ethanol volumes over 2007 are fairly significant. A small amount of PADD II ethanol volume would move by barge and rail, 0.084 bgy and 0.090 bgy respectively. Close proximity to plants will encourage the use of low working inventory requiring less tank capacity and, in turn, transport truck deliveries. Truck deliveries in PADD II are estimated at 0.348 bgy. Redistribution from hub terminals is necessary for only a very small volume in PADD II due to the numerous points of supply availability. In PADD III, 0.252 bgy is shipped by barge and 0.991 bgy by rail. PADD IV volume of 0.035 bgy would move by rail. Redistribution of larger volumes is also necessary from hub terminals in PADD III. Total shipments by mode for PADDs II, III, and IV are recapped in the following table.

Table 5-41 Scenario #2 - Year 2012 - Projected Transportation Modes (bgy)

PADD	Total Volume	Projected Transportation Modes				Redistribution from Hub Terminal
		Ship	Barge	Rail	Truck	
II	0.522	--	0.084	0.090	0.348	0.04
III	1.243	--	0.252	0.991	--	0.20
IV	0.035	--	--	0.035	--	--
Totals	1.800	--	0.336	1.116	0.348	0.24

The composite freight rates and resulting total freight charges for each PADD, as well as an average resulting freight cost per gallon of ethanol, are covered in the following table.

Table 5-42 Scenario #2 - Year 2012 - Transportation Costs

PADD	Primary Shipments: Composite Freight Rate per Gallon	Primary Shipments: Total Freight Cost (000)	Redistribution Shipments: Composite Redistribution Freight Rate per Gallon	Redistribution Shipments: Total Redistribution Cost (000)	Total Freight Cost (000)	Average Freight Costs per Gallon
II	$0.039	$20,358	$0.015	$600	$20,958	$0.040
III	$0.085	$105,655	$0.02	$4,000	$109,655	$0.088
IV	$0.105	$3,675	--	--	$3,675	$0.105
Totals		$129,688		$4,600	$134,288	$0.075

Total freight charges for the 1.800 bgy incremental ethanol volume are $134,288,000 averaging $0.075 per gallon of ethanol.

The average freight cost per gallon in PADD II increases slightly compared to year 2007 due to ethanol being distributed to more distant terminals and also more volume being redistributed from hub terminals.

The increased demand on transportation capabilities increases significantly compared to 2007, due both to the 1.8 bgy increase occuring over 5 years and also due to the greater shipping distances as more product enters PADD III.

Barge shipments are comprised of shipments to PADD III and shipments within PADD II. Barges could be turned 4 times per month in PADD II and 2 times per month in PADD III. This would require 800 barge movements per year (67 per month) and equates to 29.3 barges in service. These calculations are covered in the following table.

Table 5-43 Scenario #2 - Year 2012 - Barge Requirements

PADD	Volume (bgy)	Annual Shipments	Monthly Shipments	Monthly Turnarounds	No. of Barges Required
II	0.084	200	17	4	4.3
III	0.252	600	50	2	25.0
IV	--	--	--	--	--
Total	0.336	800	67	-	29.3

29.3 barges (10 MB capacity)
or 10.0 barges (30 MB Capacity)

Rail car shipments will also be made to PADDs III and IV as well as within PADD II. Because shipments are not unit trains, only two turns per month are assumed. Total rail car loadings are 37,200 cars annually, averaging 3,100 monthly. This yields a demand of 1,550 rail cars. These calculations are covered in the following table.

Table 5-44 Scenario #2 - Year 2012 - Rail Car Requirements

PADD	Volume (bgy)	Annual Shipments	Monthly Shipments	Monthly Turnarounds	No. of Cars Required
II	0.090	3,000	250	2	125
III	0.991	33,033	2,752	2	1,376
IV	0.035	1,167	98	2	49
Total	1.116	37,200	3,100	-	1,550

Finally, there are volumes shipped by truck. This includes the majority of product shipped within PADD II. In study year 2012, there are also some small volume redistributed from hub terminals in both PADDs II and III and these shipments have also been included. The estimated volume of 0.588 bgy moving by truck would require 73,500 annual transport truck deliveries, an average of 6,125 per month. For PADD II, truck deliveries are hauled over similar distances to those in 2007, so we have left turnaround times at 60 per truck month. For PADD III, we assume 70 turns per month since truck shipments are short hauls from redistribution terminals. It is assumed the small volume in PADD IV will be railed directly to the end use terminal. This results in the need for the equivalent of 97 truck/ transport rigs. These calculations are covered in the following table.

Table 5-45 Scenario #2 - Year 2012 - Transport Truck Requirements

PADD	Volume (bgy)	Annual Shipments	Monthly Shipments	Monthly Turnarounds	Equivalent Transport Requirement
II	0.388	48,500	4,042	60	67
III	0.200	25,000	2,083	70	30
IV	-	--	--	--	--
Total	0.588	73,500	6,125	--	97

5.4 Scenario #2 Recap of Equipment & Transportation Requirements

5.4.1 Scenario #2 Investment Requirements Recap

This section contains the three study year points for Scenario #2 to present a total investment cost for the increased ethanol volumes over the total period studied.

By year 2012, the servicing areas in Scenario #2 will encompass 535 terminals of which 367 would add ethanol. Between the baseline year and year 2012, it is estimated that 213 tanks totaling 3,280 MB (137,760,000 gallons) of capacity would need to be converted or installed. At an average of 28 turns per year this storage would be capable of handling 3.85 bgy of new ethanol volume. New ethanol volume in Scenario #2 is 3.524 bgy.

It is estimated that 16 terminal tanks could be put into ethanol service without major modification while another 30 tanks could be placed in service with conversion. However, it would be necessary to add 183 new tanks. It would also be necessary to install 229 blending systems and 18 rail spurs. We have also assumed that all 229 terminals newly converting to ethanol would incur $20,000 per terminal in miscellaneous expense. Finally, it would be necessary to convert 45,296 retail outlets to ethanol blends.

These figures are recapped in the following table.

Table 5-46 Scenario #2 - Equipment Recap

	Tanks without Conversion	Tanks with Conversion	New Tanks	Blending Systems	Rail Spurs	Misc.	Retail Units
PADD II							
2004	4	4	32	40	2	40	10,870
2007	3	5	28	36	4	36	8,035
2012	5	12	53	70	4	70	6,525
PADD II Totals	**12**	**21**	**113**	**146**	**10**	**146**	**25,430**
PADD III							
2004	0	0	0	0	0	0	0
2007	1	2	9	12	2	12	1,671
2012	3	6	60	69	5	69	17,757
PADD III Totals	**4**	**8**	**69**	**81**	**7**	**81**	**19,428**
PADD IV							
2004	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0
2012	0	1	1	2	1	2	438
PADD IV Totals	**0**	**1**	**1**	**2**	**1**	**2**	**438**
Totals 2004	**4**	**4**	**32**	**40**	**2**	**40**	**10,870**
Totals 2007	**4**	**7**	**37**	**48**	**6**	**48**	**9,706**
Totals 2012	**8**	**19**	**114**	**141**	**10**	**141**	**24,720**
TOTALS ALL	**16**	**30**	**183**	**229**	**18**	**229**	**45,296**

By the year 2012, total investments for terminal improvements and retail conversions will reach $135,365,000 to accommodate the premised volume increase of 3.524 bgy. This equates to $0.0060 per gallon of ethanol on an amortized basis or slightly less than $0.00060 per gallon of gasoline ethanol blend.

The required investment estimates by category, study year, and PADD are presented in the following table.

Table 5-47 Scenario #2 - Investment Recap

	New ethanol Volume (bgy)	Cost of Tank Conversion (000)	Cost of New Tanks (000)	Cost of Blending Systems (000)	Mod. for Rail Receipt (000)	Contingency (000)	Retail Conversions (000)	Total (000)	Amortized cost per gallon
PADD II									
2004	0.924	$220	$5,550	$12,000	$710	$800	$6,413	$25,368	$0.0043
2007	0.683	$195	$3,750	$10,800	$1,420	$720	$4,741	$21,626	$0.0049
2012	0.522	$430	$7,100	$21,000	$1,420	$1,400	$3,850	$35,200	$0.0110
Total PADD II	**2.129**	**$845**	**$16,075**	**$43,800**	**$3,550**	**$2,920**	**$15,004**	**$82,194**	**$0.0060**
PADD III									
2004	-	-	-	-	-	-	-	-	-
2007	0.117	$90	$1,125	$3,600	$710	$240	$986	$6,751	$0.0090
2012	1.243	$280	$10,375	$20,700	$1,775	$1,380	$10,477	$44,987	$0.0056
Total PADD III	**1.360**	**$370**	**$11,500**	**$24,300**	**$2,485**	**$1,620**	**$11,463**	**$51,738**	**$0.0059**
PADD IV									
2004	-	-	-	-	-	-	-	-	
2007	-	-	-	-	-	-	-	-	
2012	0.035	$30	$150	$600	$355	$40	$258	$1,433	$0.0064
Total PADD IV	**0.035**	**$30**	**$150**	**$600**	**$355**	**$40**	**$258**	**$1,433**	**$0.0064**
Totals									
2004	**0.924**	**$220**	**$5,225**	**$12,000**	**$710**	**$800**	**$6,413**	**$25,368**	**$0.0043**
2007	**0.800**	**$285**	**$4,875**	**$14,400**	**$2,130**	**$960**	**$5,727**	**$28,377**	**$0.0055**
2012	**1.800**	**$740**	**$17,625**	**$42,300**	**$3,550**	**$2,820**	**$14,585**	**$81,620**	**$0.0071**
TOTAL ALL	**3.524**	**$1,245**	**$27,725**	**$68,700**	**$6,390**	**$4,580**	**$26,725**	**$135,365**	**$0.0060**

It should again be noted that in Scenario #2 there is no seasonal demand split as in the case of Scenario #1. If Scenario #2 utilized the same seasonal demand split (i.e. 65/35) as Scenario #1, terminal and retail equipment requirements would be increased by a factor of 1.3. Transportation equipment requirements (covered in the next section) would be increased by a like amount.

5.4.2 Scenario #2 Freight Requirement Recap

This section combines the study year points for Scenario #2 to present a total freight cost and freight equipment requirement for the ethanol volume increase that would occur between the baseline and year 2012. This would represent a volume of 3.524 bgy. Total freight costs for the new volume will, by 2012, reach $203,427,000 representing an average freight cost of $0.0577 per gallon of ethanol, or $0.0057 per gallon of gasoline ethanol blend. Freight costs by PADD are covered in the following table.

Table 5-48 Scenario #2 - Freight Cost by PADD Recap

Year	Amount (bgy)	Total Freight Costs PADD II (000)	PADD III (000)	PADD IV (000)	TOTALS (000)	Average Freight Cost Per Gallon
2004	0.924	$32,340	--	--	$32,340	$0.035
2007	0.800	$26,254	$10,545	--	$36,799	$0.046
2012	1.800	$20,958	$109,655	$3,675	$134,288	$0.075
Totals	**3.524**	**$79,552**	**$120,200**	**$3,675**	**$203,427**	**$0.0577**

By 2012, the ethanol shipments for Scenario #2 would require 1,900 annual barge shipments requiring the use of 41.9 barges (10 MB capacity barges). Annual rail car loadings will reach 43,700 shipments requiring the use of 1,820 rail cars. Annual truck cargoes would reach 244,625 shipments requiring the use of the equivalent of 315 truck/transport rigs. There would be no shipments of the new ethanol volume by ocean going vessel.

These figures are recapped by PADD and study year in the following table.

Table 5-49 Scenario #2 - Freight Shipments by PADD Recap

	PADD II	PADD III	PADD IV	TOTALS
Annual Ship Cargoes				
2004				0.00
2007				0.00
2012				0.00
Totals		**0.00**	**0.00**	**0.00**
Annual Ship Requirement				
2004				0.00
2007				0.00
2012				0.00
Totals	**0.00**	**0.00**	**0.00**	**0.00**
Annual Barge Cargoes				
2004	200			200
2007	200	100		300
2012	800	600		1,400
Totals	**1200**	**700**	**0**	**1,900**
Annual Barge Requirement				
2004	4.3			4.3
2007	4.3	4.00		8.3
2012	4.3	25.00		29.3
Totals	**12.9**	**29.00**	**0.00**	**41.9**
Annual Rail Cargoes				
2004	2,000			2,000
2007	2,000	2,500		4,500
2012	3,000	33,033	1,167	37,200
Totals	**7,000**	**35,533**	**1,167**	**43,700**
Annual Rail Requirement				
2004	83			83
2007	83	104		187
2012	125	1,376	49	1,550
Totals	**291**	**1,480**	**49**	**1,820**
Annual Truck Cargoes				
2004	97,500			97,500
2007	69,875	3,750		73,625
2012	48,500	25,000		73,500
Totals	**215,875**	**28,750**		**244,625**
Annual Truck Requirement				
2004	116			116
2007	97	5		102
2012	67	30		97
Totals	**280**	**35**		**315**

Section 5 - Scenario #2 Specific References

None

Section 5 -Scenario #2 General References

1. Downstream Alternatives Inc. (DAI). 2002. *Infrastructure Requirements for an Expanded Fuel Ethanol Industry*, Phase II Project Deliverable Report, Oak Ridge National Laboratory, Ethanol Project, Subcontract No. 4500010570, South Bend, IN 46680-2587, January 15, http://www.afdc.doe.gov/pdfs/6235.pdf

2. Downstream Alternatives Inc. (DAI). 2002. *Assumptions and Premises for Phase III Task 1 Deliverable For Studies on Ethanol Logistics Issues*, Submitted to Oak Ridge National Laboratory, Ethanol Project, Subcontract No. 4500010570, South Bend, IN 46680-2587, March 14,

Section 6

Discussion, Observations, and Comparison of Scenarios Studied

6.0 Discussion, Observations, and Comparison of Scenarios Studied

This section discusses some of the key observations and compares the requirements for the two scenarios studied.

Volume Comparison Between Scenarios

Tables 6-1 (Scenario #1) and 6-2 (Scenario #2) list the new ethanol volume by PADD, for each year studied.

Table 6-1 New Ethanol Volume by PADD - Scenario #1 (bgy)

PADD	Base	New Volume 2004	New Volume 2007	New Volume 2012	New Volume Total	Total Base + New Volume
I	0.111	0.39	0.299	0.800	1.489	1.600
II	1.071	0.313	0.116	0.300	0.729	1.800
III	0.083	-	0.182	0.235	0.417	0.500
IV	0.065	-	-	0.035	0.035	0.100
V	0.146	0.154	0.3	0.400	0.854	1.000
Total	1.476	0.857	0.897	1.77	3.524	5.0

Table 6-2 New Ethanol Volume by PADD - Scenario #2 (bgy)

PADD	Base	New Volume 2004	New Volume 2007	New Volume 2012	New Volume Total	Total Base + New Volume
I	0.111	-	-	-	-	0.111
II	1.071	0.924	0.683	0.522	2.129	3.200
III	0.083	-	0.117	1.243	1.360	1.443
IV	0.065	-	-	0.035	0.035	0.100
V	0.146	-	-	-	-	0.146
Total	1.476	0.924	0.800	1.800	3.524	5.000

In Scenario #1, a larger portion of new ethanol volume is used in PADDs I and V while in Scenario #2, new ethanol volume is used primarily in PADDs II and III. Also, Scenario #1 is premised to have a seasonal split in usage patterns where 65% of the ethanol is used in one six month period, while 35% is used in the other (i.e., 65/35 split). Table 6-3 provides a comparison of total volume by PADD for the two scenarios over the study's entire time frame.

Table 6-3 New Ethanol Volume Comparison (bgy)

PADD	Scenario #1	Scenario #2
I	1.489	0.000
II	0.729	2.129
III	0.417	1.360
IV	0.035	0.035
V	0.854	0.000
Total	3.524	3.524

With the two scenarios resulting in different distribution profiles among PADDs it is worthwhile to compare various requirements between the scenarios. The next table provides a terminal profile comparison. In Scenario #1 the servicing markets encompass 557 terminals with 333 handling ethanol. In Scenario #2 there are 535 terminals in the servicing markets of which 367 terminals offer ethanol. Scenario #1 requires the addition or conversion of 215 tanks while Scenario #2 requires 213. Comparing the added storage requirements, it is obvious that the tanks added in Scenario #1 are much larger. This is, of course, a result of needing to carry larger inventories due to greater distances from sourcing plants and also due to the 65/35 seasonal split. In Scenario #1 a total of 4,715 MB of new storage is added while in Scenario #2 only 3,280 MB is added.

Table 6-4 Terminal Profile Comparison

	Servicing Terminals	Number with Ethanol	Number of Tanks Converted/Installed	Total Storage Added - bbl (gal)
Scenario #1	557	333	215	4,715 MB (198,030,000)
Scenario #2	535	367	213	3,280 MB (137,760,000)

Since the number of new ethanol terminals and new tanks is similar between the scenarios, it is not surprising that the requirements for blending systems and the miscellaneous contingency category are similar, 216 in Scenario #1 and 229 in Scenario #2. In Scenario #1 it is necessary to add 31 rail spurs versus only 18 in Scenario #2. This is due to the greater shipping distances involved with Scenario #1. It is also necessary to add more retail units in Scenario #1, 53,627 compared to only 45,296 in Scenario #2. While retail unit gasoline volumes are higher in PADDs I and V, Scenario #1 requires more retail units to convert to ethanol blends for two reasons. First, California stations are assumed to blend at the 5.7 v% level which nearly doubles the number of units for the volumes directed to California. Secondly, in Scenario #1, the seasonal use factor of 65/35 requires a 30% increase in the number of retail units offering gasoline ethanol blends to achieve premised ethanol volumes. These requirements are covered in the following table.

Table 6-5 Terminal Equipment and Retail Conversion Comparison

	Blending Systems	Rail Spurs	Misc. Contingency	Retail Units
Scenario #1	216	31	216	53,627
Scenario #2	229	18	229	45,296

Table 6-6 provides a comparison of investments required for the two scenarios. While investment category totals may differ between Scenario #1 and Scenario #2, the totals are similar, $148,746,000 in Scenario #1 and $135,365,000 in Scenario #2. On an amortized basis, this amounts to only a difference of $0.0006 per gallon of ethanol or a difference of approximately $0.00006 per gallon of gasoline ethanol blend. These figures are covered by category for each scenario in the following table.

Table 6-6 Terminal and Retail Investment Cost Comparison (000)

	Tank Conversion	New Tanks	Blending Systems	Rail Spurs	Misc. Contingency	Retail	Total	Amortized Cost Per Gallon of Ethanol
Scenario #1	$1,885	$35,000	$64,800	$11,000	$4,320	$31,639	$148,746	$0.0066
Scenario #2	$1,245	$27,725	$68,700	$6,390	$4,580	$26,725	$135,365	$0.0060

It should be noted that Scenario #1 assumes the 65/35 seasonal split. While this does not affect freight cost per gallon, it does increase amortized investments by a factor of 1.3. If Scenario #1 utilized the 50/50 split of Scenario #2, amortized costs would be approximately $0.0051 per ethanol gallon. This would be lower than Scenario #2 and results from the higher volumes and fewer terminal conversions necessary to serve the higher population centers in PADDs I and V.

The major differences between the scenarios are in transportation equipment requirements and freight costs.

Scenario #1 would require the use of 6.5 small Jones Act Vessels where as Scenario #2 requires none. Barge requirements are higher in Scenario #1 with 185.5 barges required, compared to only 41.9 barges in Scenario #2. Rail requirements are also higher in Scenario #1 with 3,990 rail cars required compared to 1,820 for Scenario #2. Truck requirements are lower for Scenario #1 because of less ethanol shipped by truck and more by other modes. Scenario #1 would require the equivalent of 261 tractor/trailer rigs while Scenario #2 would require 315. These figures are recapped in the following table.

Table 6-7 Transportation Profile Comparison

For New Ethanol Volume

	Scenario #1		Scenario #2	
Cargoes	**Annual Shipments**	**Annual Equipment Requirement**	**Annual Shipments**	**Annual Equipment Requirement**
Shipping	82.9	6.5	n/a	n/a
Barge	3,407	185.5	199	41.9
Rail	59,791	3,990	43,700	1,820
Truck	158,450	261	244,625	315

Freight costs are quite different between the scenarios owing largely to the shipping distances. In Scenario #1, total freight cost for the new ethanol volume is $369,800,000 averaging $0.1049 per gallon while in Scenario #2, it is $203,427,000 averaging $0.0577 per gallon. If one considers that the 1.476 bgy of ethanol used in the base year of 2000 continues to go to the same markets, and the same average freight costs are used, this adds $86,240,000 for existing volume freight costs. Then the total freight charges for 5.0 bgy of ethanol are $456,040,000 in Scenario #1 ($0.0912 per gallon average). In Scenario #2, total freight costs would be $289,667,000 ($0.0579 per gallon average). These figures are recapped in the following table.

Table 6-8 Freight Cost Comparison

	New Volume Freight Charges (000)	**Average per Gallon**	**Existing Volume Freight Charges (000)**	**Total Freight All Ethanol (000)**	**Average per Gallon Existing Plus New Ethanol Volume**
Scenario #1	$369,800	$0.1049	$86,240	$456,040	$0.0912
Scenario #2	$203,427	$0.0577	$86,240	$289,667	$0.0579

Combining the annual amortized costs and freight costs, it can be seen that for Scenario #1, the total cost per gallon of new ethanol volume is $0.1115 or $0.01115 per gallon of gasoline ethanol blend. For Scenario #2 the combined cost is $0.0637 per gallon of new ethanol volume or $0.00637 per gallon of gasoline ethanol blend. Scenario #2 would then be $0.0478 cheaper for each new ethanol gallon or $0.00478 cheaper per gallon of gasoline ethanol blend. These figures are covered in the following table.

Table 6-9 Per Gallon Cost Comparison Between Scenarios For New Ethanol Volume

	Amortized Investment per Gallon	Freight Cost per Gallon	Total
Scenario #1	$0.0066	$0.1049	$0.1115
Scenario #2	$0.0060	$0.0577	$0.0637
Difference	$0.0006	$0.0472	$0.0478

Comparison of Scenarios to *Infrastructure Requirements for an Expanded Fuel Ethanol Industry*

In the scenarios studied in this work, terminal and retail unit investments are lower than in our earlier study *Infrastructure Requirements for an Expanded Fuel Ethanol Industry,* while freight costs are higher for Scenario #1 and lower for Scenario #2. The terminal and retail investments are slightly lower in this analysis primarily because the ethanol volume is concentrated in more condensed market areas, whereas in our earlier study it was geographically more dispersed, requiring more terminals to handle ethanol.

In Scenario #1, freight costs are higher than our earlier work because in that study some production was premised to be in PADDs I and V. Scenario #2 results in lower freight costs compared to our earlier study. This is, of course, due to the larger volumes distributed close to the PADD II production facilities in this scenario.

Demands on the Transportation Infrastructure

We did not undertake a full transportation infrastructure analysis for the scenarios studied. However, we did calculate the percentages of certain transportation modes to conduct a cursory assessment for the infrastructure demands once the 5.0 bgy ethanol volume of 2012 is achieved. At that point the following would apply:

- In Scenario #1, additional annual barge cargoes would equate to 4.7 million short tons equating to 0.75% of total tonnage moved on the inland waterways in 1998. In Scenario #2 additional barge shipments equate to 0.399 million short tons or 0.064% of total tonnage moved on the inland waterways in 1998.

- In Scenario #1, additional annual rail car shipments would reach 59,791 cargoes. This represents only 3.9% of the total tank cars loaded on the Class I railroads in 1999 and only 0.27% of all car loadings. In Scenario #2, additional rail car shipments will reach 43,700 annual cargoes representing 2.84% of total tank cars loaded in 1999 and only 0.2% of all cars loaded.

- Transport trucks are more difficult to assess. In Scenario #1 a total of 158,450 truck shipments per year are needed. In Scenario #2 the annual truck shipments total 244,265 loads. This only results in an increase of 260 to 315 more trucks (or truck equivalents) being on the road.

For a more detailed discussion of transportation infrastructure requirements, please refer to the recently completed study, *Infrastructure Requirements for an Expanded Fuel Ethanol Industry* which was cited in the introduction section.

Observations

The key observations from this work are:

- The number of terminals converted will be similar in either scenario, although Scenario #1 will require more total storage capacity.

- When compared on an amortized basis, the total investment for terminal equipment and retail conversions are nearly the same for the two scenarios.

- Freight costs for new ethanol volume for Scenario #1 average $0.1049 per gallon while Scenario #2 freight costs average only $0.0577 per gallon of new ethanol volume.

- Combining amortized terminal and retail investments with annual freight costs results in Scenario #1 costing $0.1115 per gallon of new ethanol volume. For Scenario #2 these costs total $0.0637 per gallon of new ethanol volume or $0.0478 per gallon of ethanol less than Scenario #1.

- The cost for transportation and distribution of ethanol, then, can be assumed to be between $0.00637 per gallon of gasoline ethanol blend in Scenario #2, the lower boundary/least difficult scenario and $0.01115 per gallon of gasoline ethanol blend in Scenario #1, the upper boundary/more difficult scenario.

- Scenario #2 has transportation and distribution costs that are $0.00478 (per gallon of gasoline ethanol blend) lower than Scenario #1.

- With cost differences between the scenarios less than one half cent per gallon of gasoline ethanol blend, refinery operations and economics may play a greater role than logistics in the decision of where to use ethanol, at least in the long term.

- It is not likely that the resulting market, after implementation of the RFS, will follow the path of either scenario but will lay somewhere between the two. However, since the boundary cases represent upper and lower boundaries, it can be assumed that the transportation and distribution costs per gallon of gasoline ethanol blend will be between $0.00637 and $0.01115 per gallon.

- The additional ethanol movements by barge, rail, and truck represent a very small amount of total movements by these modes and should have no major impact on these transportation sectors.

Section 6 - Discussion, Observations, and Comparison of Scenarios Studied: Specific References

None

Section 6 - Discussion, Observations, and Comparison of Scenarios Studied: General References

1. Downstream Alternatives Inc. (DAI). 2002. *Infrastructure Requirements for an Expanded Fuel Ethanol Industry*, Phase II Project Deliverable Report, Oak Ridge National Laboratory, Ethanol Project, Subcontract No. 4500010570, South Bend, IN 46680-2587, January 15, http://www.afdc.doe.gov/pdfs/6235.pdf

Appendix A

Assumptions and Premises for Phase III
Task 1 Deliverable - Revised March 10, 2002

Assumptions and Premises for Phase III Task 1 Deliverable
For
Studies on Ethanol Logistics Issues

Submitted by
Downstream Alternatives Inc.
March 14, 2002

Background

The U.S. Department of Energy's (DOE) Office of Transportation Technologies (OTT) Office of Fuels Development (OFD) is responsible for major planning, programming, and budget analysis initiatives to ensure consistency of program objectives with the Energy Policy Act and supportive legislation. OFD has a requirement for analytical support on issues related to legislative impacts on ethanol logistics, specifically:

> **Phase III Task 1 (P3T1) - Legislative Impacts on Ethanol Logistics:** Legislative initiatives with potentially important connections with ethanol logistics will be examined. Premises will be developed for two or three scenarios of various legislative approaches. Given premise approval, a brief paper will be completed on the overall legislative ramifications. The paper will include discussion of areas that might differ from the current Biofuels logistics study, and/or cite current work where applicable.

Draft Premises/Legislative Scenarios for Task

The study of legislative impacts on ethanol logistics will be performed with two boundary cases, a high cost/more difficult case and a low cost/least difficult case. These cases are described more thoroughly in the premises. The boundary case approach is being taken because of the many uncertain issues in potential legislative initiatives.

A number of issues affect how the refining industry will choose to comply with a Renewable Fuels Standard (RFS). Some examples include potential changes in the RVP waiver for conventional gasoline containing ethanol, potential changes in the Driveability or Distillation Index, the length of any banking and trading credit program and the life of credits, existing and proposed state MTBE bans, and any limitations on seasonal use. These are all items that are, or have been, considered for inclusion in RFS legislation.

In addition, future refinery operational considerations may impact how a refiner/blender chooses to comply with any RFS requirement. Examples here would include the potential for importing reformulated gasoline (RFG) and various blendstocks to balance refinery runs, expansion of alkylate production, and future developments of new or improved process catalysts that could improve yields of desired RFG components. Seasonal differences in ethanol prices and/or ethanol pricing patterns could also play a role in how decisions are made. The aforementioned items will all enter the decision making process on where the refining industry, and even individual refiner/blenders, will choose to sell gasoline ethanol blends.

At the extremes of the many possible outcomes are two scenarios. In one scenario, refiners do not need to use ethanol for RFG compliance and would therefore direct ethanol usage to conventional gasoline (CG) markets. Given CG usage patterns and the low freight costs for ethanol shipments, this would concentrate ethanol use in PADDs II and III where a great deal of ethanol blending infrastructure already exists. The combination of low capital investment and low freight rates for these markets would yield the lowest cost, least difficult, scenario.

In the other scenario, refiners would need to use ethanol for RFG compliance, resulting in much greater use of ethanol in PADDs I and V. These are not traditional ethanol markets and would necessitate more infrastructure investments for tanks, rail spurs, and blending equipment. Also freight rates would be higher to ship ethanol from the ethanol plants in PADD II to the outlying PADDs. These combined factors would therefore yield the most expensive and most difficult scenario.

The adoption or exclusion of the various aforementioned requirements in RFS legislation, or future developments in refining/logistics operations would yield scenarios that lie somewhere between these two cases. Consequently, these two scenarios have been selected as boundary cases since they would provide least cost/least difficulty and highest cost/highest difficulty cases from a logistics standpoint. This document is the final premise document pending formal approval.

Potential Legislative Initiatives to Adopt a Renewable Fuels Standard

There are two avenues that would likely be pursued to adopt an RFS in the 107th Congress. One route would be to adopt RFS legislation as a stand alone bill. The other route would be for it to be included as part of an overall energy bill.

Analysts differ on how an RFS would be adopted and how extensive it will be. Downstream Alternatives Inc. (DAI) believes it is important to note the following:

- A stand alone bill that significantly increases the use of renewables is not likely. This is because the fossil fuel industry hopes to use the RFS as a bargaining chip in the energy bill to obtain features in the legislation it wants.

- The most likely energy legislation to be passed would be S.517 (Daschle). The provisions of S.517 are supported by several legislators who have prepared their own bills. However, some observers on Capitol Hill believe that agreement on a comprehensive energy bill may not be reached before 2003.

Given the current legislative focus, the analytical approach and key premises for the PT31 deliverable are based on key provisions of S.517, which:

1. Specifies the RFS requirement (a volume formula is used for years after 2012):

Calendar year	Applicable volume of renewable fuel (in billions of gallons)
2004	2.3
2005	2.6
2006	2.9
2007	3.2
2008	3.5
2009	3.9
2010	4.3
2011	4.7
2012	5.0

2. Provides for the generation of credits by any person that refines, blends, distributes or imports gasoline that contains a quantity of renewable fuel that is greater than the quantity required.

3. Ensures that 35 percent or more of the quantity of the renewable fuels requirement is used during each of two specified seasons.

4. Allows repeal of the 1 psi Reid vapor pressure (RVP) waiver for CG blended with 10 percent ethanol, given supporting documentation, from the Governor of a State that the RVP waiver will increase emissions that contribute to air pollution in any area in the State.

5. Prohibits the use of MTBE, not later than 4 years after the date of enactment.

6. Eliminates the oxygen content requirement for RFG.

7. Maintains Toxic Air Pollutant emission reductions for RFG at 1999-2000 baseline levels.

8. Consolidates the Volatile Organic Compound (VOC) emissions specification for RFG to the more stringent requirement for southern RFG.

9. Contains provisions for additional opt-in areas under the RFG program.

Premised Scenarios

Certain provisions of S.517 provide an unambiguous basis for P3T1 premises (i.e., the RFS schedule, MTBE ban, revised specifications for RFG). However, other provisions introduce significant uncertainty (i.e., optional repeal of the RVP waiver for CG and provision for additional reformulated gasoline opt-in areas). Given this uncertainty, we recommend boundary case studies, with P3T1 premises as follow:

Scenario #1 - High Cost/High Difficulty Boundary Case

In Scenario #1, refiners would use ethanol for RFG production, resulting in much greater use of ethanol in PADDs I and V. These are not traditional ethanol markets and would necessitate more infrastructure investments for tanks, rail spurs, and blending equipment. Also freight rates would be higher to ship ethanol from the ethanol plants in PADD II to the outlying PADDs. These combined factors would therefore yield the most expensive and most difficult scenario.

In this scenario, we would start with the baseline of existing ethanol sales and use three date points in the RFS schedule, 2004, 2007, 2012. Most new ethanol volume would be directed into PADD I and PADD V. The volumes by PADD and year are listed in the following table.

Scenario #1 - High Cost/High Difficulty Boundary Case Ethanol Use (bgy)

PADD	Base	2004	2007	2012
I	-	0.5	0.8	1.6
II	-	1.4	1.5	1.8
III	-	0.1	0.3	0.5
IV	-	-	-	0.1
V	-	0.3	0.6	1.0
Total	-	2.3	3.2	5.0

For Scenario #1, we premise that:

1. The more stringent VOC requirement for summer RFG and the optional repeal of the RVP waiver for summer CG drive the maximum allowable seasonal use of renewables into the winter season. [Note: Summer volatility specifications in these P3T1 premises are different from the premises and, therefore, the seasonal ethanol demand patterns in the OFD-sponsored report on *Ethanol Demand in United States Regional Production of Oxygenate-Limited Gasoline* (Hadder 2000).]

2. Over time, regional RFG-CG price differentials will become increasingly attractive for transport of ethanol produced in PADD II to the more distant RFG markets. In PADD V, there could be repetitions of recent markets situations. For example, RFG(PADD V)-CG(PADD II) differential prices in the winter of 2000 were as high as 25 cents per gallon (DOE 2001b). DAI (2002) estimates that freight costs and amortized infrastructure costs for ethanol shipped from PADD II to PADD V would be about 14 cents per gallon. [Note: The maximum requirement for ethanol in PADD II winter RFG is satisfied in these premises (EPA 2001).]

3. The value and required volumes of ethanol in RFG will increase over time due to additional RFG opt-ins and due to the need for a clean replacement for MTBE. For example, refiners supplying PADD I are premised to need increasing volumes of ethanol in RFG for compliance with Toxic Air Pollutant regulations.

4. The RFS volume requirements drive the increasing use of ethanol in RFG over time. The mandated renewable volume is increasing faster than the RFG volume, and ethanol percentages are increasing as shown in a possible winter season outcome for PADDs I and V:

Scenario #1 - High Cost/High Difficulty Boundary Case
Winter Ethanol Use (bg)

PADD	Base	2004	2007	2012
I	-	0.3	0.5	1.0
V	-	0.2	0.4	0.7

Scenario #1 - High Cost/High Difficulty Boundary Case
Ethanol in Winter RFG (average percent)

PADD	Base	2004	2007	2012
I	-	3.6	5.5	9.9
V	-	2.6	4.9	7.4

5. At the combinations of ethanol concentrations implied by the above table (based in part on DOE 2001c), we premise that refiner/blenders will produce RFG in compliance with Federal and California specifications for emissions of NOx and Toxic Air Pollutants (see, for example, the Phase 3 CARBOB Predictive Model in CARB 2001).

Scenario #2 - Low Cost/Low Difficulty Boundary Case

In Scenario #2, refiners do not need to use ethanol for RFG production and would therefore direct ethanol usage to CG markets. Given CG usage patterns and the low freight costs for ethanol shipments, this would concentrate ethanol use in PADDs II and III, where a great deal of ethanol blending infrastructure already exists. The combination of low capital investment and low freight rates for these markets would yield the lowest cost, least difficult, scenario.

In this scenario, we also start with existing baseline volumes and use the three date points of 2004, 2007, 2012. In this scenario, new ethanol volumes are directed into PADD II and then into PADD III. To optimize utilization of facilities, there will be a more uniform seasonal distribution of ethanol.

Scenario #2 - Low Cost/Low Difficulty Boundary Case (bgy)

PADD	Base	2004	2007	2012
I	-	-	-	-
II	-	2.4	3.0	3.3
III	-	-	0.2	1.7
IV	-	-	-	0.1
V	-	-	-	-
Total	-	2.4	3.2	5.0

Please note that in both scenarios actual volumes may be slightly different due to existing sales in each PADD and also from use in CO programs (e.g., in Los Angeles). However these volumes should be relatively small.

Contingency Scenarios

A. *In the event that actual legislation is adopted during the course of assessing the two above scenarios, the task would be switched to the actual legislation.*

B. In the event that another widely supported legislative proposal for an RFS, that is significantly different from existing proposals, were to be introduced, a "quick-response" evaluation of such legislation would be performed. This evaluation would not be as extensive as the other scenarios due to time limitations. It may also be necessary to adjust priorities, schedules, and time demands as a result of additional work.

Additional Premises Applicable to All Scenarios

1. Ethanol Production: Ethanol production will consist of existing plants, plants under construction or expansion, and hypothetical plants. Since S.517 only requires 5 billion gallons per year of renewable production in 2012 (the most distant date point in this study), it will be assumed that all hypothetical plants will be grain based and located in PADD II.

2. Biodiesel Portion: Since we are using boundary cases, no calculations will be made for biodiesel, but the final document will reference the impact biodiesel could have on slightly reducing ethanol demand.

3. Gasoline Demand Increases: Since S.517 uses an actual RFS in gallons, it is not necessary to determine the actual demand increase for gasoline. However, it may be necessary to make some assumptions about demand increase if gasoline ethanol blend market share approaches 100 percent in an area. For purposes of market assessment, the Federal Highway Administration's state-specific gasoline volumes will be used. Any projected gasoline demand increase employed in this work will be based on DOE (2001a).

4. Ethanol Source: All ethanol used in the analysis will be assumed to be domestically produced.

5. CO Non-attainment Areas: It will be assumed that all CO non-attainment areas (except Los Angeles) utilizing an oxyfuel program will come into compliance in 2004 but will utilize oxyfuel for one more year (i.e., 2005) for maintenance of the State Implementation Plan (SIP). It will be assumed that Los Angeles achieves compliance in 2010 with no continuation for SIP maintenance.

6. ETBE: No ETBE will be used.

7. RFG VOC: All RFG must comply with the southern RFG requirement for emissions of VOCs.

8. Compliance Averaging and Credit Trading: Premises will be consistent with provisions of S.517.

9. Seasonal Ethanol Use: Some observers believe that credit trading will result in greater seasonal use of ethanol (i.e., more use in summer than winter or vice versa). This would result in greater seasonal storage necessitating more tanks for ethanol inventory. Additionally, if some areas do

not utilize ethanol year round, then more areas would need to handle ethanol to achieve required volume levels.

An important unknown here is that, rather than incur seasonal storage costs, ethanol producers may chose to discount ethanol prices to eliminate or minimize seasonal use, i.e., promote year round blending. Scenario #1 will assume a 65/35 seasonal volume split. Scenario #2 will assume 50/50 seasonal split but will also discuss the increased infrastructure requirements should a 65/35 seasonal split develop.

Methodology

The SOW calls for a "brief paper" and allows dependence upon "Infrastructure Requirements for an Expanded Ethanol Industry" (DAI 2002) where applicable. Consequently, this work will not be, in any way, as detailed as the aforementioned study. The anticipated process would include:

1. General placement of plants.

2. Development of gasoline and gasoline ethanol blend baseline.

3. Analysis to identify the likely ethanol markets in each scenario, to be reviewed before proceeding to next steps (and making adjustments if necessary).

4. A brief terminal analysis estimating the number of terminals. Also a summary cost estimate of terminal expenses based on previous work.

5. A brief transportation overview covering most likely modes of delivery and associated costs, again, based on previous work.

6. A summary citing differences among the scenarios and any variations from the previous study. This will include estimated freight costs.

7. This document will include a brief discussion of the many variables at play and thus why the boundary cases were developed. The intent of the final document is to develop a range, within which costs and degree of difficulty would lie, depending on how the variables are addressed.

References

California Air Resources Board (CARB). 2001. *California Gasoline Program Procedures Documents, Predictive Models, and CARBOB Model*, December 27, http://www.arb.ca.gov/cbg/premodel/Ph3CARBOBPMFlat011602.xls

Downstream Alternatives Inc (DAI). 2002. *Infrastructure Requirements for an Expanded Fuel Ethanol Industry*, South Bend, IN 46680, January 15, http://www.afdc.doe.gov/pdfs/6235.pdf

Hadder, G.R. 2000. *Ethanol Demand in United States Regional Production of Oxygenate-Limited Gasoline*, ORNL/TM-2000/165, Oak Ridge National Laboratory, Oak Ridge, TN 37831, August.

U.S. Department of Energy (DOE), Energy Information Administration. 2001a. *Annual Energy Outlook 2002 with Projections to 2020*, DOE/EIA-0383(2002), Washington, DC, December 21, http://www.eia.doe.gov/oiaf/aeo99/aeo99tables/aeo99b.pdf

U.S. Department of Energy (DOE), Energy Information Administration. 2001b. *Petroleum Marketing Annual, 2000*, DOE/EIA-0380(00), Washington, DC, http://www.eia.doe.gov/oiaf/aeo/aeotab_11.htm

U.S. Department of Energy (DOE), Energy Information Administration. 2001c. *Petroleum Supply Annual 2000 Volume 1*, DOE/EIA-0340(00)/l, Washington, DC, http://www.eia.doe.gov/oil_gas/petroleum/data_publications/petroleum_supply_annual/psa_volume1/psa_volume1.html

U.S. Environmental Protection Agency (EPA). 2001. "Revised PADD Data," from Weihrauch to Hadder.

Appendix B

Discussion of Uncertainties

Discussion of Uncertainties

As noted in Section 1, the boundary case approach was chosen for this study because a number of items that could be included in any final Renewable Fuel Standard/Energy Legislation could affect a refiner's or importer's choice about where to market ethanol blends. Operational factors and refinery process developments could have a similar effect. This Appendix provides a brief overview of some of the primary issues.

MTBE Ban: The time frame for banning MTBE could play a major role in refiner choices. When MTBE is banned, refiners lose 11v% of their gasoline pool in RFG areas. This volume would need to be made up by addition of other hydrocarbons and possibly by ethanol. However, in the case of RFG, the addition of ethanol would require a reduction in fuel vapor pressure which would require the removal of more light ends which also represents a volume loss.

Vapor Pressure Controls: The final legislation could result in reduced availability of the 1.0 psi vapor pressure waiver that CG ethanol blends currently enjoy during summer months. If this would occur, the volatility of the base fuel would need to be adjusted, similar to, but less severe than, RFG (see above). This could lead to a refiner preference to market ethanol blends in areas where a volatility waiver is available and then trade credits to other areas to achieve compliance.

Distillation Index: The inclusion of a Distillation Index (or Driveability Index) in any final standards could, depending on the final number required, further reduce refinery volumes due to the potential rejection of some refinery streams from the gasoline pool.

Alkylate Production: Certain alkylates are desirable components in RFG. If alkylate production increases, it could be used to replace some of the volume losses due to MTBE bans. This could contribute to either decreased ethanol use (as refiners use alkylates) or increased ethanol use (because the lower volatility alkylate may help in trimming vapor pressure to accommodate ethanol addition).

Credit Trading Procedure: The final regulation for RFS credit trading provisions could also affect refiner compliance strategy. The life span of credits generated, as well as geographic limitations, could affect when and where refiners/importers decide to use ethanol.

Imports: The import of RFG or RFG blend components, if increased, could affect a refiner's compliance strategy since these components could be used to make up the volume loss that results from MTBE removal.

Refinery Operations: Refiners are dealing with various, and often numerous, interrelated compliance issues for both the finished products (fuel regulations) and the plants that make them (stationary source issues). Future transportation fuel production is complicated by ether bans, reduced sulfur levels for both gasoline and diesel fuel, toxics anti-backsliding, etc. On the stationary side, it is often difficult to get new process units permitted.

Process Technology/Catalyst Development: In many cases when the refining industry has been faced with new fuel regulations, process engineering companies and catalyst suppliers have developed new processes or catalysts to increase yields of products necessary to achieve compliance. The development and availability of such processes or catalysts can alter a refiner's compliance strategy.

New Ozone Standards: New, tighter standards for tropospheric ozone may result in new areas electing to require RFG or boutique fuels. This, in turn, could affect a refiner's choice of fuel components as they develop their compliance strategy.

Seasonal Use: Some industry observers have noted that ethanol may be used more heavily in winter grades of gasoline than summer grades of gasoline (or vice versa). For instance, refiners might choose to tilt ethanol use to winter grade if an RVP waiver for summer grade is not available. Similarly, if ethanol's octane value can offset volatility control costs, refiners could direct blending to summer months. Either way, if ethanol use is not fairly stable from month to month, it could affect operational cost.

Ethanol Prices/Pricing Patterns: Traditionally, ethanol has been priced relative to the price of gasoline at its destination market. This has often resulted in the ethanol producer failing to recoup all of the additional freight costs associated with more distant markets. In an RFS scenario this could change. Ethanol producers may be able to charge prices that reflect true distribution costs. This could result in ethanol being priced on a plant basis, with the price in each market reflecting its true freight cost. If this were to happen, it could create a preference for using ethanol in markets nearest to the production points, with credits being traded to more distant markets.

Conversely, the regional price of gasoline may, in some cases, be sufficient to offset additional transportation costs. However, this has not been the case on a historic basis.

Another way that ethanol pricing patterns could come into play is with the seasonal split issue. Many industry observers believe that ethanol could be used more in one season than another (e.g., higher winter use due to more flexible volatility requirements). However, this would require more storage capacity during the lower volume season and could create an imbalance in transportation equipment. Ethanol producers might choose to price ethanol lower in the slow season to avoid these problems, especially if the foregone revenues were less than storage costs and the interest on working capital to maintain large volumes of product in storage.

Appendix B: Specific References

None

Appendix B: General References

1. Downstream Alternatives Inc. (DAI). 2002. *Infrastructure Requirements for an Expanded Fuel Ethanol Industry*, Phase II Project Deliverable Report, Oak Ridge National Laboratory, Ethanol Project, Subcontract No. 4500010570, South Bend, IN 46680-2587, January 15, http://www.afdc.doe.gov/pdfs/6235.pdf

Appendix C

Cost Estimates and Amortization Calculations

Cost Estimates and Amortization Calculations

This analysis relies on estimates and amortization factors developed in our recent study *Infrastructure Requirements for an Expanded Fuel Ethanol Industry*. This work can be accessed via the internet at http://www.afdc.doe.gov/pdfs/6235.pdf. The pertinent data are in Appendix E of that study.

The basic information is recapped here for the convenience of the reader.

New Tankage Costs

5 MB to 24 MB	$15 per steel barrel
25 MB to 49 MB	$12 per steel barrel
50 MB or more	$10 per steel barrel

Conversion of Existing Tanks

20% of the cost of new tanks. In many cases, terminal tanks in various product service may have a fixed roof or a floating roof. In the case of ethanol storage, the preferred configuration is a fixed roof with a floating internal cover.

Miscellaneous Contingency Costs

$20,000 per terminal.

Blending Systems

$300,000 per terminal (consisting of two blending units per terminal).

Rail Spurs

Assumption is a 4000 foot (i.e., 3/4 mile) rail spur at $85 per track foot plus $15,000 for piping costs and miscellaneous expense. The total, per terminal requiring rail spurs, is $355,000.

Amortization Calculations

In order to provide a reasonable comparison of program costs, it is necessary to amortize costs for investments over the projected lifetime of the equipment or program.

We have chosen to present costs on an amortized cents per gallon of new ethanol volume basis. The useful life of terminals and retail unit conversions is assumed to be 20 years.

To develop a reasonable amortization factor in our earlier study we reviewed different sources. As an example, past work by Turner, Mason and Company for the National Petroleum Council[(1)] utilized a capital recovery factor (CRF) of 0.171 actual for 20 years.

We also consulted with Technology and Management Services Inc. (TMS). TMS has calculated capital recovery factors for various assumptions. Assumptions employed in developing the factors we considered are as follows:

- Tax rate 34%
- Capital replacement increment of 1.6% (of initial capital cost)
- Return on Investment (ROI) - 10%

The TMS assumptions result in a 20 year amortization factor of 0.156. Of the options reviewed, we selected the factors developed by TMS, in part, because the TMS analysis is based on recently developed premises. We believe the TMS factors are representative of both the long term petroleum industry performance, and future performance that could be expected.

To arrive at an amortized cents per gallon of new ethanol volume, the program cost being amortized is divided by the applicable new annual ethanol volume and then multiplied by the above factors for the equivalent life cycles.

Appendix C: Specific References

1. National Petroleum Council (NPC). 1993. *U.S. Petroleum Refining*, Washington, DC, August.

Appendix C: General References

1. Downstream Alternatives Inc. (DAI). 2002. *Infrastructure Requirements for an Expanded Fuel Ethanol Industry*, Phase II Project Deliverable Report, Oak Ridge National Laboratory, Ethanol Project, Subcontract No. 4500010570, South Bend, IN 46680-2587, January 15, http://www.afdc.doe.gov/pdfs/6235.pdf

Appendix D
Glossary of Commonly Used Terms and Acronyms

GLOSSARY

In the course of preparing this report, a number of acronyms and common industry terms have been used. For the convenience of the reader some of the frequently used terms are listed here along with a brief description when deemed necessary.

Acronyms

bbls or BBLS: (Barrels)

bd or BD: (Barrels per day)

bgy or BGY: (Billion gallons per year)

CARBOB: (California Reformulated Gasoline Blendstock for Oxygenate Blending)

CO: (Carbon Monoxide)

CG: (Conventional gasoline) Gasoline sold in the U.S. which is not subject to the reformulated gasoline program requirements.

DI: (Driveability Index)

DOE: (U.S. Department of Energy)

DOT: (U.S. Department of Transportation)

E-10: Commonly used term to describe gasoline containing 10 v% ethanol.

E-5.7: Commonly used term to describe gasoline containing 5.7 v% ethanol.

E-7.7: Commonly used term to describe gasoline containing 7.7 v% ethanol.

EPA: (U.S. Environmental Protection Agency)

ETBE: (Ethyl tertiary butyl ether)

HC: (hydrocarbon)

M or m: (thousands) add 000.

MM or mm: (millions) add 000,000

MTBE: (Methyl tertiary butyl ether)

NO_X: (Oxides of Nitrogen)

OPA90: (1990 Oil Pollution Act) Legislation that requires that certain petroleum products be hauled in double hulled vessels and requires the phase out of single hulled vessels from petroleum products transport.

ORNL: (Oak Ridge National Laboratory)

PADD: (Petroleum Administration for Defense Districts) Originally established for national defense purposes breaking the nation into 5 geographic areas designated PADD I through V. These geographically divided areas are also routinely used for the purpose of study and analysis of the petroleum industry.

psi: (Pounds per square inch)

RFG: (Reformulated gasoline)

RFS: (Renewable Fuels Standard)

RVP: (Reid vapor pressure) A measure of a fuels volatility typically taken at 100 degrees F by specified ASTM test methods. One early test method of measuring the vapor pressure of gasoline. The Reid test method is seldom used now but due to its frequent use in earlier years many in the industry still refer to a fuels vapor pressure as RVP.

VOC: (Volatile Organic Compounds)

Commonly Used Industry Terms

Barrel: 42 US gallons.

Hub terminal: See Redistribution terminal.

Jones Act: The Merchant Marine Act of 1920 commonly referred to as the Jones Act. Requires shipments of products between U.S. ports to be made by vessels that were built in the U.S., flagged in the U.S., are owned by a U.S. person or entity, and manned by a certified U.S. crew. Ships meeting these criteria are commonly referred to as Jones Act vessels or Jones Act tonnage.

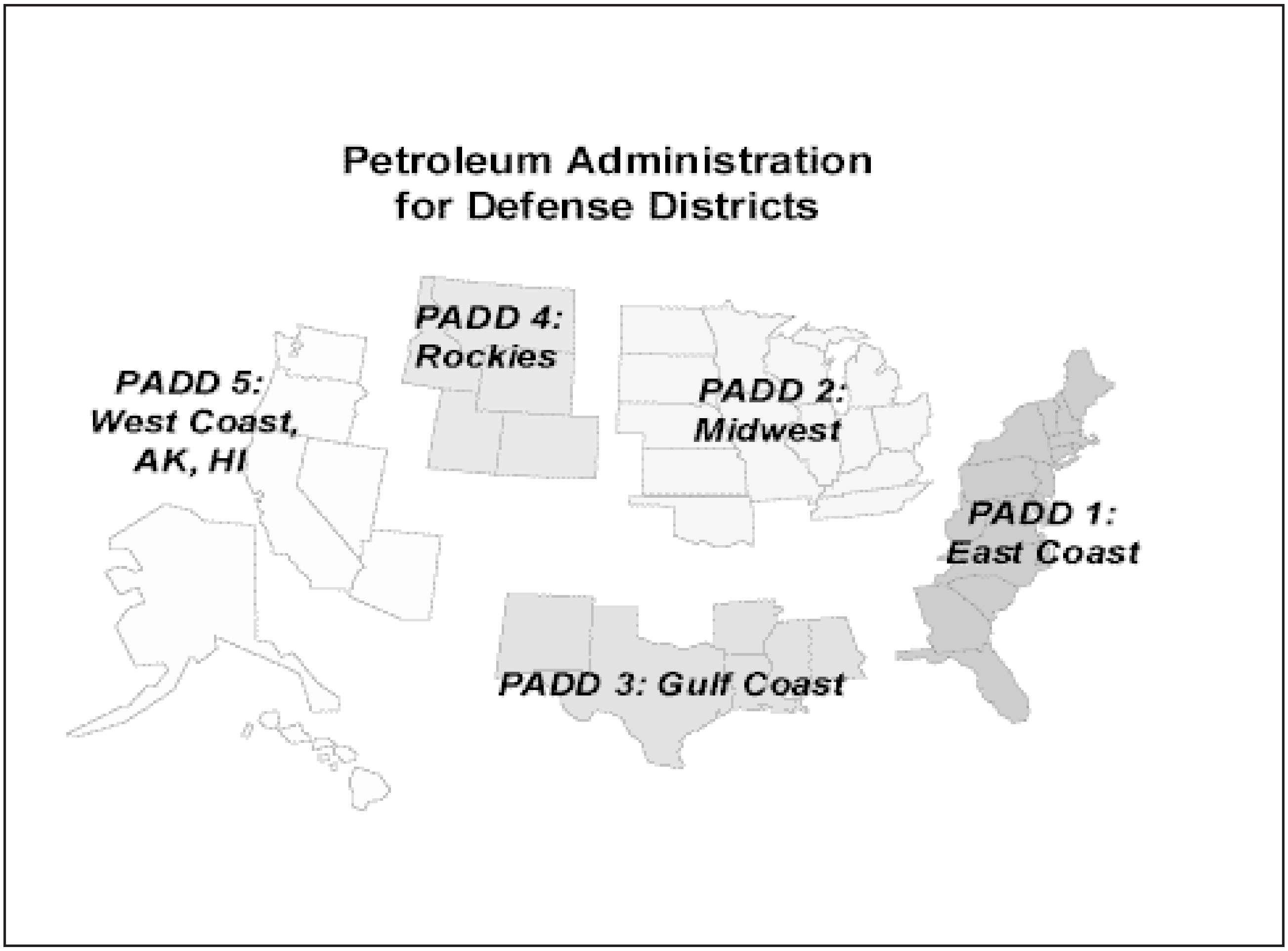
Nameplate capacity: The design capacity of a plant, in this case ethanol plants.

Redistribution terminal: A terminal which serves as a facility to receive product for redistribution to other terminals. Sometimes referred to as a hub terminal or hub terminal operation.

Staging: In this report, an interim stop in an intermodal transportation scenario. The primary example is when ethanol is shipped by barge to the Gulf Coast and stored in tanks (staged) for loading onto a cargo vessel and then shipped to its final destination on the East or West Coasts.

Unit train: Typically a train of 100 cars. For purposes of this report, 100 tank cars with a nominal capacity of 30,000 gallons each. Unit trains are pulled with dedicated power (i.e., a locomotive) to move the cars to their destination and back. Note that some unit trains of larger capacity cars may be only 82 to 84 cars.

Appendix E
PADD Map


Petroleum Administration
for Defense Districts
PADD 4:
Rockies
PADD 5:
West Coast,
AK, HI
PADD 2:
Midwest
PADD 1:
East Coast
PADD 3: Gulf Coast

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Evaluation of transportation and infrastructure requirements for the increased ethanol use that would result from the Renewable Fuels Stand described in US Senate Bill S.527.

Keywords (5-7)

ORNL, Renewable Fuels Standard, Legislation, Ethanol Production, Gasoline, Transportation