

# Comments to Florida Department of Transportation

## Additional Comments on Discount Rates:

Jim Mack, PE, CEMEX

### DISCOUNT RATE

As mentioned in comment 19 of the SUMMARY OF COMMENTS BY INDUSTRY WITH DEPARTMENT RESPONSES, Attachment A for Workshop #3 and on a clarification email from Greg Schiess on Oct 7, 2010, it appears that FDOT's approach for the discount rates will be to use a the *ten year running average 30-Yr OMB Real Discount Rate* for both products (asphalt and concrete).

This is based on the current FHWA position is that the inflation rates between pavement types be kept the same. Based in discussions with FHWA, there are two arguments to the FHWA position:<sup>1</sup>

1. A sustained increased in the spread between commodity inflation rates would eventually exclude one from being competitive and the alternative would no longer be considered. As this will not happen, there will be a "reversion back to the mean."
2. The argument to use inflation is rooted in historical data while LCCA is a forward looking analysis – as much as 40 to 50 years. That is, just because two commodities inflated differently in the past is not a guarantee that they will inflate the same in the future. (eg past performance is no guarantee of future results).

#### Discussion – Point 1

If the "supply" of asphalt was constant, a sustained spread between commodity inflation rates would eventually exclude asphalt from being competitive. This would cause an over-supply of asphalt, would lower process and there would be a reversion of inflation rates back towards the mean to balance the supply-demand curve. However, asphalt is not the only product that can be manufactured from a barrel of oil and therefore its price is not controlled by a simple supply-demand curve based on the amount of concrete vs asphalt paving. Rather, the price of asphalt is a function of the return on it versus other refined petroleum products and if liquid asphalt goes below a certain rate of return, refineries will switch to other products. Therefore, asphalt's return must at least match the return on alternate refined petroleum products or it will not be made.

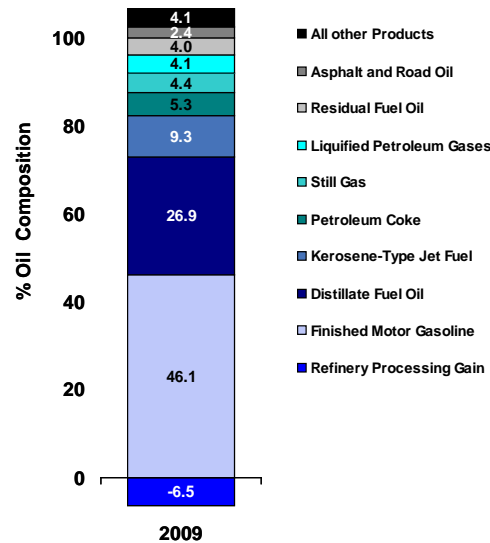
Figure 1 shows the typical products produced from a barrel of oil on a national level<sup>2</sup>. As can be seen, asphalt makes up only small portion of the product from a barrel of oil. Also, as 55% of all refineries do not produce asphalt, it can be deduced that asphalt is not a by-product and that if there was no asphalt demand, the refineries would produce some other product. (Note: 66 out of

---

<sup>1</sup> Discussions with Michael Smith, FHWA, September 24, 2010

<sup>2</sup> Refinery gain is the volumetric amount by which total output is greater than input for a given period of time. This difference is due to the processing of crude oil into products which, in total, have a lower specific gravity than the crude oil processed.

**Figure 1: Refined Crude Oil Yields (All Refineries)**



145 refineries (46%) in the US actually produce asphalt<sup>3</sup>. For the refineries that do produce asphalt “on purpose”, asphalt is 14.6% of their refined products.)

According to the Argus Asphalt Report, asphalt will only be produced when the price of asphalt is higher than the High Sulfur Fuel Oil (HSFO) Alternate price (eg. the asphalt’s HSFO alternative tells what asphalt is worth if it is blended into fuel oil<sup>4,5</sup>). That is, if asphalt’s profits are lower than the HSFO, refineries will switch their asphalt production into other HSFO products that provide higher profit.

Figure 2 is a comparison of BLS PPI’s for petroleum based fuel oils and liquid and paving asphalt since 1993. The CPI data is also shown as a reference for the general rate of inflation. As can be seen, while most these different petroleum products (gasoline, liquid asphalt, home heating oil and residual fuel) do not follow each other exactly, they all trended and tracked each other reasonably well. Over this time period, they all increased at a rate between 7.4% to 8.6%, whereas the CPI only increased at a 2.5% rate (note that the Liquid Asphalt Compound Annual Growth Rate or CAGR is approximately equal to the average of Oil and Home Heat Oil and Distillates CAGR).

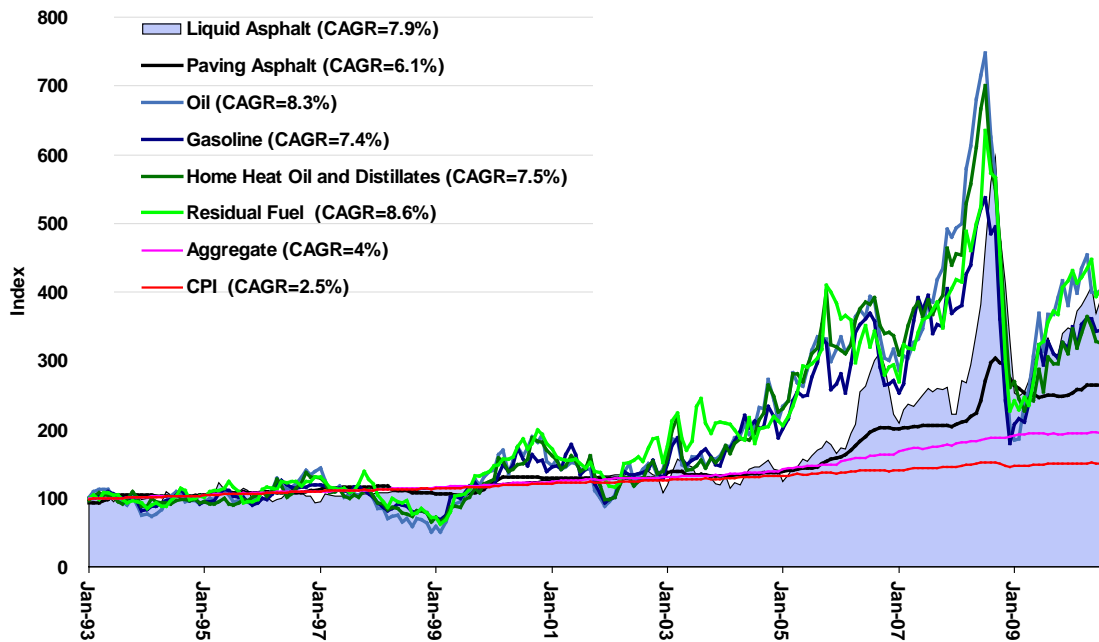
Paving Asphalt’s trend is lower than the other petroleum products (CAGR=6.1%) . It is believed that it is lower because paving asphalt is made up of both liquid asphalt and aggregate (also on the chart), and the lower aggregate inflation rate has dampened the paving asphalt’s inflation rate. However, it is still much higher than the CPI

<sup>3</sup> Energy Information Administration, Data for 2008, [http://www.eia.gov/pub/oil\\_gas/petroleum/data\\_publications/refinery\\_capacity\\_data/historical/2008/refcap2008.html](http://www.eia.gov/pub/oil_gas/petroleum/data_publications/refinery_capacity_data/historical/2008/refcap2008.html)

<sup>4</sup> Argus Asphalt Reports, Argus Media, <http://www.argusmedia.com>

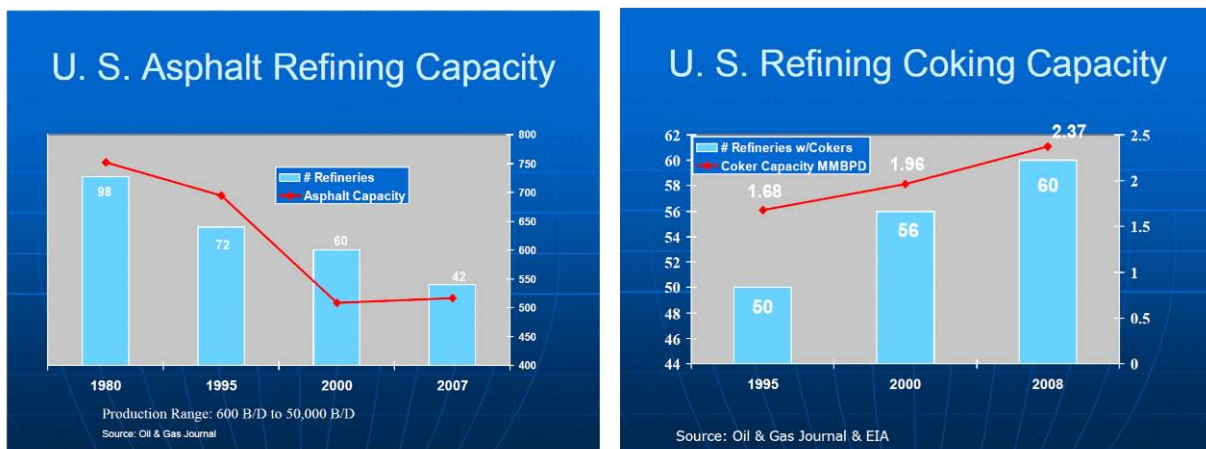
<sup>5</sup> Fuel oils are classified into 6 classes (1 thru 6) that include items such as kerosene, diesel fuel, heating oil, distillate fuel oil, and residual fuel oils.

**Figure 2: Comparison of Producer Price Indexes for Refined Petroleum Products (Base Year = 1993)**



Understanding this, then price of liquid asphalt must continue to track the other petroleum based materials so that it has the at least the same profit, or the refineries will switch to another product. In fact, that switching to other products is already occurring. Since 1980, the number of refineries producing asphalt has dropped by half (see Figure 3), while the number of refineries with Coking capabilities has increased<sup>6</sup>. Furthermore, this increase in coker capacity is expected to increase, which should tighten asphalt supply even more.<sup>7</sup>

**Figure 3: US Asphalt and Coking Refining Capacity**



<sup>6</sup> Asphalt Supply Outlook, Bill Haverland, ConocoPhillips Company, Presentation at the 2008 TxDOT Short Course

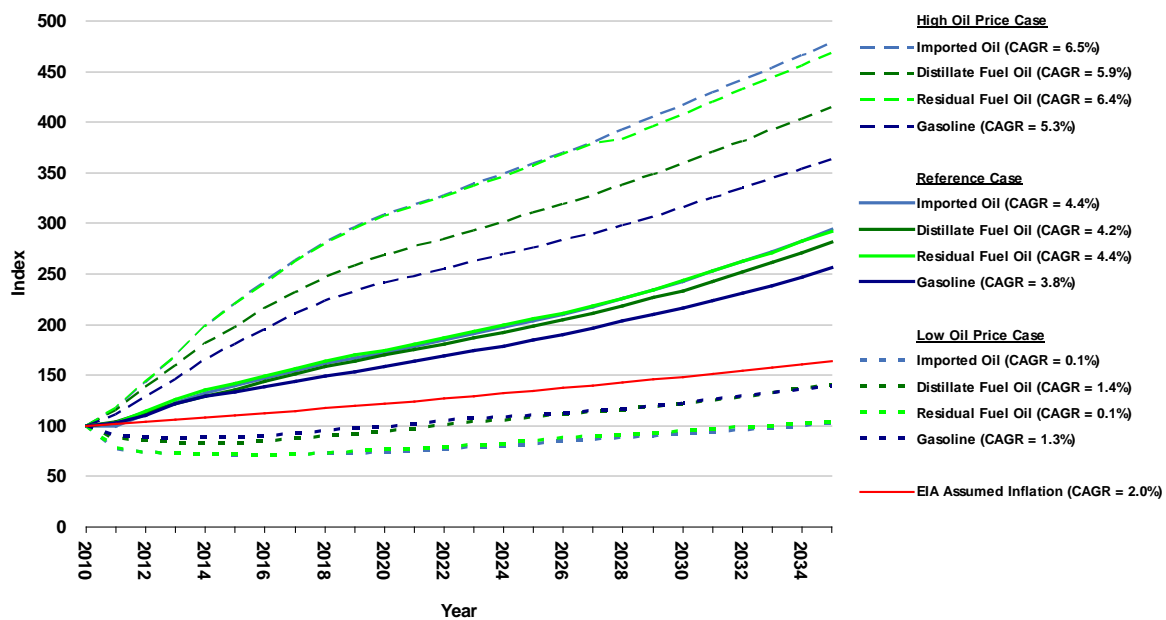
<sup>7</sup> NuStar Analyst Day, Philadelphia, PA and Paulsboro, NJ, June 24 2009, <http://phx.corporate-ir.net/External.File?item=UGFyZW50SU09MzQzMjUyYjE5ODQxYFR5cGU9MQ==&t=1>

## Discussion – Point 2

While there is no way to definitively determine what future prices will be, it is possible to get an estimate of petroleum products using information from the Energy Information Administration. The U.S. Energy Information Administration (EIA) is the statistical and analytical agency within the U.S. Department of Energy. EIA collects, analyzes, and disseminates independent and impartial energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment. Each year, EIA publishes the *Annual Energy Outlook*, which is a projection and analysis of US energy supply, demand, and prices (the current outlook is through 2035). The projections are based on results from the Energy Information Administration’s National Energy Modeling System and include a reference case as well as additional cases examining alternative energy scenarios (eg high or low oil prices).

Figure 4 is the projected refined petroleum product price indices from the 2010 *Annual Energy Outlook*<sup>8</sup> for three primary cases (reference or most likely case, high oil price case, and low oil price case). As can be seen, the reference case has an expected growth rate for oil, gasoline, distillate fuel (home heating oil) and residual fuel over the next 25 years of about 4%. As the EIA projected prices includes an assumed a 2% inflation component; these indices show that the most likely fuel prices will grow at a rate of 2% faster than the general inflation rate.

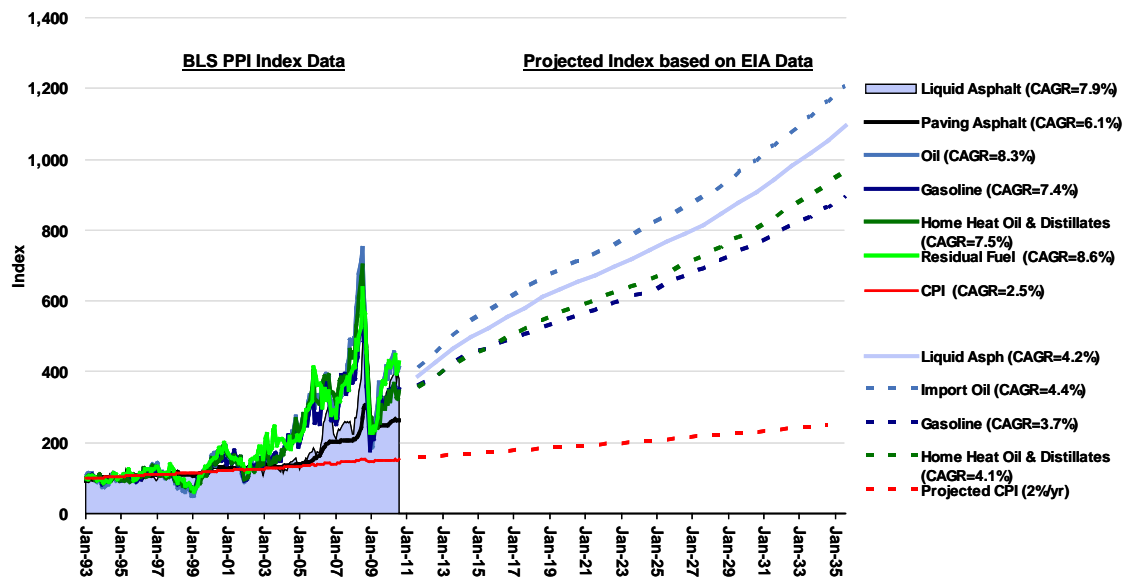
**Figure 4: EIA Projected Refined Petroleum Product Price Indices (Base Year = 2010)**



<sup>8</sup> Annual Energy Outlook 2010, Energy Information Administration, Data Release Date - May 11, 2010, <http://www.eia.doe.gov/oiaf/aeo/index.html>, Table 12 (Note the Energy Outlook breaks out these item fuel prices on sector – Residential, Commercial, Industrial, Transportation, Electric Power, and Refined Petroleum Prices. The values used to create this graph are based on the average of all sectors.)

Based on the discussion of point 1 that price of liquid asphalt must continue to track the other petroleum based materials to have at least the same profit, and using indices in Figure 4, it possible to combine Figure 2 and Figure 4 into a third graph (Figure 5) showing the projected fuel and asphalt price indices through 2035 (note that only the reference case is shown for clarity. Similar graphs for the other cases can be supplied if desired). Also shown on this graph is the assumed inflation rate in used by the EIA, which as mentioned is 2.0% year.

**Figure 5: Estimation of Future Producer Price Indexes for Refined Petroleum Products Based on EIA Projections (Base Year = 1993)**



As can be seen, the liquid asphalt price has a high likelihood of continuing to inflate at a substantially higher inflation rate than the standard rate of inflation in the future. If it does not, grow at least as fast as the other refined petroleum products, there is good evidence that the refineries will switch the production of liquid asphalt to another refined petroleum products that has a greater return.

For additional discussion on this issue, see the [http://www.ibroof.com/knowledge\\_center/asphalt\\_predictions.pdf](http://www.ibroof.com/knowledge_center/asphalt_predictions.pdf)

## Recommendation:

As mentioned in the previous submittals, we still believe that difference in the underlying inflation rates of the asphalt and concrete products need to be taken into account. Previously, we recommended that FDOT address the issue by using the different inflation rates and the nominal discount rate. However, as mentioned the previous submittals,<sup>9,10</sup> this is only one of the two procedures that can be used to address this issue. As a reminder, the two procedures are:

- 1) Estimate future costs to the year of activity by inflating today's costs using the appropriate rate of inflation and then discount back using "nominal" discount rates.<sup>11</sup>
- 2) Escalate the today's constant dollar by the difference of the general inflation rate and the commodities inflation rate to the year of activity and then discount back using "real" discount rates.

While we recommended procedure 1, in our continued review of the issue, we have learned that many economists prefer procedure 2 because it is generally considered easier to conduct the LCCA in constant dollars where the rate of inflation from year to year over the study period need not be estimated. Furthermore, such a recommendation is in line with the FHWA recommendations in their Life-Cycle Cost Analysis Primer.<sup>12</sup> On page 13 of the Primer, it states:

*An agency may also increase its discount rate to account for project risk. FHWA recommends, however, that risk be treated directly with risk analysis tools rather than through adjustments to the discount rate (see section on Risk Analysis, page 30).*

In the Risk Analysis portion, it further states that while uncertainty is a factor, much of the uncertainty associated with transportation investments can be evaluated and managed be identified and understood by answering three questions:

1. What can happen?
2. How likely is it to happen?
3. What are the consequences of an event occurring?

As we believe that our data shows that this event can happen, and that the likelihood of it happening is great, FDOT needs to investigate the consequences of the likelihood using either procedure 1 or 2. Note that the example discussed in the primer deals with "*the price of a paving material may be subject to large swings*" and how it may or may not impact the results. It is important to recognize that the underlying LCCA methodologies used by Department of Army, Department of Energy / Federal Energy Management Program (DOE/FEMP), and the

---

<sup>9</sup> Economic Analysis: Description and Methods, Army Pamphlet 415-3, Department of the Army, August 10, 1992, [http://www.army.mil/usapa/epubs/xml\\_pubs/p415\\_3/head.xml](http://www.army.mil/usapa/epubs/xml_pubs/p415_3/head.xml) (see specifically Section 3-6)

<sup>10</sup> Life-Cycle Costing Manual for the Federal Energy Management Program, National Institute of Standards and the US Department of Commerce, NIST Handbook 135, <http://www.bfrl.nist.gov/oe/publications/handbooks/135.pdf> (see specifically Chapter 3, Section 3.3)

<sup>11</sup> For "nominal" discount rates, we recommend the current 30 year Nominal Interest Rates on Treasury Notes and Bonds of Specified Maturities from OMB Circular A-94, which is currently 4.5%.

<sup>12</sup> Economic Analysis Primer, U.S. Department of Transportation, Federal Highway Administration FHWA Publication No. FHWA-IF-03-032, August 2003

FHWA/OMB are identical, with the exception of their treatment of the inflation. FHWA/OMB assumes all products inflation rates mirror the general rate of inflation. Conversely, the DOE/FEMP recognizes that fuel/energy price inflation does not match the general rate of inflation and therefore they adjust the estimated costs to account for differences between the general rate of inflation and the inflation rate of fuel/energy. If the inflation rates of the different materials are the same; these adjustments will give the same results as the procedures outlined by FHWA.

### **Process for Performing a LCCA with Projected Asphalt Escalation Index**

To use procedure 2, the analyst needs an estimate of the “escalation difference” between the general inflation rate and the commodities inflation rate. As mentioned in the last Alternate Pavement Selection Task Force meeting on September 23, 2010, the DOE/FEMP releases a supplement each year listing Energy Price Indexes and Discount Factors to use in their LCCA procedures. Tables Ca-1 through Ca-5 in this supplement are the projected fuel price indexes, excluding general inflation, for end use sector and fuel type for 4 different regions in the US as well as the average for the US. Table 1 is a copy of the projected fuel price indices (excluding general inflation), by end-use sector for petroleum based fuel type for the US Average from the 2010 supplement.<sup>13</sup>

These indices, when multiplied by annual energy costs computed at base-date prices (i.e., as of April 1, 2010), provide estimates of future-year costs (also as of April 1) in constant base-date (real) dollars. Constant-dollar cost estimates are needed when discounting is performed with a real discount rate (i.e., a rate that does not include general price inflation) such as recommended by OMB . That is, in the LCCA, the cost for a given fuel in a future year is the base year’s costs (e.g. today’s cost) multiplied by the index.

As an example of how this works in a LCCA that uses real discount rates, assume that the cost of Residential Distillate oil is \$40 a barrel. In a FHWA/OMB LCCA process with real discount rates, the cost in any other year would also be \$40. However, the DOE / FEMA process says that the cost for fuel oil in any given year is today’s costs (\$40) multiplied by the Residential Distillate Oil index. For example:

- In Year 2012                      Cost = 1.05 x \$40 = \$42.00 / barrel
- In Year 2020                      Cost = 1.36 x \$40 = \$54.40 / barrel
- In Year 2030                      Cost = 1.50 x \$40 = \$60.00 / barrel

---

<sup>13</sup> Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis – 2010, Annual Supplement to NIST Handbook 135 and NBS Special Publication 709, U.S. Department of Energy, Federal Energy Management Program, <http://www1.eere.energy.gov/femp/pdfs/ashb10.pdf>

**Table 1: Projected Fuel Price Indices (excluding general inflation)  
for Petroleum Based Fuels  
US Average from the 2010 supplement**

Year	Residential	Commercial		Industrial		Transportation
	Distillate Oil	Distillate Oil	Residual Oil	Distillate Oil	Residual Oil	Motor Gasoline
2011	1	1	1.02	1.02	1.08	1.03
2012	1.05	1.07	1.12	1.09	1.15	1.08
2013	1.11	1.14	1.24	1.17	1.24	1.16
2014	1.15	1.19	1.34	1.22	1.3	1.22
2015	1.19	1.23	1.39	1.27	1.34	1.25
2016	1.23	1.28	1.44	1.32	1.38	1.28
2017	1.27	1.33	1.49	1.36	1.42	1.3
2018	1.31	1.37	1.55	1.41	1.45	1.33
2019	1.34	1.4	1.61	1.44	1.48	1.34
2020	1.36	1.43	1.64	1.46	1.49	1.36
2021	1.37	1.44	1.66	1.48	1.51	1.37
2022	1.38	1.46	1.69	1.5	1.52	1.39
2023	1.4	1.48	1.71	1.51	1.54	1.4
2024	1.41	1.49	1.73	1.52	1.56	1.41
2025	1.42	1.5	1.75	1.54	1.57	1.43
2026	1.44	1.52	1.77	1.56	1.58	1.44
2027	1.45	1.54	1.78	1.58	1.6	1.46
2028	1.47	1.56	1.81	1.6	1.61	1.48
2029	1.49	1.58	1.83	1.62	1.64	1.49
2030	1.5	1.6	1.86	1.64	1.66	1.5
2031	1.52	1.62	1.89	1.66	1.68	1.52
2032	1.55	1.65	1.92	1.69	1.71	1.54
2033	1.57	1.67	1.94	1.72	1.73	1.55
2034	1.59	1.7	1.98	1.74	1.75	1.57
2035	1.62	1.73	2	1.77	1.78	1.59
2036	1.63	1.75	2.03	1.8	1.8	1.61
2037	1.65	1.77	2.06	1.82	1.83	1.63
2038	1.67	1.8	2.1	1.84	1.86	1.65
2039	1.69	1.82	2.13	1.86	1.88	1.66
2040	1.71	1.84	2.17	1.89	1.91	1.68

Because the DOE/FEMP is focused on Energy prices, they do not develop an Index for asphalt.<sup>14</sup> However, as shown in Figure 2, the PPI's for petroleum based products (gasoline, liquid asphalt, home heating oil and residual fuel) all trend and track each other reasonably well. Furthermore, based on the information presented in Discussion Point 2 above, it can be surmised that the liquid asphalt will continue to move with gasoline, home heating (distillate) oil, and residual oil and inflate at a substantially higher inflation rate than the standard rate of inflation. Therefore, it is possible to develop a projected Liquid Asphalt index, similar to what is shown in Table 1,

<sup>14</sup> The DOE/FEMP indexes are derived from the same Energy Information Administration data shown in Discussion Point 2 earlier in this document, but that EIA data includes the general rate of inflation for the next 30 years. The DOE/FEMP indexes shown here remove the inflation component so that the indexes can be used in a LCCA with a real discount rate.

by averaging the end-use sector's petroleum based products indices to develop a liquid asphalt multiplier. Table 2 shows this.

**Table 2: Average Projected Fuel Price Indices for Petroleum Based Fuels  
and a Potential Liquid Asphalt Index.  
Based on US Average from the 2010 supplement**

Year	Overall Average			Recommended Liquid Asphalt
	Distillate Oil	Residual Oil	Motor Gasoline	
2011	1.01	1.05	1.03	1.03
2012	1.07	1.14	1.08	1.10
2013	1.14	1.24	1.16	1.18
2014	1.19	1.32	1.22	1.24
2015	1.23	1.37	1.25	1.28
2016	1.28	1.41	1.28	1.32
2017	1.32	1.46	1.3	1.36
2018	1.36	1.50	1.33	1.40
2019	1.39	1.55	1.34	1.43
2020	1.42	1.57	1.36	1.45
2021	1.43	1.59	1.37	1.46
2022	1.45	1.61	1.39	1.48
2023	1.46	1.63	1.4	1.50
2024	1.47	1.65	1.41	1.51
2025	1.49	1.66	1.43	1.53
2026	1.51	1.68	1.44	1.54
2027	1.52	1.69	1.46	1.56
2028	1.54	1.71	1.48	1.58
2029	1.56	1.74	1.49	1.60
2030	1.58	1.76	1.5	1.61
2031	1.60	1.79	1.52	1.64
2032	1.63	1.82	1.54	1.66
2033	1.65	1.84	1.55	1.68
2034	1.68	1.87	1.57	1.70
2035	1.71	1.89	1.59	1.73
2036	1.73	1.92	1.61	1.75
2037	1.75	1.95	1.63	1.77
2038	1.77	1.98	1.65	1.80
2039	1.79	2.01	1.66	1.82
2040	1.81	2.04	1.68	1.84

**Process for Performing a LCCA with Projected Asphalt Escalation Index**

The process for performing a LCCA using Projected Asphalt Escalation Index is the same as procedure outlined by FHWA, with 1 additional calculation (step 6 below):

- 1) Design equivalent pavement sections
- 2) Estimate the initial construction costs.
- 3) Estimates the initial life of each alternate

- 4) Determine the maintenance and rehabilitation strategies (activities and timing) to be used on the pavement over the analysis period.
- 5) Estimate rehabilitation costs for each activity in today's dollars
- 6) For petroleum based products that inflate at rates different than the general rate of inflation, escalate today's cost to the activity year using the appropriate year's inflation index from Table 2 and multiplying today's cost by the index.
- 7) Estimate user costs (optional)
- 8) Compute Net Present Value (NPV) of initial and rehabilitation costs using the using the real discount rates
- 9) Analyze results & Reevaluate strategies as needed

**Process for Establishing Escalation Index and Real Discount Rates:**

To provide guidance with escalation index, FDOT can develop a table such as Table 2, updated each year, using Table Ca-3 from the Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis Annual Supplement (reference 13). Table Ca-3 is the Projected fuel price indices (excluding general inflation), by end-use sector and fuel type for Southern and Mid Atlantic States. For the liquid Asphalt binder index, average the overall index for petroleum based products as done in Table 2.

For real discount rates, use the Real Interest Rates on Treasury Notes and Bonds for a maturity of 30 years from the OMB circular A-94, Appendix C, which is updated every December for the following year.