Environmental Sustainability Implications of Road Construction

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POLYTECHNIC CAMPUS

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What is NEPA?

- National Environmental Policy Act of 1969
- Enacted by Congress October 1969
- Signed into law January 1,1970
- FHWA Primary References
  - CEQ regulations 40 C.F.R. §§ 1500–1508
  - FHWA regulations 23 C.F.R. § 771
  - FHWA guidance T 6640.8A

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Source: Mark Hollowell, ADOT

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NEPA Documentation

- Three levels of NEPA documentation
- Categorical exclusion (CE)
  - action does not individually or cumulatively have a significant effect on the environment
- Environmental assessment (EA)
  - action in which the significance of the environmental impact is not clearly established
- Environmental impact statement (EIS)
  - action will have a significant effect on the environment
- South Mountain Freeway study is an EIS

Source: Mark Hollowell,

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Affected Environment and Environmental Consequences

- Land Use
- Social Conditions
- Title VI and Environmental Justice
- Displacements and Relocations
- Economic Impacts
- Air Quality (includes MSATs)
- Noise
- Water Resources
- Floodplains
- Waters of the United States
- Topography, Geology, and Soils
- Biological Resources
- Cultural Resources
- Prime and Unique Farmlands
- Hazardous Materials
- Visual Resources
- Energy
- Temporary Construction Impacts
- Irreversible and Irretrievable Commitment of Resources
- Relationship Between Short-Term Uses of the Environment and Long-Term Productivity
- Secondary and Cumulative Impacts
- Section 4(f) Evaluation
  - Recreation facilities-parks
  - Historic sites
  - Cultural properties

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Source: Mark Hollowell, ADOT

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Why study cumulative and secondary impacts?

- To understand and disclose ALL potential impacts as mandated by NEPA
- To better understand the overall condition of each resource
- To understand where impacts may occur elsewhere or later in time as a result of the project

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Source: Mark Hollowell, ADOT; and Scott Stapp, HDR

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Why study cumulative and secondary impacts?

- Public disclosure
- Understand the project's contribution to impacts on the environment
- Determine if distinctive differences would occur among the alternatives

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Source: Mark Hollowell, ADOT; and Scott Stapp, HDR

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Definitions

- Induced travel
  - Indirect effect – increased traffic observed on a new highway after it has opened
- Induced demand
  - Increased traffic observed later in time that increases demand for freeway use
- Induced growth
  - Unplanned growth or "urban sprawl"

Source: Mark Hollowell, ADOT; and Scott Stapp, HDR

Issue for Future Public Policy Formulation

- NEPA does not require mitigation of cumulative and secondary impacts; induced travel or induced growth factors
- Should future national policy address mitigation of these impacts and factors?

Air Quality

- Carbon monoxide is used as a surrogate for air quality impacts
- Impacts from PM_{10}, $PM_{2.5}$, NO_X, VOCs, Ozone, and Mobile Source Air Toxics (MSATs) are not studied at the microscale level

Why Are Some Air Pollutants Omitted?

- O_3, PM_{10}, $PM_{2.5}$, NO_X and MSATs are regional in nature
- Modeling methods and EPA guidance are not currently available for conducting microscale analysis of impacts from these pollutants

Issue for Future Public Policy Formulation

- Modeling tools exist and new ones are under development
- Existing tools include:
  - National Mobile Inventory Model
  - MOBILE6.2
  - HAPEM6 mobile inventory exposure model
  - Maricopa County PM10 microscale studies
  - Maricopa County ozone studies (ISC/UAS models)
- Future NEPA related rule revisions should consider more detailed air quality impact assessments to include MSATs, O_3, NO_X, PM_{10} and $PM_{2.5}$

Greenhouse Gas Emissions

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Background

- Green House Gas (GHG) is a growing national and international concern - inherently a global issue
- Transportation is a major source of greenhouse gases, particularly of carbon dioxide (CO_2) emissions - the predominant GHG
- Impact determination and nature of the concern do not fit well to an analysis at a local level
- Current tools at the project level are not sophisticated enough

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Background Cont.

- Regional level analysis may be more meaningful than attempting to address a global issue at a project level
- No national standards have been established by EPA
- GHG issues are evolving and will be disclosed in the Draft EIS

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Source: Mark Hollowell, ADOT; and Scott Stapp,

Issue for future public policy formulation

- Should GHG's be addressed in future NEPA affected projects?
- Are construction phase GHG reductions feasible?

- Currently, for third party rating systems, there are few options for Streets/Roads—
  - USGBC is attempting to use LEED-type ratings for streets and roads construction but are in preliminary stages—

- U.S. Green Building Council. (2005). *Green building rating system for new construction & major renovations (2nd ed.).* Bethesda, MD: U.S. Green Building Council.
- U.S. Green Building Council. (2008, March 21). USGBC: LEED Reference Documents. LEED ID Credit
- Roads & Streets Catalog. 2008, http://www.usgbc.org/ShowFile.aspx?DocumentID=3569.

Consider: GreenRoads Green Rating System

- **How Greenroads Works**

- The Greenroads rating system is a collection of sustainable roadway design/construction practices. Each "credit" describes a partcular sustainable practice and assigns it a point value according to its impact on roadway sustainability.
- There are 11 required "credits" that must be done in order for a roadway to be considered a Greenroad. There are also a great number of voluntary "credits" that a project team can choose to pursue or not. The points associated with the voluntary credits that are achieved are added together to give a final Greenroads score.
- That score can then be used directly for sustainability tracking, internal information, publicity, etc. Greenroads projects can earn several levels of "certification" based on the voluntary points achieved.

  – The more points the higher the certification level. Currently, there are 4 certification levels: certified, silver, gold, and evergreen.

Connection To NEPA of 1969

- **PR-1 NEPA Compliance**

- **Credit Requirements**
- For one (1) credit: completion of the NEPA process or state level equivalent process to its conclusion,
  - including federal and/or state approval of the selected alternative and mitigation commitments.

- **Explanation The Guiding Assumptions Are:**

(1) completion of the NEPA or equivalent procedure should receive one credit, because the influence on the project essentially ends once construction is complete, and

(2) the credit is achieved by meeting a regulatory requirement. Completion of the process to its conclusion is required because completion of a draft NEPA or equivalent state-level document does not provide the legal standing of a Record of Decision with approved mitigation commitments.

Greenroads Rating Points for NEPA Compliance

- **Submittal Documents**
- The following documents are required to qualify for this NEPA credit:

  Final federal or state environmental impact statement, environmental assessment report, or documented categorical exclusion with signatures of the lead federal, state, and regional or local agency representatives.

- **Strategies**
- Sustainability is becoming increasingly prominent as a focal point for NEPA practice, particularly in cumulative effects assessment.

Greenroads Rating Points for NEPA Compliance

- **References**

- Sustainability has always been a subtext of NEPA and equivalent state level processes, even when not explicitly cited in the enabling legislation and implementing regulations. The following examples provide supporting evidence from the peer reviewed literature:

- Caldwell, L. K. 1999. The National Environmental Policy Act: An Agenda for the Future. Bloomington: Indiana Univ. Press. 209 pp.
- Clark, R. 1994. Cumulative effects assessment: a tool for sustainable development. Impact Assessment 12(3): 319-331.
- Lemons, J. 1998. Burden of Proof Requirement and Environmental Sustainability. Chap. 6, pp. 75-103, in: J. Lemons, L. Westra, and R. Goodland. Ecological Sustainability and Integrity: Concepts and Approaches. Boston: Kluwer Academic Publishers. 315 pp.

--(These are a few examples; the list of citations could be much longer…)

- *CASE STUDY: Warm Mix Asphalt vs Hot Mix Asphalt in Vantage, WA*

- *Introduction to the Study*
- The Washington State Department of Transportation (WSDOT) recently completed a 10.6 mile mill-and overlay project on the eastbound truck lane of Interstate 90 between Vantage and George, WA [WSDOT, 2008]. Part of the project (approximately 5.0 miles) was paved using conventional HMA, while the remaining final 5.6 miles was paved using WMA. The same contractor, production plant, trucks and paving equipment were used for both mixes. Both mixes were placed in one two-inch lift and contained 20 percent recycled asphalt pavement (RAP), the maximum allowed by WSDOT without special testing. The mix design was half-inch Superpave with 5.2 percent PG76-28 binder. Sasobit® was added to the warm mix at 2.0 percent by weight of the binder. The Sasobit® additive was provided by Sasolwax, Inc. and produced at the Sasol South Africa plant in Sasolburg, RSA. The additive cost was roughly $25,000
- (including shipping), or about two percent of the total $1.36 million paving portion of the project.

Case Study Methods (for your reference/use)

- *Study Methodology*
- Based on field data collected, the WMA was mixed at 300 F and the HMA was mixed at 350 F. This resulted in a 23.5 percent reduction of diesel fuel use in the burner. The manufacturing processes for these two types of asphalt pavement were generally identical, save that the WMA includes the Sasobit® additive to allow a lower production temperature to be used in the burner. (It is worth noting that this temperature was much higher than the minimum temperature necessary for the additive, according to Sasolwax) [Sasol Wax Gmbh, 1997].

Case Study Methods (for your reference/use)

- Methodology (Continued)
  - A life cycle analysis (LCA) of the pavement structure was conducted in 2008 by the University of Washington Civil and Environmental Engineering Department [Anderson, Weiland, Lin, Muench, Submitted] in accordance with outlined methods for life cycle assessment (LCA) in the International Standard Organization's ISO 14040 and 14044 standards [2006]. This study also included a life cycle impact assessment investigating global warming, photochemical smog, acid rain and human health impacts. Based on the results of the study, quantitatively, the WMA had a significantly lower output of global warming gases such as CO2 than HMA. This is likely primarily due to the reduction in fuel use at the plant burner. Data for plant emissions and binder production was missing, but would very likely increase this difference. Additionally, the impact assessment indicated that the warm mix asphalt had less negative impact on human health. Results for other impact categories considered were inconclusive due to lack of data.

    Reference: Greenroads Rating System v0.95 Manual: Pavement Technologies (PT); PT3 Warm Mix Asphalt (WMA); (2008)

Case Study Statistics (for your reference/use)

- *Some Specific Results and Energy Comparisons*
- Noted in the case study cited, during transfer of the warm mixes to the windrow paver, emissions can be quite visibly lower than the hot mix asphalt at this particular stage of the paving process.
  - The results of **the LCA,** though based on limited data, **showed that a normalized average American household uses approximately 8900 kWh (30.3 million BTU) of electricity per year in their household [USDOE, 2008].** Based on the impact assessment results, **one ton of WMA uses 1.66 percent of this energy and HMA uses 1.82 percent. Similarly, the carbon footprint per person (in CO_2 equivalents) is approximately 20,750 pounds of CO_2 per year [EPA, 2008].**

Case Study Statistics (for your reference/use)

- **The Big Benefits For Environmental Impact**

  *Translating these values to a transportation construction context means that **in about one day's time, a 1000-ton paving project similar to this overlay (in this WMA vs HMA study), uses energy at least equivalent to 16.6 houses (WMA) and 18.3 houses (HMA), and makes a carbon footprint on the order of magnitude of the annual contribution of two Americans (personal carbon footprints) in a year's time.**

    *(Here's what you can use in getting your project 'certified' green through the Greenroads Rating System)

Other Notes & Summation

- Other notes on this case study:
- --Field compaction test results (using standard WSDOT procedures) averaged 93.7% for WMA (11lots with 5 random samples per 400 ton lot) and 93.6 percent for HMA (19 lots), with WMA allowing more time for the rollers to reach compaction;
- -- During placement, infrared photographs taken during observations indicated that temperatures were more uniform across the WMA mat than the HMA mat---that's worth more green points!

References Used In This Case Study

- Just a few from the Washington Study Example:
- Anderson, J., Weiland, C., Lin, Y., Muench, S.T. *Life Cycle Assessment: Warm Mix Asphalt Using Sasobit® Additive*. Submitted for publication.
- D'Angelo, J. et al. Warm Mix Asphalt: European Practice. Report No. FHWA PL 08 007
- http://international.fhwa.dot.gov/pubs/pl08007/pl08007.pdf February 2008. (28 June 2008). 72pp.
- Gandhi, T. (2008). Effects of warm asphalt additives on asphalt binder and mixture properties. Thesis (Ph.D.) Clemson University, 2008.
- Gasthauer, E., Maze, M., Marchand, J. P., & Amouroux, J. (2008). Characterization of asphalt fume composition by GC/MS and effect of temperature. *FUEL: GUILDFORD*. 87 (7), 1428-1434.
- Greenroads Rating System v0.95 Pavement Technologies (PT); 2008
- Herrick, R. F., McClean, M. D., Meeker, J. D., Zwack, L., & Hanley, K. (2007). Physical and Chemical Characterization of Asphalt (Bitumen) Paving Exposures. *JOURNAL OF OCCUPATIONAL AND ENVIRONMENTAL HYGIENE.* 4, 209-216.

Other References For Overall Presentation by Brown and Hild

Arizona Department of Transportation, 2009, Categorical Exclusion for SR 74 to Anthem Way Route I-17, Prepared by David Webb, AZTEC Engineering

Arizona Department of Transportation, 2008, Presentation to South Mountain Freeway Citizens Advisory Committee, by Mark Hollowell, Planner II

Arizona Department of Transportation, 2008, Presentation to South Mountain Freeway Citizens Advisory Committee, 2008, by Mark Hollowell and Scott Stapp

Arizona Department of Transportation, 2006, South Mountain Transportation Corridor Study, Draft Air Quality Technical Report Summary, Downloaded March 22, 2009 from: http://www.azdot.gov/Highways/Valley_Freeways/Loop_202/South_Mountain/PDF/CAT_Air_Quality_Sum_Rep.pdf

U.S. Environmental Protection Agency, Mobile Source Air Toxics, Downloaded March 22, 2009 from: http://www.epa.gov/otaq/toxics.htm

References (Continued)

- U.S. Federal Highway Administration, 2002, Final Environmental Assessment, SR85 Gila Bend to I-10, by Richard Duarte, ADOT Environmental Planning Group

- U.S. Federal Highway Administration, 1999, Red Mountain Freeway SR 87 to US 60 Final Environmental Impact Study Text

Questions and Discussion

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