Comparing Forecasting Methods: Expert Land Use Panel vs. Simple Land Use Allocation Model

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ABSTRACT

An Expert Land Use Panel was used to forecast the land use impacts of a major highway project in the Washington, DC area, the Inter-County Connector. What makes this panel noteworthy is the fact that a subgroup of panelists, convinced that the accessibility impacts of the highway were not being adequately considered by the majority, developed a simple land use allocation model which they then used to produce independent forecasts. This allows us to compare more intuitive and ad hoc forecasts based only on expert opinion with those based on a formal land use allocation model. At least in this case, the two differed sufficiently to suggest that the two processes are not mere substitutes for one another. This prompts us to recommend that subsequent panels be fed accessibility data early in the process to inform their intuitive judgments, and that simple land use allocation models be considered as a complement to expert opinion.

INTRODUCTION

Major highway construction projects are valued for their economic development and congestion relief benefits. However, they also raise concerns; highway capacity improvements themselves may induce urban sprawl and increase vehicle miles of travel (phenomena known, respectively, as induced development and induced travel) (Boarnet 2000a, Boarnet 2000b, Cervero 2002, Cervero 2003). The environmental review process requires a detailed analysis of such impacts on the manmade and natural environments.

The impacts of major highway projects on land use patterns are treated as *secondary* impacts under the National Environmental Policy Act (NEPA). Council on Environmental Quality (CEQ) guidelines define secondary impacts are those that are "caused by an action and are later in time or farther removed in distance but are still reasonably foreseeable" (40 CFR 1508.8). Generally, these impacts are induced by the initial action and include changes in land use. Two recent NEPA court decisions find that induced development may be a significant secondary impact of major highway projects (*Sierra Club, Illinois Chapter v. U.S. Department of Transportation*, 962 F.Supp. 1037 (N.D. IL 1997); *Senville et al. v. Mary E. Peters and Patricia McDonald*, Case Number 2:03-cv-279 (U.S. District Court for Vermont, May 10, 2004)).

Neither NEPA regulations, nor related case law, specify acceptable methods of secondary impact analysis. They simply require that a reasonable attempt be made to quantify such impacts. Two alternative ways of meeting NEPA requirements are through the use of an expert panel and the development of a formal land use allocation model. As will be apparent immediately from the following case study, these two approaches may lead to very different outcomes.

Inter-County Connector

The ICC has long been planned—and debated—in the Washington DC area. The proposed project is pictured in Figure 1. The ICC is a roughly 20-mile highway that would connect two major radial corridors: I-95 between Washington and Baltimore and I-270 between Washington and Frederick. Most of the proposed facility lies in Montgomery County, MD, a northern suburb of Washington, DC. A small segment connects it to I-95 in Prince George's County, MD. This highway has been studied and restudied for over 30 years as a strategy for *completing the grid* and taking pressure off the Capitol Beltway (I-495).

Apart from the ICC, there is no continuous east-west travel corridor across the northern metropolitan area except for the Beltway at the southern end of Montgomery County and Interstate 70 which is some 30 miles to the north. Many feel that the ICC may represent the first step in ultimate construction of an outer beltway (also controversial), so the decision on the ICC carries this added significance.

Two different alignments are being considered, differing for the eastern half of the facility. One of these—referred to as the Southern Alignment—is the original alignment. Its eastern portion crosses sensitive stream valleys and wetlands. The second, or Northern Alignment, jogs to the north away from the wetland areas, adding several miles to the travel distance and moving closer to the County's rural preserve

While the primary purpose of the facility is to provide a *connector* between east and west, thus presumably alleviating intense traffic congestion on the Capitol Beltway, the new facility would provide nine interchanges along its length in addition to the two end points, providing significant new access to previously undeveloped areas in the interior of Montgomery County. Those areas that have not been previously developed are either environmentally sensitive or zoned rural or agricultural. This raises the possibility of significant induced development in areas that ICC opponents would like to preserve.

The ICC was last studied in 1999, when Maryland's then Governor—architect of the state's Smart Growth Program—perceived so much public rancor over the highway and its environmental impacts that he cancelled the study. His efforts to sell off rights-of-way and put the controversy permanently behind the state were unsuccessful, and after a change of administration in 2002, the ICC received new life. In his first State of the State address, the new Governor stated: "A small band of opponents wish to derail the ICC despite strong bipartisan support…They will fail. Trust me, they will fail." (Natkin, 2004) This is indicative of the level of controversy surrounding this particular highway.

As a result of these considerations, and the fact that the ICC has been placed on an environmental *fast track* by the Federal government, a higher level of scrutiny greeted our expert panel than its predecessors.

EXPERT PANEL PROCESS

Expert panels are finding increasing use in transportation planning. One source distinguishes expert panel from other group processes (advisory committees, stakeholder review committees, etc.) by emphasizing the highly structured nature of the expert panel process, the qualifications of panelists, and the reliability of resulting forecasts (Seskin and Boroski, 2002). In an expert panel process, "selected experts provide their assessment of likely future outcomes by responding to several rounds of questions. An expert panel can be used as a primary analysis method or in conjunction with other tools, and is a cost-effective technique that can be applied in a variety of settings to produce reliable results. Expert panels combine an understanding of the theory of urban development, empirical knowledge of transportation/land use relationships, and detailed understanding of local conditions. They are not a replacement for quantitative data, but rather integrate data with the perceptions, intuition, and judgment of people familiar with the study area."

The panel about which we write was established by the Maryland Department of Transportation and dubbed an Expert Land Use Panel, or ELUP. According to the department, an ELUP is a "well balanced mixture of informed individuals brought together to assess a complex situation using their judgment and experience. 'Well balanced' is defined as representing a variety of backgrounds and viewpoints, while 'informed' means that panel members should understand and be familiar with local and national conditions and the factors that affect development patterns." (MDOT SHA, 2002) Panel members are expected to have open minds regarding development and not be locked into a single point of view. They must be, and be perceived to be, objective as well as informed. They must also have no conflicts of interest.

Desirable professional backgrounds when assembling an ELUP include real estate specialists (developers, attorneys, economists), public and private planning professionals (transportation, land use, traffic, transit), academics (demography, geography, public policy, planning), financial institutions, employers, and community and special interests (transit or bicycle advocates, environmental concerns, informed citizens, business leaders, civic organizations).

The panel's job—much like that of a jury—is to weigh the *evidence* presented to them given their particular experience and expertise, and then individually and collectively reach a *verdict* regarding the impacts the proposed project on future land use patterns. Given a reasonably large and diverse panel, the projected impacts are fairly presumed to incorporate the many complex factors that influence development trends, including the induced development impacts of highway investments.

Like any Delphi process, the ELUP requires its members to assimilate important background information on current conditions and past and future trends, and work independently to forecast changes in development patterns in response to one or more *build* alternatives. Results are tabulated and subjected to various statistical tests to reflect how close or divergent the panel is in its forecasts. A skilled facilitator encourages the panelists to exchange views and

justifications for their particular allocations. These exchanges are intended to both enlighten other panel members who do not share that particular expertise, and to give the owner of the given forecast an opportunity to hear critiques of his/her judgment. Through a series of iterative rounds, panelists are encouraged to adjust their forecasts to take account of new information or insights, with the result that differences should narrow and come to reflect the panel's cumulative knowledge base.

An ELUP is a relatively fast and inexpensive method of assessing highway land use impacts. A panel can be formed and the process completed in 4 to 6 months. It can tap the rich storehouse of intellectual capital that exists within the local planning and development professions. Most metropolitan areas do not have a standing land use modeling capability. Models such as DRAM-EMPAL, TRANUS, and MEPLAN are not only costly and time-consuming to develop but have been challenged for the accuracy of their simulation routines. There are questions as to whether they adequately account for many factors deemed central to residential and commercial development trends, and whether they place too much emphasis on the influence of the transportation investments.

ICC Panel

The State of Maryland has relied heavily on the ELUP process in earlier highway impact studies, including studies for I-270, US 301 and MD 32. In each of these cases, the process passed the test of credibility for the regulatory agencies and special interest groups.

In the ELUP process for the ICC, Parsons Brinckerhoff, consultants for the State, were responsible for panel selection, conduct of panel meetings, and summarization of results. The final panel (less dropouts) consisted of 15 diverse members who met as a panel five times.

Initial meetings were designed to provide the panel with a thorough understanding of conditions in the corridor, past growth trends, and future growth projections. Planning directors

from each of the affected jurisdictions were brought in to present the highlights of their long-range transportation and comprehensive land use plans. Demographic data for the allocation process were provided by the Metropolitan Washington Council of Governments (MWCOG), the regional MPO. Population, households, and employment were provided for 1990 and 2000 (from the Census) and for the 2030 horizon year (from the regional cooperative forecasts).

Given the scale of the ICC project, the area of influence/study area was defined to include all of Montgomery County, Howard County, and the District of Columbia, and adjacent parts of Prince George's, Frederick, Anne Arundel, and Baltimore counties. The study area was partitioned into forecast zones that served as the basis for growth allocations. After some discussion among panelists, a system of 34 zones was created (see Figure 1). Finer geographic detail was provided in the immediate vicinity of the highway through the delineation of smaller zones.

(Insert Figure 1)

Revised No-Build Baseline

Before the panel began its job of reallocating jobs and households for the build alternatives, it was necessary to agree that the no-build 2030 baseline was an acceptable starting point for subsequent adjustments. The existing baseline from MWCOG became suspect when it was revealed that, while MWCOG had never included the ICC in any of its transportation planning analyses, Montgomery County actually had been assuming the ICC in place for several years. Since the allocations of growth to TAZs at the county level fall within the purview of each county, and these forecasts are subsequently used by MWCOG in the regional planning process, there was concern that MWCOG no-build baseline was tainted by Montgomery County's assumption. Hence, the ELUP facilitator permitted the panel to reconsider the no-build numbers and suggest revisions.

This process ended up taking a somewhat counterintuitive turn. Rather than the panel recommending that the no-build growth allocations for zones immediately adjacent to the highway be scaled back, the majority of panelists recommended that MWCOG growth allocations be increased. This reallocation was done without apparently considering that the transportation capacity of zones receiving additional growth was already strained, and that later reallocations to reflect the presence of the ICC would begin to bump up against development capacity ceilings and hence would show lesser impacts than if begun with a lower baseline.

First-Round Build Growth Allocations

With the revised 2030 no-build baseline in place, the panel then focused on the task of reallocating jobs and households for the two ICC build alternatives. While existing zoning and development capacities were not to be assumed as hard and fast, panelists were nevertheless sensitized to the fact that their assumptions in this regard were important. They were advised to share these assumptions in their accompanying write-ups. The group was also instructed to assume that congestion tolls would be instituted on the ICC to ensure that it would continue to operate at level of service C. These tolls were to be considered as a potential factor in location decisions of employers and households related to the ICC.

Several things are noteworthy about the resulting first-round build growth allocations:

- The panel's adjustments to households and jobs for most of the jurisdictions were less than the panel's previous changes to MWCOG's adopted forecasts.
- There were very wide differences in opinion among panelists as to which areas would receive or lose development due to the ICC, differences which tended to cancel one another and produce small composite changes.
- Many panelists presumed that the effects of the ICC on development patterns would only be felt close to the highway, which meant that changes for jurisdictions other than Montgomery County were quite small.

Neglect of Accessibility Effects

When these issues were taken up with the ELUP, it became apparent that there were very different perspectives behind the wide ranging estimates. Moreover, there seemed to be little ability to change anyone's point of view.

Perhaps the most difficult perspective to convey was the importance of accessibility, that is, how the addition of a major regional transportation facility like the ICC would have a wide-ranging effect on travel times and distances. While the typical panelist could see an immediate advantage to locations directly served by the facility, it proved harder to envision how the new facility would affect the overall highway network. Transportation planners see these relationships intuitively, since they routinely work with travel demand models. For non-planners it is not so intuitive. Even for transportation planners, attempting to intuit the effect of changes in a complex network is a very challenging task.

This is not to say that expert opinion has no value in such a process—the breadth of experience contained in an ELUP is valuable in that it introduces real-world business sense and knowledge of local trends and conditions to what might otherwise be a strictly number crunching exercise. As important as accessibility is, it is only one of many influences on development. Nevertheless, it was the absence of a formal and explicit accounting for accessibility that made several of us on the panel feel that the ELUP process would be incomplete—and potentially highly inaccurate—unless a model-based forecast became part of the process.

Since there was no working land use allocation model available for the study area, nor budget for developing such a model within the ELUP process, a group of us on the panel combined forces to develop a simple land use forecasting model and apply it to our final build forecasts. We worked together on this effort, since it was too large a task for one person in the available time.

SIMPLE LAND USE ALLOCATION MODEL

Our first step was to estimate the relationship between regional accessibility and household and job location. We needed long-run elasticities of households and jobs with respect to highway and transit accessibility in order to predict the shift in location accompanying changes in accessibility with ICC construction.

Model Form

The models we estimated may be categorized as "equilibrium" models, in that they explained end-state distributions of households and jobs rather than changes in household and job distributions over some time period. They may also be categorized as spatial interaction models, in that they captured the attraction of households to jobs and jobs to other jobs within the study area.

They were simplified versions of the most commonly applied land use allocation model, DRAM-EMPAL. Like DRAM-EMPAL, they were spatial interaction models that assumed equilibrium. Also like DRAM-EMPAL:

- Our units of analysis (ICC forecast zones) were relatively large compared to traffic analysis zones (MWCOG TAZs),
- Our functional form (a power function) was nonlinear, and
- Our allocation models included measures of land availability and regional accessibility.

The main differences between our simple models and DRAM-EMPAL were:

- Our dataset and models included no measures of attractiveness for ICC zones, and

- Our measure of accessibility in both household and job models was the accessibility to jobs; we knew that only job accessibility would be readily available from MWCOG.

While the models we developed are much simpler than formal land use allocation models like DRAM-EMPAL, they were empirically based and reflective of relationships within the study area.

Data Sources

MWCOG supplied the basic data used in this modeling exercise. Our model dependent variables were the numbers of households and jobs by ICC zone. Our independent variables were the area of ICC zones in acres and numbers of jobs reachable from each zone within specified travel time ceilings by highway and transit. The base year for forecasting purposes was 2000 and the target year was 2030.

Total area was available for all zones, while developable area (excluding water bodies and conservation lands) was available only for Montgomery County zones. Since total area performed almost as well as an explanatory variable for Montgomery County zones, and was available for the entire study area, it emerged as the preferred measure of land availability.

Accessibility values reflected morning peak travel time skims—that is, the number of jobs reachable during the morning peak for different travel time ceilings. For each ICC zone, accessibility values for all MWCOG TAZs lying within their boundaries were averaged. The one exception was Catonsville, which lies outside the MWCOG study area and has no base or target year accessibility data from MWCOG. It was excluded from the analysis.

Upon inspecting the MWCOG accessibility values, we realized that they did not include jobs outside the MWCOG region, most notably jobs in Baltimore City and Baltimore and Harford counties. Job accessibilities seemed particularly understated for ICC zones along the I-95

corridor such as Ellicott City, Columbia, Fulton, and Severn. This was confirmed by MWCOG staff. To correct for this major shortcoming, we requested equivalent values of accessibility to Baltimore jobs for each of the MWCOG zones from the Baltimore Metropolitan Council (the regional MPO). These were added to MWCOG accessibility values to obtain total jobs reachable within various travel time ceilings from ICC zones. Table 1 shows 25-minute job accessibility values for highway users in the base year 2000, for Washington, Baltimore, and the two combined. Comparable figures were not available for accessibility to Baltimore jobs by transit. Therefore, transit accessibilities were limited to Washington jobs. We reasoned that transit accessibility to Baltimore jobs would have a minor impact on growth in the ICC study area.

(Insert Table 1)

Three travel time ceilings were tested: 25, 45, and 60 minutes. Scatterplots and regression analyses suggested that the 25-minute job accessibilities explained the most variance in household and job levels for both highway and transit modes. Hence only 25-minute accessibility values were used in our final models. The use of 25-minute accessibilities is contrary to standard practice in the MWCOG region, where transportation system performance has routinely been evaluated based on 45-minute accessibilities. The better fit between 25-minute accessibilities and household and job levels may reflect historic commuting patterns, and to the extent it does, longer commutes in recent years might argue for the use of 45-minute accessibilities instead. However, with work trips as a small and declining percentage of all trips, and with trips for other purposes substantially shorter than work trips, we reasoned that the number of trip attractions (jobs in this case) within 25 minutes might be a more important location determinant anyway. That is to say, Washington area residents might be acclimated to long commutes to work but be reluctant to accept long travel times for all other purposes. On this basis, we were inclined to stick with the accessibility measure (25-minute) that provided the best fit to historic data.

Model Estimation

Our models were estimated with multiple regression analysis. Since scatterplots showed that relationships in many cases were nonlinear and logarithmic in shape, logarithms were taken of both dependent and independent variables. The dependent variables were the logarithms of numbers of households and jobs by ICC zone. The independent variables were the logarithms of ICC zone total acres, 25-minute highway accessibilities, and 25-minute transit accessibilities. ICC zone area was included in the regressions as a control variable. Only the 25-minute highway and transit accessibilities varied between ICC build and no-build alternatives.

The regression models explained 57 percent of the variation in the logarithm of households across ICC zones, and 73 percent of the variation in the logarithm of jobs across ICC zones. The t-statistics of all regression coefficients were significant at conventional levels. We ran log-log regressions for Montgomery County zones alone and got greater explanatory power.

Running a log-log regression produces a power function in the original variables. The regression coefficients are arc elasticities of the dependent variable with respect to the independent variables. Hence no additional processing of data was necessary to move directly to forecasts of build vs. no build land use patterns.

Elasticities are presented in Tables 2 and 3 for households and jobs, and for the entire sample and Montgomery County zones alone. Again, ICC zone area is included as a control variable. Elasticities are higher for highway accessibility than transit accessibility, reflecting the relative importance of the two modes. Elasticities are higher for jobs than households, reflecting the relative sensitivity of the two land uses to accessibility variations.

(Insert Tables 2 and 3)

Pivot Point Land Use Forecasts for Build Alternatives

Given elasticity estimates, it was possible to forecast households and jobs in 2030 for the ICC build alternatives by using the elasticities to "pivot" around no-build forecasts. Pivot point models are widely used in this kind of sketch planning activity. We chose to pivot around the expert panel's *consensus* no-build forecasts. In fact, the difference between build and no-build alternatives depended only marginally on which no-build forecast we started with.

The elasticities used to pivot around no-build forecasts represented a compromise between those derived for the full sample of ICC zones, and those derived for Montgomery County zones alone. Since the primary impact of the ICC will be on Montgomery County, it seemed appropriate to give Montgomery County extra weight in parameter selection. Elasticities used in our forecasts are presented in Table 4.

(Insert Table 4)

From the definition of arc elasticity, the numbers of households and jobs for build alternatives became simple functions of no-build households and jobs plus relative highway and transit accessibilities. Formulas for computing them were:

$$H_{2030\ \text{build}} = H_{2030\ \text{no build}} * (R_{2030\ \text{build}} / R_{2030\ \text{no build}})^{\text{elasticity of hshs wrt highway accessibility}} * (T_{2030\ \text{build}} / T_{2030\ \text{no build}})^{\text{elasticity of hshs wrt transit accessibility}}$$

$$J_{2030\ \text{build}} = J_{2030\ \text{no build}} * (R_{2030\ \text{build}} / R_{2030\ \text{no build}})^{\text{elasticity of jobs wrt highway accessibility}} * (T_{2030\ \text{build}} / T_{2030\ \text{no build}})^{\text{elasticity of jobs wrt transit accessibility}}$$

(H = Households, R = Highway Accessibility, T = Transit Accessibility, J = Jobs)

Plugging in appropriate values, we obtained 2030 forecasts for build alternatives. For some zones, forecasts of households and jobs exceeded, sometimes by substantial margins, capacity

to absorb growth under current Montgomery County zoning. For other zones, forecasts fell short of capacity. So we followed these rules:

- If forecasts were under zoning capacity (in Montgomery County) or capacity was unknown (in the rest of the study area), we used forecasted values.
- If forecasts were above zoning capacity (in Montgomery County), we generally capped development at current zoning capacity.
- In a few cases where development pressures will be particularly intense, we assumed an increase in zoning capacity based on our knowledge of the area, reverting to judgment.

Consideration of zoning capacity allowed us to limit overly-aggressive allocations to places like Germantown, Gaithersburg, Montgomery Village, Aspen Hill and Wheaton, while allowing for a slight increase in capacity in places like Laytonsville, Burtonsville, Cloverly and Deer Park where current capacities are quite low and where we feel that the accessibility provided by the ICC will create tremendous growth pressures. The revised forecasts reflected these new capacities put in place as constraints (see Table 5).

(Insert Table 5)

Our forecasts could be off for various reasons. Most important, the use of equilibrium models would tend to overstate change in any given time period, since they assume that the real estate market has time to adjust to changing accessibility contours. In fact, the long lives of buildings and infrastructure mean that the market never fully adjusts. On the other hand, the use of 25-minute job accessibilities probably understates change relative to a longer travel time ceiling.

COMPARING RESULTS

In Figures 2 through 13, individual growth allocations are compared for the 15 panel members. These figures allow us to compare more intuitive and ad hoc forecasts based only on expert

opinion with those based on a formal land use allocation model informed by expert opinion. Panelists 3, 8, and 15, two of whom are co-authors of this paper, submitted the modeled results. The rest relied strictly on expert opinion. Where zero values are shown, panelists assumed no difference between build and no-build alternatives.

For the Southern Alignment of the ICC, use of accessibility information caused modeled results for the entire 34-zone study area to be 3.4 percent higher for households, and 3.5 percent higher for jobs, than were results based only on expert opinion. For the Northern Alignment, use of accessibility information caused modeled results for the entire study area to be 2.6 percent higher for households, and 1.0 percent higher for jobs. Overall, we forecasted greater changes (both gains and losses) for the Southern Alignment than the Northern Alignment. The rest of the panel's forecasts showed the opposite.

Looking at individual jurisdictions in Figures 2 through 13, the principal differences between the modeled growth allocations and those based only on expert opinion were:

- In Montgomery County, where the ICC would seemingly have its greatest impact, the model based forecasts of growth in both jobs and households were about three times greater than those based on expert opinion only (see Figures 2 and 3). Whereas the 12 panelists who relied on judgment forecasted an average growth of 11,075 households and 14,697 jobs for the Southern Alignment, we forecasted increases of 30,424 households and 46,916 jobs. Differences were not uniform across the county: the model predicted larger increases in jobs at locations near the ends of the ICC facility, such as Rockville, Gaithersburg, Germantown and Montgomery Village, and in places with an existing commercial character that would be given new direct access via the ICC, such as Wheaton, White Oak, Aspen Hill and Burtonsville. With regard to households, the model predicted increases in the interior of the county that have had limited accessibility in the past, such as Deer Park, Cloverly, Burtonsville, and

Potomac. In these instances, the growth potential suggested by the accessibility relationships overwhelmed the existing zoning capacity for households, as many of these zones are currently zoned rural or agricultural. This caused us to moderately raise the zoning caps in these zones to accommodate at least some of the projected growth, while the other panelists were more likely to adhere to the existing zoning ceilings. Differences between model and judgment were similar for Southern and Northern Alignments: both approaches forecasted slightly more households and jobs for the Southern Alignment than the Northern alignment.

(Insert Figures 2 and 3)

While differences between modeled and judgmental forecasts were significant in an order-of-magnitude sense for Montgomery County, the differences that showed up in the surrounding counties were even more pronounced. We feel this is due to most panelists not perceiving much impact on development beyond the corridor itself, whereas the travel time changes brought about by the ICC are much more widely distributed than intuition would suggest.

- Very important differences emerge in Frederick County, to the north of the ICC (see Figures 4 and 5). Still heavily rural, Frederick County has grown rapidly over the past 15 years as job growth in the I-270 corridor and scarcity of affordable housing in Montgomery County have made living in Frederick County an economically attractive alternative. Interestingly, most panelists felt that construction of the ICC in Montgomery County would have no effect on this trend. As evidence, the average change in households forecast by the panelists based only on expert opinion was 33 for the Southern Alignment, 104 for the Northern alignment, compared to the model's forecast of 15,198 additional households for the Southern Alignment and 13,929 for the Northern Alignment. As for employment, panelists relying on expert opinion estimated a *loss* of 1,500 jobs for the Southern Alignment and 1,859 jobs for the

Northern Alignment versus increases of 15,513 and 4,782 jobs for the two alignments, respectively, based on the model. The jobs difference is due to a continued buildup of traffic congestion in the lower I-270 corridor that will push job growth further north and also allow an increasing number of workers to live in Montgomery County (including along the ICC), and reverse commute north to jobs in Frederick County.

(Insert Figures 4 and 5)

- Prince George's County proved to be another area with divergent forecasts (see Figures 6 and 7). County officials are concerned that the ICC will siphon off future economic development in favor of Montgomery County. Somewhat in response to this concern, panelists relying on expert opinion forecasted modest growth of households and jobs with the ICC, specifically, increases of 3,800 households and 4,864 jobs for the Southern Alignment and 3,711 households and 4,640 jobs for Northern Alignment. Using accessibility information, we forecasted considerably larger increases: 14,603 households and 46,722 jobs for the Southern Alignment and 11,803 household and 30,099 jobs for the Northern Alignment. The reason for these differences is telling. Much of the new growth would be located in the more suburban portions of Prince George's County, not in the older inner core, and particularly in places that would be well served by the ICC eastern extension into Prince George's County: Beltsville, Muirkirk, Laurel and Laurel Pines.

(Insert Figures 6 and 7)

- In Washington DC, the existence of transit infrastructure and supportive development may mitigate the impacts of the ICC (see Figures 8 and 9). Nevertheless, we projected somewhat greater losses for the District than did the rest of the panel: losses of 367 households and 5,305 jobs for the Southern Alignment, and 4,326 households and 15,565 jobs for the Northern Alignment. The other panelists forecasted average losses of only 108 households and 1,795 jobs for *both* ICC alignments. This is a case in

which the two forecasting approaches not only differed, but differed in a relative sense between alignments.

(Insert Figures 8 and 9)

- In fast growing Howard County, the models forecasted greater impacts than expert opinion alone would indicate (see Figures 10 and 11). This is likely due to the same phenomenon as in Montgomery County, where modeled forecasts reflect huge improvements in accessibility while judgmental forecasts appear constrained by existing zoning capacities. We forecasted increases of 2,584 households and 9,366 jobs for the Southern Alignment and 3,444 households and 14,415 jobs for the Northern Alignment. The other panelists forecasted average growth of only 385 households and 1,493 jobs for the Southern Alignment, and 1,370 households for the Northern Alignment. They forecasted an actual loss of 575 jobs for the Northern Alignment. This is another case in which the two forecasting approaches not only differed, but differed in a relative sense between alignments

(Insert Figures 10 and 11)

- Finally, for Anne Arundel County, we predicted entirely different growth trends than the panelists relying exclusively on judgment (see Figures 12 and 13). They forecasted 1,375 additional households and 1,795 additional jobs with the ICC Southern Alignment, while we forecasted a loss of 1,429 households and 5,305 jobs relative to the no-build alternative. Our results initially seemed counterintuitive, since one purpose of the ICC is to support continued growth around BWI Airport, which should benefit Anne Arundel County. However, because of our focus on accessibility, this part of the region stands to *lose* in a relative and absolute sense as congestion increases on approaches to the ICC where highway capacity is limited and no highway improvements are programmed. For the Northern Alignment, modeled forecasts differ

even more from judgment based: for us, a loss of 4,328 households and 15,565 jobs vs. almost no difference for the other panelists.

(Insert Figures 12 and 13)

CONCLUSION

This paper has provided a case study from the Washington DC metropolitan area, in which an Expert Land Use Panel was used to forecast the land use impacts of a major highway project, the controversial Inter-County Connector. What makes this panel process noteworthy is the fact that a subgroup of panelists, convinced that the accessibility impacts of the highway were not being adequately considered by the majority, developed a simple land use allocation model which they then used to produce independent forecasts. This allows us to compare more intuitive and ad hoc forecasts based on expert opinion with those based on a formal land use allocation model. At least in this case, the two differed sufficiently to suggest that the two processes are not mere substitutes for one another. This prompts us to recommend that subsequent panels be fed accessibility data early in the process to inform their intuitive judgments, and that simple land use allocation models be considered as a complement to expert opinion.

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Table 1. 25-Minute Job Accessibilities by Highway for ICC Zones (2000)

ICC Zone	ICC Zone Name	Job Accessibilities		
		Washington	Baltimore	Total
1	Frederick	80,836	0	80,836
2	Monocacy	51,448	0	51,448
3	Urbana	42,349	0	42,349
4	Poolesville	30,773	0	30,773
5	Germantown	98,029	0	98,029
6	West Friendship	29,343	15,764	45,107
7	Potomac	117,693	0	117,693
8	Gaithersburg	175,460	0	175,460
9	Montgomery Village	119,428	0	119,428
10	Olney	40,375	0	40,375
11	Laytonsville	35,044	0	35,044
12	Burtonsville	97,155	0	97,155
13	Fulton	184,477	56,750	241,227
14	Columbia	147,412	115,411	262,823
15	Ellicott City	107,464	201,672	309,136
16	Catonsville *	NA	629,913	629,913
17	Rockville	220,770	0	220,770
18	Aspen Hill	95,497	0	95,497
19	Cloverly	84,016	0	84,016
20	Deer Park	137,050	0	137,050
21	Muirkirk	176,935	0	176,935
22	Laurel	227,870	24,974	252,844
23	Laurel Pines	200,651	0	200,651
24	Severn	223,939	300,629	524,568

25	Hanover	161,292	534,214	695,506
26	Bethesda	266,615	0	266,615
27	Wheaton	189,720	0	189,720
28	White Oak	196,897	0	196,897
29	Beltsville	272,757	0	272,757
30	New Carrollton	138,015	0	138,015
31	Odenton	116,674	0	116,674
32	Washington	566,651	0	566,651
33	Inner Prince George's	386,150	0	386,150
34	Clinton	93,550	0	93,550

Table 2. Elasticities of Households and Jobs with Respect to ICC Zone Area and Highway and Transit Accessibilities (All Zones)

	Households	Jobs
Acres	0.62	0.66
25-Minute Highway Accessibility	0.61	1.09
25-Minute Transit Accessibility	0.18	0.24

Table 3. Elasticities of Households and Jobs with Respect to ICC Zone Area and Highway and Transit Accessibilities (only Montgomery County Zones)

	Households	Jobs
Acres	0.62	0.83
25-Minute Highway Accessibility	0.40	1.37
25-Minute Transit Accessibility	0.32	0.33

Table 4. Composite Elasticities of Households and Jobs with Respect to Highway and Transit Accessibilities

	Households	Jobs
25-Minute Highway Accessibility	0.5	1.2
25-Minute Transit Accessibility	0.25	0.3

Table 5. Zoning Capacities and Forecasts of Households for No-Build and Build Alternatives (2030)

ICC Zone	ICC Zone Name	Zoning Capacity		Forecasts		
		Original	New	No Build	Corridor 1 (modeled)	Corridor 2 (modeled)
1	Frederick			48,684	48,770	48,770
2	Monocacy			7,808	8,522	7,069
3	Urbana			27,195	41,592	41,775
4	Poolesville	22,135	22,135	15,166	15,218	15,266
5	Germantown	50,635	50,635	47,801	50,635	50,635
6	West Friendship			18,493	19,282	18,556
7	Potomac	40,253	40,253	34,879	37,961	38,067
8	Gaithersburg	41,098	41,098	35,137	37,481	37,079
9	Montgomery Village	28,410	31,500	29,665	31,500	31,500
10	Olney	13,485	15,000	13,441	15,000	15,000
11	Laytonsville	2,834	5,000	1,825	1,993	1,981
12	Burtonsville	3,111	5,000	2,012	4,220	4,734
13	Fulton			5,145	5,487	5,403
14	Columbia			66,615	67,783	67,951
15	Ellicott City			48,199	48,424	49,986
16	Catonsville *			19,311	19,311	19,311
17	Rockville	37,146	37,146	32,530	35,181	34,942
18	Aspen Hill	27,919	27,919	27,238	27,919	27,919
19	Cloverly	6,903	10,000	6,993	10,000	10,000
20	Deer Park	12,940	15,000	9,237	14,588	13,300
21	Muirkirk			10,842	14,707	13,650
22	Laurel			8,559	12,836	12,673
23	Laurel Pines			11,759	14,976	14,457
24	Severn			34,376	35,272	34,513
25	Hanover			33,153	32,229	30,594
26	Bethesda	97,378	97,378	83,097	85,684	85,672
27	Wheaton	65,105	65,105	64,687	65,105	65,105
28	White Oak	30,649	30,649	29,001	30,649	30,649
29	Beltsville			11,910	13,520	13,297
30	New Carrollton			59,312	57,973	59,045
31	Odenton			34,471	33,070	32,565
32	Washington			290,748	290,381	288,609
33	Inner Prince George's			161,226	164,325	162,657
34	Clinton			30,539	30,413	30,171
	Total			1,361,054	1,422,007	1,412,902

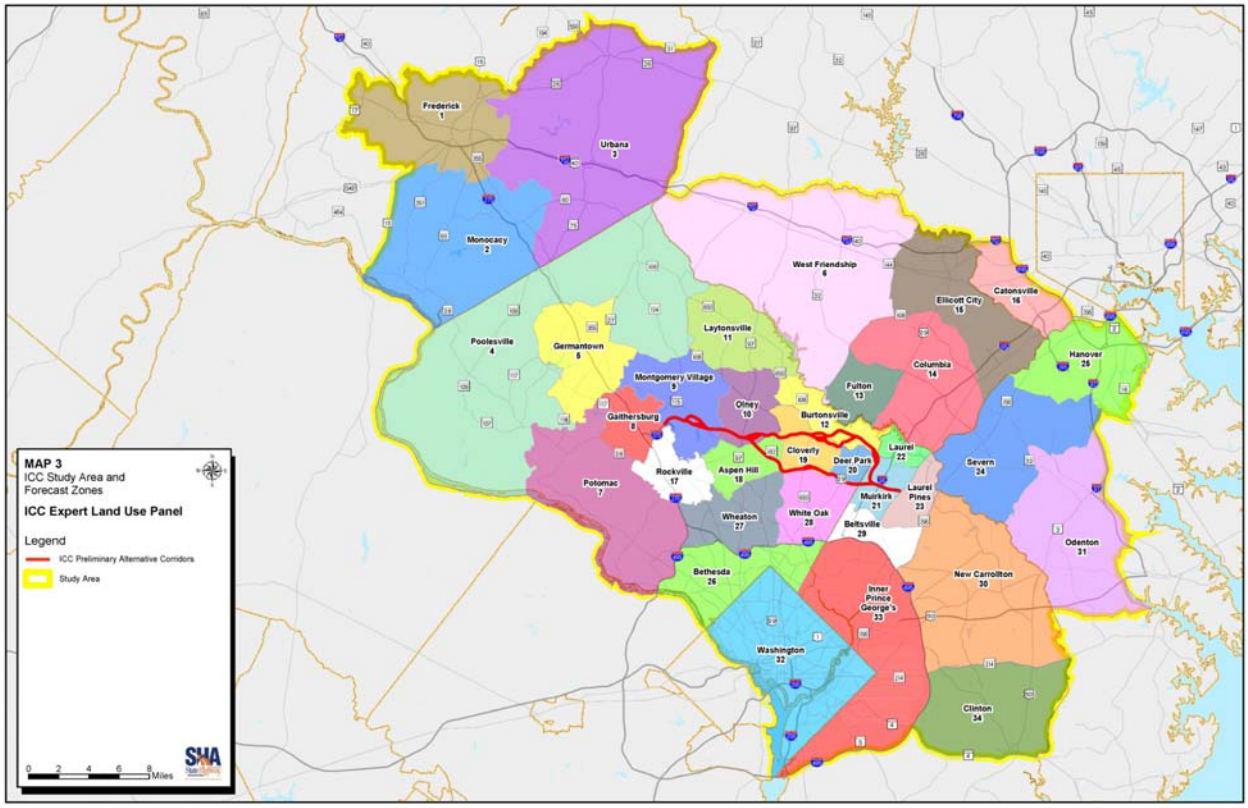

Figure 1. ICC Alignments and Forecast Zones

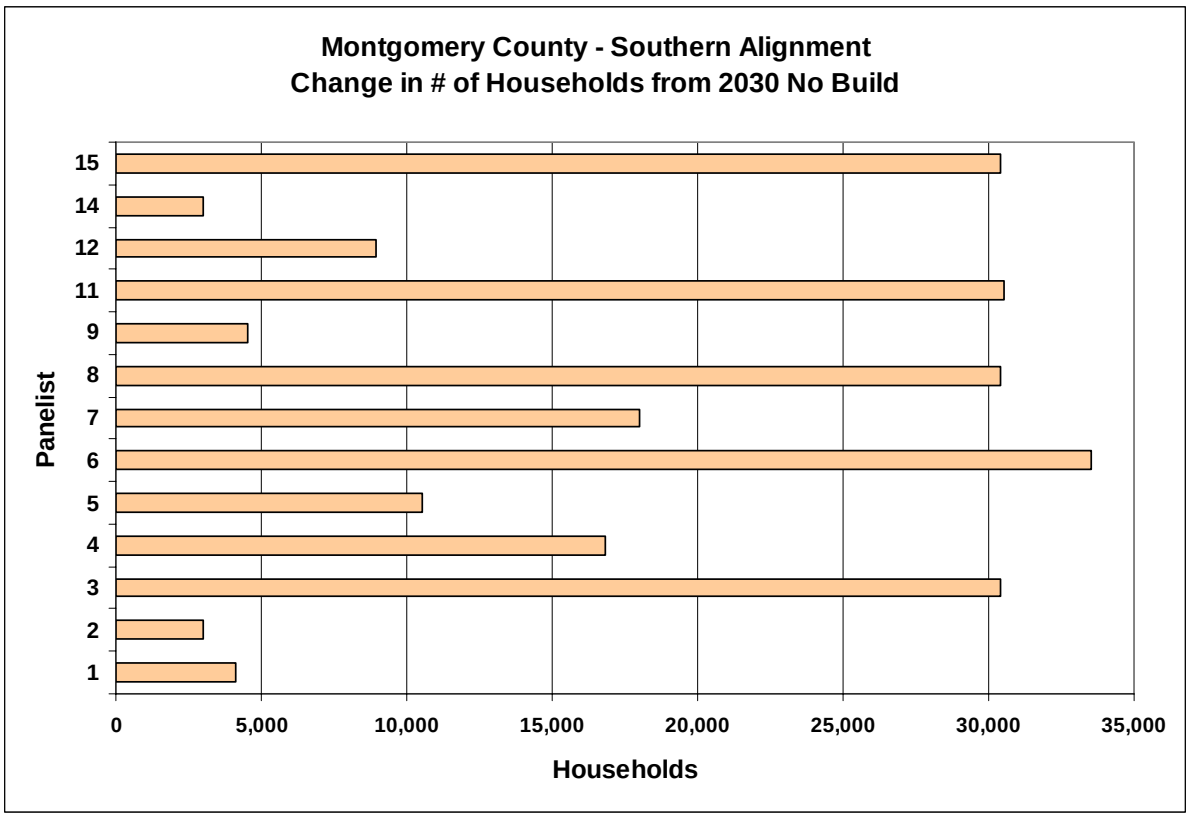

Figure 2. Individual Forecasts for Montgomery County—Household Growth for Southern Alignment Relative to 2030 No-Build Allocation (Panelists 3, 8, and 15 have modeled results)

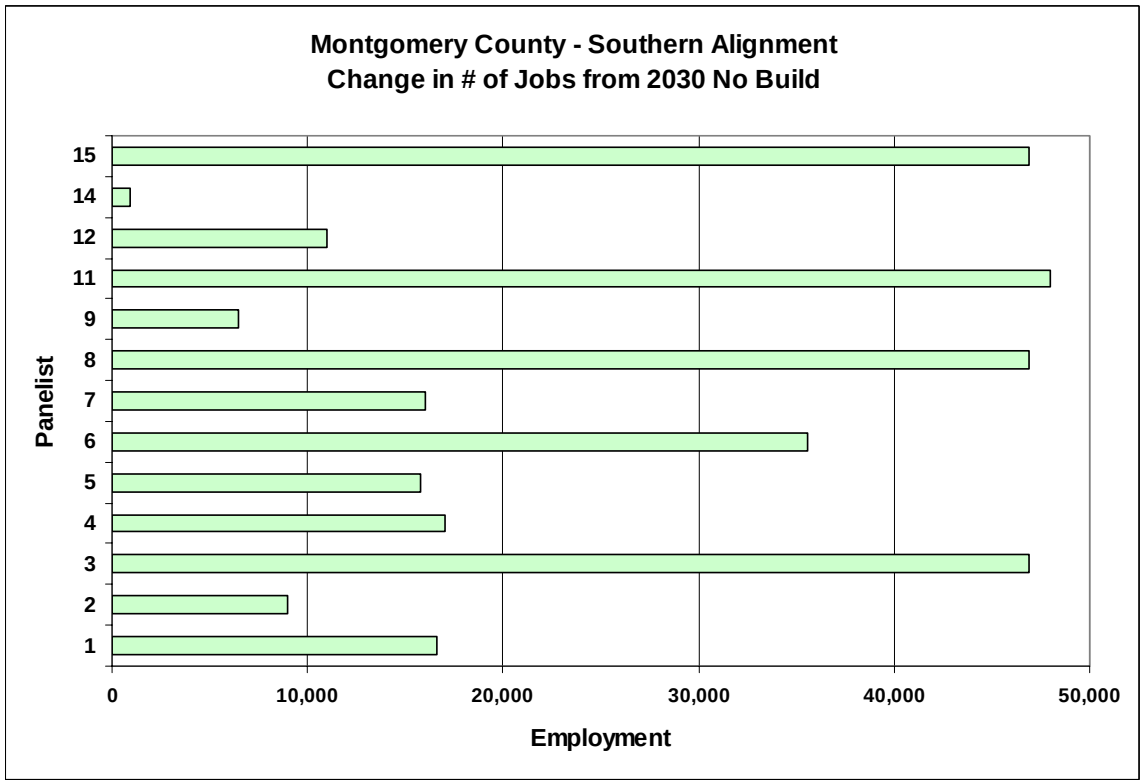

Figure 3. Individual Forecasts for Montgomery County—Job Growth for Southern Alignment Relative to 2030 No-Build Allocation (Panelists 3, 8, and 15 have modeled results)

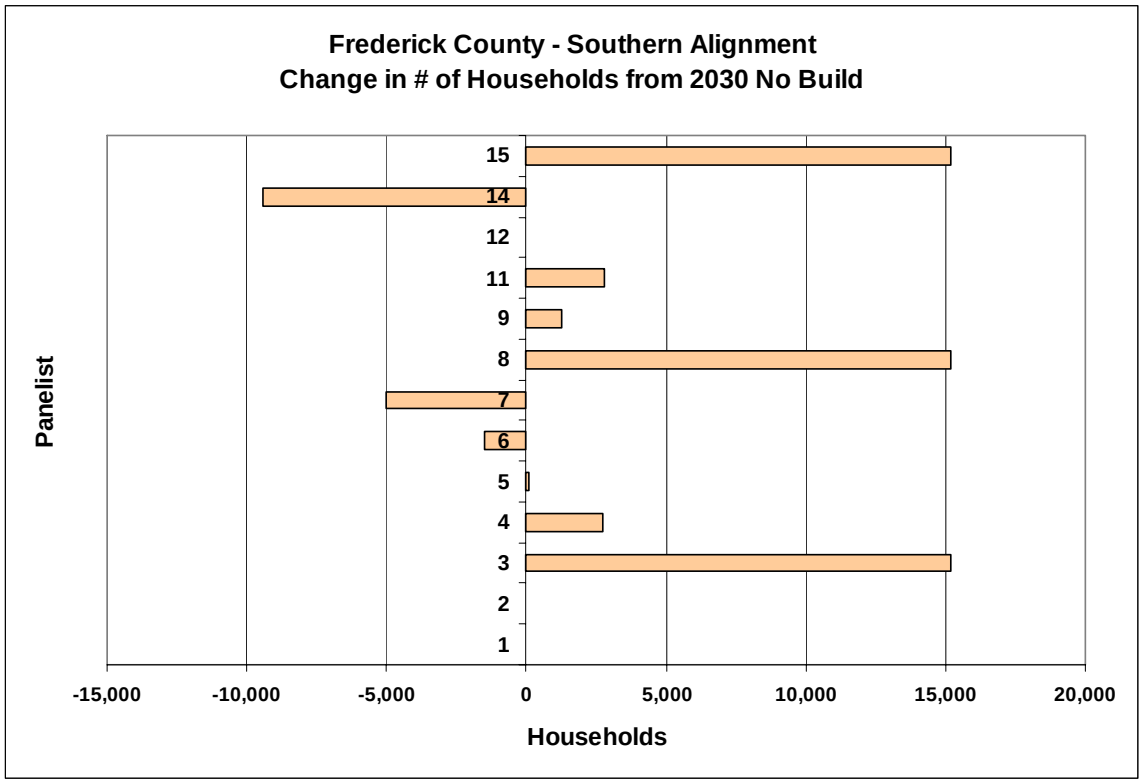

Figure 4. Individual Forecasts for Frederick County—Household Growth for Southern Alignment Relative to 2030 No-Build Allocation (Panelists 3, 8, and 15 have modeled results)

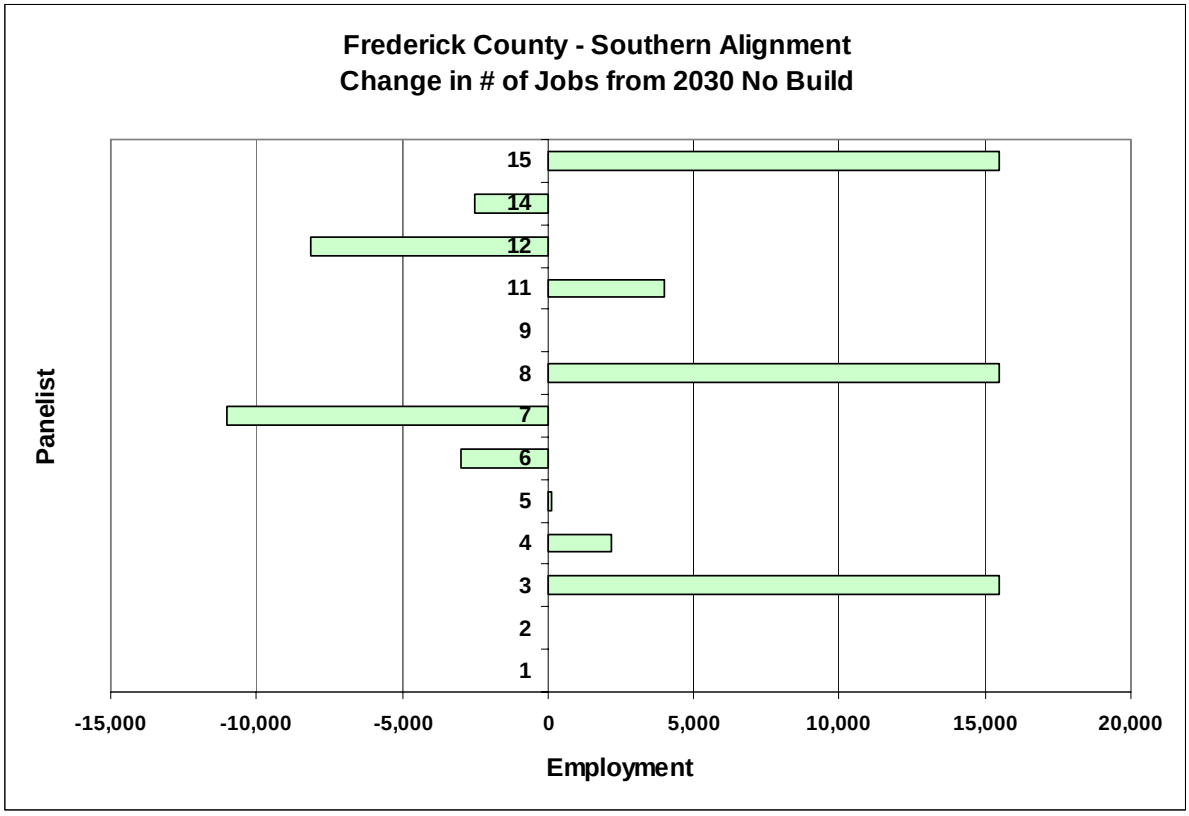

Figure 5. Individual Forecasts for Frederick County—Job Growth for Southern Alignment Relative to 2030 No-Build Allocation (Panelists 3, 8, and 15 have modeled results)

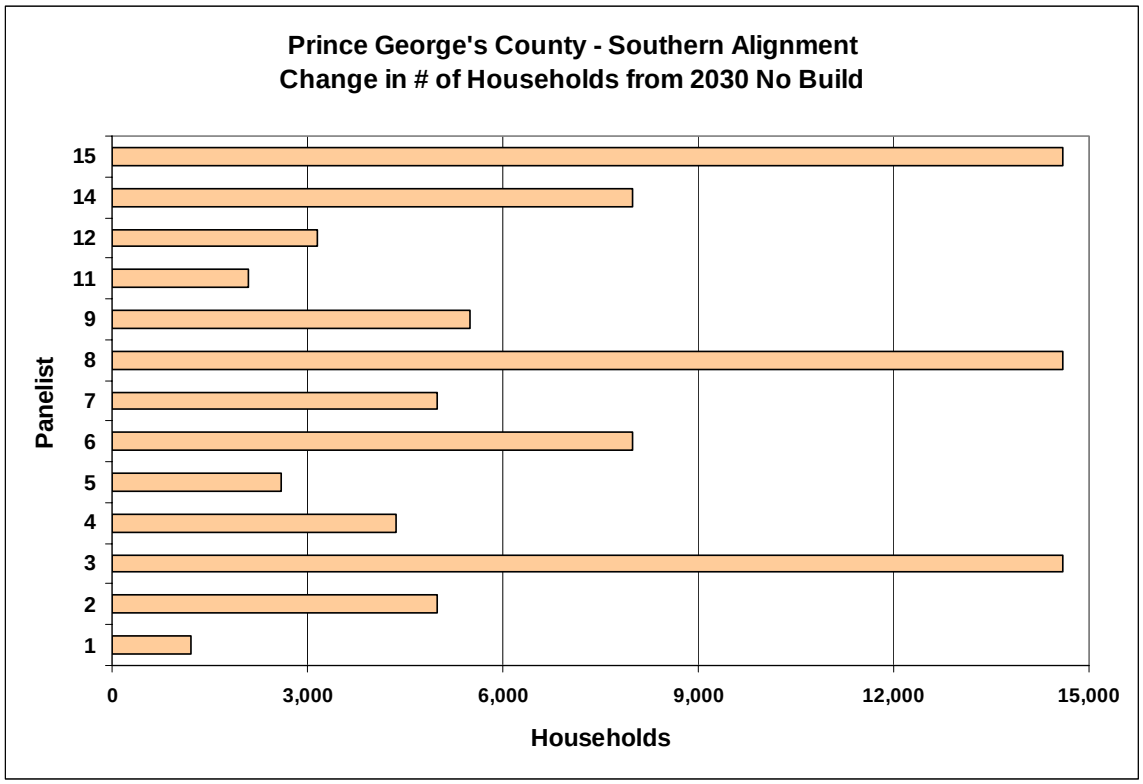

Figure 6. Individual Forecasts for Prince George's County—Household Growth for Southern Alignment Relative to 2030 No-Build Allocation (Panelists 3, 8, and 15 have modeled results)

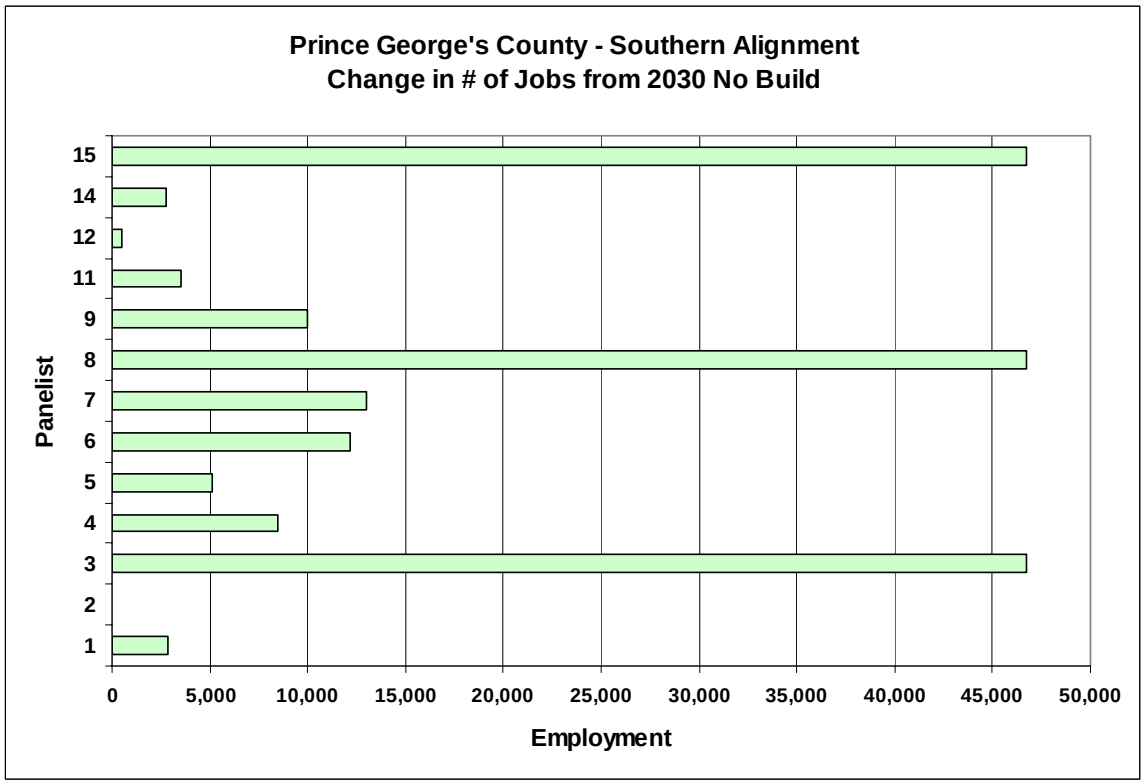

Figure 7. Individual Forecasts for Prince George's County—Job Growth for Southern Alignment Relative to 2030 No-Build Allocation (Panelists 3, 8, and 15 have modeled results)

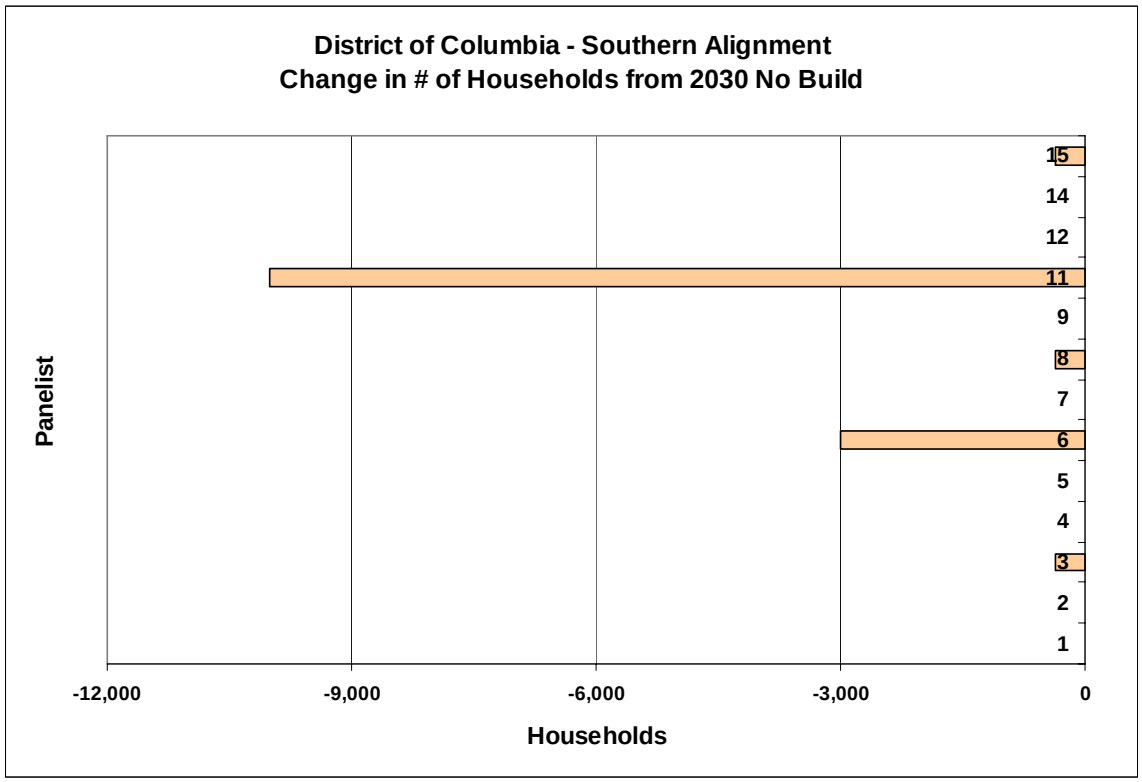

Figure 8. Individual Forecasts for the District of Columbia—Household Growth for Southern Alignment Relative to 2030 No-Build Allocation (Panelists 3, 8, and 15 have modeled results)

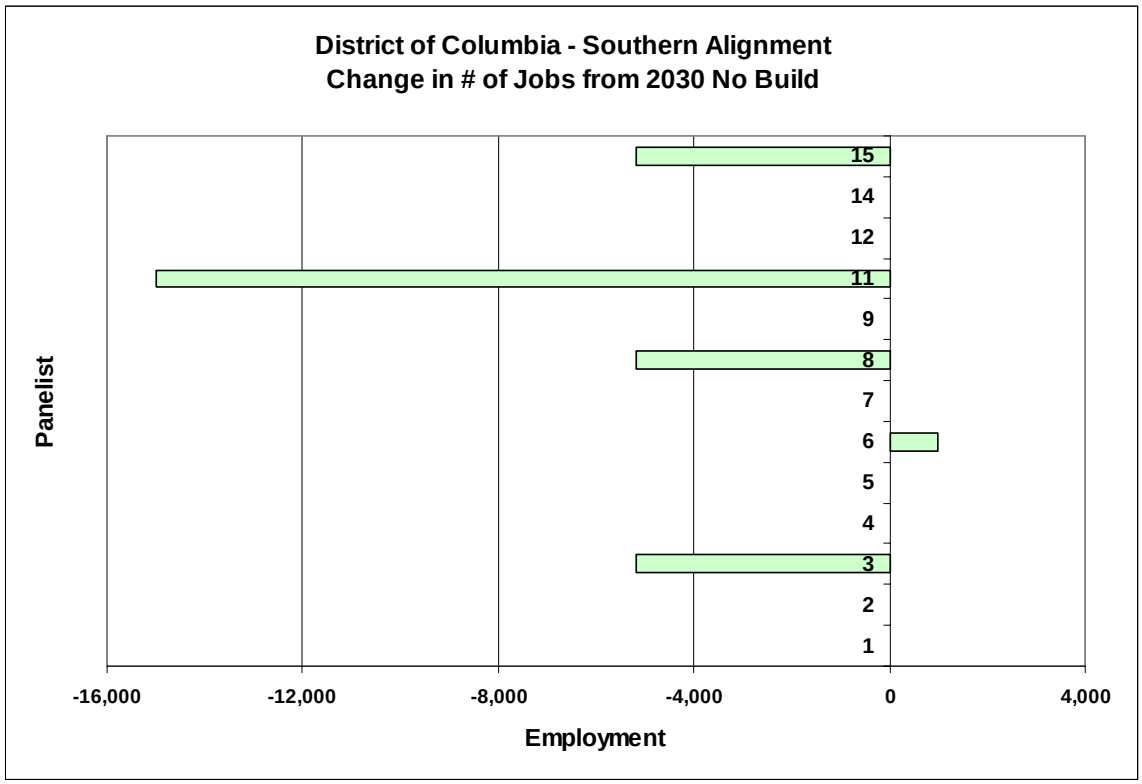

Figure 9. Individual Forecasts for the District of Columbia—Job Growth for Southern Alignment Relative to 2030 No-Build Allocation (Panelists 3, 8, and 15 have modeled results)

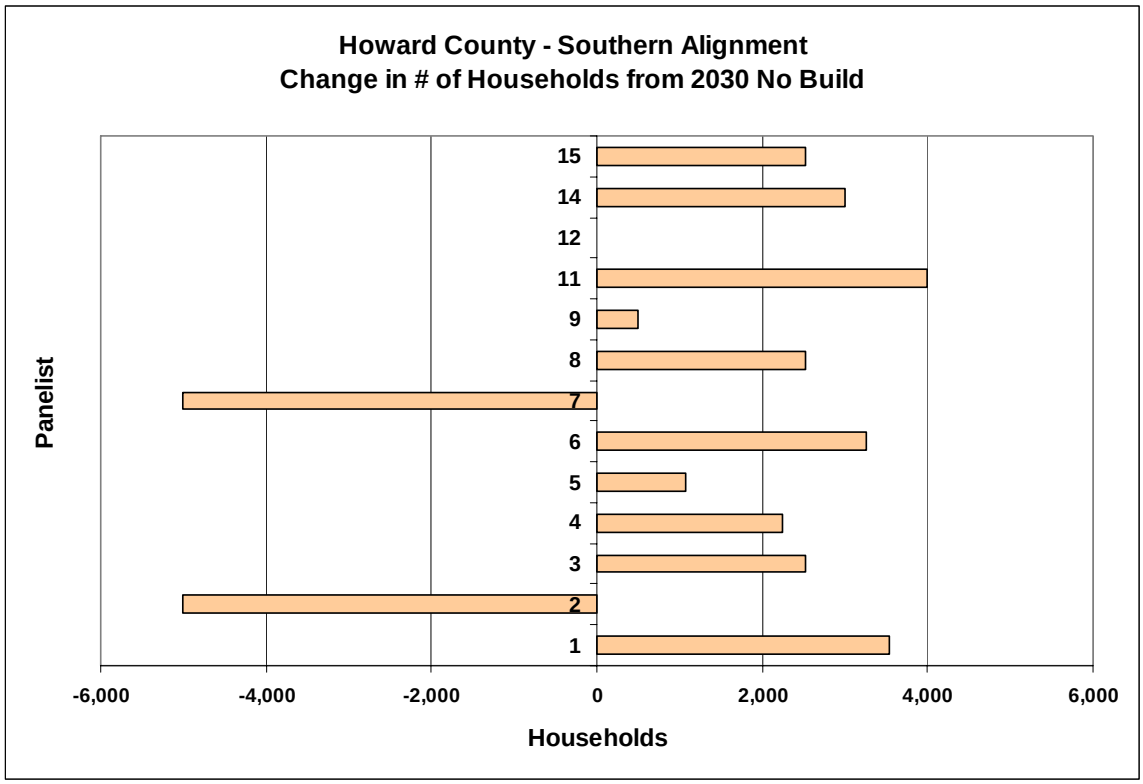

Figure 10. Individual Forecasts for Howard County—Household Growth for Southern Alignment Relative to 2030 No-Build Allocation (Panelists 3, 8, and 15 have modeled results)

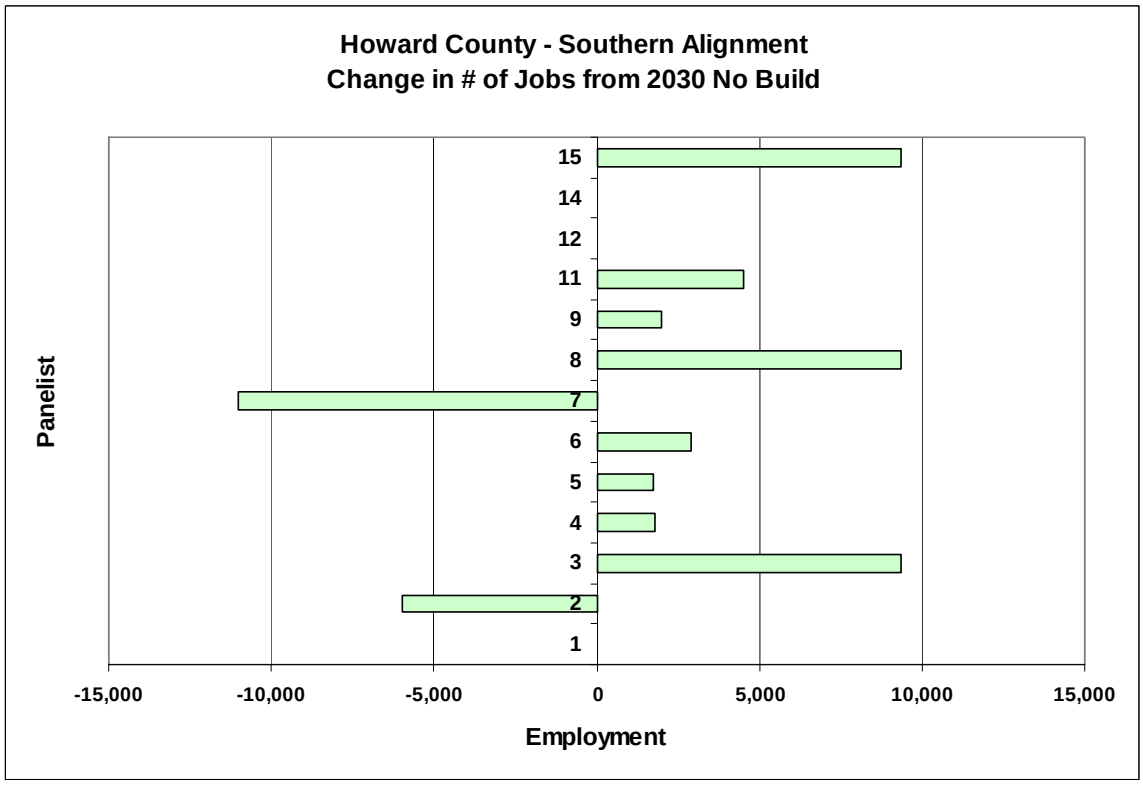

Figure 11. Individual Forecasts for Howard County—Job Growth for Southern Alignment Relative to 2030 No-Build Allocation (Panelists 3, 8, and 15 have modeled results)

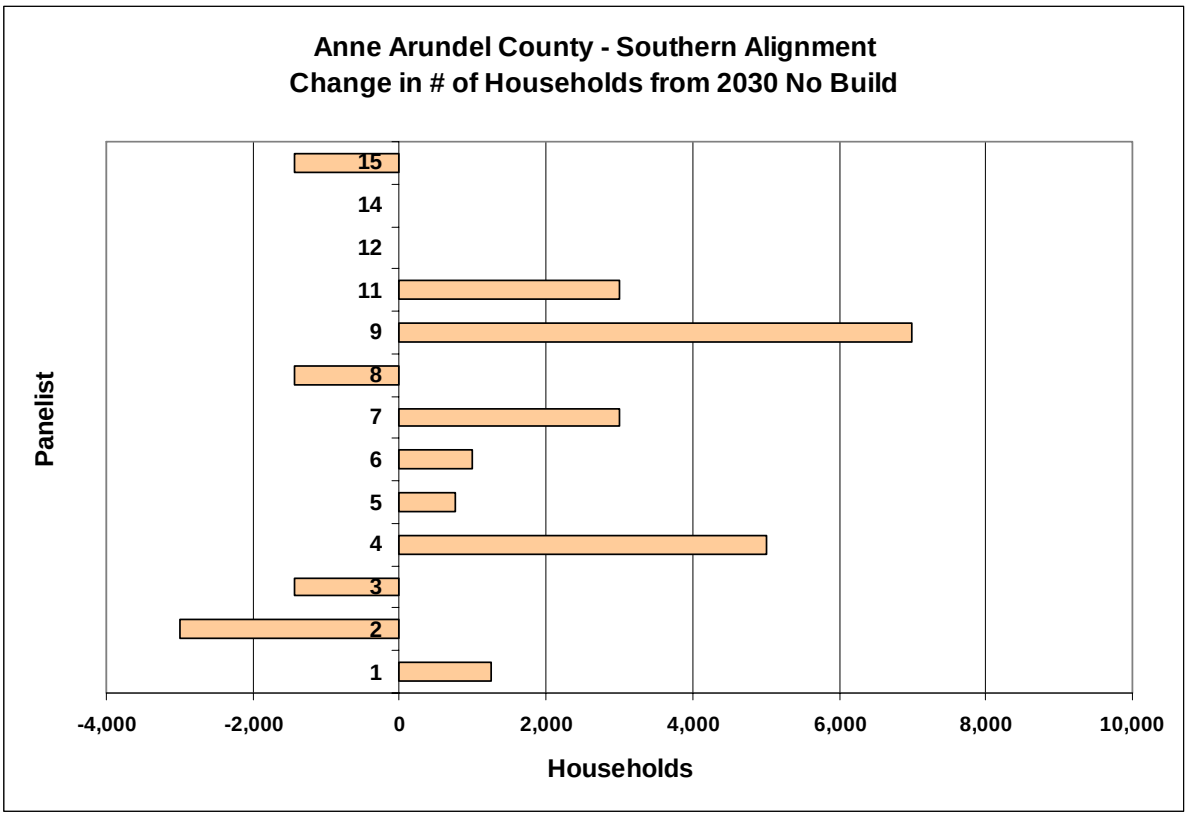

Figure 12. Individual Forecasts for Anne Arundel County—Household Growth for Southern Alignment Relative to 2030 No-Build Allocation (Panelists 3, 8, and 15 have modeled results)

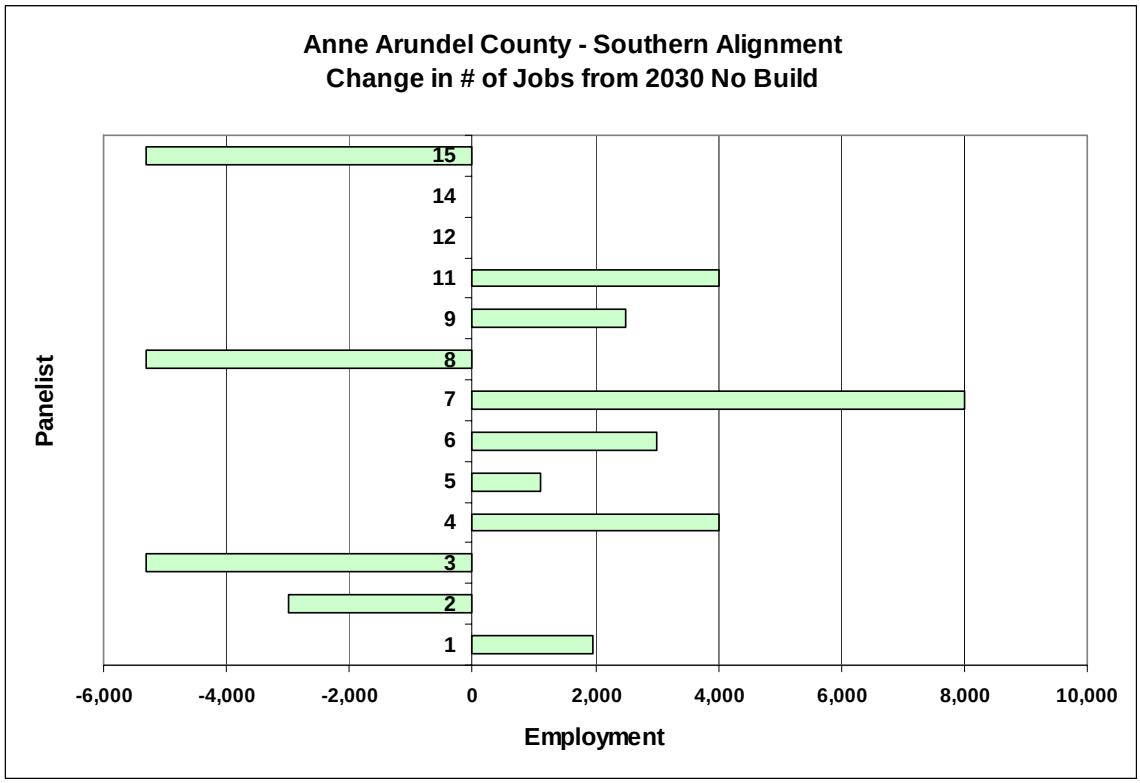

Figure 13. Individual Forecasts for Anne Arundel County—Job Growth for Southern Alignment Relative to 2030 No-Build Allocation (Panelists 3, 8, and 15 have modeled results)