M E M O R A N D U M

TO: Mayor and Council Members

FROM: Robert Goode, Assistant City Manager

DATE: April 6, 2018

SUBJECT: **2016 Bond Corridor Construction Program – Prioritization Model**

At the Council meeting on March 22, Council members asked about the scoring methodology utilized to rank the 34 unique investment packages. I have attached a detailed memo from our consultant who developed our ranking model. They created this model to ensure that our prioritization methodology aligns with the Council resolution that established the commitment to develop a *"Corridor Construction Program" in ways that prioritize: a) reduction in congestion; b) improved level of service and reduced delay at intersections for all modes of travel; c) connectivity, and improved effectiveness of transit operations within these corridors and throughout the system; and subject to the foregoing, also makes allowances for: i) preservation of existing affordable housing and local businesses on the corridors, and opportunities for development of new affordable housing along the corridors, including, but not limited to, the use of community land trusts, tax increment finance zones along corridors, homestead preservation zone tools, revisions to the S.M.A.R.T. Housing Program, and targeted investments on the corridors utilizing affordable housing bonds and the Housing Trust Fund; ii) geographic dispersion of funding; and iii) opportunities to facilitate increased supply of mixed-income housing".*

The attached memo is complex because the model itself is complex. Our intention is to share the deliberate thought process that went into the development of the computer model and even share the complexity of the mathematical structure used in the ranking system. You can dive into the meat of the equations if you choose since we have provided that background, but I also have attempted to give you a high level summary of the model below.

The Prioritization Model Approach

Every investment package—based on each corridor's short-, mid-, and long-term safety and mobility improvements—had to be compared to every other investment package to determine how well they align with the mobility priorities and considerations noted above. In other words, we have to determine how each package compared to the other 33 unique packages in the 2016 Mobility Bond universe of corridors eligible for construction funding. But we have many data points and resulting scores and we needed to develop a method that facilitates a fair comparison across packages that all vary in length, mobility scores, community considerations, costs, etc. Because of this, we normalized the scores using project length as described below.

Project Length - To facilitate a fair comparison, the data values (how each package scored on each mobility priority noted above) were divided by the length of the corridor in each package. For example, let's say that we have 8 great things that happen as a result of building Project A, which is 1 mile in length. In comparison, we also have 8 great things that happen as a result of building Project B, but this package is 2 miles in length. Project A's score is 8 great things/mile while project B's score is 4 great things/mile.

Now as you take into account all the metrics and the weighting to get each package's "overall score" it gets very complicated (see attachment), but this is the general idea.

Cost Effectiveness - To facilitate a fair comparison in regards to cost, each package's estimated cost was divided by the length of the corridor in each package. Thus, we developed a cost/mile similar to the great things/mile described above. Then to evaluate the cost-effectiveness of each package, each package's overall score was divided by the cost/mile. For example, if you have 8 great things that happen per mile on Project C and 8 great things happen per mile for Project D, but Project C costs $6 million/mile while Project D costs only $3 million/mile then Project D gives us the same *bang* that Project C does but for half the *bucks*.

Final Ranking - Packages that have high overall scores and are less costly were highly prioritized while those that are relatively more costly or provide fewer benefits, when compared to other investment packages as mentioned above, will fall lower on the prioritization scale.

We hope this helps answer some of your questions. Please feel free to contact me or Mike Trimble if you have any additional questions.

xc: Spencer Cronk, City Manager
Mike Trimble, Director, Corridor Program Office
Rob Spillar, Director, Austin Transportation Department

austin MOTION 2016 MOBILITY BOND

MEMO

DATE	3/21/2018
FROM	Marissa Birtz, Senior Economist, HDR & Pamela Yonkin, Principal Economist, HDR
SUBJECT	**Prioritization Model Approach**

MEMO

DISCUSSION

The program prioritization process employed the principles of multi-criteria analysis to assess recommendations from the nine Corridor Mobility Plans, which recommend short-, mid-, and long-term safety and mobility improvements. These recommendations were evaluated to determine how well they align with the priorities and considerations outlined in the 2016 Mobility Bond. This memo describes the methodology used in the prioritization process.

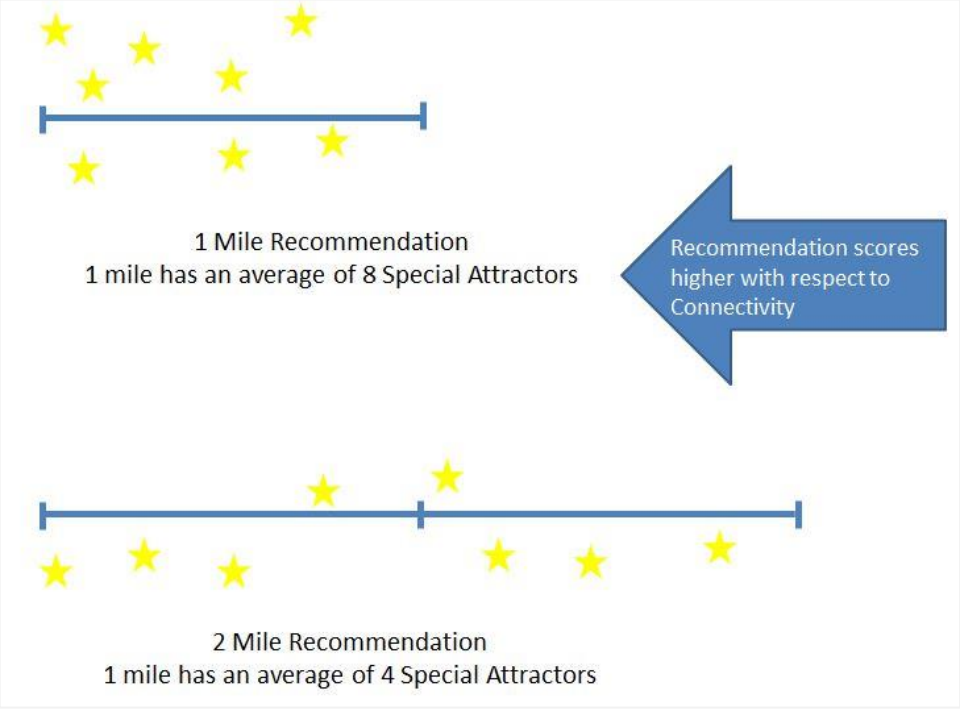
MOBILITY PRIORITY SCORING

The first step in the process was to score each recommendation based on each metric associated with the four Mobility Priorities outlined in the Contract With Voters:

1. Reduction in congestion;
2. Improved level-of-service for all modes of travel;
3. Connectivity; and
4. Improved effectiveness of transit operations.

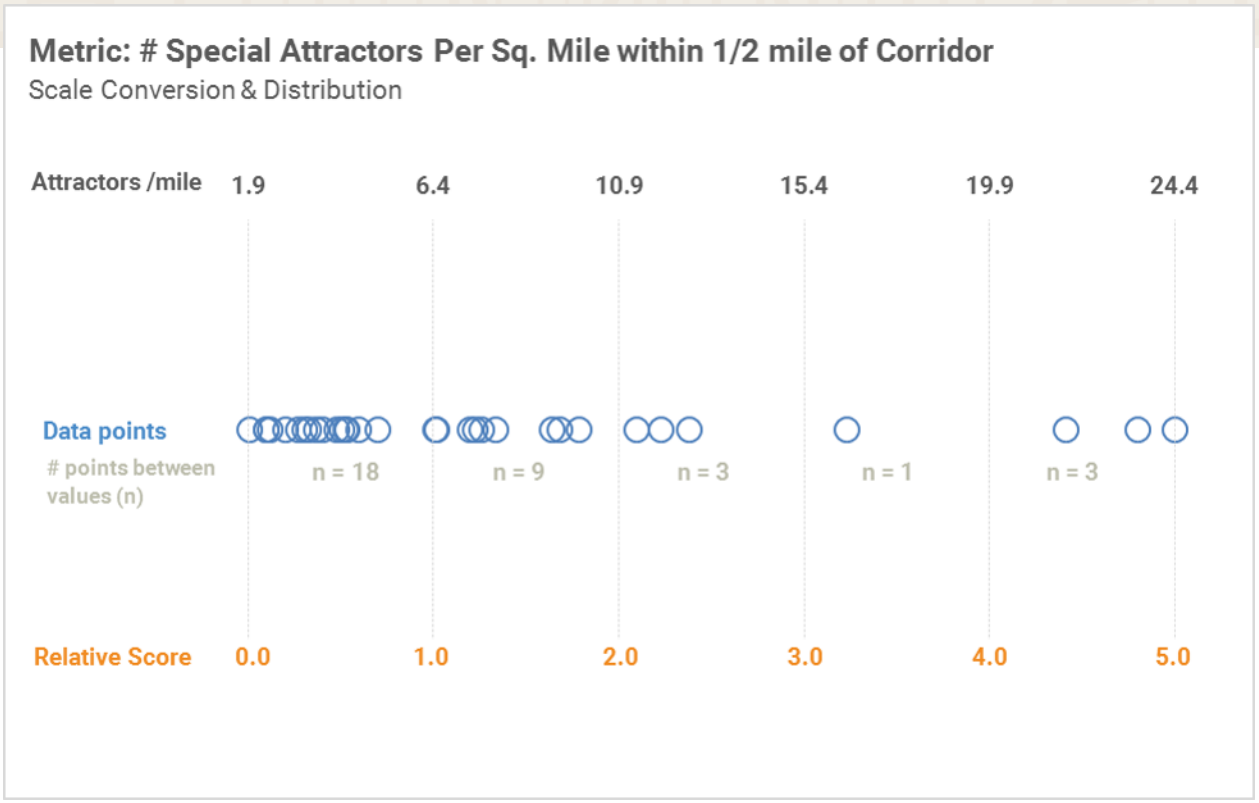
Data were gathered from a variety of sources, including the Vissim model, GIS/spatial data from the United States Census Bureau and the City of Austin Open Data Portal, preliminary designs from the recommendations in the Corridor Mobility Plans, quantitative analysis and existing studies.

To facilitate comparison, the metrics' data values were divided by the length (in miles) of the recommendation to provide a per unit value that can be compared across recommendations. The rationale for this adjustment is best expressed through an example. If the per mile cost of two recommendations was equal, but one recommendation was located in an area that has, on average, more special attractors per mile, that recommendation would be considered relatively more valuable from a connectivity perspective. It provides twice as many connection opportunities for the same per mile cost. This is visually depicted in the figure below.



Each metric has a specific scale to determine the magnitude of the improvement corresponding to any two reference points on the scale. It is assumed that a one-unit increase anywhere in the data range represents the same incremental difference as a one-unit change anywhere else within the data range (i.e., a linear relationship). Because this evaluation begins with a pre-defined set of options, end points of the scale are established using the highest and lowest value within the particular criteria. This is considered a target scale, which avoids making judgments about the extremes of the scale that may not be relevant or add value.[1] The figure below provides an example, showing the value for the number of special attractors per square mile within ½ mile of the corridor range from 1.9 attractors per square mile to 24.4 attractors per square mile. The other gray labels at the top of the figure represent intermediate values that divide the difference between the maximum and minimum values into five equally spaced groups. These values are specific to each metric and will vary in accordance with the specific range of observed data.

[1] Department for Communities and Local Government: London. *Multi-Criteria Analysis: A Manual*, January 2009. Chapter 5. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/7612/1132618.pdf



Values for the number of special attractors per square mile within ½ mile of the corridor for the remaining 32 recommendations fall between the minimum value of 1.9 and the maximum value of 24.4; each of the 34 recommendations is represented by a blue circle in the middle of the figure. For some metrics, several recommendations may have the same value. When this is the case, the circle appears darker.

The observed data are not evenly distributed, but are evaluated on a continuum relative to one another. Because of this uneven distribution, a note identifying the number of recommendations falling between two highlighted values are shown underneath the blue circles. The specific location of a point represents its actual value.

To compare across metrics, each of these values were converted to a scale of zero to five with zero corresponding to the lowest value in the range and five corresponding to the highest, shown in orange at the bottom of the example figure. Each data point was converted to a value on this continuous scale. Lower relative scores indicate that a recommendation does not support the goal or creates little or no measurable improvement; higher relative scores indicate that a recommendation is very likely to support the goal or has the greatest amount of improvement compared to the other recommendations. A relative score of five always indicates the most desirable impact, even if the actual value is a large negative number (for instance, change in emissions). No negative relative scores are given.

MOBILITY SCORE

After individual metrics were scored, they were combined to construct a Mobility Score. While the Mobility Priorities are explicitly listed in the Contract With Voters, there is no guidance related to the relevant weight of each priority. In the absence of guidance, interpretation of the Contract With Voters led to a decision to weight each Mobility Priority equally, with each of the four priorities accounting for 25 percent of the Mobility Score.

Additionally, within each priority, each metric has an equal weight, as calculated in the equations below. Note that there are four Mobility Priorities. As a result, each priority comprises ¼ of the Mobility Score.

MOBILITY SCORE

$$MobilityScore_i = w_1 s_{i1} + w_2 s_{i2} + \cdots + w_{14} s_{i14} = \sum_{j=1}^{14} w_j s_{ij}$$

$$where\ i = specific\ recommendation\ (1\ to\ 34)$$
$$j = metric\ (1\ to\ 14)$$
$$s_j = score\ on\ particular\ metric\ (continuous\ from\ 0\ to\ 5)$$
$$w_j = weight\ of\ each\ metric$$

WEIGHT

$$w_j = \left(\frac{1}{4}\right)\left(\frac{k}{j}\right)$$

$$where\ k = the\ mobility\ priority$$
$$j = number\ of\ metrics\ within\ the\ mobility\ priority$$

The Mobility Score equation can be described as the sum of each recommendation's score on a particular metric multiplied by the weight of that metric. This weighted Mobility Score reflects the relative potential for the recommendation to achieve the Mobility Priorities articulated in the 2016 Mobility Bond and the City's Contract With Voters.

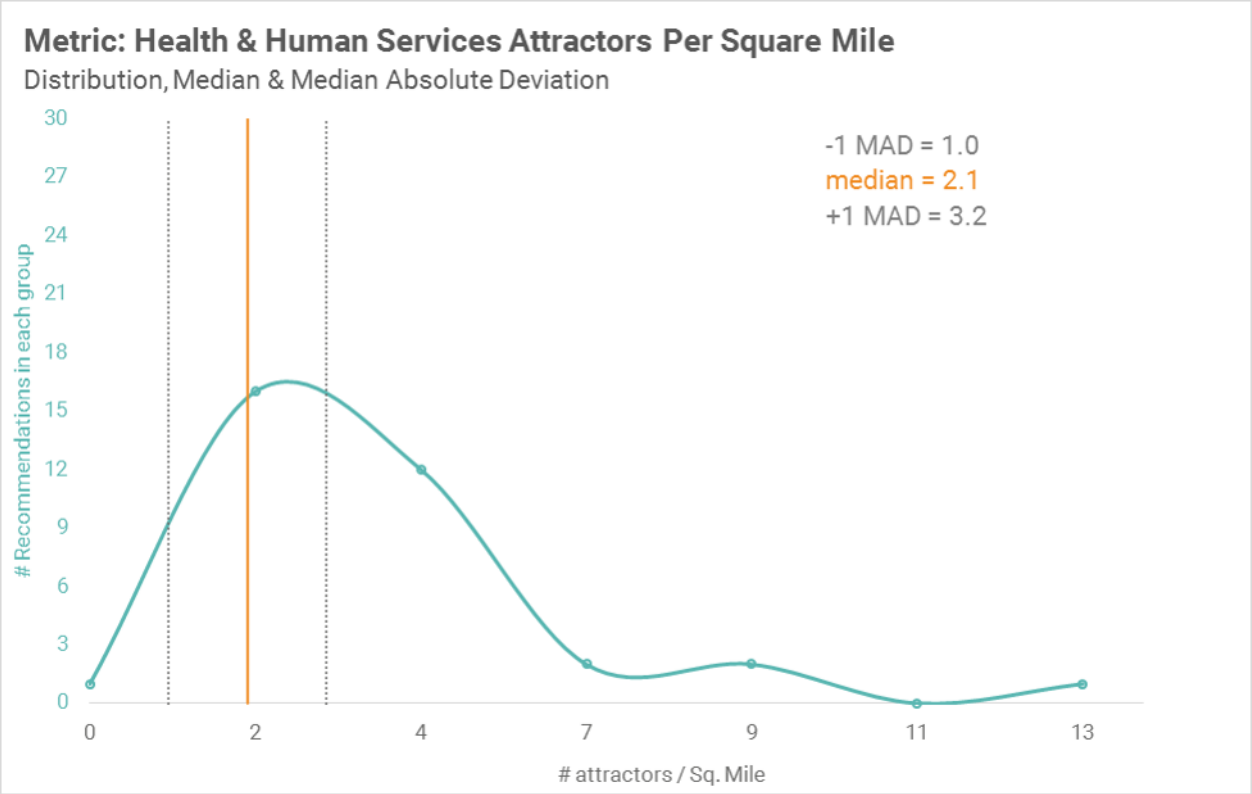
COMMUNITY CONSIDERATIONS RATING

In addition to the Mobility Priorities, the Contract With Voters also identified allowances and considerations that extend beyond the direct transportation improvements. The six Community Considerations serve two important purposes: informing the selection and sequencing of projects included in the Corridor Construction Program; and identifying areas that may require additional policies or efforts beyond the scope of this mobility improvements implementation. These Community Considerations are each important and they are also interrelated; some factors may support multiple considerations.

Many factors that emphasize livable, walkable, safe and transit-supportive corridors also promote healthy, equitable and Complete Communities. For this reason, and because Mobility Bond funding cannot be utilized to make changes directly addressing these considerations (such as subsidizing affordable housing), our rating approach was designed to create a gauge of relative opportunity based on existing and potential future conditions. As a result, our prioritization of Community Considerations utilizes a qualitative scale of a low, medium or high designation for each recommendations.

As an example, a corridor that has a significant number of existing affordable housing units may also be a corridor with substantial opportunity for economic development. A recommendation in this area would not rate well in terms of preservation of existing affordable housing, but would rate well in terms of opportunity for development of new affordable housing, if supportive policies were put in place. These interrelationships and competing priorities were important to consider when creating the prioritized list of recommendations.

Relevant data was gathered for metrics associated with each consideration. As with the Mobility Priorities, the data supporting each recommendation were compared only amongst the 34 options available. Values were rated as low, medium or high based on their relative values utilizing the median absolute deviation (MAD) to determine the range of ratings. An example of the distributions is shown below.



The MAD is a statistical assessment of how much values differ from the median value of a range. Due to the non-normal distribution of values in this assessment, this approach provides a better means of evaluation than the standard deviation. Values within one MAD above or below the median rated a 2 or 1, respectively, and were considered "medium." Those values that were more than one MAD higher than the median rated a 3 or "high" and those that were more than one MAD lower than the median were rated a 0 or "low" for that particular metric. Each of the considerations was composed of multiple metrics which were averaged to generate a score for that particular consideration. This value corresponds to one of the six components of the Community Considerations index and can be defined by the formula below.

$$r_{im} = \frac{1}{n} * \sum_{k=1}^{n} m_{ik}$$

$$where\ n = number\ of\ metrics;$$
$$m = community\ consideration\ rating;$$
$$k = individual\ metric;\ and$$
$$i = specific\ recommendation\ (1\ to\ 34)$$

COMMUNITY CONSIDERATIONS INDEX

Each component of each Community Consideration was counted equally. For example, the preservation of affordable housing included three different metrics. Each recommendation was rated on each metric and these ratings were aggregated. In this instance, if a recommendation rated "high" on each of the three metrics, it would receive 9 points (out of 9 available) and an overall rating of "high."

Each Community Consideration was rated relative to the others, utilizing the MAD approach to create the relevant scale for the overall consideration. A recommendation with a value more than one MAD above the median will rate "high." This creates a distribution relative to the actual ratings rather than relative to the available points, as shown in the equation below.

$$CCI_i = \frac{1}{6} * \sum_{m=1}^{6} r_{im}$$

$$\begin{aligned} where\ m &= community\ consideration\ (1\ to\ 6), \\ i &= specific\ recommendation\ (1\ to\ 34), and \\ r_{im} &= rating\ on\ specific\ consideration\ (discrete, 0\ to\ 3) \end{aligned}$$

The values for each of the six Community Considerations are then averaged to create a Community Considerations Index (CCI). This provides an assessment of how well a recommendation aligns with the various allowances as discussed in the Contract With Voters. The CCI is an average, rather than an aggregate, because of the overlapping and interrelated nature of so many of the components.

OVERALL SCORE

The Contract With Voters dictates that recommendations be prioritized based on how well they achieve the four Mobility Priorities while also considering and making allowances for the various Community Considerations.

The Contract With Voters does not explicitly dictate how to weight the Mobility Priorities relative to the Community Considerations. In the absence of explicit guidance, and based on interpretation of the Contract With Voters, it was decided to weight the Mobility Score as 60 percent of the Overall Score and the Community Considerations Index as 40 percent of the Overall Score, as defined below.

$$OverallScore_i = 0.6 * MobilityScore_i + 0.4 * CCI_i * \left(\frac{100}{3}\right)$$

Note that the Mobility Score is on a scale of 0 to 100 and the CCI is on a scale of 0 to 3. Prior to combining the Mobility Score and CCI, the CCI value is multiplied by (100/3) so that the Overall Score is out of 100 to simplify interpretation. The Overall Score is useful to evaluate how well each recommendation addresses the priorities articulated in the Contract With Voters but it does not take into consideration the project cost.

COST & COST-EFFECTIVENESS

Because recommendations differ in terms of length and scope, they will also differ in anticipated cost. As the 2016 Mobility Bond only provides funding for up to $482 million of improvements, it was important to also consider the relative project cost when prioritizing the recommendations.

To account for the different recommendation lengths and allow for comparisons, the estimated costs were divided by the proposed project distance to determine a cost per mile. It is important to note that the cost per mile will vary across recommendations because each recommendation contains different components and each corridor has differing existing conditions.

To evaluate the cost-effectiveness of each recommendation, the Overall Score is divided by the cost per mile. This will generate a value that reflects "points per million dollars per mile." This value indicates the cost-effectiveness of each recommendation, given the currently available information. Recommendations that achieve high Overall Scores and are less costly will be highly prioritized. Those recommendations that are either relatively more costly or provide fewer benefits will fall lower on the prioritization scale.