BOULDER CITY COUNCIL MEETING
MUNICIPAL BUILDING, 1777 BROADWAY
SPECIAL MEETING
Tuesday, June 15, 2015
6 PM

AGENDA

1. CALL TO ORDER AND ROLL CALL

2. MATTERS FROM CITY MANAGER

A. Request for **City Council input** on the **Guiding Principles for the pilot Form-Based Code (FBC) are in Boulder Junction** (prepared by CodaMetrics)

3. PUBLIC HEARINGS

A. Consideration of a motion to **approve Living Lab Phase II "rightsizing" transportation pilot projects, as part of the implementation of the Transportation Master Plan**

4. ADJOURNMENT

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CITY OF BOULDER
CITY COUNCIL AGENDA ITEM

MEETING DATE: June 15, 2015

AGENDA TITLE: Request for City Council input on the Guiding Principles for the pilot Form-Based Code (FBC) area in Boulder Junction (prepared by CodaMetrics).

PRESENTER/S
Jane S. Brautigam, City Manager
Tom Carr, City Attorney
David Driskell, Executive Director of Community Planning and Sustainability
Susan Richstone, Deputy Director of Community Planning and Sustainability
Charles Ferro, Development Review Manager
Sam Assefa, Senior Urban Designer
Karl Guiler, Senior Planner/Code Amendment Specialist

EXECUTIVE SUMMARY
City Council received an update on the Form-Based Code (FBC) project on May 26, 2015. The purpose of this item is to receive feedback from council on the draft Guiding Principles for the pilot FBC area in Boulder Junction (**Attachment A** prepared by CodaMetrics). The council should note that the Guiding Principles have been updated slightly since the draft was sent to council on May 26th. The changes include a new overview section at the beginning and new sections on building proportion and length at the end. Questions for council:

1. Does the City Council have any feedback on the Draft FBC Guiding Principles?

2. Does the City Council have any additional items that should be included in the Guiding Principles?

Leslie Oberholtzer of CodaMetrics will also be attending the meeting on June 15, 2015 to answer any questions.

BOARD AND COMMISSION FEEDBACK

Planning Board

Planning Board reviewed the draft guiding principles and discussed the FBC pilot project at its June 4th meeting. Overall, the board was supportive of the draft guiding principles. Most of the discussion involved how the review process might work (e.g., Site Review or not), whether or not discretion should be reduced if prescriptive rules are met, what the level of specificity in the rules should be and whether there is support to eliminate traditional development metrics like floor area ratio (FAR) and dwelling units per acre (du's/ac). The board provided helpful feedback and while there were some divergent opinions, the board sounded excited and open minded about the pilot. The Planning Board discussion can be viewed here.

FBC Working Group

The FBC Working Group has met on two occasions with the latter meeting focusing on the draft guiding principles. Overall, the group supported the content and direction of the guiding principles, but felt that some example architectural designs should be formulated based on the draft FBC to see what the outcomes might be (*Planning Board agreed with this suggestion and two board members offered their services to provide such examples*). Some of the group felt that public realm and streetscape issues should be emphasized within the document – perhaps by putting those issues first. The majority of the group felt that there should be more discussion related to protecting site lines/view corridors towards the Flatirons. The group also felt that the Depot building should be respected and honored, although there were degrees of opinion related to how architecture and building forms should reference the building. One member expressed concern about allowing "towers" at key locations as sometimes emphasized architecture at corners, for instance, isn't always successful. Others felt that unique architecture or unique site design, including but not limited to towers and alternatively chamfered corners or recessed courtyards at corners, can create the same effect of visual interest or architectural variation. There was a sense from the group that not all buildings should be built up to the 55 foot height limit and that a diversity of building heights should be an outcome. It was stated that taller retail first floors should not preclude a five-story building. Some members felt that the charter restricted height should not necessarily be taken for a given if a diversity of heights is to be achieved.

Following a walking tour of Boulder Junction, much of the discussion focused on general design comments of what should be included in the FBC, including the following observations:

- Appropriate building rhythm/proportion are important.
- Stark, windowless walls should be prohibited – may require coordination with building code officials.
- Greater levels of permeability – that are public accessible– should be created by requiring additional pedestrian pathways (like the Walnut Street cut-through) for enhanced connectivity and to mitigate the impacts of large block-long buildings. The pedestrian experience is important between buildings.

- Indents on the façade of buildings do not effectively reduce mass or create the perception of multiple buildings.
- Buildings are over-articulated and look too busy and include too many material changes.
- Materials should be high quality, should not change at building corners or on the same horizontal building façade element, and should not be overused.
- Some materials on buildings are already showing signs of wear and tear (e.g., cracks, buckling).
- Building entries should be more obvious and not just be to individual units.
- Flush mounted, vinyl windows look cheap.
- Wood under balconies looks cheap and will not weather well.
- Mediocrity should not be accepted – we should plan for long-term buildings.
- The FBC should be driven by quality of public spaces and amenities.
- Streets should be more narrow and human-scaled.

Transportation Advisory Board and Boulder Junction Access District
While the guiding principles were not a primary topic of discussion, staff has presented to both TAB and BJAD in recent weeks on the progress of the FBC pilot project. TAB and BJAD were also involved the joint board workshop with CodaMetrics.

BACKGROUND
Form-Based Code pilot project
As part of the Design Excellence Initiative, the city is piloting a Form-Based Code (FBC) in Boulder Junction, defined as the area within the adopted Transit Village Area Plan. This area was selected on a recommendation by Victor Dover of Dover/Kohl Partners based on his work on the Design Excellence Initiative last winter. That work culminated with a recommendation to City Council last January for piloting a FBC for a limited area such as Boulder Junction where there is already a consensus on land use and urban design policy articulated in an adopted Transit Village Area Plan.

As requested by City Council, the FBC project was commenced in April of this year and is anticipated to be a six-month process. The project will involve outreach to the community and coordination with review boards (i.e., Planning Board, Transportation Advisory Board, Design Advisory Board and Boulder Junction Access District) and council about desired building designs and forms that would inform the final pilot FBC. A working group composed of representatives of above referenced boards will also inform the pilot FBC. The purpose and composition of the group is found in **Attachment B**.

The overall purpose of considering FBC as a new tool for Boulder is to address design quality and provide more predictability on development review issues recently articulated through community, board and council conversations, as summarized in the January 20, 2015 memo from Dover Kohl (link to memo). The City of Boulder's Community Planning & Sustainability Department (CP&S) is leading the effort in collaboration with other city departments and two consultant teams: Dover Kohl and Partners and CodaMetrics. Dover Kohl and Partners will assist in the broad, citywide Design

Excellence discussions that would ultimately inform changes to the land use code, and CodaMetrics will assist in preparation of the pilot FBC.

Completion of the pilot FBC project for Boulder Junction is targeted for October 2015 (i.e., six months). A work plan has been developed which specifies the scheduled meetings and deliverables at each phase of the process. The work plan can be viewed here. For more information on the FBC project, including the roles of the consultants, the desired outcomes, and how projects in Boulder Junction will be reviewed during this process, please see the attached FAQ document in **Attachment C**.

If adopted, the FBC pilot would apply to the Phase I area of Boulder Junction. Victor Dover's recommendation was that it be tested in a small geographic area where an adopted vision is already established. Staff understands that this is challenging considering that there are already development projects in the review pipeline within the area that may be acted upon prior to adoption of the FBC. Staff and CodaMetrics are currently working with applicants of the S*park, Reve and The Commons projects in a two-way conversation of how the projects could be informed by the progress of the FBC. While the projects may not end up 100 percent consistent with the final FBC pilot, the hope is that they will adopt and address design elements within their projects to reflect the evolution of the FBC. It is important to note that the city is embarking on what could be a longer process of determining whether FBC is appropriate for Boulder to achieve better design outcomes. Boulder Junction is an opportunity to test the FBC tool itself as well as the process. If successful, staff anticipates more robust processes in the future if FBC is applied elsewhere (e.g., Phase II Boulder Junction, Downtown, North Boulder etc.). This is further discussed in the attached FAQ document (**Attachment C**).

May 2015 events

Events related to the FBC pilot commenced in the week of May 11th and included a joint meeting of Planning Board, Boulder Design Advisory Board (BJAD), Transportation Advisory Board (TAB) and the Boulder Junction Access District on Thursday, May 14th. At the May 14th board workshop, CodaMetrics lead a discussion with board members on desired and undesired design elements that would help inform what the FBC covers and the types of prescriptive standards to achieve the desirable elements that may be incorporated into the draft FBC.

On May 15th, Dover Kohl and Partners presented to the public, "Form-Based Code 101", which summarized what form-based codes are, the benefits of a form-based code for the Boulder Junction area, how it might be useful elsewhere in Boulder, as well as some of the limitations of form-based codes. The event also included a question and answers session that can be viewed at the link above.

Lastly, CodaMetrics held a community workshop open to the greater public on Saturday, May 16th at the Hotel Boulderado. The event was attended by roughly 30 persons and involved lively discussion about design and what would be appropriate in the Boulder Junction area. While there were expressions of varying architectural taste, there were also

common themes of agreement. A summary of the joint boards and community workshop is attached in **Attachment D**.

City Council was briefed on the subject on May 26th and Planning Board reviewed the guiding principles on June 4th. The board's input is included in 'Board and Commission feedback' on page 2.

ANALYSIS

Guiding Principles for Excellent Design to inform the pilot FBC area in Boulder Junction

CodaMetrics has been contracted with the city as part of the broader Design Excellence Initiative to draft the pilot FBC for the Boulder Junction area. The first deliverable of this six-month endeavor is to prepare a document of Guiding Principles that would be based on community feedback on design and would ultimately inform the final draft FBC for Boulder Junction. The document is also important because there are several projects already in the review pipeline in Boulder Junction that can help inform the development of the FBC and also be informed by the direction of the FBC itself. For a broader explanation for how these reviews would work, please see **Attachment C**.

Attachment A contains CodaMetric's document that Guiding Principles for the FBC area. Given the tight turnaround since the events of May 14-16th, it is still a working draft but has been updated following input from Planning Board and the working group to its current state. Staff finds that many of the principle design issues expressed at the workshops and stakeholder meetings are well captured. Before finalizing the principles to inform the draft FBC, staff is looking to get feedback from the City Council.

Next Steps

The guiding principles will assist in the formulation of the draft FBC and inform applicants that have project in the pipeline in the Boulder Junction area. The FBC staff team will continue working with CodaMetrics on incorporating the input received through the community outreach and board communications and determine the content and structure of the FBC.

CodaMetrics is planning to return to Boulder in July to hold a Code Workshop with the community where a draft FBC will be presented for feedback with respect to its structure and table of contents as informed by the guiding principles. A joint board meeting of the Planning Board, Boulder Design Advisory Board, Transportation Advisory Board and Boulder Junction Access District is also scheduled for June 23rd. A study session with City Council to review a draft FBC is set for August 11, 2015.

ATTACHMENTS

A. Draft FBC Guiding Principles
B. Boulder Junction Form-Based Code (FBC) Pilot Working Group
C. FAQ document on FBC pilot
D. Summary of Joint Board and Community Workshops
E. Public Comment

BOULDER JUNCTION:
PILOT FORM-BASED CODE
GUIDING PRINCIPLES

JUNE 8, 2015

CODAMETRICS CUNINGHAM GROUP

1: OVERVIEW

Simple, Honest, Human Scaled

Boulder is, by many measures, a desirable place to live work and visit. Strong job growth, a growing University, access to outdoor recreation, a thriving arts and culture scene, and picturesque natural and built environments combine to create a place where many want to be and to invest. As a result, the City is in the middle of a building boom.

Despite having policies that encourage compact infill development, the recent pace of development has been concerning to the community. Whereas there is a general commitment to and agreement with Smart Growth policies, the community has not reacted universally in favor of much of the larger residential and mixed use buildings in town. Agreement with policy (location and density) is not necessarily agreement with the built results.

The City was initially built on a tight urban grid with narrow lots. Generally residents and visitors react favorably to downtown Boulder, where this tight urban fabric is still intact. The physical DNA of downtown has allowed it to evolve incrementally – resulting in a walkable, bikeable, colorful, and constantly changing place. In recent years, the building boom has resulted in several large, block-long buildings that have been found to be unsuccessful at appearing human-scaled with their overly complicated and massive facades -- many of which were designed in attemps to reduce mass and scale and create the apearance of multiple buildings.

Such buildings, if taller than two stories, have been subject to complicated and somewhat arbitrary reviews. The review process addresses many issues, but the primary intent has been to break down the scale of larger buildings so as to replicate the beloved scale of Pearl Street and Downtown.

Whereas the intent of achieving humane architecture by reducing its scale is not misdirected, most parties would agree that the end products have been mixed. In many cases it has created overly complicated buildings that are not becoming of the quality that Boulder expects. The pendulum swung too far.

Our interviews, discussions, and Image Preference Surveys indicated a clear desire to design buildings that are simple, honest, and human scaled.

These terms are subjective but by exploring what is meant by these terms, we can develop metrics and a code that move the next generation of buildings in Boulder toward an architectural ensemble that better reflects the aspirations and expectations of residents in Boulder.

SIMPLE

- Fewer Materials
- Fewer Articulations
- Fewer unique elements
- More repetitions and regularity
- Simple hierarchy

Ways in which these objectives can be achieved in a zoning code:

To ensure simpler buildings, the code can address key issues related to building material, façade expression, and massing. For example, the code can specify the maximum number of materials allowed on a building or require that one dominant material cover a certain percentage of the principle façade. Code could also require façade expression lines (such as those indicating the top, middle, or bottom of a building) or indicate that buildings longer than a certain length must have a principle massing.

This building can be considered simple because: the palette is limited to three materials, there are only two articulations, it uses two simple additional elements (awning and balconies), and regular windows are repeated in a simple pattern.

This building received high marks on the survey. The palette is limited to one material, there is only one articulation, the windows, awnings, and decorative details repeat, and the corner tower provides a simple hierarchy.

This building is simple because the palette is limited to two or three materials and there is a regularity to the multiple repeating elements and forms.

HONEST

- Clear expression of uses within the building – especially the ground floor;
- Clear indication of main entrances to upper floors
- Honest structural expressions
- Honest uses of materials
- Buildings that can be considered "contemporary" or current in some ways (building technology, aesthetics, etc)
- No need to make a larger building look like a series of turn of the century buildings

Ways in which these objectives can be achieved in a zoning code

To ensure more honest buildings, the code can address key issues related to building entrances, massing, and façades. For example, the code can require first floor expression lines or façade compositions that reflect the uses inside the building

This building received high marks on the survey. It is honest because there is a clear differentiation of the uses between the floors, the entrances are clearly indicated, and one can easily understand the building structure by its form.

This building also received high marks on the survey. It is honest because the entrances are clearly indicated and one can easily understand the building structure and access by its form and elements.

This building is honest because there is a clear differentiation of the uses between the floors, the entrances are clearly indicated, and one can easily understand the building structure by its form.

HUMAN SCALED

- Tactile materials at the ground floor
- Varied experience at the ground floor
- Massing that allows light and sun penetration to sidewalks and public spaces
- Façade and massing compositions that follow basic rules of proportions
- Comfortable public places to gather and to rest
- Marking the corner with height instead of void
- Opportunities for personalization
- Clear transitions between public and private spaces
- Variability in height

Ways in which these objectives can be achieved in a zoning code:

To ensure more buildings are human-scaled and comfortable, the code can address key issues related to the relationship of the building to the ground floor environment (sidewalk), materials, and massing. For example the code could require that building users or tenants are allowed to make use of the sidewalk or patio space. Building materials on the first floor could be deemed acceptable or unacceptable based on their tactileness. Buildings longer than a certain length may be required to follow certain massing articulation to create more comfortable proportions.

This building is human-scaled and comfortable because the porch not only provides a clear transition between public and private space but also allows for personalization.

This building is human-scaled and comfortable because its location and orientation allows light and air into a comfortable place for the public to gather and rest and the materials on the ground floor are tactile.

This building is human-scaled and comfortable because the materials at the ground floor are tactile and the façade and massing compositions follow basic rules of proportions.

2: POTENTIAL REGULATIONS

Building Form
Overall Building Siting

Draft Statement of Intent:

To define the location of the building on the site with reference to the sidewalk, provide an appropriate level of flexibility for the different frontage treatments, while maintaining the composition of the blockface and street space.

Potential Regulations:

- Set build-to zones/lines for each frontage type (storefront, stoop, porch, forecourt, etc. as appropriate), possibly set by location on Regulating Plan.
- Set percent of build-to zone occupied by building to establish enclosure of street space.
- Require that the building be located up to the corner, unless an open space type is permitted
- Locate allowable parking areas to the rear of the building. Allow any side yard parking for the interim, to be infilled later? (sometimes this parking is necessary for successful retail). Set by location on Regulating Plan.
- Define permitted locations for garage and driveway entrances, usually via designation of primary and secondary streets.
- Define specific no-or low-build locations for plazas, courtyards, views or access through the site. Locate these spaces on Regulating Plan or define by specific site parameters (view corridors, long blocks, access to trails).
- Establish limitations on building footprint/ length, apart from defining segments of façade differentiation? Specifically to increase permeability of sites, allow access through, to break up buildings to smaller scale along sidewalk, to read as decision points along the lines of the most walkable blocks (downtown blocks are 300x300) even though streets may not cut through.

Building Form
Overall Building Height

Draft Statement of Intent:

To guide the scale of the building, relate the height of the building to people, and provide variability in height, preserving low scale feel of Boulder while maximizing views of the mountains.

Potential Regulations:

- Establish requirements for minimum and maximum building heights by setting the heights in stories and not just overall height.
- Define a range of allowable heights for each story, measured from floor to floor. May set ground story heights based on frontages that may house uses such as retail, service, restaurants, or maker spaces.
- In certain locations, [carefully] require stepped-back floors above certain floors (use 3/5 proportions? No more than 2 floors?) to allow more sky and light? Set minimum and maximum range of depth for the step-back.
- Require variability in height, allowing taller heights at specific locations on the Regulating Plan to terminate a vista or add interest to/break up a façade. And allow generally for roof access/decks?
- Ground floor elevation to be set by building or frontage type. Within X' of average sidewalk grade for storefronts, elevated a minimum of X feet, maximum X feet for residential. Define "visible basement": requirements for transparency when basement is exposed X feet above average grade.

Facade Design

General Materials and Facade Design

Draft Statement of Intent:

To guide the design of the overall façade to result in a simple and appropriate mix and quality building materials, and a comfortable but interesting level of façade variety and articulation.

Potential Regulations:

- Set maximum façade segments with courtyards or entry courts define to break up long buildings?
  [*A typical block in downtown is about 300 x 300, with the alley division along the side streets (approx. 140 long buildings). Downtown block faces are rarely one building. Two Nine North is almost 400' along 30th, with three building sections (one 115', then 140', then 105', with two inset entrances about 20' wide each. Each segment is treated with the same material mix and lots of changes in planes. Hotel Boulderado is only 140' long; conference center is approx. 200' long.]*
- Set allowable materials palette of main background façade materials applied to the main planes of the building or building segments defined by Building Siting. High quality, natural materials (stone, brick, wood?, glass?) Set high percentage of façade to be main materials (80% of the façade). *Require façade details to break up the facades instead of variety of materials, to avoid the busy-ness? Allow for ground and upper stories to be a different background material to define the different portions of the façade?*
- Set palette of accent materials to be limited to details and not planes. In addition to main materials, allow for metal? panels? Cast stone concrete, others?
- Address the integration of solar panels into facade design.
- Require vertical proportioning by requiring the ground story to be divided vertically on a small increment based on building or frontage type. For example, setting divisions based upon 30' historic façade divisions in the downtown for ground floor storefronts. Set higher for residential or office buildings.
- Require horizontal proportioning by requiring the ground story to be set apart from base and upper floors with an expression line/design element. May also require horizontal division for top floor?
- Building variety. Carefully define differentiation between different buildings and building segments, avoiding too many materials and too many planar changes. Simpler buildings seem to be the most appealing to most participants

Facade Design
General Building Elements Design

Draft Statement of Intent:

To define certain design characteristics of building elements resulting in higher quality buildings, scaled to people, and creating a higher level of activity on the sidewalk and permeability between the building and street providing "eyes on the street".

Potential Regulations: Windows

- Require minimum amounts of windows/ transparency (clear transparent, low-reflectance glass in windows and doors) for a high level of permeability between the interiors of the buildings and the street. Different requirements set to different frontages. Typically minimum of 20% for all building facades, though historic buildings tend to be 12 to 15%. Store window frontages require at least 60% (some places require 75%). Allow flexibility to include or not a knee wall below the storefront? Require transom definition across storefronts to bring the overall height of the storefronts down to more human scale?
- Set maximum amount of glass to avoid too much curtain wall with spandrel glass?
- Require window glass and frames to be inset a minimum amount to avoid flat looking facades.
- Require windows to include some articulation of the base and top of the window with sills and lintels expressed through a change in material or a change in application of the adjacent material? Set minimum vertical dimension?
- Consider window proportions?

Potential Regulations: Entrances

- Define a set of allowable entrance/ frontage types: through a porch, a stoop, a recessed storefront entrance, a forecourt, etc. based on historic types of entry ways.
- Require principal building or shop entrance on primary street frontage
- Require regularly spaced entrances to activate the street. Spacing determined by building or frontage type.
- Doorways to be delineated by a lintel on some entrance/frontage types.
- Types and grades of doors can also be defined.

Potential Regulations: Balconies

- Limit ways in which to incorporate balconies? Study different balcony designs: inset, attached, structures mounted, different types of supports, separate roofs, etc.
- - Required minimum sizes (and maximums?)
- Limit the number connected together?
- Limit the coverage of the façade? (Toronto has lots of new buildings where the entire façade is covered by balconies...some very appealing...)

Potential Regulations: Other Elements?

Facade Design
Cap/Roof Design

Draft Statement of Intent:

To address the top of the building, setting the base by the frontage/entrance type, defining requirements for the middle, then capping the building.

Potential Regulations

- Define a series of acceptable caps to buildings: parapets, pitched roofs acceptable in the region, "flat" roofs with extended eaves and range of thickness, others? (butterfly roofs with limitations to façade height extension to achieve the roof design, barrel vaults limited – someone said Boulder doesn't need any more curved roofs, "special" roofs available through special review – for domes, steeples, other unique roof designs – with parameters)
- Require horizontal expression line at base of most cap types, delineating and adding more definition/depth.

Facade Design

General Quality of Construction & Detailing

Draft Statement of Intent:

To require certain details and construction practices that tend to result in higher quality construction and buildings with a more permanent presence.

Potential Regulations

- Define details related to changes in materials at corners, changes in materials on the same plane
- Define trim detail requirements for doors and windows
- Limit materials that tend to be executed poorly
- Require sample mock-ups of certain materials for approval? This practice is very time intensive for staff. Building inspectors probably can't do this. But, this could be limited to materials of highest concern. Another option is to maintain a list of approved contractors for certain materials?
- Address concerns of materials that do not age well by limiting their use?
- Other

Proportion
General Building Composition

Draft Statement of Intent:

To address the building massing and composition and change in materials of façades, relying on historic proportions and vocabularies of building composition.

Potential Regulations

- Establish "rules" of composition such as the golden section, golden mean ratio, golden spiral to be utilized on the façade? This ratio has been used throughout history to define both classical buildings and modern buildings of architects like Corbusier and Mies. The golden ratio is evident on the human body and in nature, and, therefore, provides some basis for mathematics/metrics in aesthetics. The golden rectangle, for example, has a short side of a and a long side of a+b, where a+b/a is equal to a/b. The numerical ratio is approximately 1:1.618.
- Rule of Thirds, while used for general composition, is also discussed in the book Victor Dover mentioned in his presentations (John Beverley Robinson's Architectural Composition, available as a pdf from google books). Specifically on pages 126-7, it discusses dividing a building into horizontal thirds, and when dividing into more than three sections, the additional parts should be subordinate. We may be able to craft code language that limits those rule-breakers in a way that is not too confining? Perhaps these can be guidelines, but are required to be delineated on the building elevations? Study: Cuningham Group is currently studying these proportions on some current submittals. A few are attached as an appendix.
- Rules would be applied to protrusions and recesses along the façade, window distribution?

Public Realm Elements
Street Types

Draft Statement of Intent:

To ensure the buildings and the streets work together to create the public space of the street and maximize the comfort and ability of pedestrians and cyclists to circulate and enjoy the area.

Potential Regulations

Establish a set of street types that fulfill the pedestrian, bicycle, and vehicular requirements of the streets, working with the adjacent buildings.

Open Space Types

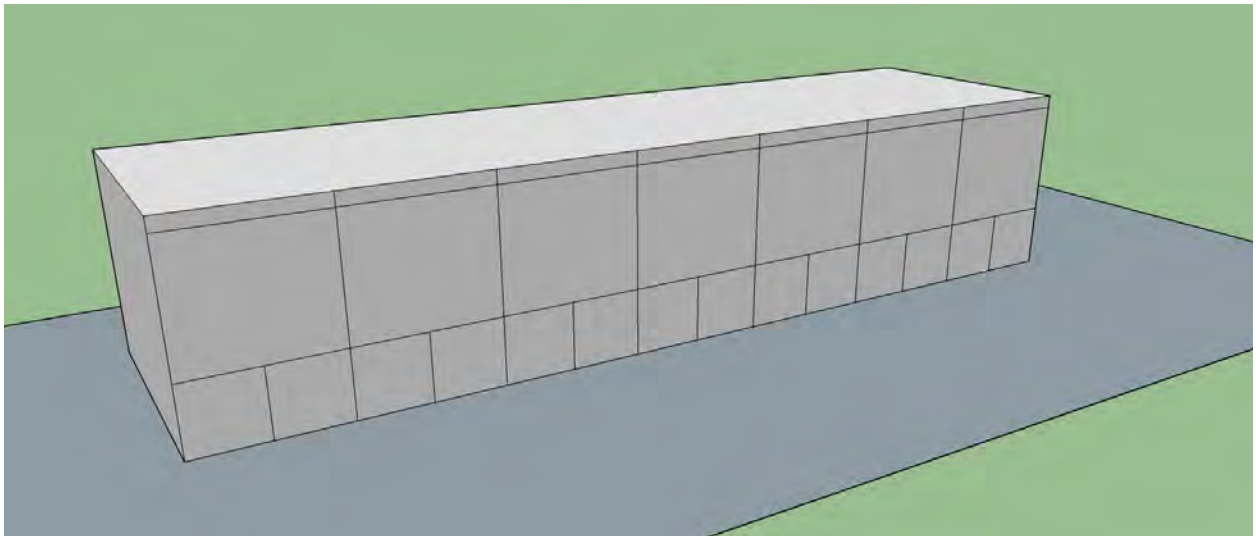
Define a variety of types of open space types that would be applicable to building design: center court, corner court, interior court, rear commons, internal square, internal green, edge greenway.

3: APPENDIX OF STUDIES

Long Buildings

In the past, small buildings were built against one another to allow for the most convenient shopping experience for pedestrians. Today we no longer rely only on our feet for getting around, so buildings can be built on larger parcels. However we are discovering that these long continuous building façades do not create a comfortable urban environment. Long buildings can be "broken up" through façade treatments, articulation, or massing. Below is a discussion about which methods may or may not be fitting for the Boulder Junction area.

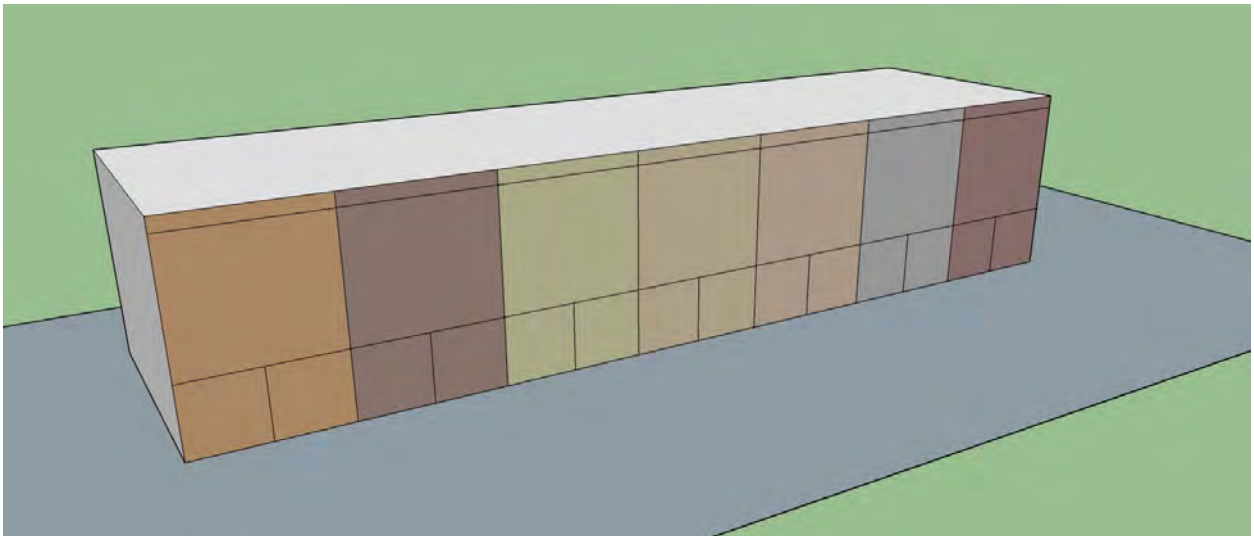
1. Historic Pattern of Small Buildings Grouped a One Long Building



In this historic pattern, small mercantile buildings about 30' wide are built abutting one another, creating a continuous mass along the street. The "wall" of different façades, however, create an interesting experience for the pedestrian.

Long Buildings

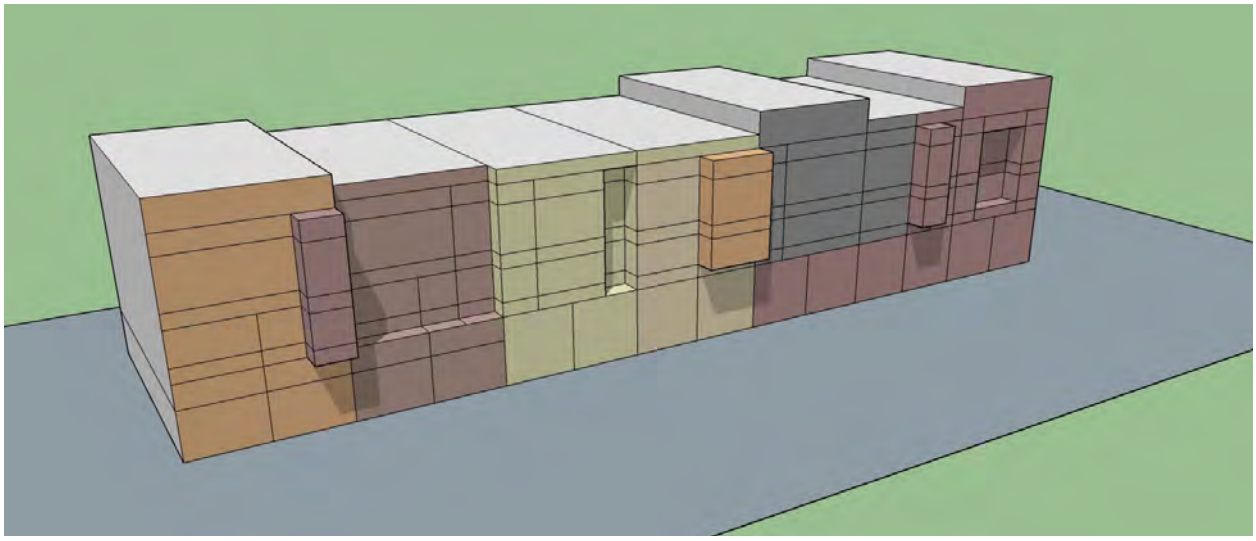
2. Long Building Articulated as Several Small Buildings through Regular Material Changes



This type of building replicates the historic pattern through material changes and articulation, creating the appearance of multiple buildings on one long building. While this is appropriate in the downtown area, it may not be so in Boulder Junction.

Long Buildings

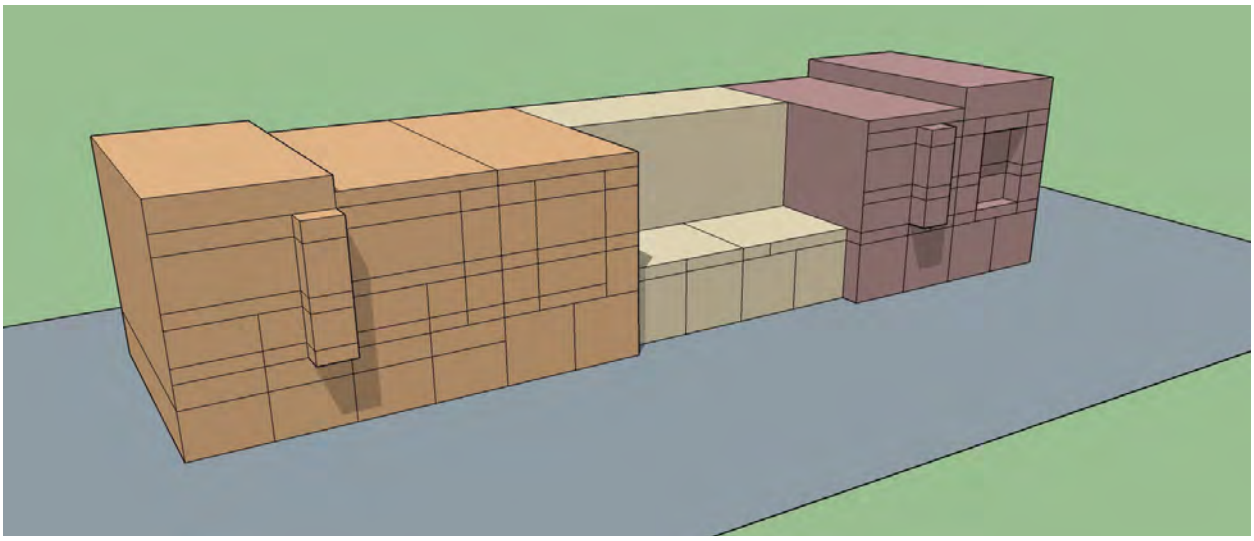
3. Long Building with Multiple Materials and Articulations that Create "Interest"



This method uses multiple materials and articulations to visually break up the long flat face of the building. Our survey indicated that the people of Boulder consider these types of buildings too "busy" and preferred buildings that are simpler and more honest.

Long Buildings

4. Long Building with Honest Massing Changes



This method breaks the mass of the building into forms that are more comfortable proportionally. Based on the classic 5 x 8 rule of proportion, it creates a comfortable and varied pedestrian environment. This method may be more appropriate to Boulder Junction.

Building Proportions

The following studies examine 3 current building design proposals in the Boulder Junction area. For each development, we diagrammed elements of the facade design for a main building facade along a street. The study was meant to determine whether the golden ratio was used, consciously or not, to layout the facade and building massing designs.

Proportion Analysis

Reve - Building 1, West Elevation (30th St)

Architectural Designs by Oz Architecture

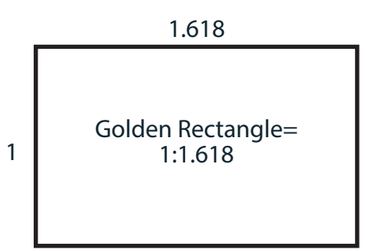
Proposed Elevation

Major Articulations

Building uses only articulation to differentiate between top, middle, and bottom.

Actual Proportions

Except for the rectangular windows, the building does not make use of any true Golden Ratio proportions. The facade has little rhythm and few repetitive forms.



Golden Rectangle (Ideal Proportions)

For a 50' tall building to achieve a Golden Ratio proportion, it would need to be 80' long. Integrating the Golden Ratio into the articulation of the facade of the building creates a well-proportioned look.

Proportion Analysis

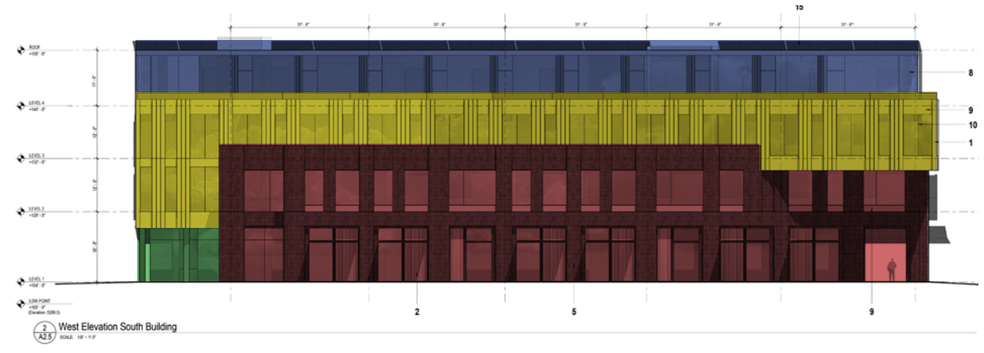
The Commons - South Building, West Elevation

Architectural Designs by Coburn Architecture

Proposed Elevation

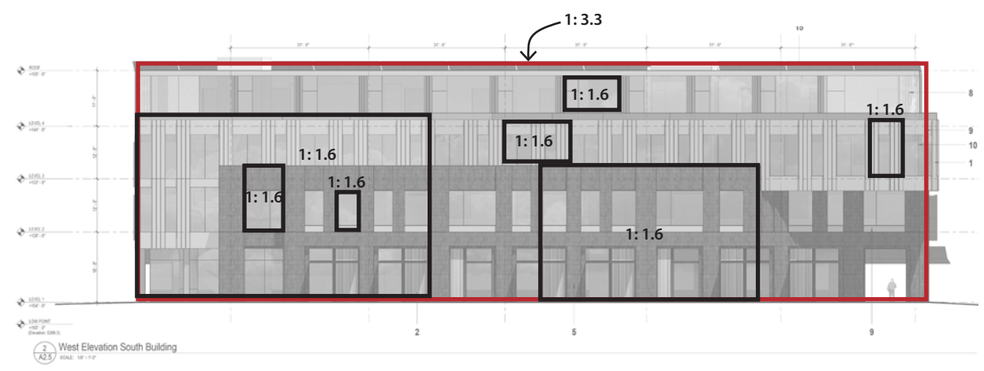
Major Articulations

Building uses different materials, window patterns, articulation, and horizontal lines to differentiate between top, middle, and bottom.



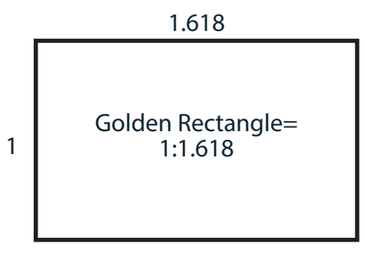
Actual Proportions

Because of the many vertical lines, Golden Rectangles can be identified almost anywhere on the facade. There are a number of strong - but harmonious - rhythms created by repetitive windows and vertical lines running along the length of the building.



Golden Rectangle (Ideal Proportions)

The overall mass of the building does not achieve a Golden Ratio proportion but the facade overall conveys a proportional effect.

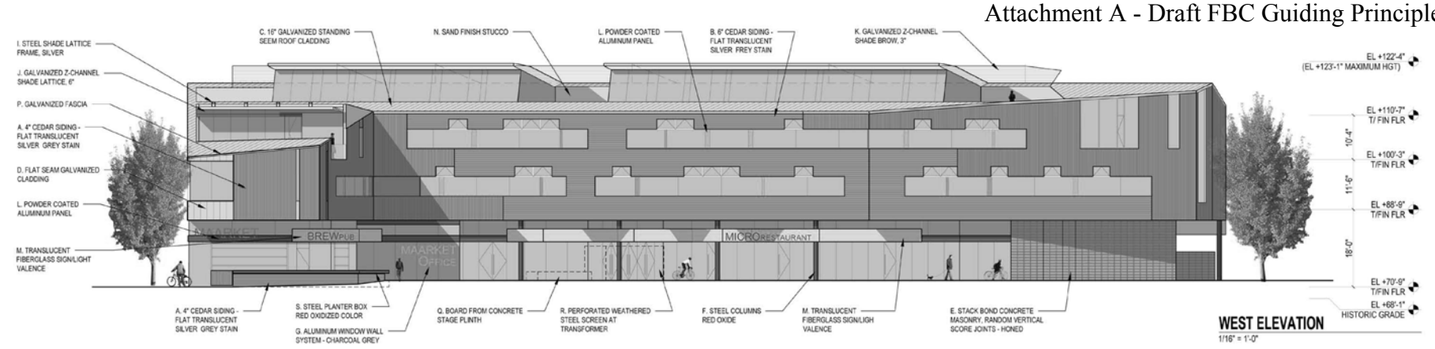


Proportion Analysis

S'PARK - Maarket Building, West Elevation

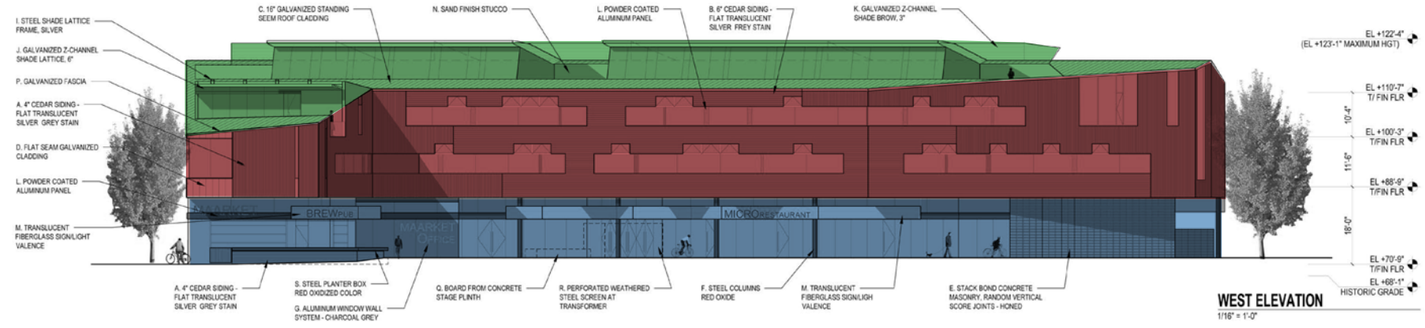
Architectural Designs by Worksbureau

Proposed Elevation



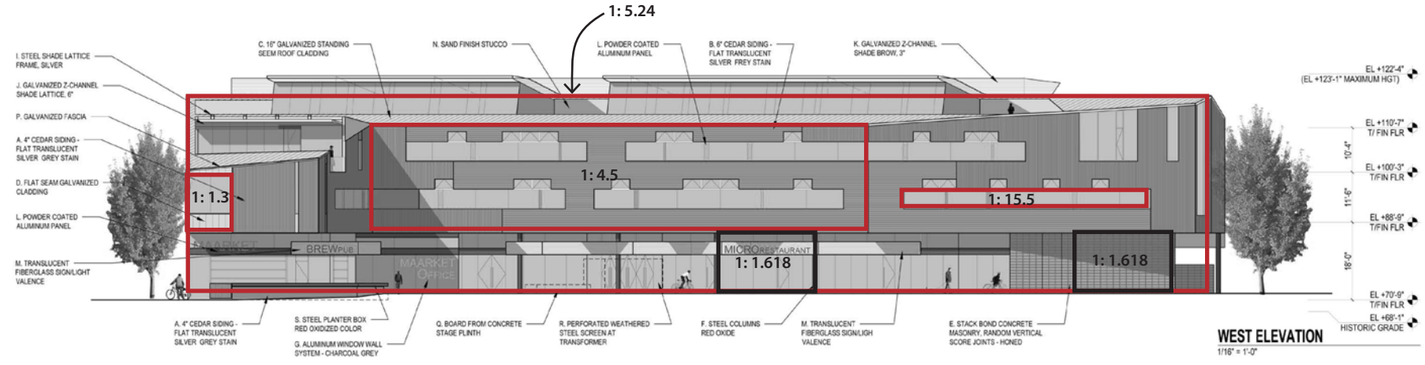
Major Articulations

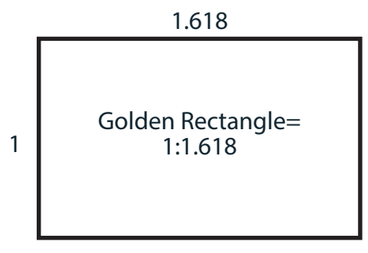
Building uses different materials, window patterns, and horizontal lines to differentiate between top, middle, and bottom.



Actual Proportions

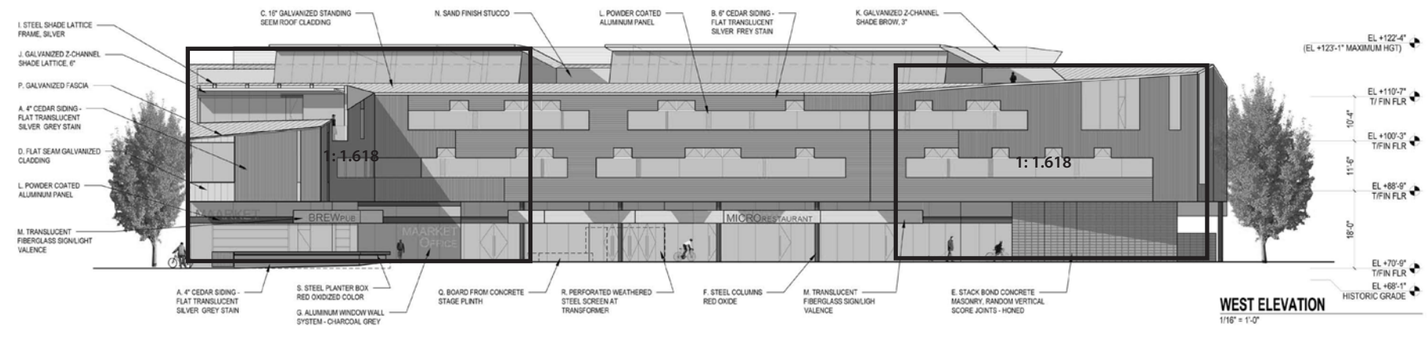
The building has very few regular forms but a few Golden Rectangles can be identified on windows or rectangular faces. The facade has little rhythm and few repetitive forms.





Golden Rectangle (Ideal Proportions)

The overall mass of the building does not achieve a Golden Ratio proportion.



Boulder Junction Form-Based Code (FBC) Pilot Working Group

Purposes and Responsibilities: The FBC Pilot Working Group will function in an advisory capacity on the development of a pilot FBC for Boulder Junction, with city staff and review boards having responsibility for recommendations to City Council. The group will provide input into the pilot FBC, including the development of guiding principles, content of the FBC, and reviewing draft documents.

Members: Members of the Working Group serve on behalf of boards and commissions and are expected to provide updates to their respective boards/commissions on key issues and/or milestones regarding the FBC. The following is the list of the FBC Pilot Working Group:

- Planning Board: Crystal Gray & Liz Payton
- Boulder Design Advisory Board: Jamison Brown & Jeff Dawson
- Transportation Advisory Board: Andrea Bilich & Zane Selvans
- Boulder Junction Access District Board: Susan Osborne & John Pawlowski

Meetings: Meetings will be scheduled periodically through the process of the FBC development. Where possible, meeting will be when the consultant, CodaMetrics, is in Boulder, or alternatively, the consultant could be a part of the meetings via telephone or Webex. At least one or two meetings are anticipated per month prior to October.

What is a Form-Based Code?

A form-based code is a land development regulation that fosters predictable built results and a high-quality public realm by using physical form (rather than separation of uses) as the organizing principle for the code. A form-based code is a regulation, not a mere guideline, adopted into city, town, or county law. A form-based code offers an alternative to conventional zoning regulation.

Form-based codes address the relationship between building facades and the public realm, the form and mass of buildings in relation to one another, and the scale and types of streets and blocks. The regulations and standards in form-based codes are presented in both words and clearly drawn diagrams and other visuals. They are keyed to a regulating plan that designates the appropriate form and scale (and therefore, character) of development, rather than only distinctions in land-use types.

What is the "Form-Based Code Pilot"?

As part of the Design Excellence Initiative, the city is piloting a Form-Based Code (FBC) in Boulder Junction, defined as the area within the adopted Transit Village Area Plan. This area was selected because the community visioning and plan adoption processes were recently completed, so the project can focus more on the FBC as an implementation tool rather than having to start from scratch in articulating a vision for the area. As requested by City Council, the FBC project was commenced in April of this year and is anticipated to be a six-month process. The project will involve outreach to the community and coordination with review boards (i.e., Planning Board, Transportation Advisory Board, Design Advisory Board and Boulder Junction Access District) and council about desired building designs and forms that would inform the final pilot FBC.

Why are we doing it and what do we hope to achieve?

The purpose of the effort is to test FBC as an approach to address design quality and development review issues recently articulated through community, board and council conversations, as summarized in the January 20, 2015 memo from Dover Kohl (link to memo). The City of Boulder's Community Planning & Sustainability Department (CP&S) is leading the effort in collaboration with other city departments and two consultant teams: Dover Kohl and Partners and CodaMetrics. Dover Kohl and Partners will assist in the broad, citywide Design Excellence discussions that would ultimately inform changes to the land use code, and CodaMetrics will assist in preparation of the pilot FBC.

What is the project schedule?

Completion of the pilot FBC project for Boulder Junction is targeted for October 2015 (i.e., six months). A work plan has been developed which specifies the scheduled meetings and deliverables at each phase of the process. The work plan can be viewed here.

What do we expect to be the outcome, and what will happen after that?

CodaMetrics will assist the city team in conducting community workshops with the public and coordination with review boards to determine acceptable building types and forms as applied to the Boulder Junction area. A working group comprised of board members will also inform the FBC. A draft will be prepared for Planning Board and City Council consideration in September and October.

The anticipated outcome is an adopted FBC that will apply only to the Boulder Junction area. The exact content and how an FBC would fit into the current land use code is not yet determined; however, it is expected to prescribe acceptable building forms, heights, locations, façade detailing (e.g., window glazing, proportionality, etc.) , materials and design amenities, etc.

Dover Kohl and Partners will assist the city in working with the community and review boards to provide recommendations on the following:

- How FBC should fit into the format of the land use code and the current discretionary review process?
- What is great design in Boulder?
- What specific changes should be made to the land use code (principally the Site Review criteria) that would enable better design outcomes citywide?
- What other areas of the city should be considered for FBC?

Following adoption of the pilot FBC, the city will begin work on changes to the land use code considering the recommendations above and direction from City Council. Next steps may also include preparing FBCs in other areas of the city.

There are projects already submitted for review in the same area where the FBC pilot is taking place. How will it affect them?

The applicants of three projects have indicated their interest in working with the city and the consultants as part of the FBC pilot's development. The three projects are:

- S*PARK (3390 Valmont Road)
- Reve (3000 Pearl Street)
- The Commons (2490 Junction Place)

As no FBC is currently in place or will be in place until October, projects would continue to be evaluated pursuant to the existing Site Review criteria at time of decision. Nevertheless, the applicants have indicated that they would play a part in the process to formulate the FBC as well as expressing openness to being informed directly by the evolving FBC. While it is not expected that the resultant projects will be 100 percent consistent with the final FBC given the project timeline, the city views the three projects as an opportunity for seeing how the evolving FBC may improve certain design aspects of projects. The city has requested that guiding principles for FBC in Boulder Junction be developed by the CodaMetrics mid-summer after receiving input from the community and boards in order to more clearly specify how the case study projects could be influenced.

How will we coordinate between the FBC discussions and the Site Review processes?

City staff has already contacted and met with each applicant about the process. Staff and CodaMetrics will continue to work with them through the review process as the FBC is developed. The applicants' decision to work with the city is voluntary and any such guiding principles that are prepared would not be legally binding as are the currently adopted Site Review criteria. The hope is that the general design of projects could be enhanced by what is learned through the FBC pilot enabling for a greater consistency with the Site Review criteria. That review will include compatibility of proposed projects with the height, mass, scale, orientation, architecture and configuration of the existing character of the area or character established by the Transit Village Area Plan. Consistency with the evolving FBC is not a standard under which the decision can be made for site review applications filed prior to the adoption of the FBC. Projects submitted after adoption of the FBC would be fully subject to the new code.

City of Boulder

Boulder Junction: Pilot Form-Based Code

image preference survey **results**

May 21, 2015

The results within this report summarize the image preference surveys conducted with the Joint Board on May 14, 2015, and a public community workshop on May 16, 2015.

An Image Preference Survey (IPS) is a powerful tool used for eliciting group preferences on community character and appearance. It can help create a visual vocabulary to enhance discussion of image and definition of place. In our IPS, participants were shown a series of PowerPoint slides, each containing photographs related to geographic areas within the station areas. To offer a full range of options, images were drawn from local, regional, and national examples. Participants scored each image from -5 to +5 (most negative to most positive), and then images with the highest and lowest overall scores were discussed at smaller table gatherings.

This summary shows the average score for each image, as well as comments from participants recorded during the discussions following the survey. Average scores and comments are colored coded per the key at the top of each page. These results will be used to help establish preferred building design to write the pilot form-based code for Boulder Junction.

image preference survey **results**

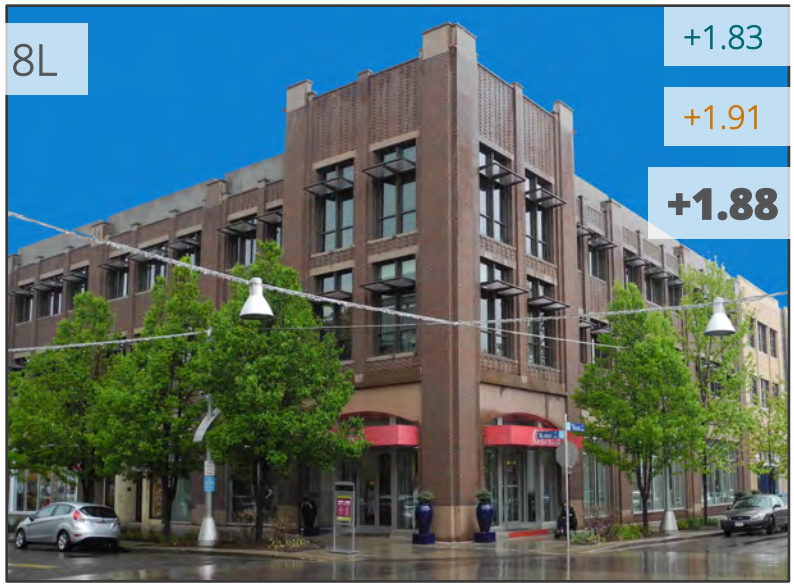
Mixed-Use Buildings

Mixed-Use Buildings IPS Results

KEY: Joint Board Average Score/Comments Community Average Score/Comments **Overall Average Score**

- Taller corner as punctuation to corner
- Variety
- Good openings
- Obvious storefront

- Lots of doorways on street
- Like scale, materials, articulation
- Not enough shade or street proximity in high summer sun
- Shorter buildings feel more "human scale"
- This works well – holds corner well



- Elegant proportions
- Lots of windows/depth despite being massy
- Holds corner
- Windows set in
- Street trees
- Depth
- Awnings

- Like corner presence
- Like recess of windows in the buildings

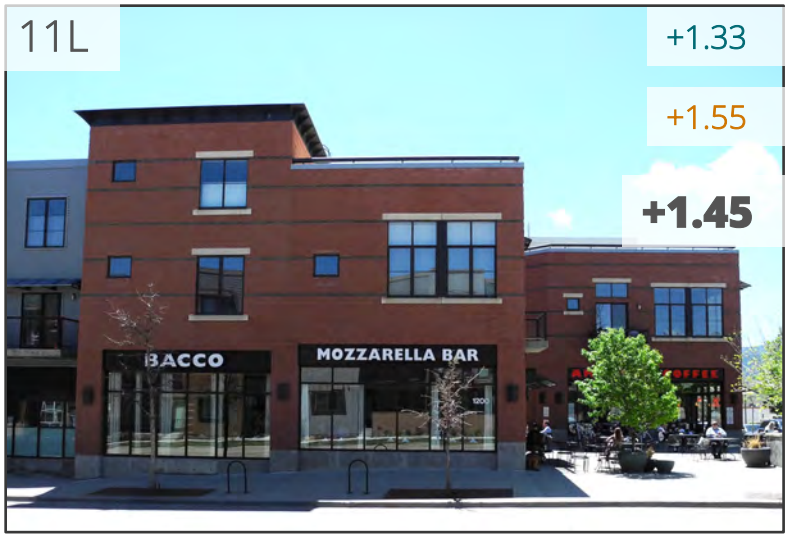
- Approachable
- Good pedestrian scale
- Kick plate better than floor to ceiling windows
- Like - Balcony extended, not recessed
- Friendly pedestrian zone
- Like - Base bays extend
- Don't like static form
- Balconies are strange

- Stronger corner would be good
- Store front

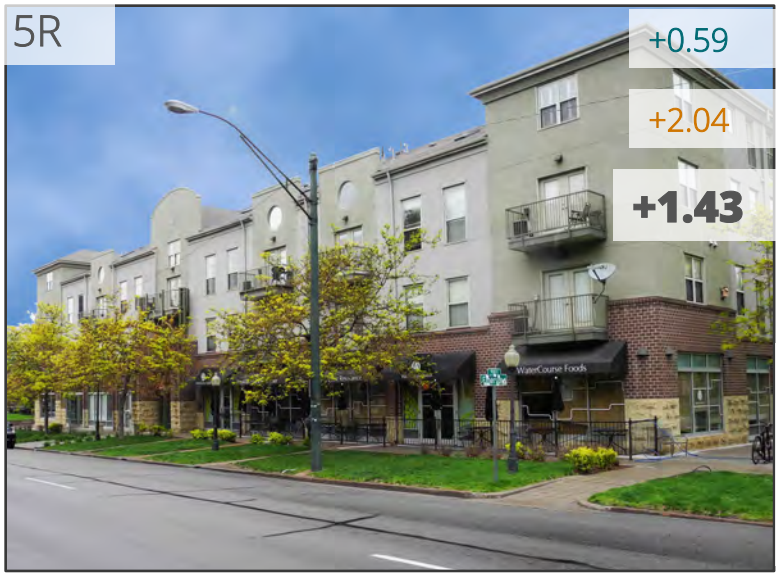
- Balconies varied, not roof lines – also help with depth and shadow
- Exposed balcony is bad, compared to protected balconies or setback balconies

Mixed-Use Buildings IPS Results

KEY: Joint Board Average Score/Comments Community Average Score/Comments **Overall Average Score**



- Like public space and stepping down towards it



- Not enough
- Looks cheap – materials and way the building is done
- Disneyland-ish
- Flimsy
- Windows too high

- Public space is important for mixed-use
- Safe but inviting place is important
- Has some private space
- Façade material too homogenous

- Jumbled
- Too much
- Like lines
- Like depth
- Like setback

Mixed-Use Buildings IPS Results

KEY: Joint Board Average Score/Comments Community Average Score/Comments **Overall Average Score**

- Like first floor activation
- Trying too hard – swooping lines
- Like – holds corner
- Like symmetry

- Like, except for the curve
- Simple but strong
- Like balconies for weather protection
- Like balconies to open up facade

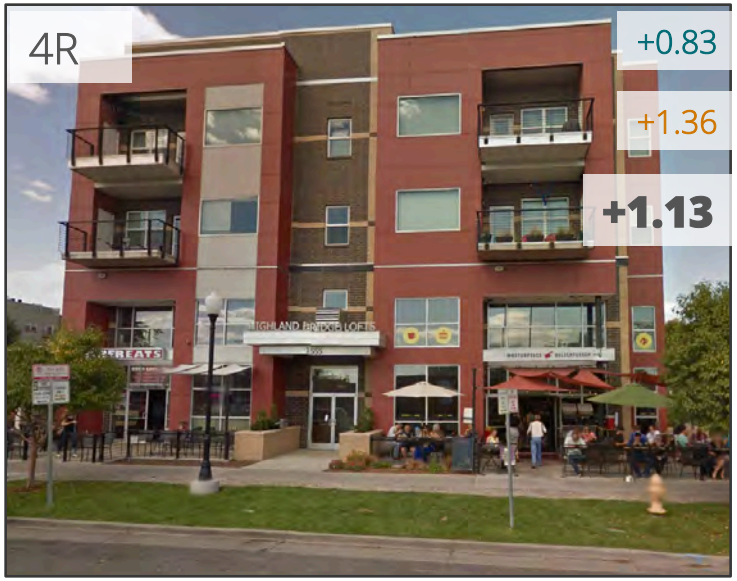
- Balconies give outside access, like windows – lots of natural light
- Looks too "busy" – varied materials, textures, windows
- Not pedestrian-friendly
- Too "square"
- Like warm feel of material – higher quality
- Nice proportion of features (windows)
- Decoration at smaller scale is nice (window details)
- Strong corner
- Simpler
- Good retail on ground

- Very tall first floor – feels like traditional retail
- Rhythm on façade
- Quality materials
- Urban and traditional
- Window detailing
- Mixed use
- Identifiable entrances

- Great because it has people
- Opening on streets, uses make or break a place
- Important corner; gateway
- Like materials and scale
- Like doors
- Authentic corner

Mixed-Use Buildings IPS Results

KEY: Joint Board Average Score/Comments | Community Average Score/Comments | **Overall Average Score**



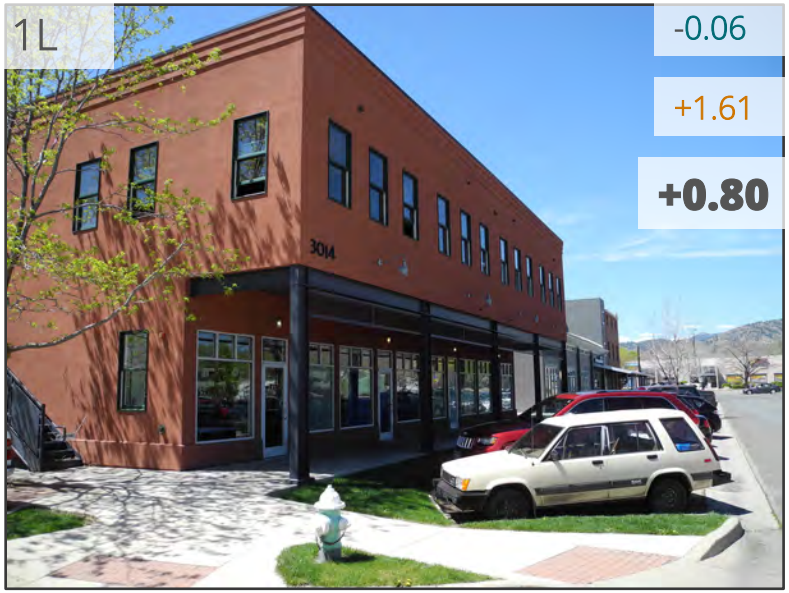
- Good activation at ground level
- Strong middle & top
- Like dimension and depth

- Like entry
- Too plain
- Safe and inviting to pedestrians

- No relationship between top and bottom

- Successful mixed-use building
- Wish corner had more going on
- Should not dishonor building
- Feels like simple commercial

- Industrial materials – metal materials
- Boxy
- Do not know what it is
- Like alternating facades

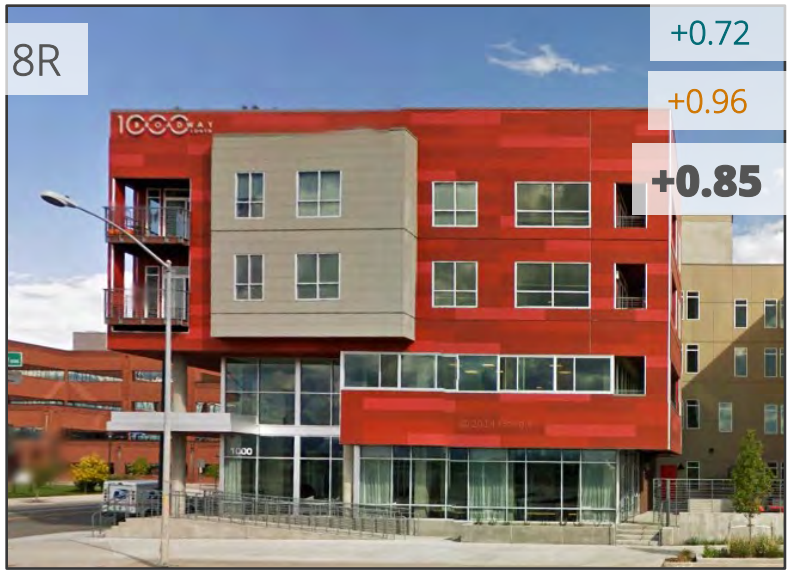


- Shadowy, looming
- Street activation
- Nice depth

- Like accessibility to the street – pedestrian friendly windows
- 2nd story overhang is pedestrian friendly – provides shade
- Don't like plainness – it fulfills FAR, not visually interesting
- Like that brick matches many Boulder buildings
- Width of overhang walkway is narrow but acceptable for use, but too low

Mixed-Use Buildings IPS Results

KEY: Joint Board Average Score/Comments Community Average Score/Comments **Overall Average Score**



- Too much ground floor transparency
- Recessed balcony gives depth
- Building is light and airy – floats

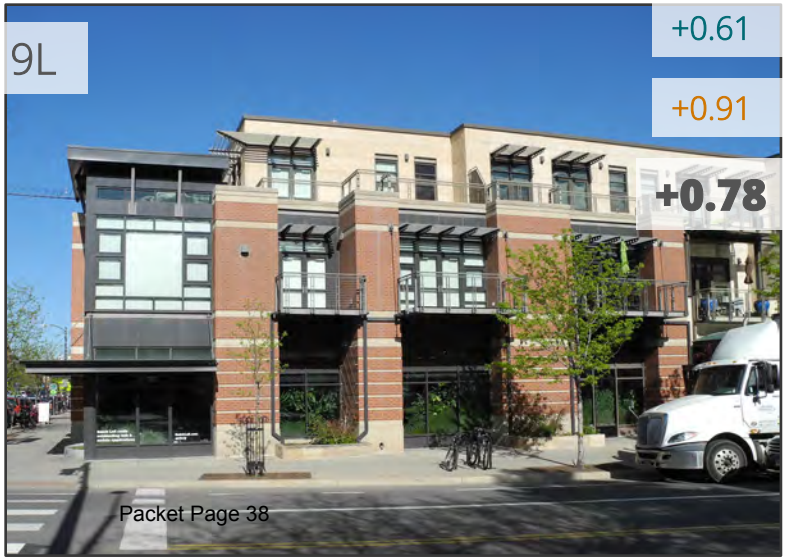
- Like modern architecture
- Although a flat façade, small variations in decoration and variation in fiber cement façade color help it not feel flat
- Scale/proportion feels contemporary/ European – good for the Junction
- 1st story might not work for pedestrians
- 1st story windows help lessen

"heaviness" of red materials
- Like materials, but not roof – flat rooflines are boring
- No cornice
- Strange protrusion
- Square glass – bad!

- Decent streetface
- Defined top, middle, and bottom
- Good balance
- A little too much
- Columns keep pedestrians away

- Don't like – too many materials
- Like traditional proportion of windows – window shape, simple and symmetrical
- Like strong corner anchor
- Very transit-oriented
- Like variety of forms, but to a certain degree

- Like strong cornice
- Like industrial feel
- Love industrial modern with traditional elements, and metal

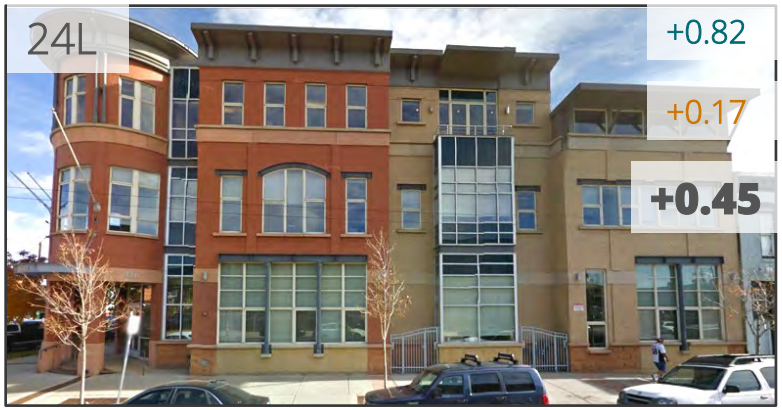


- Like scale, that it is so close to street
- Architecture could be better

Mixed-Use Buildings IPS Results

KEY: Joint Board Average Score/Comments Community Average Score/Comments **Overall Average Score**

- Tower complements the rest of the building
- Reminds of Walgreens (negative)
- Don't like balconies enclosed by walls



- Like arch, varied windows, variation in façade color
- But no relationship to the street (overhang, etc.)

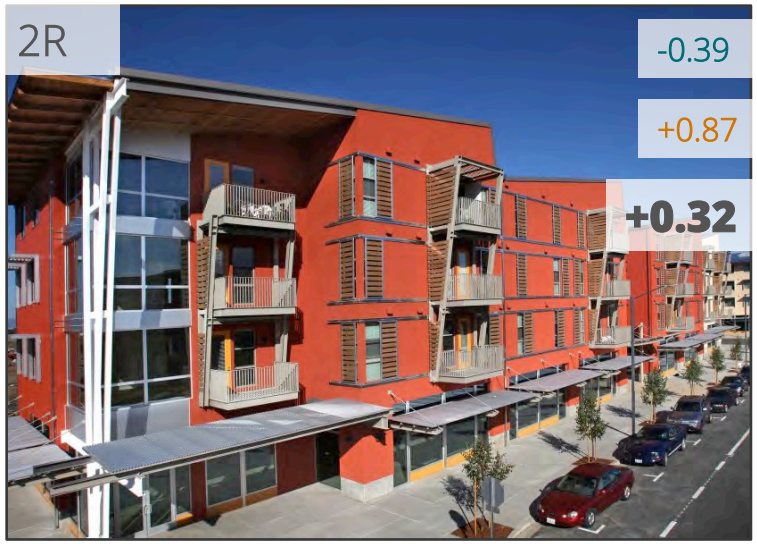
- Looked active – had people
- Tall ground floor scale
- Highly constrained
- Simple palette
- Bright
- Deep set windows
- Protected entrance

- Like artistic varied panels ("so Boulder")
- Like porch-like walkways, possibility of rooftop gardens
- Functional busy-ness is okay
- Height of 2nd story overhang is good
- Vertical outdoor space (multilevel porch) is good – feels integrated

- Do not like parking orientation – people will drive
- Like corner
- Simplicity glass corner

Mixed-Use Buildings IPS Results

KEY: Joint Board Average Score/Comments Community Average Score/Comments **Overall Average Score**



- No comfortable space for eyes
- Didn't work as a whole
- Imbalanced
- Flimsy

- Like canopy, arched passages (arcade)
- Like modern architecture
- Color is too bright
- Like shade
- Like form, connects to street
- Busy
- If it was simpler and had less ins/outs, would work better

- Varied, non-square shapes are better than square shapes
- No easy pedestrian access

- Like architecture and color palette
- Maybe not good for Boulder Junction
- Open storefronts on bottom floor is more inviting

Mixed-Use Buildings IPS Results

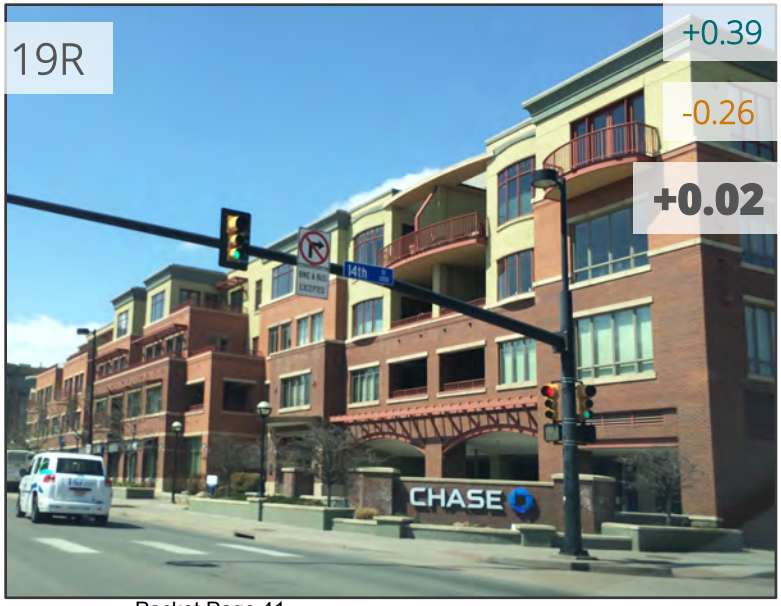
KEY: Joint Board Average Score/Comments Community Average Score/Comments **Overall Average Score**

- Nice color
- Like pop of color, but too many colors overall
- Uncharming
- Not activated at ground level

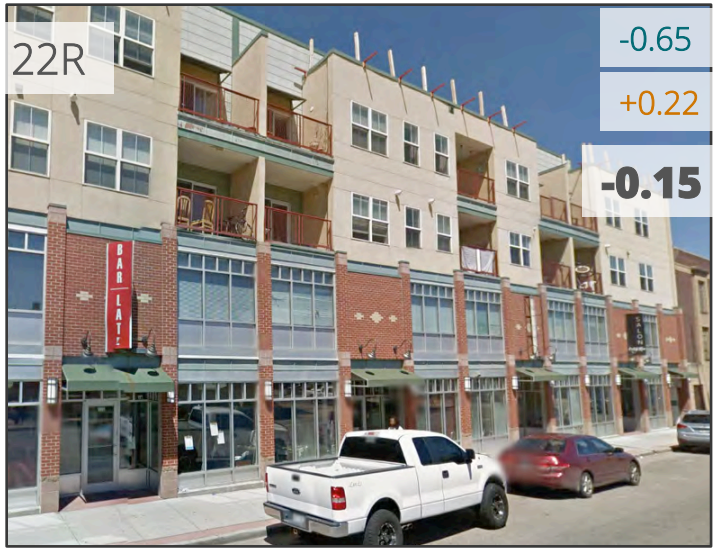
- Too contrasting
- Green is too bright

- Negative – rounded corners

- Looks bad – be a punctuation, rather than not
- Don't like – too massive
- Absolute biggest scale allowable
- Variation breaks the flatness of the building

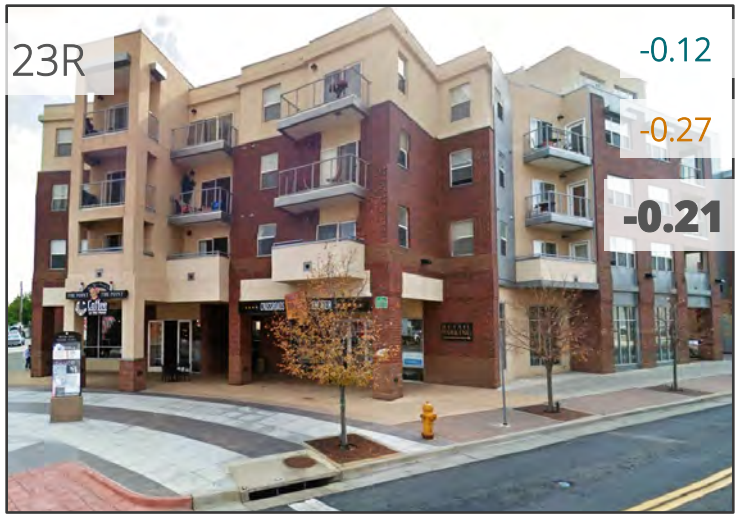


- Prefer varied façade setback depth and shadow

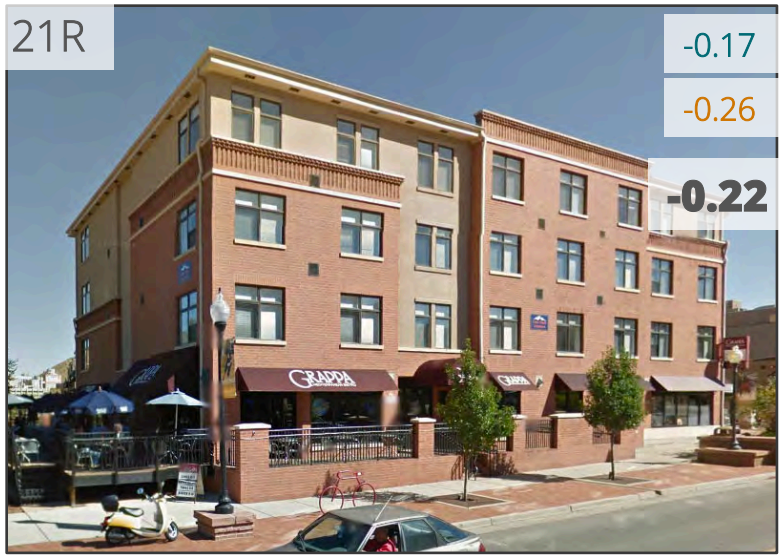


Mixed-Use Buildings IPS Results

KEY: Joint Board Average Score/Comments | Community Average Score/Comments | **Overall Average Score**



- Too many ins/outs



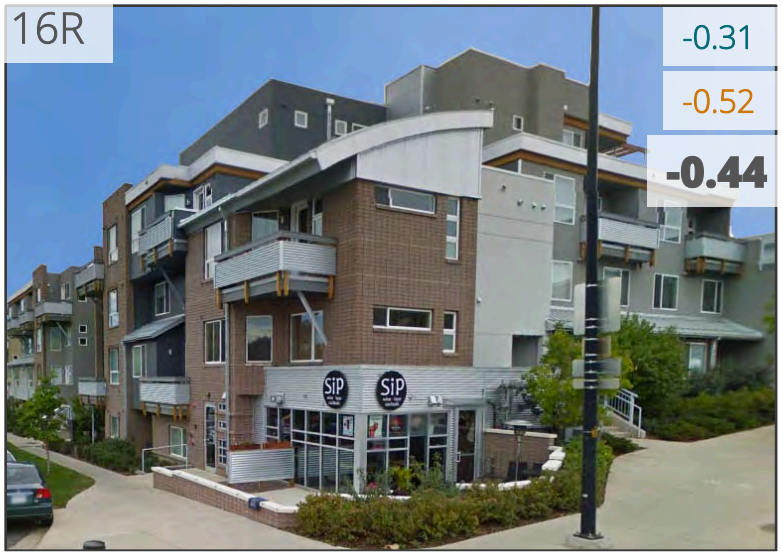
- Separation is too abrupt
- Scaling – different context on diferent roads. It would be helpful to do by typology

- Needs more entrances
- Feels like office building
- Totally dead
- Too uniform

- Like ground level & overhang
- Overwhelming top – like wedding cake
- Looks like a chain motel
- EIF
- Single ground floor tenant
- Parking lot-oriented
- Monochromatic; flat

Mixed-Use Buildings IPS Results

KEY: Joint Board Average Score/Comments | Community Average Score/Comments | **Overall Average Score**



- "random note building" – form is random
- Inviting way in
- Overdone articulation
- Too chaotic; busy
- Where do I go? – confusing
- Sunken in – bad

- Too busy
- Good palette
- Sick of arcs
- Balconies on front of building are nice

- Like trees
- Cheesy tower, abrupt

- Bad to see on each corner
- Don't like corner – looks like Disneyland
- Do not like architecture
- A lot of cars parked along the street

- Because windows are sunken and in brick, not enough texture in façade
- Need atmosphere to bring interest

- Suburban looking – car-oriented
- Like rhythm
- Like arcade

- Mixed use on 2nd story could change over time; might be timeless
- Receives good sun through windows
- 1st story proportions work well for pedestrians
- 2nd story walkway overhang height feels too high; walkway too narrow
- Like roof overhang
- Good transparency
- Don't like fake gables

Mixed-Use Buildings IPS Results

KEY: Joint Board Average Score/Comments Community Average Score/Comments **Overall Average Score**

- Militant looking (black metal)
- Negative – rounded corners
- Crown of thorns
- Chaotic
- Drab colors

- Too much corner
- Building is designed for lighting to come in
- Spinner top feels like building will take off and isn't grounded

- Like industrial roots
- A little too big
- Needs more interesting storefronts
- Façade materials are too homogenous
- Busy with push-ins/outs

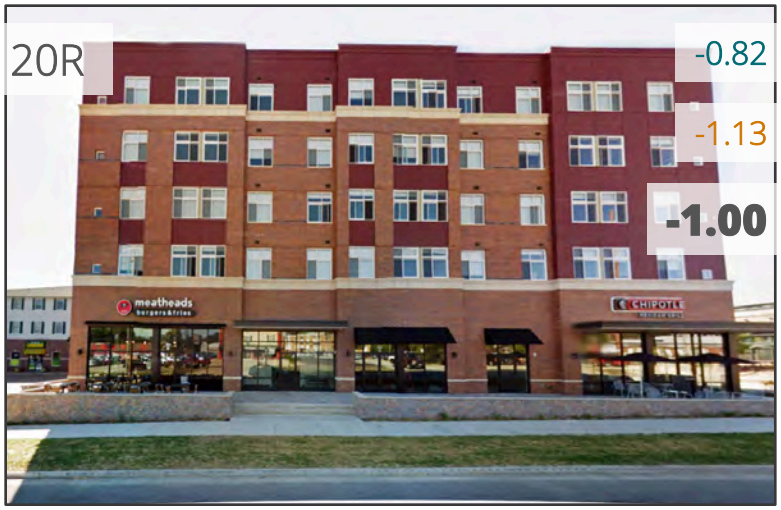
- Confined
- Sterile; like a hospital

- Too bold/expansive color expression; works better in smaller-scale decoration

- Nice use of color as accents
- Lack of overhang for balconies feels too exposed
- Very random materials not good
- Like the variations in color

Mixed-Use Buildings IPS Results

KEY: Joint Board Average Score/Comments Community Average Score/Comments **Overall Average Score**



- Strange roof lines; poor roofline
- No relationship between top and bottom of building
- Roof line bugs me, but base works

- Arbitrary roofline is no good
- Looks too indicative of east coast/seaport style; should feel more agrarian (should reflect local vernacular)
- Looks out of place

- Would like mass on corner rather than void
- First floor is squat
- Dropped out of the 1960s

- White material choice looks shoddy – panels might look better

- Artful and well done
- Pedestrian experience not great
- No depth to façade
- Monolithic
- Boxy
- Looks like legos
- Color scheme is problematic
- Too separated from sidewalk

City of Boulder

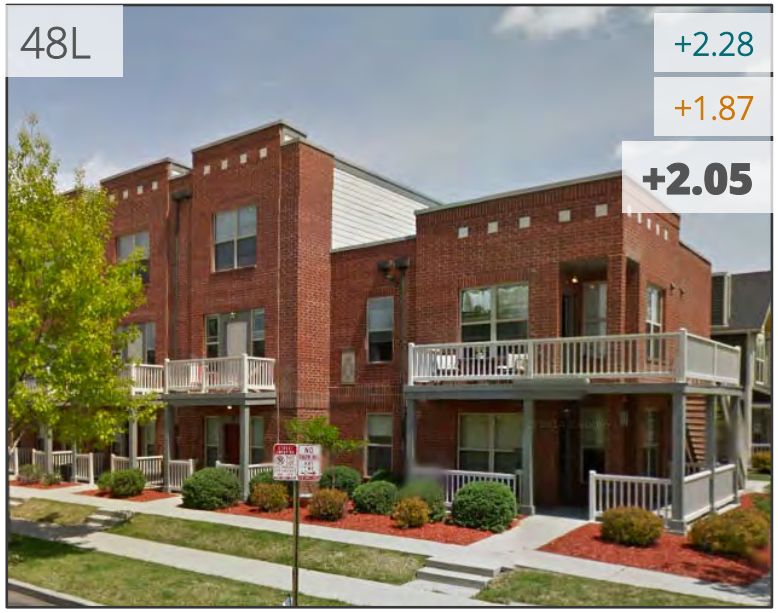
Boulder Junction: Pilot Form-Based Code

image preference survey **results**

Residential Buildings

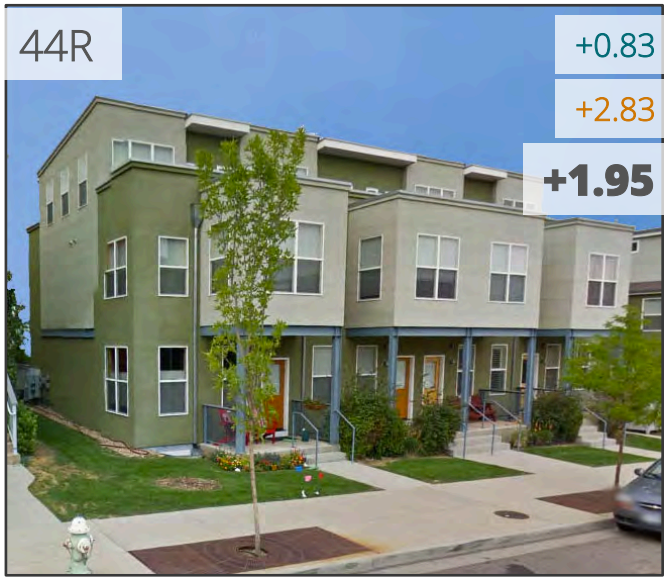
Residential Buildings IPS Results

KEY: Joint Board Average Score/Comments | Community Average Score/Comments | **Overall Average Score**



- Visually interesting
- Not too repetitive
- Good social spaces

- Railings look out of place
- Don't like the ornamentation of brick – draws eye up in the wrong way
- Porches are great
- Like traditional brick façade
- Good proportion, scale, and windows
- Not urban enough; porch is country-look



- Porches are great to interact
- Seems urban enough

- Nice stoops
- Friendly/ inviting
- Traditional flare

- Windows are dimensioned appropriately
- Like tree line

- Too much brick facade

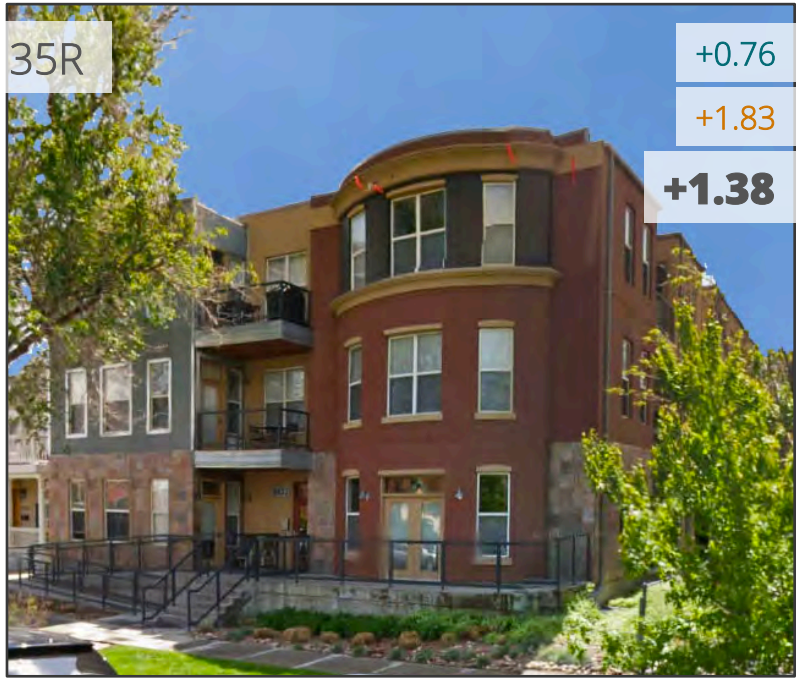
- Like mix of color – playful
- Like articulation

- Kentucky or New Orleans cottage; does not mix with TOD or modern transit development
- Materials are the problem, not concept or composition
- Porches
- Small scale
- Mix of shapes
- Opportunity to create new precedent – more urban

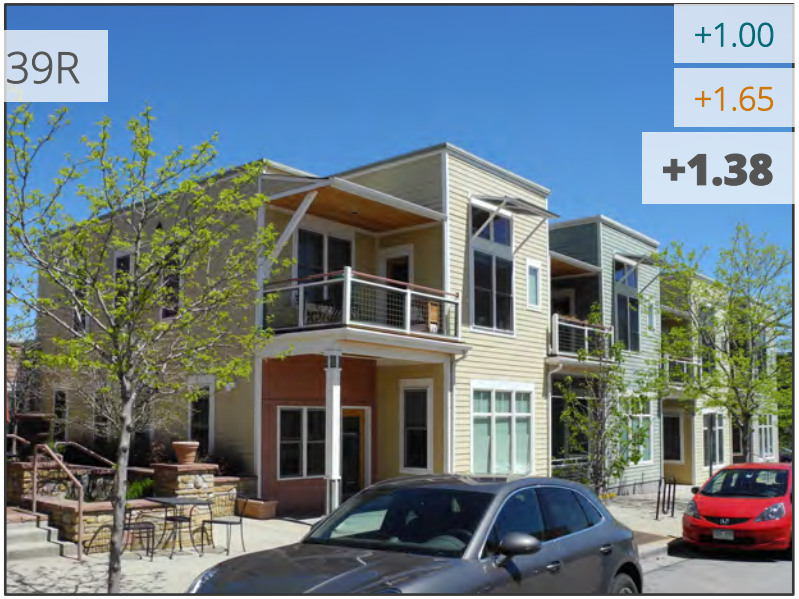
- Differentiation between the units/entry ways
- Roofing inappropriate
- Elements of traditional housing
- Amateur
- Form is good
- Colors are appealing

Residential Buildings IPS Results

KEY: Joint Board Average Score/Comments | Community Average Score/Comments | **Overall Average Score**

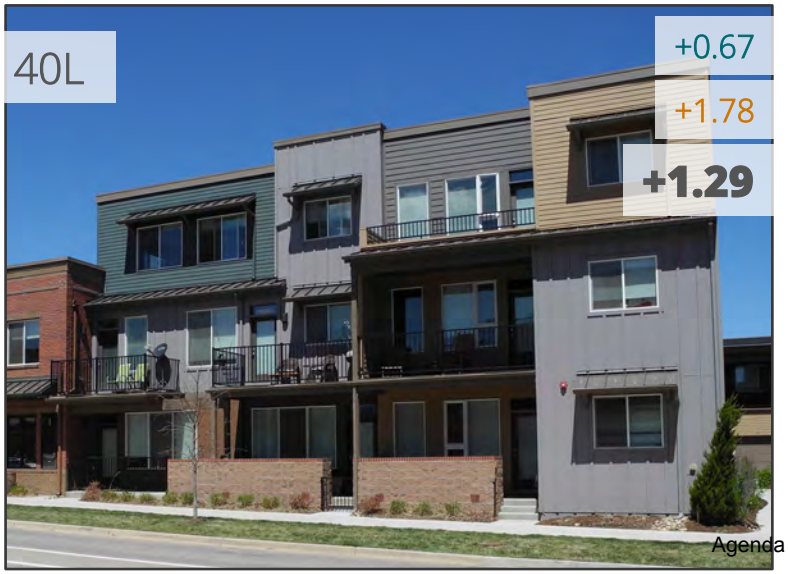


- Too many materials
- Traditional



- Like the seating congregation spaces
- Balconies are good
- Great proximity to transit
- Walkable
- Old-town feel
- Small scale, overhang/awning

- Good window proportions

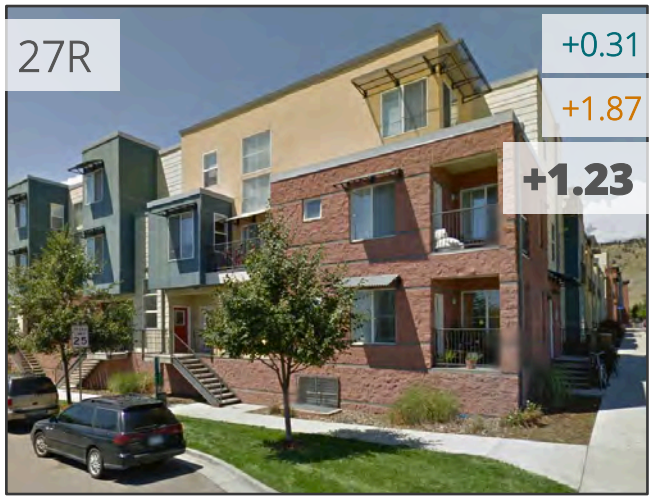


- Haphazard materials and colors
- Too chaotic
- No rhyme or reason
- Looks cheap
- Too many colors and too many materials

- Not transit-oriented
- Not welcoming
- Top floor is great; lower floor doesn't work well (dark and uninviting), but overall really like the building

Residential Buildings IPS Results

KEY: Joint Board Average Score/Comments | Community Average Score/Comments | **Overall Average Score**



- Looks livable
- Negative – stark
- Dimensions of shapes

- Positive – limited palette of materials
- Like ins and outs, but consistent plane without being busy
- Like transparent
- Unifying elements throughout
- Don't like dark color
- Like stores on street, activity on sidewalk
- Too large of scale for Boulder Junction

- Tall – like big blocks of matching materials
- Simple and holds its pieces as unique and separate instead of commingling
- Multiple materials feel like a "trick" to break down the scale
- 3 stories would be good
- Enjoy corner feature – strength on the corner, clocktower or some element

- Like rhythm
- Like richness of materials
- Stoops engage the street
- Good street presence
- Negative – reads more like office, don't like flatness of roof
- Pedestrian-friendly
- Good interface with street
- Looks lived-in
- Good materials
- Negative – hiding upper story?

- Good material palette
- Recessed balcony
- Durability and maintenance of façade will be expensive, but looks better than the bright wood
- Quality of materials, simplicity, and spacing

- Good materiality – looks durable, simple, two dominant materials
- Like vertical elements
- Like compact, efficiency
- Like discernible pattern – not random, but enough variation
- Roofline is interesting
- Like rhythm, repeating forms
- Like richness of materials
- Strong streetscape, like street trees
- Like distinct top and bottom
- Negative – dated (could be)

- Really like the 2 materials – stucco and red; like 2 colors – not too many
- Vertical proportions feel compact and efficient – appropriate for Boulder Junction
- Glass looks "market rate" not "low-income" – is there enough privacy? Glass is interesting. Like glass.
- Like multiple entrances – articulates façade
- Roof is interesting
- Simple, progressive, but modest
- Tower, roof lines are too stark
- Stairs are good
- Like towers.
- Hat[?] is hideous – for lighting?

Residential Buildings IPS Results

KEY: Joint Board Average Score/Comments | Community Average Score/Comments | **Overall Average Score**

- Lack of green elements on street
- Like wood/ organic materials

- 2nd and 3rd floor façade should extend to first floor
- Too much concrete
- Needs furniture and light
- Like wood façade

- Materials important – should reflect younger generation
- Typical modern
- Well done balance, colors, materials, put well together

- Like attached gutter – it is efficient
- Don't like material change on side; different siding is bad
- Don't like "brick retro legacy transit feel"
- Like façade
- Like landscaping
- Need functional porch
- Easy to get in and out of – makes it feel communal so people can talk
- Engaging transition and welcoming entrance; much more accessible
- Love colored doors
- Human scale

- Good materials, not busy
- Like style/good repetition
- Looks relatable
- Kind of plain/boxy

- Stairs – no transition to inner-space, no porch
- Negative – material changes at corners

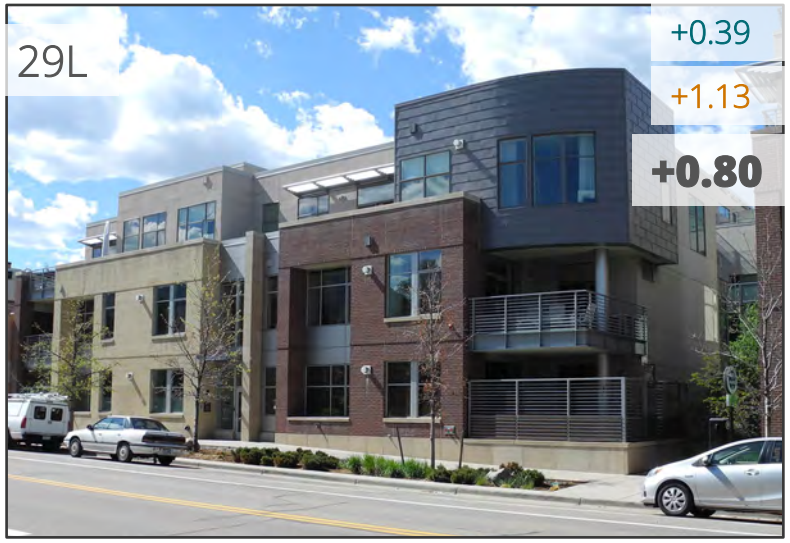
- Tries to be too funky
- Don't like [illegible] mustard colors together
- Not opposed to metal or brick

- Lost space in middle
- Looks livable for residential – not trying to be NY or somewhere super urban
- Out of context – smaller-scale neighborhood
- Better for multifamily – much better scale

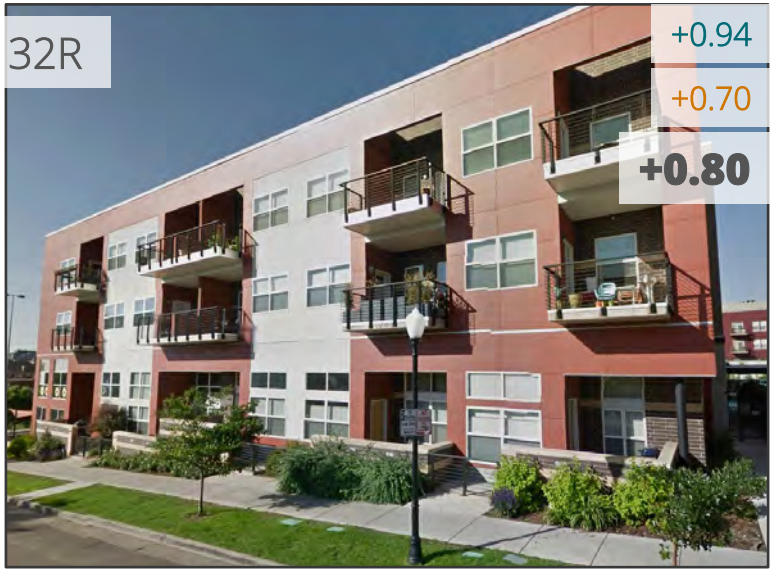
- Like traditional peaked roofs
- Charming, pleasant, lovely
- Good materials
- Reads residential
- Easily understood spaces
- Separate entrances

Residential Buildings IPS Results

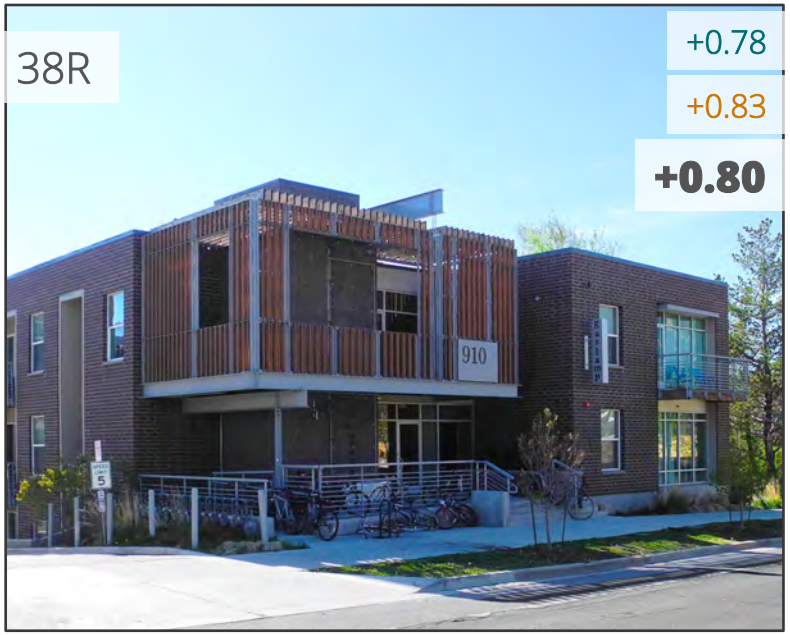
KEY: Joint Board Average Score/Comments Community Average Score/Comments **Overall Average Score**



- Good – not a monolith
- Simplest pieces work together well
- Porches understated and subtle
- Proportions are well done
- Meaningful use of materials
- Texture and variety and subtle progression

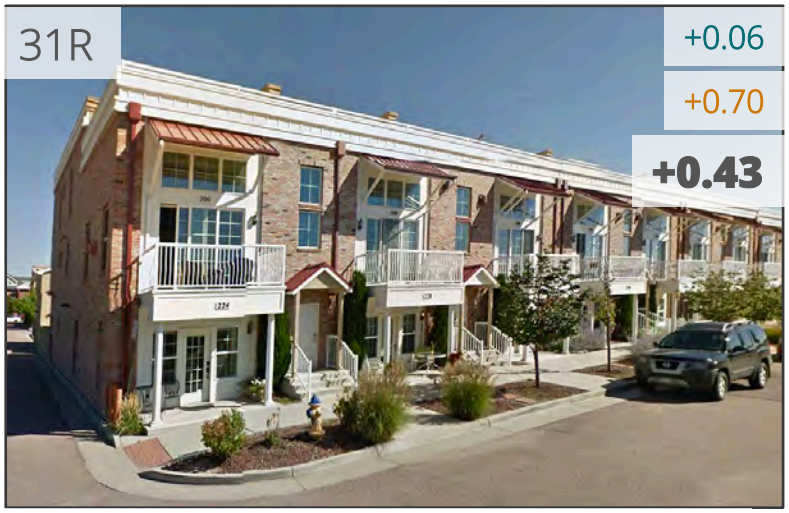


- Simple recessed balconies – clean



- Appropriate materials to Boulder Junction
- Too heavy
- Looks inviting

- Heavy and light
- It is super fun – like the mixed materials, feel appropriate for Boulder Junction
- Lots of bike parking is great
- Want more windows, but big windows are good
- Do not like the materials
- Cool, open

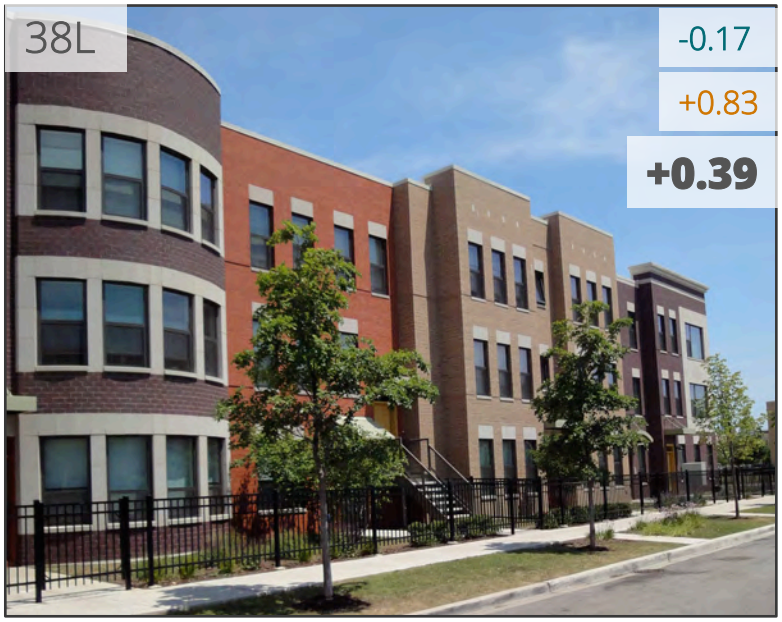


- Separate entrances

- Articulation, smaller scale
- Porches/entry way

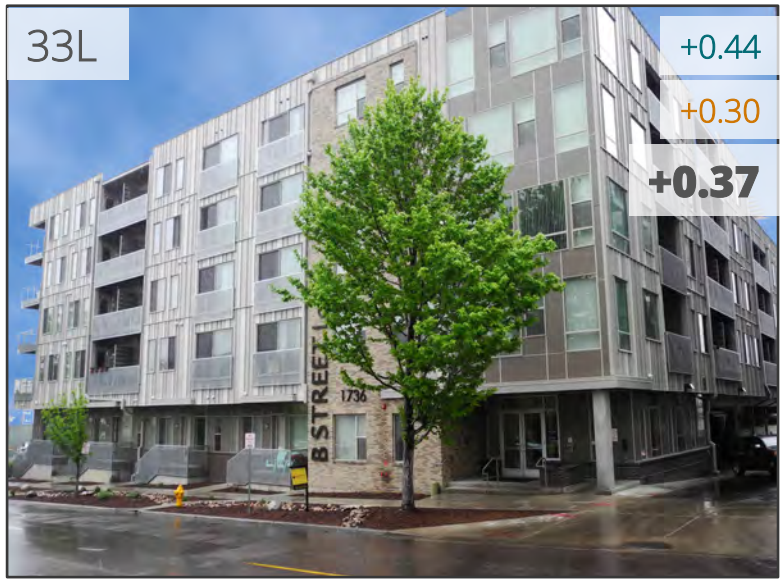
Residential Buildings IPS Results

KEY: Joint Board Average Score/Comments | Community Average Score/Comments | **Overall Average Score**

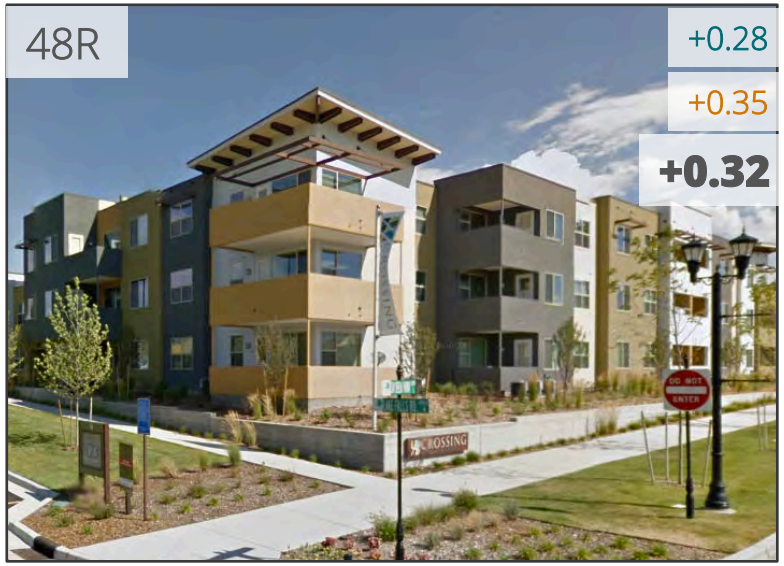


- Like cohesion within building
- Don't like gate in front

- Like the resident court
- Like the transition and fence
- Like the rounded façade; good facade



- Like balconies – integrated clean shapes and transparency
- Don't like ground floor
- Interesting – a good palette alternative to brick
- Industrial feel fits Boulder Junction
- Feels a little "cold"
- Would pick a different warmer brick – or maybe dark?
- More engagement on street front (mixed use)
- Materials are contemporary
- More likely to be enduringly "cool"
- Higher quality construction, materials, and detailing
- Extends into a long and monotonous building; scale is too large
- Needs more pop-out façade elements
- Simple, urban, modern, clean, not cluttered



- Like mulch, but need a way to get up these? But depends on how public/private you want it

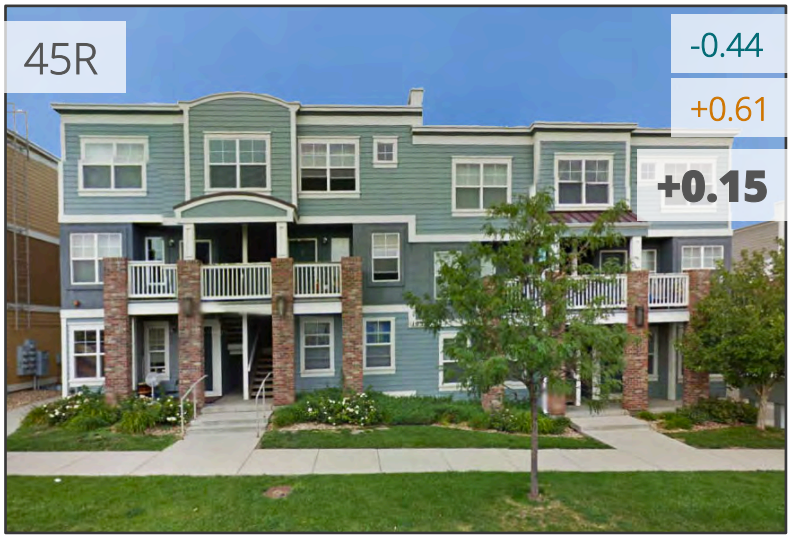
- Bring it to street
- 50's architecture

- Density/scale is good
- Like 1st floor retail; mixture of uses

Residential Buildings IPS Results

KEY: Joint Board Average Score/Comments Community Average Score/Comments **Overall Average Score**

- Too many colors and too many materials
- Like the way the balconies work



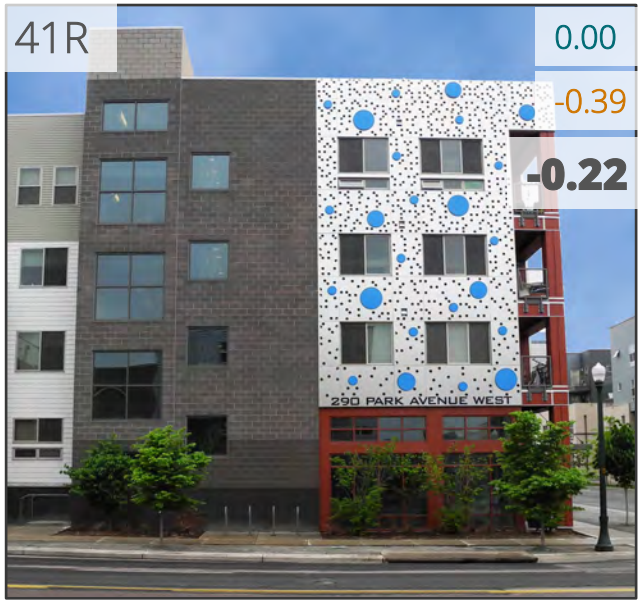
- Negative – too detached
- Not suitable for anywhere
- Too random!
- Odd materials
- Cheap and cheesy
- Chaotic form
- Nice entrances

- Too generic
- No vibrancy
- How many materials are too many? It depends on what they are – typical cottage siding from the 1950s
- Columns are awful
- Doesn't fit into context – need more modern look

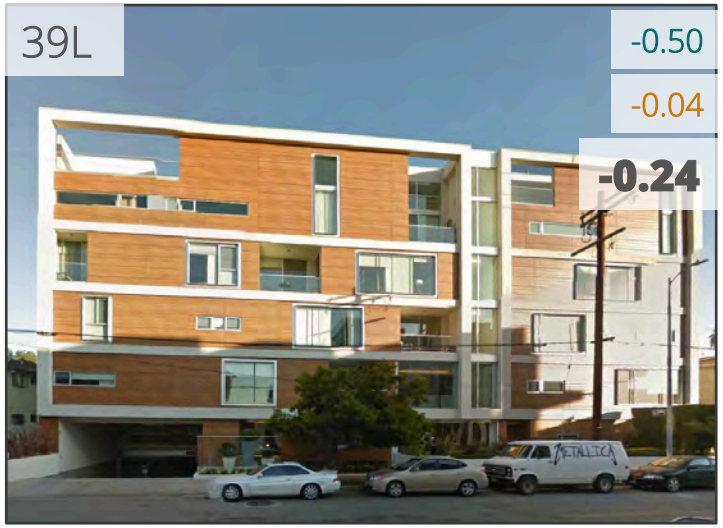
- Too many colors/materials
- Too busy
- "lost potential" – but the small gardens are nice – brings beds closer to street for protected pedestrian area but would be better if bottom floor was commercial, not residential
- Haphazard, incoherent, although broken up

Residential Buildings IPS Results

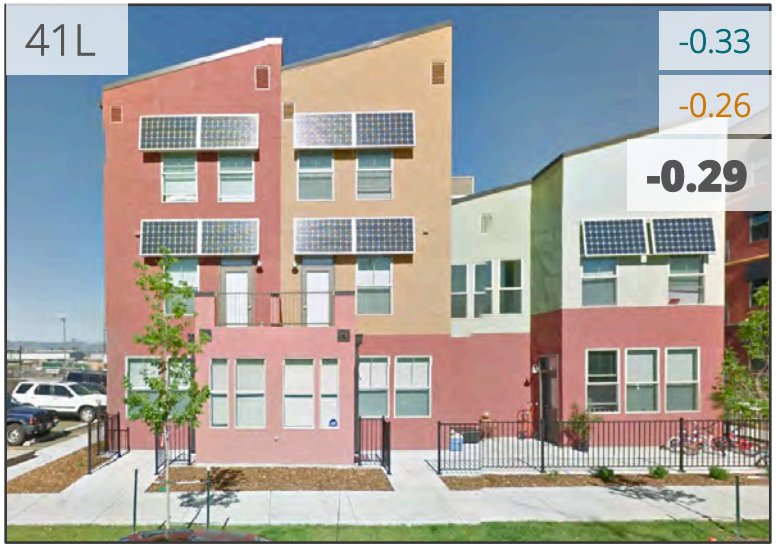
KEY: Joint Board Average Score/Comments | Community Average Score/Comments | **Overall Average Score**



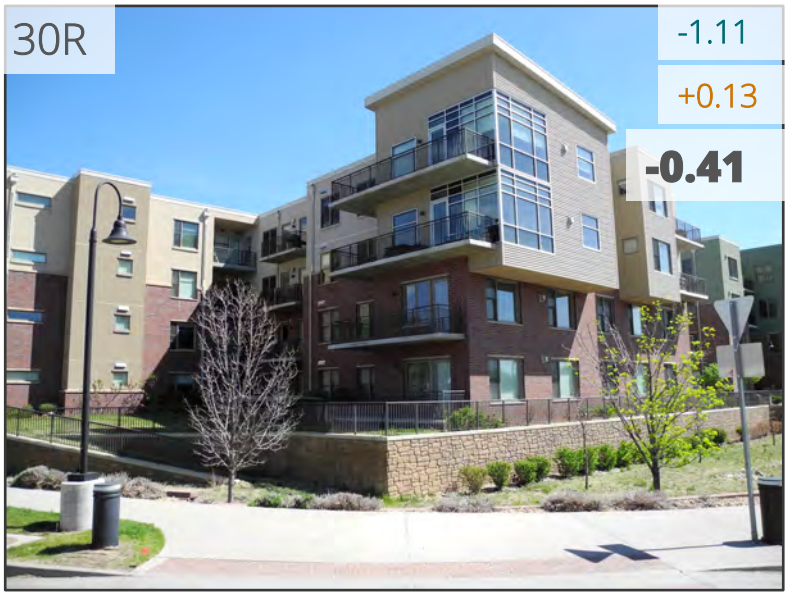
- Like windows reflect underlying structure
- No way – too goofy!
- Dot façade/art is good – need more public art
- Slick but has façade layers
- Like the modern façade and colors
- Don't like dots; look like a bathroom
- Not artistic – not for a building



- Like materiality
- Architectural interest
- Interesting window placement
- Like linear terraces
- Negative – parking access, unsafe
- Negative – lack of ornamentation
- Negative – dated
- Bad how it meets the ground
- Don't like this – feels weird and retro
- Okay if it is a small structure, not if it goes on for blocks
- Playful proportions
- Nice but powerlines



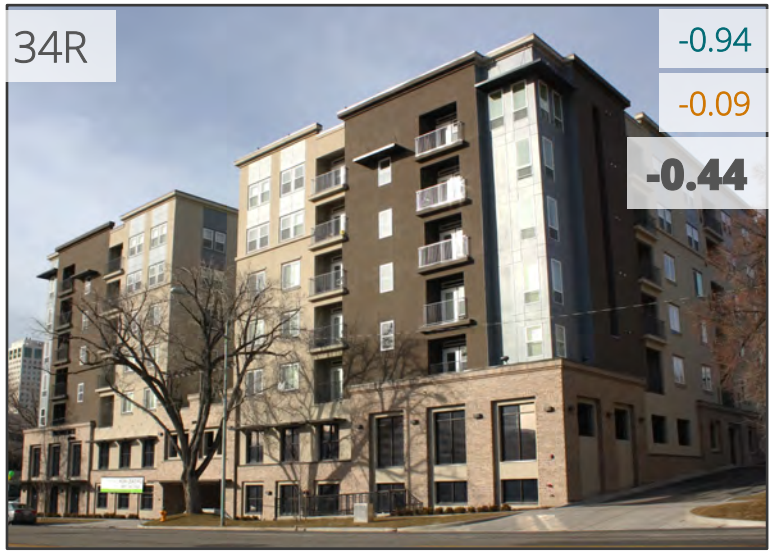
- Like angled roof
- Placement of solar panels is strange
- No rationale, no connection for colors and shapes
- Like the dual-function solar panels; like how these are incorporated – wonderful feature



- Don't like "moat" (wall)
- Top portion is strange
- Complicated
- Top heavy
- Arbitrary design moves
- Tall windows are great, especially on top floors, helps create diverse price points
- Scale, seems never-ending complex broken into separate buildings
- Site relationship is okay, but depends on the site
- Like separation between private and public realm
- Like separation of buildings, instead of one long row – easier to manage an emergency
- Windows on the sides of the home; pattern language lights in 2/3 bedrooms

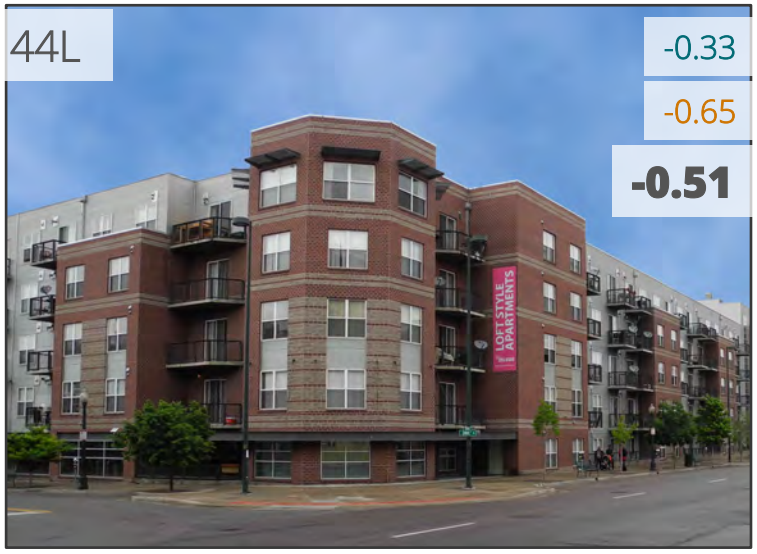
Residential Buildings IPS Results

KEY: Joint Board Average Score/Comments | Community Average Score/Comments | **Overall Average Score**

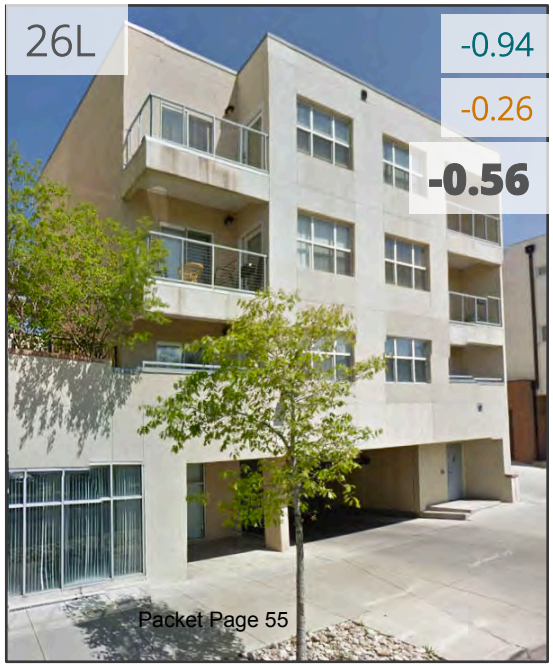


- Too tall/boxy/monolithic
- Looks anonymous/unlivable
- Like street interface

- Height is okay
- Parking not great
- Materials are okay-ish



- Strong looking
- Like presence on corner
- Ground level is strange



- Monolithic with no life
- No pedestrian scale
- Boxy and a lot of concrete
- Has broken façade variation
- Looks like it has community activity area
- Street environment is not great
- Factory-ish
- Downtown Denver feel – lack of detail

- Bottom structure feels stable
- Negative street relationship
- Materials look cheap

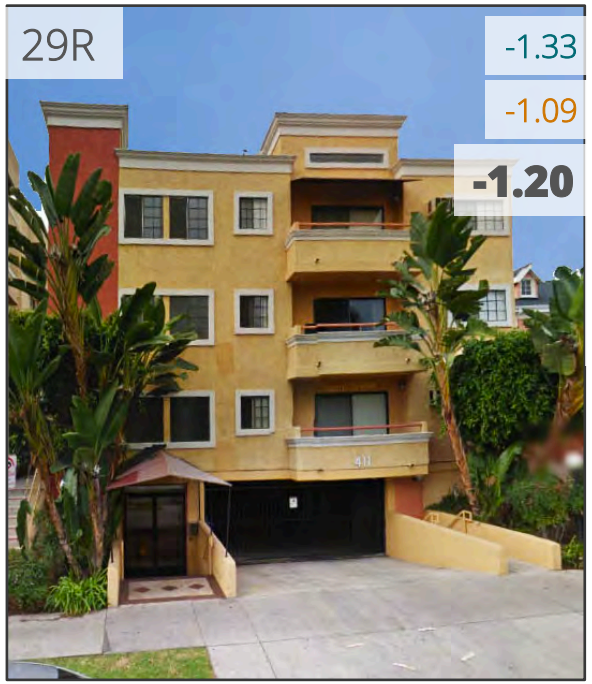
Residential Buildings IPS Results

KEY: Joint Board Average Score/Comments | Community Average Score/Comments | **Overall Average Score**

- Good window proportions, but very flat façade
- Too much going on – mullions are too much with the amount going on
- Paint or materials could be better used to simplify and articulate façade
- Good maximum urban look
- Impersonal; imposing

- Too much green lawn – not appropriate for Boulder Junction
- Too much grass/landscape to maintain; very tricky
- No enclosure
- No public/community space

- Looks like a prison
- Uninviting
- Useless courtyard
- Disconnected from street
- Should have hedges, not fence
- Like landscaping and seating areas, but not the fence; privacy is good, but the material is bad
- "this is where you go for rehab"
- "electric fence"
- No chainlink fence and landscape
- Modern looking courtyard
- Need more seating areas
- Good open space
- A lot of concrete
- Like variety and colors of façade



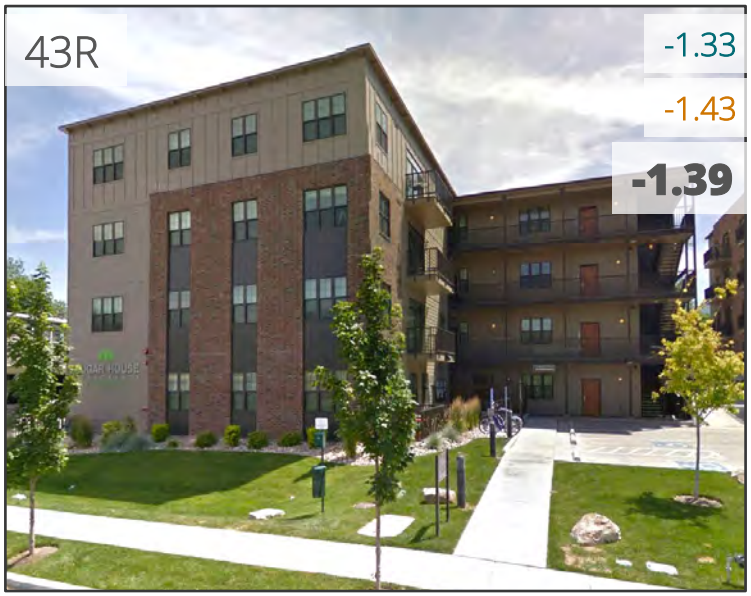
- Garage creates gaping hole in sidewalk
- The worst of LA – materials, color, boxy balconies look cheesy and cheap
- Underground parking looks like a hotel
- Like colors, façade; colors are appealing
- Car entrance okay

Residential Buildings IPS Results

KEY: Joint Board Average Score/Comments | Community Average Score/Comments | **Overall Average Score**

- Boring – too much of the same
- Bad pedestrian-scape – lack of street activity
- Wasted space by fence
- Material change at corner
- Cheap

- This scares me!
- Terrible roof, colors, street front
- Like this one – inside color gives more light; good combination of colors



- Looks like student housing – not appropriate for Boulder Junction
- Like scale
- Like residential public space
- Calm peaceful colors, facade

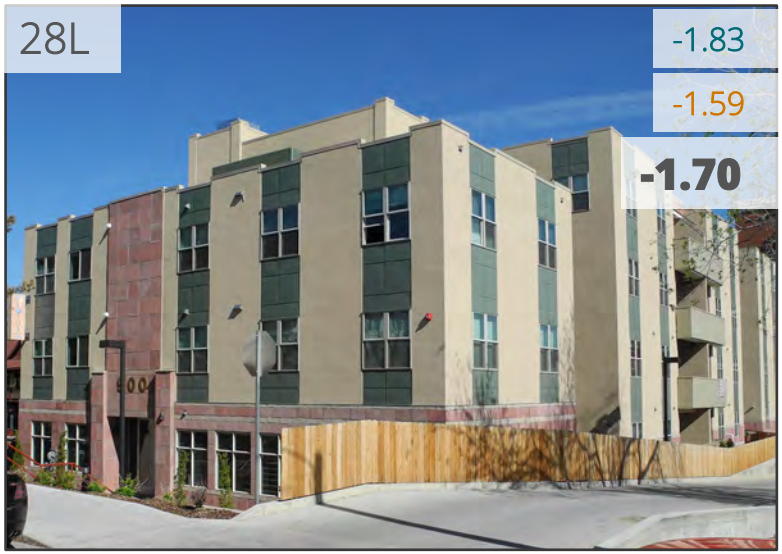
- No interface with street
- Nice simplicity, materials

- Looks like senior housing
- Negative – suburban, not inviting
- Generic, but not offensive
- Enclosed porches

- Too suburban
- Looks like a Hampton Inn
- Hip roof not urban
- Monochromatic
- Balconies are good

Residential Buildings IPS Results

KEY: Joint Board Average Score/Comments Community Average Score/Comments **Overall Average Score**



- Materials look dated
- Too many colors/materials
- Too 2-dimensional
- Looks like wallpaper

- Why cut off with fence

- Horrific; blocky
- Reads industrial
- Poor details; zero ornamentation
- Feels temporary
- Prefer vertical windows to horizontal

- Landscape is bad
- Use industrial materials
- Rocks are bulky and weird
- Doesn't fit, feels cheap
- Rip rock foundation walls – materials are good, modern
- Fits the street traffic on 28th
- Do not like covered stairway
- Lacks appeal because it looks cheap, window construction and simplistic building overly styled and will not stand the test of time – not an enduring cool

- Too suburban
- Set back too far
- Visual clutter
- Too many white elements
- Like green in front of building

- This scares me!
- "visual noise"
- Ghastly; looks cheap and decorated
- Lacks site specificity and integration
- Roof line not good; too peaked
- Didn't like scale
- Reminds me of Westminster

- Looks institutional
- Not pedestrian friendly
- Suburban/cookie-cutter
- Not Boulder character

- Not progressive
- Window proportion is too small
- Very flat, cheap façade
- Feels institutional
- Do not like the secluded car-oriented entrance
- White trim needs to be contextual
- Dining hall
- Shouldn't be duplicated

image preference survey **results**

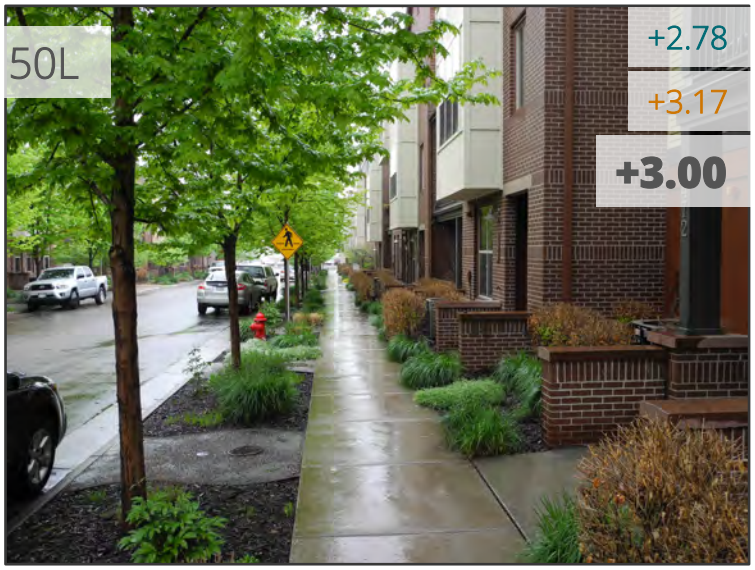
Pedestrian Realm

Pedestrian Ream IPS Results

KEY: Joint Board Average Score/Comments Community Average Score/Comments **Overall Average Score**

- Positive – hide sidewalk, but interesting
- Tall windows – transparency
- Like simplicity of materials
- Building has variation, but not overly
- Like interest on both sides of walk
- Sidewalk feels narrow
- Feeling of enclosure

- Like building design
- Like light fixture, planters, width of sidewalk
- Awning feeling good
- Narrow sidewalk
- Active space
- Inviting building entrances
- Love this – recessed doors, varied landscape, glass
- Like the transparency of the windows
- Overhang of façade extending into street



- Negative – narrow, but feels intimate
- Likes softness with materials, and not uninviting
- Likes canopy, but mulch might be too much
- Healthy landscape materials
- Like detached walk with plants on both sides
- Like on-street parking, parallel parking is friendly
- Like building height and trees – provide more comfortable sidewalk
- Building has variation, but not overly
- Sidewalk is a bit narrow, but good in residential
- Like green and entryways
- Seems comfortable, nice to sit on porches

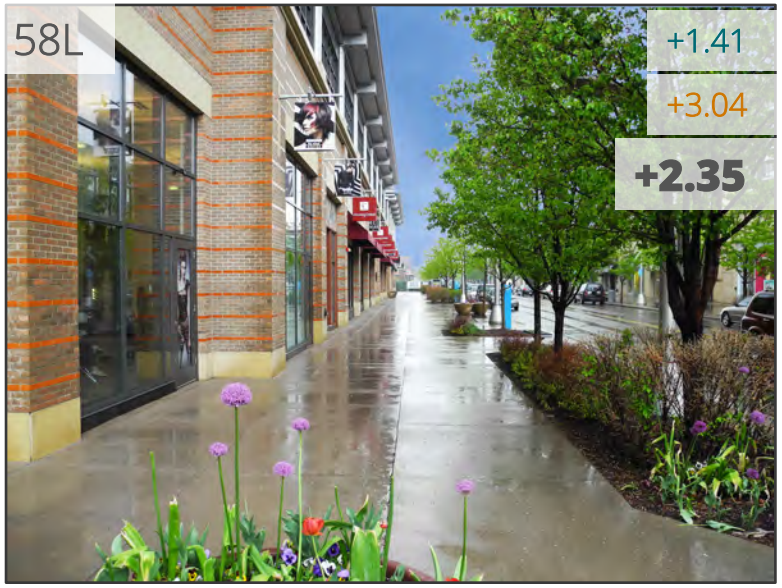
- Inviting; like landscaping
- Good setback
- Is tree or planting bed better? – can tree thrive?
- Sidewalk is narrow – should be wider
- Appropriate for residential
- Greenery
- Front is set back, but not a place to stop; building has a social space – set back
- Shade and green overwhelmed with too much concrete
- Not bike friendly
- Sense of enclosure – mature trees
- Too close with branches; safety issue with snow and branches falling down
- Narrower sidewalk perhaps more efficient for lower traffic areas
- Should use separated bike lanes
- Porches toward pedestrian streets are good – not toward car streets
- Love narrow width – feels urban and comfortable
- Like break between sidewalk and street
- Transition is great with help of vegetation

Pedestrian Ream IPS Results

KEY: Joint Board Average Score/Comments Community Average Score/Comments **Overall Average Score**

- Like seating, but needs to be interesting
- Building face is pleasant; like articulation
- Like mixture of plants
- Like width of sidewalk-scape
- Like staggered depths of buildings
- Narrow sidewalk makes more cozy and width of street
- Like buffer between parking and walk – room for street furniture

- Attractive place to linger – slanted parking, trees need to grow up
- Like seating, parking
- Good for pedestrians
- Angle parking has more mass
- Variation of building materials at ped level is good; material change; in and out of façade; differing articulation
- Planter not good; too small to be useful, and feels in the way
- Tree grates better than grass – raised beds okay too; mulch or rocks okay
- Love – feels interesting
- Proportion of width in walkway is nice



- Like tree/landscaping separation
- And is long enough buffer

- Wide sidewalk
- Good landscaping
- Elevation change
- Not drawing in, no access points
- Landscape, buildings feel good
- Street trees
- Like awnings and flags

- Negative – Pull-in is more aggressive than parallel parking
- Like head-in parking
- Like cars and landscaping and seating
- Seating is key
- Overhangs are very pedestrian-friendly
- Like canopy overhead
- Like materials, shape, and landscaping

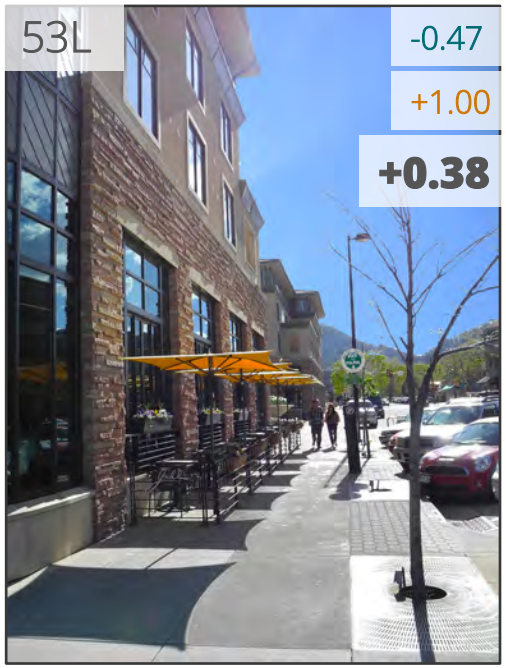
- Very attractive space
- Okay for retail only – like overhangs
- Having 2 walking areas is weird
- Too much grade change
- Flower bed rather than ground cover is more inviting

Pedestrian Ream IPS Results

KEY: Joint Board Average Score/Comments Community Average Score/Comments **Overall Average Score**

- Like traditional, and simple palette
- Shops were visible
- Trees and interesting and wide entryway
- Wide sidewalk, but not too wide

- Like close to street, like trees
- Too wide
- People congregate here
- Familiarity
- Wise ped area is good for varied ped use

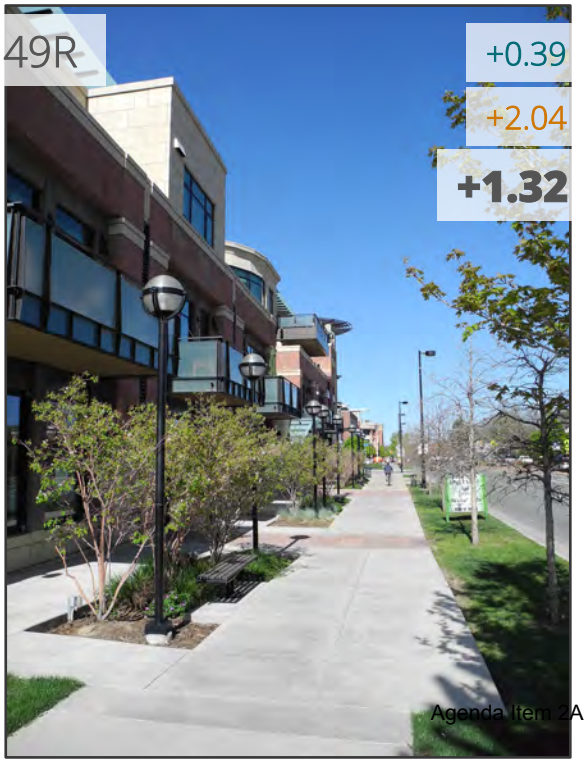


- Like outdoor seats, trees, cars help protect sidewalk
- Architecture is bad
- Like street furniture & trees
- Like sidewalk dining, though may be narrow

- Texture variation good
- Like café zone
- There are going to be people – umbrellas make it feel like people
- Single-person wide sidewalks ruin pedestrian experience

- Like open space
- Like separation from street
- Little separation between street and buildings
- Very exposed – doesn't feel like a cozy room
- Inaccessible to hang out in space
- Need to activate space
- Sign is overkill

- Public art and sidewalk is great that connect different places
- Plaza adds great element – creates interest



- Like landscaping
- Like scale of buildings and light fixtures
- Looks nice, but area is dead because of heavy canyon traffic and lack of uses
- Do not like shrubs
- Needs more places for people to go – too loud
- Too much exposed space in bright sun

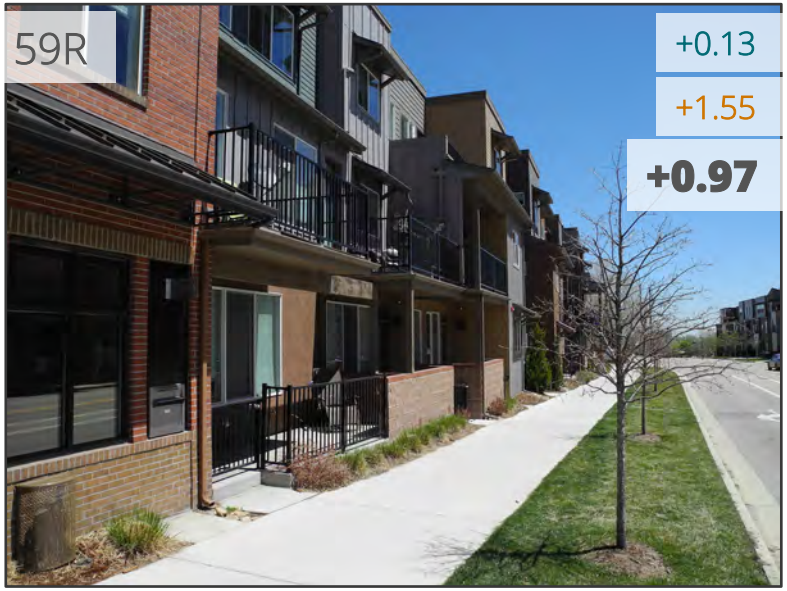
Pedestrian Ream IPS Results

KEY: Joint Board Average Score/Comments Community Average Score/Comments **Overall Average Score**

- This works if moved Uptown to Boulder Junction

- Not inviting to go down into space
- View may be good from shop, and may like view going by
- Looks complicated and uninviting, but looks nice if you are a resident
- Slower traffic next to sidewalk
- Back from traffic and noise
- Sunken committed space is okay (like this one), but don't like sunken passive spaces

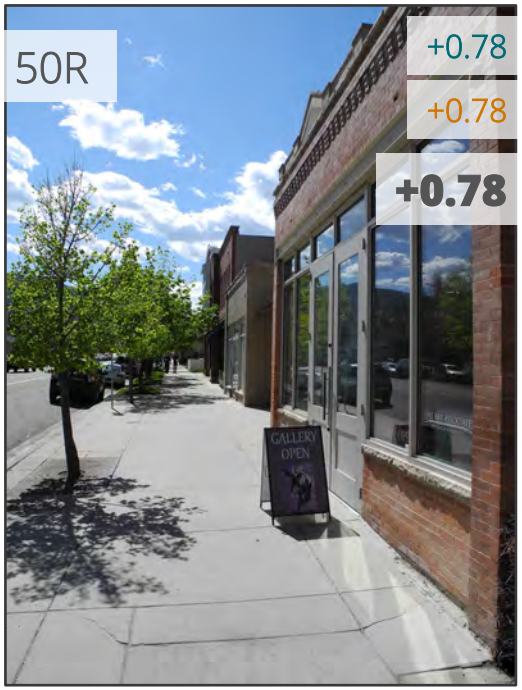
- Sidewalk feels too wide; and not enough interest
- Bike parking helps reduce parking congestion where not planned (e.g. restaurant porch fence)
- Like the proportion of street width and building
- Large sidewalks!



- Like orderly trees – all lined up
- Very good proportions and transitions
- Communication of public/private

Pedestrian Ream IPS Results

KEY: Joint Board Average Score/Comments | Community Average Score/Comments | **Overall Average Score**

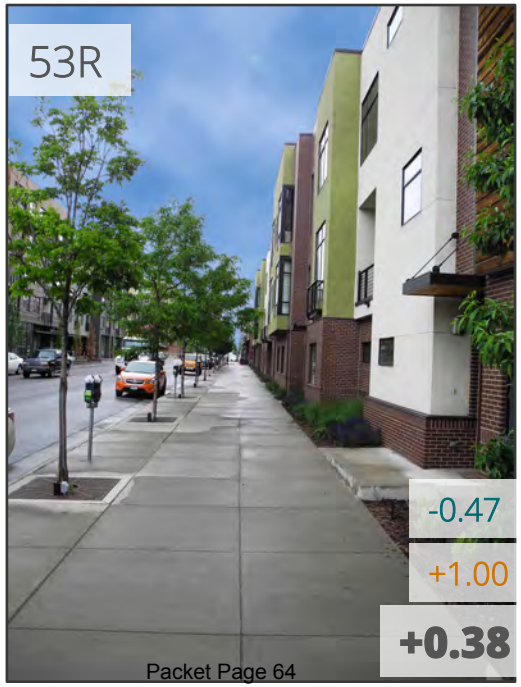


- Negative – bleak street
- Need width between street and building, but not stark

- Trees in grates without landscaping feel lonely

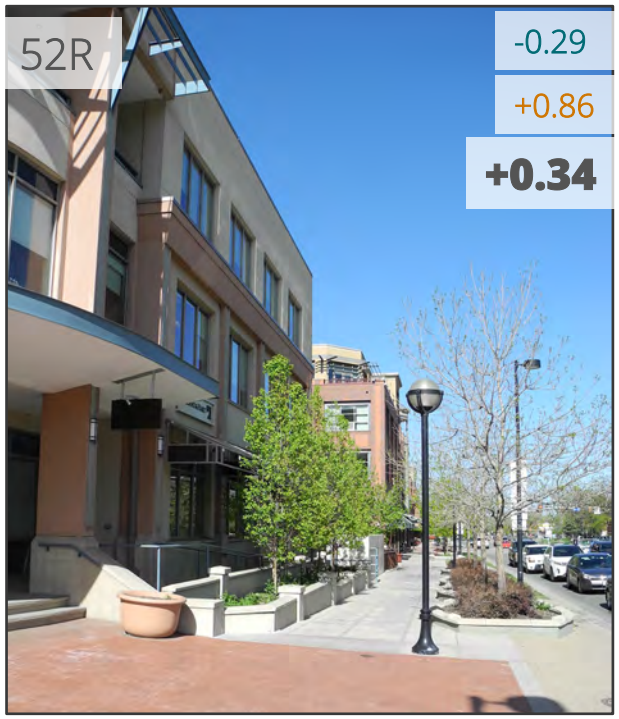
- Never sit there; not inviting
- Close to freeway

- Like overhang
- No grass



- Negative – sidewalk is way too wide
- Tiny planters – eye catches street harshness
- Bad buildings that don't intercut with street, such as shops, signs
- Negative – no eyes on streets

- Don't like trees in grates
- Had to tell where to go in?
- Need relationship between street and building

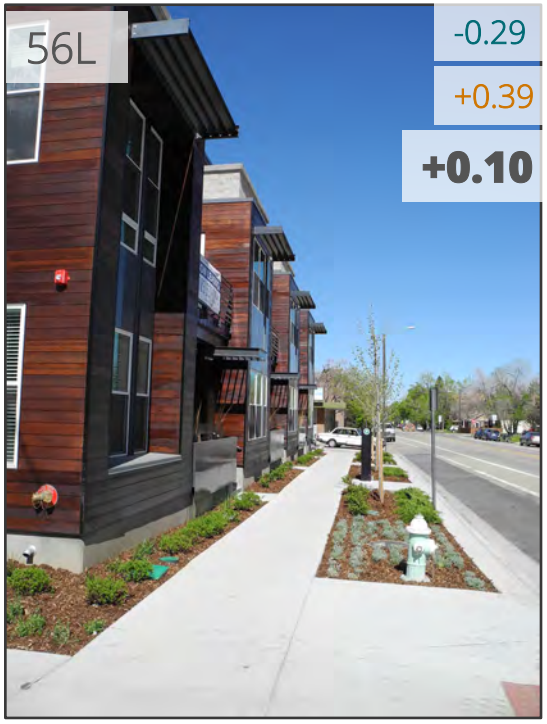


- Like sidewalk close to building
- Privacy trees might be a necessary evil

- Allows public space
- Sidewalk not integrated into retail/building
- Raised beds work great!
- Large sidewalks
- Variations of different vegetation

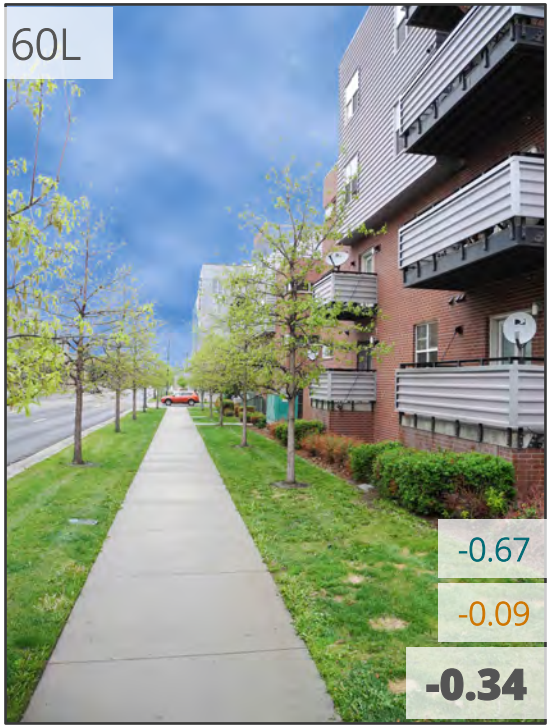
Pedestrian Ream IPS Results

KEY: Joint Board Average Score/Comments | Community Average Score/Comments | **Overall Average Score**



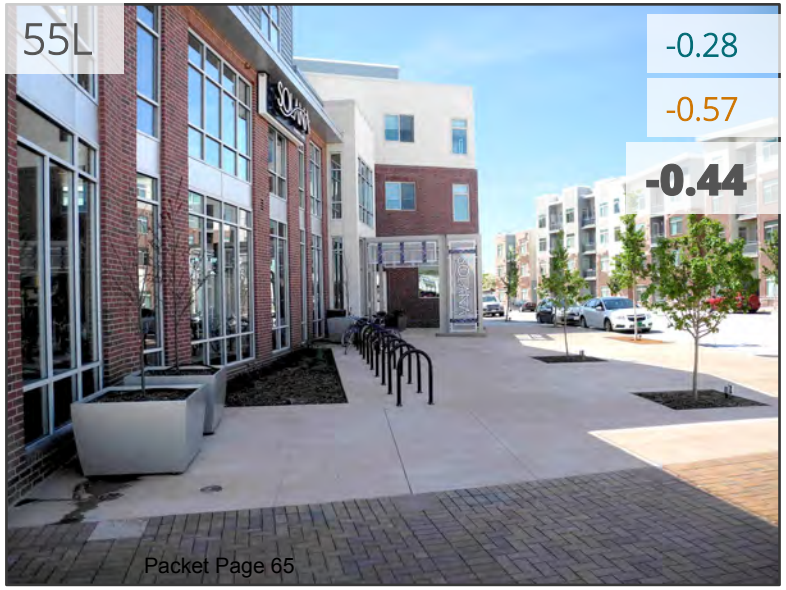
- Like the void and solid rhythms of building
- Like dual side planters between building and sidewalk
- Like the little bit against the building
- Trees growing will help

- Like light fixture
- For modern style
- Wider sidewalk generally best – invites more people; good, big and wide enough
- Like the stoops – good transition
- Created interaction
- Less organic to have divided gardens
- Great eyes on street and right depth



- No parking, too sterile, vacant space, vacant space, no character
- Sidewalk is too far from building, not commanding with entryway to sidewalk
- Back end of building to street, no energy from people entering
- No relationship of walk to buildings and lack of access

- Good balance
- Like seeing balcony
- No front doors
- Small sidewalks
- Underutilized



- Too wide

- Too wide
- No transition between sidewalk and building
- Bike parking nearby but not in front is great. Covered is even better.
- Simple, but some decoration on bike structures
- Dead plaza with bike racks cluttering it up

- Roof line doesn't match junction style

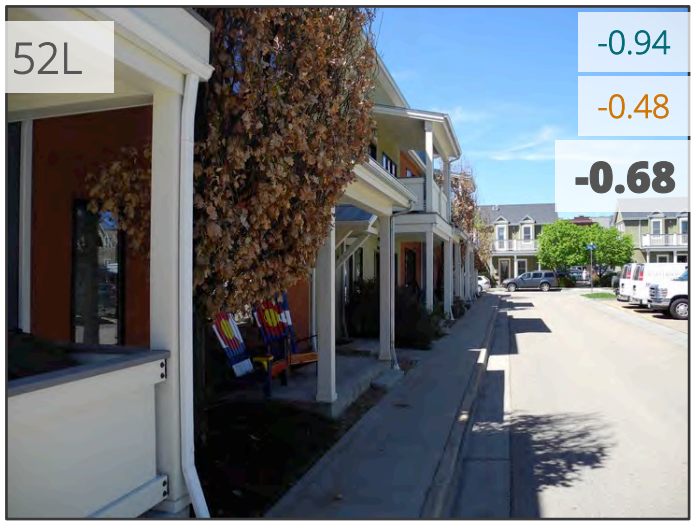
- Too grey – needs trees
- Weird dead space – no grass

Pedestrian Ream IPS Results

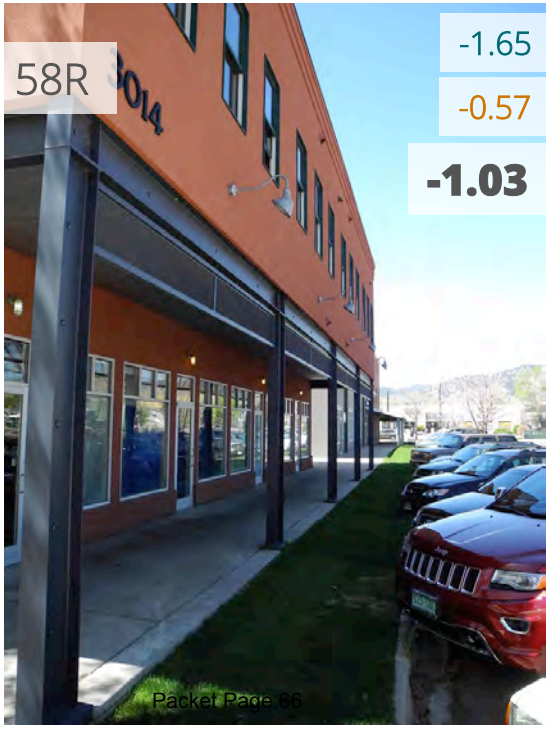
KEY: Joint Board Average Score/Comments | Community Average Score/Comments | **Overall Average Score**

- Poor pedestrian experience, looking down and see entrance far away
- Don't like that building is below sidewalk
- Sloping landscape is bad
- Odd to go down to entrance – prefer to go up

- If residence, gives privacy
- Bike not like it
- Sinking off of sidewalks detracts from public use
- Grade separation makes it uncomfortable and divisive



- Close to street, trees, column
- Looks a little cheap
- Weird sidewalk feels like you will fall off onto street
- Design of building does not give a strong residential feel
- Building is very enclosed



- Feels weird with building, overhang feels overbearing
- Like arcade but is narrow, and has hard edge
- Proportion is off too much for parking – need more people

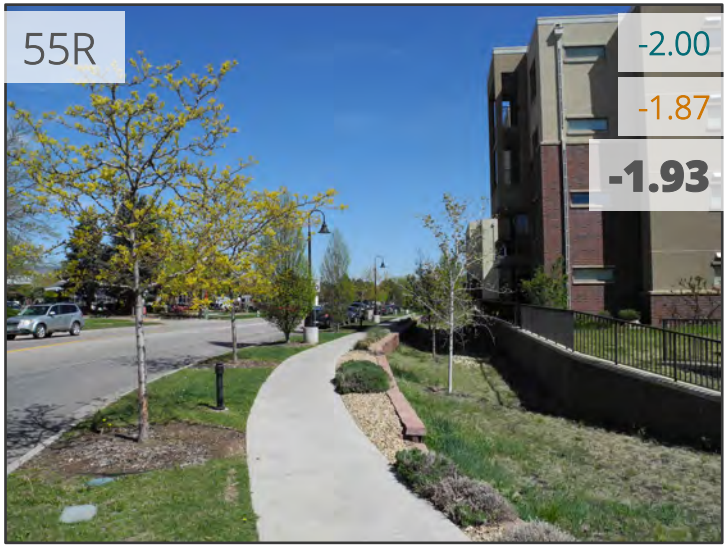
- Needs parallel parking
- Black/brown nice
- Nice if there were plants
- Has to interact with other place and people – needs to connect more
- Windows should be set in
- Tasteful modern design
- Quality building
- Needs more human scale
- Arcade is okay, but needs landscaping
- Feel like sitting in parking lot; cars too close
- Not inviting; dark, unsafe looking; arcade is cave-like
- Canopy & seating can help
- Arcade coverage good to provide shade/multiuse, but must be wide/ high enough for multiple use

- Hard to activate space, too big of setback and dead space
- Barren, no landscaping
- Big windows, but no doors
- Very little awnings (negative)
- Trying to add variation in landscaping, but fails

- Barren and straight
- Materials are good, but façade is still boring
- Don't like zero setback – too harsh
- Like planting area and space with trees and benches
- Strange depth to/al from street – lonely and exposed

Pedestrian Ream IPS Results

KEY: Joint Board Average Score/Comments Community Average Score/Comments **Overall Average Score**



- Too much setback
- No relationship to street

- Street is too far – dividing private/public
- Fence is a barrier
- Should not separate public and commercial
- Building set back too far; don't see people using area
- Poor connectivity

- Don't like wall and fence
- Walking freeway
- Narrow sidewalk – like space between sidewalk & building
- Kid can move
- Moat condition is impenetrable

- Ugly transformers along sidewalk – don't have utility boxes along street
- Has too much void and solid articulation
- Too much space between building and street edge
- No trees
- Building façade too busy
- Light fixtures are not pedestrian scale or anything human scale
- Street speed is too fast to make intimate space
- Like street parking along 30th and remove traffic lanes
- However, not terrible and functional sidewalk but transit-only (bike)
- Have to endure to go through
- Too stark and no access to buildings

- Like wide sidewalk
- Not inviting – too wide
- Invites bike because it's too wide
- Sidewalk not tied to building
- Don't like lawn on urban street; ugly, too much water needed

- Façade is flat, boring, institutional
- Street is not pedestrian friendly
- Planting strips "in center" of sidewalk
- Sitting there doesn't feel nice
- Building ruins streetscape and pedestrian experience
- Zero setback; no soft edge – is too harsh

- Don't like lack of base
- Not enough variation – blank wall, monolithic
- Windows do not invite
- No entries, activity, or awning
- Lack of shape and form

From: noreply@bouldercolorado.gov [mailto:noreply@bouldercolorado.gov]
Sent: Sunday, May 17, 2015 8:06 AM
To: Guiler, Karl
Subject: Form Based Code Feedback Form Results

name: David Takahashi
phone: 1234567890
email: the.dragons.be.here@gmail.com
comments: I believe Form Based Codes will help the world move away from the current zoning single use paradigm to a multi-use paradigm more in line with todays, and more importantly, tomorrow's reality.

The single use zoning almost guarantees vehicle miles traveled between residential and commercial zones. In an age of reducing carbon footprint, this seems like a likely place to affect a cause of automobile dependence, instead of a symptom.

Further, the lack of prescription in the by right process creates needless work in the permitting process, and ends up consuming our planning board docket with developer plans almost exclusively, which leaves little time for the planning board to set the vision for the future in terms of our desired future outcome.

The decision to do a pilot project is commendable. I believe the incremental iterative approach, learn as you go, is one proven to scale well.

Finally, our work today must consider the legacy we will be leaving future generations and the world we bequeath them as an inheritance. Our job is to attempt to leave a BETTER world than the one we were given. I think moving to a form based code can help us.

Keep up the great work!

From: noreply@bouldercolorado.gov [mailto:noreply@bouldercolorado.gov]
Sent: Thursday, May 14, 2015 4:18 PM
To: Guiler, Karl
Subject: Form Based Code Feedback Form Results

name: Amy Helen Tremper
phone: 303-709-9102
email: 40inseam@gmail.com
comments: I am excited about the potential for better design in Boulder.

CITY OF BOULDER
CITY COUNCIL AGENDA ITEM

MEETING DATE: June 15, 2015

AGENDA TITLE: Consider a motion to approve Living Lab Phase II "rightsizing" transportation pilot projects, as part of the implementation of the Transportation Master Plan.

PRESENTER/S: Jane S. Brautigam, City Manager
Maureen Rait, Executive Director of Public Works
Michael Gardner-Sweeney, Acting Director of Public Works for Transportation
Kathleen Bracke, GO Boulder Manager
Dave (DK) Kemp, Senior Transportation Planner
Marni Ratzel, Senior Transportation Planner
Bill Cowern, Transportation Operations Engineer
Shannon Young, Transportation Engineer

EXECUTIVE SUMMARY

One action item of the Transportation Master Plan (TMP) implementation plan is to install "Complete Street" projects through the Living Lab program. Introduced during the TMP update process, the Living Lab approach installs pilot projects to test new roadway designs, allow experimentation, and gather community feedback on the user experience.

The concept of street rightsizing involves the reallocation, or repurposing, of existing street space to safely and comfortably accommodate people walking, bicycling, and driving while reducing motor vehicle speeds, as well as the frequency and severity of motor vehicle collisions. The pilot project evaluation is envisioned as a before/after analysis of technical data, user experience and observational surveys, which will inform the development of a network of low-stress bicycle routes, enhance transit access, and create a more pedestrian-friendly community.

The Living Lab Phase II candidate corridors under consideration for rightsizing include segments of Iris Avenue, Folsom Street, 55th Street, and 63rd Street. A map of the candidate corridors is provided in **Attachment A**. Rightsizing the candidate corridors is

operationally feasible, and staff has created design options to strike a balance among all travel options.

Based upon the guidance provided by City Council during the Feb. 24, 2015 study session, the Transportation Division developed an enhanced and focused public process to gather community input on the Living Lab Phase II design options. The combination of an in-depth technical analysis and a community input process guided the staff recommendation to install the four rightsizing projects.

On June 8, 2015, the Transportation Advisory Board (TAB) held a public hearing and passed three motions recommending that City Council adopt the staff recommendation to advance all four of the rightsizing pilot projects.

If council approves the staff and TAB recommendation, the city will install the rightsizing pilot projects July and August 2015. For the 12 to 18 months following the project installation, staff will utilize walk/bike audits, surveys, social media, and public meetings to gather community input and evaluate the new street configurations.

Staff will periodically brief the Transportation Advisory Board (TAB) and City Council with updates and will request input during the pilot project evaluation phase. Following the evaluation period, staff will return to the TAB and City Council to report on the successes and challenges associated with the rightsizing pilot projects.

STAFF RECOMMENDATION

Suggested Motion Language:
Staff requests council consideration of this matter and action in the form of the following motion:

Motion to approve Complete Streets Living Lab pilot projects to test rightsizing design treatments for 12 to 18 months, as recommended by staff in **Attachment F,** on the following arterial roadways: Iris Avenue (Broadway to Folsom Street); Folsom Street (Valmont Road to Colorado Avenue); 55th Street (Pearl Parkway to Arapahoe Avenue); and 63rd Street (Lookout Road to Gunbarrel Avenue/Nautilus Drive).

COMMUNITY SUSTAINABILITY ASSESSMENTS AND IMPACTS

Economic: The Living Lab pilot projects are a cost-efficient strategy to test transportation designs and roadway treatments to evaluate safety, increase comfort and decrease collisions on city streets.

Environmental: The Living Lab pilot projects are intended to help achieve the city's TMP objectives of reducing single-occupancy vehicle (SOV) travel, managing traffic congestion, and reducing air pollution emissions, including greenhouse gases (GHGs). Biking and walking are zero-emission transportation options that reduce GHG pollution,

and transit and transportation demand management (TDM) programs are key to reducing the number of trips made by SOVs.

Social: The Living Lab pilot projects will further the city's social sustainability goals by increasing transportation mobility, access and safety for all members of the community, including expanding transportation choices for those with low income, older adults and children.

OTHER IMPACTS

- **Fiscal:** The Phase II Living Lab program is supported by existing funding in the city's 2015 budget. The estimated installation cost for completing all four corridors is approximately $300,000. There will also be additional maintenance costs associated with keeping pavement markings and protected bike lane elements in place throughout the experiment.
- **Staff time:** Staff resources for this project are included in the 2015 budget.

BOARD FEEDBACK:

Transportation Advisory Board (TAB)

The TAB has been involved with the community engagement for the Living Lab, providing input on the scope and schedule of the process. Below are links to the TAB meeting packets, along with the final TAB minutes for each meeting.

- Sept. 8, 2014 – Staff briefing and TAB input regarding the Bicycle Living Lab evaluation update and next steps. View the TAB minutes from Sept. 8.
- Feb. 9, 2015 – Staff briefing and TAB input regarding the six-month TMP implementation check-in with City Council. View the TAB minutes from Feb. 9.
- April 13, 2015 – Staff briefing and TAB input regarding the Complete Streets Phase II Living Laboratory program and TAB minutes of April 13, 2015.
- May 11, 2015 – Staff briefing and TAB input regarding the Complete Streets Phase II Living Laboratory program and TAB minutes of May 11, 2015.

On June 8, 2015, the Transportation Advisory Board (TAB) held a public hearing to consider a recommendation to City Council. Fifty community members provided spoke during the public hearing, expressing viewpoints ranging from full support to opposition of the staff proposal. Those opposed to the rightsizing expressed concern for impacts to vehicular travel times. Several community members voiced concerns about the potential for diverting vehicle traffic onto adjacent residential streets along the Iris Avenue corridor. Supporters of the rightsizing pilot projects remarked that enhanced bicycle facilities along each corridor would greatly improve safety with minimal impact on vehicular travel times while advancing the community's goals to reduce greenhouse gas emissions and vehicle miles traveled. View a draft summary of the public testimony.

The TAB passed three motions recommending that council adopt the staff proposal for advancing all four of the rightsizing corridor pilot projects. The motions are as follows:

- **Motion:** TAB recommends that council adopt the staff recommendation on the Iris Avenue Corridor
- **Motion by:** Nozzi
- **Seconded:** Bilich
- **Vote:** 4-0; motion passes

- **Motion:** TAB recommends that council adopt the staff recommendation on the Folsom Street Corridor
- **Motion by:** Nozzi
- **Seconded:** Rigler
- **Vote:** 4-0; motion passes

- **Motion:** TAB recommends that council adopt the staff recommendations on the 55th Street and 63rd Street corridors
- **Motion by:** Bilich
- **Seconded:** Nozzi
- **Vote:** 3-1 (Rigler opposed); motion passes
    - Rigler declines to add an opposing position statement

PUBLIC OUTREACH AND FEEDBACK:

Based upon the guidance from City Council provided during the Feb. 24, 2015 study session discussion, the Transportation Division developed an enhanced and focused public process to gather community input on the Living Lab Phase II design options. Throughout May and early June, a series of stakeholder meetings and pop-up events were conducted to share information and request public comments on the rightsizing design options under consideration. The Transportation Advisory Board (TAB) hosted an open house on May 20 and has been engaged in the development of the corridor projects since the inception of the Living Lab Phase II program.

A calendar with details about all of the public forums is included in **Attachment B**. More than 200 community members participated in the engagement opportunities at the May 20, 2015 open house, stakeholder meetings, and pop-up events. Hundreds of community members provided written comments through social media and email on the proposed design options. The individual comments received prior to distribution of this memo are available on the project Web page and key themes from the comments are summarized later in this section of the memo. In response to several commenters' concerns about the 55th Street candidate corridor pilot project, two stakeholder meetings were scheduled for June 11 (in collaboration with the Flatiron Property Management Team) to present design options and gather input. At the June 16 council meeting, staff will provide a summary of the community feedback gathered from these meetings.

Community engagement has included an extensive social media presence, including a Living Lab introduction video that was shared on Twitter, Facebook and Inspire Boulder. The video has been played more than 380 times since its release on Saturday May 16, 2015. Additionally, several community partners have supported and promoted the community engagement events via their social media outlets.

The www.BoulderLivingLab.net Web page provides project information and an online comment form. Stakeholders interested in receiving emails with periodic updates may sign up for the Boulder Living Lab email newsletter, which will be used to distribute one or two messages a month regarding the Living Lab program, including upcoming engagement opportunities, throughout the duration of the rightsizing pilot projects.

These Web-based tools have enhanced the city's ability to reach new and diverse populations when combined with traditional approaches of print media, open houses and board meetings.

In addition to the aforementioned outreach methods, the project team also presented and received input on design options from the University of Colorado's Pedestrian Safety Committee, Growing Up Boulder, and Better Boulder organizations. To address specific concerns from residents adjacent to the proposed Iris Avenue project area, homeowners' association meetings were also held with the Heritage Meadows and Melody Catalpa neighborhoods. Letters from community organizations received prior to the distribution of this memo are included in **Attachment C**.

While a variety of comments were received, most were supportive of the pilot projects and testing rightsizing design treatments. Common themes of public input are summarized below.

Considerations on the rightsizing approach

- Striking a balance among travel modes is important along these corridors.
- Design aesthetics are important, even for temporary installations, as design often influences perceptions and behaviors.
- Winter maintenance is a concern.
- The efficiency of motor vehicle traffic flow and congestion along the candidate corridors is a concern, especially in the event of emergency response situations.

Support for testing rightsizing treatments

- Improves safety of bicyclists and pedestrians crossing these arterial roadways.
- Encourages people to make active trips by walking and bicycling.
- More buffer is better – it creates a safe separated environment for non-motorized modes within the street.
- Increases walking and biking comfort.
- Improves and provides more north-south bicycling route options.
- Slows motor vehicle speeds.

Concerns for testing rightsizing treatments

- Increases cyclist and bus interactions.
- Delays of vehicles turning left onto Iris Avenue from streets without traffic signals.
- Delays along 55th Street due to the train crossing, tractor trailer trucks and buses.
- Increased traffic along 63rd Street due to the residential and commercial developments recently completed and underway.

Ongoing community engagement during pilot projects
If council approves installation of the pilot projects, staff proposes an active, ongoing community engagement process throughout the duration to seek feedback from the public about their experiences using the new street configurations. This community feedback will be used along with the before/after technical analysis to determine future phases and locations for the Living Lab program.

BACKGROUND
Boulder is committed to providing the best infrastructure for the community to walk, bike, bus, or drive safely and efficiently. Boulder is not alone in this goal, as the U.S. Department of Transportation's Secretary Foxx recently challenged mayors and local elected officials to take significant action to improve safety for bicyclists and pedestrians of all ages and abilities during the next year.

The vision of the city's Transportation Master Plan (TMP) is to create and maintain a safe and efficient transportation system that meets the sustainability goals of the community to accommodate increased trips by providing travel choices and reducing the share of single-occupant vehicle (SOV) trips. The TMP objectives include safety improvements for people using all transportation options while working "Toward Vision Zero" for fatal and serious injury crashes. The 2014 TMP enhanced objectives include reducing SOV travel to 20 percent of all trips for residents and to 60 percent of work trips for non-residents, as well as reducing vehicle miles traveled for both residents and non-resident employees. In addition, the 2014 TMP increases the city's previous goals for walking, biking, and transit mode share. Currently, Boulder residents ride the bus at twice the national average, walk three times as much, and bicycle at 21 times the national average. The 2014 TMP sets ambitious, yet realistic, goals of 30 percent bike, 25 percent walk, and 10 percent transit mode share for all trips taken within the city.

To accomplish these goals, the TMP's Complete Streets focus area strives to accommodate people walking, biking, riding buses, and driving as city transportation facilities are planned, designed, constructed, and maintained. This approach develops the balanced and complete multimodal transportation system needed to enhance safety and increase access while shifting trips away from single-occupant vehicles. An emphasis is to increase walk and bike trips made by women, older adults and families.

Complete Streets Living Lab Program
The Complete Streets Living Lab pilot projects program, which began as part of the 2014 TMP update, is intended to enhance the existing transportation system for cyclists of all ages and riding abilities. The Living Lab program is being deployed in phases of pilot projects, with qualitative and quantitative analysis, including extensive community

feedback, to evaluate the potential for long-term application in Boulder. The Living Lab program builds on prior city experience with "rightsizing" streets such as north Broadway, west Table Mesa Drive, and Baseline Road, as well as from similar work being done in peer cities and national/international examples.

The first phase of Living Lab projects is providing a forum for testing new, innovative facilities and contemporary treatments to improve Boulder's existing bicycle infrastructure. Phase I projects have been opportunistic and primarily bicycle-related, with a focused public engagement process prior to installations and a robust evaluation process after installation, including community feedback, technical evaluation, and field "before and after" behavior observations. Phase I experiences have informed Phase II.

Phase II – Complete Streets Corridors

From a complete streets perspective, corridor enhancements include repurposing street space to better serve all travel options. Responding to input from the community, boards, and City Council during the 2014 TMP update, staff has developed a set of candidate 2015 Phase II Living Lab projects. Potential Phase II projects include a "rightsizing" approach along four candidate corridors, including Iris Avenue, Folsom Street, 55th Street and 63rd Street. These projects are primarily comprised of signing, striping, and markings, and do not include major capital improvements. These projects are temporary in nature, which makes them relatively simple to modify or remove. The impetus of these pilot projects is to collect empirical data to understand and gauge the effectiveness of innovative street designs that increase comfort and safety for people using all modes of transportation along each of the proposed corridors.

Staff anticipates the overall safety of the candidate corridors will be improved by providing center turn lanes where they do not exist today, reducing the number of lanes that pedestrians and vehicles need to cross from side streets, reducing motor vehicle speeds and increasing the visibility of vulnerable users traveling along the corridors. Other benefits of rightsizing include improved safety and comfort for bicyclists by widening and buffering the bike lanes from vehicle travel lanes, fewer vehicle travel lanes for pedestrians to cross, and improved access to transit.

Roadway rightsizing is a practice of revisiting a street design and repurposing vehicle lanes to enhance how the street works for pedestrians, cyclists, and transit users (within the context of adjacent land uses) while maintaining appropriate functionality for motor vehicle trips. Rightsizing projects have been implemented across the United States, with significant benefits for all users. Peer cities that have enhanced bike and walk travel options through rightsizing include Portland, OR; Seattle, WA; Charlotte and Raleigh, NC; Tampa, FL; New York, NY; and Washington, D.C.

While the rightsizing term is new to our community, the concept is not. The city has repurposed vehicle lanes to enhance bicycle facilities along Baseline Road from Mohawk to 30th Street and from 28th to 30th Street; Table Mesa Drive from Broadway to Lehigh Street; 13th Street from Canyon Boulevard to Spruce Streets; Broadway north of Norwood Avenue; and, more recently, Broadway between Linden and Norwood avenues.

The pilot project evaluation will inform the development of a network of low-stress bicycle routes, enhance transit access, and create a more pedestrian-friendly community.

ANALYSIS

The Transportation Division has conducted an extensive analysis of the four proposed corridors and has developed multimodal evaluation criteria that have been previously vetted through the TAB and City Council.

The analysis has yielded the development of conceptual design options based upon the TMP goals of enhancing the bicycling, walking, and transit experience, improving safety, and managing potential trade-offs such as vehicle travel time delays. The multimodal technical analysis, including results of a dynamic system analysis using VISSIM modeling of the four proposed corridors, is provided in **Attachment D**.

Research from peer cities shows that rightsizing projects have resulted in decreased crashes and vehicle speeds while increasing bicycle trips. According to the American Association of State Highway and Transportation Officials (ASSHTO) Highway Safety Manual, an estimated 29 percent reduction in vehicle collisions occurs following the installation of rightsizing treatments.

Locally, staff compiled a collision history detailing the quantity and types of collisions along each of the four proposed corridors. Staff anticipates that the rightsizing treatments will reduce a portion of these collisions. A summary can be found in **Attachment E.**

Highlights of Multimodal Analysis

The results of the technical analysis have provided a basis for understanding the operational and safety benefits and challenges associated with rightsizing the four candidate corridors. From an operational perspective, rightsizing each of the candidate corridors is feasible, provides multimodal benefits, and supports the goals of the TMP. At the intersections of Iris Avenue at Broadway and of Folsom Street at Arapahoe Avenue, the analysis indicates that rightsizing would significantly increase vehicle travel time by creating a compounding queue effect. To address these operational challenges, staff prepared multiple design options for community consideration.

Design Options

Rightsizing four-lane arterials can be generally accomplished using two different lane configurations: four-to-two lane conversion or four-to-three lane conversion. The technical analysis revealed several operational challenges associated with the four-to-two lane conversion, including vehicle left-turn difficulties and the potential for increased rear-end collisions. Therefore, staff proceeded with design options based upon the four-to-three lane conversion, which allows for the installation of a continuous vehicle left-turn lane while maintaining a buffer between the vehicle lane and the bicycle lane. When comparing the two lane configurations side by side, the addition of the continuous left-turn lane allows vehicles to transition from the through lane into to the left-turn lane, thereby maintaining corridor throughput for motor vehicles.

Physical Separation Types for Bike Lane Facilities
A buffered bike lane is a facility that creates space between the vehicle travel lane and the bike lane. The buffer is typically demarcated with striping. A protected bike lane, or "cycle track" is similar to a buffered bike lane, but is equipped with a method of physical separation. Several options exist to physically separate bike lanes from vehicle travel lanes. Staff recommends utilizing temporary vertical elements (flexible delineators) to provide physical separation during the experimentation phase of the rightsizing projects. If any of the projects are deemed unsuccessful; this temporary protection will be less costly to remove. Opportunities to improve the aesthetic appeal of the protective barriers can be evaluated following the conclusion of the experiment.

Project Corridors

Folsom Street *(Valmont Road to Arapahoe Avenue) – Existing conditions: Four/five-lane arterial roadway with substandard bike lanes in each direction.*

The goals of rightsizing can be accomplished successfully along the majority of the corridor. The operational challenges associated with Folsom Street are in the section between Pearl Street and Arapahoe Avenue, with the greatest challenge at the Arapahoe Avenue intersection. Currently, dual southbound left-turn lanes at this intersection accommodate the bulk of the turning movements during the evening peak time, as traffic is generally moving from a northwest to southeast direction. Rightsizing the intersection of Arapahoe Avenue (Option 1) involves the removal of one of the southbound left turn lanes, which would create significant travel time delays for motor vehicle drivers, but would create a seamless, enhanced travel lane for bicyclists.

Option 2 would be to extend the rightsizing treatment to Canyon Boulevard, leaving the existing four-lane segment of road between Canyon Boulevard and Arapahoe Avenue to better accommodate motor vehicle traffic. Additional modifications can be made to improve the comfort and safety of bicyclists along this segment of the road while improving the overall performance of the corridor, as compared to Option 1.

Option 3 would provide the least amount of travel time delay for motor vehicles and would address operational challenges between Canyon Boulevard and Pearl Street, but would have an impact on the bicycle facility by lengthening the gap between the proposed protected bike lanes at South Street and the buffered bike lanes south of Arapahoe Avenue.

The following table describes the design options and associated considerations.

Option	Consideration
Folsom 1 Valmont Road to Arapahoe Avenue – Includes removal of one	• Provides a protected bikeway along the entire length of the corridor in both directions. • Increases delay and travel time of southbound traffic between Canyon Boulevard and Arapahoe Avenue. The traffic queues would extend along a large portion of corridor.

of the dual southbound left-turn lanes.	• More than doubles average southbound motor vehicle travel time in the evening peak time.
	  o Existing travel time: 3 minutes 12 seconds
	  o Option #1 forecasted travel time: 6 minutes 35 seconds (105% increase from existing travel time).
	• Has the greatest potential for traffic diversion and corresponding impact on adjacent transportation facilities.

Folsom 2
Valmont Road to Canyon Boulevard – Maintains dual southbound left-turn lanes at Arapahoe Avenue
	• Maintains the vehicular capacity of southbound Arapahoe Avenue for high-volume, southbound left-turn movements.
	• Reduces southbound queues from impacting the entire corridor, when compared to Option 1.
	• Mitigates potential increase in motor vehicle travel time in the PM peak period:
	  o Existing travel time: 3 minutes 12 seconds.
	  o Option #2 forecasted travel time: 4 minutes 30 seconds (41% percent increase from existing travel time).
	• Provides a southbound bike box at Arapahoe Avenue.
	• Has less potential for traffic diversion and corresponding impact on adjacent transportation facilities than Option 1.

Folsom 3 Valmont Road to South Street - Maintains dual southbound left-turn lanes at Arapahoe Avenue	Same as Option 2, except: • Improves vehicular operations at Arapahoe Avenue and Canyon Boulevard intersections. • Results in less motor vehicle travel time when compared to other two options. • Truncates the protected bike lanes to South Street widening gap of enhanced bicycle facility. • Introduces a lane reduction with a merge for northbound vehicles. • Has the least potential for traffic diversion and corresponding impact on adjacent transportation facilities.

Based on the technical analysis, staff recommends Option 2, which would install protected bike lanes along Folsom Street from Valmont Road to Canyon Boulevard. To increase bicyclists' comfort and safety in the non-rightsized segment between Canyon Boulevard and Arapahoe Avenue, a one-foot buffer stripe would be installed between the bike and travel lanes. Staff would also install and experiment with a bike box facility on Folsom Street at Arapahoe Avenue to improve visibility and queuing space for bicyclists at this intersection. The recommendation would include installation of buffered bike lanes south of Arapahoe Avenue along Folsom Street to connect to Colorado Avenue and the University of Colorado Boulder. The estimated installation cost of Option 2 is $140,000.

Iris Avenue *(Broadway to Folsom Street) – Existing conditions: Four-lane arterial roadway with substandard bike lanes in each direction.*

The goals of rightsizing can be accomplished successfully along the majority of the corridor. The operational challenge for rightsizing the full extent of Iris Avenue exists at the

Broadway intersection during the evening peak time. Currently, dual westbound left-turn lanes on Iris Avenue accommodate the bulk of vehicle turning movements at the intersection. Removing one of the left-turn lanes (Option 2) at this location in order to rightsize the intersection would create significant travel delays and corresponding vehicle queuing along westbound Iris Avenue, with vehicles estimated to back up as far as 19th Street during the weekday evening peak time between 3 and 7 p.m. However; rightsizing the intersection of Iris Avenue and Broadway would also create a seamless, enhanced bike lane within the roadway.

Option 1 would maintain the dual left-turn lanes on Iris Avenue at Broadway to accommodate the bulk of left-turning motor vehicles. A traditional non-buffered bike lane would extend from the end point of the rightsize treatment to the intersection. Staff also proposes to construct an extension of the multi-use path along the north side of Iris Avenue to connect 16th Street to Broadway and better accommodate bicyclists.

Currently, the volumes of traffic along Iris Avenue make it difficult to turn left from side streets during certain times of the day. Some community members have expressed concern that repurposing a lane in each direction will exacerbate this condition. To address this concern, staff is conducting additional study to measure before and after conditions. Staff anticipates that conditions will generally improve following the rightsizing installation, since left-turn vehicles will cross one lane of traffic instead of the current two lanes. Vehicles may also enter into the continuous left-turn lane from side streets to transition safely into the through lane. Additionally, left-turning vehicles from Iris Avenue onto side streets such as 16th and 22nd streets may transition from the through lane into the continuous left-turn lane. Staff also anticipates that this design feature may also mitigate the potential for rear-end collisions.

The following table describes the design options and associated considerations.

Option	Consideration

Iris 1
Maintain two westbound left-turn lanes at intersection of Iris Avenue and Broadway
	• Maintains vehicular capacity at Broadway for high-volume left turns and mitigates most of the potential travel time increase.
	• Slightly increases WB motor vehicle travel time in the PM peak period:
	  o Existing travel time: 2 minutes 54 seconds.
	  o Option #1 forecasted travel time: 3 minutes 6 seconds (7% increase in travel time from existing travel time).
	• Has the least potential for diversion of traffic and corresponding impacts to adjacent roadways.

Iris 2 Remove one westbound left-turn lane at Broadway	• Provides a protected bikeway along the entire length of the corridor in both directions. • Allows a double-buffered westbound bikeway at Broadway. • Increases westbound traffic delays and queues at Broadway. The

	queue blocks vehicles from reaching appropriate turn lanes and resulting compounding queues were modeled to extend east to 19th Street.
	• Increases average WB travel time significantly (double) in the PM peak period:
	  o Existing travel time: 2 minutes 54seconds
	  o Option 2 forecasted travel time: 4 minutes 50 seconds (98% increase from existing travel time).
	• Has the greatest potential for diversion of traffic and corresponding impact to adjacent roadways.

Staff recommends Option 1. Maintain the dual westbound left-turn lanes at Iris Avenue at Broadway. Construct an extension of the multi-use path on the north side of Iris to connect Broadway to 16th Street that would better accommodate less confident or non-seasoned bicyclists. Right-size Iris Avenue from Folsom Avenue to roughly 300' east of Broadway and install protected bike lanes. The estimated installation cost of Option 1 is $89,000.

63rd Street *(Lookout Road to Gunbarrel Avenue/Nautilus Drive) – Existing conditions: Five-lane arterial roadway with no bike lanes.*

Staff recommends rightsizing the full extent of the proposed project along 63rd Street from Lookout Road to Gunbarrel Avenue/Nautilus Drive. 63rd Street presents no significant operational challenges to achieve the goals of rightsizing. The vehicle lanes can be reduced to one through lane in each direction without any significant travel delays, while also accommodating buffered bike lanes in both directions. The corridor is currently operating at high level of service for motor vehicles. Staff's analysis indicates that the rightsized corridor will continue to function with limited travel delays, even with the anticipated level of development in Gunbarrel. The estimated installation cost is $46,000.

55th Street *(Pearl Parkway to Arapahoe Road) – Existing conditions: Five-lane arterial roadway with standard bike lanes in each direction.*

Staff recommends rightsizing the full extent of the proposed project along 55th Street from Pearl Parkway to Arapahoe Avenue. 55th Street presents no significant operational challenges to achieve the goals of rightsizing. The vehicle lanes can be reduced to one through lane in each direction without any significant travel delays, while also accommodating buffered bike lanes in both directions. The only operational caveat to 55th Street concerns the Burlington Northern Sante Fe (BNSF) railroad crossing. Currently, irregular and infrequent trains crossing 55th Street can sometimes cause traffic congestion. The rightsizing may exacerbate this traffic congestion in some instances when the train passes through 55th Street. The estimated installation cost is $54,000.

<u>Staff Recommendation Summary</u>

The staff-recommended conceptual designs are provided in **Attachment F** and details of the corridor plans, design options, renderings, and open house materials can be viewed on www.BoulderLivingLab.net.

Living Lab Phase II Evaluation Criteria
Rightsizing pilot projects installed as part of the Living Lab are anticipated to continue for 12 to 18 months. Performance monitoring will include several qualitative and quantitative measurements. A matrix of quantitative and qualitative transportation data collection and evaluation measures for each corridor is provided in **Attachment G.** Staff collected "before" data in April and May 2015. Post-installation data collection will continue throughout the duration of the pilot projects.

Following the installation of the pilot projects, community feedback will be gathered through social media and direct contact with city staff through traditional correspondence and walk/bike audits.

A Low-stress Bicycling Network Connectivity analysis underway citywide will provide an understanding of the functionality of the existing bike network and quantify the value of the rightsizing pilot projects. High-stress streets are measured as those with high speed limits, limited or nonexistent bike lanes and signage, and large distances to cross at intersections. A before/after level analysis of the Living Lab pilot projects is planned to determine whether these treatments reduce stress levels for bicyclists. The low-stress network analysis also will help guide prioritization of potential transportation improvement projects that would create a connected low-stress bicycle network. Additionally, the results of rightsizing pilot projects will inform the development of bikeway design installation guidelines and refine multimodal access policy, as identified in the update of the 2014 Transportation Master Plan.

NEXT STEPS
If the proposed Living Lab pilot projects are approved by City Council, staff will proceed with the installations on Folsom Street and Iris Avenue in July, and on 63rd and 55th streets in August. The city will coordinate the installations with existing special events and back to school travel needs in order to mitigate any potential conflicts. The pilot program will include ongoing community outreach on the experiments, along with ongoing evaluation to encourage public participation and input throughout the 12- to 18-month project duration. Corridors will be evaluated at the end of the experiment to determine if corridor improvements remain, are modified or removed.

Please visit www.BoulderLivingLab.net for more information.

ATTACHMENTS:
- Attachment A: Map of Living Lab Phase II candidate corridors
- Attachment B: Spring 2015 engagement opportunities calendar
- Attachment C: Letters from community organizations
- Attachment D: Multimodal technical analysis memo

- Attachment E: Safety Analysis for Phase II Living Laboratory Projects
- Attachment F: Proposed corridor design options
- Attachment G: Project evaluation criteria

Rightsizing Candidate Corridors Map

For more information visit:
BoulderLivingLab.net

Spring 2015 Engagement Calendar

Monday	Tuesday	Wednesday	Thursday
4	5	6	7
East Stakeholder Meeting 4 to 6 p.m. Valmont Presbyterian Church	**Pop Up Events** Iris Foothill Elementary 7:45-8:15am **City Council Meeting** 6 pm	**West Stakeholder Meeting** 4 to 6 p.m. Unity Spiritual Center of Boulder	**Walk/Bike Audit** Iris + Folsom 4 to 6 p.m. **Pop Up Events** McGuckins 11 a.m.-2p.m.
11	12	13	14
TAB Meeting 6 p.m.	**Pop Up Events 55th** Upslope 4 - 6 p.m.	**Presentation to Better Boulder**	
18	19	20	21
Pop Up Events 63rd Street Avery Tap Room		**Living Lab Open House** 4 to 6 p.m. BMOCA	**Walk/Bike Audit** 55th 4 to 6 p.m.
25	26	27	28
Memorial Day			**Presentation to Boulder Chamber**
1	2	3	4
Walk/Bike Audit 63rd 4 to 6 p.m.	**Neighborhood Meetings** Iris Avenue		
8	9	10	11
TAB Meeting Council Chambers 6 p.m.			
15	16	17	18
	Council Meeting Council Chambers 6 p.m.		

May 18, 2015

Better Boulder supports the proposed "rightsizing" pilot projects on Iris, Folson, 55th and 63rd street. We believe that these projects can make our roads safer, create a more pleasant environment for people walking and cycling, and thus give more people real choices in how they travel. A sustainable future for Boulder requires a city that is designed for people, not just for cars.

Many other communities have taken 4 lane arterials and retrofitted them into complete streets, and have found that there are multiple benefits. Studies have shown that at the type of traffic volumes found on these streets, road diets don't increase congestion, and that neighboring businesses see no negative impacts. According to the US Department of Transportation, studies show that road diets reduce traffic crashes by an average of 29 percent.

At the same time, we believe that the city should be very thoughtful about how these projects are implemented. It is important that these be successful, and receive wide community support. We are encouraged by the detailed corridor analysis that the city has performed, which shows that over the vast majority of these corridors rightsizing can be done with little increased vehicle delay. The studies identify two problematic sections – Iris from Broadway to 15th and the section of Folsom from South Street to Arapahoe. We would recommend a careful approach that avoids additional vehicle congestion in these locations in order to maximize the likelihood that the pilot project will be well-received by residents who use all transportation modes.

We also support the pilot approach, allowing modifications to improve performance as we learn how these work in practice on these particular corridors. However, the appearance matters – it is important that these by beautiful, not just functional, so we would encourage, for example, the use of planters rather than plastic bollards.

www.betterboulder.com; info@betterboulder.com

FOX TUTTLE HERNANDEZ
TRANSPORTATION GROUP

MEMORANDUM

To: David Kemp, City of Boulder

From: Bill Fox, PE
Steve Tuttle, PE, PTOE

Date: April 29, 2015

Project: Living Lab "Rightsizing" Corridor Evaluations

Subject: Technical Summary

As part of the ongoing Living Lab project, the Fox Tuttle Hernandez Transportation Group has been working with City of Boulder staff to evaluate potential changes to several roadway corridors to better optimize effective use of existing roadway widths for all modes of travel. These "rightsizing" evaluations have included several stages of evaluation and preliminary concept design to identify impacts and trade-offs between current and proposed operating conditions. The purpose of this memorandum is to summarize these efforts.

Candidate corridors being considered for the rightsizing pilot project design treatments include:

- Iris Avenue from Broadway to Folsom Street
- Folsom Street from Arapahoe Avenue to Valmont Road
- 55th Street from Arapahoe Avenue to Pearl Parkway
- 63rd Street from Lookout Road to Gunbarrel Avenue

All of these roadways, except 63rd Street, currently have on-street bicycle lanes with two through lanes in each direction and with varying left-turn lane accommodations. An initial assessment of

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daily traffic volumes by City Staff along these corridors suggests there is the potential for repurposing an existing through lane in each direction to enhance multi-modal travel. The more detailed assessments that have been performed by Fox Tuttle Hernandez are described in the following text.

Preliminary Level of Service Screening

Fox Tuttle Hernandez performed a comparison of vehicle Level of Service (LOS) modeling at signalized intersections using Synchro software between the existing and future roadway design. The existing laneage on each corridor was compared to the possible repurpose of one through lane per direction to provide an improved bicycle facility. This analysis was summarized in detail in a memo to staff dated December 31, 2014. The results of this LOS screening showed that the majority of the corridor intersections could operate with repurposed vehicular lanes without significant impacts to overall intersection or individual approach movement LOS. The screening also identified key intersections and traffic movements along the Iris Avenue, Folsom Street, and 55th Street corridors where removal of existing vehicular lanes would result in poor LOS (typically LOS E or F), particularly in the PM peak hours due to heavy traffic volumes. These key locations include:

Level of Service: *To measure and describe the operational status of an intersections a grading system referred to as "Level of Service" (LOS) is used that is defined by the Highway Capacity Manual. LOS characterizes the operation conditions of traffic flow, ranging from LOS A (very good, free flow) to LOS F (congested and sometimes oversaturated). These grades represent the perspective of drivers and are an indication of the comfort and convenience associated with traveling through the intersections. The intersection LOS is represented as a delay in seconds per vehicle for the intersection as a whole and for each turning movement.*

- Iris Avenue – Westbound Approach at Broadway (existing dual-left turn lane)
- Folsom Street – Southbound Approach at Arapahoe Avenue (existing dual-left turn lane)
- Folsom Street – Northbound and Southbound Approach at Canyon Boulevard
- Folsom Street – Northbound Approach at Pearl Street
- 55th Street – Southbound Approach at Arapahoe Avenue (existing dual-left turn lanes)

The capacity analysis of 63rd Street focused on the signalized intersections at Lookout Road and at Spine Road. The LOS results indicated that the rightsizing of 63rd Street will not impact the overall LOS of either intersection. Lookout Road will have LOS C overall in both scenarios and Spine Road will have LOS B overall in both scenarios. The movement LOS will remain the same as existing even

with the repurposing of one travel lane and there would be relatively low impacts to the vehicular operations along the corridor. Due to the acceptable LOS results with one travel lane repurposed on 63rd Street, it was determined that further evaluation in VISSIM was unnecessary.

Deciding to Rightsize between 4 to 3 Lanes OR 4 to 2 Lanes

Currently, Iris Avenue and the northern segment of Folsom Street have 4 travel lanes with no center turn lane between the larger signalized intersections. In these sections there is the potential to rightsize to either 2 or 3 lanes, where the 3 lane segments would maintain a two way center turn lane in the middle of the roadway. Maintaining a center turn lane allows left turning motorists to move out of the through lane when slowing and potentially waiting to turn left at a driveway or unsignalized intersection. Eliminating the center turn lane allows for wider buffers, but also results in the potential for an increase in traffic accidents, particularly rear-end collisions.

Based on a review of existing traffic counts and information in the National Cooperative Highway Research Program's (NCHRP) Report 279, *Intersection Channelization Design Guide* (see Appendix for reference materials), and the Federal Highway Administration's (FHWA) *Road Diet Informational Guide*, it is recommended to eliminate the rightsize opton from 4 to 2 lanes. The minor street volumes compared to the main street volumes indicated that Iris Avenue and Folsom Street (north section) needed to provide a center turn lane to reduce the potential congestion and conflict with left-turning vehicles. All of these areas still allowed for a significant buffer between the through lane and the bike lane in each direction.

The corridors of 55th Street and 63rd Street were not considered for a 4 to 2 lane conversion because there are physical medians and prohibit restriping to a 4 to 2 lane conversion. The medians provide left-turn lanes where necessary and divide the roadway along the entire length of the study areas. It is proposed that these corridors rightsize from a 4 to 3 lane roadway, with the center lane maintaining the existing median.

Travel Time and VISSIM Modeling

While the LOS analysis using Synchro modeling provided a high-level, macroscopic view of projected intersection delays, VISSIM software modeling was then used to provide a microscopic simulation of traffic flow for both vehicles and bicycles along the Iris Avenue, Folsom Street, and 55th Street corridors. VISSIM modeling provides a three dimensional depiction of the corridor and models all vehicles and traffic controls. The model can be viewed to observe traffic queues and vehicular interactions, while also providing quantitative results such as corridor and segment travel times. While individual intersection LOS results provided by the Synchro model are a

common metric used by transportation engineers, travel times are more easily understood by a greater audience and also tell more about potential impacts on a corridor-length basis.

The VISSIM models for Iris Avenue, Folsom Street, and 55th Street were created for existing AM and PM peak hour conditions, with existing laneage, vehicular volumes, bicycle volumes, pedestrian crossing volumes, existing signals and signal timing. To validate the accuracy of the VISSIM model and determine if any calibration was needed, the VISSIM travel time results were compared to travel time data collected in the field for these corridors.

Existing travel time was collected manually for Iris Avenue, Folsom Street, and 55th Street. On the week of November 18, travel time runs were completed for each corridor during the AM and PM peak hours. The data collection plan and methodology is consistent with the *Travel Time Data Collection Handbook (FHWA, March 1998)*.

Six travel time runs for each direction were performed for each corridor. The start and end times, control point times, and stopped times were recorded during each run. The start location was the upstream intersection from the beginning of first intersection of the rightsize corridor. The signalized intersections were identified as the control points where the time was taken when the stop bar was crossed. The amount of delay was recorded when the vehicle slowed or stopped (less than 5 mph). The end of the travel time was the downstream intersection from the last intersection of the study corridor. All of the recorded times provided the total trip time, running time, stopped time, travel speed, and running speed per travel time run and as an average per peak hour. The data is provided in the Appendix.

The field-collected travel time results were then compared to the VISSIM results for the existing AM and PM peak hour conditions. The results are summarized on charts depicting the elapsed travel time from the start of the study corridor (crossing the near-side stop bar), through to the end of the study corridor for each direction of travel (passing the near-side stop bar of the final intersection). Note that this differs slightly from the "raw" travel time data, which also included the time on the approach to the first intersection in the total travel time. These charts are provided in the Appendix. The charts illustrate that the VISSIM travel time results are very similar to existing field conditions for all scenarios, indicating that the VISSIM model was well calibrated and will provide a useful tool in predicting the effects of corridor rightsizing.

The existing-condition VISSIM models were then modified for several laneage scenarios, with the variations related to addressing the "key" locations noted on page 2 of this report. The travel time charts for each scenario evaluated, which compare each laneage scenario with the "existing"

VISSIM (calibrated) travel time, are provided in the Appendix. The travel time charts are summarized by direction of travel and time period, and include the following information:

- Existing travel time
- Modified laneage travel time. Note that for any corridor, "VISSIM-01" on the travel time chart refers to a repurposed lane in each direction and with reduction of a dual left-turn to a single-left turn for the following approaches (Iris Avenue westbound at Broadway, Folsom Avenue southbound at Arapahoe Avenue, and 55th Street southbound at Arapahoe). "VISSIM-02" refers to a scenario with a repurposed through lane in each direction but maintaining the dual left-turn lanes noted above.
- The "high" travel time for the worst 10-min period of the scenario which had the highest increase in travel time; this was used to evaluate potential variation between the average and worst travel times throughout the hour, particularly where the VISSIM model showed compounding queues and delay extending significant lengths of the corridors, which would continue to build throughout much of the peak hour.
- For the peak hours and directions determined to be most critical (highest potential increases in travel times), there are also charts that show the existing and modified travel times for the "shoulder" peak periods from 3pm-5pm and 6pm-8pm, for some context to what impacts there may be to travel times outside of the peak hour. The volumes used for these "shoulder" peak hours were based on City of Boulder hourly count data at nearby count stations.

The results are summarized and discussed, as follows, with travel time charts provided in the Appendix:

<u>Iris Avenue:</u>

Existing Conditions:

- In the AM peak hour, the VISSIM existing eastbound and westbound travel times averaged 2:33 and 2:42, respectively. In the PM peak hour, the existing eastbound and westbound travel times averaged 2:26 and 2:54, respectively.

Rightsizing Options:

1. Repurpose one through lane in each direction but with maintaining the westbound dual left-turn lanes at Broadway, average travel times increased as follows:
    - AM eastbound: from 2:33 to 2:38
    - AM westbound: from 2:42 to 2:58
    - PM eastbound: from 2:26 to 2:39
    - PM westbound: from 2:54 to 3:06
2. Repurpose one through lane in each direction and repurpose one of the westbound left-turn lanes at Broadway to widen the existing bicycle lanes, average travel times increased as follows:
    - AM eastbound: from 2:33 to 2:41
    - AM westbound: from 2:42 to 3:12, with majority of this added delay on the Broadway approach
    - PM eastbound: from 2:26 to 2:39
    - PM westbound: from 2:54 to 4:50, with majority of this added delay on the Broadway approach and queues spilling back from Broadway through 16th Street
    - Further analysis of the PM westbound data showed that during the worst 10-min period, travel times could be as high as 6.5 minutes with this lane configuration

<u>Folsom Street:</u>

Existing Conditions:

- In the AM peak hour, the VISSIM existing northbound and southbound travel times averaged 2:25 and 2:56, respectively. In the PM peak hour, the existing northbound and southbound travel times averaged 3:31 and 3:12, respectively.

Rightsizing Options:

1. Repurpose one through lane in each direction and maintain the southbound dual left-turn lanes at Arapahoe Avenue, average travel times increased as follows:
    - AM northbound: from 2:25 to 2:45
    - AM southbound: from 2:56 to 3:01
    - PM northbound: from 3:31 to 4:47, with majority of this added delay on the Folsom approach to Pearl Street; further analysis indicated travel times as high as 6:00 during the worst 10-min period.
    - PM southbound: from 3:12 to 4:30, with majority of this added delay on the approach to Canyon Boulevard.
2. Repurpose one through lane in each direction and repurpose one of the southbound left-turn lanes at Arapahoe Avenue to widen the existing bicycle lanes, average travel times increased as follows:
    - AM northbound: from 2:25 to 2:45
    - AM southbound: from 2:56 to 3:02
    - PM northbound: from 3:31 to 4:48, with majority of this added delay on the Folsom approach to Pearl Street; further analysis indicated travel times as high as 6:00 during the worst 10-min period.
    - PM southbound: from 3:12 to 6:35, with majority of this added delay on the approaches to Arapahoe and Canyon; further analysis indicated travel times as high as 8.5 min during the worst 10-min period, with queues extending north of Pine towards Valmont

<u>55th Street:</u>

Existing Conditions:

- In the AM peak hour, the VISSIM existing northbound and southbound travel times averaged 2:15 and 2:10, respectively. In the PM peak hour, the existing northbound and southbound travel times averaged 2:49 and 2:16, respectively.

Rightsizing Options:

1. Repurpose one through lane in each direction, a single northbound left turn lane at Pearl Parkway, a single westbound left-turn lane on Pearl Parkway to southbound 55th Street, and maintain the southbound dual left-turn lanes at Arapahoe Avenue, average travel times increased as follows:
    - AM northbound: from 2:15 to 2:30
    - AM southbound: from 2:10 to 2:17
    - PM northbound: no increase (this is due to improved operation of the northbound left-turn at Pearl Parkway operating as a protected-permissive single left-turn lane vs. the existing dual protected-only operation, offsetting any delay created by the repurposed through lane along the corridor)
    - PM southbound: from 2:16 to 2:26
2. Repurpose one through lane in each direction and reduce to one southbound left turn lane at Arapahoe Avenue:
    - AM northbound: from 2:15 to 2:30
    - AM southbound: from 2:10 to 2:26
    - PM northbound: no increase (this is due to improved operation of the northbound left-turn at Pearl Parkway operating as a protected-permissive single left-turn lane vs. the existing dual protected-only operation, offsetting any delay created by the repurposed through lane along the corridor)
    - PM southbound: from 2:16 to 5:35, with delays and queues initially building up from Arapahoe but then extending the length of the corridor through each signal; further analysis indicated travel times as high as 10.5 min during the worst 10-min period.

- VISSIM modeling of the existing at-grade railroad crossing between Western Avenue and Central Avenue showed that northbound traffic queues during the AM peak hour (the heaviest northbound traffic period) could extend south to Arapahoe Avenue if the train

event lasted 6 minutes. With the repurposed scenario, the queue would back to Arapahoe Avenue with a 3 minute train event.

The following table summarizes the travel time for each roadway and scenario as described above:

Direction	Peak Hour	Existing	Alternative 1 Rightsize and maintain dual lefts at key Intersection	Alternative 2 Rightsize and reduce to single left at key Intersection
Iris Avenue				
Eastbound	AM	2:33	2:38 (+0:05)	2:41 (+0:08)
	PM	2:26	2:39 (+0:13)	2:39 (+0:13)
Westbound	AM	2:42	2:58 (+0:16)	3:12 (+0:30)
	PM	2:54	3:06 (+0:12)	4:50 (+1:56)
Folsom Street				
Northbound	AM	2:25	2:45 (+0:20)	2:45 (+0:20)
	PM	3:31	4:47 (+1:16)	4:48 (+1:17)
Southbound	AM	2:56	3:01 (+0:05)	3:02 (+0:06)
	PM	3:12	4:30 (+1:18)	6:35 (+3:23)
55th Street				
Northbound	AM	2:15	2:30 (+0:15)	2:30 (+0:15)
	PM	2:49	2:49 (no change)	2:49 (no change)
Southbound	AM	2:10	2:17 (+0:07)	2:26 (+0:16)
	PM	2:16	2:26 (+0:10)	5:35 (+3:19)

The results of the VISSIM modeling for the Iris Avenue, Folsom Avenue, and 55th Street corridors largely confirmed the LOS analysis and that 1) most of the corridor lengths could function with repurposed through lanes and 2) the key approaches and movements noted above could experience long vehicular delays and corresponding increases in corridor travel time if the laneage were reduced on these approaches. The VISSIM modeling and travel time estimates also illustrated the compounding nature of decreased capacity for heavy movements, where traffic queues could quickly extend for several intersections upstream from a bottleneck. The resulting effect on travel times due to multi-block queues spilling back from these heavy movements would be expected to result in some diversion onto other roadways.

Multimodal Enhancements

It should be noted that the decrease in roadway capacity and increase in travel time is a negative impact on vehicles traveling along the corridors, however, the bicyclists and pedestrians are expected to have an increased level of service, safety, and comfort.

Bicyclist experience will improve and they will benefit from:

- Wider bike lanes for comfort and to safely pass other bicyclists
- Buffer from vehicular traffic
- Protection from vehicular traffic encroaching on bike lane (where flexible delineators are provided)
- Slower automobile traffic due to narrower travel lanes
- Enhanced right-turn treatments at high volume intersections
- Increased driver awareness of the bike facility

Pedestrian experience will also improve and they will benefit from:

- Shorter crossing distances since the buffer can be used as a refuge
- Buffer from vehicular traffic that will minimize the "splash zone" and encourage use of the entire sidewalk width
- Slower automobile traffic due to narrower travel lanes creating a better walking environment

With any rightsizing project there are trade-offs between modes of travel and the goal is to balance the available space and level of service for all users.

Design Considerations

On Iris Avenue and Folsom Street the dual left-turns noted previously are locations where maintaining both left-turn lanes would preclude significant improvement to the existing on-street bicycle lanes. The buffered bikeway would have to end prior to the distance required to accommodate the dual left-turn lanes. The LOS analysis indicated the need to maintain the dual left-turn lanes. Further evaluation with VISSIM determined there will be significant queues, blocked turn lanes, and excessive delay if the rightsizing project changed the dual left-turns to a single left-turn (refer to the Travel Time and VISSIM section for more detail).

On 55th Street at Arapahoe Avenue, the roadway width is able to accommodate the buffered bike lanes in both directions while maintaining the dual left-turn lanes. The through lane alignment

across Arapahoe Avenue in both directions was slightly altered to provide the dual lefts and the buffered bikeway.

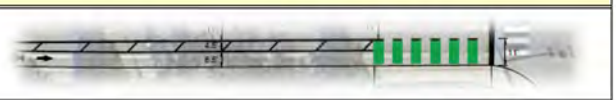
The repurposing of an existing through lane in each direction facilitates the addition of buffered bike lanes. Each corridor varies in width, number of accesses, type of center median, number of bus stops, and travel mode composition, which greatly informed the design of each rightsize corridor. The following design elements are being proposed on each of the studied corridors to fit within the existing roadway width:

Corridor		Bike Lane	Buffer	Travel Lane	Center Lane / Median	Flexible Delineators
Iris Avenue		6.5'	3'	11'	10.5'	Yes
Folsom Street						
North of Spruce St		7'	3.5'	10'	10.5'	Yes
South of Spruce St		7'	6' – 7.5'	10' – 11'	15' – 16'	Yes
55th Street		7'	10'	11'	2' – 14'	No
63rd Street		7'	6'	12'	14'	No

Note: Some variations in the widths occur at signalized intersections to accommodate turn lanes and right-turn treatments.

It should be noted that it is proposed to install a 10-foot multi-use path on the north side of Iris Avenue between Broadway and 16th Street to alleviate some of the conflict for westbound turning bicyclists and vehicles.

As part of this Living Lab project, three design options were created for right-turn treatments at the signalized intersections. These were developed based on information in the NCHRP Intersection Channelization Design Guide, from the National Association of City Transportation Official's (NACTO) Bikeway Design Guide design guidelines and right-turning volume. It is anticipated that the evaluation process will study the compliance and safety of each treatment for further use. The following table lists and illustrates the three right-turn treatments used throughout the four rightsizing corridors.

Right-Turn Treatment	Right-Turning Volume (vph)	Illustration
Skip with Green Dash	1-75	
Mixing Zone	76-125	
Buffered Transition	126+	

On April 7, 2015 staff from the City and Fox Tuttle Hernandez presented the conceptual design on Folsom Street to NACTO in a webinar that was broadcast nationally for a design critique. The purpose of the critique was to gather feedback on additional design options for the corridor and learn from the critics past experiences on similar projects. The project team has received the comments and suggestions which will be discussed further in a future meeting.

Additional designs were created to address the operational challenges as listed previously. The VISSIM analysis indicated that the rightsizing the entire length of the corridor and removing the existing dual left-turn lanes on some of the study corridors has significant impacts to the vehicular capacity and travel time. Therefore, alternative designs were created for Iris Avenue and Folsom Street. The following table lists some considerations with each scenario:

Alternative	Considerations
Iris Avenue	
1 Maintain dual WB dual lefts at Broadway	• Maintains vehicular capacity at Broadway for high-volume left-turn and mitigates most the potential corridor travel time increase with rightsizing • Significantly reduces potential WB queues when compared to full rightsize option. • Shortens the length of the potential EB buffered bikeway to 13th Street. • Narrows travel lanes in both directions for length of left-turn lane/taper
2 Full rightsize and reduce to single WB left at Broadway	• Provides buffered bikeway the entire length of the corridor in both directions. • Allows double buffered bikeway at Broadway WB. • Increases delay and queue of WB traffic at Broadway. The queue blocks vehicles from reaching appropriate turn lane and resulting compounding queues were modeled to extend east to 19th Street • Increases average WB travel time significantly (nearly double) in the PM peak hour.

Alternative	Considerations
Folsom Street	
1 Rightsize between Valmont Rd and Canyon Blvd and maintains dual left at Arapahoe Ave	• Maintains vehicular capacity SB at Arapahoe for high-volume left-turn • Reduces SB queues from impacting entire corridor when compared to full rightsize option. • Mitigates potential increases of the VISSIM-modeled average travel time to less than 78 seconds in each direction and during both peak hours. • Moves the beginning of the NB buffered bikeway to Canyon Blvd. • Ends the SB buffered bikeway at Canyon Blvd. • Provides a SB bike box at Arapahoe Ave. • Provides wider bike lane between Canyon Blvd and Arapahoe Ave.
2 Full rightsize and reduce to single SB left at Arapahoe Ave	• Provides buffered bikeway the entire length of the corridor in both directions. • Increases delay and queue of SB traffic between Canyon Blvd and Arapahoe Ave. The queues extents a large portion of corridor. • Increases average SB travel time significantly (nearly double) in the PM peak hour. • Increases NB travel time by one minute 17 seconds in the PM peak hour.
3 Rightsize between Valmont Rd and South St and maintains dual left at Arapahoe Ave	• Improves vehicular operations at Arapahoe Ave and Canyon Blvd. • Reduces SB queues from impacting entire corridor when compared to full rightsize option. • Results in less travel time increase compared to other alternatives. • Moves the beginning of the NB buffered bikeway to South St. • Ends the SB buffered bikeway at South St. • Provides a SB bike box at Arapahoe Ave. • Provides wider bike lane between Canyon Blvd and Arapahoe Ave. • Introduces a lane reduction with merge for NB vehicles.

As a part of this project, there is potential for the Folsom Street corridor to extend south of Arapahoe Avenue to Colorado Avenue. A conceptual design has been drafted and is currently under review. Further evaluation is needed along this portion of Folsom Street to determine the impacts to the existing intersections, left-turn lanes, and bicycle safety up/down the hill.

/BF/SGT

Appendix:

NCHRP Report 279, *Intersection Channelization Design Guide*
Field Travel Time Data
Travel Time Charts – Iris Avenue
Travel Time Charts – Folsom Street
Travel Time Charts – 55th Street

Appendix:

NCHRP Report 279, Intersection Channelization Design Guide

Field Travel Time Data

Travel Time Charts – Iris Avenue

Travel Time Charts – Folsom Street

Travel Time Charts – 55th Street

NCHRP Report 279, Intersection Channelization Design Guide

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM REPORT **279**

INTERSECTION CHANNELIZATION DESIGN GUIDE

TIMOTHY R. NEUMAN
Jack E. Leisch & Associates
Evanston, Illinois

RESEARCH SPONSORED BY THE AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS IN COOPERATION WITH THE FEDERAL HIGHWAY ADMINISTRATION

AREAS OF INTEREST:

FACILITIES DESIGN
OPERATIONS AND TRAFFIC CONTROL
(HIGHWAY TRANSPORTATION)

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL
WASHINGTON, D.C.

NOVEMBER 1985

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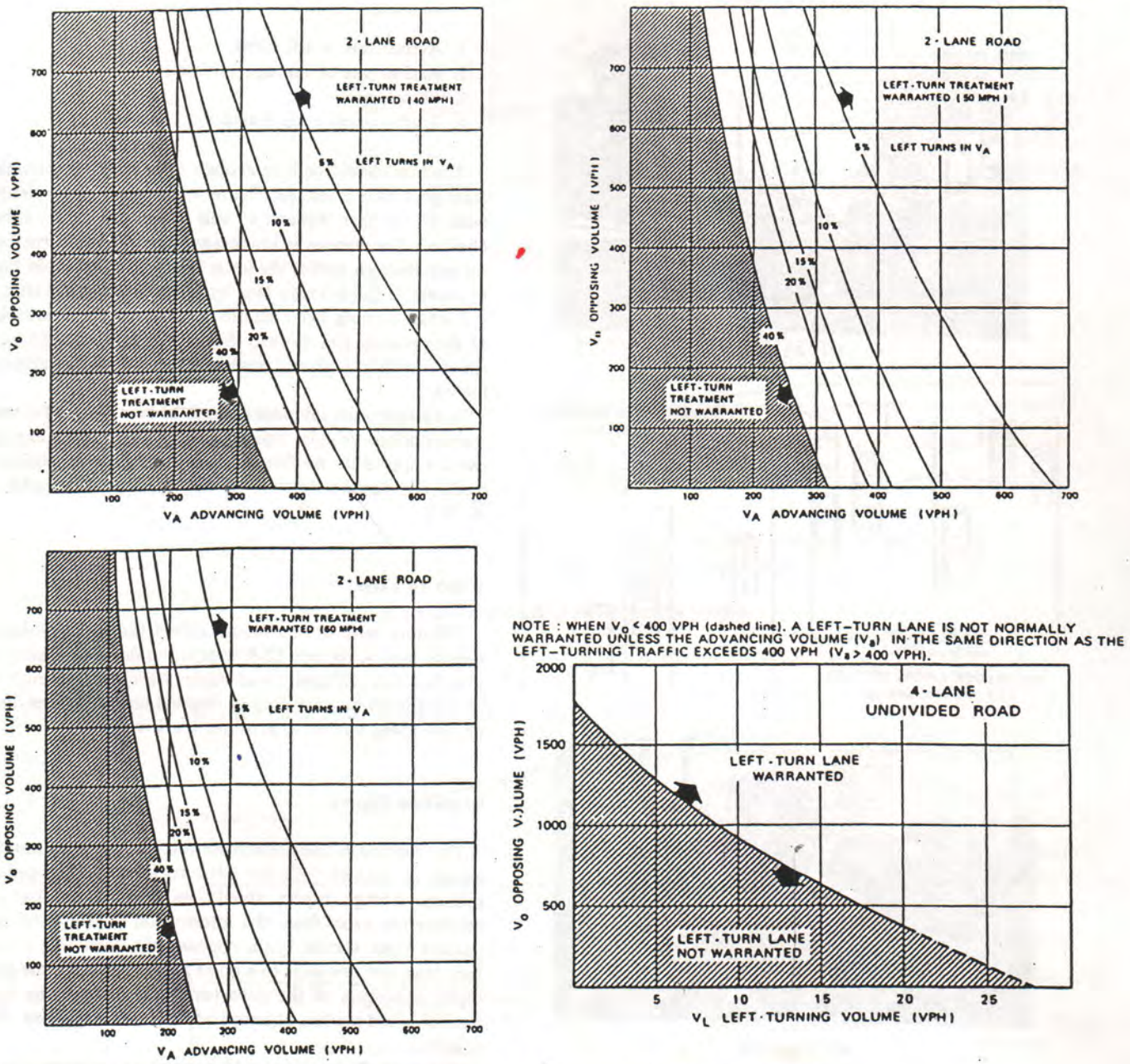


Figure 4-12. Volume warrants for left-turn lanes at unsignalized intersections. (Source: Ref. 4-7)

a partially shadowed left-turn lane, as illustrated in Figure 4-14. With partially shadowed left-turn lanes, the offset created by the approach taper does not entirely protect or "shadow" the turn lane.

Length of Lane

The left-turn lane length is among the most important design element of left-turn lanes. Its design is directly tied to the particular function of the lane, which is based on prevailing speeds, traffic volumes, and traffic control. The design basis for length can be deceleration, storage, or a combination of both.

Left-turn lanes on high-speed highways should be designed to accommodate vehicle deceleration and braking. The channelization principle of removing slow or decelerating vehicles from through traffic applies at such locations. Figure 4-15 illustrates the functional basis for design of deceleration-based left-turn lanes according to AASHTO. The assumed "reasonable" driver behavior includes deceleration in gear for 3 sec., followed by comfortable braking completely within the turning lane. Where constraints exist and speeds are moderate, an al-

$L_d/_b$ -- Length of Taper and Lane For Deceleration and Braking

Functional Basis: To provide sufficient length for a vehicle to decelerate and brake entirely outside the through traffic lanes

Desirable Design: Deceleration in gear for 3 seconds (occurs over bay taper) followed by comfortable braking to a stopped position

Design Values For $L_d/_b$

S--Speed (mph)	Length (ft) Total	Lane	Bay Taper
30	235	90	(145)
40	315	125	(190)
50	435	195	(240)
60	530	240	(290)

Minimum Design: Braking begins at 2/3 full lane width, with minimum 50-foot storage. For low speeds only, the following values apply:

Design Values For $L_d/_b$

S--Speed (mph)	Length (ft) Total	Lane	Bay Taper
30	230	50	(180)
35	250	70	(180)
40	280	100	(180)
45	320	140	(180)

Figure 4-18. Guidelines for design lengths of left-turn lanes.

L_s -- Length of Lane For Storage (Full Width Lane)

Functional Basis: To provide sufficient length for a reasonable number of vehicles to queue within the lane without affecting other lanes

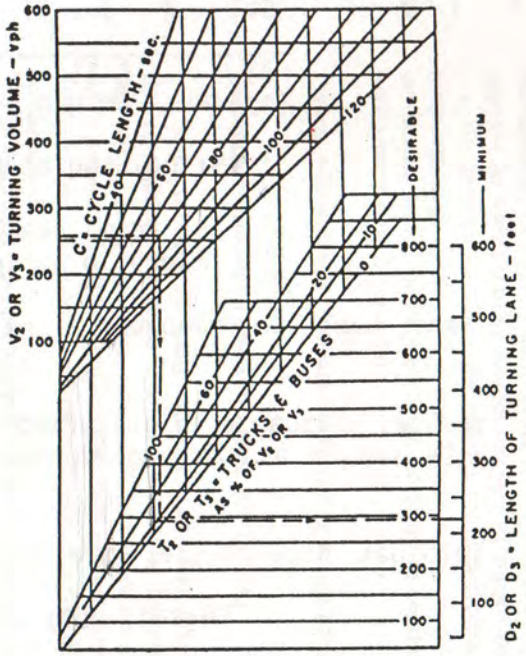
Desirable Design: Based on twice the mean arrival rate (per cycle for signals, per 2-minute period for stop control) during the peak hour of traffic

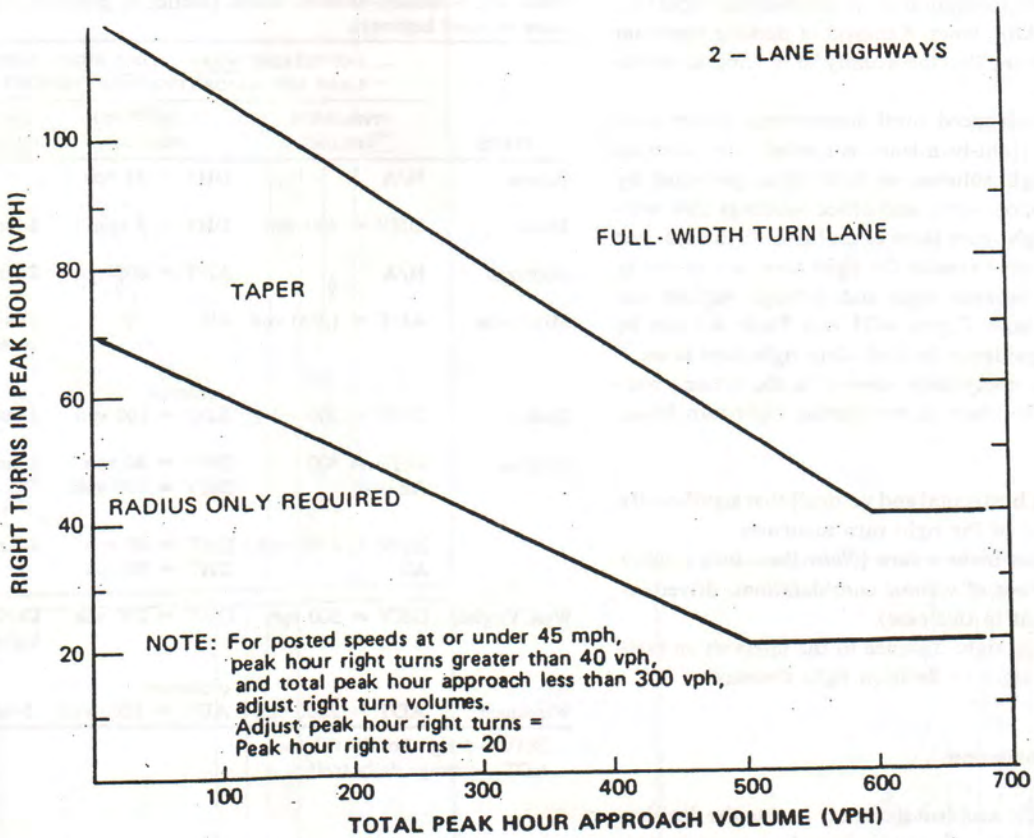
Minimum Design: Based on mean arrival rate, with minimum storage for one vehicle

L_s for Stop Control

DHV (vph)	L_s (ft)
≤60	50-75
61-120	100
121-180	150
>180	200 or more

L_s for Traffic Signal Control





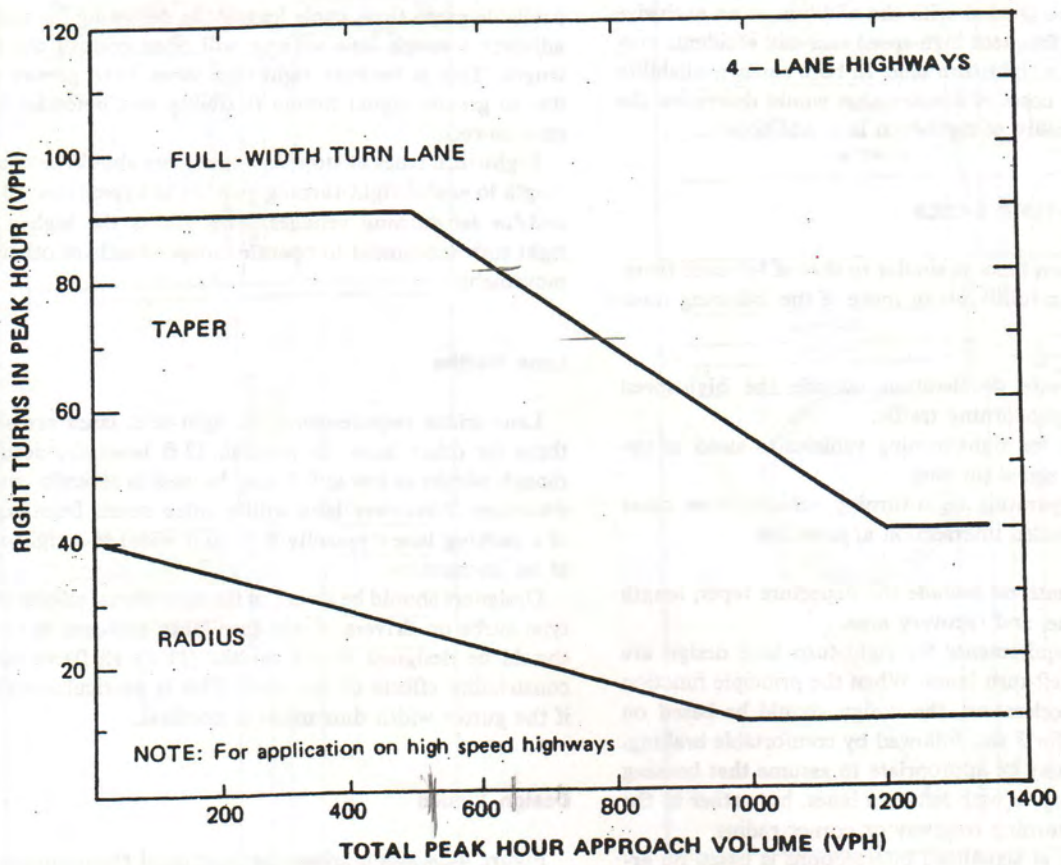


Figure 4-23. Traffic volume guidelines for design of right-turn lanes. (Source: Ref. *4-11*)

$L_d/_b$ -- Length of Taper and Lane For Deceleration and Braking

Functional Basis: To provide sufficient length for a vehicle to decelerate and brake entirely outside the through traffic lanes.

Desirable Design: Deceleration in gear for 3 seconds (occurs over bay taper) followed by comfortable braking to a stopped position or to the design speed of the corner radius.

Design Values For $L_d/_b$

For Design Speed of Corner Radius (mph)

Highway Design speed, V (mph)	Stop Condition*	15	20	25	30
30	235	185	160	140	-
40	315	295	265	235	185
50	435	405	385	355	315
60	530	500	490	460	430
65	570	540	530	490	480
70	615	590	570	550	510

*Appropriate for right turn lanes on approaches to stop signs and traffic signals.

L_s -- Length of Lane For Storage (Full Width Lane)

Functional Basis: To provide sufficient length for a reasonable number of vehicles to queue within the lane without affecting other lanes.

Desirable Design: Based on twice the mean arrival rate (per cycle for signals, per 2-minute period for stop control) during the peak hour of traffic.

Minimum Design: Based on mean arrival rate, with minimum storage for one vehicle.

L_s for Stop Control

DHV (vph)	L_s (ft)
≤60	50-75
61-120	100
121-180	150
>180	200 or more

L_s for Traffic Signal Control

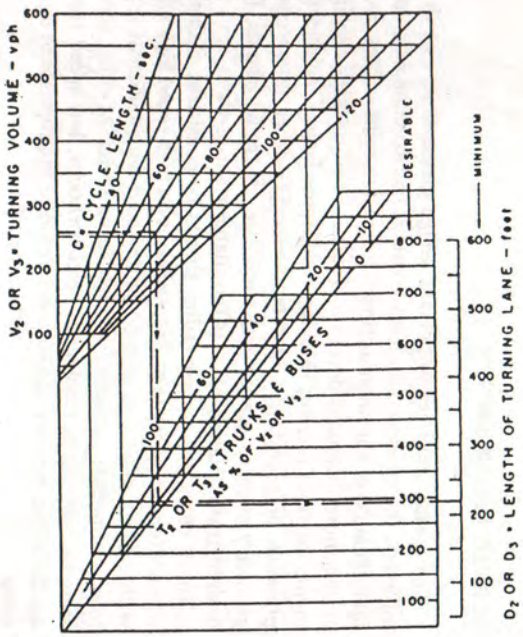


Figure 4-24. Guidelines for design lengths of right-turn lanes.

Field Travel Time Data

Iris Avenue
Travel Time Data
AM Peak 7:30 AM
Date: 11/18/2014
Weather:

From: Retail Access w/o 28th Ave
To: Hawthorne Ave (Westbound)
Juniper Ave (Eastbound)

Direction	Trip No.	Time at Control Points					Stops				Trip Length (mile)	Trip Time (min)	Running Time (min)	Stopped Time (min)	Travel Speed (mph)	Running Speed	Notes
		Broadway	16th St	19th St	22nd St	Folsom St	Location	Time	Cause	Notes							
East	1	0:15	1:21	1:47	2:10	2:35	Broadway	0:36	Signal		1.24	2:58	2:22	0:36	25	31	
	2	0:26	0:57	1:38	2:07	2:45	Broadway Folsom St	0:18 0:09	Signal Signal		1.24	3:09	2:42	0:27	24	28	Posted speed limit is 35 mph. The school zone near 22nd is 20 mph. Occurred during morning travel time.
	3	0:36	1:09	1:34	2:02	2:35	Broadway	0:26	Signal		1.24	2:58	2:32	0:26	25	29	School zone flashing.
	4	0:54	1:28	2:37	3:10	3:48	Broadway 19th St	0:41 0:35	Signal Signal	Arrived on FYA, did not get a gap.	1.24	4:12	2:56	1:16	18	25	School zone flashing.
	5	0:45	1:15	1:57	2:32	3:01	Broadway 19th St	0:30 0:08	Signal Signal		1.24	3:26	2:48	0:38	22	27	
	6	0:38	1:08	2:15	2:39	3:29	Broadway 19th St Folsom St	0:26 0:36 0:11	Signal Signal Signal		1.24	3:56	2:43	1:13	19	27	
	Average	***0:35***	***1:13***	***1:58***	***2:26***	***3:02***					***Average***	***3:26***	***2:40***	***0:46***	***22***	***28***	

Direction	Trip No.	Time at Control Points					Stops				Trip Length (mile)	Trip Time (min)	Running Time (min)	Stopped Time (min)	Travel Speed (mph)	Running Speed	Notes
		Folsom St	22nd St	19th St	16th St	Broadway	Location	Time	Cause	Notes							
West	1	0:36	1:11	1:38	2:08	2:44	Folsom St Broadway	0:09 0:31	Signal Signal		1.28	3:37	2:57	0:40	21	26	
	2	0:25	1:01	1:30	1:57	3:15	Broadway	0:46	Signal		1.28	3:35	2:49	0:46	21	27	The WB left at Folsom St had a queue of 14 vehicles that blocked through lane.
	3	0:21	0:59	2:23	2:56	3:50	19th St Broadway Hawthorne	0:42 0:16 0:06	Signal Signal Bus stop	Arrived at stop bar at 1:40.	1.28	4:28	3:24	1:04	17	23	School zone flashing.
	4	0:26	0:57	1:21	1:49	2:56	Broadway	0:25	Signal		1.28	3:13	2:48	0:25	24	27	The WB left at Folsom St had a queue blocking through lane. School zone on Iris off, but is flashing on Broadway.
	5	0:24	0:52	1:37	2:09	2:39	19th St	0:10	Signal		1.28	2:56	2:46	0:10	26	28	
	6	0:42	1:12	1:49	2:17	3:32	Folsom St 19th St Broadway	0:15 0:06 0:45	Signal Signal Signal	 Arrived at stop bar at 2:50.	1.28	3:48	2:42	1:06	20	28	
	Average	***0:29***	***1:02***	***1:43***	***2:12***	***3:09***					***Average***	***3:36***	***2:54***	***0:41***	***22***	***27***	

Note: "Time at Control Points" is the time the vehicle crossed the stop bar.

Iris Avenue
Travel Time Data
PM Peak 4:30 PM
Date: 11/18/2014
Weather:

From: Retail Access w/o 28th Ave
To: Hawthorne Ave (Westbound)
Juniper Ave (Eastbound)

Direction	Trip No.	Time at Control Points					Stops				Trip Length (mile)	Trip Time (min)	Running Time (min)	Stopped Time (min)	Travel Speed (mph)	Running Speed	Notes
		Broadway	16th St	19th St	22nd St	Folsom St	Location	Time	Cause	Notes							
East	1	0:30	1:04	1:34	1:58	2:27	Broadway	0:18	Signal	Arrived at stop bar at 0:13.	1.24	2:55	2:37	0:18	26	28	
	2	0:43	1:14	2:15	2:41	3:26	Broadway 19th St Folsom St	0:32 0:30 0:10	Signal Signal Signal	Arrived on FYA, did not get a gap.	1.24	3:55	2:43	1:12	19	27	
	3	0:43	1:13	1:38	1:59	2:28	Broadway 28th St	0:28 0:45	Signal Signal	Arrived on FYA, did not get a gap. Queue from 28th extended to Iris Ct Walk (1000 ft)	1.24	3:45	2:32	1:13	20	29	
	4	1:51	2:23	2:47	3:09	3:34	Broadway	1:43	Signal	Arrived on green, did not make it through green or FYA. Queue extended past Juniper Ave.	1.24	3:57	2:14	1:43	19	33	
	5	1:12	1:44	2:40	3:05	3:45	Broadway 19th St Folsom St	0:54 0:20 0:05	Signal Signal Signal		1.24	4:12	2:53	1:19	18	26	
	6	1:40	2:10	2:35	2:55	3:22	Broadway	1:28	Signal	Arrived on yellow arrow.	1.24	3:45	2:17	1:28	20	33	
	Average	***1:06***	***1:38***	***2:14***	***2:37***	***3:10***					***Average***	***3:44***	***2:32***	***1:12***	***20***	***29***	

Direction	Trip No.	Time at Control Points					Stops				Trip Length (mile)	Trip Time (min)	Running Time (min)	Stopped Time (min)	Travel Speed (mph)	Running Speed	Notes
		Folsom St	22nd St	19th St	16th St	Broadway	Location	Time	Cause	Notes							
West	1	0:30	1:05	1:39	2:13	2:43	Folsom St 19th St	0:01 0:03	Signal Signal		1.28	3:02	2:58	0:04	25	26	
	2	0:47	1:27	1:55	2:27	4:14	Folsom St 19th St Broadway	0:18 0:03 1:12	Signal Signal Signal	Arrived at stop bar at 0:34.	1.28	4:32	2:59	1:33	17	26	EB at Folsom queued 8+ vehicles in both lanes.
	3	0:25	0:55	1:17	1:45	2:50	Broadway	0:32	Signal		1.28	3:07	2:35	0:32	25	30	
	4	1:07	1:41	2:08	2:39	3:57	Folsom St Broadway	0:31 0:41	Signal Signal		1.28	4:13	3:01	1:12	18	25	
	5	0:38	1:11	1:44	2:13	4:01	Folsom St 19th St Broadway	0:09 0:03 1:04	Signal Signal Signal		1.28	4:17	3:01	1:16	18	25	
	6	1:06	1:57	2:24	2:53	4:10	Folsom St 22nd St Broadway	0:38 0:11 0:46	Signal Ped Signal Signal		1.28	4:27	2:52	1:35	17	27	
	Average	***0:45***	***1:22***	***1:51***	***2:21***	***3:39***					***Average***	***3:56***	***2:54***	***1:02***	***20***	***27***	

Note: "Time at Control Points" is the time the vehicle crossed the stop bar.

Folsom Street From: Harvest Manor Apartment Access To: Fremont Street

Travel Time Data

AM Peak 7:30 AM
Date: 11/19/2014
Weather: 37 degrees, partly cloudy

Direction	Trip No.	Time at Control Points					Stops				Trip Length (mile)	Trip Time (min)	Running Time (min)	Stopped Time (min)	Travel Speed (mph)	Running Speed	Notes
		Arapahoe Ave	Canyon Blvd	Pearl St	Pine St	Valmont Rd/ Edgewood Dr	Location	Time	Cause	Notes							
North	1	0:18	0:42	1:28	1:49	2:42	Pearl St Mapleton Ave	0:08 0:03	Signal Left-Turn		1.28	3:02	2:51	0:11	25	27	
	2	0:42	1:07	1:54	2:14	2:57	Arapahoe Ave Pearl St	0:21 0:12	Signal Signal		1.28	3:14	2:41	0:33	24	29	
	3	1:00	1:29	2:12	2:42	3:28	Arapahoe Ave Pearl St Spruce St	0:40 0:05 0:05	Signal Signal Ped Signal		1.28	3:49	2:59	0:50	20	26	There is a high volume of bicyclists on Folsom.
	4	0:17	0:38	1:21	1:44	2:27	Walnut St	0:07	Ped Signal		1.28	2:46	2:39	0:07	28	29	
	5	0:36	1:04	1:52	2:15	2:56	Arapahoe Ave Pearl St	0:13 0:10	Signal Signal		1.28	3:14	2:51	0:23	24	27	
	6	1:36	2:01	2:49	3:09	4:00	Arapahoe Ave Pearl St Valmont Rd	1:15 0:10 0:02	Signal Signal Signal		1.28	4:22	3:07	1:15	18	25	
	7	0:14	0:34	1:16	1:34	2:23	Pearl St	0:03	Signal		1.28	2:42	2:39	0:03	28	29	
	Average	***0:40***	***1:05***	***1:50***	***2:12***	***2:59***					***Average***	***17:20***	***11:19***	***0:28***	***24***	***27***	

Direction	Trip No.	Time at Control Points					Stops				Trip Length (mile)	Trip Time (min)	Running Time (min)	Stopped Time (min)	Travel Speed (mph)	Running Speed	Notes
		Valmont Rd/ Edgewood Dr	Pine St	Pearl St	Canyon Blvd	Arapahoe Ave	Location	Time	Cause	Notes							
South	1	0:14	1:01	1:20	2:00	3:19	Canyon Blvd Arapahoe Ave	0:03 0:44	Signal Signal		1.28	3:41	2:54	0:47	21	26	Posted Speed Limit 30 mph
	2	0:16	1:08	1:28	1:59	3:20	Pine St Arapahoe Ave	0:03 0:55	Right-turn RT & Signal	RT vehicle was waiting for crossing bike. RT vehicle was waiting for crossing peds.	1.28	3:04	2:06	0:58	25	37	
	3	0:36	1:27	1:47	2:24	3:29	Valmont Rd Arapahoe Ave	0:19 0:46	Signal Signal		1.28	4:02	2:57	1:05	19	26	
	4	1:15	2:05	2:24	3:03	4:21	Valmont Rd Arapahoe Ave	0:53 0:50	Signal Signal		1.28	4:42	2:59	1:43	16	26	
	5	0:14	0:57	1:15	1:46	2:37	Arapahoe Ave	0:21	Signal		1.28	2:58	2:37	0:21	26	29	
	6	0:16	0:59	1:18	1:51	2:54	Arapahoe Ave	0:24	Signal		1.28	3:12	2:48	0:24	24	27	
	7	0:17	1:02	1:25	3:15	4:35	Canyon Blvd Canyon Blvd Arapahoe Ave	0:12 1:05 0:49	Right-turn Signal Signal		1.28	4:56	4:44	0:12	16	16	
	Average	***0:26***	***1:14***	***1:33***	***2:19***	***3:30***					***Average***	***3:47***	***3:00***	***0:47***	***21***	***27***	

Note: "Time at Control Points" is the time the vehicle crossed the stop bar.

Folsom Street From: Harvest Manor Apartment Access To: Fremont Street

Travel Time Data

PM Peak 4:30 PM
Date: 11/19/2014
Weather: 37 degrees, Clear Skies

Direction	Trip No.	Time at Control Points: Arapahoe Ave	Canyon Blvd	Pearl St	Pine St	Valmont Rd/ Edgewood Dr	Stops: Location	Time	Cause	Notes	Trip Length (mile)	Trip Time (min)	Running Time (min)	Stopped Time (min)	Travel Speed (mph)	Running Speed	Notes
North	1	0:19	1:04	1:55	2:17	3:05	Goss St	0:12	Ped Signal		1.28	3:30	3:05	0:25	22	25	
							Pearl St	0:13	Signal								
	2	0:43	1:11	2:14	2:34	3:35	Arapahoe Ave	0:18	Signal		1.28	4:03	3:19	0:44	19	23	
							Pearl St	0:19	Signal								
							Valmont Rd	0:07	Signal								
	3	0:37	2:22	3:51	4:12	5:29	Arapahoe Ave	0:14	Signal		1.28	6:02	3:32	2:30	13	22	
							Goss St	0:09	Ped Signal								
							Canyon Blvd	1:04	Signal								
							Pearl St	0:47	Signal								
							Access across from Mobile Home Access	0:16	Left-Turn								
	4	0:15	2:01	3:25	3:49	4:41	Goss St	0:21	Ped Signal		1.28	5:10	3:22	1:48	15	23	
							Canyon Blvd	0:47	Signal								
							Pearl St	0:40	Signal								
	5	0:30	0:55	2:09	2:44	3:43	Arapahoe Ave	0:04	Signal		1.28	4:18	3:27	0:51	18	22	
							Pearl St	0:33	Signal								
							Spruce St	0:04	Ped Signal								
							Valmont Rd	0:10	Signal	Arrived on green but at back of queue.							
	6	1:36	2:02	3:17	3:44	4:40	Arapahoe Ave	1:16	Signal		1.28	5:03	3:47	1:16	15	20	
							Pearl St	0:35	Signal								
	Average	***0:40***	***1:35***	***2:48***	***3:13***	***4:12***					***Average***	***4:41***	***3:25***	***1:15***	***17***	***23***	

Direction	Trip No.	Time at Control Points: Valmont Rd/ Edgewood Dr	Pine St	Pearl St	Canyon Blvd	Arapahoe Ave	Stops: Location	Time	Cause	Notes	Trip Length (mile)	Trip Time (min)	Running Time (min)	Stopped Time (min)	Travel Speed (mph)	Running Speed	Notes
South	1	0:40	1:31	1:51	2:24	2:53	Valmont Rd	0:16	Signal		1.28	3:20	3:04	0:16	23	25	
	2	0:24	1:13	1:32	2:22	4:08	Canyon Blvd	0:13	Signal	Queue extended 8 vehicles.	1.28	4:27	2:58	1:29	17	26	
							Arapahoe Ave	0:05	Signal	Arrived at the back of queue. Did not make it through green.							
							Arapahoe Ave	1:11	Signal								
	3	0:19	1:07	1:28	3:22	3:57	Walnut St	0:05	Ped Signal		1.28	4:18	3:11	1:07	18	24	
							Canyon Blvd	1:02	Signal								
	4	0:19	1:06	2:26	3:22	3:58	Pearl St	0:54	Signal		1.28	4:20	3:16	1:04	18	24	
							Canyon Blvd	0:10	Signal								
	5	0:37	1:29	1:48	3:39	4:15	Valmont Rd	0:16	Signal		1.28	4:38	3:09	1:29	17	24	
							Canyon Blvd	1:13	Signal								
	6	0:19	1:08	1:45	2:16	3:28	Pearl St	0:43	Signal		1.28	3:47	3:02	0:45	20	25	
							Canyon Blvd	0:02	Right-Turn								
	Average	***0:26***	***1:15***	***1:48***	***2:54***	***3:46***					***Average***	***4:08***	***3:06***	***1:01***	***19***	***25***	

Note: "Time at Control Points" is the time the vehicle crossed the stop bar.

55th Street From: Lodge Ln (south) To: Valmont Rd corner (USPS)

Travel Time Data

AM Peak 7:30 AM
Date: 11/20/2014
Weather: 28 degrees, Clear skies

Direction	Trip No.	Time at Control Points				Stops				Trip Length (mile)	Trip Time (min)	Running Time (min)	Stopped Time (min)	Travel Speed (mph)	Running Speed	Notes
		Arapahoe Ave	Central Ave	Flatirons Pkwy	Pearl St/ Valmont Rd	Location	Time	Cause	Notes							
North	1	1:44	2:23	2:49	3:24	Arapahoe Ave Pearl St	1:05 0:05	Signal Signal		1.27	3:42	2:32	1:10	21	30	
	2	1:42	2:20	2:47	3:33	Arapahoe Ave Pearl St	1:10 0:14	Signal Signal		1.27	3:51	2:27	1:24	20	31	Posted speed between Pearl St and Flatirons is 35 mph. Majority of 55th St is 40 mph.
	3	0:42	1:24	1:50	3:10	Arapahoe Ave Pearl St	0:05 0:51	Signal Signal		1.27	3:29	2:33	0:56	22	30	
	4	0:26	0:59	1:24	2:54	Pearl St	0:58	Signal		1.27	3:10	2:12	0:58	24	35	Buses stop at the railroad tracks for a few seconds before crossing.
	5	0:50	1:40	2:40	3:29	Arapahoe Ave Flatirons Pkwy Pearl St	0:20 0:25 0:13	Signal Signal Signal		1.27	3:44	2:46	0:58	20	28	
	6	1:38	2:56	3:26	3:51	Arapahoe Ave Central Pkey	1:09 0:32	Signal Signal	Arrived at stop bar at 0:29. Arrived at stop bar at 2:28.	1.27	4:05	2:24	1:41	19	32	
	Average	***1:10***	***1:57***	***2:29***	***3:23***					***Average***	***3:40***	***2:29***	***1:11***	***21***	***31***	

Direction	Trip No.	Time at Control Points				Stops				Trip Length (mile)	Trip Time (min)	Running Time (min)	Stopped Time (min)	Travel Speed (mph)	Running Speed	Notes
		Pearl St/ Valmont Rd	Flatirons Pkwy	Central Ave	Arapahoe Ave	Location	Time	Cause	Notes							
South	1	0:13	0:41	1:08	2:30	Arapahoe Ave	0:44	Signal		1.27	3:06	2:22	0:44	25	32	
	2	0:16	0:44	1:13	2:30	Arapahoe Ave	0:31	Signal		1.27	3:10	2:39	0:31	24	29	Vehicles slow over railroad tracks.
	3	1:13	1:40	2:07	2:45	Pearl St	0:56	Signal		1.27	3:17	2:21	0:56	23	32	
	4	0:26	1:00	1:22	2:08	Pearl St Arapahoe Ave	0:07 0:03	Signal Signal	Queue extended 10 vehicles.	1.27	2:41	2:31	0:10	28	30	
	5	1:07	1:37	2:04	3:09	Pearl St Pearl St Arapahoe Ave	0:07 0:43 0:08	RT & Signal Signal Signal	 Queue extended 12 vehicles.	1.27	3:41	2:43	0:58	21	28	
	6	0:26	1:25	1:50	2:30	Pearl St Arapahoe Ave	0:09 0:25	Signal Signal	 Arrived at stop bar at 2:13.	1.27	3:02	2:28	0:34	25	31	SB Pearl St queued about 200 feet. SB left-turn at Flatirons Pkwy queued into through lane.
	Average	***0:36***	***1:11***	***1:37***	***2:35***					***Average***	***3:09***	***2:30***	***0:38***	***24***	***30***	

Note: "Time at Control Points" is the time the vehicle crossed the stop bar.

55th Street From: Lodge Ln (south) To: Valmont Rd corner (USPS)

Travel Time Data

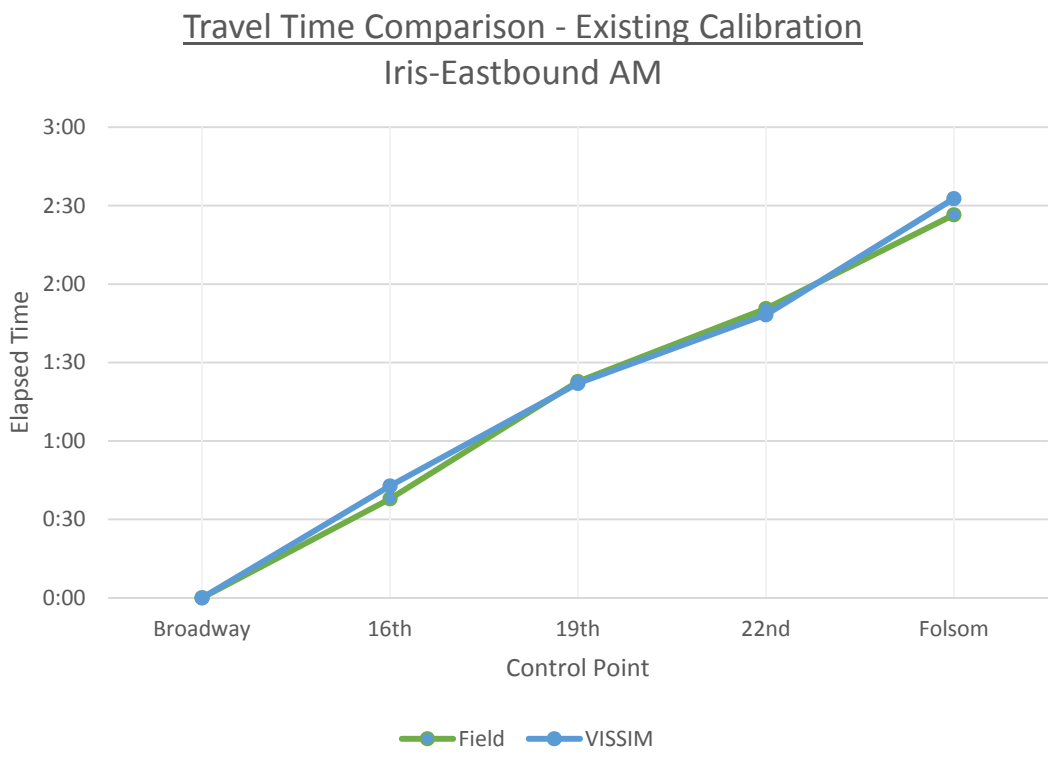
PM Peak 4:30 PM
Date: 11/20/2014
Weather: 45 degrees, Cloudy

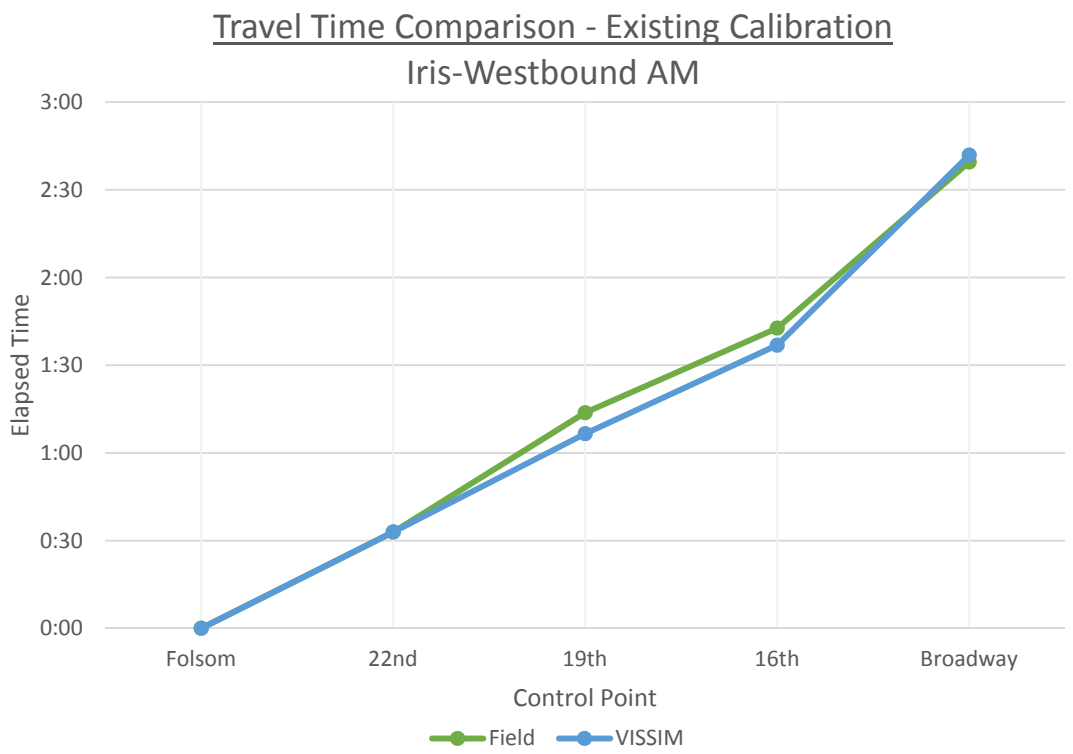
Direction	Trip No.	Time at Control Points				Stops				Trip Length (mile)	Trip Time (min)	Running Time (min)	Stopped Time (min)	Travel Speed (mph)	Running Speed	Notes
		Arapahoe Ave	Central Ave	Flatirons Pkwy	Pearl St/ Valmont Rd	Location	Time	Cause	Notes							
North	1	0:34	1:11	1:43	2:57	Pearl St	0:39	Signal		1.27	3:14	2:35	0:39	24	29	The north/southbound left phases at Pearl are Protected.
	2	1:50	2:36	3:35	4:41	Arapahoe Ave Flatiron Pkwy Pearl St	1:17 0:25 0:30	Signal Signal Signal	Arrived at stop bar at 0:34. Arrived at stop bar at 3:10.	1.27	4:58	2:46	2:12	15	28	The north/southbound left phases at Arapahoe are Permitted. Slow for people crossing the railroad.
	3	0:25	1:28	2:03	3:47	Central Ave Pearl St Pearl St	0:19 0:04 0:53	Signal Signal Signal	Arrived at the back of queue (15 vehicles). Did not make it through green. Arrived at stop bar at 2:52.	1.27	4:09	2:53	1:16	18	26	
	4	0:28	2:08	2:41	4:40	Railroad Crossing Central Ave Pearl St Pearl St	0:38 0:10 0:27 0:49	Train Signal Signal Signal	As gates raised, it was slow to get to speed and through next intersection. Queue extended 18 vehicles in right lane. Majority of vehicles turning right	1.27	5:03	2:59	2:04	15	26	
	5	1:42	2:20	2:48	4:13	Arapahoe Ave Pearl St	1:05 0:43	Signal Signal		1.27	4:30	2:42	1:48	17	28	At Arapahoe: all left phases are permitted except the WBL, which is protected. The northbound right-turning vehicles create delay for the through vehicles and the queue can extend to the bridge.
	6	1:47	2:30	3:01	3:37	Arapahoe Ave	1:18	Signal	Arrived at stop bar at 0:28.	1.27	3:52	2:34	1:18	20	30	
	Average	***1:07***	***2:02***	***2:38***	***3:59***					***Average***	***4:17***	***2:44***	***1:32***	***18***	***28***	

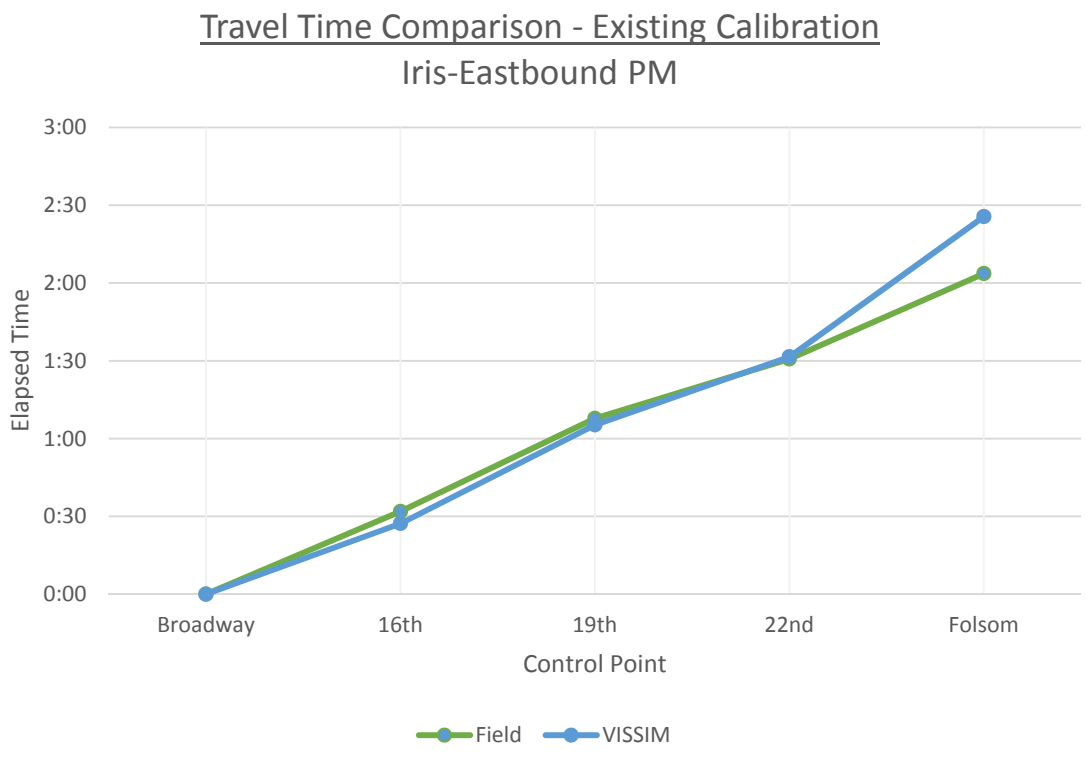
Direction	Trip No.	Time at Control Points				Stops				Trip Length (mile)	Trip Time (min)	Running Time (min)	Stopped Time (min)	Travel Speed (mph)	Running Speed	Notes
		Pearl St/ Valmont Rd	Flatirons Pkwy	Central Ave	Arapahoe Ave	Location	Time	Cause	Notes							
South	1	0:14	0:45	1:13	2:26	Railroad Crossing Pearl St	0:09 0:12	Bus stopped Signal	 Queue extended 200 ft	1.27	3:03	2:42	0:21	25	28	
	2	0:14	0:44	1:15	2:05	Arapahoe Ave	0:09	Signal	Arrived at back of queue when green started.	1.27	2:39	2:30	0:09	29	30	
	3	0:30	1:09	1:38	2:46	Pearl St Flatiron Pkwy Arapahoe Ave	0:09 0:02 0:17	Signal Signal Signal	Queue extended 10 vehicles. Queue extended 8 vehicles.	1.27	3:23	2:55	0:28	23	26	
	4	1:05	1:39	2:11	3:41	Pearl St Arapahoe Ave	0:45 0:39	Signal Signal	 Queue extended 500 ft.	1.27	4:28	3:04	1:24	17	25	
	5	1:06	1:40	2:11	3:32	Pearl St Railroad Crossing Arapahoe Ave Access s/o Arapahoe (gas station)	0:47 0:03 0:23 0:02	Signal Bus stop Signal Left-turn		1.27	4:16	3:01	1:15	18	25	
	6	0:13	0:41	1:08	3:01	Arapahoe Ave	1:15	Signal	Arrived at stop bar at 1:46.	1.27	3:34	2:19	1:15	21	33	
	Average	***0:33***	***1:06***	***1:36***	***2:55***					***Average***	***3:33***	***2:45***	***0:48***	***22***	***28***	

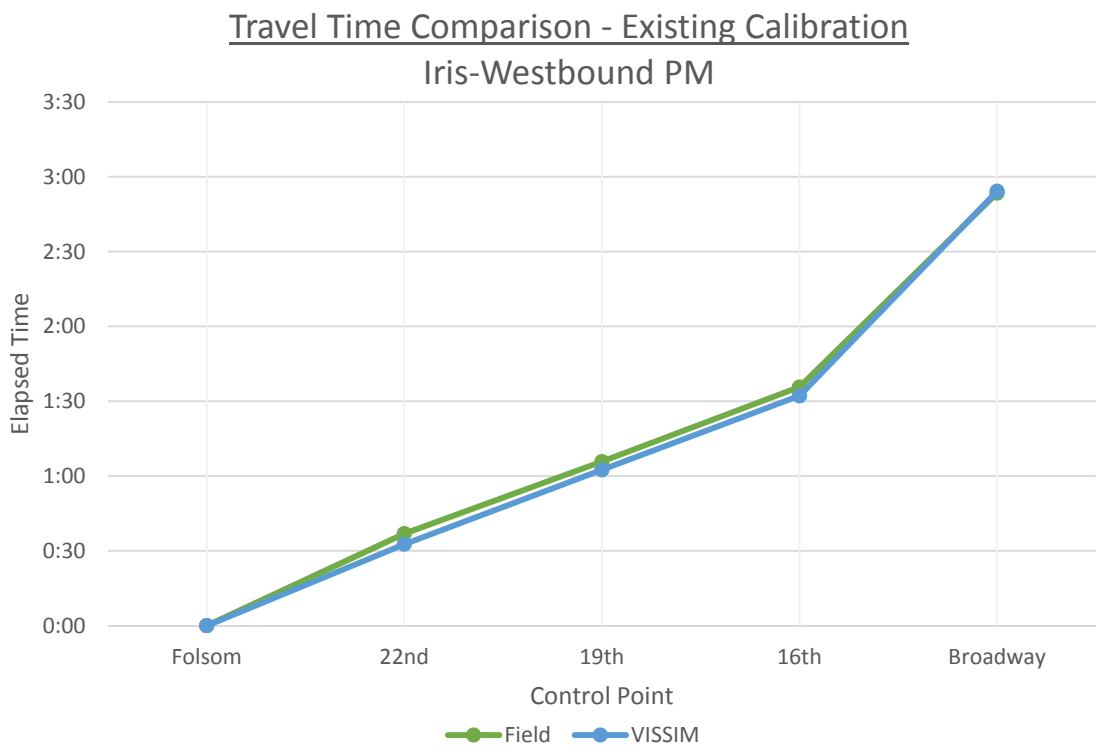
Note: "Time at Control Points" is the time the vehicle crossed the stop bar.

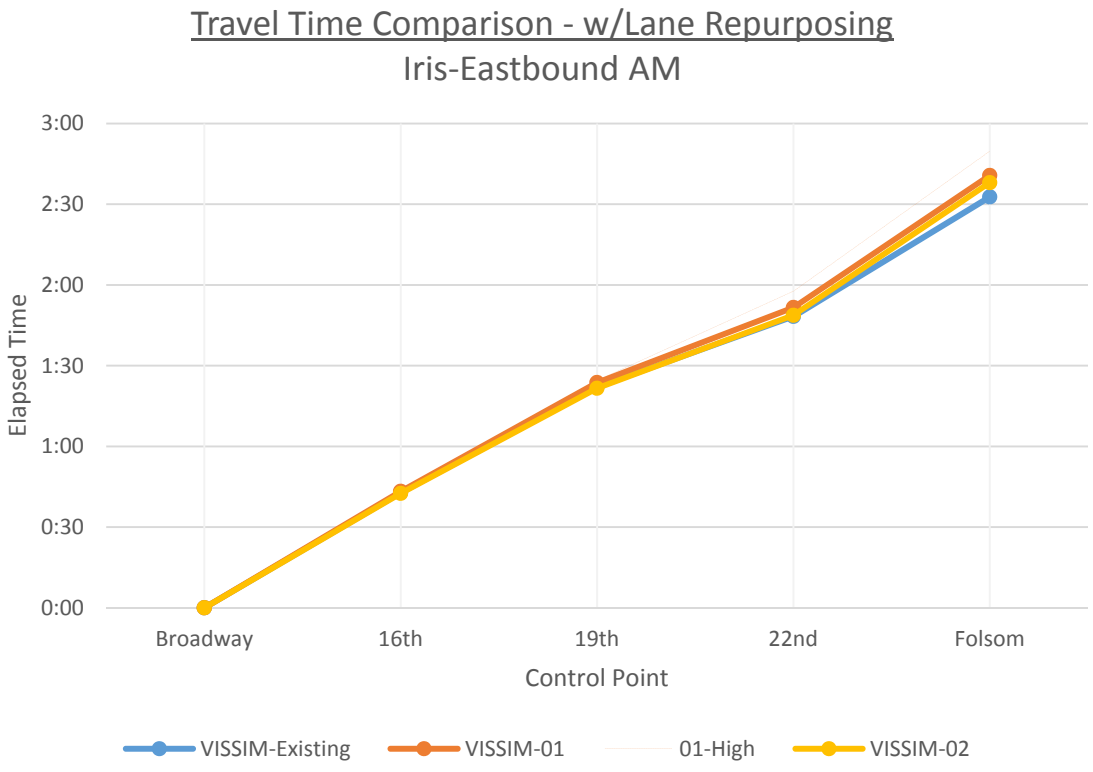
Travel Time Charts – Iris Avenue

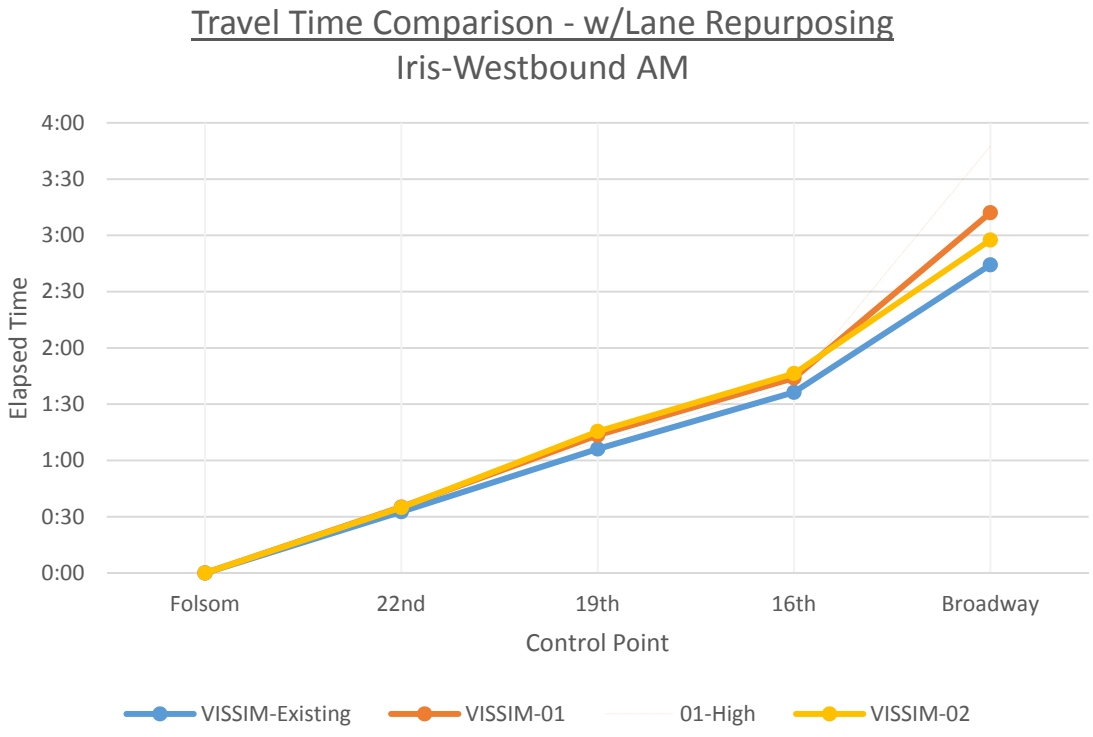

Travel Time Comparison - Existing Calibration
Iris-Eastbound AM
3:00
2:30
2:00
1:30
1:00
0:30
0:00
Elapsed Time
Broadway
16th
19th
22nd
Folsom
Control Point
Field
VISSIM

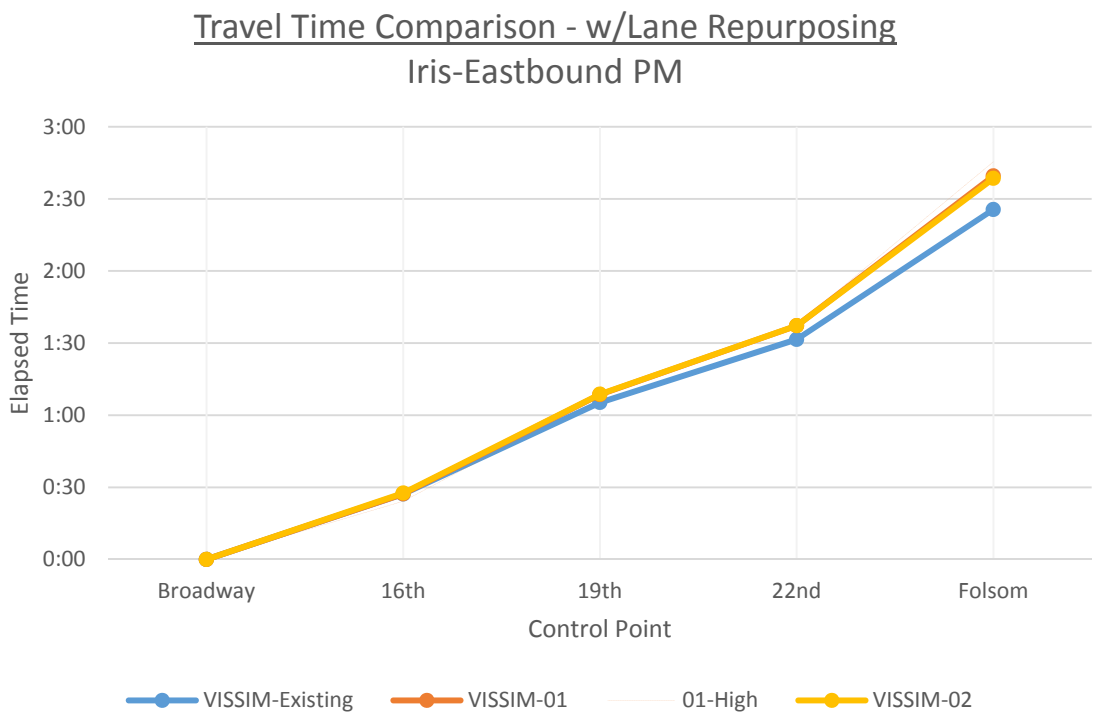

Travel Time Comparison - Existing Calibration
Iris-Westbound AM
3:00
2:30
2:00
1:30
1:00
0:30
0:00
Elapsed Time
Folsom
22nd
19th
16th
Broadway
Control Point
Field
VISSIM

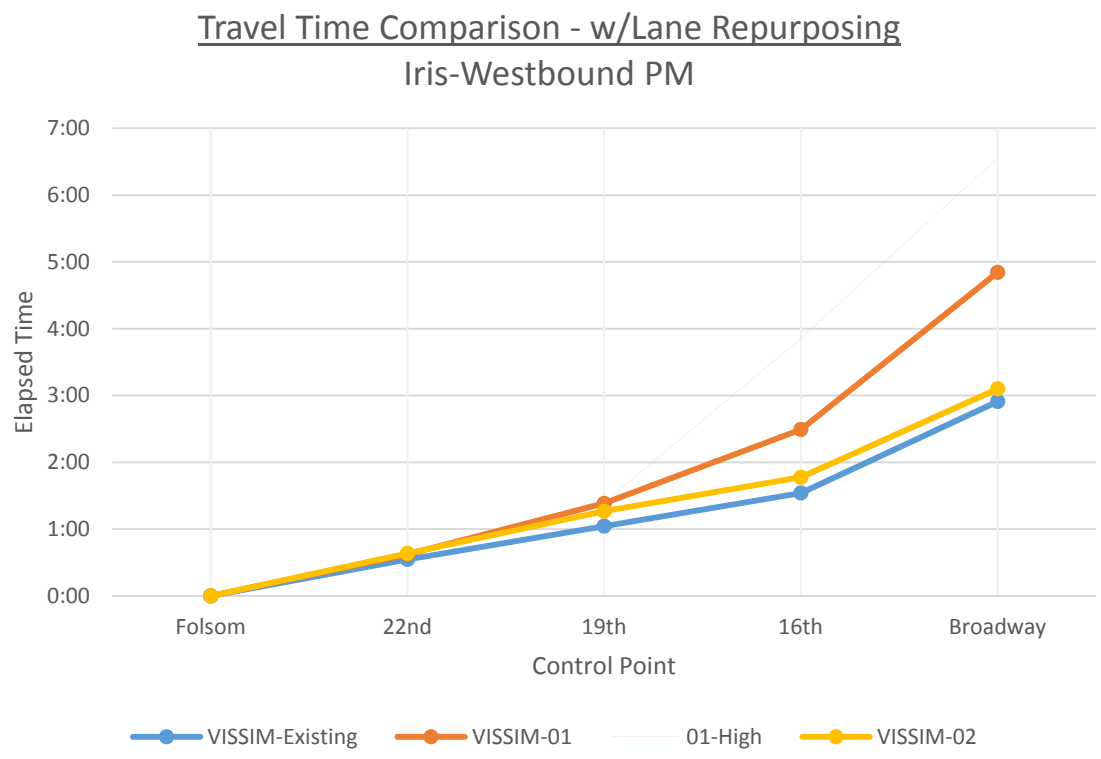

Travel Time Comparison - Existing Calibration
Iris-Eastbound PM
3:00
2:30
2:00
1:30
1:00
0:30
0:00
Elapsed Time
Broadway
16th
19th
22nd
Folsom
Control Point
Field
VISSIM

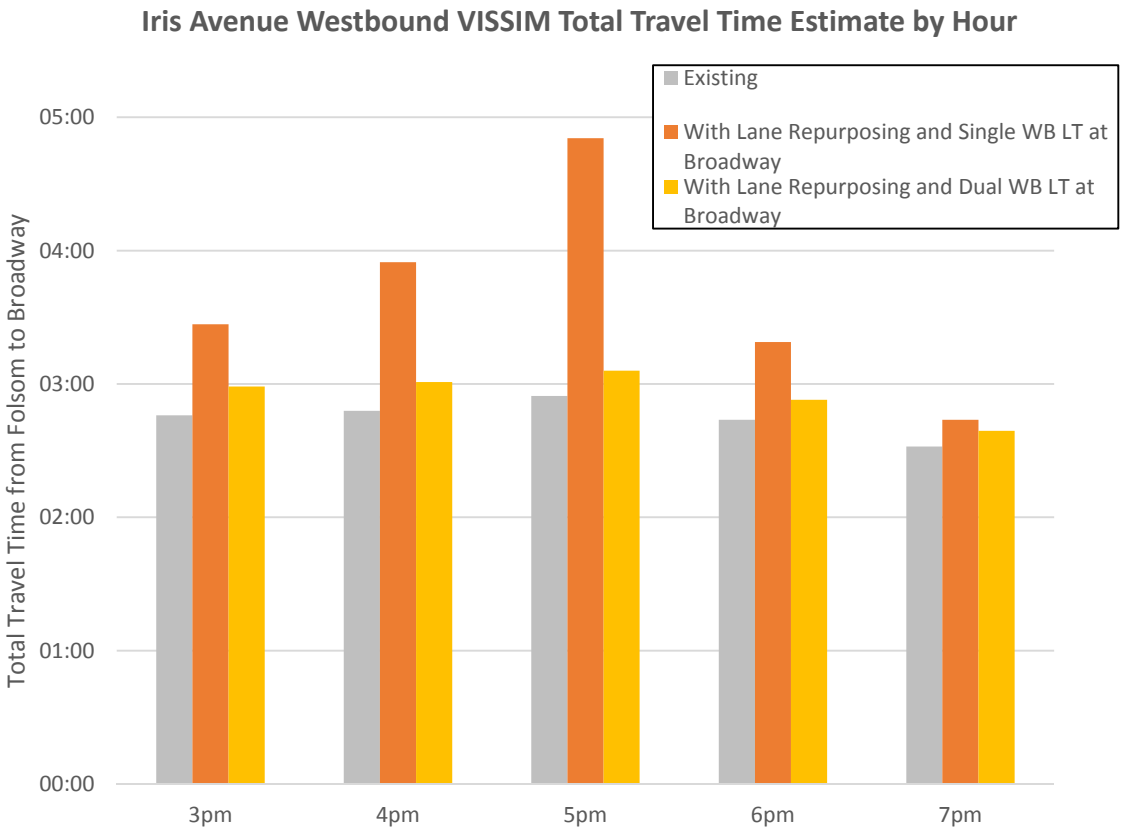

Travel Time Comparison - Existing Calibration
Iris-Westbound PM
3:30
3:00
2:30
2:00
1:30
1:00
0:30
0:00
Elapsed Time
Folsom
22nd
19th
16th
Broadway
Control Point
Field
VISSIM


Travel Time Comparison - w/Lane Repurposing
Iris-Eastbound AM
Elapsed Time
3:00
2:30
2:00
1:30
1:00
0:30
0:00
Broadway
16th
19th
22nd
Folsom
Control Point
VISSIM-Existing
VISSIM-01
01-High
VISSIM-02

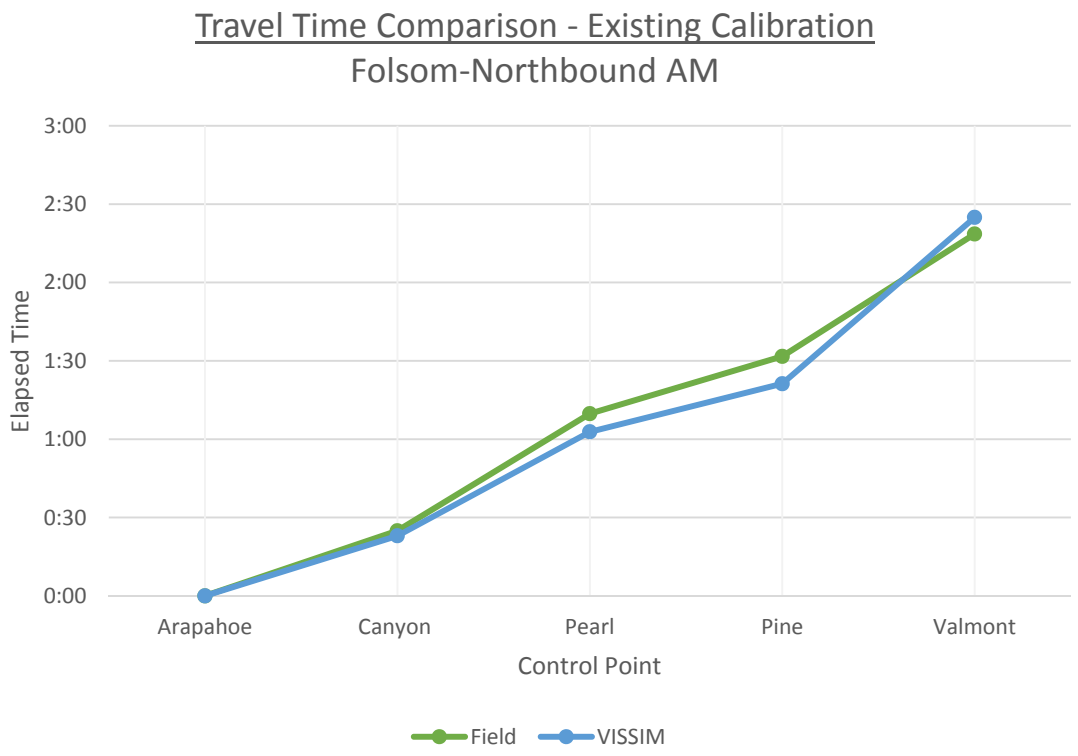

Travel Time Comparison - w/Lane Repurposing
Iris-Westbound AM
Elapsed Time
4:00
3:30
3:00
2:30
2:00
1:30
1:00
0:30
0:00
Folsom
22nd
19th
16th
Broadway
Control Point
VISSIM-Existing
VISSIM-01
01-High
VISSIM-02

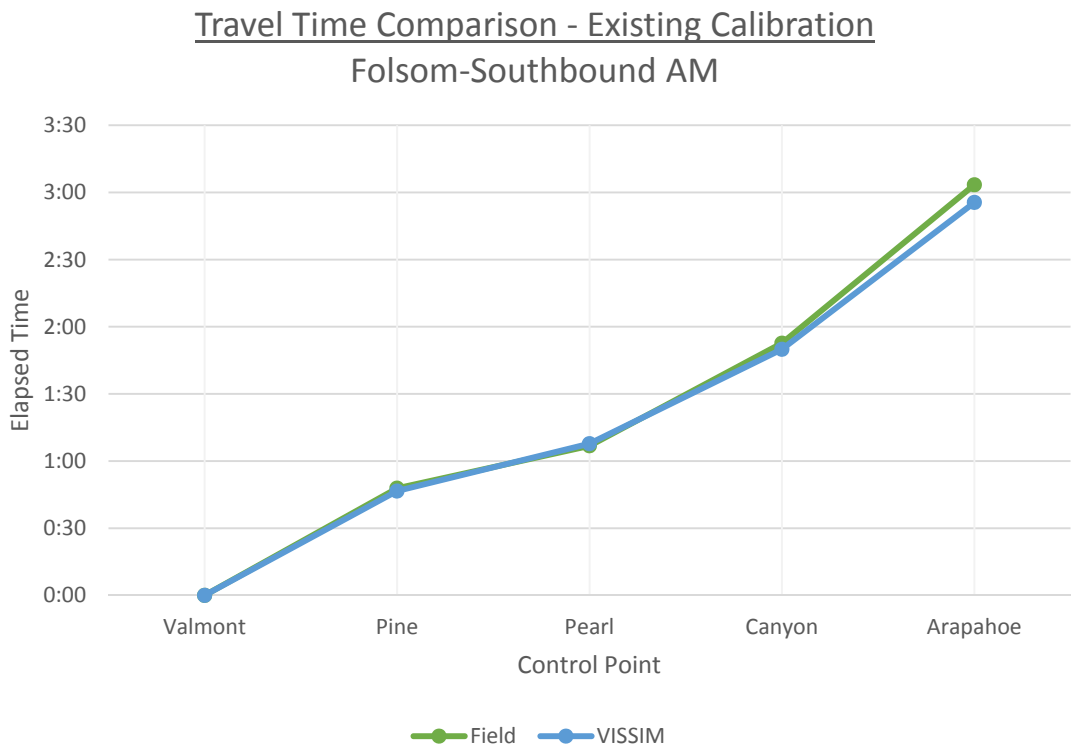

Travel Time Comparison - w/Lane Repurposing
Iris-Eastbound PM
Elapsed Time
3:00
2:30
2:00
1:30
1:00
0:30
0:00
Broadway
16th
19th
22nd
Folsom
Control Point
VISSIM-Existing
VISSIM-01
01-High
VISSIM-02

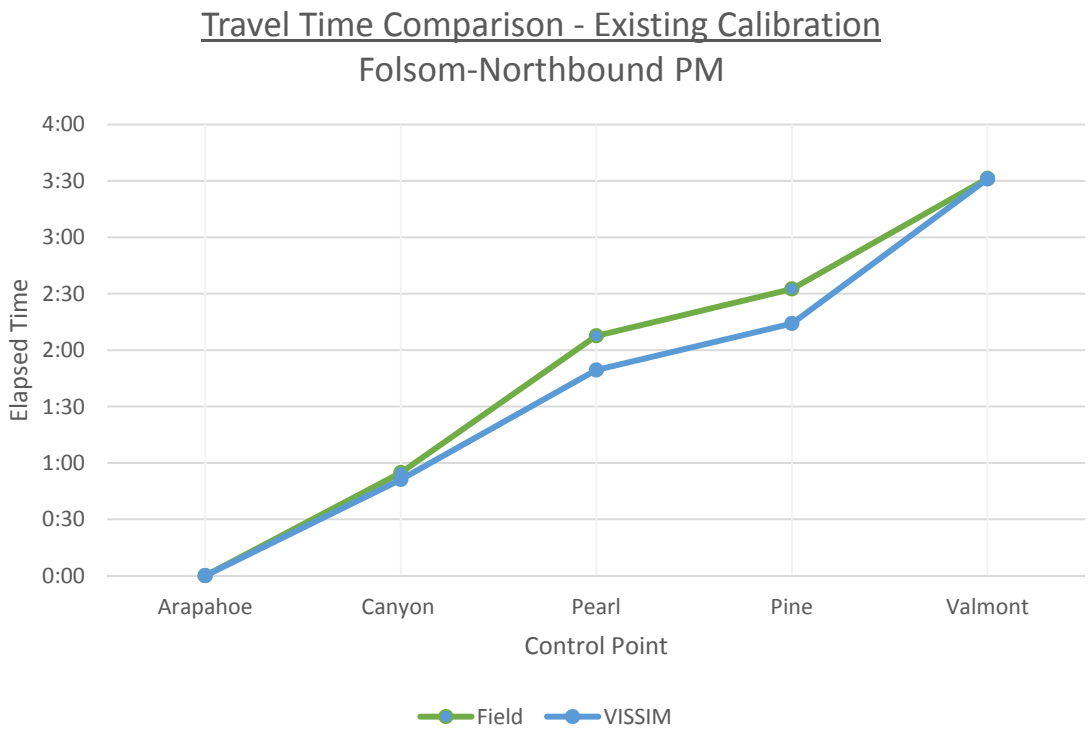

Travel Time Comparison - w/Lane Repurposing
Iris-Westbound PM
Elapsed Time
7:00
6:00
5:00
4:00
3:00
2:00
1:00
0:00
Folsom
22nd
19th
16th
Broadway
Control Point
VISSIM-Existing
VISSIM-01
01-High
VISSIM-02

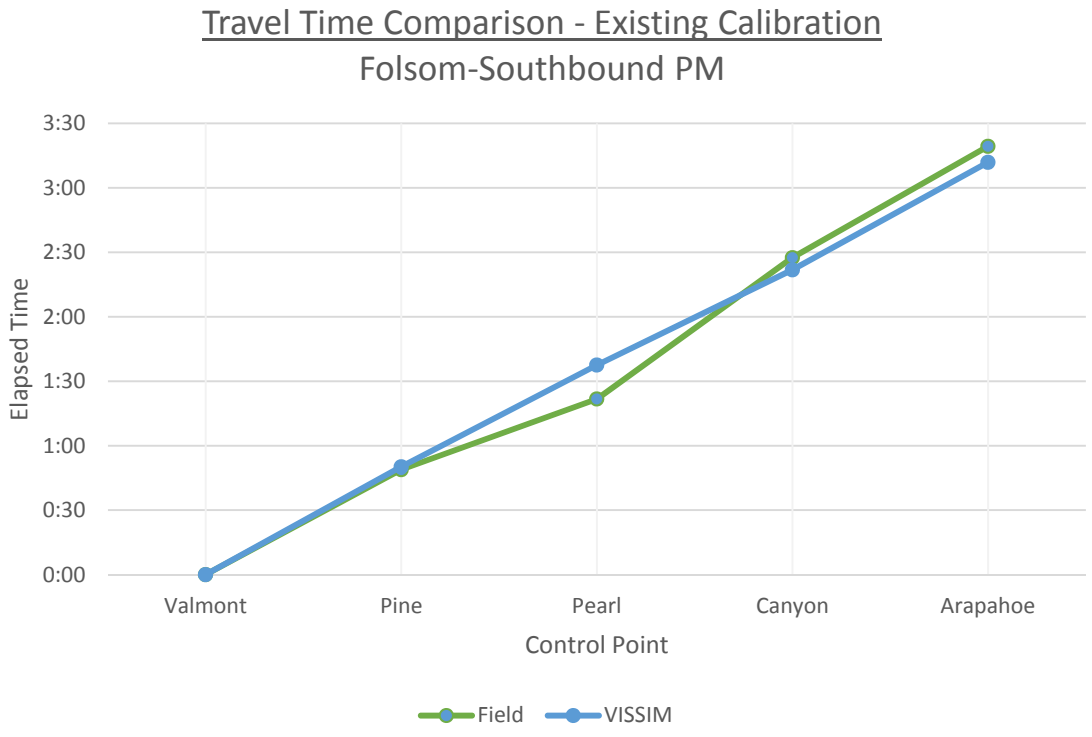

Iris Avenue Westbound VISSIM Total Travel Time Estimate by Hour
Existing
With Lane Repurposing and Single WB LT at Broadway
With Lane Repurposing and Dual WB LT at Broadway
Total Travel Time from Folsom to Broadway
05:00
04:00
03:00
02:00
01:00
00:00
3pm
4pm
5pm
6pm
7pm

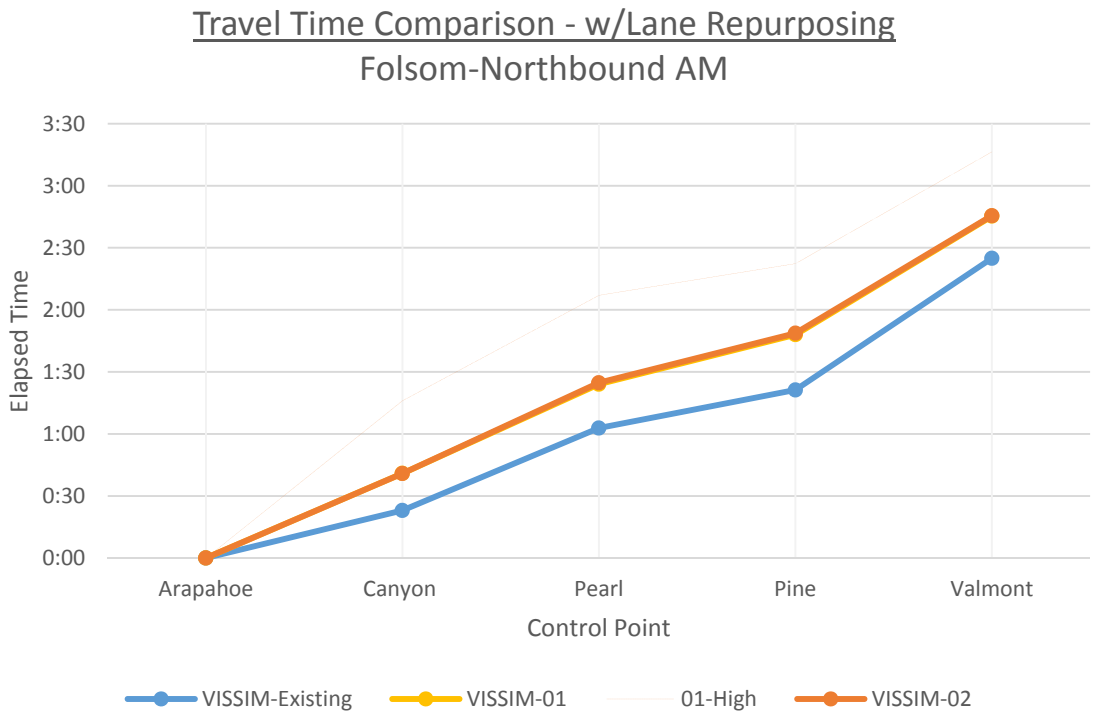
Travel Time Charts – Folsom Street

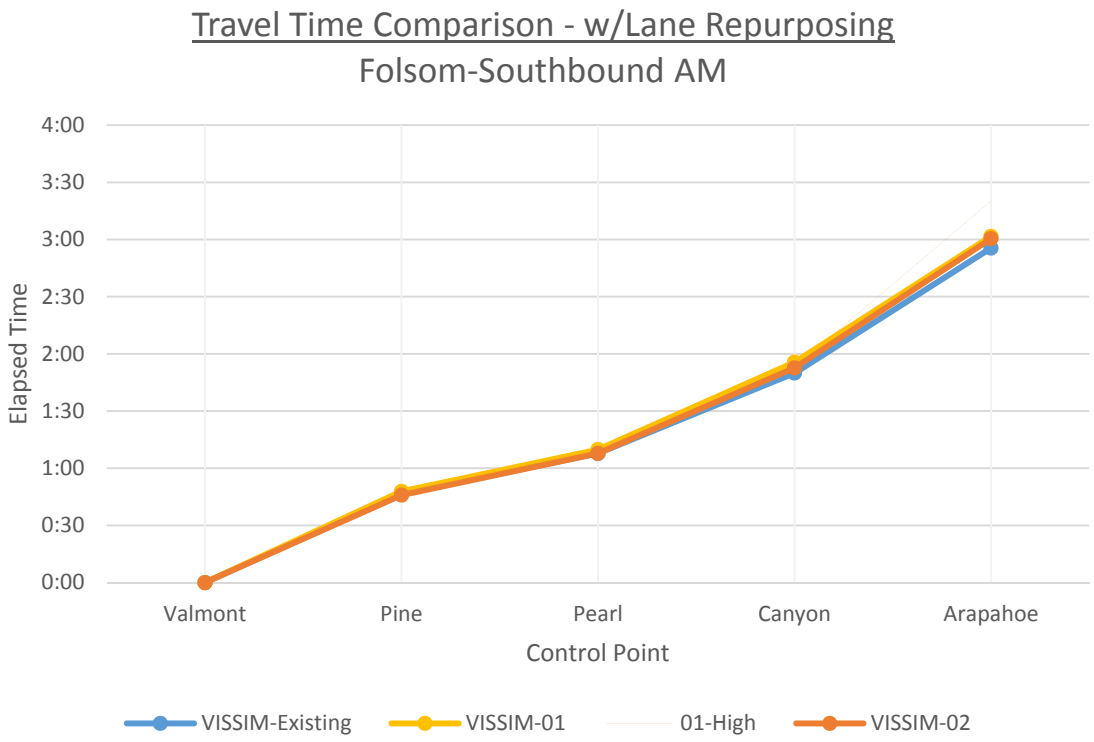

Travel Time Comparison - Existing Calibration
Folsom-Northbound AM
3:00
2:30
2:00
1:30
1:00
0:30
0:00
Elapsed Time
Arapahoe
Canyon
Pearl
Pine
Valmont
Control Point
Field
VISSIM

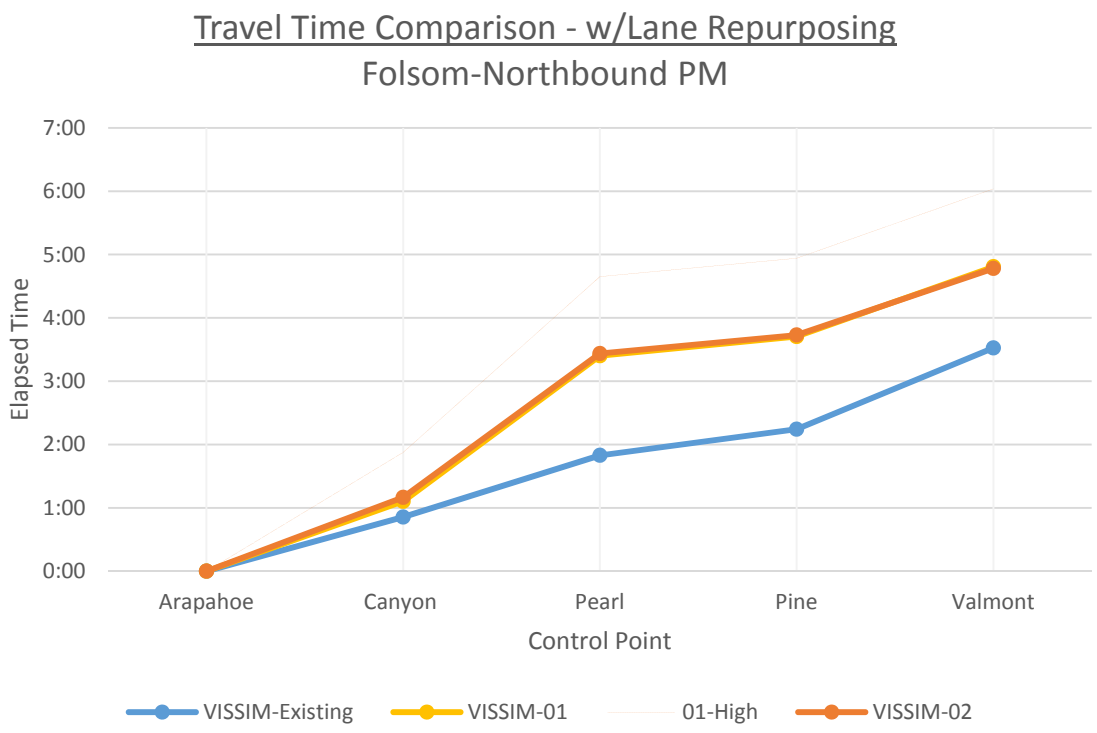

Travel Time Comparison - Existing Calibration
Folsom-Southbound AM
3:30
3:00
2:30
2:00
1:30
1:00
0:30
0:00
Elapsed Time
Valmont
Pine
Pearl
Canyon
Arapahoe
Control Point
Field
VISSIM

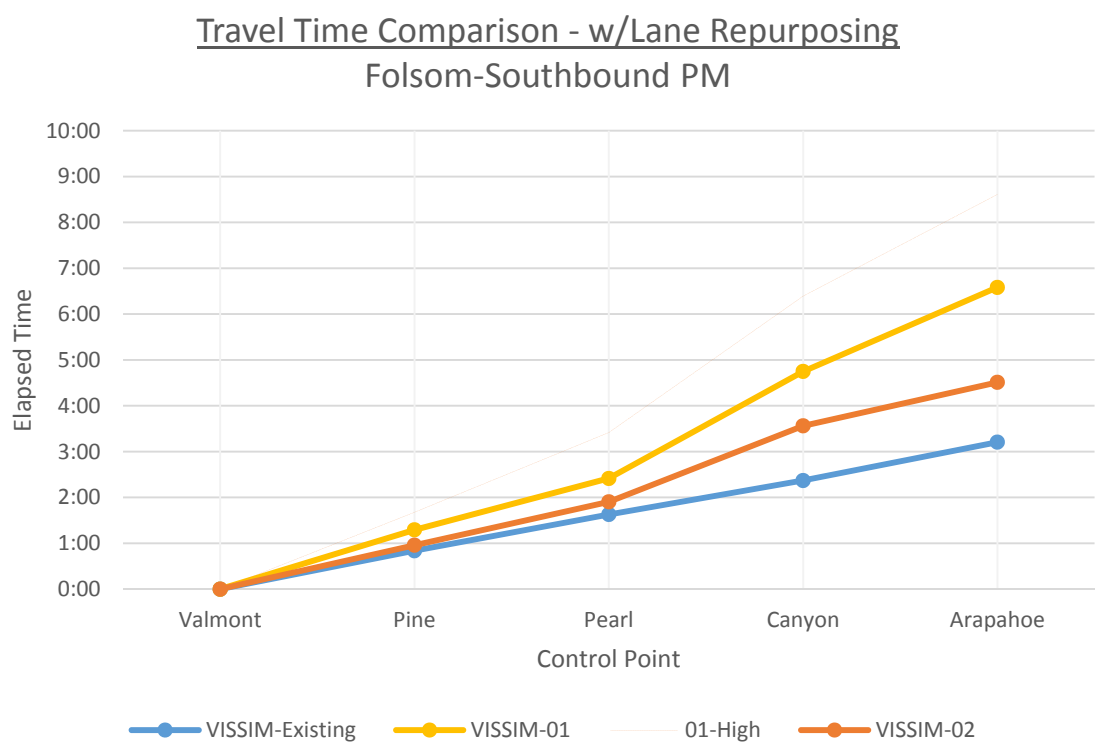

Travel Time Comparison - Existing Calibration
Folsom-Northbound PM
Elapsed Time
4:00
3:30
3:00
2:30
2:00
1:30
1:00
0:30
0:00
Arapahoe
Canyon
Pearl
Pine
Valmont
Control Point
Field
VISSIM

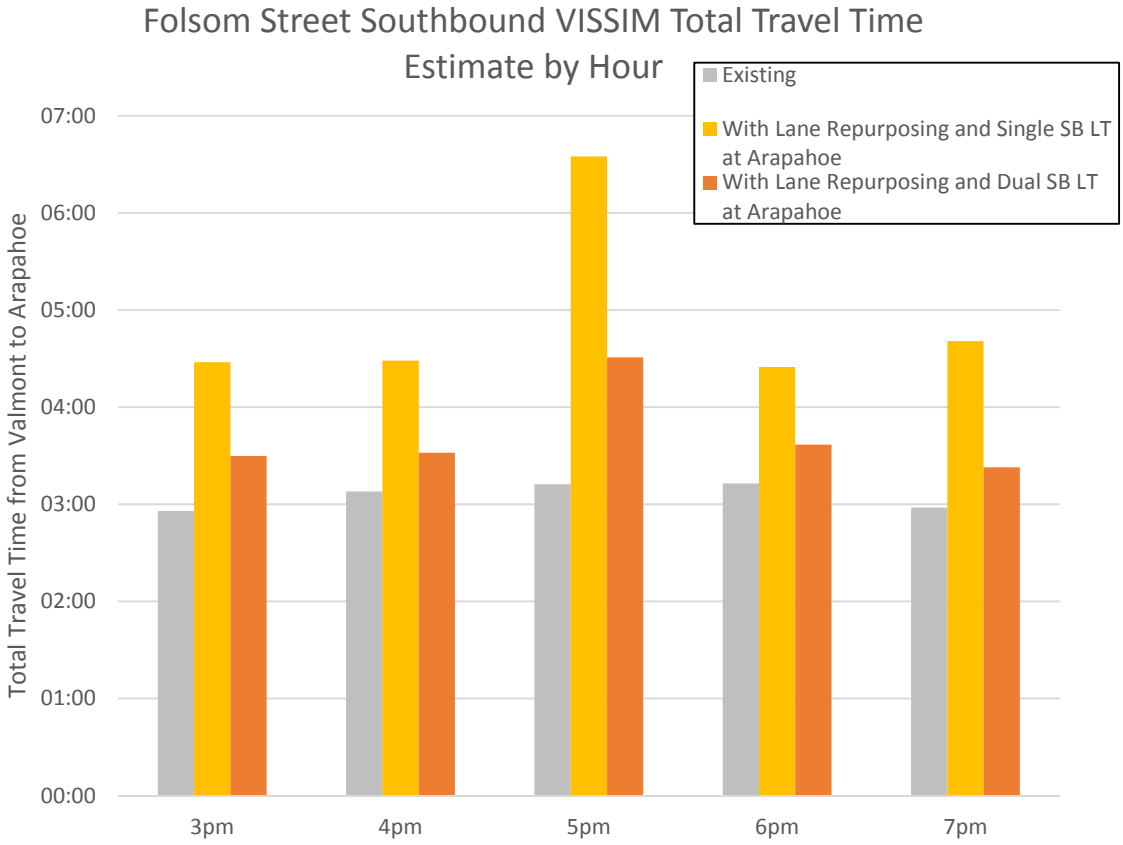

Travel Time Comparison - Existing Calibration
Folsom-Southbound PM
Elapsed Time
3:30
3:00
2:30
2:00
1:30
1:00
0:30
0:00
Valmont
Pine
Pearl
Canyon
Arapahoe
Control Point
Field
VISSIM


Travel Time Comparison - w/Lane Repurposing
Folsom-Northbound AM
Elapsed Time
3:30
3:00
2:30
2:00
1:30
1:00
0:30
0:00
Arapahoe
Canyon
Pearl
Pine
Valmont
Control Point
VISSIM-Existing
VISSIM-01
01-High
VISSIM-02

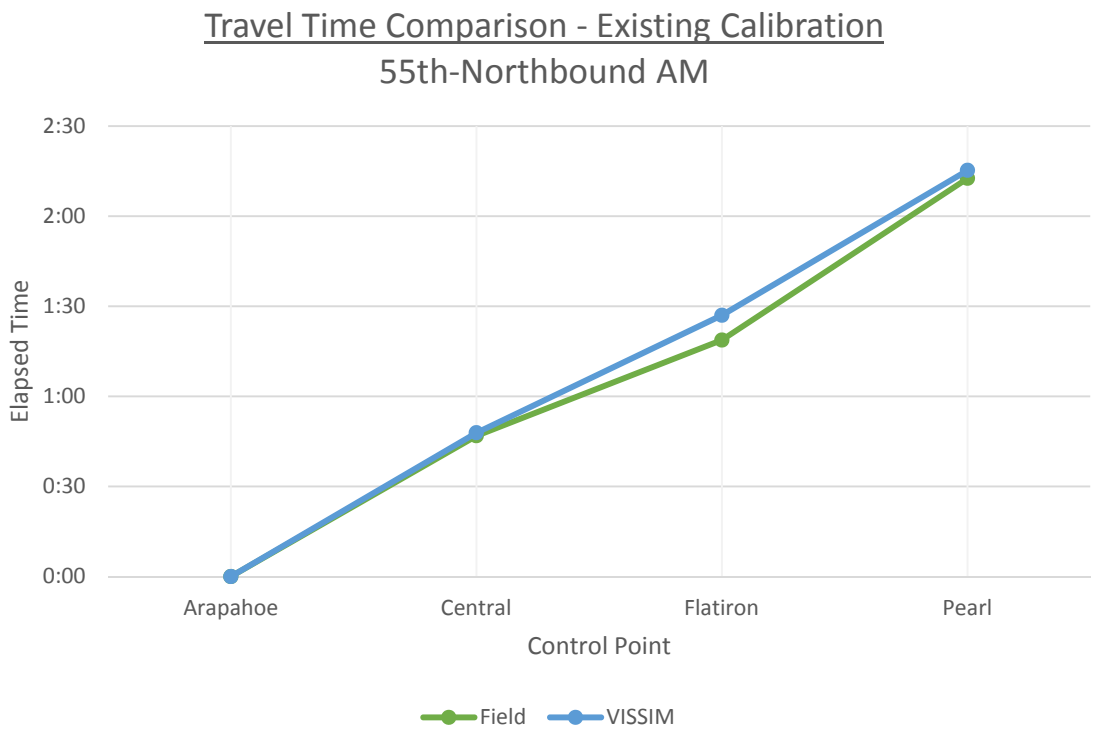

Travel Time Comparison - w/Lane Repurposing
Folsom-Southbound AM
Elapsed Time
4:00
3:30
3:00
2:30
2:00
1:30
1:00
0:30
0:00
Valmont
Pine
Pearl
Canyon
Arapahoe
Control Point
VISSIM-Existing
VISSIM-01
01-High
VISSIM-02

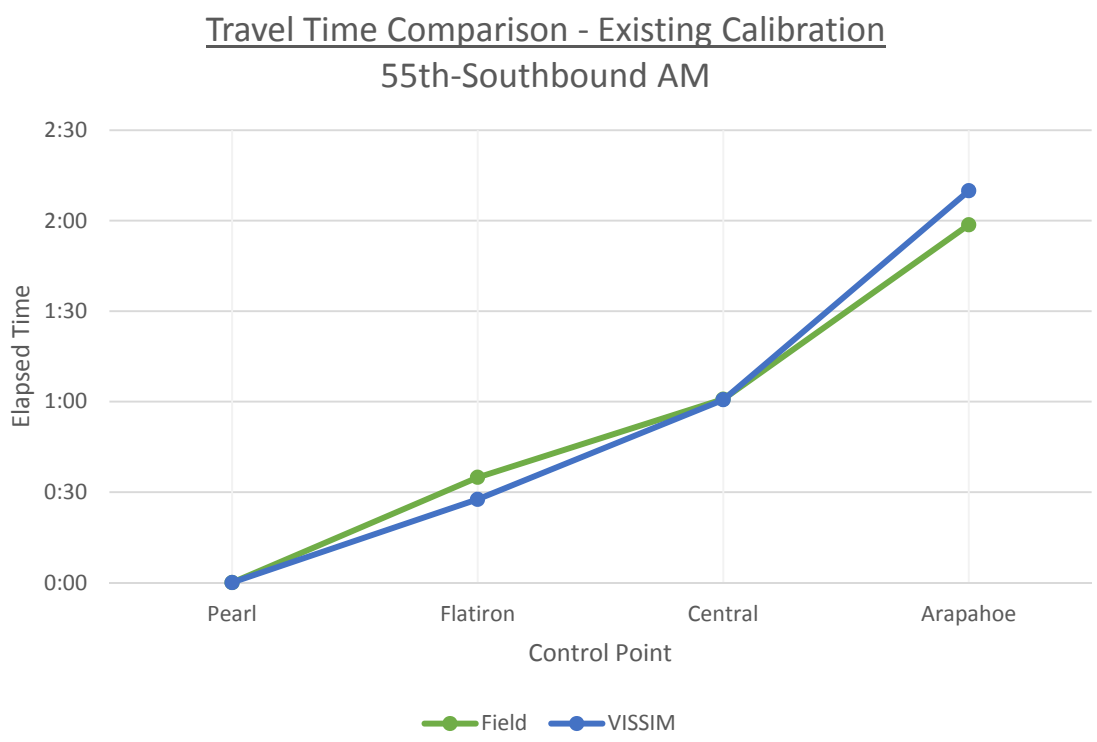

Travel Time Comparison - w/Lane Repurposing
Folsom-Northbound PM
Elapsed Time
7:00
6:00
5:00
4:00
3:00
2:00
1:00
0:00
Arapahoe
Canyon
Pearl
Pine
Valmont
Control Point
VISSIM-Existing
VISSIM-01
01-High
VISSIM-02


Travel Time Comparison - w/Lane Repurposing
Folsom-Southbound PM
Elapsed Time
10:00
9:00
8:00
7:00
6:00
5:00
4:00
3:00
2:00
1:00
0:00
Valmont
Pine
Pearl
Canyon
Arapahoe
Control Point
VISSIM-Existing
VISSIM-01
01-High
VISSIM-02


Folsom Street Southbound VISSIM Total Travel Time Estimate by Hour
Existing
With Lane Repurposing and Single SB LT at Arapahoe
With Lane Repurposing and Dual SB LT at Arapahoe
Total Travel Time from Valmont to Arapahoe
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
3pm
4pm
5pm
6pm
7pm

Travel Time Charts – 55th Street


Travel Time Comparison - Existing Calibration
55th-Northbound AM
2:30
2:00
1:30
1:00
0:30
0:00
Elapsed Time
Arapahoe
Central
Flatiron
Pearl
Control Point
Field
VISSIM


Travel Time Comparison - Existing Calibration
55th-Southbound AM
2:30
2:00
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Elapsed Time
Pearl
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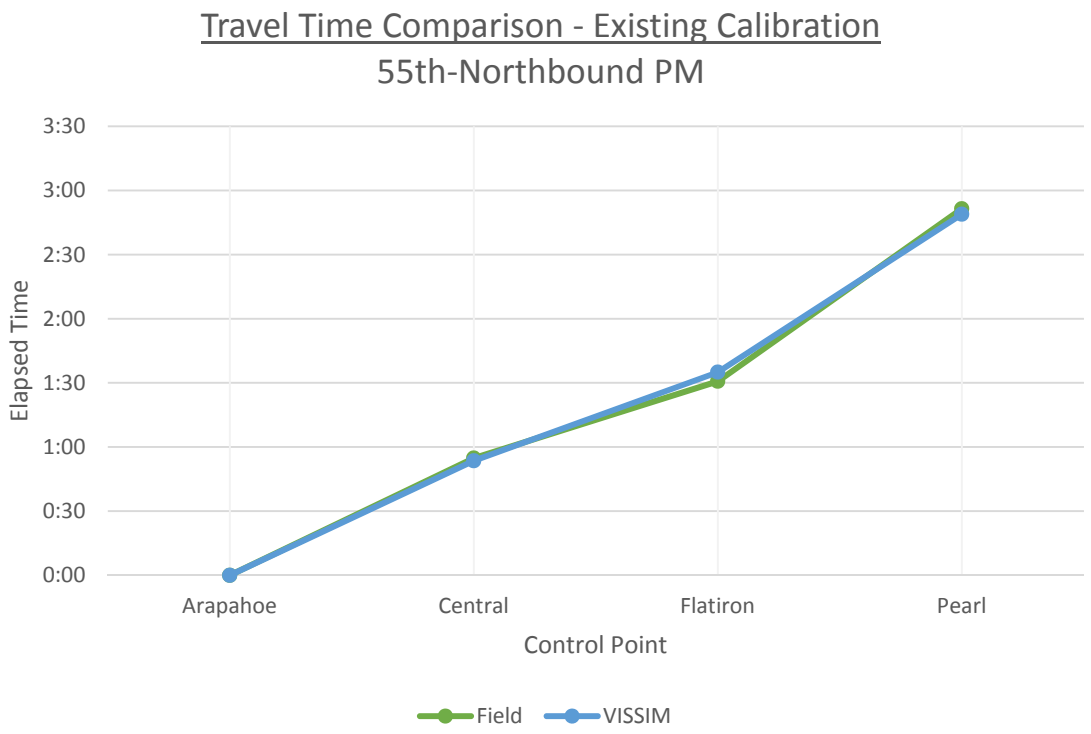
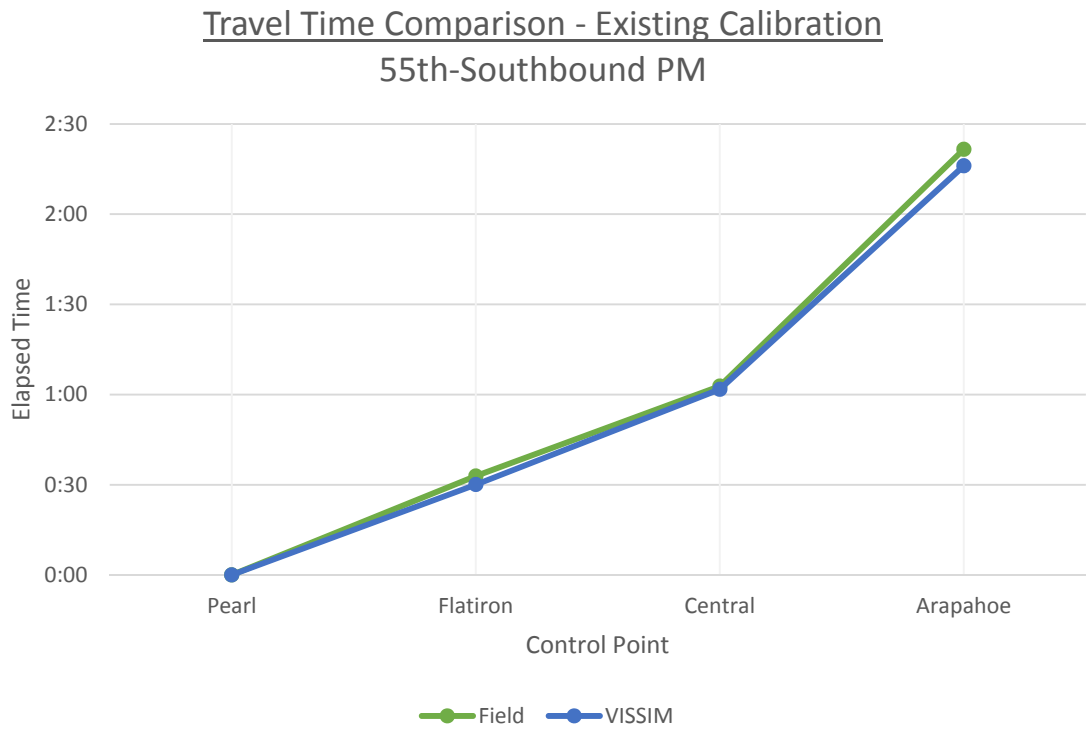
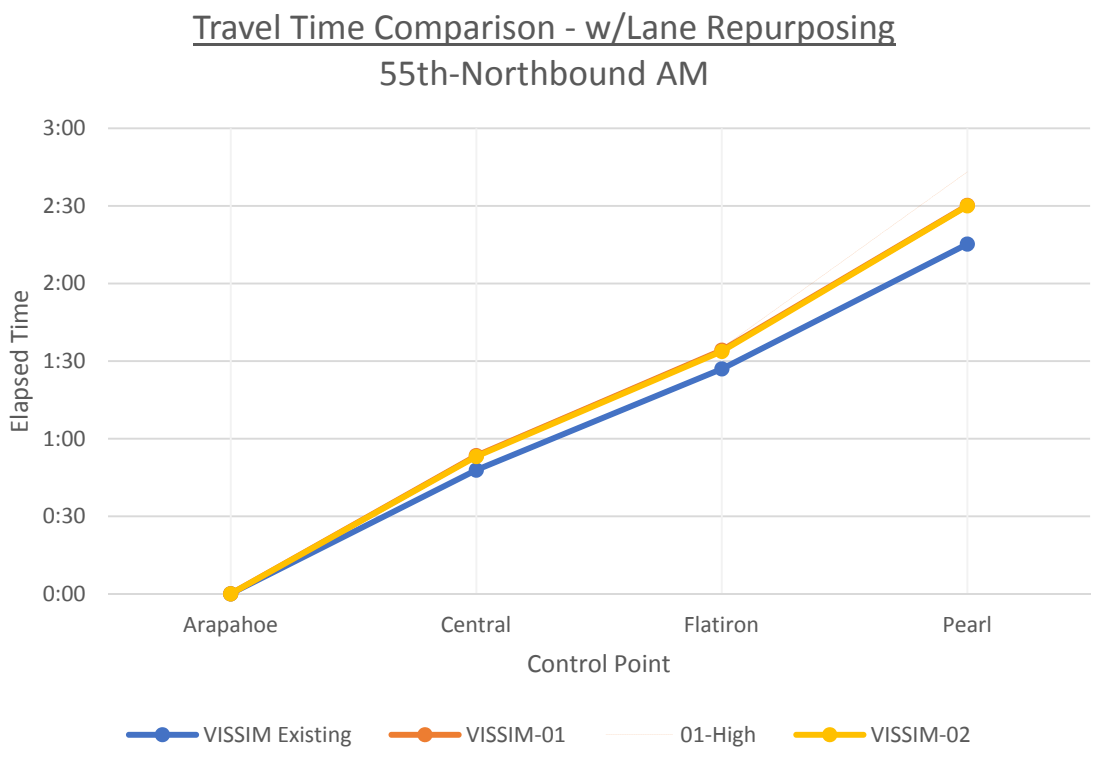
Arapahoe
Control Point
Field
VISSIM


Travel Time Comparison - Existing Calibration
55th-Northbound PM
3:30
3:00
2:30
2:00
1:30
1:00
0:30
0:00
Elapsed Time
Arapahoe
Central
Flatiron
Pearl
Control Point
Field
VISSIM


Travel Time Comparison - Existing Calibration
55th-Southbound PM
2:30
2:00
1:30
1:00
0:30
0:00
Elapsed Time
Pearl
Flatiron
Central
Arapahoe
Control Point
Field
VISSIM


Travel Time Comparison - w/Lane Repurposing
55th-Northbound AM
3:00
2:30
2:00
1:30
1:00
0:30
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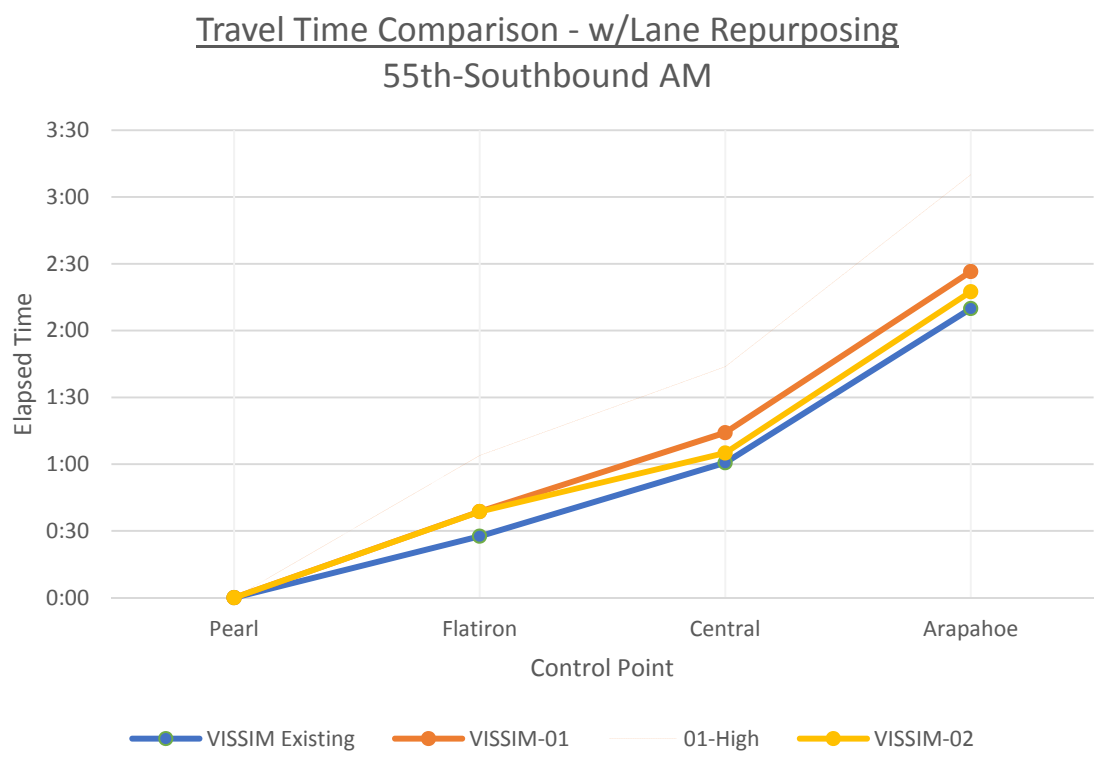
Elapsed Time
Arapahoe
Central
Flatiron
Pearl
Control Point
VISSIM Existing
VISSIM-01
01-High
VISSIM-02


Travel Time Comparison - w/Lane Repurposing
55th-Southbound AM
3:30
3:00
2:30
2:00
1:30
1:00
0:30
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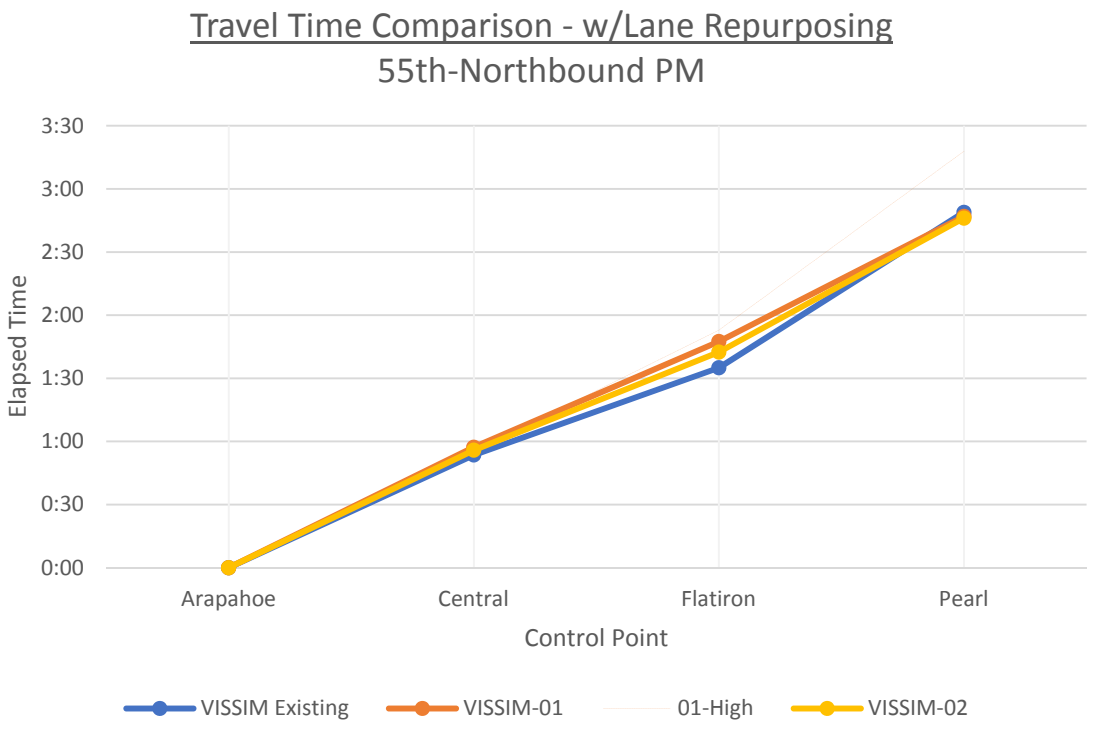
Flatiron
Central
Arapahoe
Control Point
VISSIM Existing
VISSIM-01
01-High
VISSIM-02


Travel Time Comparison - w/Lane Repurposing
55th-Northbound PM
Elapsed Time
3:30
3:00
2:30
2:00
1:30
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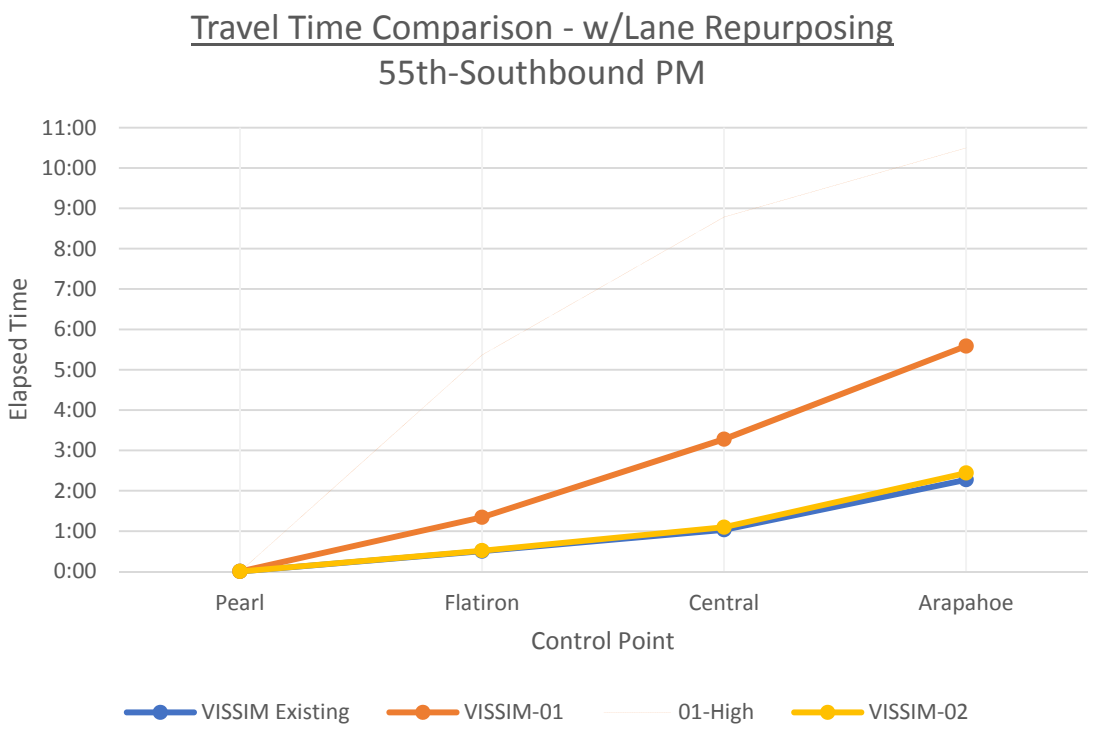
Arapahoe
Central
Flatiron
Pearl
Control Point
VISSIM Existing
VISSIM-01
01-High
VISSIM-02


Travel Time Comparison - w/Lane Repurposing
55th-Southbound PM
Elapsed Time
11:00
10:00
9:00
8:00
7:00
6:00
5:00
4:00
3:00
2:00
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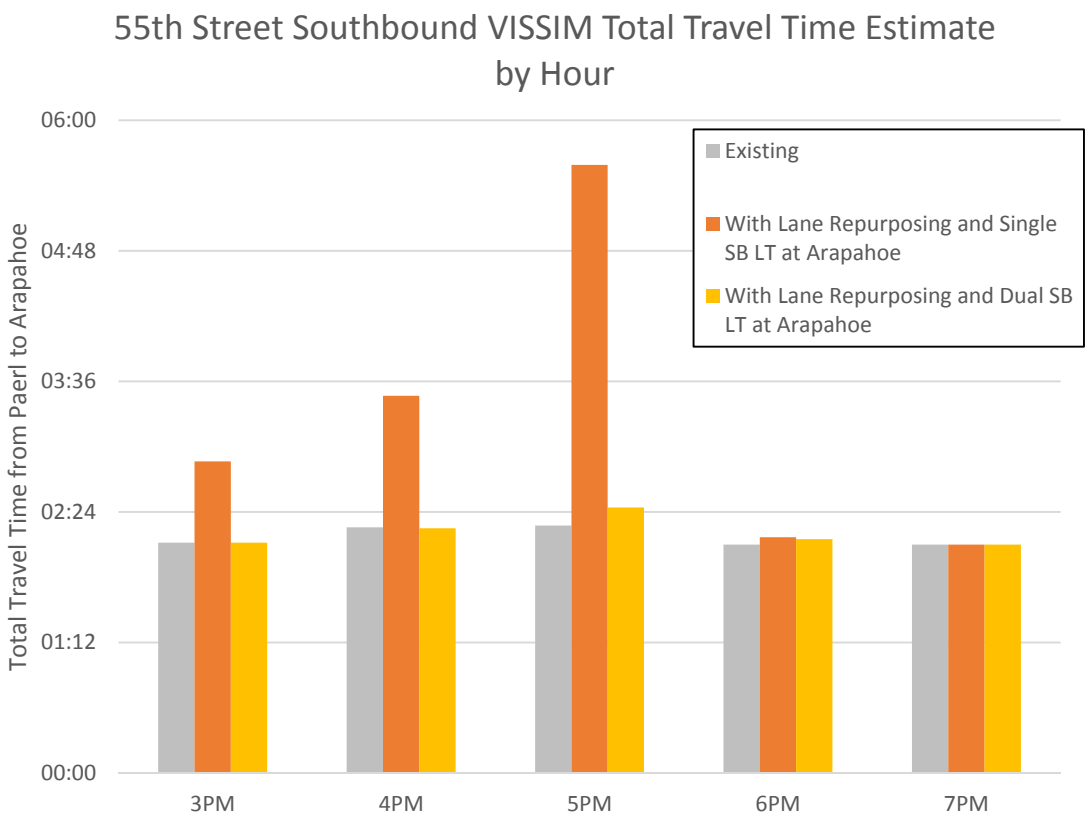
0:00
Pearl
Flatiron
Central
Arapahoe
Control Point
VISSIM Existing
VISSIM-01
01-High
VISSIM-02


55th Street Southbound VISSIM Total Travel Time Estimate by Hour
Total Travel Time from Paerl to Arapahoe
06:00
04:48
03:36
02:24
01:12
00:00
3PM
4PM
5PM
6PM
7PM
Existing
With Lane Repurposing and Single SB LT at Arapahoe
With Lane Repurposing and Dual SB LT at Arapahoe

CITY OF BOULDER

Department of Public Works Transportation Division
P.O. Box 791
1739 Broadway
Boulder, Colorado 80306
(303) 441-3266

Inter-Office Memorandum

TO: **Bill Cowern, Transportation Operations Engineer**

FROM: **Shannon Young, Transportation Engineer**

DATE: **May 19, 2015**

SUBJECT: **Safety Analysis for Phase II Living Laboratory Projects**

As part of the evaluation process of the complete streets Phase II Living Laboratory, the potential safety benefits of rightsizing projects were considered. Crash data from each proposed corridor was compiled and reviewed to determine existing crash trends which may be mitigated by the implementation of the proposed projects. The purpose of this memo is to summarize the findings of this evaluation.

Expected Crash Reduction
The Highway Safety Manual (HSM) provides information about the effects on crash frequency of various safety treatments, geometric design characteristics, and operational characteristics. The effects are quantified in the form of crash modification factors (CMF) which are based on published transportation safety research. CMFs can be applied to historic crash data in order to estimate the expected crash frequency after a treatment is installed.

The HSM presents a CMF for removing through lanes or "road diets" which is applicable to the Living Laboratory Phase II rightsizing projects. Based on the CMF, the potential crash effect of a four to three lane conversions on an urban arterial is a 29% reduction in crashes for all crash types and all severities.

Crash Types Susceptible to Mitigation
While an overall decrease in the frequency of crashes is expected, the implementation of a rightsizing project has the potential to decrease the frequency of certain crash types and increase others. The inclusion of various right-turn treatments in the Living Labs projects could provide additional benefits to bicycle-related crash frequency. The following crash types could be mitigated by the implementation of the rightsizing projects.

> Left-Turn Rear End: The addition of a two-way left-turn lane or left-turn lanes at intersections would provide space for vehicles waiting to turn left onto a side street and reduce the chances of being rear-ended.

Sideswipe-Same Direction: By repurposing a lane in each direction, there would only be one through lane in each direction and vehicles would no longer be switching lanes or traveling side-by-side.

Sideswipe-Opposite Direction: A two-way left-turn lane would provide additional space between opposing lanes of traffic, reducing the chances of a sideswipe between vehicles traveling in opposite directions.

Left-Turns from Side Streets: At unsignalized intersections, the two-way left-turn lane would provide space for vehicles to make a two-stage left-turn, and thus, they would only need to cross one lane of traffic at a time.

Pedestrian Crossing: The reduced crossing distance and reduced number of vehicle lanes results in safer crossing opportunities for pedestrians at unsignalized locations.

Right Hook: The installation of specialized right-turn treatments at signalized intersections should reduce collisions between bicyclists and right-turning vehicles.

Conversely, the potential increased congestion associated with the installation of a rightsizing project could result in an increase in rear-end collisions. However, a decrease in speeds along the corridors due to rightsizing may result in additional safety benefits and decreased crash frequency of other crash types.

Crashes by Corridor

In order to better understand the potential safety benefits of the proposed rightsizing projects, historic crash data from each candidate corridor was reviewed to determine how many crashes susceptible to mitigation have been occurring. Crash data from the past three years (2012-2014) at intersections and on segments along the corridors was used for the analysis. The crash types considered susceptible to correction vary from corridor to corridor, as the proposed facilities are different depending on the corridor and segment.

Iris Avenue

Along Iris Avenue, west of Broadway to Folsom Street, 59 crashes have occurred during the last three years. Existing crash trends which may be lessened by a four to three lane conversion include rear ends due to vehicles waiting to turn left at 16th Street and 17th Street, right angle crashes from vehicles turning left from side streets along the corridor, and right hook crashes at Folsom Street. Of the 59 crashes along the corridor, about 12 (20%) of them could be considered potentially correctable by a rightsizing project.

Folsom Street

A total of 242 crashes occurred at the intersections and on segments along Folsom Street between and including Valmont Road and Arapahoe Avenue. Potentially mitigatable crashes along Folsom Street include left-turn rear ends at Pine Street and South Street, right hook crashes at Valmont Road, Pearl Street, and Arapahoe Avenue, and sideswipes due to lane changes along the corridor. Depending on the limits chosen for the rightsizing project, the number of

potentially correctable crashes ranges from 7 to 9 and 7% to 10% of total crashes.

55th Street
From Pearl Parkway/Valmont Road to north of Arapahoe Avenue, 55th Street experienced 71 crashes within the past three years. Of the 71 total crashes, 11 (15%) were considered correctable. Most of the crashes which could be mitigated by a rightsizing project on 55th Street were right angle crashes involving eastbound vehicles turning left from Western Avenue or the driveway access north of Arapahoe Avenue. A four to three lane conversion on 55th Street would reduce the number lanes to navigate across at each location and would provide a two-way left-turn lane at the driveway access north of Arapahoe Avenue.

63rd Street
A total of 47 crashes were reported at the intersections on 63rd Street from Lookout Road to Gunbarrel Avenue/Nautilus Drive during the past three years. Twenty-three of these crashes occurred at Lookout Road and are not likely to be mitigated by the proposed rightsizing project. Since 63rd Street has a raised median and limited intersections, the potential reduction in crash frequency is lower than the other corridors. The only existing crash trend which may be corrected is right angle crashes at Longbow Drive involving eastbound left-turns. These crashes represent 6% of the total crashes on the corridor.

Conclusion
Some of the existing crash trends on Iris Avenue, Folsom Street, 55th Street, and 63rd Street could be mitigated by the implementation of the Phase II Living Laboratory rightsizing projects. Since the historic crashes and proposed facilities are different on each corridor, the potential safety benefits also vary. The frequency of crash types considered correctable by the proposed projects ranges from 6% to 20% on the candidate corridors. Actual crash reductions may be higher or lower than these projections as a result of increased congestion, decreased speeds, or changes in traffic volumes.

Appendix:
Crash Summaries by Corridor

Appendix

Crash Summaries by Corridor

Iris Avenue

Intersection/Segment	Total Crashes				Correctable Crashes	
	2012	2013	2014	Total		
Iris Ave and 13th St	3	0	1	4	2	50%
Iris Ave and 14th St	1	1	0	2	0	0%
Iris Ave and 15th St	1	1	1	3	1	33%
Iris Ave and 16th St	2	5	4	11	4	36%
Iris Ave and Iris Ct	0	1	1	2	0	0%
Iris Ave and 17th St	1	0	0	1	1	100%
Iris Ave and 19th St	4	2	1	7	0	0%
Iris Ave and 22nd St	1	0	0	1	0	0%
Iris Ave and Hermosa Dr	0	0	2	2	1	50%
Iris Ave and 25th St	1	0	1	2	0	0%
Iris Ave and Folsom St	4	12	8	24	3	13%
Total	**18**	**22**	**19**	**59**	**12**	**20%**

Folsom Street

Intersection/Segment	Total Crashes				Correctable Crashes	
	2012	2013	2014	Total		
Folsom St and Valmont Rd	6	5	6	17	2	12%
Folsom St and Bluff St	1	0	3	4	0	0%
Folsom St and Mapleton Ave	0	0	1	1	0	0%
Folsom St and Pine St	9	8	4	21	2	10%
Folsom St and Spruce St	5	5	0	10	0	0%
Folsom St and Pearl St	11	7	8	26	3	12%
Folsom St and Walnut St	1	3	1	5	0	0%
Subtotal	**33**	**28**	**23**	**84**	**7**	**8%**
Folsom St and South St	1	2	0	3	1	33%
Folsom St from South St to Canyon Blvd	3	1	0	4	1	25%
Subtotal	**37**	**31**	**23**	**91**	**9**	**10%**
Folsom St and Canyon Blvd	16	28	25	69	0	0%
Folsom St from Canyon Blvd to Goss St	1	2	0	3	1	33%
Folsom St and Goss St	5	0	0	5	1	20%
Folsom St and Grove St	2	2	2	6	0	0%
Folsom St and Arapahoe Ave	24	21	23	68	5	7%
Total	**85**	**84**	**73**	**242**	**16**	**7%**

55th Street

Intersection/Segment	Total Crashes				Correctable Crashes	
	2012	2013	2014	Total		
55th St and Pearl Pkwy/Valmont Rd	20	13	9	42	0	0%
55th St and Flatirion Ln	1	2	1	4	1	25%
55th St and Mine Way	0	1	0	1	1	100%
55th St and Central Ave	4	4	0	8	0	0%
55th St and Western Ave	4	3	1	8	5	63%
55th St from Western to Arapahoe	2	5	1	8	4	50%
Total	31	28	12	71	11	15%

63rd Street

Intersection/Segment	Total Crashes				Correctable Crashes	
	2012	2013	2014	Total		
63rd St and Lookout Rd	11	4	8	23	0	0%
63rd St and Spine Rd	6	7	5	18	0	0%
63rd St and Longbow Dr	2	0	1	3	0	0%
63rd St and Gunbarrel Ave/Nautilus Dr	2	0	1	3	3	100%
Total	**21**	**11**	**15**	**47**	**3**	**6%**

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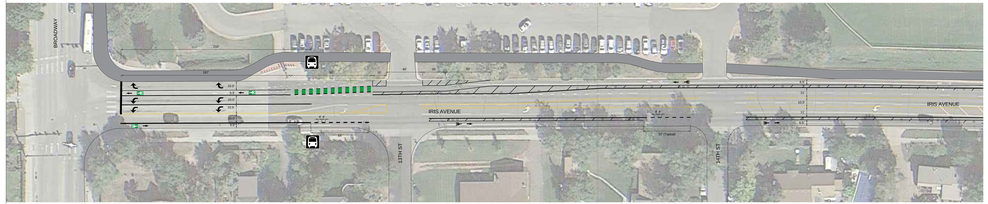
4/29/2015



REDUCE TO ONE WESTBOUND LEFT AT BROADWAY

FOX TUTTLE HERNANDEZ
TRANSPORTATION GROUP

N

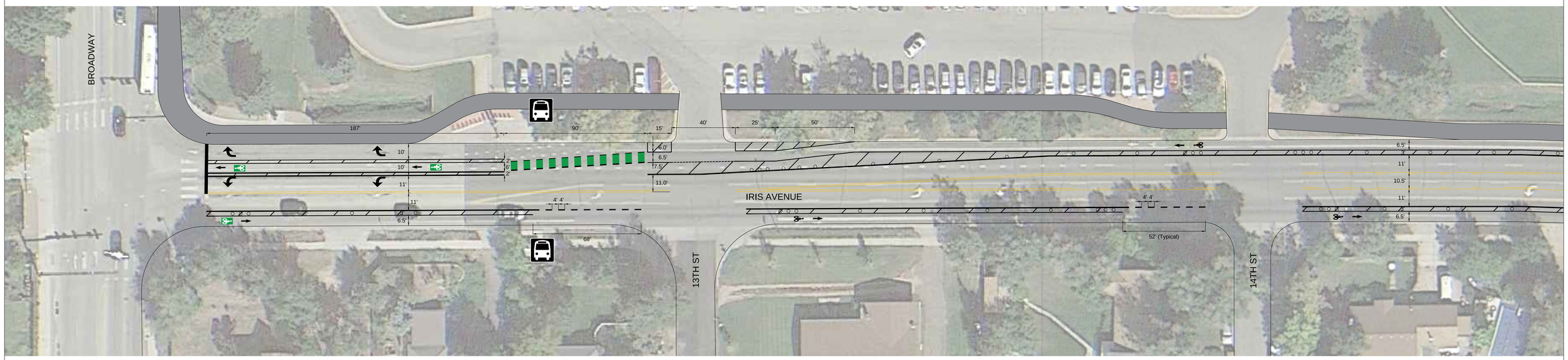
0 20' 40'

4/25/2015

BOULDER, COLORADO

LIVING LABS RIGHT-SIZING -

IRIS AVENUE



REDUCE TO ONE WESTBOUND LEFT AT BROADWAY

CITY OF BOULDER

FOX TUTTLE HERNANDEZ
TRANSPORTATION GROUP

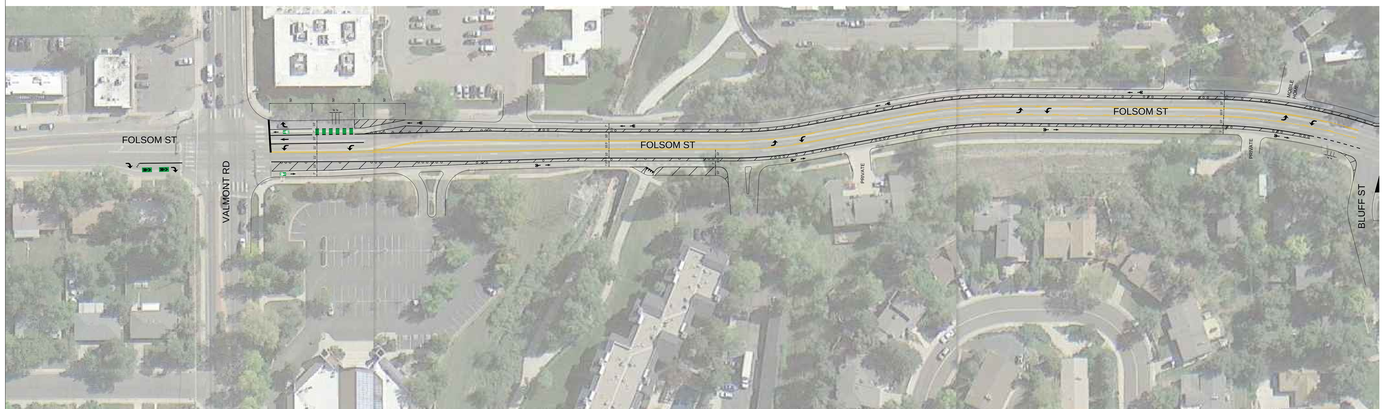
NOT FOR CONSTRUCTION
PRELIMINARY CONCEPTUAL DESIGN

4/25/2015

BOULDER, COLORAD

LIVING LABS RIGHT-S

FOLSOM STREE



FOX TUTTLE HERNANDEZ
TRANSPORTATION GROUP

4/25/2015

BOULDER, COLORADO

LIVING LABS RIGHT-SIZING -
FOLSOM STREET

WITH SINGLE SOUTHBOUND LEFT AT
ARAPAHOE AVENUE

CITY OF BOULDER

FOX TUTTLE HERNANDEZ
TRANSPORTATION GROUP

NOT FOR CONSTRUCTION
PRELIMINARY CONCEPTUAL DESIGN

4/25/2015

BOULDER, COLORADO

LIVING LABS RIGHT-SIZING -
FOLSOM STREET

RIGHTSIZING BETWEEN VALMONT ROAD AND SOUTH STREET

CITY OF BOULDER

FOX TUTTLE HERNANDEZ TRANSPORTATION GROUP

NOT FOR CONSTRUCTION
PRELIMINARY CONCEPTUAL DESIGN

4/25/2015

BOULDER, COLORADO

LIVING LABS RIGHT-SIZING -
FOLSOM STREET

WITH DUAL SOUTHBOUND LEFT AT
CANYON BOULEVARD

CITY OF BOULDER

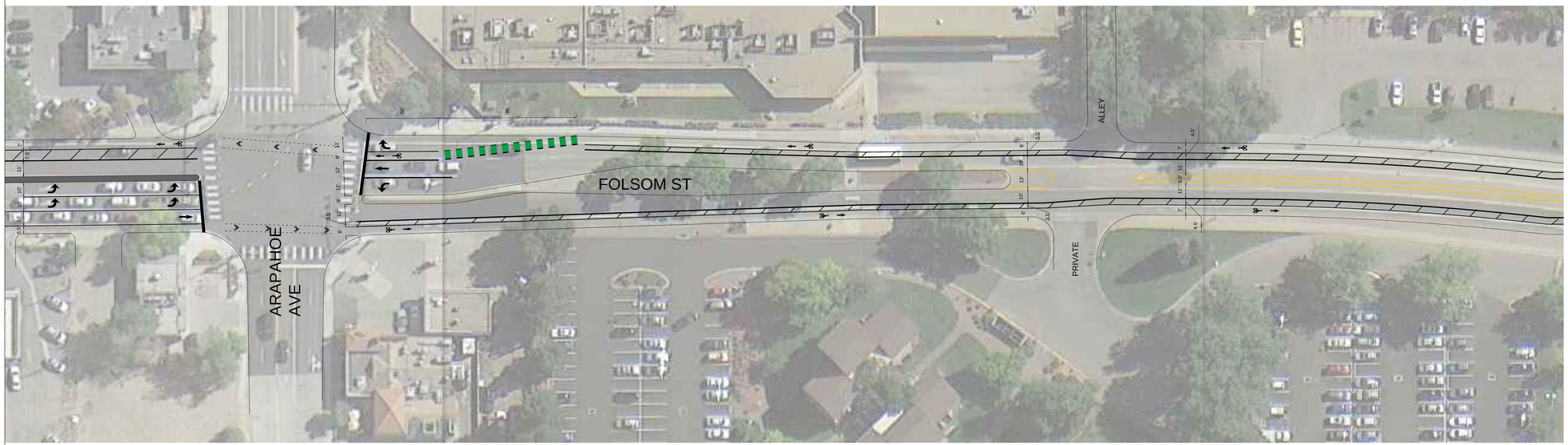
FOX TUTTLE HERNANDEZ
TRANSPORTATION GROUP

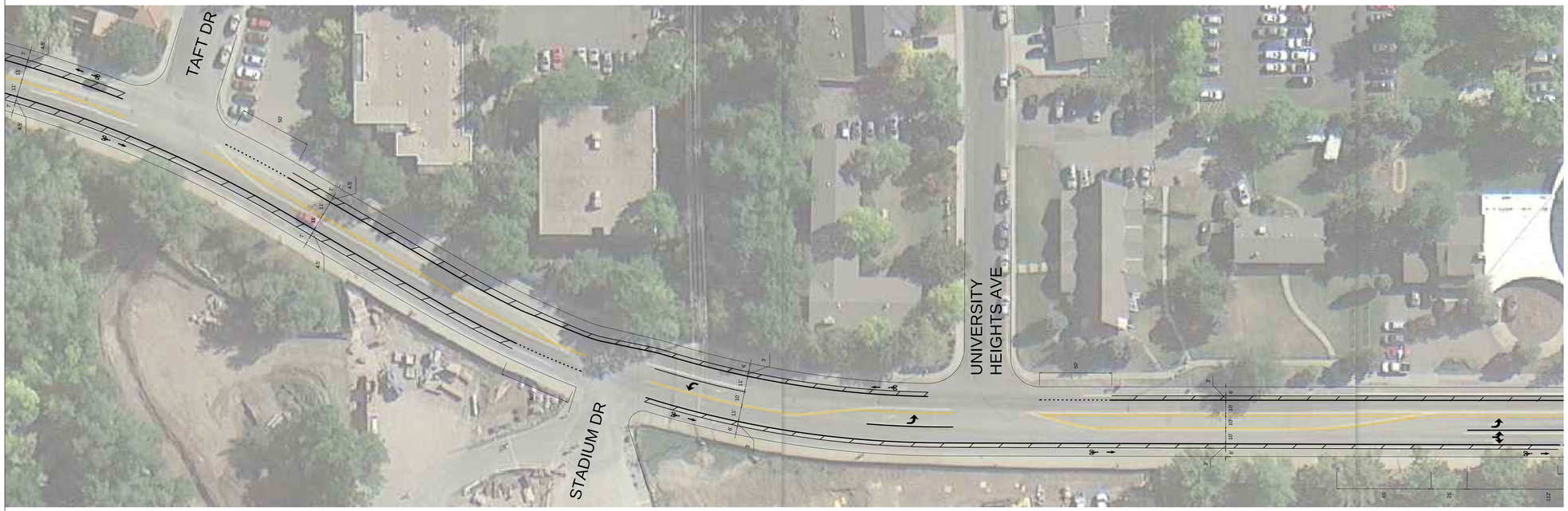
NOT FOR CONSTRUCTION
PRELIMINARY CONCEPTUAL DESIGN

4/23/2015

BOULDER, COLORADO

LIVING LABS RIGHT-SIZING -
FOLSOM STREET (SOUTH)





CITY OF BOULDER

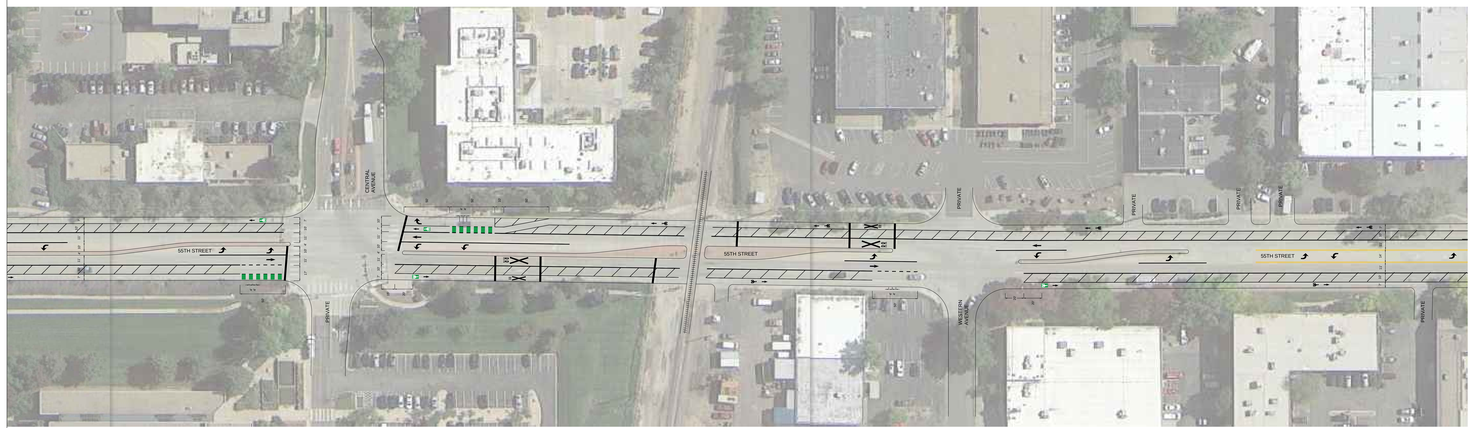
FOX TUTTLE HERNANDEZ
TRANSPORTATION GROUP

BOULDER, COLORAD

LIVING LABS RIGHT-S

55TH STREET

4/25/2015



FOX TUTTLE HERNANDEZ
TRANSPORTATION GROUP

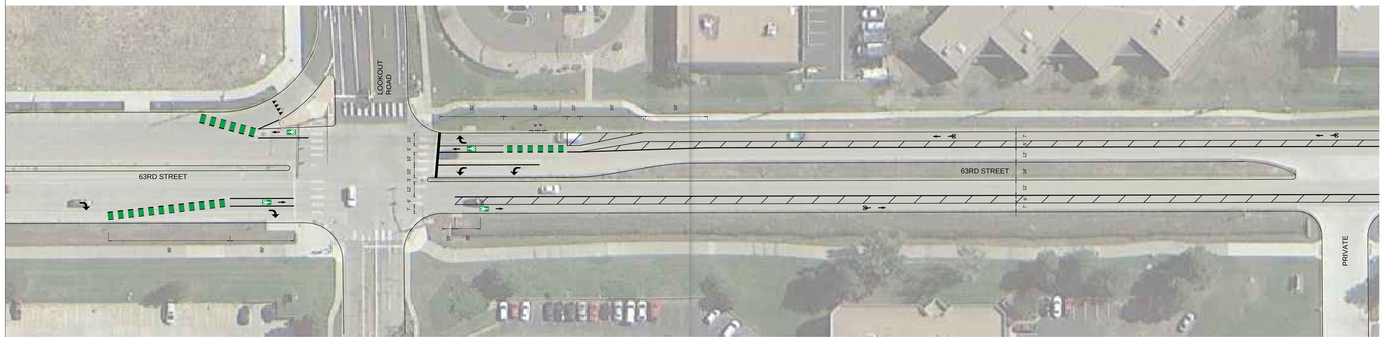
BOULDER, COLORAD

LIVING LABS RIGHT-S

63RD STREET

N

4/25/2015



FOX TUTTLE HERNANDEZ
TRANSPORTATION GROUP

Living Lab – Phase II Rightsizing Evaluation Criteria

Evaluation Criteria	Data Collection	Data Collection Method	Data Analyzed	Data Collection Time Frame	Collection & Analysis
SAFETY					
Crash History	All corridors	Review City of Boulder Crash Reports	• Fatal & serious injury crashes • Crashes involving bicyclist or pedestrian • Crash type trends (rear end, approach turn, right angle, etc.)	Before: • 5 years (2010-15) After: • 9 months • 1 year	City Staff
Right Turn Treatments & Turning Movement Conflicts	Folsom & Canyon Folsom & Pearl Iris & Broadway Iris & 19th 55th & Arapahoe 63rd & Spine (additional TBD)	Video Observation (AM & PM peak)	• Bicycle, pedestrian, and vehicle interactions in right turn treatments • Right or left turning motorist failure to yield to pedestrian or bicycle • Number of evasive actions taken by individual (cyclist, pedestrian, or motorist) • Compliance of users with signage and striping treatment	Before: • Summer 2015 After: • 3 months • 6 months • 9 months	FTH
MOTOR VEHICLES					
Volume	All corridors (locations listed below)	Jamar, Miovision, Wavetronix	• 24 hour counts of vehicles	Before: • Summer 2015 After: • 3 months • 6 months • 9 months	City Staff
Speed	All corridors (locations listed below)	Jamar, Miovision, Wavetronix	• Average daily speed of vehicles	Before: • Summer 2015 After: • 3 months • 6 months • 9 months	City Staff

Travel Time By Segment	Iris Folsom 55th 63rd	Field data collection	• Average driving time by segment for each corridor, both directions	Before: • Fall 2014 After: • 9 months	FTH
Intersection LOS / Capacity Analysis	All corridors	Turning Count Movement Data (AM & PM peak)	• Synchro capacity analysis for each intersection turning movement using data collected during City turning movement counts	Before: • Fall 2014 After: • 9 months	FTH
Left Turn Queue Length	Folsom & Canyon Folsom & Pearl Iris & Broadway	Video Observation (AM & PM peak)	• Average & maximum queue • Number of times left-turn queue blocks through lane	Before: • Summer 2015 After: • 3 months • 9 months	FTH
BICYCLES					
Volume	Folsom & Canyon Folsom & Pearl Iris & Broadway Iris & 19th 55th & Arapahoe 63rd & Spine	Before: Video Observation (AM & PM peak) After: 24 Hour Counters Video Observation (AM & PM peak)	• Bicycle volume by direction, time of day, and location within right of way	Before: • Summer 2015 After: • 3 months • 6 months • 9 months	FTH / City Staff
Demographics	Folsom & Canyon Folsom & Pearl Iris & Broadway Iris & 19th 55th & Arapahoe 63rd & Spine	Video Observation (AM & PM peak)	• Number of male, female, and children cyclists • Number of "commuters" (backpacks or bags on bike) • Number of cyclists wearing "lycra kits"	Before: • Summer 2015 After: • 3 months • 6 months • 9 months	FTH
Bicycle "Level of Service"	All Corridors	Facility design	• Measures to be determined	Before: • Spring 2015 After: • Spring 2016	City Staff / FTH TBD
PEDESTRIANS					
Crossing Volume	Folsom & Canyon	Video Observation	• Number of crossing pedestrians by	Before:	FTH

	Folsom & Pearl Iris & Broadway Iris & 19th 55th & Arapahoe 63rd & Spine	(AM & PM peak)	direction and time of day	• Summer 2015 After: • 3 months • 6 months • 9 months	
Non-auto Transportation to BVSD School	Iris	BVSD, Landon Hilliard	• Number of students accessing Foothills Elementary school along Iris by non-auto mode	Before: • Fall 2014 & Spring 2015 After: • Fall 2015 & Spring 2016	City Staff
Pedestrian "Level of Service"	All Corridors	Facility design	• Measures to be determined	Before: • Spring 2015 After: • Spring 2016	City Staff / FTH TBD
TRANSIT					
Ridership	Stops on All Corridors	RTD data	• Number of passengers boarding and alighting at stops along rightsized corridors	Before: • Fall 2014 & Spring 2015 After: • Fall 2015 & Spring 2016	FTH
Bus On-Time Performance	Stops on All Corridors	RTD data	• Percent of buses with on-time arrival at stops along rightsized corridors	Before: • Fall 2014 & Spring 2015 After: • Fall 2015 & Spring 2016	FTH
Bus Transition From Buffer to Travel Lane	RTD Stops: Folsom & Goss Iris & 22nd/Hermosa	Observation (AM & PM peak)	• Maximum and average length of time buses wait to merge	After: • Fall 2015 & Spring 2016	FTH
Transit and Bicycle Interactions	RTD Stops: Folsom & Goss Iris & 22nd/Hermosa	Observation (AM & PM Peak)	• Interactions and yielding behaviors of cyclists, transit vehicles in buffer, and motorists in travel lane	After: • Fall 2015 & Spring 2016	FTH
ECONOMIC					
Sales Tax	All Corridors Citywide	City of Boulder Finance Department	• Change in sales tax revenues of businesses along corridor in	Before: • Spring 2015	City Staff

			relation to change in sales tax revenues Citywide	After: • Spring 2016	
Property Values	All Corridors Citywide	Boulder County Assessor's Office	• Change in property values along corridor in relation to change in property values Citywide	Before: • Spring 2015 After: • Spring 2016	City Staff
PUBLIC FEEDBACK					
Public Feedback	All Corridors	Open Houses, Online Feedback, Popup Demontrations	• Online and community feedback	Before: • Ongoing After: • Ongoing	City Staff