



Town of Carrboro

Town Hall
301 W. Main St.
Carrboro, NC 27510

Meeting Agenda Board of Aldermen



Tuesday, March 11, 2014

7:30 PM

Board Chambers - Room 110

7:30-7:40

A. OTHER MATTERS

1. [14-0082](#) Charges Issued to Recently Appointed Advisory Board Members

B. Work Session

Public Comment is generally not accepted during work sessions.

7:40-8:10

1. [14-0080](#) Work Session on Ways to Expedite and Incentivize Environmentally Friendly Development Projects

PURPOSE: Board of Aldermen members have identified the provision of environmentally friendly features in development projects as desirable. This item provides information related to the concept and provides an opportunity for the Board to give staff direction on possible related changes to the development process.

Attachments: [Staff Memo on Expediting & Incentivizing Green Projects](#)

8:10-8:40

2. [14-0081](#) Discussion on land uses associated with drive-in and drive-through windows

PURPOSE: The purpose of this item is to provide the Board of Aldermen with an opportunity to discuss regulations affecting land uses with drive-in and drive-through windows

Attachments: [Att A - Excerpts from ART-XI-drive-in windows](#)

[Att B - Excerpts from ART-X](#)

[Att C - EPA Article on Extended Vehicle Idling](#)

[Att D - US Dept of Energy Idle vs stop at drive-thru](#)

[Att E - US Dept of Energy Idle vs stop and start paper](#)

[Att F - Tables](#)

8:40-9:00

3. [14-0072](#) Update on Downtown Traffic Circulation Including Traffic Model Analysis

PURPOSE: This is the next in a series of updates provided to the Board of Aldermen on traffic in the downtown area since 2011. This update provides results from traffic analysis, using Synchro software, of downtown intersections and segments.

Attachments: [Att A - RES - Downtown circulation report - Mar 11 2014](#)

[Att B - Memo - Downtown traffic report - Mar 11 2014](#)

- C. **MATTERS BY TOWN CLERK**
- D. **MATTERS BY TOWN MANAGER**
- E. **MATTERS BY TOWN ATTORNEY**
- F. **MATTERS BY BOARD MEMBERS**



Town of Carrboro

Town Hall
301 W. Main St.
Carrboro, NC 27510

Legislation Text

File #: 14-0082, Version: 1

Charges Issued to Recently Appointed Advisory Board Members

1. Environmental Advisory Board - Jae Furman
2. Transportation Advisory Board - Diana McDuffee
3. Economic Sustainability Commission - Betsy Bertram, Leo Gaev
4. Recreation and Parks Commission - Kendra Van Pelt



Town of Carrboro

Town Hall
301 W. Main St.
Carrboro, NC 27510

Legislation Text

File #: 14-0080, **Version:** 1

TITLE:

Work Session on Ways to Expedite and Incentivize Environmentally Friendly Development Projects

PURPOSE: Board of Aldermen members have identified the provision of environmentally friendly features in development projects as desirable. This item provides information related to the concept and provides an opportunity for the Board to give staff direction on possible related changes to the development process.

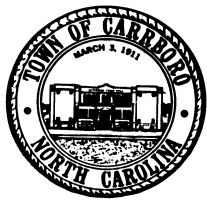
DEPARTMENT: Planning Department

CONTACT INFORMATION: Marty Roupe, Development Review Administrator, 919-918-7333, Tina Moon, Planning Administrator, 919-918-7325, and Mike Canova, Chief Code Inspector, 919-918-7337

INFORMATION: Board members requested an opportunity to discuss the concept of expediting and / or incentivizing aspects of the development review process as a way to encourage the provision of environmentally friendly or green features. The provision of such features is supported by existing adopted policies including a goal of reducing greenhouse gas emissions. More generally the provision of such features will help Carrboro move in the direction of mitigating some degree of impacts to climate change as related to development projects. The attached staff memo offers information and ideas for the Board to consider and discuss during the work session.

FISCAL & STAFF IMPACT: No impacts are associated with the receipt of this report. Impacts may be identified moving forward based on direction from the Board.

RECOMMENDATION: Staff requests that the Board consider and discuss the information and identify potential next steps.



TOWN OF CARRBORO

NORTH CAROLINA

WWW.TOWNOFCARRBORO.ORG

MEMORANDUM

TO: Mayor Lydia Lavelle and the Board of Aldermen
David Andrews, Town Manager

FROM: Martin Roupe, Development Review Administrator 

DATE: March 7, 2014

SUBJECT: Work Session on Ways to Expedite and Incentivize Environmentally Friendly Development Projects

SUMMARY & CONTEXT

Members of the Board of Aldermen have expressed interest in exploring ways to foster or support more environmentally friendly development projects. Ideas stated have included but are not limited to expediting review and providing incentives for including green features in a development. This memo provides a staff perspective on some possible ways to go about promoting green features while maintaining compliance with all applicable state and local regulations. Staff requests that the Board consider the information, discuss the topic, and provide guidance on moving forward with one or more efforts.

Of note and for context, the Town of Carrboro for a long time has proactively adopted ordinances and regulations that may be considered ahead of the curve, going above and beyond what is commonly required by other NC municipalities and / or what is required to meet state-established minimums. Some examples include but are not limited to stream buffers exceeding state-mandated minimums, stormwater regulations establishing both nitrogen and phosphorus standards in advance of a state-mandate, along with establishing a volume standard; the provision of large amounts of environmentally-sensitive lands through a 40% open space requirement in residential subdivisions, and an ordinance precluding homeowner's associations from disallowing green features in newly-approved subdivisions. Also of note, the NC building code is substantially improved from several years past regarding energy conservation measures for new construction. The current code requires measures and choices that result in new buildings being close to LEED silver certifiable status at occupancy simply by meeting minimum code requirements.

The Board also may wish to consider both the existing LUO provisions related to increased residential density in B-1(g)—CZ districts in exchange for providing additional features (LUO Section 15-141.4) and a text amendment currently under consideration which would make additional uses permissible in the M-1 zoning district in exchange for additional features, many of which have

enhanced environmentally-friendly aspects. If the Board would like to move forward with one or more approaches outlined in this memo, then staff suggests it may be helpful to consider a comprehensive analysis of all the incentives approaches either in the ordinance already or under consideration. It may be possible to create a single ordinance / system that allows for a developer to choose specific increases or bonuses in exchange for providing additional features in a more streamlined way, rather than placing the mechanisms in multiple locations within the ordinance structure.

POSSIBLE INCREASES OR BONUSES

Following are some possible increases or bonuses that may be worth considering:

Density Bonus

The Town's existing residential density bonus provisions, found in LUO Section 15-182.4, are an example of an existing incentive type approach to fostering a desired outcome within a development project, i.e. affordable housing stock. A similar ordinance potentially could be drafted related to the developer gaining a bonus, i.e. additional full residential dwelling units or accessory units in exchange for projects including desirable features.

Open Space

The Town's 40 percent open space requirement within residential subdivisions could be relaxed in exchange for desirable features. The existing language in fact allows for providing less than 40%, with the precise amount relating to the amount of land consumed by the affordable units within the project. Utilizing a similar approach related to green features may be a good fit as it would potentially free up some amount of land for placement of the features themselves. A percentage reduction based on the features could be offered, or the existing language could simply be modified to allow land on which desirable features are placed to count toward the 40% calculation.

Reduced Fees

It is unclear how much incentive would be created by reducing or foregoing fees altogether in exchange for desirable features, as the costs of many such features likely would far exceed the savings related to the Town's fees. The approach may be worthy of consideration though if combined with other approaches, as it would underscore the Town's interest and commitment to the inclusion of the features within development projects.

Shortened Stormwater Review Checklist

Use of the Town's shortened stormwater review checklist, currently limited to commercial projects and mixed use projects containing at least twenty percent commercial, could be extended to residential projects that choose to provide desirable features. This approach essentially allows a developer to reach the public hearing more quickly than they otherwise would, which results in the applicant knowing whether they have a vested right to build their project before expending the remaining funds necessary to show full compliance with the stormwater-related provisions of the LUO.

Of note the Town has limited experience with projects using this approach to date, but at least one project did seemingly complete the review process leading to a public hearing more quickly than they otherwise would have. Other projects have deferred the submittal of portions of the information, per the shortened checklist.

Conditional / Mixed Use Developments with Enhanced Environmental Features

The conditional and conditional use zoning district approaches may be worthy of consideration. To that end it is worth noting that the Town does have examples of development projects that include enhanced environmental features, some of which involved conditional and conditional use zoning. These include but are not limited to the Arcadia and Pacifica subdivisions, and the Winmore Village Mixed Use subdivision, all of which are built or are currently under construction, along with the Veridia and Shelton Station projects, both of which are permitted but not yet built. Winmore VMU and Veridia are both conditional use zoning districts, and Shelton Station is a conditional zoning district. It may be beneficial to identify specific features the Board finds commendable about these or other projects. Staff could then report back and potentially draft modifications to the ordinance accordingly for the Board's consideration.

Expedited Review

Staff has considered and provided information to the Board in the past about possible ways to expedite the development review process. Past discussions have primarily focused on projects including affordable homes as well as new schools that need to open by a predetermined date associated with the scheduled start of school year. It is conceivable that a similar approach could be used for projects qualifying by providing a sufficient number of green features within a project.

Staff sees expediting the review of a project to mean that the plans are prioritized upon submission to where they are handled before other projects currently being reviewed. Further, staff would make themselves available to assist the applicant in whatever way possible during the review in an effort to minimize the amount of review time for such projects. This would include keeping in close contact with outside reviewing agencies in order to facilitate the review process. Such efforts potentially may impact and disrupt one or more staff members' work schedules, but impacts and disruptions likely could be managed unless a large number of projects are all submitted back-to-back in such a way that the review time effectively is normalized again. It is also plausible that the review of one or more non-qualifying projects may be delayed by staff focusing attention on a qualifying, expedited project.

Staff is not suggesting that expedited review would lessen the Town's development related requirements in any way. All projects would still be required to comply with all adopted ordinances and regulations.

Of note the applicant and outside reviewing agencies must play equally important roles in order for an expedited review process to succeed. Staff cannot directly control what happens outside of our own purview, and the applicant must understand their role and responsibility clearly. In communicating with outside reviewing agencies in the past regarding this matter, staff has received a generally willing response.

POSSIBLE DESIRABLE ENVIRONMENTALLY-FRIENDLY / GREEN FEATURES

Following is a non-comprehensive list of examples of possible features that may be desirable. The Board may recognize some or many of these as they have been pulled from existing and proposed ordinance language, as referenced in the last paragraph of the Summary & Context section at the beginning of the memo:

Exceeding Building Code Requirements

A developer might choose as an option to exceed the minimum requirements established by the NC building code requirements. Staff has identified an approach that would involve the applicant having to demonstrate that they exceed the minimum by a defined percentage above the minimum as a way of recognizing that the standards in the code change over time. Examples include but are not limited to: insulation and wall panel materials choices, glass ratings, ceiling and roof materials choices, provision of solar panels, etc. Some examples are included in the table provided below.

Site Planning to Facilitate Green Features

Appropriate site planning choices could be recognized as a feature in and of itself. In other words, a developer could voluntarily modify designs to accommodate placement of solar panels, geothermal wells, provision of facilities for onsite food production such as community gardens, and other similar physical structures. Actually including such features obviously may warrant further credit, but the site design itself must first accommodate such features for them to succeed. This feature may potentially tie in well with the potential allowance for a reduction in the amount of required open space mentioned in the previous section.

Additional Desirable Features

The Board could determine that a number of additional features are desirable, including but not limited to the use of native plant species, provision of chicken coops or constructing a community garden, achieving certifiable Gold level LEED status, etc. The table below is a working draft of items related to the proposed text amendment for the M-1 zoning district, which identifies options that may be worthy of consideration.

Working draft of M-1 text amendment table:

Site and Building Element Categories	Examples of Performance Measures
Stormwater management and Water conservation	1) Substantial stormwater retrofits 2) Reduction in nitrogen loading from the site by at least 8% from the existing condition, as determined by the Jordan Lake Accounting Tool
Substantial transportation improvement and Alternative transportation enhancement	3) Provision of a safe, convenient, and connected internal street system or vehicle accommodation area designed to meet the needs of the expected number of motor vehicle, bicycle, pedestrian, and transit trips 4) Substantial improvement to public infrastructure, such as enhanced bicycle and pedestrian paths, or access to transit 5) Construction of substantially improved site entrance, intersection
On-site energy production and energy conservation	6) Meets or exceeds standards for LEED Gold certification 7) Installation of active and passive solar features such as sufficient solar arrays to account for 50 percent or more of the electrical usage for the property 8) Use of harvested rainwater for toilet flushing 9) Use of devices that shade at least 30% of south-facing and west-facing building elevations 10) Use of low emissivity (low-E) windows along south-facing and west-facing building elevations 11) Installation of attic insulation that exceeds the current building code R-value rating by 35% or greater 12) Use of geothermal heat system to serve the entire complex 13) Use of LED fixtures for parking and street lights 14) Meets the Architecture 2030 goal of a 50 percent fossil fuel and greenhouse gas emission reduction standard, measured from the regional (or country)

	average for that building type or the US Conference of Mayors fossil fuel reduction standard for all new buildings to carbon neutral by 2030
Creation of new and innovative light manufacturing operations	15) The development of clean, innovative light manufacturing operation(s) that creates employment for a more than ten workers 16) Incorporates technologies to reduce production waste by 50 percent or more
The provision of public art and/or provision of outdoor amenities for public use	17) Outdoor amenities such as major public art 18) Amphitheatre or outdoor theater, outdoor congregating/gathering area 19) Outdoor eating facilities 20) Outdoor tables with game surfaces, etc.

In closing regarding the list of choices identifying desirable features, the Board may wish to consider asking staff to look at a system that somehow weights or gives more credit for what the Board may identify as more desirable features. The existing B-1(g)—CZ district and the M-1 language currently under consideration both involve the developer choosing to include a number of features within their development, but does not formally recognize that some features are significantly more expensive and / or desirable than others. One approach staff has identified that may be plausible is a table similar to the existing recreation facilities table that establishes a points system. The features themselves would be granted a point factor based on their expected costs and the project would have to provide enough points to get the desired bonus. Another approach may be to give significant credit to highly-desirable features, whatever the Board may determine should qualify, and less credit to other features, with no direct reference to the expected costs of the features themselves.

RECOMMENDATION

Staff requests that the Board consider and discuss the information and identify potential next steps.



Legislation Text

File #: 14-0081, **Version:** 1

TITLE:

Discussion on land uses associated with drive-in and drive-through windows

PURPOSE: The purpose of this item is to provide the Board of Aldermen with an opportunity to discuss regulations affecting land uses with drive-in and drive-through windows

DEPARTMENT: Planning

CONTACT INFORMATION: Christina Moon - 919-918-7325; Patricia McGuire - 919-918-7327

INFORMATION: In June and September of 2013, the Board of Aldermen considered a request for a conditional use permit (CUP) modification for the Bank of America branch located on East Main Street regarding its drive-through teller station. Shortly thereafter, the Board received a request for text amendments to allow additional uses in M-1 zoning district subject to a CUP, including banks with drive-in windows and freestanding ATMs. These recent requests have brought to the surface questions relating to the appropriateness of drive-in and drive-through windows in the downtown and elsewhere in the Town's jurisdiction. At the October 22, 2013 meeting, the Board directed staff to prepare an ordinance that would remove land uses with drive-through windows as a potential use for future development from the remaining zoning districts that allow them.

In following up with this directive, staff reviewed historical information and more recent findings related to the environmental, accessibility and land use implications of drive-through uses. Staff felt it would be helpful to share this information with the Board of Aldermen before text amendments were drafted.

Background

The Board discussed the topic of drive-in and drive-through windows at length during several meetings in 1997 and 1998 and subsequently adopted amendments to the Land Use Ordinance (LUO) following a public hearing on June 9, 1998. Agenda materials from the public hearing may be found at:

http://www.townofcarrboro.org/BoA/Agendas/1998/06_09_1998.pdf. The LUO distinguishes drive-in uses from drive-through uses in the Table of Permissible Uses (Section 15-146). The descriptions for use category 8.000 restaurants (including food delivery services), bars, night clubs, includes the following subsections:

- 8.300 Drive-in windows (service to and consumption in vehicle on premises)
- 8.400 Drive-through windows (service directly to vehicles primarily for off-premise consumption)

These uses should not to be confused with 8.500 carry out service (food picked up inside for off-premises consumption), 8.600 food delivery, or 8.700 mobile prepared food vendors.

The 1998 discussion focused on the use of drive-in/drive-through windows in the downtown, mainly in the B-1 (c) and B-1(g) zoning districts. Staff included a brief analysis of existing businesses with drive-through

windows as part of the work session materials for March 24, 1998. Information from that meeting can be found at the following link: http://www.townofcarrboro.org/BoA/Agendas/1998/03_24_1998.pdf

As part of that analysis, staff identified six existing businesses with drive-in/drive-through uses in or near the downtown. Five businesses are still in operation in those locations: Bank of America, Wendy's, PNC Bank, Sun Trust Bank, and Burger King. Of those, three-Bank of America, Wendy's and PNC Bank are within the downtown and still appear to be compatible with the needs of the community for those who may have limited mobility and for those who do not and prefer to walk. (Two other businesses have subsequently located in Carrboro Plaza, the State Employees Credit Union and Arby's. Sun Trust Bank, previously known as Central Carolina Bank, is also located in Carrboro Plaza.)

Staff presented three alternatives for the Board's consideration in 1998.

1. Adopt an ordinance prohibiting drive-in and drive-through uses in all zoning districts.
2. Provide direction to staff concerning those uses and locations where drive-in/through uses may be allowed to continue and where they should be prohibited entirely.
3. Leave the present use classifications and regulatory measures as they are.

The Board moved forward with the second option. Advisory board comments, during the public hearing process, provided further refinement to the draft amendment in an effort to address safety concerns such as the potential for drive-through patrons to interact with patrons leaving the building on foot. The Board of Aldermen subsequently adopted text amendments which included the performance standards for businesses with drive-in windows found in Section 15-176.1 of the LUO, Supplementary Use Regulations (*Attachment A*). The adopted amendment included provisions for a handrail barrier to prevent pedestrians from walking directly into the path of the drive-through lane, in response to advisory board comments.

Considerations

To reiterate the difference between drive-through and drive-in windows, a drive-through window allows customers to purchase products or conduct business without leaving their vehicle. Cars typically stack and move in one direction within a designated lane. Drive-in uses typically provide a place for customers to park their cars while food is brought to them or while they watch a movie. The general discussion regarding land uses with drive-in and drive-through windows, in the late 1990s and in the present, tends to target four main areas which when in balance support a vibrant and successful community.

- 1) Addressing environmental concerns (air quality) linked to idling;
- 2) Creating and promoting a walkable community, one that encourages residents to get out of their cars for all of the associated benefits ;
- 3) Promoting economic development by allowing land uses with a strong economic return to occur in key areas; and
- 4) Ensuring equal access to services for all citizens including those with special needs such as the elderly, those with disabilities and perhaps even parents with young children.

Research on the negative effects of extended idling have focused more on large diesel truck use than on individual cars. Findings from environmental studies comparing the impact of car idling while using drive-through windows as opposed to parking and going inside the building have not conclusively supported either option as significantly less detrimental (*attachments C through E*). Information regarding the other three elements has also proved somewhat inconclusive in that there are a number of elements that impact walkability in a downtown and the ability of special needs population to have access to services. For example, some

patrons may find a drive-through lane or window difficult to maneuver while others may find the services virtually unavailable to them without a drive-through option. Similarly, the practical impact of prohibiting certain uses such as banks with drive-in windows in zoning districts that are outside of the downtown may effectively result in banks not locating in those districts.

The attached two tables (*Attachment F*) are designed to facilitate further discussion by providing a comparison of the existing land use classifications that include a drive-in/drive-through service with the four areas identified as elements that contribute to a vibrant and successful community. Staff has inserted + and - symbols to indicate potential scenarios whereby the use classification would contribute to the discussion topic elements in a positive way (+) or negative way (-), (+/-) to indicate where the scenario could be perceived to be either a positive or negative depending on one's perspective, and NA to indicate scenarios which would not apply to either. Using Drive-In Movie Theaters (use 6.260) as an example staff has inserted NA under environmental protection and walkability and + under economic development and equal access. Since the romantic appeal of a drive-in movie is to watch the movie from the car it seems unlikely that someone would walk or bike to a drive-in. Therefore the elements of idle/stop-start concerns and walkability seem non-applicable for this particular land use. However, the retro appeal of drive-in theaters could contribute to economic development and could make it easier for citizens with mobility issues to attend movies (+).

The charts are not intended to predict the only way to evaluate these use classifications and their potential impact to the community. Rather, the purpose of the charts is to try to gain a better understanding of land uses that include a drive-in or drive-through window component to aid in a determination of when and where such uses may be appropriate or even beneficial.

FISCAL & STAFF IMPACT: There is no fiscal impact related to the discussion of this item. Costs are associated with public hearings and staff time should the Board wish to pursue text amendments to the Land Use Ordinance.

RECOMMENDATION: Staff recommends that the Board of Aldermen discuss regulations affecting land uses with drive-in windows and drive-through windows and provide input on this topic.

ARTICLE XI

SUPPLEMENTARY USE REGULATIONS

PART II. MISCELLANEOUS SUPPLEMENTARY USE PROVISIONS

Section 15-176.1 Businesses with Drive-In Windows (AMENDED 06/09/98)

In addition to other applicable provisions of this chapter, use classifications 2.140, 2.240, 3.230, 3.250, 8.300, 8.400, and 16.100 shall be subject to the following requirements:

- (1) The entrance/exit doors of such uses shall be located in such a manner that a person entering/exiting such business is not required immediately to cross a drive-in window exit lane.
- (2) Drive-in windows shall be located in such a fashion that vehicles using or waiting to use such drive-in or drive-through facilities do not interfere with vehicles seeking to enter or leave parking areas.
- (3) Where it is necessary for patrons wishing to park and enter such businesses to cross a drive-in window lane, crosswalks leading from parking areas to building entrances shall be clearly marked.
- (4) The vehicular entrances or exits of such uses shall not be located within 300 feet of the intersection of the centerlines of intersecting streets.
- (5) A building housing an 8.400 classification use may not be located closer than 1,000 feet to the nearest point of another building housing an 8.400 classification.
- (6) A Type B screen shall be erected, on the exterior border, from the service window to the entrance of the stacking lane.

Article X

PERMISSIBLE USES

Section 15-146 Table of Permissible Uses.¹

The following Table of Permissible Uses should be read in close conjunction with the definitions of terms set forth in Section 15-15 and the other interpretative provisions set forth in this article.

¹The Table of Permissible Uses was amended 05/12/81 to add the R-SIR-2 and W categories.

The Table of Permissible Uses was amended 12/07/83 to delete the W category and to add the C, R-40, R-80, B-5, and WM-3 categories.

The Table of Permissible Uses was amended 02/04/86 to add the R-2, B-1(c), B-1(g), and CT categories; 04/05/88 the B-3T; and 04/16/91 the O and OA zones.

The Table of Permissible Uses of the Carrboro Land Use Ordinance was amended 6/22/04 to modify the permit requirements for the 8.000 uses.

The Table of Permissible Uses was amended 5/24/2005 modifying the use classification 15.800.

The Table of Permissible Uses is further amended 5/24/2005 by adding a new classification 17.400 Underground Utility Lines.

The Table of Permissible Uses is amended 3/7/06 by adding the letter “S” opposite use classifications 3.110, 3.120, and 3.130 under the B-3 district column to indicate that these uses are permissible with the special use permit in that district.

The Table of Permissible Uses is further amended 3/7/06 by replacing the designation “ZC” opposite use classification 3.150 under the B-3 district column with the designation “S” to indicate that this use is permissible in this district with a special use permit.

The Table of Permissible Uses is amended 6/26/07 by modifying the use classification 21.000 Cemetery and Crematorium by creating two new subcategories for this use so that the permit requirements now read as follows: 21.200 All other cemeteries; and 21.300 Crematorium.

The Table of Permissible Uses is amended by deleting the entries for 1.510 Hotels and Motels and 1.530 Bed and Breakfast, renumbering the remaining Temporary Residential use classification that is remaining, 1.520 Tourist Homes and other Temporary Residences Renting Rooms for Relatively Short Periods of Time, from 1.520 to 1.510; and a new use classification 34.000 Temporary Lodging with associated permit requirements.

Art. X PERMISSIBLE USES (con't)

The Table of Permissible Uses is amended 6/26/07 by changing adding the letter “S” opposite use classification 22.100 under the B-1-C district column to indicate that this use is permissible with a Special Use Permit in that district. The Table of Permissible Uses is further amended by adding the letter “Z” opposite use classification 22.200 under the B-1-C district column to indicate that this use is permissible in this district with a Zoning Permit.

The Table of Permissible Uses is amended 6/26/07 by changing the letter “S” to letter “Z” opposite the classification 22.200 under the B-2, B-4, and CT district column to indicate that this use is now permissible with a Zoning Permit in these districts.

The Table of Permissible Uses is amended 6/26/07 by relabeling use 22.300 as Senior Citizens Day Care, Class A and by changing the letter “S” to letter “Z” opposite the classification 22.300 under the B-2, B-4, and CT district column to indicate that this use is now permissible with a Zoning Permit in these districts.

The Table of Permissible Uses is amended 6/26/07 by adding a new use classification, 22.400, Senior Citizens Day Care, Class B and adding the letter “S” opposite this use classification under the columns for the R-2, R-3 R-7.5, R-10, R-15, R-20, RR B-2, B-4, and CT zoning districts, by adding a “Z” under the columns for the B-1(G), B-1(C), B-3, M-1, O, and O/A zoning districts.

The Table of Permissible Uses is amended 11/27/07 by adding the letter “C” opposite use classifications 2.112, 2.120, 2.150, 3.120, and 3.220 under the WM-3 district column to indicate that these uses are permissible with a Conditional Use Permit in that district.

The Table of Permissible Uses is amended 6/24/08 by adding a new use classification 8.700 entitled “Mobile prepared food vendors” and by adding the letter “z” opposite this use classification under the B-1(C), B-1(G) and M-1 zoning district columns to indicate that this use is permissible in those districts with a zoning permit.

The Table of Permissible Uses is amended 10/28/08 by adding the letter “C” opposite use classifications 2.210, 2.220, 2.230 under the WM-3 district column to indicate that these uses are permissible with a Conditional Use Permit in that district.

The Table of Permissible Uses is amended 11/24/09 by the addition of a “Z(l)” opposite the 5.110 use classification in the column for the B-4 zoning district to indicate that these uses are permissible with a zoning permit in that district, subject to the limitations provided in Section 15-147(m).

The Table of Permissible Uses is hereby amended 6/22/10 to include “electronic gaming operations” as use # 6.150 and to add the electronic gaming definition. Electronic gaming operations shall be permitted with a special use permit in the B-4 zoning district, and the Table of Permissible Uses is amended accordingly.

Art. X PERMISSIBLE USES (con't)

The Table of Permissible is hereby amended on 4/23/13 is amended by changing the permit designation “ZS” to “ZC” wherever the former designation appears in the table under the zoning district columns applicable to the commercial and manufacturing districts. No change shall be made with respect to use classification 26.100 (major subdivisions).

²Use classifications amendment/repeal dates are as follows:

1.112—Amended 10/01/85	8.600—Amended 06/22/04
1.120—Amended 10/01/85	9.100—Amended 6/25/02
1.420—Amended 05/10/83; 06/22/04	15.147—Amended 06/22/04
1.480-- Amended 04/19/05	15.800—Amended 05/24/05
1.640—Amended 10/22/85	17.400—Amended 05/24/05
1.700—{Repealed}	18.200---Amended 11/12/85
1.800	19.100---Amended 05/12/81
2.110	19.200---Amended 05/12/81
2.120	21.000—Amended 06/20/06
2.111--Amended 04/15/81; 12/14/82	21.100—Amended 06/20/06
2.210—Amended 05/28/02 ; 10/28/08	21.200—Amended 06/20/06
2.220—Amended 10/28/08	21.300—Amended 06/20/06
2.230—Amended 5/28/02; 10/28/08	22.100—Amended 06/26/07
3.110—Amended 03/7/06	22.200—Amended 06/26/07
3.120—Amended 03/7/06	22.300—Amended 06/26/07
3.130---Amended 03/7/06	2.120—Amended 11/27/07
3.140---Amended 12/07/83	2.150—Amended 11/27/07
3.150—Amended 03/7/06	3.120—Amended 11/27/07
7.200---Amended 05/10/83	3.220—Amended 11/27/07
8.100—Amended 06/22/04	8.700—Amended 06/24/08
8.200—Amended 06/22/04	2.210---Amended 10/28/08
8.500—Amended 6/22/04	2.220---Amended 10/28/08
22.400--Amended 6/26/07	2.230---Amended 10/28/08
34.000--Amended 11/28/06	5.110---Amended 11/24/09
34.100--Amended 11/28/06	6.150---Amended 06/22/10
34.200--Amended 11/28/06	ZS to ZC --- Amended 04/23/13
2.112—Amended 11/27/07	

TABLE OF PERMISSIBLE USES

Last Amended: 4/23/13

DESCRIPTION	R-2	R-3	R-7.5	R-SIR, SIR2, 10	R-15	R-20	RR	B-1 (C)	B-1 (G)	B-2	B-3	B-3-T	B-4	M-1	M-2	CT	C	W-R	B-5	WM-3	O	O/A
1.000 Residential																						
1.100 Single Family Residences																						
1.110 Single Family Detached One Dwelling Unit Per Lot																						
1.111 Site Built/Modular	Z	Z	Z	Z	Z	Z	Z		Z	Z	Z	Z				Z		Z			Z	Z
1.112 Class A Mobile Home			Z	Z	Z	Z	Z											Z				
1.113 Class B Mobile Home																						
1.120 Single Family Detached More Than One Dwelling Unit Per Lot																						
1.121 Site Built/Modular	*	*	*	*	*	*	*		*	*	*	*				*					*	*
1.122 Class A Mobile Home			*	*	*	*	*															
1.123 Class B Mobile Home																						
1.200 Two-Family Residences																						
1.210 Two-Family Conversion	*	*	*	*	*	*	*	*	*	*	*	*				*					*	*
1.220 Primary Residence with Accessory Apartment	*	*	*	*	*	*	*	*	*	*	*	*				*					*	*
1.230 Duplex	*	*	*	*	*	*	*	*	*	*	*	*				*					*	*
1.231 Maximum 20% units > 3 bedrms/du	*	*	*	*	*	*	*	*	*	*	*	*				*					*	*
1.232 No bedroom limit	*	*																				
1.240 Two Family Apartment	*	*	*	*	*	*	*	*	*	*	*	*				*					*	*
1.241 Maximum 20% units > 3 bedrms/du	*	*	*	*	*	*	*	*	*	*	*	*				*					*	*
1.242 No bedroom limit	*	*																				
1.300 Multi-Family Residences																						
1.310 Multi-Family Conversion	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC				SC					SC	SC
1.320 Multi-Family Townhomes	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC				SC					SC	SC
1.321 Maximum 20% units > 3 bedrms/du	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC				SC					SC	SC
1.322 No bedroom limit	SC	SC																				
1.330 Multi-Family Apartments	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC				SC					SC	SC
1.331 Maximum 20% units > 3 bedrms/du	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC				SC					SC	SC
1.332 No bedroom limit	SC	SC																				
1.340 Single-Room Occupancy	SC							SC	SC	SC	SC					SC						
1.400 Group Homes																						
1.410 Fraternities, Sororities, Dormitories and Similar Housing	C	C	C	C	C	C	C		C	C						C						
1.420 Boarding Houses, Rooming Houses	S	S	S	S	S	S	S		C	S						C		C				
1.430 Adult Care Home, Class A	Z	Z	Z	Z	Z	Z	Z		Z	Z	Z	Z				Z		Z			Z	Z
1.440 Adult Care Home, Class B	S	S	S	S	S	S	S		Z	Z						Z		S				
1.450 Child Care Home, Class A	Z	Z	Z	Z	Z	Z	Z		Z	Z	Z	Z				Z		Z			Z	Z
1.460 Child Care Home, Class B	S	S	S	S	S	S	S		Z	Z						Z		S				
1.470 Maternity Home	Z	Z	Z	Z	Z	Z	Z		Z	Z	Z	Z				Z		Z			Z	Z
1.480 Nursing Care Home	Z	Z	Z	Z	Z	Z	Z		Z	Z	Z	Z				Z		Z			Z	Z
1.500 Temporary Residences																						
1.510 Tourist Homes and other Temporary Residences Renting Rooms for Relatively Short Periods of Time	S	S	S	S						S									C			
1.600 Homes Emphasizing Services, Treatment or Supervision																						
1.610 Temporary Homes for the Homeless		S	S				S	S		S	S	S										
1.620 Overnight Shelters for Homeless								S		S	S	S										
1.630 Senior Citizen Residential Complex				C	C																	
1.700																						
1.800																						
1.900 Home Occupation	Z	Z	Z	Z	Z	Z	Z			S	S	S				S		Z			Z	Z

TABLE OF PERMISSIBLE USES

Last Amended: 4/23/13

DESCRIPTION	R-2	R-3	R-7.5	R-SIR, SIR2, 10	R-15	R-20	RR	B-1 (C)	B-1 (G)	B-2	B-3	B-3-T	B-4	M-1	M-2	CT	C	W-R	B-5	WM-3	O	O/A
2.000 Sales and Rental of Goods, Merchandise and Equipment																						
2.100 No Storage or Display of Goods Outside Fully Enclosed Building																						
2.110 High-Volume Traffic Generation								ZC	ZC		ZC	ZC	ZC	ZC	ZC	C			C			ZC
2.111 ABC Stores								ZC	ZC		C	C	C			C						
2.112 Specialty High Volume Retail										ZC										C		
2.120 Low-Volume Traffic Generation								ZC	ZC	ZC	ZC	ZC	ZC	ZC	ZC	C			C	C		ZC
2.130 Wholesale Sales									ZC			ZC	ZC	ZC	ZC	C			C	C		ZC
2.140 Drive-In Windows											C	C	C	C								
2.150 Retail Sales with Subordinate Manufacturing and Processing								ZC												C		
2.200 Display of Goods Outside Fully Enclosed Building																						
2.210 High-Volume Traffic Generation								ZC	ZC					ZC	ZC	ZC			C	C		ZC
2.220 Low-Volume Traffic Generation								ZC	ZC					ZC	ZC	ZC			C	C		ZC
2.230 Wholesale Sales									C					ZC	ZC	ZC			C	C		ZC
2.240 Drive-In Windows											C	C		C								
2.300 Storage of goods outside fully enclosed building																						
2.310 High-volume traffic generation														ZC								
2.320 Low-volume traffic														ZC								
2.330 Wholesale Sales														ZC								
2.340 Drive-in Windows																						
3.000 Office, Clerical, Research and Services Not Primarily Related to Goods or Merchandise																						
3.100 All operations conducted entirely Within Fully Enclosed Building																						
3.110 Operations designed to attract and serve customers or clients on the premises, such as the office of attorneys, physicians, other professions, insurance and stock brokers, travel agents, government office buildings, etc.								ZC	ZC	ZC	S		ZC	ZC	ZC	C			C		ZC	ZC
3.120 Operations designed to attract little or no customer or client traffic other than employees of the entity operating the principal use								ZC	ZC	ZC	S		ZC	ZC	ZC	C			C	C	Z	ZC
3.130 Office or clinics of physicians or dentists with not more than 10,000 square feet of gross floor area								ZC	ZC	ZC	S		ZC	ZC		ZC			C		ZC	ZC
3.140 Watershed research																	C					
3.150 Copy Centers/Printing Operations								ZC	ZC	ZC	S	ZC	ZC	ZC	ZC	ZC			ZC		ZC	

TABLE OF PERMISSIBLE USES

Last Amended: 4/23/13

DESCRIPTION	R-2	R-3	R-7.5	R-SIR, SIR2, 10	R-15	R-20	RR	B-1 (C)	B-1 (G)	B-2	B-3	B-3-T	B-4	M-1	M-2	CT	C	W-R	B-5	WM-3	O	O/A
3.200 Operations conducted within or outside fully enclosed buildings																						
3.210 Operations designed to affect and serve customers or clients on the premises														ZC	ZC				C			ZC
3.220 Operations designed to attract little or no customer or client traffic other than employees of the entity operating the principal use														ZC	ZC	C			C	C		ZC
3.230 Banks with drive-in window											C	C	C		C							
3.240 Watershed research																	C					
3.250 Automatic Teller Machine, Freestanding								C	C		C		C			C					C	C
4.000 Manufacturing, Processing, Creating, Repairing, Renovating, Painting, Cleaning, Assembling of Goods, Merchandise and Equipment																						
4.100 All operations conducted entirely within fully enclosed buildings									ZC					ZC	ZC	C				C		C
4.200 Operations conducted within or outside fully enclosed buildings															ZC							
5.000 Educational, Cultural, Religious, Philanthropic, Social, Fraternal Uses																						
5.100 Schools																						
5.110 Elementary and secondary (including associated grounds and athletic and other facilities)	C	C	C	C	C	C	C	C	C				Z(1)					Z	C			
5.120 Trade or vocational school								Z	ZC				C	ZC	C	C			C			
5.130 Colleges, universities, community colleges (including associated facilities such as dormitories, office buildings, athletic fields, etc)							C	Z	ZC				C	C		C						
5.200 Churches, synagogues and temples (including associated residential structures for religious personnel and associated buildings but not including elementary school buildings) school or secondary	ZS	ZS	ZS	ZS	ZS	ZS	ZS	Z	ZC	ZC	ZC	ZC	ZC	ZC		ZC		C	C		ZS	ZS
5.300 Libraries, museums, art galleries, art centers and similar uses (including associated educational and instructional activities)																						
5.310 Located within a building designed and previously occupied as a residence or within a building having a gross floor area not in excess of 3,500 square feet	S	S	S	S	S	S	S	ZC	Z	Z	Z	Z	S	ZC		ZC			C		Z	ZS
5.320 Located within any permissible structures								ZC	ZC	ZC			S	ZC		ZC			C		C	ZS
5.400 Social, fraternal clubs and lodges, union halls, and similar uses								ZC	ZC	ZC			S	S		ZC			C			
6.000 Recreation, Amusement, Entertainment																						
6.100 Activity conducted entirely within building or substantial structure																						
6.110 Bowling alley, skating rinks, indoor tennis and squash courts, billiards and pool halls, indoor athletic and exercise facilities and similar uses.								ZC	ZC		ZC	ZC	ZC	ZC		ZC			C			

TABLE OF PERMISSIBLE USES

Last Amended: 4/23/13

DESCRIPTION	R-2	R-3	R-7.5	R-SIR, SIR2, 10	R-15	R-20	RR	B-1 (C)	B-1 (G)	B-2	B-3	B-3-T	B-4	M-1	M-2	CT	C	W-R	B-5	WM-3	O	O/A
6.120 Movie Theaters																						
6.121 Seating capacity of not more than 300								ZC	ZC				ZC	S		ZC						S
6.122 Unlimited Seating Capacity								S	ZC				ZC	S		ZC						
6.130 Coliseums, stadiums, and all other facilities listed in the 6.100 classification designed to seat or accommodate simultaneously more than 1000 people								C	C				C	C		C						
6.140 Community Center--a Town sponsored, non-profit indoor facility providing for one or several of various type of recreational uses. Facilities in a Community Center may include, but are not limited to gymnasia, swimming pools, indoor court areas, meeting/activity rooms, and other similar uses	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z		Z	Z		Z
6.150 Electronic Gaming Operations													S									
6.200 Activity conducted primarily outside enclosed buildings or structures.																						
6.210 Outdoor recreational facilities developed on private lands, without Town sponsorship or investment, such as golf and country clubs, swimming or tennis clubs, etc. and not constructed pursuant to a permit authorizing the construction of a residential development.	S	S	S	S	S	S	S		C							C	C	C	C			
6.220 Outdoor recreational facilities developed on public lands, or on private lands with swimming pools, parks, etc., not constructed pursuant to a permit authorizing the construction of another use such as a school																						
6.221 Town of Carrboro owned and operated facilities.	Z	Z	Z	Z	Z	Z	Z	Z	Z				Z	Z		Z	Z	Z	Z	Z		
6.222 Facilities owned and operated by public entities other than the Town of Carrboro	C	C	C	C	C	C	C	C	C				C	C		C	C	C	C	C		
6.230 Golf driving ranges not accessory to golf course, par 3 golf courses, miniature golf course, skateboard parks, water slides, and similar uses.														ZC					C			
6.240 Horseback riding stables (not constructed pursuant to permit authorizing residential development)							S							S			Z	C	C			
6.250 Automobile and motorcycle racing tracks															S							
6.260 Drive-in Movie Theaters														C								
7.000 Institutional Residence or Care of Confinement Facilities																						
7.100 Hospitals, clinics, other medical (including mental health) treatment facilities in excess of 10,000 square feet of floor area									C							C						

TABLE OF PERMISSIBLE USES

Last Amended: 4/23/13

DESCRIPTION	R-2	R-3	R-7.5	R-SIR, SIR2, 10	R-15	R-20	RR	B-1 (C)	B-1 (G)	B-2	B-3	B-3-T	B-4	M-1	M-2	CT	C	W-R	B-5	WM-3	O	O/A
7.200 Nursing care institutions, intermediate care institutions, handicapped, aged or infirm institutions, child care institutions	C	C					C		C							C			C			
7.300 Institutions (other than halfway houses) where mentally ill persons are confined									C							C						
7.400 Penal and Correctional Facilities																						
8.000 Restaurants (including food delivery services), Bars, Night Clubs																						
8.100 Restaurant with none of the features listed in use classification below as its primary activity								ZC	ZC(l)	C			Z						C			ZC
8.200 Outside Service or Consumption								ZC	ZC(l)	C			S						C			ZC
8.300 Drive-in (service to and consumption in vehicle on premises)													C									
8.400 Drive Through Windows (service directly to vehicles primarily for off-premises consumption)													C									
8.500 Carry Out Service (food picked up inside of off-premises consumption)								ZC	ZC(l)				Z						C			
8.600 Food Delivery								ZC	ZC(l)				Z						C			
8.700 Mobile prepared food vendors								Z	Z					Z								
9.000 Motor Vehicle-Related Sales and Service Operations																						
9.100 Motor vehicle sales or rental of sales and service									C					ZC	ZC							
9.200 Automobile service stations													S	C	Z							
9.300 Gas sales operations											S	S	S	C	Z							
9.400 Automobile repair shop or body shop									C			S	S	C	Z							
9.500 Car wash														C	Z							
10.000 Storage and Parking																						
10.100 Independent automobile parking lots or garages								ZC	Z				Z	Z	Z	C						
10.200 Storage of goods not related to sale or uses of those goods on the same lot where they are stored																						
10.210 All storage within completely enclosed structures														Z	Z							C
10.220 Storage inside or outside completely enclosed structures														C	Z							ZC
10.300 Parking of vehicles or storage of equipment outside enclosed structures where: (i) vehicles or equipment are owned and used by the person making use of the lot, and (ii) parking or storage is more than a minor and incidental part of the overall use made of the lot														S	S							
11.000 Scrap Materials Salvage Yards, Junkyards, Automobile Graveyards															S							
12.000 Services and Enterprises Related to Animals																						
12.100 Veterinarian							S		ZC				S	S	S							
12.200 Kennel							S							S	S							
13.000 Emergency Services																						
13.100 Police Stations	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
13.200 Fire Stations	Z	Z	Z	Z	Z	Z	Z		Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
13.300 Rescue Squad, Ambulance Service	S	S	S	S	S	S	Z		S	S	S	S	S	S	Z	S	C	C	C	C	S	S
13.400 Civil Defense Operation	S	S	S	S	S	S	Z		S	S	S	S	S	S	Z	S	C	C	C	C	S	S
14.000 Agricultural, Silvicultural, Mining, Quarrying Operations																						
14.100 Agricultural operations, farming																						
14.110 Excluding livestock		Z	Z	Z	Z	Z	Z								Z		Z	Z	Z			
14.120 Including livestock							Z										Z	Z	Z			
14.200 Silvicultural operations		Z	Z	Z	Z	Z	Z								Z							

TABLE OF PERMISSIBLE USES

Last Amended: 4/23/13

DESCRIPTION	R-2	R-3	R-7.5	R-SIR, SIR2, 10	R-15	R-20	RR	B-1 (C)	B-1 (G)	B-2	B-3	B-3-T	B-4	M-1	M-2	CT	C	W-R	B-5	WM-3	O	O/A
14.300 Mining or quarrying operations, including on-site sales of products															S							
14.400 Reclamation landfill		Z	Z	Z	Z	Z	Z						Z	Z	Z							
15.000 Miscellaneous Public and Semi-Public Facilities																						
15.100 Post Office								C	C		C	C	C	C	C	C						
15.200 Airport							C		S				S	S								C
15.300 Sanitary landfill							C							C								
15.400 Military reserve, National Guard centers														Z								
15.500 Recycling materials collection operations																						
15.510 Using collection facilities other than motor vehicles									Z				Z	Z	Z							
15.520 Aluminum recycling using motor vehicles									S				S	S	S							
15.600 Public utility service complex																			C			
15.700 Cable Television Signal Distribution Center								S	S	S	S		S	S	S	S					S	S
15.800 Town-owned and/or Operated Facilities and Services																						
15.810 Town-owned and/or Operated Public Parking Lot								Z	Z	Z	Z	Z	Z	Z	Z	Z				Z		Z
15.820 All other town-owned and/or operated facilities and services	Z	Z	Z	Z	Z	Z	Z		Z		Z	Z		Z	Z	Z	Z	Z	Z	Z	Z	Z
16.000 Dry Cleaner, Laundromat																						
16.100 With drive-in windows											C	C	C	C								C
16.200 Without drive-in windows									Z		S	S	Z	S		Z			C			S
17.000 Utility Facilities																						
17.100 Neighborhood	S	S	S	S	S	S	S		S	S	S	S	S	S	S	S	C	C	C			S
17.200 Community or regional														S	S		C		C			S
17.300 Cable Television Satellite Station							S				S	S	S	S	S	S					S	S
17.400 Underground Utility Lines	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	C	C	Z	C	Z	Z
18.000 Towers and Related Structures																						
18.100 Towers and antennas fifty feet tall or less	Z	Z	Z	Z	Z	Z	Z	Z	Z		Z	Z	Z	Z	Z	Z	Z	C	Z			Z
18.200 Towers and antennas attached thereto that exceed 50 feet in height, and that are not regarded as accessory to residential users under 15-150(c)(5)						C	C				C	C	C	C	C	C			C	C	C	C
18.300 Antennas exceeding 50 feet in height attached to structures other than towers, [other than accessory uses under 15-150(c)(5)]	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
18.400 Publicly-owned towers and antennas of all sizes that are used in the provision of public safety services									ZC													
19.000 Open Air Markets and Horticultural Sales																						
19.100 Open air markets (farm and craft markets, flea markets, produce markets)								ZC	ZC	ZC	S	S		S		S					S	S
19.200 Horticultural sales with outdoor display									ZC	ZC	S	S		S		S					S	S
19.300 Seasonal Christmas or pumpkin sales								Z	Z	Z	Z	Z	Z	Z	Z						Z	Z
20.000 Funeral Homes													Z	Z								
21.000 Cemetery and Crematorium																						
21.100 Town-owned cemetery	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
21.200 All other cemeteries							S							Z	Z		C	C	C			
21.300 Crematorium														Z	Z							
22.000 Day Care																						
22.100 Child Day Care Home	ZZ	Z	Z	Z	Z	Z	Z	S	S	Z	S	S				Z		Z			S	S
22.200 Child Day Care Facility	S	S	S	S	S	S	S	Z	Z	Z	Z	Z	Z	Z		Z		C	C		Z	Z
22.300 Senior Citizens Day Care, Class A	S	S	S	S	S	S	S		Z	Z	Z	Z	Z	Z		Z		C	C		Z	Z
22.400 Senior Citizens Day Care, Class B	S	S	S	S	S	S	S	Z	Z	S	Z	Z	S	Z		S					Z	Z

TABLE OF PERMISSIBLE USES

Last Amended: 4/23/13

DESCRIPTION	R-2	R-3	R-7.5	R-SIR, SIR2, 10	R-15	R-20	RR	B-1 (C)	B-1 (G)	B-2	B-3	B-3-T	B-4	M-1	M-2	CT	C	W-R	B-5	WM-3	O	O/A
23.000 Temporary structure or parking lots used in connection with the construction of a permanent building or for some non-recurring purpose																						
23.100 Temporary structures located on same lot as activity generating need for structure	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	C	C	C	C	Z	Z
23.200 Temporary parking facilities located on or off-site of activity generating need for parking	Z																					
24.000 Bus Station									ZC				S	S		S						
25.000 Commercial Greenhouse Operations																						
25.100 No on-premises sales						S	S							Z								
25.200 On-premises sales permitted							S							Z								
26.000 Subdivisions																						
26.100 Major	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	SC	C	C	C	C	SC	SC
26.200 Minor	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	C	C	C	C	Z	Z
27.000 Combination Uses	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	C	*	*	*	*
28.000 Planned Unit Developments	Permissible only in Planned Unit Development Districts (See Section 15-139) pursuant to a conditional use permit).																					
29.000 Special Events	C	C	C	C	C	C	C	ZC	ZC	ZC	C	C	C	C	C	C	C	C			C	C
30.000 Planned Industrial Development	Permissible only in Planned Industrial Development Districts [See Subsection 15-137(c)] pursuant to a conditional use permit																					
31.000 Off-Premises Signs															Z							
32.000 Village Mixed Use Development	Permissible only in Village Mixed Use Districts (See Section 15-141.2 pursuant to a conditional use permit).																					
33.000 Office/Assembly Planned Development	Permissible only in Office/Assembly Conditional Use Districts [see Subsection 15-136(11) pursuant to a conditional use permit].																					
34.000 Temporary Lodging																						
34.100 Hotels and Motels	C							C	C				C			C						C
34.200 Bed and Breakfast	S	S	S	S	S	S	S			S						S		C	S			

*Art. X PERMISSIBLE USES (con't)***Section 15-147 Use of the Designations Z,S,C in Table of Permissible Uses (AMENDED 11/18/03; 6/22/04; 10/25/05; 11/22/05; 6/26/07; 11/27/07; 10/28/08, 11/24/09. REWRITTEN 4/23/09)**

(a) Subject to Section 15-148, and subsection (h) of this section, when used in connection with a particular use in the Table of Permissible Uses (Section 15-146), the letter “Z” means that the use is permissible in the indicated zone with a zoning permit issued by the administrator (except that, in connection with use classification 26.200, minor subdivisions, the letter “Z” means that final plat approval shall be granted by the Planning Director). The letter “S” means a special use permit must be obtained from the board of adjustment, and the letter “C” means a conditional use permit must be obtained from the Board of Aldermen. **(AMENDED 1/22/85; 11/18/03)**

(b) When used in connection with single-family, two-family and multi-family residences (use classifications 1.100, 1.200 and 1.300) outside the watershed districts, the designation “ZSC” or “SC” means that tracts developed with four dwelling units or less require a zoning permit, tracts developed with between five and twelve dwelling units require a special use permit, and tracts developed with more than twelve dwelling units require a conditional use permit. When used in connection with single-family, two-family, and multi-family residences in the watershed districts, the designation “ZC” means that tracts developed with one dwelling unit shall require a zoning permit and tracts developed with two or more dwelling units shall require a conditional use permit. **(AMENDED 1/22/85; 2/24/87; 12/15/87)**

(c) When used in connection with major subdivisions (use classification 26.100) outside the watershed districts, the designation “SC” means that subdivisions containing between five and twelve lots shall require a special use permit, and subdivisions containing thirteen or more lots shall require a conditional use permit. **(AMENDED 7/21/87; 12/15/87)**

(d) Subject to Section 15-148, use of the designation “ZC” (which designation appears only under the zoning district columns applicable to the commercial and manufacturing districts) means that a conditional use permit must be obtained if the development involves the construction of more than 3,000 square feet of new building gross floor area *or* the development is located on a lot of more than one acre, and a zoning permit must be obtained if the development involves the construction of 3,000 square feet or less of new building gross floor area *and* the development is located on a lot of one acre or less. **(AMENDED 11/14/88) (REWRITTEN 4/23/13)**

(e) Subject to Section 15-148, use of the designation “Z,S” means that a zoning permit must be obtained if the development is located on a lot of two acres or less while a special use permit must be obtained for developments in excess of two acres.

(f) Use of the designation Z,S,C, for combination uses is explained in Section 15-154.

(g) When used in connection with use classification 18.400 (publicly-owned towers and antennas of all sizes that are used in the provisions of public safety services), the designation “ZC” means that the development of such towers that are fifty feet tall or less

Art. X PERMISSIBLE USES (con't)

shall require a zoning permit, and the development of such towers that are more than fifty feet tall shall require a conditional use permit. **(AMENDED 10/04/88, 02/18/97)**

- (h) Whenever any 1.000 classification use is proposed for a lot in the R-2, R-3, R-7.5, and R-10 zoning districts and such use would otherwise require the issuance of a zoning permit under the provisions of this section, a special use permit shall nevertheless be required if:
 - (1) The use involves (i) construction of an addition to an existing dwelling, or (ii) construction of an additional dwelling on a lot where at least one dwelling already exists, or (iii) construction of a dwelling on a lot from which a previously existing dwelling has been removed within a period of three years prior to the application for a permit under this chapter, and
 - (2) The gross floor area of any one dwelling unit exceeds 3,500 square feet, or the gross floor area of all dwellings covered by the proposed permit exceeds 5,500 square feet.
 - (3) This requirement shall not apply if at least one of the dwelling units is an affordable housing unit as defined in Section 15-182.4(a).
 - (4) This requirement shall not apply with respect to a proposed one-time addition to a dwelling that has been in existence for a period of at least twenty years if such one-time addition results in less than a 25 percent increase in the gross floor area of such dwelling and less than a 15 percent increase in the gross floor area of all dwellings covered by the proposed permit.
- (i) When used in connection with 8.100, 8.200, 8.500 and 8.600 uses, the designation "ZC(l)" means that a zoning permit must be obtained if the total area within a development to be used for this purpose does not exceed 1,500 square feet and the use is to take place in a building in existence on the effective date of this subsection while a conditional use permit must be obtained whenever the total area to be used for this purpose is equal to or exceeds 1,500 square feet.
- (j) Notwithstanding the other provisions of this section, whenever a building of more than two stories or 35 feet in height is proposed within the B-1(g), B-1(c), B-2, CT or M-1 zoning districts, a conditional use permit must be obtained from the Board of Aldermen. **(AMENDED 10/25/05)**
- (k) Notwithstanding the foregoing, Uses 22.200 Child Day Care Facilities serving nine to fifteen children, and 22.300 Senior Citizen Day Care, Class A, serving four to sixteen seniors, that are located on collector or arterial streets are permissible with a Zoning Permit issued by the

Art. X PERMISSIBLE USES (con't)

Administrator. For the purposes of this section, collector streets are those streets whose function and design meet the current town standards for classification as collector streets; and arterial streets are those listed in subsection 15-210.

l) Notwithstanding the foregoing, if a use within use classifications 2.112, 2.120, 2.150, 2.220, 2.230, 3.120, or 3.220 is proposed for an existing building within the WM-3 zoning district, and no other changes to the site are proposed that would require the issuance of a new permit under Section 15-46, then such use shall be permissible with a zoning permit. **(Amended 10/28/08)**

m) Notwithstanding the foregoing, 5.110 uses may be permitted within the B-4 zoning district only when proposed within an existing building and when no other changes to the site are proposed that would require the issuance of a new permit under Section 15-46. **(AMENDED 11/24/09)**

Section 15-148 Board of Adjustment Jurisdiction Over Uses Otherwise Permissible With a Zoning Permit.

(a) Notwithstanding any other provisions of this article, whenever the Table of Permissible Uses (interpreted in the light of Section 15-147 and the other provisions of this article) provides that a use is permissible with a zoning permit, (i) a conditional use permit shall nevertheless be required if the administrator finds that the proposed use is located within the University Lake Watershed (i.e., the C, B-5, and WM-3 districts) and would have a substantial impact on neighboring properties or the general public, and (ii) a conditional use permit shall nevertheless be required if the administrator finds that the proposed use is located in the B-1(c), B-1(g), B-2, or CT zoning districts, the use is shown as permissible in those districts with a "ZC" designation in the Table of Permissible Uses, and the proposed use would have a substantial impact on neighboring properties or the general public; (iii) otherwise, a special use permit shall nevertheless be required if the administrator finds that the proposed use would have a substantial impact on neighboring properties or the general public. **(AMENDED 01/22/85; 12/15/87; 02/25/92)**

(b) A special use permit shall be required for any use that is otherwise permissible with a zoning permit if the administrator concludes that, given the impact of the proposed use on neighboring properties, the vested right conferred upon the permit recipient pursuant to Section 15-128.2 should not be conferred without an opportunity for public input. A conditional use permit shall be required for any use that is otherwise permissible with a zoning permit if the administrator concludes that, given the impact of the proposed use on the general public, the vested right conferred upon the permit recipient pursuant to Section 15-128.2 should not be conferred without an opportunity for public input. However, if the zoning administrator makes this determination, the permit applicant may require that the application be returned to the zoning permit process by submitting to the administrator a written waiver of the vested right normally acquired under Section 15-128.2 upon the issuance of a zoning permit. **(AMENDED 10/01/91; 02/25/92)**

Section 15-149 Permissible Uses and Specific Exclusions **(AMENDED 6/24/08)**

Extended Vehicle Idling

Extended Vehicle Idling

■ Introduction

Item (xi) of Section 108 (f) of the 1990 amended Clean Air Act defines "programs to control extended idling of vehicles" as a candidate transportation control measure. The idea is that vehicular emissions can be reduced by eliminating vehicle idling, either by turning the engine off while the vehicle is stopped or by limiting the periods of time in which a vehicle must be stopped and idling. One method of reducing vehicle idle time is through the use of traffic flow improvement techniques, and these are discussed in the corresponding chapter of these information documents. This chapter addresses two other sources of extended idling of vehicles:

- Passenger vehicles using drive-through facilities, such as those existing at banks and fast food restaurants, where the vehicle is kept idling during the service period.
- Heavy-duty vehicles that are not in use and are kept idling rather than being shut off, such as buses that are kept idling at layover points or trucks that are left to idle while being loaded or unloaded.

The tradeoff between idling emissions and hot start emissions by vehicles of a particular type depends on a number of factors including the age of the vehicle, the type of control equipment used, the type of fuel used, the pollutant of interest, and the ambient temperature. For example, catalytic controls work well in the idle mode, so that idle emissions from newer vehicles are far less of a problem than from older, non-catalyst equipped automobiles. It is difficult, therefore, to develop a single transferable number that represents the maximum desired idling time. The following is an analysis for one urban area which indicates the factors which should be considered.

In preparing the 1982 Revised Air Quality Management Plan (AQMP) for the South Coast Air Basin, a strategy for reducing idling emissions by restriction or elimination of drive-through facilities was considered (3). An emissions analysis of drive-through facilities was done by comparing the emissions from idling with those from a hot start/hot soak cycle, which would represent a person parking, carrying out a business transaction within an hour, restarting the car, and leaving. The results are summarized in Table 1.

According to this analysis, for CO a car could idle for 6 minutes before it would generate the same emissions as when it was restarted. The equivalent idling times are even greater for HC and NO_x. Based on this analysis, it was concluded that the banning of drive-through facilities would be counter-productive.

Table 1. Vehicle Idle vs. Hot Start/Soak Emissions

Year	Pollutant	Hot Start Emissions (gm/start)	Hot Soak Emissions (gm/soak)	Idling Emissions (gm/min)	Idling Time Equivalent to Start/Stop Cycle Emissions
1987	THC	4.16	1.67	.2217	26
	NOx	.71		.0551	13
	CO	13.18		2.3541	6
2000	THC	4.06	.67	.1743	27
	NOx	.41		.0386	11
	CO	10.93		1.8164	6

Source: (3)

Heavy-duty vehicle idling represents a different problem. Trucks are often left idling while their drivers await access to facilities to make pickups or deliveries. Older trucks often required longer amounts of time to warm up and cool down, and some operating habits have carried over in the use of modern vehicles. Modern vehicles, however, require less than five minutes to reach an operating temperature that assures proper engine lubrication under load.

Not all engine idling is at the discretion of the driver. Many facilities are operated in such a manner that idling is required. For example, at some facilities, trucks are required to be in a slowly moving queue to make pickups or deliveries; trucks are required to move at a moment's notice, and are therefore kept idling to be ready to move.

Public transit vehicles such as diesel buses and diesel locomotives also may be left idling for long periods of time. Examples include the period between runs, midday layovers, or even overnight. Transit authorities increasingly are instituting operations policies to limit this idling as a means of controlling fuel costs and minimizing community complaints over excessive emissions and noise.

Description of Measures

The following types of measures have been considered to control extended vehicle idling:

- Controls on drive-through facilities;
- Laws or operating policies that limit idling of heavy-duty vehicles; and
- Mechanical modifications to the vehicle that restrict the amount of time that it can idle.

Possible controls on drive-through facilities include:

- Limitations on the construction of new drive-through facilities,
- Removal of existing facilities, and
- Specification of design standards applicable to the development and operation of new drive-through facilities.

The removal of existing facilities would affect the largest market, but also would involve a retroactive control or reversal of previous development decisions. Proposals to eliminate existing drive-through facilities have resulted in considerable opposition and been abandoned as being politically infeasible. More realistic approaches are to manage the way in which new drive-through facilities are developed and operated. For example, a fast food window configuration could be required where there are three stops – one to

place the order, one to pay, and one to receive the food. Such an approach could shorten the total length of time a vehicle is in queue, and thereby lead to both reduced idling time and fewer acceleration/deceleration cycles. As described in the following section, this kind of management approach is receiving current interest as a means of controlling both congestion and emissions.

Interest also is increasing in more carefully managing the emissions of heavy-duty vehicles while operating in the idle mode. For example, a law to restrict heavy-duty vehicle idling has been considered by the California legislature. As an example of the third type of control, Volkswagen is working on an engine that may increase fuel efficiency by as much as 90 per cent, using measures such as computer control that shut off the engine during idling and storing energy in a flywheel to provide an instant restart.

■ Case Study Examples

Proposed California Legislation to Limit Heavy Truck Idling

The South Coast Air Quality Management District (SCAQMD) has worked with the California state legislature to develop legislation that would restrict truck idling. The proposed law was developed by the California AB 2595 Technical Advisory Group with the cooperation of the trucking industry (2). The trucking industry cooperated because they believed that it would be better to have a single, consistent statewide law on heavy duty vehicle idling than to have a number of possibly different regional or local regulations.

The proposed law has two significant provisions:

- No person shall cause, allow, or permit the engine of a heavy-duty motor vehicle to idle for more than five consecutive minutes if the vehicle is not performing useful work.
- No person responsible for the shipping or receiving of goods by a heavy-duty motor vehicle shall operate a facility in such a manner that causes, allows, or permits, a heavy-duty motor vehicle to idle for more than five consecutive minutes when the vehicle is not performing useful work.

The proposed bill contains exceptions for buses picking up passengers, motor vehicles stopped in the line of traffic, snow removal equipment, and emergency vehicles. It also provides for the following exceptions that pertain especially to trucks:

- Motor vehicles whose primary power source is utilized in whole or part for necessary and definitively prescribed mechanical operation other than propulsion, passenger compartment heating, or air conditioning (e.g., refrigerated trailers that require an idling engine to receive power).
- Motor vehicles manufactured with a sleeper berth while the sleeper berth is being used, in a non-residential area, by the vehicle operator for sleeping or resting, provided that the vehicle is not in a queue, and provided that the operation of the vehicle does not create a public nuisance.
- Motor vehicles used under adverse weather conditions, including rain, snow, temperatures below freezing, and temperatures in excess of 100 degrees Fahrenheit.
- Motor vehicles when the driver compartment is in direct sunlight and the temperature is in excess of 80 degrees Fahrenheit, provided that the engine idling is required to operate an air conditioning system.

The Technical Advisory Committee also determined that a truck operator education program would be a cost-effective measure in conjunction with the proposed law.

Limitations on Drive-Up Windows

In the Sacramento metropolitan area, the 1982 AQMP programs for the County of Placer and the Cities of Lincoln, Rocklin, and Roseville included drive-up window limitations (3). The measures are intended to limit the number and design of new drive-up window facilities to reduce idling time and congestion.

The County of Sacramento regulates drive-up facilities by a use permit. The code is intended to ensure that the design and location of a drive-up facility will not contribute to increased congestion on public or private streets adjacent to the facility. The code requires that:

- Design and location will not impede access to or exit from the parking lot serving the facility, nor impair normal circulation in the parking lot;
- No drive-up lane shall extend closer than 25 feet to the access driveway;
- Advance ordering stations be located a minimum of 120 to 180 feet from the window;
- The window cannot be used to justify fewer parking spaces; and
- The use permit is revocable if congestion due to the window regularly occurs.

■ Estimated Impacts

The regional emission reductions associated with reducing the number of new drive-through facilities are expected to be minimal, primarily because of the small amount of travel impacted relative to the total highway vehicle mobile source inventory. At best, such measures may be effective in reducing localized CO hotspots.

Controls on extended vehicle idling of heavy duty vehicles may have a larger emissions reduction impact in commercial urban areas than will the limitations of drive-through facilities. This is because of the higher unit emissions of heavy duty vehicles compared to light duty automobiles.

Program Costs and Other Considerations

The proposed California law on heavy duty truck idling would require funding for public awareness, facility inspection, law enforcement, and truck operator education. It could also incur additional cost to truck operators by shortening starter life, but would also reduce the costs of fuel consumption and engine wear.

Elimination of existing drive-through facilities would require compensation of the affected businesses and physical modifications to the facilities. The affected market segments would be shopping and personal business trips that use these facilities, primarily in suburban areas.

The costs associated with efforts to influence the design or limit the number of new drive-through facilities would largely be limited to small administrative costs to manage the new development code. Costs to building owners and operators could be mixed, with lower construction costs and higher operating costs if buildings must be kept open for longer periods of time.

Implementation Considerations

Because most heavy-duty vehicles operate across jurisdictional boundaries, laws to restrict heavy-duty vehicle idling should be implemented statewide rather than locally so as to ease enforcement. In the case of California, the proposed law would be enforced by air pollution control districts through routine inspections of facilities with heavy-duty truck activity and through response to public complaints. The California Highway Patrol and local law enforcement agencies would have discretionary enforcement authority. The Technical Advisory Committee suggested that current resource constraints on enforcement of traffic safety regulations might make it necessary to develop new funding or cost sharing mechanisms between law enforcement and air pollution control agencies in order to enforce the proposed restrictions (2).

Affecting the development of drive-through facilities currently is controlled through the zoning process and limitation of conditional use permits, which is exclusively under the control of cities and counties. Hence, this type of control measure may be difficult to implement on a regional, statewide, or national basis.

Equity considerations are an issue that has arisen in past public policy debates over the possible limitation of drive-through facilities. Is it fair to remove existing, already approved and operating drive-up facilities? Conversely, is it fair to ban or even limit new drive-up facilities and allow existing services to continue to operate?

The following implementation guidelines can be summarized:

- Controls on vehicle operations are probably most effectively implemented at the state level.
- Controls on development are the province of local jurisdictions. In this case, regional and state agencies can play a valuable technical assistance role.
- Controls on drive-through facilities generally are most effective as limitations rather than outright bans.
- Design standards represent an appropriate implementation mechanism, based on congestion as well as emission considerations.
- Data should be collected prior to enactment of any measure so as to establish the magnitude of existing idling emissions that would be impacted.
- Controls on extended idling of vehicles will impact existing businesses as well as the public. It is important that representatives of both groups be actively involved in the planning, analysis, and development of any such controls. As evidenced by the history of the proposed California legislation on heavy-duty vehicle idling, implementation prospects can be enhanced by actively involving potentially impacted business interests in the development of proposed control measures.

■ Bibliography

1. Guensler, Randall, Daniel Sperling, and Paul Jovanis, "Uncertainty in the Emission Inventory for Heavy-Duty Diesel-Powered Trucks", report prepared for the TRED Foundation, Sacramento, California, Institute of Transportation Studies, University of California, Davis, Research Report No. UCD-ITS-RR-91-02, June 1991.
2. "Guidelines for Local Air Districts Considering Transportation Control Measures Directed at Heavy-Truck Operations", report prepared by the AB2595 Technical Advisory Group Established pursuant to the California Clean Air Act (Assembly Bill

2595, 1988), Business, Transportation and Housing Agency, Air Resources Board, California Highway Patrol, September 1990.

3. "Information Document H: Control of Extensive Idling", California Air Resources Board, n.d.

Which Is Greener: Idle, or Stop and Restart?

Comparing Fuel Use and Emissions for Short Passenger-Car Stops

L. Gaines, E. Rask, and G. Keller, Argonne National Laboratory

Overview

The argument against parking and going into a business, rather than using a drive-through window, has been that the emissions and fuel use associated with restarting your car are greater than those incurred by idling for that time. Argonne National Laboratory undertook a series of measurements to determine whether this was true, by comparing actual idling fuel use and emissions with those for restarting. This work seeks to answer the question: Considering both fuel use and emissions, how long can you idle in a queue before impacts from idling are greater than they are for restarting? Fuel use and carbon dioxide emissions are always greater for idling over 10 seconds; the crossover times are found to vary by pollutant.

Background

The bulk of idling research to date has focused on the effects of heavy- and medium-duty diesel vehicle idling. But most research has ignored passenger car idling—even at schools—as a source of emissions and wasted fuel.

While idling in traffic is necessary for safety, vehicles can be turned off while waiting for passengers or for freight trains to pass. Consumers can choose to park and enter a fast-food restaurant, rather than idle in a drive-through line (Figure 1). If each car in the United States idles just 6 minutes per day, about 3 billion gallons of fuel are wasted annually, costing drivers over \$10 billion or more. And they haven't gotten anywhere!

The U.S. Department of Energy Clean Cities Program uses its national network of almost 100 local coalitions to reduce transportation dependence on petroleum through the use of alternative fuels and efficiency measures, including idling reduction. The program therefore funded Argonne to measure idling fuel use by and emissions from light-duty vehicles and to compare these to start-up emissions to enable data-based decision making.



Figure 1. Americans love their drive-throughs, but are they more fuel-efficient and environmentally friendly than parking and going into the restaurant?

Testing



Figure 2. Ford Fusion Test Vehicle

Argonne National Laboratory used a 2011 Ford Fusion mid-sized sedan with a 2.5-L, 4-cylinder engine (175 HP) and 6-speed automatic transmission (Figure 2). Its EPA fuel-efficiency label shows 23 mpg city/33 mpg highway and 26 mpg combined. We equipped the vehicle to measure numerous engine parameters and temperatures, including catalyst inlet and brick temperatures and oil and coolant temperatures. We collected data in one of Argonne's test cells at the Advanced Powertrain Research Facility (APRF), using a SemtechD emissions analyzer for emissions and a direct fuel flow meter for fuel measurement. The vehicle was prepared and run by using approximate Federal Test Procedure (FTP) standard ambient temperature testing criteria. The emissions of interest in this study include total hydrocarbons (THC), nitrogen oxides (NO_x), carbon monoxide (CO), and carbon dioxide (CO₂).

Testing at 21°C ambient conditions on a late-model mid-sized American car shows that idling for more than 10 seconds uses more fuel (Figure 3) and emits more CO₂ (Table 1) than engine restarting.

Table 1. Idling Emissions and Fuel Use per Second

NO _x (mg)	THC (mg)	CO (mg)	CO ₂ (mg)	Fuel (cc)
0.0097	0.266	0.108	0.887	0.279

- Criteria pollutant emissions were low for idling following catalyst activation.

Table 2. Comparison of Emissions from Cold Start, Restart, and Idling

Emission	Tier 2-Bin 5 (g) ^a	Cold Start	Restart	Idle 30 s	Cold Start ÷ Restart
THC (mg)	878	191	16–40	0.8	4.4–12
NO _x (mg)	552	228	1.3–1.6	0.3	140–175

^a Tier 2-Bin 5 g/mi converted to FTP-75 mg

- Emissions from restarting were larger, but at least an order of magnitude lower than those from starting a cold engine.
- The catalyst cooled down slowly, so that restarts after times equivalent to a short transaction at a bank or restaurant are unlikely to allow the temperature to drop below light-off and incur large cold-start emissions.

Research Limitations

Data presented here are based on one vehicle at one temperature, with a small number of runs. Therefore, although several conclusions are suggested by this work, generalizations are unwarranted without additional work to confirm the extent to which the results apply, for the following reasons:

- Hot and cold ambient conditions are likely to affect results, as are the loads required to supply passenger comfort at those temperatures.
- Older vehicles and diesels are both likely to behave differently.
- More research is required to explain differences in THC emissions between the runs, as well as to make more generalizations regarding the emissions impacts of different restart/soak times. Additional research to fill in all these gaps would enable more conclusive statements concerning the differences in emissions between idling and restarts.

Conclusions

Testing at 21°C ambient conditions on a late-model mid-sized American car shows that:

- Idling for more than 10 seconds uses more fuel (Figure 3) and emits more CO₂ than engine restarting.
- Idling fuel usage varies from 0.2 to 0.5 gal/h for passenger vehicles across a range of sizes, and increased with idling speed.
- The vehicle warms up faster when driving than it does when idling.
- NO_x and THC emissions from restarting are larger, but at least an order of magnitude lower than those from starting a cold engine (Table 2).
- For short stops, it makes sense to turn the vehicle off in order to minimize fuel use and CO₂ emissions. At least for the conditions evaluated in this work, the penalty in terms of criteria pollutant emissions is very small compared to cold-start emissions.

Acknowledgments

Argonne National Laboratory's work was supported by the U.S. Department of Energy, Office of Vehicle Technologies, Clean Cities Program, under contract DE-AC02-06CH11357. We also wish to thank Steven McConnell, Christopher Saricks, Michael Duoba, and Terry Levinson of Argonne's Center for Transportation Research for extremely helpful discussions and insights.

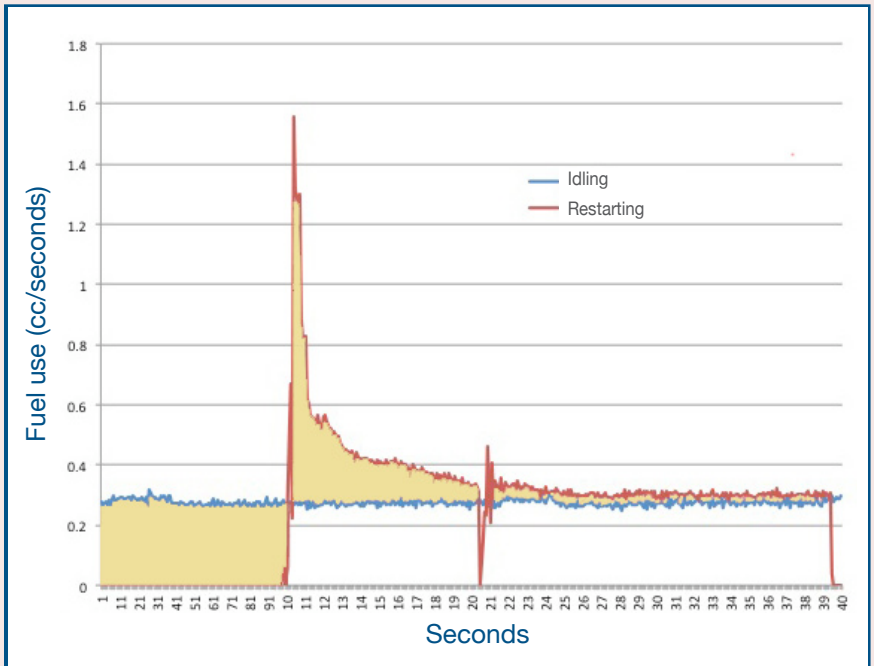


Figure 3. The shaded area under the blue line (idling fuel rate) and the red line (restart) before the engine is restarted (at 10.1 s) represents the quantity of fuel that the engine would have burned if it were idling instead of being off, and the area between the red and blue lines after the engine is restarted represents the excess on restart.

Which Is Greener: Idle, or Stop and Restart? Comparing Fuel Use and Emissions for Short Passenger-Car Stops

November 2012

by

*L. Gaines, E. Rask, and G. Keller
Argonne National Laboratory
Energy Systems Division
9700 South Cass Avenue
Argonne, IL 60439

*Corresponding Author

Linda Gaines
lgaines@anl.gov
630.252.4919 phone
630.252.3443 fax

Eric Rask
erask@anl.gov
630.252.3110 phone

Glenn Keller
gkeller@anl.gov
630.252.2028 phone
630.252.3443 fax

4,074 words plus 7 figures (1,750) and 5 tables (1,250) = 7,074

Which Is Greener: Idle, or Stop and Restart? Comparing Fuel Use and Emissions for Short Passenger-Car Stops

L. Gaines, E. Rask, and G. Keller
Argonne National Laboratory

ABSTRACT

Most advice to the public about idle-reduction lacks scientific basis. And the information in the literature is often inconsistent. Argonne National Laboratory performed some simple experiments to provide a preliminary factual basis for recommendations on when to keep the engine on, and when to turn it off, for the minimum environmental impact.

Our previous work demonstrated that idling is a very inefficient way to warm up your car (your diesel might never warm up if it is very cold [1]), and that the catalytic converter cools slowly enough that it will still be working when you return to your car after a short stop. The argument against parking and going into a business, rather than using a drive-through window, has been that the emissions and fuel use associated with restarting your car are greater than those incurred by idling for that time. Argonne undertook a series of measurements to determine whether this was true by comparing actual idling fuel use and emissions with those for restarting. This work seeks to answer the question: Considering both fuel use and emissions, how long can you idle in a queue before impacts from idling are greater than they are for restarting? We determined that fuel use and carbon dioxide emissions are greater for idling over 10 seconds. Other emissions from idling were found to be low, so that much longer idling times were preferable before they exceeded restart emissions; these crossover times were found to vary by pollutant. The restart emissions were found to be much smaller than those from cold starts. Note, however, that these results are very limited and more research is necessary.

BACKGROUND

Idling reduction efforts have focused on heavy-duty diesel vehicles because they are typically idled for extended periods. Long-haul trucks often idle overnight to keep the driver comfortable; our previous work has identified and compared lower-impact alternatives (2, 3). We have also identified workday idling by all classes of vehicles as a significant waste of petroleum and source of excess emissions (4). And the EPA's large and visible program to reduce emissions from school buses includes a component on idling reduction (5). But many people ignore passenger car idling—even at schools—as a source of emissions and wasted fuel. While idling in traffic is necessary for safety, drivers can turn off their vehicles while waiting for passengers or for freight trains to pass. And remote start, although now a popular option, is still idling, and in some jurisdictions, idling an unattended vehicle is illegal. If each of the 250 million cars in the United States idles just 6 minutes per day at 0.3 gal/h, almost 3 billion gallons of fuel are wasted annually, costing drivers \$10 billion or more, with no vehicle miles traveled.

Major vehicle manufacturers and suppliers hold the view that idling modern engines is not only unnecessary but undesirable (6). Owner's manuals often advise against idling and encourage "ecodriving" as a way to increase fuel economy and reduce emissions. In addition, the U.S. Department of Energy (DOE), U.S. Department of Transportation (DOT), and the U.S. Environmental Protection Agency (EPA) discourage unnecessarily idling, and the Department of Defense (DOD) attempts to reduce idling to limit fuel costs and engine wear (7, 8, 9, 10).

We found inconsistent and conflicting recommendations, with minimal scientific data to support them, in anti-idling literature distributed across North America. One fast-food chain claimed that it was "greener" (from an emissions perspective) to use the drive-through than to park and go into the restaurant. The study it cited used actual drive-through vehicle statistics but relied on

modeled emission data that are several orders of magnitude higher than what we report here (11). One technical paper (12) did report hydrocarbon and NO_x emissions from several model-year 2004 passenger vehicles, but it did not measure fuel use or CO₂ emissions.

The U.S. Department of Energy Clean Cities Program uses its national network of almost 100 local coalitions to reduce transportation dependence on petroleum through the use of alternative fuels and efficiency measures, including idling reduction. The program therefore funded Argonne to measure idling fuel use by and emissions from light-duty vehicles and to compare these to start-up emissions to enable data-based decision-making.

EXPERIMENT DESCRIPTION

Vehicle Set-Up

A model year 2011 Ford Fusion was used for the majority of the analysis for this work (Figure 1). This vehicle is a 4-door mid-size sedan with a 2.5-L 4-cylinder engine (175 HP) and 6-speed automatic transmission. Its EPA fuel-efficiency label shows 23 mpg city/33 mpg highway and 26 mpg combined. It was instrumented with equipment to measure numerous engine parameters and temperatures, including catalyst inlet and brick temperatures (see Figure 2) and oil and coolant temperatures. The vehicle was installed in one of Argonne's test cells at the Advanced Powertrain Research Facility (APRF), utilizing a Semtech emissions analyzer for emissions and a direct fuel flow meter for fuel measurement. The APRF has a two-wheel-drive (2WD) chassis dynamometer that is used for simulating road load, monitoring tractive effort, and performing coast-down testing; it is also used for the calibration of 2WD vehicles of up to 12,000 lb. The restart emissions and the idle emissions were measured in real time at a no-load stationary position; one exception is noted below. The vehicle was prepared and run by using approximate Federal Test Procedure (FTP) standard ambient temperature testing criteria.

The vehicle was connected to a PEMS SemtechD at the tailpipe, which allowed emissions data to be gathered for each species with respect to time. The emissions of interest in this study include total hydrocarbons (THC), nitrogen oxides (NO_x), carbon monoxide (CO), and carbon dioxide (CO₂). The SemtechD is equipped with a heated sample line to minimize the loss of hydrocarbons before they are in range of the sensors. It measures the hydrocarbon emissions by using a Flame Ionization Detector (FID), while the NO_x species are measured by using a Non-Dispersive Ultra Violet (NDUV) method. It measures CO and CO₂ via a Non-Dispersive InfraRed Analyzer (NDIR).



FIGURE 1 Ford Fusion Test Vehicle.

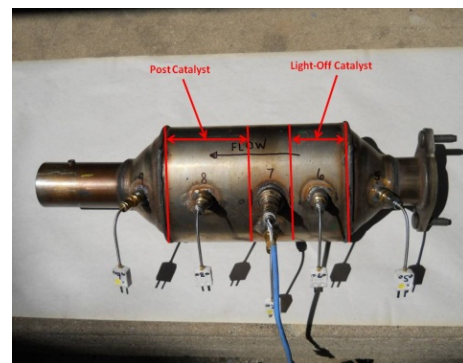


FIGURE 2 Catalyst Temperature Measurement Sites.

The SemtechD analyzer also accounts for the ambient humidity in the calculation of the emissions. It has been verified to be accurate when testing for these emission species (7, 8). The specifications for the analyzer are listed in Table 1. Additionally, the fuel consumption rate was measured directly. For this study, the emission concentrations were measured every 0.1 s, and concentrations were converted to actual masses by using measured air-flow volume. The exhaust measurement was accomplished by using an AVL North America DVE-150 direct vehicle exhaust (DVE) measurement device. This device, when coupled to the SemtechD analyzer, allows the collection and analysis of exhaust mass emissions, particularly in ultra-low- and super ultra-low-emitting vehicles. Flow meter specifications are shown in Table 2.

TABLE 1 PEMS SemtechD Emissions Analyzer Specifications (1)

Parameter	NO	NO ₂	THC	CO	CO ₂
Measurement Range	0–2,500 (ppm)	0–500 (ppm)	0–1,000 (ppm)	0–4 (%)	0–20 (%)
Accuracy (% of Reading)	±3	±3	±2	±3	±3
Resolution	1 ppm	1 ppm	1 ppm C	10 ppm	0.01%
Response Time (T90) (s)	≤2	≤2	≤2	≤3	≤2

TABLE 2 AVL DVE-150 Flow Meter Specifications (1)

Exhaust Flow Measurement	8–350 scfm FS
Accuracy (% of Reading)	±1% FS
Resolution	0.1 scfm
Tailpipe Backpressure	±1.5 in. H ₂ O

Procedure

The intent was to simulate a vehicle idling in queue for the drive-through window at a bank or fast-food restaurant. Fuel use and emissions from an idling hot engine were measured, as were those from a case in which the vehicle was keyed off for 5 minutes following roughly 8 minutes of urban-style driving and then restarted every minute. These cases simulate both a 5-minute visit into the business and turning the vehicle off and on in a queue.

There were two dynamometer runs with the instrumented 2011 Ford Fusion in which emissions were measured as described above and a third without emission measurements. All data were taken at roughly 21°C ambient conditions. Limited funding precluded investigation of additional vehicles or temperatures. To summarize:

1. *20-min idle run:* Turn the cold engine on, idle the vehicle at steady state until the engine temperatures are stabilized. Allow the vehicle to idle in “Drive” with the brake applied. Begin timing 20-min interval and collect emissions data during a 20-min idling interval (initially at higher rpm but then at constant ~750 rpm). Turn the engine off for 30 s, then restart for 30 s, off for 30 s, on for 30 s, and off. No loads are applied.
2. *505 UDDS run + idle:* Turn on the already-warm engine, “drive” for 5 min on the UDDS cycle, turn off the car (soak) for 5 min, then restart 7 times, with 30 s in between. The first five restarts were with no load, 30 s on, and off. The last two on periods are longer (60 s, 90 s) with a load to simulate 3-mph creep or heavy traffic.
3. *50-mph steady speed:* Turn on the cold engine and drive at a steady 50 mph for about 10 minutes.

EXPERIMENTAL RESULTS

Idling

The first run enabled estimation of long-duration idling emissions and fuel use, from 700 s in the flat part of the 20-min run at 750 RPM (after an initial period of higher RPM). For each parameter of interest, cumulative readings were calculated, and the difference between the total at the selected end-point (1200 s) and the start point selected during stable 750-RPM idling (500 s) was obtained. This difference represents the emissions during 700 s of stable idling and was used to estimate the emission and fuel use rates for idling at 750 RPM. Table 3 summarizes the calculation and the results. Emissions of criteria pollutants are extremely low.

TABLE 3 Calculation of Idling Emissions and Fuel Use

Time (s)	NO _x (mg)	THC (mg)	CO (mg)	CO ₂ (g)	Fuel (cc)
500.1	70.27	159.2	549.5	430.0	135.22
1200.1	77.04	177.8	625.3	1053.0	331.15
Difference	6.77	18.64	75.8	623.0	195.93
Per hour	34.8	95.9	389.8	3204.2	1007.6
Per second	0.0097 ^a	0.266	0.108	0.588	0.279

^a Emissions are nominally zero

The fuel consumption can be converted to a rate of 0.265 gal/h (1 gal = 3785.41 cc). Fuel consumption at idle varies with engine size; other ongoing work on similarly instrumented vehicles at Argonne has estimated fuel consumption at idle of about 0.2 gal/h for a 2004 Ford Focus (2.0-L I4) and 0.5 gal/h for a late-model Crown Victoria Police Cruiser (4.6-L V8).

Fuel consumption at idle also depends on engine speed. The higher RPM period at the start of the long idling period allowed us to verify that fuel use increases with idling speed (see Figure 3).

Restarts

As can be seen in Figure 4, when the engine was restarted, there was an initial sharp rise in fuel use. There were also peaks of THC and sometimes NO_x and/or CO (Figure 5). The fuel use settled back close to the idling rate within about 15 s, but the THC and CO declined more slowly after the spike, remaining elevated for the entire 30-s restart period. Both test scenarios showed emissions spikes during the subsequent engine starts — NO_x spikes appear sporadically, and THC and CO spikes occur consistently, but are variable in size. Both effects are worth additional investigation.

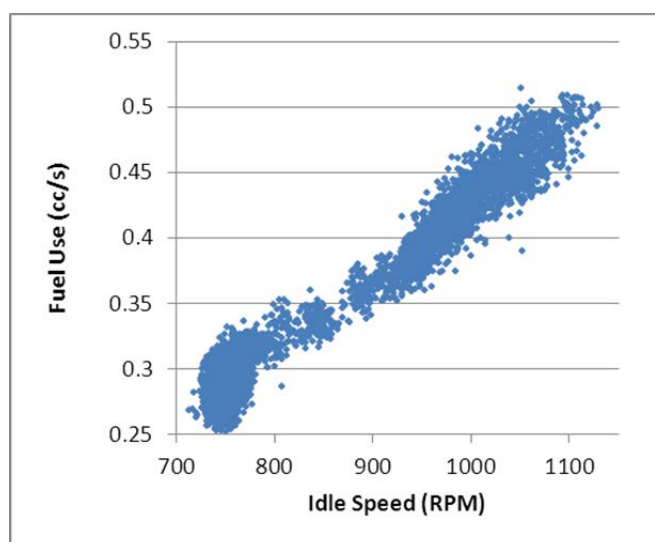


FIGURE 3 Increase of Fuel Use with Idling Speed.

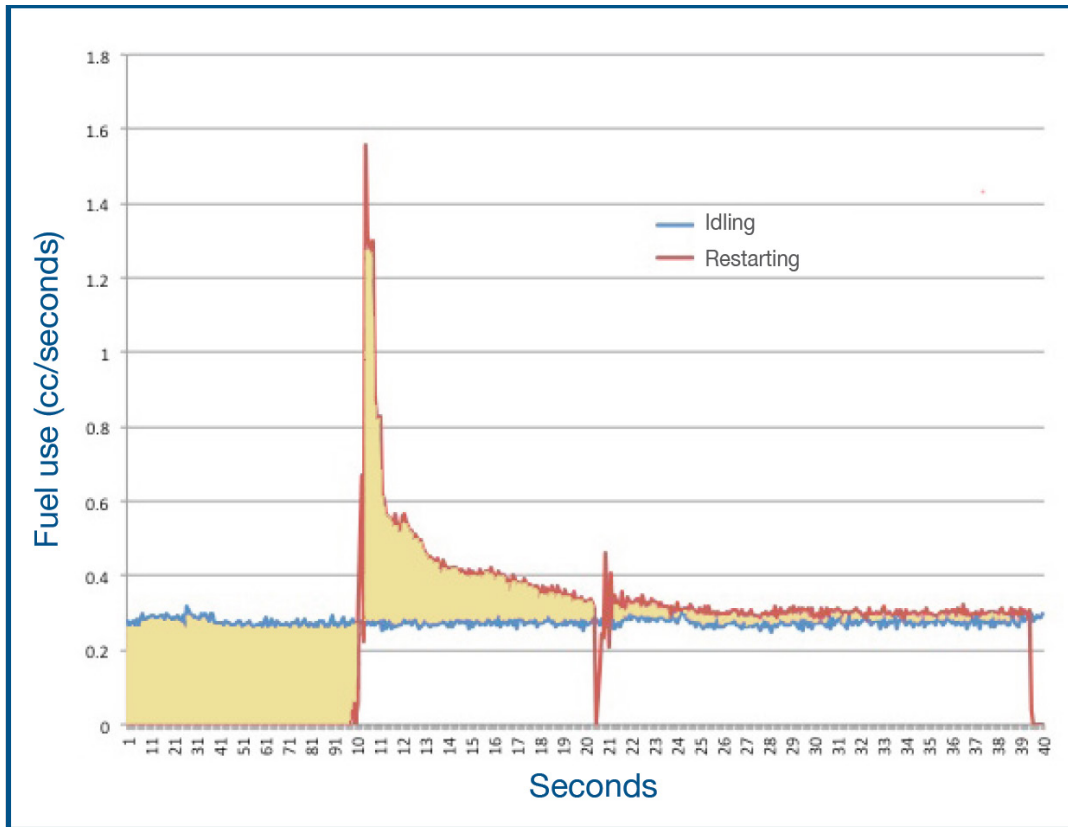


FIGURE 4 Fuel Use for Idling and Restarting.

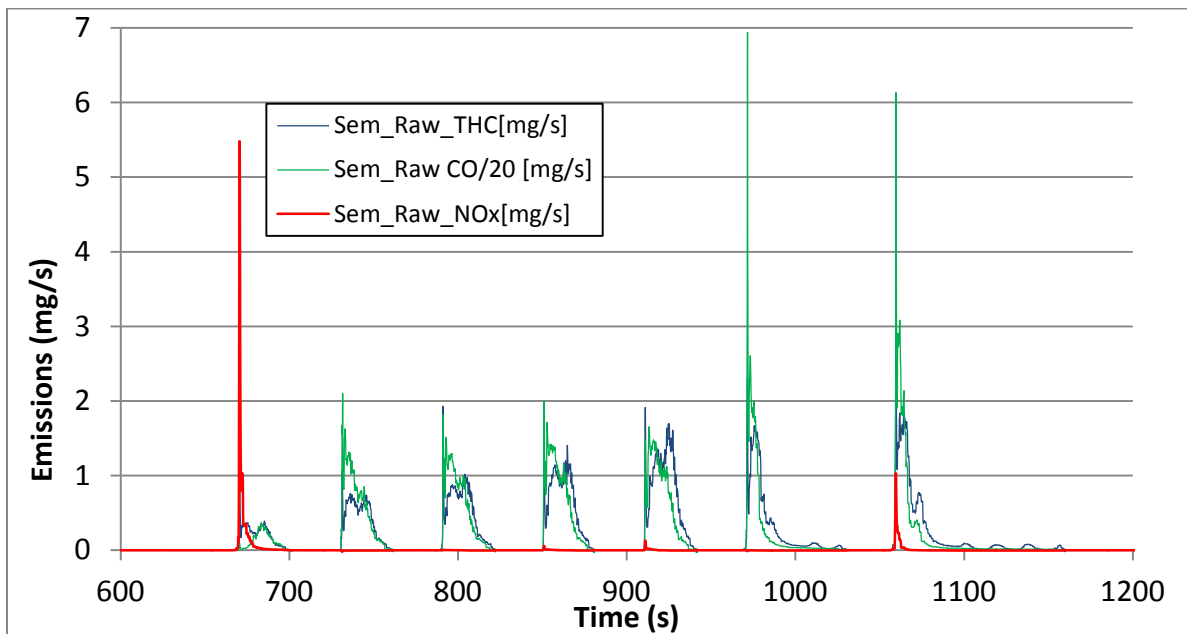


FIGURE 5 Emissions for 7 Restarts.

NO_x emissions were essentially zero, actually at the limit of instrument resolution. The two longer restarts in the run with seven restarts included a dynamometer load to simulate 3-mph

creeping. In those two cases, the THC dropped quickly back to near the idling levels after about 30 s. Therefore, the 30-s starts captured most of the excess (compared to idling) THC emissions from restart. Emissions of CO on restart were similar to those during vehicle operation and over two orders of magnitude larger than those during idling. For both CO and THC, emissions during restart were over a factor of 2 larger during the restarts after a long idling period than after a 5-min soak. This difference has not been explained and will likely be investigated in future work. Emissions during restarts while the catalyst is still hot are likely due primarily to engine start calibrations for consistent engine start, as well as additional issues related to stopping/starting the engine.

To estimate additional impacts caused by the restarts, we compared the fuel use and emissions from the restarts with those from an equivalent period (30 s) of idling at 750 RPM. Figure 4 includes a graphical representation for this comparison. In the graph, the shaded area under the blue line (idling fuel rate) and the red line (restart) before the engine is restarted (at 10.1 s) represents the quantity of fuel that the engine would have burned if it were idling instead of being off, and the area between the red and blue lines after the engine is restarted represents the excess on restart. All of the impacts and calculated excesses (over idling levels) for the restarts are shown in Table 4, along with equivalent idling times for that excess impact. *Our key conclusion: To minimize fuel use (and CO₂ emissions) under nominal test conditions (25°C ambient temperature), the engine should be turned off if idling is to be over 10 s in duration.* The appropriate “crossover” (maximum idling duration) is longer if the objective is to minimize criteria pollutant emissions, and that duration depends on the pollutant. The maximum idling duration is for CO, which is emitted in significant quantities during restarts.

TABLE 4 Emissions and Fuel Use for Restarts and Equivalent Idling Times

Parameter	Average (per second)	Average per start	Equivalent idling time
NO _x after soak	0.043 mg	1.3 mg	1.7 min
NO _x after idle	0.050 mg	1.6 mg	2.3 min
THC after soak	0.53 mg	16.0 mg	10 min
THC after idle	1.34 mg	40.4 mg	25 min
CO after soak	10.5 mg	315 mg	48 min
CO after idle	35.0 mg	1050 mg	2.7 h
Fuel after soak	0.34 cc	10.2 cc	6 s
Fuel after idle	0.38 cc	11.3 cc	10 s

Thus, we can see that, on the basis of fuel use, idling should be minimized. In terms of criteria pollutant emissions, frequent restarts do have some negative impacts. However, to put these into perspective, it is necessary to compare them to emissions from cold-starting the vehicle.

Comparison to Cold Start

While the criteria emissions related to vehicle restarting with a hot catalyst are, on a percentage basis, relatively large compared to the extremely low emissions during warm vehicle idling, it is important to understand these emissions in the context of overall allowable vehicle emissions. Although this work did not include measurements of cold start, data were available from other experiments performed with the same instrumented 2011 Ford Fusion. Emissions from restarts and idling are compared with those from initial engine cold-start and with regulated emission levels for the vehicle class in Table 5. For comparison with the collected data, the Tier 2-Bin 5 CO criteria emissions limit is 3.4 g/mi for the first 50,000 mi (14). So even with the higher restart emissions described above, the

engine must be restarted three times to equal the emissions from just one mile of driving, and so CO emissions from restarts are a less-serious concern.

TABLE 5 Comparison of Emissions from Initial Engine Start and Restart

	Tier 2-Bin 5 (15)^a	Initial Engine Start	Engine Restart
THC (mg)	878	191	44
NO_x (mg)	552	228	6
CO (mg)	31290	2970	1253

^a Tier 2-Bin 5 g/mi converted to FTP-75 mg

These results clearly imply that emissions from starting an engine cold are by far the largest environmental risk. Therefore, we also considered how quickly the catalyst cooled when the vehicle was turned off.

Rate of Catalyst Cooling

The catalyst brick temperature was monitored for both runs and can be seen in Figure 6. In the long-idle run, the catalyst temperature remained stable around 375°C after the initial warm-up. In the other run, the catalyst temperature reached over 550°C during the period in which a “driving” load was applied and cooled down slowly, falling to about 460°C after 5 min with the engine off and stabilizing around 350°C (above the catalyst activation temperature) after three restarts. The engine dipstick oil temperature was also measured, and it did not decrease significantly during the 5-min soak (see Figure 7). This cooldown was slow because the vehicle was not moving and therefore experienced little airflow and resultant heat transfer.

We estimate from the cooling results that the catalyst remained above the light-off temperature for at least 5 min after the engine was turned off, at 21°C. The catalyst would not cool any faster at higher (4) temperatures, but it would certainly cool faster at lower ambient temperatures. Funding constraints prevented us from repeating these experiments at lower temperatures. However, other work done at Argonne confirmed this (1). Measurements during a Chicago winter of the external temperature of the catalytic converter of a 2009 Volkswagen Jetta after the vehicle was shut down showed that the time it took to cool down decreased slowly, from about 3 min to just under 2 min when the temperature dropped from 1°C to -17°C.

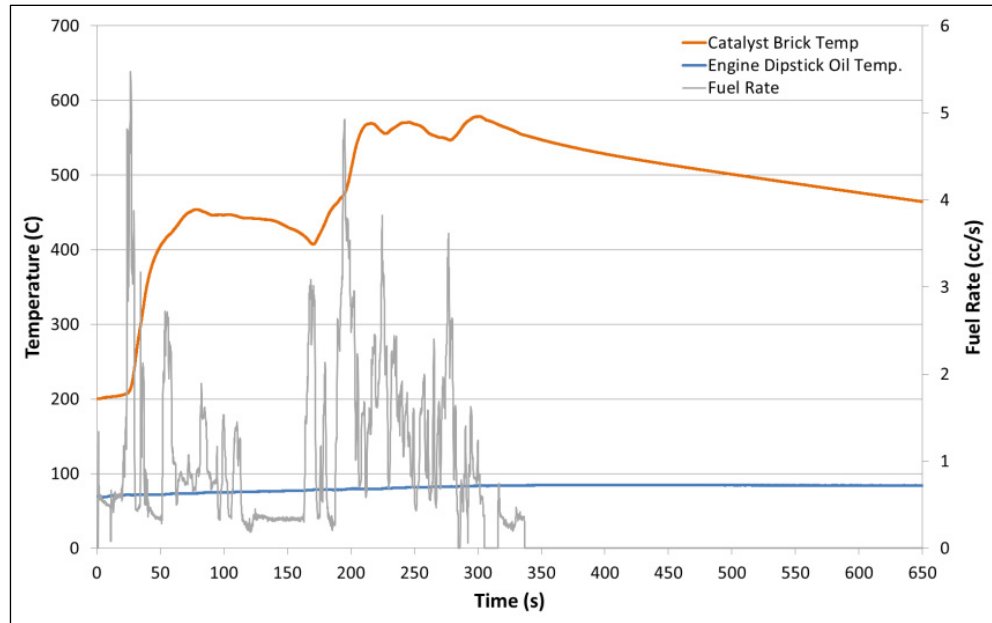


FIGURE 6 Catalyst and Dipstick Temperature Behavior when Engine Is Shut Off (at ~340 s).

Engine Warm-Up

The conventional wisdom has always been that it is necessary to idle for some period to warm up the engine before driving the car. This strategy might actually be appropriate in some circumstances, such as in extremely cold temperatures. Hard acceleration is also not recommended with a cold engine and catalyst. However, under normal conditions, the engine warms up much faster when driven than when idled. Figure 7 compares engine oil temperature for the case where the engine is started and then idled for 20 min with the case when the engine was started and then run at a constant 50 mph (and then restarted several times). As a point of comparison, note that the engine oil reaches 60°C (a nominal comparison point) roughly 4 min faster when driving versus at idle. There is no need to consume fuel in idle if the intent is to warm the engine.

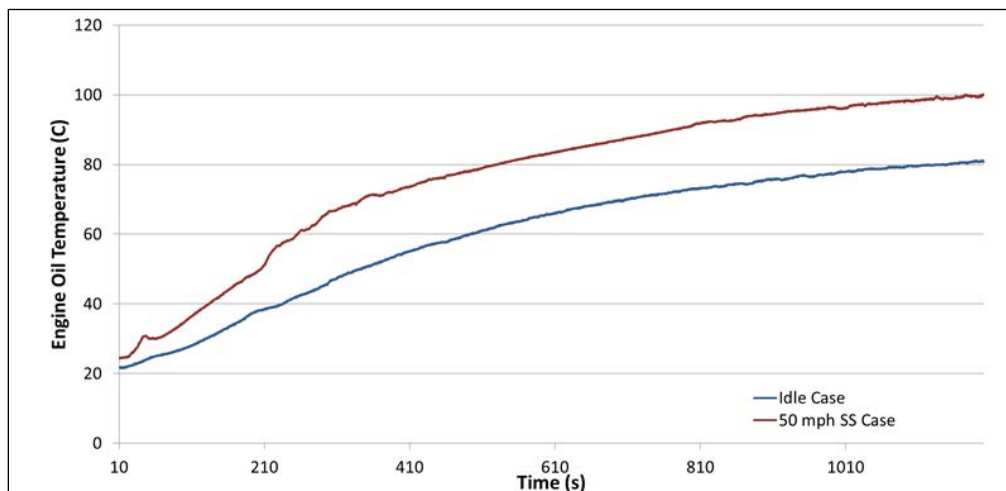


FIGURE 7 Coolant Temperature for 50-mph Drive on Start-Up vs. Idle on Start.

EXPERIMENT LIMITATIONS

Data presented here are extremely limited, based on one vehicle at one temperature, with a small number of runs. Therefore, although several conclusions are appropriate as a result of this work, generalizations are unwarranted without additional work to confirm the extent to which the results apply. Hot and cold ambient conditions are likely to impact results, as are the loads required to supply passenger comfort at those temperatures. Older vehicles and diesels are both likely to behave differently. And no simulation of driving away immediately on restart was done, and so this work does not compare warming up the vehicle during idling with warming up the vehicle as it is being driven. In addition, more research would be required to explain differences in THC emissions between the runs, as well as to make more generalizations regarding the impacts of different restart/soak times on emissions. Additional research to fill in all these gaps would enable more conclusive statements concerning the differences in emissions between idling and restarts.

CONCLUSIONS

Argonne testing at 21°C ambient conditions on a late-model mid-sized American car (2011 Ford Fusion) shows that idling for more than 10 s uses more fuel and emits more CO₂ than restarting the engine. Idling fuel usage was shown to vary from 0.2 to 0.5 gal/h for passenger vehicles across a range of sizes. Criteria pollutant emissions were determined to be relatively low for idling following catalyst activation. Emissions from restarting were larger, but at least an order of magnitude lower than those from starting a cold engine, as shown in Table 5. The catalyst was found to cool down slowly so that restarts after times equivalent to a short transaction at a bank or restaurant are unlikely to allow the temperature to drop below light-off and result in high cold-start emissions. Therefore, for short stops, it makes sense to turn the vehicle off in order to minimize fuel use and CO₂ emissions.

Unpublished results of recent tests at Argonne that involve auto-stopping/starting a vehicle are similar to those of Fusion testing conducted here; clearly, stop/start decreases fuel consumption, but engine re-starts result in increased emissions (16). The degree of increased emissions has differed among vehicles, as well as between engine technologies (diesel versus gasoline).

At least for the conditions evaluated in this work, a penalty in terms of criteria pollutant emissions is very small compared to cold-start emissions. Idling was also shown to be a very slow way to warm up your car.

ACKNOWLEDGMENTS

This work was sponsored primarily by the Clean Cities Program U.S. Department of Energy's Office of Vehicle Technologies, to which we offer our thanks. We also thank Steven McConnell, Christopher Saricks, Michael Duoba, and Terry Levinson of the Center for Transportation Research for extremely helpful discussions and insights.

This paper was created by UChicago Argonne, LLC, Operator of Argonne National Laboratory ("Argonne"). Argonne, a U.S. Department of Energy Office of Science laboratory, is operated under Contract No. DE-AC02-06CH11357. The U.S. Government retains for itself, and others acting on its behalf, a paid-up nonexclusive, irrevocable worldwide license in said article to reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, by or on behalf of the Government.

1 REFERENCES

- 2 1. Johnson, M., S. Duncan, and S. McConnell. Startup and Idle Emissions Analysis of a
3 2009 VW Jetta Using PEMS SemtechD, ICES2012-81170. Presented at ASME 2012
4 Internal Combustion Engine Division Spring Technical Meeting, Torino, Italy,
5 May 6–9, 2012.
- 6 2. Gaines, L.L., and C.J. Brodrick. Energy Use and Emissions Comparison of Idling
7 Reduction Options for Heavy-Duty Diesel Trucks. Presented at TRB 88th Annual
8 Meeting, January 2009 (Transportation Research Record 2010).
- 9 3. Gaines, L., and T. Levinson. *Idling: Cruising the Fuel Inefficiency Expressway*.
10 Argonne National Laboratory Report ANL-11/08 (June 2011).
11 <http://www.transportation.anl.gov/pdfs/EE/700.PDF>. Accessed July 26, 2012.
- 12 4. Gaines, L.L., A. Vyas, and J.L. Anderson. Estimation of Fuel Use by Idling
13 Commercial Trucks. Presented at Transportation Review Board Meeting, Washington,
14 D.C., Jan. 2006 (Transportation Research Record 2007).
- 15 5. National Clean Diesel Campaign: Clean School Bus. [www.epa.gov/cleanschoolbus/
16 csb-overview.htm](http://www.epa.gov/cleanschoolbus/csb-overview.htm). Accessed July 26, 2012.
- 17 6. 10 Eco-Driving Tips for Everyone, Ford Motor Company. [http://media.ford.com/
18 article_display.cfm?article_id=28946](http://media.ford.com/article_display.cfm?article_id=28946). Accessed Oct. 25, 2012.
- 19 7. Multi-Pollutant Emissions Benefits of Transportation Strategies-FHWA; Appendix A:
20 List of Transportation Strategies. [www.fhwa.dot.gov/environment/air_quality/
21 conformity/research/mpe_benefits/mpe09.cfm](http://www.fhwa.dot.gov/environment/air_quality/conformity/research/mpe_benefits/mpe09.cfm). Accessed Oct. 24, 2012.
- 22 8. Alternative fuels Data Center: Idle Reduction. [www.afdc.energy.gov/conservation/
23 idle_reduction_basics.html](http://www.afdc.energy.gov/conservation/idle_reduction_basics.html). Accessed Oct. 24, 2012.
- 24 9. Fuels and Vehicle Technology: Other Technology Strategies, USDOT Transportation
25 and Climate Change Clearinghouse. [http://climate.dot.gov/ghg-reduction-
26 strategies/fuels-technologies/other-technology.html](http://climate.dot.gov/ghg-reduction-strategies/fuels-technologies/other-technology.html). Accessed Oct. 25, 2012.
- 27 10. Letter to the Airmen of the US Air Force from the Secretary of the Air Force and the
28 Chief of Staff (USAF) (September 28, 2012). [www.af.mil/shared/media/
29 document/AFD-121001-014.pdf](http://www.af.mil/shared/media/document/AFD-121001-014.pdf). Accessed Oct. 25, 2012.
- 30 11. Air Quality Survey for the Quick Service Industry. Prepared by Rowan Williams
31 Davies and Irwin, Inc., for the Ontario Restaurant, Hotel and Motel Association,
32 Aug. 18, 2003.
- 33 12. Zietsman, J., et al. Emissions of Light Duty Gasoline Vehicles Due to Idling and
34 Restarts: A Comparative Study. Presented at TRB 84th Annual Meeting, January 2005.
- 35 13. Dearth, M.A., J.Q. Butler, A. Colvin, C. Gierczak, S. Kaberline, and T. Korniski.
36 *SemtechD: The Chassis Roll Evaluation of a Commercial Portable Emissions
37 Measurement Systems (PEMS)*. SAE Technical Paper 2005-01-0673, 2005.
- 38 14. Miers, S.A., R.W. Carlson, S.S. McConnell, H. Ng, T. Wallner, and J. LeFeber. *Drive
39 Cycle Analysis of Butanol/Diesel Blends in a Light-Duty Vehicle*. SAE Technical Paper
40 2008-01-2381, 2008.
- 41 15. Light-Duty Vehicle, Light-Duty Truck, and Medium-Duty Passenger Vehicle — Tier 2
42 Exhaust Emission Standards. www.epa.gov/otaq/standards/light-duty/tier2stds.htm.
43 Accessed July 19, 2012.
- 44 16. Personal communication between Henning R.A. Lohse-Busch, Argonne National
45 Laboratory, and Eric Rask, Argonne National Laboratory, November 2012.

Table 1. Use Classification and Description

Use Classification	Description	Discussion Topics – elements that create a more vibrant and successful community			
		Environmental Protection	Walkability	Economic Development	Equal Access
2.140	Retail/No Outside Display/Drive-In Window	+/-	-	+	+/-
2.240	Retail/Outside Display/Drive-In Window	+/-	-	+	+/-
3.230	Bank with Drive-In Window	+/-	+	-	+/-
3.250	Freestanding ATM	NA	+	+	+
6.260	Drive-In Movie Theaters	NA	NA	+	+
8.300	Drive-In Restaurant	NA	NA	+	+/-
8.400	Drive-Through Restaurant	+/-	NA	+	+/-
16.100	Dry Cleaners with Drive-In Window	+/-	NA	+	+/-

Table 2. Use Classification and Potential Location by Zoning District

Zone	2.140	2.240	3.230	3.250	6.260	8.300	8.400	16.100	Discussion Topics – elements that create a more vibrant and successful community			
									Environ	Walk	Econ	Access
B-1(c)				C					-	-	+	+/-
B-1(g)				C					-	-	+	+/-
B-3	C	C	C	C				C	-	NA	+	+/-
B-3T	C	C	C					C	-	NA	+	+/-
B-4	C		C	C	C	C	C	C	+/-	NA	+	+/-
B-5*									NA	NA	NA	NA
M-1	C	C						C	-	-	+	+/-
M-2			C						-	NA	+	+/-
CT				C					-	-	+	+/-
O				C					-	NA	+	+/-
O/A				C				C	-	NA	+	+/-

*Some drive-in/drive-through uses were allowed in the B-5 zoning classification prior to the 1998 amendments.



Town of Carrboro

Town Hall
301 W. Main St.
Carrboro, NC 27510

Legislation Text

File #: 14-0072, **Version:** 1

TITLE:

Update on Downtown Traffic Circulation Including Traffic Model Analysis

PURPOSE: This is the next in a series of updates provided to the Board of Aldermen on traffic in the downtown area since 2011. This update provides results from traffic analysis, using Synchro software, of downtown intersections and segments.

DEPARTMENT: Planning

CONTACT INFORMATION: Jeff Brubaker - 918-7329

INFORMATION: The Board of Aldermen previously received information on downtown traffic at the following meetings:

- * November 1, 2011
- * March 13, 2012
- * February 12, 2013

At each of these meetings, Board members received new information and offered comments.

At the February 12, 2013, meeting, staff presented some preliminary data on traffic volumes and level of service at various downtown intersections, using the traffic modeling program, Synchro. This update provides additional data.

Planning Department staff contracted with an engineering firm to review this traffic data, edit it where needed, and offer further Synchro analysis of both signalized and unsignalized intersections downtown.

FISCAL & STAFF IMPACT: No fiscal or staff impacts accrue to receiving the update.

RECOMMENDATION: Staff recommend that the Board of Aldermen adopt the resolution in Attachment A receiving the update.

A RESOLUTION RECEIVING A REPORT ON DOWNTOWN TRAFFIC CONDITIONS

WHEREAS, *Carrboro Vision 2020* declares that the “safe and adequate flow of bus, auto, bicycle and pedestrian traffic within and around Carrboro is essential”; and,

WHEREAS, several approved or proposed development projects, capital projects, and planning processes affecting traffic in downtown Carrboro suggest a need to reflect on conditions for all of these modes; and,

WHEREAS, the Board of Aldermen has received reports each year since 2011 on downtown traffic conditions;

NOW, THEREFORE BE IT RESOLVED by the Carrboro Board of Aldermen that:

1. The Board receives the report.
2. The Board provides the following comments or guidance:
 - a. _____
 - b. _____
 - c. _____

This is the 11th day of March in the year 2014.



TOWN OF CARRBORO

NORTH CAROLINA

MEMORANDUM

DELIVERED VIA: ☐ HAND ☐ MAIL ☐ FAX ☒ EMAIL

DATE: March 11, 2014

TO: David Andrews, Town Manager
Mayor and Board of Aldermen

CC: Christina Moon, Planning Administrator
Patricia McGuire, Planning Director

FROM: Jeff Brubaker, Transportation Planner JSB

RE: Report on Traffic in Downtown Carrboro – Part 4

Background

This is the fourth in a series of reports to the Board of Aldermen on traffic in downtown Carrboro. Previously:

- A November 1, 2011, report summarized the recommendations of plans, policies, and studies relating to traffic in the downtown area. The report also provided some traffic data relating to the Weaver Street Reconstruction project. Agenda materials are available here: http://townofcarrboro.org/BoA/Agendas/2011/11_01_2011.htm.
- A March 13, 2012, report summarized downtown traffic volume trends; trip generation potential from approved, proposed, and potential developments; and additional data relating to the Weaver Street Reconstruction and its effect on the Main-Greensboro intersection. Agenda materials are available here: http://townofcarrboro.org/BoA/Agendas/2012/03_13_2012.htm.
- A February 12, 2013, report focused on downtown intersection level of service (LOS), an initial step at addressing what level of congestion downtown Carrboro intersections may face after buildout of approved developments and a modest background traffic growth rate of 1%.

Also, in January 2013, the Board received a report on the impact on Main St. level of service (LOS) of closing Weaver Street for an event. The report included details on how traffic changed for the Weaver Street Reconstruction and traffic volumes on weekend days. Agenda materials are available here: http://townofcarrboro.org/BoA/Agendas/2013/01_22_2013.htm.

This report presents additional information on intersection delay provided by RSTS, who was contracted by the Planning Department to provide technical review of the Town's Synchro

model of downtown traffic. The Synchro model is a work in progress, with new volume information being added as new traffic data becomes available and development statuses change.

Methodology

The model and traffic volumes reflecting future year buildout maintained by Town staff were sent to RSTS, who revised the model as needed. These volumes are for the PM peak hour. The AM peak hour generally has lower traffic volumes (although individual movements are in some cases higher). These data include 1% background growth rates. While background growth rates may not seem to be the most appropriate given evidence that average daily traffic has not increased, and in fact has decreased, since the late 1990s, they are intended to generally account for additional traffic generated by other developments, such as those in downtown Chapel Hill that are either under construction or approved. The data also include specific developments in Carrboro where the development outlook has recently changed; despite these changes, someday the sites can be expected to be developed, adding trips to the downtown network. In summary, the model results have a margin of error, but are overall useful in gauging the approximate congestion issues during the PM peak hour at downtown signalized intersections.

Intersection delay and queue length statistics are averages.

Main St./Franklin St./Merritt Mill Rd./Brewer Ln.

Approach volumes



- Intersection delay: 1445 sec. / veh. (worst of intersections studied)
- Queue length: 749 ft. (3rd worst of intersections studied)

Notes

- The 300 E. Main St. revised TIA (December 5, 2007) projected that at full buildout the intersection would operate at LOS D, with the northbound (Merritt Mill) approach operating at LOS F. Hotel guests and others who park in the parking deck may access it from NC-54 via Merritt Mill Rd. / Main St., thus adding trips to this intersection.
- The Greenbridge TIA projected LOS F for the intersection and two approach lanes, and LOS E for two others.
- This intersection was found to have the third-worst future (2030) PM peak delay (LOS F) of all intersections studied in the 2005 Downtown Circulation Study.
- Town staff and staff from the Town of Chapel Hill met on August 29, 2013, to begin discussion of information and challenges with this intersection.
- Under construction and approved developments in the western part of downtown Chapel Hill will add vehicular trips to this intersection.

Main St. and Lloyd St.

Approach volumes



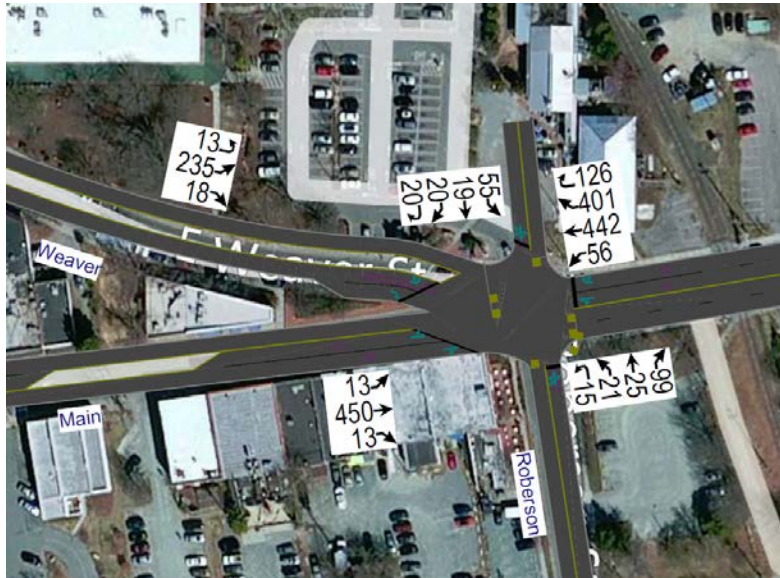
- Intersection delay: 540 sec. / veh. (3rd worst)
- Queue length: 387 (ranked 5th)

Notes

- Town staff and RSTS have found larger delays and worse LOS from modeling this intersection. However, the 300 E. Main developer's engineering consultant has maintained that intersection LOS is will still be LOS B.
- An August 2012 memo from Main Street Properties' engineering consultant proposed signal timing revisions that have now been implemented. The memo's recommendations are summarized in the Feb. 2013 memo. The recommended timing was an attempt to accommodate both the significant through volumes and left turns from E. Main St. without widening to add left turn storage. It found an intersection signal delay of 17.9 seconds (LOS B) but also found that the westbound 95th percentile queue length exceeded the length of the segment between signalized intersections. This suggests what can be sometimes be anecdotally observed in the PM peak hour, which is a line of cars stacked from this intersection back beyond the Main-Rosemary intersection.
- Town staff have received two comments from citizens concerned about congestion and delay at this intersection.
- The intersection is being improved to a four-way approach as part of the Fleet Feet building construction.
- 300 E. Main buildout obviously is a significant factor in this intersection's traffic volumes and operation. Consideration of how the proposed performing arts center at E. Main-Roberson affects traffic at this intersection is an important factor.
- >60 sec. delay was observed by Town staff in calling the pedestrian signal at the crosswalk across Main St. Several pedestrians were observed crossing against the light, evidence that longer delays in calling the pedestrian signal will encourage such behavior.
- A delivery tractor trailer was observed making an eastbound right turn into the 300 E. Main driveway. The swept path of the truck took up the entire driveway width. This suggests that, when four-way operation begins, right turning trucks may conflict with northbound vehicle queues and may back up the eastbound E. Main St. approach. However, this could be confirmed via a discussion with the developer's engineer.
- An approved signal plan modification for this intersection, developed by the Town's bike loop detector project consultant, shows bike loop detection added at this intersection. However, funding has not yet been identified to make this improvement, as the budget for bike loop detection is being devoted to other intersections.

Main St./Weaver St./Roberson St./Carr Mill Mall driveway

Approach volumes



- Intersection delay: 203 sec. / veh. (3rd ranked of 7 signalized intersections studied)
- Queue length: 687 (ranked 5th of 7)

Notes

- This intersection was found by the August 2012 Main Street Properties memo to experience LOS D under the preferred signal phasing scenario for the Main-Lloyd intersection. The source of the most delay was the southeastbound left turn from E. Weaver St. to Main St., which was LOS F (137.5 seconds of delay).
- Consideration of how the proposed performing arts center at this intersection affects traffic and pedestrian volumes is an important factor.
- Identified for bike loop detection installation.

Main St. and Greensboro St.

Approach volumes

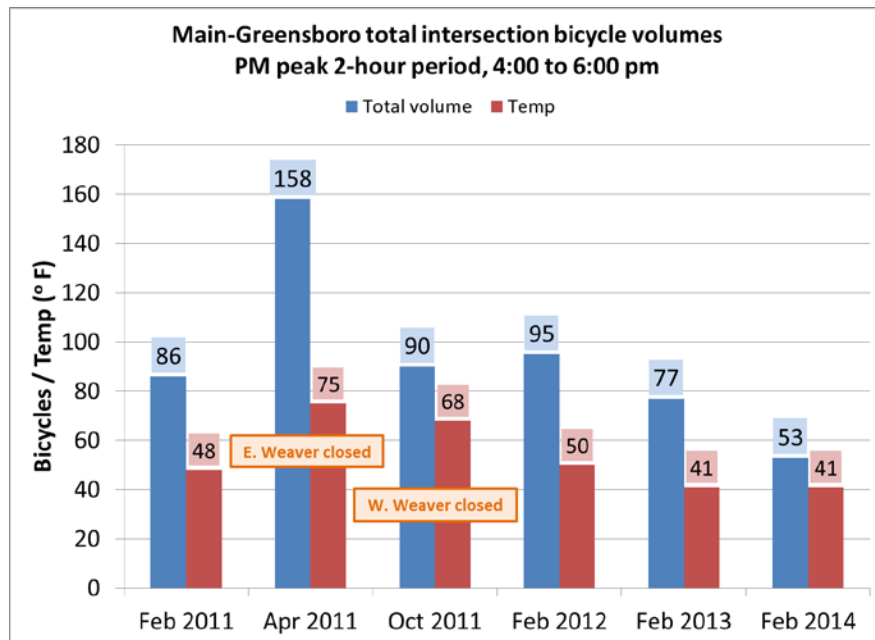
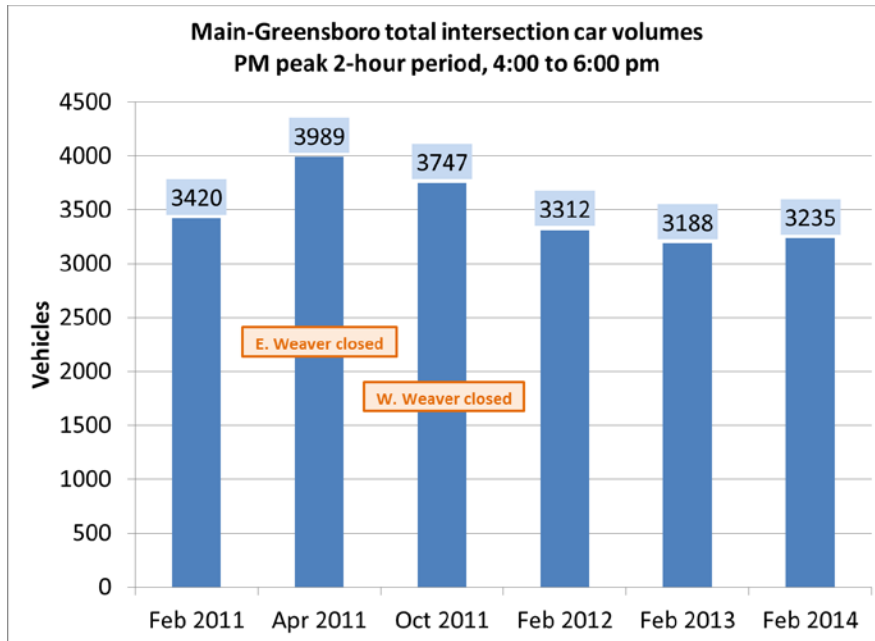


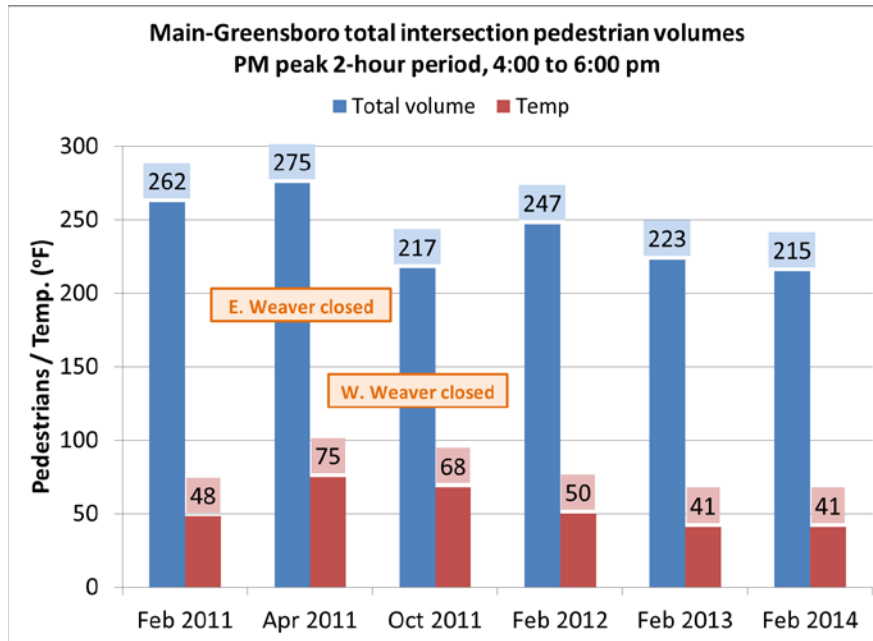
- Intersection delay: 143 sec. / veh. (3rd best of 7 signalized intersections)
- Queue length: 514 ft. (4th of 7)

Notes

- Town and TIA analyses have shown LOS C or better for this intersection. However, anecdotally, staff have observed occasional longer queues, including northbound queues backing up from Greensboro-Weaver into the intersection, and this intersection leading to southbound back-ups into the Greensboro-Weaver intersection.
- A TIA conducted for the 501 S. Greensboro St. (South Green / Rogers-Triem) development application showed LOS D at the intersection at buildout in 2016 (39.5 sec. intersection delay)
- A bike loop detector has been included in the bike detection project to accommodate the significant NBL movements from cyclists

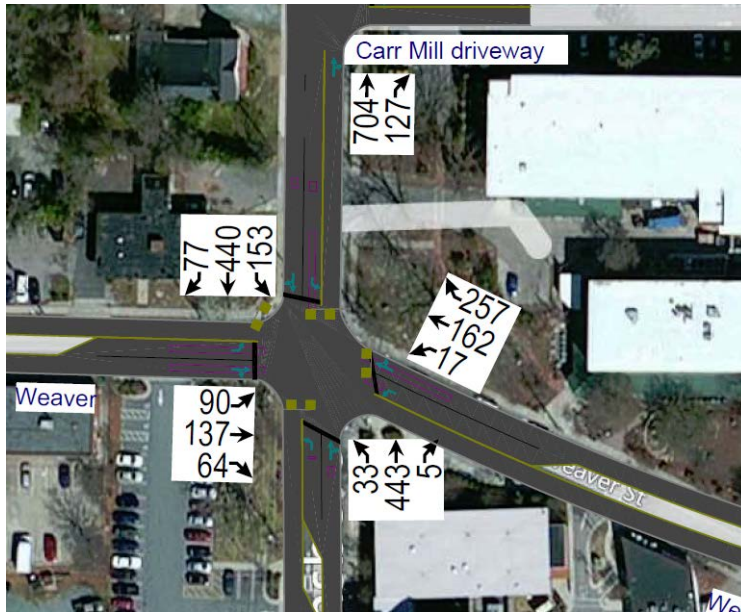
PM peak hour counts conducted by Town staff from Feb. 2011 to Feb. 2014 are shown in the graphs below. These include two other 2011 counts related to the Weaver Street Reconstruction traffic analysis.





Greensboro St. and Weaver St.

Approach volumes



- Intersection delay: 62 sec. / veh. (2nd best of 7 signalized intersections)
- Queue length: 329 ft. (4th of 7)

Notes

- This intersection has been modeled at LOS C or D overall, but the westbound right-through approach is the most congested, and has been modeled at a worse LOS.

- A lead pedestrian interval may be considered to allow pedestrians crossing the southbound approach better pedestrian LOS; however this would require changing the sequence of the signal cycle, potentially lagging the eastbound protected left-turn phase after the eastbound-westbound through green interval. This could also further affect the westbound right-through LOS. Further engineering study should be done before pursuing this option.