CUP Form 08/01/2010

TOWN OF CHRISTIANSBURG

100 East Main Street
Christiansburg, VA 24073
Phone (540) 382-6120 Fax (540) 381-7238

Conditional Use Permit Application

Landowner: RWW 36, LLC Agent: Balzer & Associates

Address: 144 Oak Tree Blvd Address: 448 Peppers Ferry Rd, NW

Christiansburg, VA 24073 Christiansburg, VA 24073

Phone: 540-382-5885 Phone: 540-381-4290

I am requesting a Conditional Use Permit to allow A Multi-Family Planned Housing Development - See Attached

on my property that is zoning classification B-3 under Chapter 30: Zoning of the Christiansburg Town Code.

My property is located at Farmview Road

Tax Parcel(s): 436-A 41, 436-A 40, 436-A 39, 436-A 38, 436-A 37, 436-A 36 (Portion) 436-A 35 (Portion)

Fee: $500.00 - paid with Code Amendment request - RSW

I certify that the information supplied on this application and any attachments is accurate and true to the best of my knowledge. I understand that Conditions may be placed on my property in regards to the above mentioned use/activity. I also understand that the Conditional Use Permit may be revoked and/or additional Conditional Use Permits required should questions regarding conformity arise.

Signature of Landowner(s): RWW 36 LLC Date: _____

By: [signature] Date: 12-19-11

_____ Date: _____

This request was approved / disapproved by a vote of the Christiansburg Town Council on _____. Any Conditions attached shall be considered requirements of the above request.

_____ _____

Town Manager Date

CONDITIONAL USE PERMIT APPLICATION FOR

MEGA BUILDERS, LLC MULTI-FAMILY DEVELOPMENT FARMVIEW ROAD

TAX PARCELS
436-A 41
436-A 40
436-A 39
436-A 38
436-A 37
436-A 36 (Portion of)
436-A 35 (Portion of)

DECEMBER 20, 2011

PREPARED FOR: MEGA BUILDERS, LLC

PREPARED BY: BALZER & ASSOCIATES, INC.

MEGA BUILDERS, LLC MULTI-FAMILY DEVELOPMENT
COMPREHENSIVE PLAN JUSTIFICATION

The property described in the Conditional Use Permit is currently zoned General Business B-3. The property is a combination of seven whole or partial tax parcels. The proposed site area requested for a Conditional Use Permit is approximately 21.1 acres. The site is currently vacant and is vegetated with grass and shrub/scrub plants. The proposal calls for all 21 acres to be granted a Conditional Use Permit for a Multi-Family Planned Housing Development.

The requested Conditional Use Permit for a multi-family planned housing development would allow for a future land use that is in keeping with the Town of Christiansburg Comprehensive Plan. The Plan calls for this area along Peppers Ferry Road and Franklin Street to be a mixed use area. This mixed use designation encourages both commercial and residential uses. Residential uses in this designation should be a higher density to take advantage of the surrounding transportation network, utility infrastructure and existing commercial development. The proposal calls for nine apartment buildings with a total maximum unit count of 330. The conceptual plan shows the proposed locations of these buildings along with the required parking. The plan also calls for a number of common space elements not typically found in other multi-family developments located in Christiansburg. These include a clubhouse, a gym, an outdoor basketball court, a grilling area, a dog park and a walking trail. These amenities, along with the project's location, create a very unique housing product.

In 2007, the General Assembly added a section to the Code of Virginia requiring high growth localities to designate Urban Development Areas (UDA) in their Comprehensive Plan. The idea behind the UDA is to encourage reasonably compact development in areas that can accommodate 10 to 20 years of projected growth and that have necessary services such as adequate transportation and utilities. Christiansburg has been designated a high growth locality and is currently in the process of updating its Comprehensive Plan. The Town plans to address UDA's in that update. The area along Peppers Ferry Road and 460 Business is mentioned several times throughout the Town's current Comprehensive Plan. This area is targeted as a high growth area. The Town of Blacksburg and Montgomery County have added the UDA requirement into their Comprehensive Plans and both show UDA designations along the 460 Business corridor. While the Town of Christiansburg has not recognized this area officially as a UDA, the Comprehensive Plan does encourage new, higher density residential growth.

The proposed development and requested CUP fits well within this area and will provide a much needed housing type to the area. The location also provides all the needs and services for its future residents within walking distance or a short drive. Easy access to major thoroughfares limits traffic concerns whether users are heading towards Blacksburg, Roanoke, Radford or just travelling around town. With much of the area already developed commercially or with a similar type use, there should be little, if any, adverse impact on any adjacent properties.

General Conditions of the proposed Mega Builders Multi-Family Development

The following Conditions shall apply to the subject property upon approval of the requested Conditional Use Permit:

1. The property shall be developed in substantial conformance to the concept plan prepared by Balzer & Associates, Inc. and dated 12-20-2011.

2. All exterior lighting in the parking areas shall be directed towards the interior of the property.

3. There shall be a maximum of 330 residential units.

4. Facades/exterior walls shall be articulated with recesses, projections, doors, balconies or windows. No uninterrupted length of any façade shall exceed fifty (50) feet.

5. The property will be designed and developed in a unified manner and will incorporate similar and complementary architectural features such as masonry materials and roof materials, planting materials, signage, lighting and paving surfaces.

6. The exterior of the principal buildings shall be primarily brick.

7. All buildings shall be a maximum of three (3) full stories above front street/parking lot grade.

8. No dumpster shall be located within 75 feet of the southern boundary line of the property.

9. A vegetative buffer shall be installed along the southern property boundary adjacent to Wheatland Retirement Community. This buffer will consist of evergreen trees planted at a 6' minimum height and planted on a minimum 12' center.

Project Phasing

It is anticipated that due to the size of the project, the development and construction of the project will be phased. Phase I is expected to include the construction of the larger project amenities, such as the clubhouse, gym and basketball court as well as approximately half of the units. Depending on the market and leasing rates, Phase II may begin immediately after final construction of Phase I or may be delayed accordingly. A best case and aggressive timeline would be two years for full build-out. Stormwater management, waterlines, and sanitary sewer will be designed in Phase I to accommodate full build-out of the project and shall be constructed as required to service the first Phase. Any road improvements required will be completed as determined by the overall build-out density and traffic projections for this project alone.

Water & Sewer Service

The proposed development area is located at the end of Farmview Road. Currently the site has public water and public sewer service extended to the parcel boundary. Both are located on the north side of the property adjacent to the Lowes and Grand Home Furnishings properties. Those line sizes are a 6" waterline and an 8" sanitary sewer line. There is also a

6" waterline and 8" sewer line along Farmview Road that could be extended to the property. Other utilities exist along Franklin Street and behind Kmart that could be connected to the property in the future as the remaining commercial property develops. Final design of waterline extensions will be coordinated with Town engineering staff to ensure the project has adequate normal operating water pressure and fire suppression water pressure to meet all local and state building codes and fire codes.

Based on Virginia Department of Health Standards, an average daily flow is estimated as follows for the proposed uses:

MULTI-FAMILY

Multi-Family Residential: 330 Total Units
Design Assumptions and Calculations:

1. Assume 1 occupant per bedroom at maximum build-out = 580
2. Water and Sewer usage for residential use is 100 gal/day per person = 58,000 gal/day

TOTAL ESTIMATED WATER/SEWER USAGE BY PROPOSED DEVELOPMENT = 58,000 gallons per day

Applicant will construct or cause to be constructed at no expense to the Town all water/sewer mains and appurtenances on the Property and will connect the water/sewer mains to publicly owned water/sewer mains. All water mains and sewer mains will be constructed to the Town Standards, will comply with the regulations and standards of the Town and will comply with the regulations and standards of all other applicable regulatory authorities. All water mains and appurtenances and sewer mains will be dedicated to public use.

Roads

The proposed development is currently planned to be accessed from Farmview Road. Farmview Road serves the existing uses of Wheatland Retirement Community, NRV Magic Wand Carwash, Alleghany Church of Christ, Tomorrows World, an office complex, and two single family residences. The unbuilt portion of Farmview Road will need to be designed and constructed to meet all Town of Christiansburg road standards. This will include pavement widths, pavement section, pedestrian accommodations, and storm water controls.

A traffic study was performed in 2007 and supplemented in 2008 by Mattern & Craig of Roanoke, Virginia. This study was done in conjunction with the original rezoning request for the overall property. This property was rezoned at that time to a business use. When the traffic study was done, it was anticipated that the entire property would be developed into commercial & retail uses. A concept plan was prepared by Mattern & Craig and the uses shown were the basis for their study. From these uses, average daily trips were generated and used to determine traffic patterns, intersection capacity, signal design, etc. under different phasing scenarios of how the parcel would commercially develop. The average daily trips generated from that proposed development were 18,370. As part of that study, recommendations were made to improve the intersection at Farmview and Franklin.

With this current proposal, we have used the base information provided by the Mattern & Craig study and inserted the multi-family development of 2,194 ADT into the analysis. The analysis shows the impacts of the multi-family development on the Farmview/Franklin

intersection only since no other entrances or exits are planned with this development. This also does not account for any future development on the remaining commercial property owned by RWW36, LLC. According to the original study, the Farmview/Franklin intersection is currently operating at no less than a Level of Service C. As noted in the Mattern & Craig report *"...good levels of service exist as the geometrics reflect the much higher traffic volumes using Route 460 Business prior to the opening of the Route 460 By-pass. The latest VDOT count for Route 460 Business prior to the opening of the By-pass was 53,000 vpd in 2003."*

When the proposed development traffic is added to the existing traffic counts during the peak hour, the Level of Service for the intersection remained unchanged except for two movements. One is the southbound movement, which is Farmview Road. The Level went from a LOS C (34.6 second delay) to LOS D (38.5 second delay). Basically adding an additional 4 second delay during the peak hour. The other movement is the Eastbound Left Turn, which is the left turn movement from Franklin Street to Farmview. This Level went from a LOS C (34.6 second delay) to LOS D (37.1 second delay). For reference, the threshold for LOS D is 35 seconds. Per VDOT standards, a Level of Service D is acceptable for transportation planning. The vehicle storage or queue was also analyzed for the project. The 95% queue for Farmview was 180' or 7.2 vehicles. This stacks traffic back between the church entrance and Sunset Drive. The 95% queue for the eastbound Franklin Street left turn is 130' or 5.2 vehicles. The existing turn lane has a 150' taper and 150' storage lane which is adequate for the proposed queue. Based on this analysis, no traffic or intersection improvements are being proposed with this project, other than the extension of Farmview Road to the site.

The project also provides for two future access points. One is located to the north heading toward the vacant Teal parcel. The second would extend to the west and tie into the future road network developed when the commercial property fronting Franklin Street is developed. These future roads will provide for the interconnectivity that will allow the entire area to function as a true mixed use development.

Water Quality & Stormwater Management Standards

Approximately 92% of the subject property shown for development drains naturally to the east. Surface runoff flows to two existing culverts located under the 460 bypass. Both pipes drain into an unnamed tributary of Wilson Creek. Thus, this property is part of the Roanoke River watershed. The current masterplan shows two preliminary locations for stormwater management areas. These two areas would be sized to accommodate the additional stormwater runoff created by the increased impervious areas of the development. The stormwater management ponds would work in conjunction with one another and reduce the amount of post development runoff as well as treating the stormwater runoff for water quality purposes. Onsite measures such as Low Impact Development techniques may be implemented as well to further control the point source pollutants coming off the parking areas. A small portion of the project drains northwest toward the Teal property. This area drains to the New River and may require a separate stormwater management facility. The proposed stormwater management areas will conform to all applicable Department of Conservation and Recreation regulations dealing with stormwater quantity and quality. At a minimum, the 2-Year and 10 Year post-development runoff rates will be less than or equal to the 2-Year and 10-Year pre-development runoff rates. With these design measures in place there should be no negative impact on the groundwater supply for any adjacent downstream well users.

Housing Resources

The Town of Christiansburg Comprehensive Plan has identified goals and objectives for housing within the Town. Objective #1 is *"Provide for a range of housing choices to ensure that housing will be available to a broad range of income groups."* One of the strategies to achieve this is listed as *"a. Provide opportunities for diversity of housing types including apartments, townhouses, condominiums, and duplexes as well as small- and large-lot single family."* The proposed project fits well into this goal of the Town. There are relatively few multi-family apartment developments in Town. Several, as described in the Comprehensive Plan, are lower income, income restricted, or income assisted. The proposed development will provide new, highly amenitized apartments that can serve a portion of the population that currently has relatively few options for apartment living. The location of the project is also a benefit due to its close proximity to retail shopping, grocery, gas, and restaurants. The property being close to three main roads, Franklin Street, Peppers Ferry Road, and 460 Bypass allows for easy access and traffic flows and also helps keep site traffic out of single family neighborhoods.

Maintenance

A site and project of this size will have a full time staff handling unit maintenance. Mega Builders will hire Hawthorne Residential Properties to manage the maintenance of the project. Hawthorne is a full service regional property management company that has extensive experience managing large multi-unit properties. All common space elements including the structures and exterior elements such as trails will be under the development's ownership and will be maintained at no cost to the general taxpayer. Hawthorne will hire a local company to do grounds maintenance and landscaping around the units and the common space.

Landscaping/Buffering

Landscaping will be provided as specified in the Town of Christiansburg Zoning Ordinance. This will include the required interior parking greenspace areas as well as the overall site greenspace and landscaping requirements. Additional screening has been designed to help mitigate any concerns from adjacent properties or address screening desired by the applicant.

Environmental Impacts & Concerns

The property is located on a topographic high point and sits at the drainage divide between the Roanoke River Basin and the New River Basin. The site contains no streams or wetlands. A preliminary geotechnical report has been prepared for Mega Builders, LLC by Froehling & Robertson, Inc. which provides Mega Builders general information on the soil structure of the site and other factors such as rock, existing fill material, and subsurface water data.

PLANNED RESIDENTIAL DEVELOPMENT FOR MEGA BUILDERS, LLC

1. Permitted Uses

Structures to be erected or land to be used shall be one or more of the following:

(a) Multiple-family dwellings, including up to three unrelated individuals per unit.

(b) Planned housing developments subject to the special regulations of Section 30-57 below, including up to two unrelated individuals per unit.

(c) Open Space, including park, playgrounds, trails, and similar recreational uses.

(d) Home Occupational as defined by the Town of Christiansburg Zoning Ordinance.

(e) Off-street Parking and Loading as required by The Town of Christiansburg Zoning Ordinance.

(f) Public Utilities such as poles, lines, transformers, pipes, meters, and other facilities necessary for the provision and maintenance of Public utilities including water and sewage facilities.

(g) Temporary construction trailers on active construction sites only.

(y) Signs in accordance with the Sign Ordinance.

2. Area and Density

(a) No more than 330 units (±15.7 units per acre on average) can be built in the Development

(b) The minimum lot area for a multiple-family dwelling shall be 15,625 square feet and density of development shall not exceed the ratio of 20 dwelling units per gross acre.

3. Setback.

Structures shall be located 30 feet or more from any street right-of-way, or, in the event that buildings are already constructed on the same side of the street in the block, no new structure shall be closer to the street right-of-way line than a distance equal to the average of the distance to the street right-of-way of all existing structures in the same block on the same side of the street. This shall be known as the setback line. Parking lots shall have a minimum setback of 15 feet from any street right-of-way.

4. Frontage and lot depth.

The minimum lot width at the setback line and street line shall be 125 feet for a multiple-family dwelling. All structures in this district shall be located on the lot with the front of the structure facing the front of the lot, the front of the lot being the shortest side of the lot which abuts on a street. On a lot which extends through from street to street, structures shall be faced on the street on which the majority of existing structures face, or in case there are no existing buildings, the building official shall determine on which street the structure shall face. Where permitted, multiple buildings on a single lot may be arranged in accord with approved site plans. (Code 1972, § 30-51; Ord. of 6-20-89; Ord. of 6-2-98)

5. Yards.

The minimum side yard for each main structure shall be ten percent of the width of the lot at the setback line or a minimum of ten feet or side lot line easement width, whichever is greatest. Each main structure shall have a rear yard of 20 feet or more. Accessory structures shall have a side and rear yard of 3 feet or more. The front yard shall contain a minimum of twenty (20) percent greenspace or landscaped area. For duplexes for individual sale, the greenspace or landscaped area in the front yard shall be maintained at a ratio of twenty (20) percent for

each dwelling unit on each lot. For this purpose, corner lots shall be deemed to contain a minimum of twenty (20) percent greenspace or landscaped area in each yard fronting a public street. Sidewalks and curb and gutter shall be required on both sides of the public streets for all new streets and for all multi-family residential development. In lieu of sidewalks and curb and gutter, an owner or developer shall provide a paved multi-use trail a minimum of ten (10) feet in width connecting to the street right-of-way adjoining other properties and to each lot within the development for single-family, duplex, or townhouse development or at least the length of the total street frontage connecting to the right-of-way adjoining other properties and to each apartment or condominium unit within the development by a hard surface connection. (Code 1972, § 30-52; Ord. of 6-20-89; Ord. 2002-2 of 3-5-02; Ord. 2007-1 of 4-3-07; Ord. 2010-9 of 12-21-10)

6. Height

Buildings may be erected up to 35 feet in height from street grade or lot grade at Setback line, whichever is greater; except, that:

(a) Church spires, belfries, cupolas, monuments, water towers, chimneys, flues and flagpoles shall be exempt from this section.

(b) Parapet walls may be up to four feet above the height of the building on which the walls rest.

(c) No accessory building which is within ten feet of any property lot line shall be more than one story high.

(d) Accessory buildings shall not exceed the main structure in height except that when the accessory building is located at a lower ground elevation, then the elevation of the roofline of the accessory building shall not be higher than the elevation of the roofline of the main structure, but not to exceed two stories in height.

7. Development standards for apartments

(a) The development or project shall be designed to promote harmonious relationships with surrounding adjacent and nearby developed properties, particularly in larger developments or projects where more than one building is involved, and to this end may employ such design techniques as may be appropriate to a particular case, including use of building types, orientation, spacing and setback of buildings, careful use of topography, maintenance of natural vegetation, location of access points, recreation areas, open spaces, and parking areas, grading, landscaping, and screening.

(b) No apartment building shall contain more than 36 dwelling units and no more than three apartment buildings shall be contiguous.

(c) No apartment building shall be located closer than 15 feet from a private drive, access road or open common parking area whether oriented to the front, sides or rear of the buildings, except that parking areas may be located within five feet and private drives may be located within 10 feet of any blank or windowless wall.

(d) More than one apartment building may be located on the lot provided a minimum distance of 25 feet shall separate any two buildings or groups of apartment buildings from any other abutting use or building type.

(e) At least 400 square feet of commonly usable open space shall be provided for each dwelling unit. Such space shall be of such location and dimensions as to provide for outdoor living, patios, pools, lawns, play areas, walks, wooded areas and the like, but not including driveways and parking areas.

(f) Where community refuse containers are provided as accessory uses to apartment developments, such containers shall be conveniently located for

pickup vehicle access and completely screened from view by means of a fence or wall with outside landscaping and an appropriately designed gate which can be latched open and closed.

(g) Each apartment dwelling unit shall contain at least 600 square feet of livable floor area, exclusive of garages, carports, cellars, basements, attics, open porches, patios, or breezeways, except that up to ten percent of the units may be constructed with less floor area than this minimum.

(h) Apartment development requiring ingress and egress to a public street shall meet all the requirements of the Town Subdivision Ordinance.

(i) Parking lots shall have a minimum setback of 15 feet from any street right-of-way.

(Code 1972, § 30-56; Ord. of 6-20-89; Ord. 2002-2 of 3-5-02)

8. Planned housing developments

Within an R-3 Residential District as a conditional use or in conjunction with an application for conditional zoning for R-3 Residential, and in order to encourage improved housing design, variety in housing types and best use of topography, a site plan may be submitted for a planned housing development, together with a subdivision plan if required by this chapter or the subdivision chapter and such other descriptive material or proffers as may be necessary to fully determine the development, even though such development does not comply in all respects to the dimensional requirements of the R-3 District, provided:

(a) One or more major features of the development, such as unusual natural features, yard spaces, open spaces, and building types and arrangements, are such as to justify application of this section rather than a conventional application of the other regulations of the R-3 District.

(b) Materials submitted, drawings, descriptions, proffers and the like are sufficiently detailed to assure compliance with the intent of this section.

(c) The project itself, or a larger project of which it is a part, is of sufficient size in the location proposed as to permit development of an internal environment, which, if different from designs otherwise permitted in the R-3 District, will not adversely affect existing and future development in the surrounding area.

(d) The overall dwelling unit density does not exceed that permitted in the R-3 District for development of comparable housing types.

(e) The development is designed to promote harmonious relationships with surrounding adjacent and nearby developed properties and to this end may employ such design techniques as may be appropriate to a particular case, including use of building types, orientation, and spacing and setback of buildings, careful use of topography, maintenance of natural vegetation, location of recreation areas, open spaces, and parking areas, grading, landscaping, and screening.

(f) Provision satisfactory to the Planning Commission and approved by the Town Attorney shall be made to assure that nonpublic areas for the common use and employment of occupants, but not in individual ownership by such occupants, shall be maintained in a satisfactory manner without expense to the general taxpayer.

Procedures and general standards for approval of an application under this section shall be the same as those for a Conditional Use Permit or for Conditional Zoning as described in Article I as the case may require.

(Code 1972, § 30-57)

N

MEGA BUILDERS

MEGA BUILDERS, LLC - PROPOSED MULTI-FAMILY DEVELOPMENT

EXISTING CONDITIONS - AERIAL VIEW

BALZER AND ASSOCIATES, INC.
REFLECTING TOMORROW

LAUREL ST NE
LAUREL ST NE
SYCAMORE ST NE
MARKET ST NE
N FRANKLIN ST
N FRANKLIN ST
SPRADLIN FARM DR NW
GORSTON AVE NW
FARMVIEW RD NW
FARMVIEW RD NE
SUNSET DR NE
RT 460 BYPASS EBL
RT 460 BYPASS WBL
Manholes
Gravity Main
Fire Hydrant
Water Main
Roads
Tax Parcels
Farmview Rd NE
Water and Sewer
N
0
150
300
Feet

TOWN OF CHRISTIANSBURG
FUTURE LAND USE

NOTE: The floodplain depicted on this map should only be used as a visual aid, official FEMA, Flood Insurance Rate Maps should be consulted for any other purpose.

NOTE: The proposed road improvements/extensions shown on this future land use map are for graphical purposes only. These are not definite locations, but shown for planning purposes only.

LEGEND

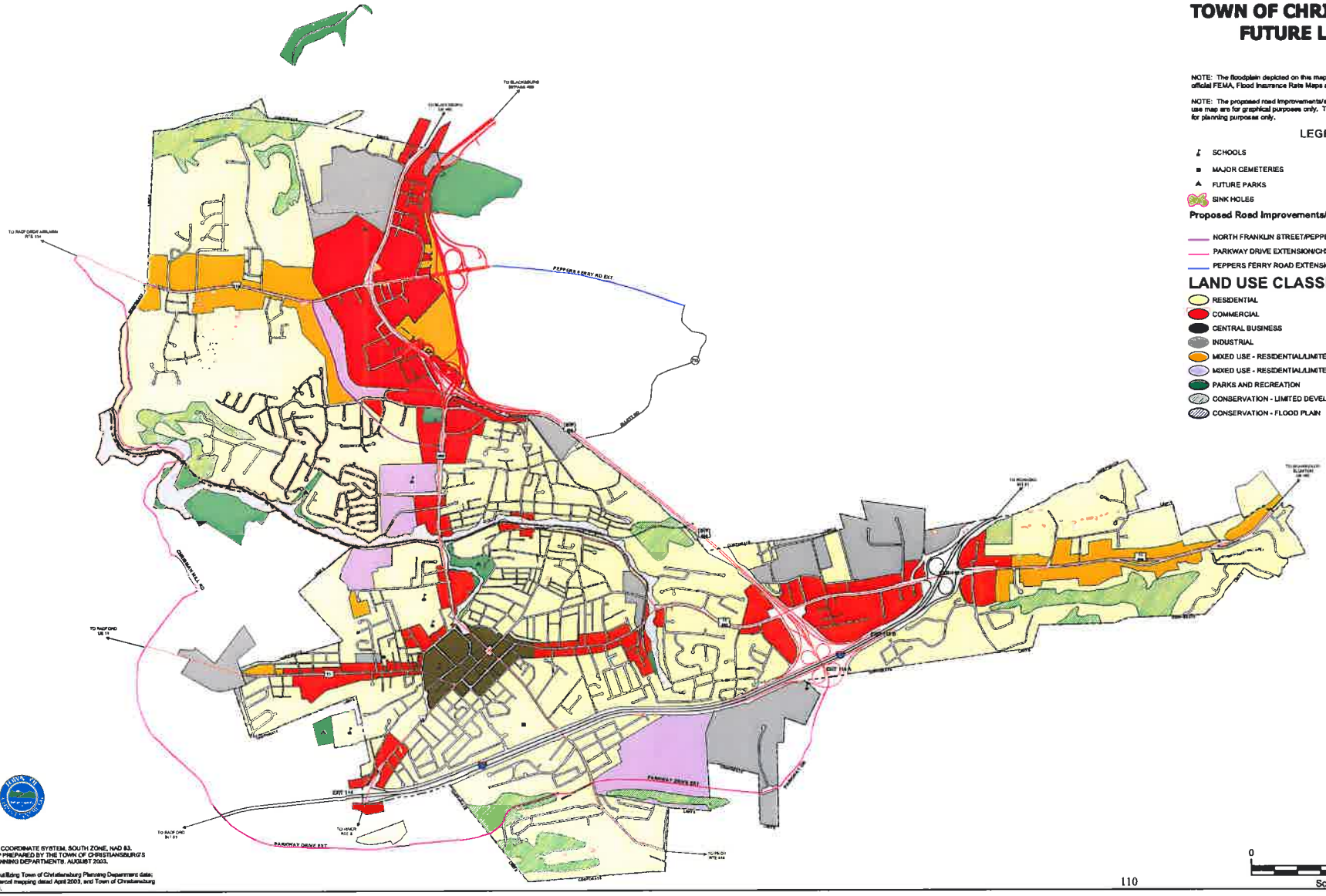
- SCHOOLS
- MAJOR CEMETERIES
- FUTURE PARKS
- SINK HOLES

Proposed Road Improvements/Extensions

- NORTH FRANKLIN STREET/PEPPERS FERRY ROAD CONNECTOR ROUTE
- PARKWAY DRIVE EXTENSION/CHRISMAN MILL ROAD IMPROVEMENTS
- PEPPERS FERRY ROAD EXTENSION

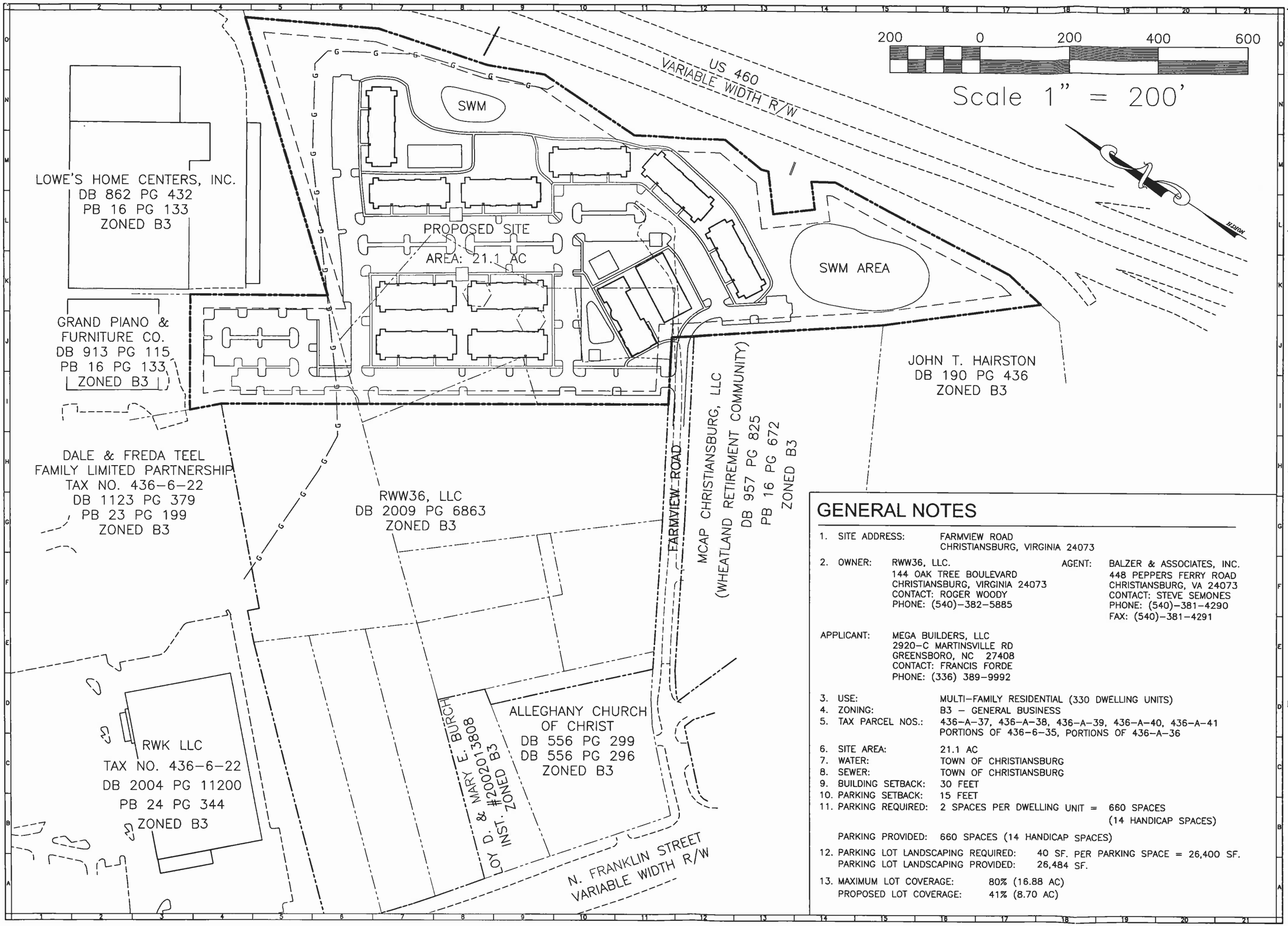
LAND USE CLASSIFICATION

- RESIDENTIAL
- COMMERCIAL
- CENTRAL BUSINESS
- INDUSTRIAL
- MIXED USE - RESIDENTIAL/LIMITED BUSINESS
- MIXED USE - RESIDENTIAL/LIMITED BUSINESS/LIMITED INDUSTRIAL
- PARKS AND RECREATION
- CONSERVATION - LIMITED DEVELOPMENT
- CONSERVATION - FLOOD PLAIN



VIRGINIA STATE PLANE COORDINATE SYSTEM, SOUTH ZONE, NAD 83.
FUTURE LAND USE MAP PREPARED BY THE TOWN OF CHRISTIANSBURG'S ENGINEERING AND PLANNING DEPARTMENTS. AUGUST 2003.

SOURCE: Map prepared utilizing Town of Christiansburg Planning Department data; Montgomery County tax parcel mapping dated April 2003, and Town of Christiansburg base mapping dated 2003.



GENERAL NOTES

1. SITE ADDRESS: FARMVIEW ROAD
   CHRISTIANSBURG, VIRGINIA 24073
2. OWNER: RWW36, LLC.
   144 OAK TREE BOULEVARD
   CHRISTIANSBURG, VIRGINIA 24073
   CONTACT: ROGER WOODY
   PHONE: (540)-382-5885

   AGENT: BALZER & ASSOCIATES, INC.
   448 PEPPERS FERRY ROAD
   CHRISTIANSBURG, VA 24073
   CONTACT: STEVE SEMONES
   PHONE: (540)-381-4290
   FAX: (540)-381-4291

   APPLICANT: MEGA BUILDERS, LLC
   2920-C MARTINSVILLE RD
   GREENSBORO, NC 27408
   CONTACT: FRANCIS FORDE
   PHONE: (336) 389-9992
3. USE: MULTI-FAMILY RESIDENTIAL (330 DWELLING UNITS)
4. ZONING: B3 – GENERAL BUSINESS
5. TAX PARCEL NOS.: 436-A-37, 436-A-38, 436-A-39, 436-A-40, 436-A-41
   PORTIONS OF 436-6-35, PORTIONS OF 436-A-36
6. SITE AREA: 21.1 AC
7. WATER: TOWN OF CHRISTIANSBURG
8. SEWER: TOWN OF CHRISTIANSBURG
9. BUILDING SETBACK: 30 FEET
10. PARKING SETBACK: 15 FEET
11. PARKING REQUIRED: 2 SPACES PER DWELLING UNIT = 660 SPACES
    (14 HANDICAP SPACES)

    PARKING PROVIDED: 660 SPACES (14 HANDICAP SPACES)
12. PARKING LOT LANDSCAPING REQUIRED: 40 SF. PER PARKING SPACE = 26,400 SF.
    PARKING LOT LANDSCAPING PROVIDED: 26,484 SF.
13. MAXIMUM LOT COVERAGE: 80% (16.88 AC)
    PROPOSED LOT COVERAGE: 41% (8.70 AC)

BALZER AND ASSOCIATES, INC.
REFLECTING TOMORROW
www.balzer.cc
New River Valley
Richmond
Roanoke
Shenandoah Valley

RESIDENTIAL LAND DEVELOPMENT ENGINEERING
SITE DEVELOPMENT ENGINEERING
LAND USE PLANNING & ZONING
LANDSCAPE ARCHITECTURE
LAND SURVEYING
ARCHITECTURE
STRUCTURAL ENGINEERING
GEOTECHNICAL ENGINEERING
TRANSPORTATION ENGINEERING
ENVIRONMENTAL & SOIL SCIENCE
WETLAND DELINEATIONS & STREAM EVALUATIONS

Balzer and Associates, Inc.
448 Peppers Ferry Road, NW
Christiansburg, VA 24073
540-381-4290
FAX 540-381-4291

MEGA BUILDERS

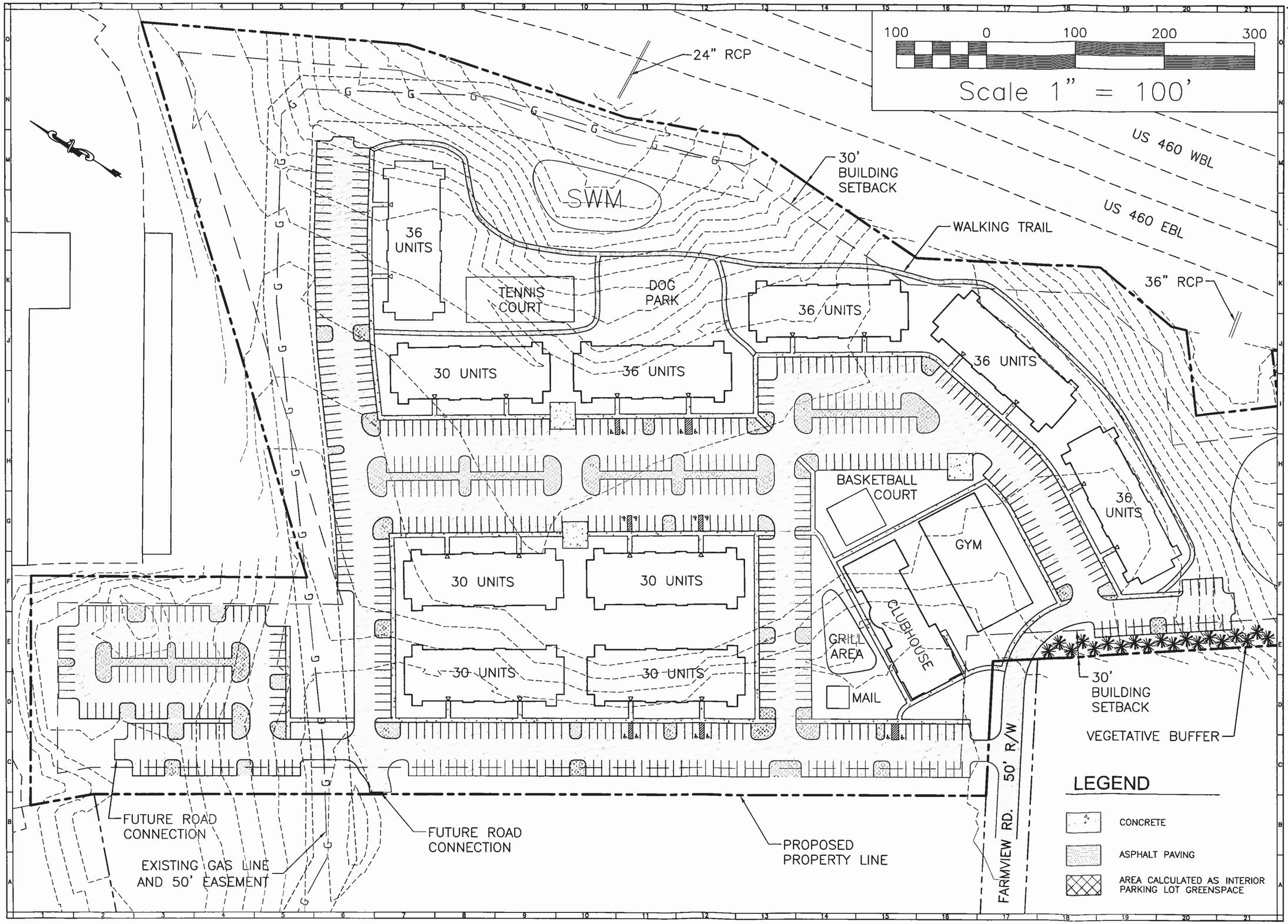
OVERALL PLAN

TOWN OF CHRISTIANSBURG
MONTGOMERY COUNTY, VIRGINIA

DRAWN BY	JRT
DESIGNED BY	JRT
CHECKED BY	SMS
DATE	12/20/11
SCALE	1" =200'
REVISIONS:	

SHEET NO.
CUP 1

JOB NO. B1100073.00



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REFLECTING TOMORROW

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New River Valley
Richmond
Roanoke
Shenandoah Valley

RESIDENTIAL LAND DEVELOPMENT ENGINEERING
SITE DEVELOPMENT ENGINEERING
LAND USE PLANNING & ZONING
LANDSCAPE ARCHITECTURE
LAND SURVEYING
ARCHITECTURE
STRUCTURAL ENGINEERING
GEOTECHNICAL ENGINEERING
TRANSPORTATION ENGINEERING
ENVIRONMENTAL & SOIL SCIENCE
WETLAND DELINEATIONS & STREAM EVALUATIONS

Balzer and Associates, Inc.
448 Peppers Ferry Road, NW
Christiansburg, VA 24073
540-381-4290
FAX 540-381-4291

MEGA BUILDERS

CONCEPTUAL MASTERPLAN

TOWN OF CHRISTIANSBURG
MONTGOMERY COUNTY, VIRGINIA

DRAWN BY	JRT
DESIGNED BY	JRT
CHECKED BY	SMS
DATE	12/20/11
SCALE	1" =100'
REVISIONS:	

SHEET NO.
CUP 2

JOB NO. B1100073.00

Apartment
(220)

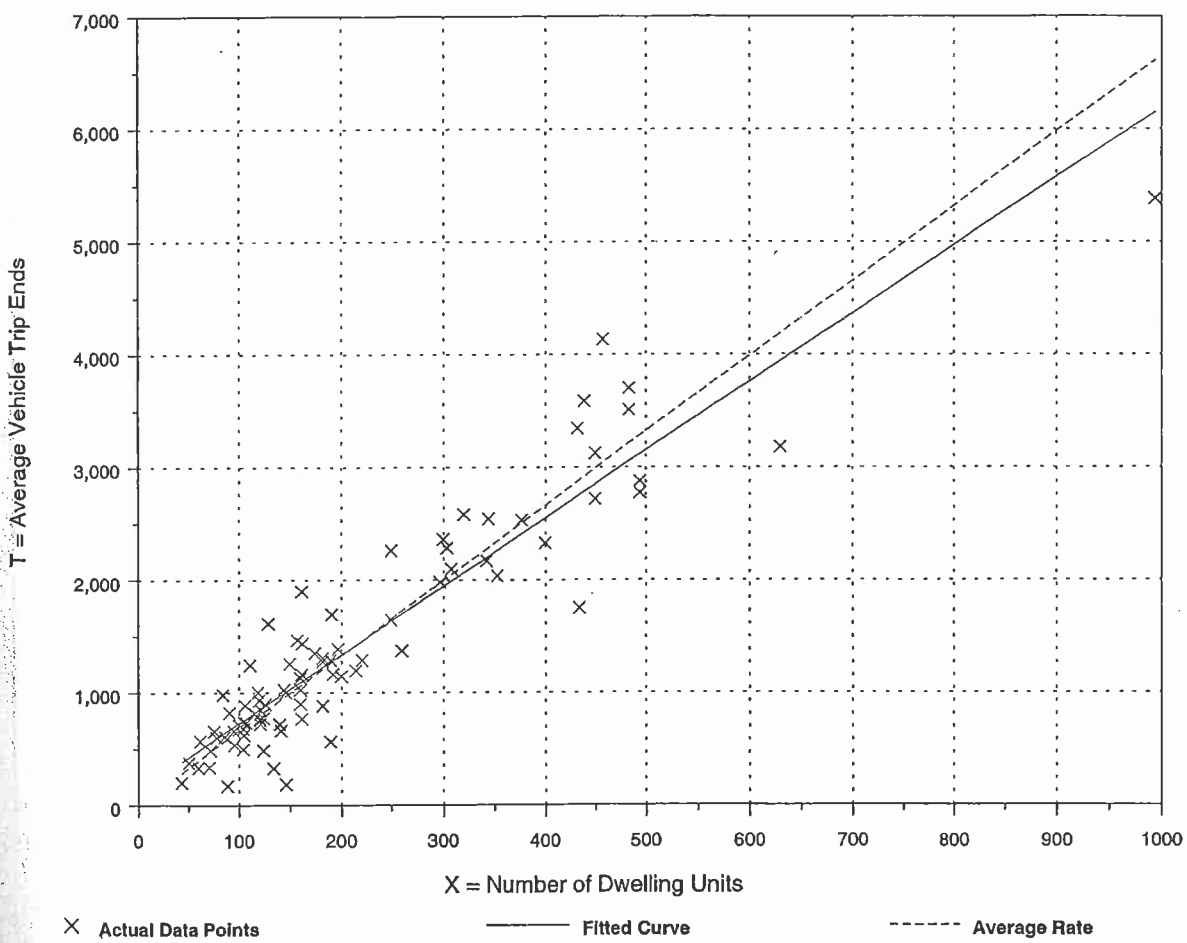
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Number of Studies: 88
Avg. Number of Dwelling Units: 210
Directional Distribution: 50% entering, 50% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
6.65	1.27 - 12.50	3.07

Data Plot and Equation



Fitted Curve Equation: T = 6.06(X) + 123.56 $R^2 = 0.87$

Apartment
(220)

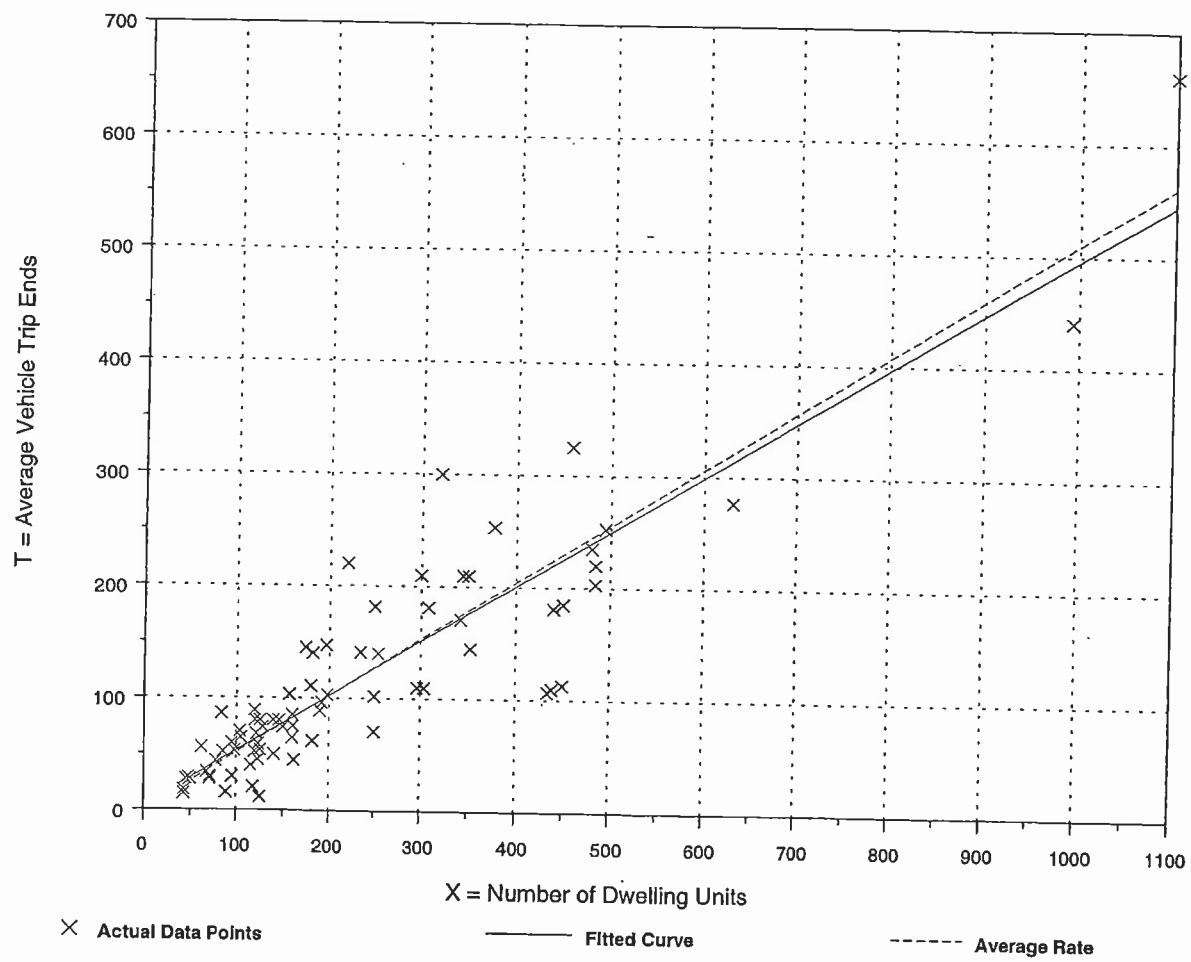
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.

Number of Studies: 78
Avg. Number of Dwelling Units: 235
Directional Distribution: 20% entering, 80% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.51	0.10 - 1.02	0.73

Data Plot and Equation



Fitted Curve Equation: T = 0.49(X) + 3.73

R^2 = 0.83

Apartment
(220)

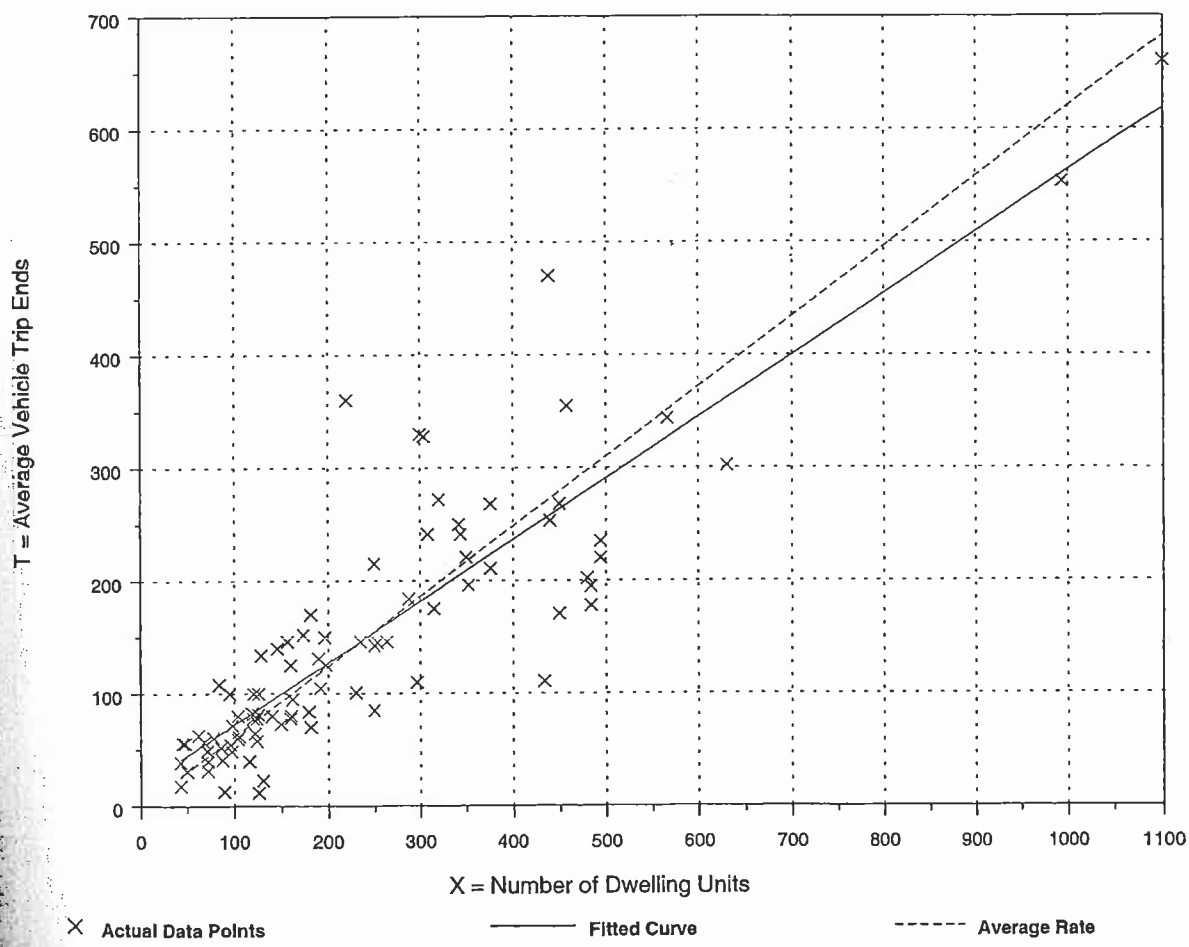
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.

Number of Studies: 90
Avg. Number of Dwelling Units: 233
Directional Distribution: 65% entering, 35% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.62	0.10 - 1.64	0.82

Data Plot and Equation



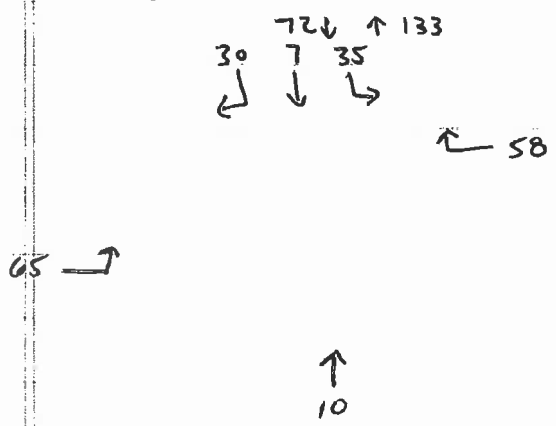
Fitted Curve Equation: T = 0.55(X) + 17.65 $R^2 = 0.77$

FARMVIEW ROAD TRAFFIC STUDY

APARTMENT - ITE 220

330 DWELLING UNITS

	AM IN	AM OUT	AM TOTAL	PM IN	PM OUT	PM TOTAL	WEEKDAY
RATES	34	134	168	133	72	205	2194
EQUATIONS	33	132	165	129	70	199	2123



LONG REPORT

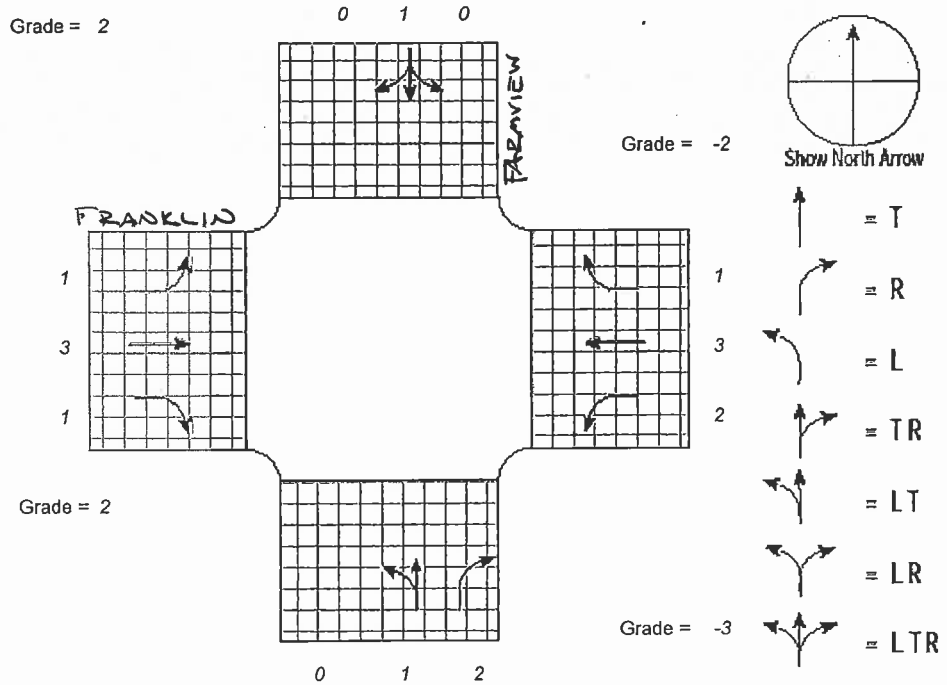
General Information

Analyst	*CPB*
Agency or Co.	*Balzer & Associates, Inc.*
Date Performed	*12/19/2011*
Time Period	*PM Peak Hr*

Site Information

Intersection	*Rte 460/Farmview Rd*
Area Type	*All other areas*
Jurisdiction	*Town of Christiansburg*
Analysis Year	*Existing 2006*

Intersection Geometry



Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (vph)	27	993	114	110	893	20	76	2	102	27	4	22
% Heavy Veh	0	5	0	0	5	0	0	0	0	0	0	0
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Actuated (P/A)	A	A	A	A	A	A	A	A	A	A	A	A
Startup Lost Time	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	
ExtenSion of Effective Green	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	
Arrival type	3	3	3	5	5	5		3	3		3	
Unit Extension	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	
Ped/Bike/RTOR Volume	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0		12.0	
Parking (Y or N)	N		N	N		N	N		N	N		N
Parking/Hour												
Bus Stops/Hour	0	0	0	0	0	0		0	0		0	
Pedestrian Timing	3.2			3.2			3.2			3.2		

	Excl. Left	Thru & RT	03	04	NB Only	SB Only	07	08
Timing	G = 12.0	G = 30.0	G = 0.0	G = 0.0	G = 15.0	G = 13.0	G = 0.0	G = 0.0
	Y = 5	Y = 5	Y = 0	Y = 0	Y = 5	Y = 5	Y = 0	Y = 0
Duration of Analysis (hrs) = 0.25						Cycle Length C = 90.0		

VOLUME ADJUSTMENT AND SATURATION FLOW RATE WORKSHEET

General Information

Project Description

Volume Adjustment

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume	27	993	114	110	893	20	76	2	102	27	4	22
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adjusted Flow Rate	30	1103	127	122	992	22	84	2	113	30	4	24
Lane Group	L	T	R	L	T	R		LT	R		LTR	
Adjusted Flow Rate	30	1103	127	122	992	22		86	113		58	
Proportion of LT or RT	1.000	--	1.000	1.000	--	1.000	0.977	--	1.000	0.517	--	0.414

Saturation Flow Rate

Base Satflow	1900	1900	1900	1900	1900	1900		1900	1900		1900	
Number of Lanes	1	3	1	2	3	1	0	1	2	0	1	0
f_W	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_{HV}	1.000	0.952	1.000	1.000	0.952	1.000		1.000	1.000		1.000	
f_g	0.990	0.990	0.990	1.010	1.010	1.010		1.015	1.015		0.990	
f_p	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_{bb}	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_a	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_{LU}	1.000	0.908	1.000	0.971	0.908	1.000		1.000	0.885		1.000	
f_{LT}	0.950	1.000	--	0.950	1.000	--		0.953	--		0.975	--
Secondary f_{LT}			--			--			--			--
f_{RT}	--	1.000	0.850	--	1.000	0.850	--	1.000	0.850	--	0.944	
f_{Lpb}	1.000	1.000	--	1.000	1.000	--		1.000	--		1.000	--
f_{Rpb}	--	1.000	1.000	--	1.000	1.000	--	1.000	1.000	--	1.000	
Adjusted Satflow	1787	4880	1599	3540	4978	1631		1839	2901		1731	
Secondary Adjusted Satflow			--			--			--			--

CAPACITY AND LOS WORKSHEET

General Information

Project Description

Capacity Analysis

	EB			WB				NB			SB	
Lane Group	*L*	*T*	*R*	*L*	*T*	*R*		*LT*	*R*		*LTR*	
Adjusted Flow Rate	*30*	*1103*	*127*	*122*	*992*	*22*		*86*	*113*		*58*	
Satflow Rate	*1787*	*4880*	*1599*	*3540*	*4978*	*1631*		*1839*	*2901*		*1731*	
Lost Time	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*		*2.0*	*2.0*		*2.0*	
Green Ratio	*0.13*	*0.33*	*0.56*	*0.13*	*0.33*	*0.48*		*0.17*	*0.17*		*0.14*	
Lane Group Capacity	*238*	*1627*	*888*	*472*	*1659*	*779*		*307*	*484*		*250*	
v/c Ratio	*0.13*	*0.68*	*0.14*	*0.26*	*0.60*	*0.03*		*0.28*	*0.23*		*0.23*	
Flow Ratio	*0.02*	*0.23*	*0.08*	*0.03*	*0.20*	*0.01*		*0.05*	*0.04*		*0.03*	
Critical Lane Group	*N*	*Y*	*N*	*Y*	*N*	*N*		*Y*	*N*		*Y*	
Sum Flow Ratios	*0.34*											
Lost Time/Cycle	*20.00*											
Critical v/c Ratio	*0.44*											

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB				NB			SB	
Lane Group	*L*	*T*	*R*	*L*	*T*	*R*		*LT*	*R*		*LTR*	
Adjusted Flow Rate	*30*	*1103*	*127*	*122*	*992*	*22*		*86*	*113*		*58*	
Lane Group Capacity	*238*	*1627*	*888*	*472*	*1659*	*779*		*307*	*484*		*250*	
v/c Ratio	*0.13*	*0.68*	*0.14*	*0.26*	*0.60*	*0.03*		*0.28*	*0.23*		*0.23*	
Green Ratio	*0.13*	*0.33*	*0.56*	*0.13*	*0.33*	*0.48*		*0.17*	*0.17*		*0.14*	
Uniform Delay d_1	*34.4*	*25.8*	*9.7*	*35.0*	*25.0*	*12.4*		*32.8*	*32.5*		*34.1*	
Delay Factor k	*0.11*	*0.25*	*0.11*	*0.11*	*0.19*	*0.11*		*0.11*	*0.11*		*0.11*	
Incremental Delay d_2	*0.2*	*1.1*	*0.1*	*0.3*	*0.6*	*0.0*		*0.5*	*0.2*		*0.5*	
PF Factor	*1.000*	*1.000*	*1.000*	*0.897*	*0.667*	*0.390*		*1.000*	*1.000*		*1.000*	
Control Delay	*34.6*	*27.0*	*9.7*	*31.7*	*17.3*	*4.9*		*33.3*	*32.8*		*34.6*	
Lane Group LOS	*C*	*C*	*A*	*C*	*B*	*A*		*C*	*C*		*C*	
Approach Delay	*25.4*			*18.6*			*33.0*				*34.6*	
Approach LOS	*C*			*B*			*C*				*C*	
Intersection Delay	*23.3*			Intersection LOS							*C*	

SUPPLEMENTAL UNIFORM DELAY WORKSHEET FOR LEFT TURNS FROM EXCLUSIVE LANES WITH PROTECTED AND PERMITTED PHASES

General Information

Project Description

v/c Ratio Computation

	EB	WB	NB	SB
Cycle Length, C (s)	*90.0*			
Prot. Phase Eff. Green Interval, g (s)				
Opposed Queue Eff. Green Interval, g_q (s)				
Unopposed green interval, g_u (s)				
Red Time, r(s)				
Arrival Rate, q_a (veh/s)				
Protected Phase Departure Rate, s_p (veh/s)				
Perm. Phase Departure Rate, s_s (veh/s)				
X_{perm}				
X_{prot} (N/A for Lagging Left-turns)				

Uniform Queue Size and Delay Computations

Queue at Start of Green Arrow, Q_a				
Queue at Start of Unsaturated Green, Q_u				
Residual Queue, Q_r				
Uniform Delay, d_1				

Uniform Queue Size and Delay Equations

	Case	Q_a	Q_u	Q_r	d_1
If X_{perm} <= 1.0 & X_{prot} <= 1.0	1	$q_a r$	$q_a g_q$	0	$[0.5/(q_a C)][rQ_a + Q_a^{2/(S_p - q_s)} + g_q Q_u + Q_u^{2/(S_s - q_a)}$
If X_{perm} <= 1.0 & X_{prot} > 1.0	2	$q_a r$	$Q_r + q_a g_q$	$Q_a - g(s_p - q_a)$	$[0.5/(q_a C)][rQ_a + g(Q_a + Q_r) + g_q (Q_r + Q_u) + Q_u^{2/(S_s - q_a)}$
If X_{perm} > 1.0 & X_{prot} <= 1.0	3	$Q_r + q_a r$	$q_a g_q$	$Q_u - g_u(s_s - q_a)$	$[0.5/(q_a C)][g_q Q_u + g_u(Q_a + Q_r) + r(Q_r + Q_a) + Q_a^{2/(S_p - q_a)}$
If X_{perm} <= 1.0 (lagging lefts)	4	0	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + Q_u^{2/(S_s - q_a)}$
If X_{perm} > 1.0 (lagging lefts)	5	$Q_u - g_u(s_s - q_a)$	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + g_u(Q_u + Q_a) + Q_a^{2/(S_p - q_a)}$

BACK-OF-QUEUE WORKSHEET

General Information

Project Description

Average Back of Queue

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Lane Group	L	T	R	L	T	R		LT	R		LTR	
Initial Queue/Lane	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	
Flow Rate/Lane	30	1103	127	122	992	22		86	113		58	
Satflow/Lane	1787	1791	1599	1823	1827	1631		1839	1639		1731	
Capacity/Lane	238	1627	888	472	1659	779		307	484		250	
Flow Ratio	0.0	0.2	0.1	0.0	0.2	0.0		0.0	0.0		0.0	
v/c Ratio	0.13	0.68	0.14	0.26	0.60	0.03		0.28	0.23		0.23	
I Factor	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
Arrival Type	3	3	3	5	5	5		3	3		3	
Platoon Ratio	1.00	1.00	1.00	1.67	1.67	1.67		1.00	1.00		1.00	
PF Factor	1.00	1.00	1.00	0.92	0.80	0.39		1.00	1.00		1.00	
Q_1	0.7	8.7	1.5	1.3	6.1	0.1		1.9	1.4		1.3	
k_B	0.3	0.5	0.6	0.3	0.5	0.6		0.3	0.3		0.3	
Q_2	0.0	1.0	0.1	0.1	0.7	0.0		0.1	0.1		0.1	
Q Average	0.7	9.7	1.6	1.4	6.8	0.1		2.0	1.5		1.4	

Percentile Back of Queue (95th percentile)

$f_{B\%}$	2.1	1.8	2.0	2.1	1.9	2.1		2.0	2.1		2.1	
BOQ, $Q_{\%}$	1.5	18.0	3.4	2.8	13.0	0.3		4.1	3.0		2.8	

Queue Storage Ratio

Q Spacing	25.0	25.0	25.0	25.0	25.0	25.0		25.0	25.0		25.0	
Q Storage	0	0	0	0	0	0		0	0		0	
Average R_Q												
95% $R_{Q\%}$												

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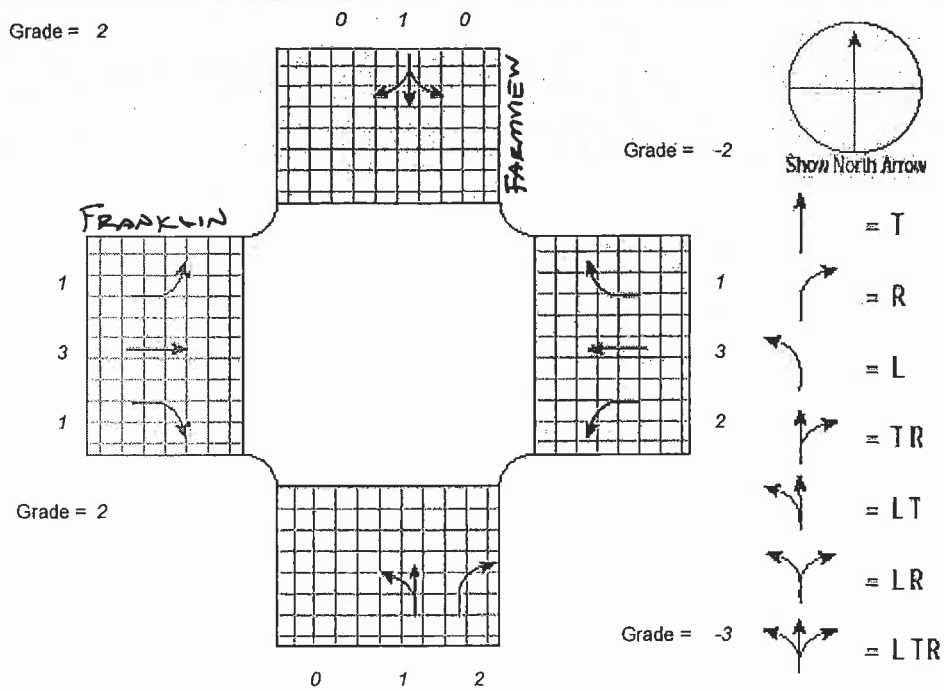
LONG REPORT

General Information		Site Information	
Analyst	*CPB*	Intersection	*Rte 460/Farmview Rd*
Agency or Co.	*Balzer & Associates, Inc.*	Area Type	*All other areas*
Date Performed	*12/19/2011*	Jurisdiction	*Town of Christiansburg*
Time Period	*PM Peak Hr*	Analysis Year	*Apartment Buildout 2006*

Intersection Geometry



Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (vph)	92 (65)	993	114	110	893	78 (58)	76	12 (10)	102	62 (35)	11 (7)	52 (30)
% Heavy Veh	0	5	0	0	5	0	0	0	0	0	0	0
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Actuated (P/A)	A	A	A	A	A	A	A	A	A	A	A	A
Startup Lost Time	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	
ExtenSion of Effective Green	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	
Arrival type	3	3	3	5	5	5		3	3		3	
Unit Extension	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	
Ped/Bike/RTOR Volume	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0		12.0	
Parking (Y or N)	N		N	N		N	N		N	N		N
Parking/Hour												
Bus Stops/Hour	0	0	0	0	0	0		0	0		0	
Pedestrian Timing	3.2			3.2			3.2			3.2		

	Excl. Left	Thru & RT	03	04	NB Only	SB Only	07	08
Timing	G = 12.0	G = 30.0	G = 0.0	G = 0.0	G = 15.0	G = 13.0	G = 0.0	G = 0.0
	Y = 5	Y = 5	Y = 0	Y = 0	Y = 5	Y = 5	Y = 0	Y = 0
Duration of Analysis (hrs) = 0.25						Cycle Length C = 90.0		

VOLUME ADJUSTMENT AND SATURATION FLOW RATE WORKSHEET

General Information

Project Description

Volume Adjustment

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume	92	993	114	110	893	78	76	12	102	62	11	52
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adjusted Flow Rate	102	1103	127	122	992	87	84	13	113	69	12	58
Lane Group	L	T	R	L	T	R		LT	R		LTR	
Adjusted Flow Rate	102	1103	127	122	992	87		97	113		139	
Proportion of LT or RT	1.000	--	1.000	1.000	--	1.000	0.866	--	1.000	0.496	--	0.417

Saturation Flow Rate

Base Satflow	1900	1900	1900	1900	1900	1900		1900	1900		1900	
Number of Lanes	1	3	1	2	3	1	0	1	2	0	1	0
f_W	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_{HV}	1.000	0.952	1.000	1.000	0.952	1.000		1.000	1.000		1.000	
f_g	0.990	0.990	0.990	1.010	1.010	1.010		1.015	1.015		0.990	
f_p	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_{bb}	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_a	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_{LU}	1.000	0.908	1.000	0.971	0.908	1.000		1.000	0.885		1.000	
f_{LT}	0.950	1.000	--	0.950	1.000	--		0.958	--		0.976	--
Secondary f_{LT}			--			--			--			--
f_{RT}	--	1.000	0.850	--	1.000	0.850	--	1.000	0.850	--	0.944	
f_{Lpb}	1.000	1.000	--	1.000	1.000	--		1.000	--		1.000	--
f_{Rpb}	--	1.000	1.000	--	1.000	1.000	--	1.000	1.000	--	1.000	
Adjusted Satflow	1787	4880	1599	3540	4978	1631		1848	2901		1732	
Secondary Adjusted Satflow			--			--			--			--

CAPACITY AND LOS WORKSHEET

General Information

Project Description

Capacity Analysis

	EB			WB				NB			SB	
Lane Group	L	T	R	L	T	R		LT	R		LTR	
Adjusted Flow Rate	102	1103	127	122	992	87		97	113		139	
Satflow Rate	1787	4880	1599	3540	4978	1631		1848	2901		1732	
Lost Time	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	
Green Ratio	0.13	0.33	0.56	0.13	0.33	0.48		0.17	0.17		0.14	
Lane Group Capacity	238	1627	888	472	1659	779		308	484		250	
v/c Ratio	0.43	0.68	0.14	0.26	0.60	0.11		0.31	0.23		0.56	
Flow Ratio	0.06	0.23	0.08	0.03	0.20	0.05		0.05	0.04		0.08	
Critical Lane Group	Y	Y	N	N	N	N		Y	N		Y	
Sum Flow Ratios	0.42											
Lost Time/Cycle	20.00											
Critical v/c Ratio	0.53											

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB				NB			SB	
Lane Group	L	T	R	L	T	R		LT	R		LTR	
Adjusted Flow Rate	102	1103	127	122	992	87		97	113		139	
Lane Group Capacity	238	1627	888	472	1659	779		308	484		250	
v/c Ratio	0.43	0.68	0.14	0.26	0.60	0.11		0.31	0.23		0.56	
Green Ratio	0.13	0.33	0.56	0.13	0.33	0.48		0.17	0.17		0.14	
Uniform Delay d_1	35.8	25.8	9.7	35.0	25.0	13.0		33.0	32.5		35.8	
Delay Factor k	0.11	0.25	0.11	0.11	0.19	0.11		0.11	0.11		0.15	
Incremental Delay d_2	1.2	1.1	0.1	0.3	0.6	0.1		0.6	0.2		2.7	
PF Factor	1.000	1.000	1.000	0.897	0.667	0.390		1.000	1.000		1.000	
Control Delay	37.1	27.0	9.7	31.7	17.3	5.1		33.6	32.8		38.5	
Lane Group LOS	D	C	A	C	B	A		C	C		D	
Approach Delay	26.1			17.8			33.1			38.5		
Approach LOS	C			B			C			D		
Intersection Delay	23.8			Intersection LOS						C		

SUPPLEMENTAL UNIFORM DELAY WORKSHEET FOR LEFT TURNS FROM EXCLUSIVE LANES WITH PROTECTED AND PERMITTED PHASES

General Information

Project Description

v/c Ratio Computation

	EB	WB	NB	SB
Cycle Length, C (s)	*90.0*			
Prot. Phase Eff. Green Interval, g (s)				
Opposed Queue Eff. Green Interval, g_q (s)				
Unopposed green interval, g_u (s)				
Red Time, r(s)				
Arrival Rate, q_a (veh/s)				
Protected Phase Departure Rate, s_p (veh/s)				
Perm. Phase Departure Rate, s_s (veh/s)				
X_{perm}				
X_{prot} (N/A for Lagging Left-turns)				

Uniform Queue Size and Delay Computations

Queue at Start of Green Arrow, Q_a				
Queue at Start of Unsaturated Green, Q_u				
Residual Queue, Q_r				
Uniform Delay, d_1				

Uniform Queue Size and Delay Equations

	Case	Q_a	Q_u	Q_r	d_1
If X_{perm} <= 1.0 & X_{prot} <= 1.0	1	$q_a r$	$q_a g_q$	0	$[0.5/(q_a C)][rQ_a + Q_a^{2/(S_p - q_s)} + g_q Q_u + Q_u^{2/(S_s - q_a)}$
If X_{perm} <= 1.0 & X_{prot} > 1.0	2	$q_a r$	$Q_r + q_a g_q$	$Q_a - g(s_p - q_a)$	$[0.5/(q_a C)][rQ_a + g(Q_a + Q_r) + g_q (Q_r + Q_u) + Q_u^{2/(S_s - q_a)}$
If X_{perm} > 1.0 & X_{prot} <= 1.0	3	$Q_r + q_a r$	$q_a g_q$	$Q_u - g_u(s_s - q_a)$	$[0.5/(q_a C)][g_q Q_u + g_u(Q_a + Q_r) + r(Q_r + Q_a) + Q_a^{2/(S_p - q_a)}$
If X_{perm} <= 1.0 (lagging lefts)	4	0	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + Q_u^{2/(S_s - q_a)}$
If X_{perm} > 1.0 (lagging lefts)	5	$Q_u - g_u(s_s - q_a)$	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + g_u(Q_u + Q_a) + Q_a^{2/(S_p - q_a)}$

BACK-OF-QUEUE WORKSHEET

General Information

Project Description

Average Back of Queue

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Lane Group	L	T	R	L	T	R		LT	R		LTR	
Initial Queue/Lane	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	
Flow Rate/Lane	102	1103	127	122	992	87		97	113		139	
Satflow/Lane	1787	1791	1599	1823	1827	1631		1848	1639		1732	
Capacity/Lane	238	1627	888	472	1659	779		308	484		250	
Flow Ratio	0.1	0.2	0.1	0.0	0.2	0.1		0.1	0.0		0.1	
v/c Ratio	0.43	0.68	0.14	0.26	0.60	0.11		0.31	0.23		0.56	
I Factor	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
Arrival Type	3	3	3	5	5	5		3	3		3	
Platoon Ratio	1.00	1.00	1.00	1.67	1.67	1.67		1.00	1.00		1.00	
PF Factor	1.00	1.00	1.00	0.92	0.80	0.41		1.00	1.00		1.00	
Q_1	2.3	8.7	1.5	1.3	6.1	0.5		2.1	1.4		3.2	
k_B	0.3	0.5	0.6	0.3	0.5	0.6		0.3	0.3		0.3	
Q_2	0.2	1.0	0.1	0.1	0.7	0.1		0.2	0.1		0.4	
Q Average	2.6	9.7	1.6	1.4	6.8	0.6		2.3	1.5		3.6	

Percentile Back of Queue (95th percentile)

$f_{B\%}$	2.0	1.8	2.0	2.1	1.9	2.1		2.0	2.1		2.0	
BOQ, $Q_{\%}$	5.2	18.0	3.4	2.8	13.0	1.2		4.6	3.0		7.2	

Queue Storage Ratio

Q Spacing	25.0	25.0	25.0	25.0	25.0	25.0		25.0	25.0		25.0	
Q Storage	0	0	0	0	0	0		0	0		0	
Average R_Q												
95% $R_{Q\%}$												

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