



STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION
800 BAY ROAD
P.O. BOX 778
DOVER, DELAWARE 19903

SHAILEN P. BHATT
SECRETARY

August 8, 2011

Mr. David Culver
General Manager
New Castle County Department of Land Use
87 Reads Way
New Castle, DE 19720

Dear Mr. Culver:

The enclosed Traffic Operational Analysis (TOA) review letter for the **Newark Wawa-Kirkwood Highway** development has been completed under the responsible charge of a registered professional engineer whose firm is authorized to work in the State of Delaware. They have found the TOA to conform to DelDOT's Standards and Regulations for Subdivision Streets and State Highway Access and other accepted practices and procedures for such studies. DelDOT accepts this TOA review and concurs with the recommendations. We are providing it to you in fulfillment of our joint agreement regarding the review of TOA. If you have any questions concerning this letter or the attached review letter, please contact me at (302) 760-2109.

Sincerely,

T. William Brockenbrough, Jr.
County Coordinator

TWB:km
Enclosures
cc with enclosures:

Ms. Constance C. Holland, Office of State Planning Coordination
Ms. Tigist Zegeye, WILMAPCO
Mr. John R. Wichner, Traffic, Planning and Design
Mr. George Haggerty, New Castle County Department of Land Use
Mr. John Janowski, New Castle County Department of Land Use
Mr. Andrew Parker, McCormick Taylor
Mr. Mir Wahed, Johnson, Mirmiran, and Thompson



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Marco K. Boyce, Planning Supervisor, Statewide & Regional Planning
J. Marc Coté, Subdivision Engineer, Development Coordination
Joshua Schwartz, Project Engineer, Development Coordination
Troy E. Brestel, Project Engineer, Development Coordination

August 8, 2011

Mr. William Brockenbrough, Jr.
County Coordinator
DelDOT Division of Planning
P.O. Box 778
Dover, DE 19903

RE: Agreement No. 1529
Traffic Impact Study Services
Task No. 1A – Newark Wawa – Kirkwood Highway

Dear Mr. Brockenbrough,

McCormick Taylor has completed its review of the Traffic Operational Analysis (TOA) for the Newark Wawa - Kirkwood Highway development prepared by Traffic Planning and Design, Inc. (TPD), dated September 3, 2010. This review was assigned as Task Number 1A. TPD prepared the report in a manner generally consistent with DelDOT's *Standards and Regulations for Subdivision Streets and State Highway Access*.

The TOA evaluates the impacts of the Newark Wawa - Kirkwood Highway development, proposed to be located on the southwest corner of Kirkwood Highway (Delaware Route 2 / New Castle Road 11) and Harmony Road (New Castle Road 355), just outside of the City of Newark in New Castle County, Delaware. The proposed development would consist of a 4,770 square-foot convenience store with 16 vehicle fueling positions and another building with 4,620 square feet of retail space, to join an existing 7,894 square-foot retail building and a 2,737 square-foot fast-food restaurant with drive-through window, all on 3.66 acres of land. Currently, the 24,670 square-foot Kirkwood Fitness Center is also located on the site. The retail building and fast-food restaurant would remain but the Kirkwood Fitness Center would be removed as the site is redeveloped. There are four existing access points: two on Kirkwood Highway, one on Harmony Road, and one on Darwin Drive. The developer proposes to keep the access points on Harmony Road and Darwin Drive, and to combine the two access points on Kirkwood Highway into one. Construction is anticipated to be complete by 2012.

The land is currently zoned as CN (Neighborhood Commercial) within New Castle County, and the developer does not propose to change the zoning.

DelDOT currently has one relevant project in the study area. It is the *SR 2 and Upper Pike Creek Road* Project (State Contract No. 28-007-12). This project was generated by DelDOT's Hazard Elimination Program (HEP). The intersection of Kirkwood Highway and Upper Pike Creek Road (New Castle Road 295) / Old Harmony Road (New Castle Road 355F) was evaluated as part of Site C of the 2003 HEP, and the committee developed a recommendation to address safety concerns. The project will close the median on Kirkwood Highway at that intersection, and provide left-turn access to and from Upper Pike Creek Road and Old Harmony Road via u-turns at the signalized intersections of Green Valley Circle and Harmony Road. It

will also lengthen the westbound Kirkwood Highway left-turn lane at Harmony Road by 875 feet (to a total distance of nearly 1,500 feet including taper) and lengthen the eastbound Kirkwood Highway u-turn lane at Green Valley Circle by 250 feet (to a total distance of nearly 550 feet including taper). This project will affect the signal phasing at the intersection of Kirkwood Highway and Harmony Road by changing the Kirkwood Highway left-turn phasing from protected-permitted phasing to protected-only phasing. It will also widen the shoulder on westbound Kirkwood Highway at Green Valley Circle to better accommodate the increased volume of u-turns. Construction is scheduled to begin in the spring of 2011, and is anticipated to take approximately four months to complete.

Based on our review, we have the following comments and recommendations:

New Castle County has determined that the proposed development is a minor land plan and is therefore not subject to the Level of Service (LOS) requirements for a Traffic Impact Study (TIS) as stated in the Unified Development Code (UDC).

However, based on DeIDOT’s evaluation criteria, the stop-controlled minor street approaches at the following intersections exhibit LOS deficiencies without the implementation of physical roadway and/or traffic control improvements:

<i>Intersection</i>	<i>Existing Traffic Control</i>	<i>Situations for which deficiencies occur</i>
Harmony Road and Site Entrance	Unsignalized	2012 AM and PM with Wawa (with no rights out at site entrance on Kirkwood Highway – Case 4)
Kirkwood Highway and Darwin Drive	Unsignalized	2010 Existing PM and Saturday; 2012 PM and Saturday without Wawa; 2012 AM, PM, and Saturday with Wawa

In addition to the LOS deficiencies, there were other traffic operations and safety concerns related to the proposed development and its site entrances. Primarily, the concerns had to do with the potential for weaving near the site entrances, and with allowing left turns at the Harmony Road site entrance within the area of queued traffic on the northbound approach to the nearby signalized intersection at Kirkwood Highway. Based on our review of the TOA, consideration of many different combinations of site access and traffic circulation alternatives, additional analysis cases, and coordination with DeIDOT staff from the Development Coordination, Subdivision, and Traffic Sections, we have attempted to address the concerns to the extent it is feasible to do so without causing significant new problems.

Should the County choose to approve the proposed development, the following items should be incorporated into the site design and reflected on the record plan. All applicable agreements (i.e. letter agreements for off-site improvements and traffic signal agreements) should be executed prior to entrance plan approval for the proposed development.

1. The developer should close both existing right-in/right-out site entrances on eastbound Kirkwood Highway and construct one new right-in/right-out site entrance on eastbound Kirkwood Highway. The new site entrance should be located approximately halfway between the two existing site entrance locations. The proposed configuration is shown in the table below.

Approach	Current Configuration	Proposed Configuration
Northbound Site Entrance	Approach does not exist (would replace two existing site entrances)	One right-turn-only lane
Eastbound Kirkwood Highway	Two through lanes and one right-turn lane	Two through lanes and one right-turn lane
Westbound Kirkwood Highway	Two through lanes and one left-turn lane (for left-turns at Darwin Drive), separated from eastbound lanes by mountable curb median	Two through lanes and one left-turn lane (for left-turns at Darwin Drive), separated from eastbound lanes by mountable curb median

There is no specific turn-lane length for the eastbound right-turn lane because right turns from eastbound Kirkwood Highway into the site will be made from a continuous right-turn lane between Darwin Drive and Harmony Road. The developer should coordinate with DelDOT's Subdivision Section to determine striping details for that turn lane.

To further reinforce the northbound left-turn prohibition at this intersection, a No Left Turn sign (MUTCD R3-2) should be installed along the northbound site entrance approach.

2. The developer should improve the site entrance on Harmony Road. The proposed configuration is shown in the table below.

Approach	Current Configuration	Proposed Configuration
Northbound Harmony Road	One shared through/left-turn lane and two exclusive through lanes	One left-turn lane and three through lanes
Southbound Harmony Road	One shared through/right-turn lane	One through lane and one right-turn lane
Eastbound Site Entrance	One right-turn lane (operates as shared left/right-turn lane)	One right-turn-only lane

The northbound Harmony Road left-turn lane should have a minimum of a 100-foot storage length plus a 100-foot taper. The southbound right-turn lane should be striped to be as long as possible within the constraints of the short section of Harmony Road between Kirkwood Highway and the site entrance (approximately 200 feet between intersections). As such, the existing shoulder should be striped as a southbound right-turn lane to a length of approximately 100 feet, with no taper. The developer should

coordinate with DeIDOT’s Subdivision Section to determine the final lengths and striping details for these turn lanes.

The improvements at this intersection should also include adding one or more concrete islands and/or modifying the existing concrete median on Harmony Road to restrict eastbound left turns from being made at this intersection. To further reinforce the left-turn prohibition at this intersection, a No Left Turn sign (MUTCD R3-2) should be installed on the eastbound site entrance approach.

3. The developer should improve the intersection of Kirkwood Highway and Darwin Drive. The proposed configuration is shown in the table below.

Approach	Current Configuration	Proposed Configuration
Northbound Darwin Drive	One shared left/right-turn lane	One left-turn lane and one right-turn lane
Eastbound Kirkwood Highway	One u-turn lane, two through lanes, and one right-turn lane	One u-turn lane, two through lanes, and one right-turn lane
Westbound Kirkwood Highway	One left-turn lane and two through lanes	One left-turn lane and two through lanes

The existing Kirkwood Highway turn-lane lengths are adequate. Along westbound Kirkwood Highway, the existing No U-Turn sign (MUTCD R3-4) should remain.

The separate left-turn and right-turn lanes on northbound Darwin Drive should extend approximately 180 feet back to the site entrance on Darwin Drive, and this may require widening Darwin Drive to achieve adequate lane widths. The improvements should also include installing a concrete island to channelize the northbound Darwin Drive right-turn movement. This island will also serve to protect northbound Darwin Drive left-turn traffic by deterring eastbound Kirkwood Highway drivers from cutting across the end of Darwin Drive as they enter the eastbound deceleration lane for right turns into the site or onto Harmony Road. Furthermore, the developer should modify the curb radius for the northbound Darwin Drive right-turn movement, extend the Darwin Drive median closer to Kirkwood Highway by approximately 25 feet, and relocate the existing crosswalk across Darwin Drive so it connects with the concrete channelization islands.

The developer should coordinate with DeIDOT's Subdivision Section regarding final design details and plans for implementation of improvements at this intersection.

4. The developer should enter into an agreement with DeIDOT to fund a localized study evaluating traffic operations and safety aspects associated with the modified intersection of Kirkwood Highway and Darwin Drive. The study would be conducted at DeIDOT’s discretion, approximately 12 to 18 months after the proposed Wawa store has opened on this site (after the improvements described in Item No. 3 have been made). It would be conducted at the developer’s expense by a consultant of DeIDOT’s Planning Division.

The study would include, but not be limited to, up-to-date traffic counts, analyses of delays, LOS, and queuing, and a safety evaluation including up-to-date crash data analysis. The study would also require public outreach to the Area Legislators and nearby Civic Association(s). The language of the agreement and the detailed scope of the study should be further discussed with DeIDOT and approved as part of the plan approval process.

After the Wawa store has opened, DeIDOT will coordinate with the developer before and during this traffic operations and safety study, and with regard to the study's findings. The developer would then be responsible to fund and implement any intersection improvements that DeIDOT requires as a result of the localized study.

5. The developer should enter into an agreement with DeIDOT to contribute towards improvements as part of DeIDOT's *SR 2 and Upper Pike Creek Road* Project (State Contract No. 28-007-12). In the vicinity of the site, the *SR 2 and Upper Pike Creek Road* Project includes extending the westbound Kirkwood Highway left-turn lane at Harmony Road. It also modifies the signal phasing at the intersection of Kirkwood Highway and Harmony Road by changing the westbound left-turn phase from protected-permitted phasing to protected-only phasing. The developer should coordinate with DeIDOT regarding the implementation of, and fair contribution towards, this project.
6. It is anticipated that a possible result of the future localized traffic study described in Item No. 4 may be a recommendation to eliminate the left-turn movement from northbound Darwin Drive to westbound Kirkwood Highway. Should this movement be eliminated, it is anticipated that the volume of eastbound u-turns on Kirkwood Highway at Harmony Road would increase. If this does occur, the developer should lengthen the eastbound Kirkwood Highway u-turn lane at Harmony Road by a distance to be determined based on traffic analyses to be conducted at that time. At that same time, the developer should evaluate the eastbound Kirkwood Highway u-turn maneuver using turning templates to determine if the shoulder on westbound Kirkwood Highway can adequately accommodate u-turns by single-unit trucks. If it is determined that the existing shoulder along westbound Kirkwood Highway is not wide enough to handle eastbound u-turns, the developer should widen the shoulder and make associated improvements as needed.

The developer should coordinate with DeIDOT's Subdivision Section to determine final turn-lane lengths, signing and striping details, and u-turn maneuver evaluation requirements.

7. The developer should enter into a traffic signal agreement with DeIDOT for the intersection of Kirkwood Highway and Harmony Road. The agreement will cover the signal adjustments required by the physical improvements noted in Item Nos. 5, 6, and 8. The agreement should include pedestrian signals, crosswalks, interconnection, and ITS

equipment such as CCTV and/or Red Light Enforcement cameras at DelDOT's discretion.

8. The following bicycle, pedestrian, and transit improvements should be included:
 - a. Along eastbound Kirkwood Highway between Darwin Drive and Harmony Road, a minimum of a five-foot bicycle lane should be dedicated and striped with appropriate markings for bicyclists between the right-most through lane and the right-turn lane in order to facilitate safe and unimpeded bicycle travel. Although widening will be needed to accommodate the bicycle lane, which would involve moving back the curbline along the Kirkwood Highway site frontage, the design should hold the location of the existing drainage inlet on the curbline on the southwest corner of the intersection of Kirkwood Highway and Harmony Road.
 - b. Where the right-turn lane is added to southbound Harmony Road at the site entrance, a minimum of a five-foot bicycle lane should be dedicated and striped with appropriate markings for bicyclists through the turn lane in order to facilitate safe and unimpeded bicycle travel.
 - c. Appropriate bicycle symbols, directional arrows, striping (including stop bars), and signing should be included along bicycle facilities and right-turn lanes within the project limits.
 - d. Utility covers should be flush with the pavement.
 - e. Bike parking should be provided near building entrances within this development.
 - f. The existing sidewalk along the Kirkwood Highway frontage should remain (or be reconstructed as needed due to curbline relocation). Where the existing right-in/right-out entrance driveways are being closed (and no sidewalk currently exists), the former driveways should be filled in to match the surrounding landscape and a minimum of a five-foot wide sidewalk (with a minimum of a five-foot buffer from the roadway) that meets current AASHTO and ADA standards should be constructed. These new sections of sidewalk should connect to the adjacent existing or reconstructed sidewalks along the Kirkwood Highway frontage. As such, there should be continuous sidewalk along the Kirkwood Highway frontage between Darwin Drive and Harmony Road, with crosswalks across the proposed new right-in/right-out entrance driveway.
 - g. ADA compliant curb ramps and marked crosswalks should be provided at all pedestrian crossings, including across internal roads and across all site entrances. Type 3 curb ramps are discouraged.
 - h. Internal sidewalks for pedestrian safety and to promote walking as a viable transportation alternative should be constructed within the development. We recommend that these sidewalks each be a minimum of seven feet wide (with a minimum of a five-foot buffer from the roadway) and should meet current AASHTO and ADA standards. These internal sidewalks should connect the building entrances to the frontage sidewalks on Kirkwood Highway and Darwin Drive.

- i. Where internal sidewalks are located alongside of parking spaces, a buffer or bollards should be added to eliminate vehicular overhang onto the sidewalk.
- j. The developer should coordinate with the Delaware Transit Corporation regarding the possibility of adding other transit services and facilities at this location. Internal sidewalks should be connected to any new transit facilities and parking facilities for bicyclists should be included.

Improvements in this TOA may be considered “significant” under DelDOT’s *Work Zone Safety and Mobility Procedures and Guidelines*. These guidelines are available on DelDOT’s website at http://www.deldot.gov/information/pubs_forms/manuals/de_mutcd/index.shtml. For any additional information regarding the work zone impact and mitigation procedures during construction please contact Mr. Adam Weiser of DelDOT’s Traffic Section. Mr. Weiser can be reached at (302) 659-4073 or by email at Adam.Weiser@state.de.us.

Please note that this review generally focuses on capacity and level of service issues; additional safety and operational issues will be further addressed through DelDOT’s subdivision review process.

Additional details on our review of this TOA are attached. Please contact me at (302) 738-0203 or through e-mail at ajparker@mtmail.biz if you have any questions concerning this review.

Sincerely,

McCormick Taylor, Inc.



Andrew J. Parker, P.E., PTOE
Project Manager

Enclosure

General Information

Report date: September 3, 2010

Prepared by: Traffic Planning and Design, Inc.

Prepared for: Joyce Realty Corporation

Tax parcels: 08-054.40-143, 08-054.40-145, and 08-054.40-146

Generally consistent with DelDOT's *Standards and Regulations for Subdivision Streets and State Highway Access*: Yes

Project Description and Background

Description: The proposed development would consist of a 4,770 square-foot convenience store with 16 vehicle fueling positions and another building with 4,620 square feet of retail space. Currently, a 7,894 square-foot retail building, a 2,737 square-foot fast-food restaurant with drive-through window, and the 24,670 square-foot Kirkwood Fitness Center are located on the site. The retail building and fast-food restaurant would remain but the Kirkwood Fitness Center would be removed as the site is redeveloped.

Location: Newark Wawa - Kirkwood Highway is proposed to be located on the southwest corner of Kirkwood Highway (Delaware Route 2 / New Castle Road 11) and Harmony Road (New Castle Road 355), just outside of the City of Newark in New Castle County, Delaware. A site location map is included on Page 9.

Amount of land to be developed: the three tax parcels for this site cover a total of 3.66 acres

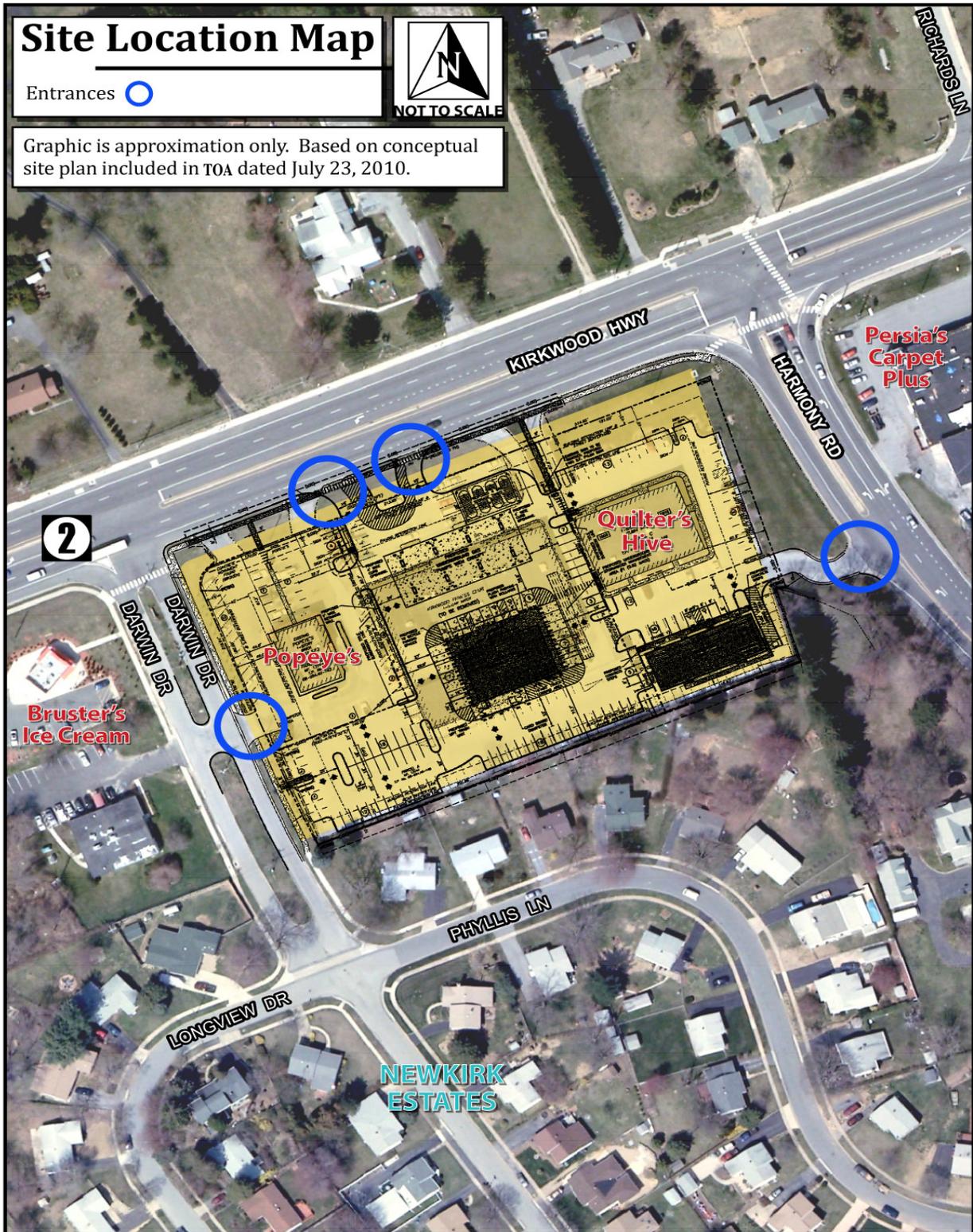
Land use approval(s) needed: Subdivision approval. The land is currently zoned as CN (Neighborhood Commercial) within New Castle County, and the developer does not propose to change the zoning.

Proposed completion date: 2012

Proposed access locations: The site currently has four existing access points: two on Kirkwood Highway, one on Harmony Road, and one on Darwin Drive. The developer proposes to keep the access points on Harmony Road and Darwin Drive, and to combine the two access points on Kirkwood Highway into one.

Daily Traffic Volumes:

- 2009 Average Annual Daily Traffic on Kirkwood Highway: 38,270 vpd
- 2009 Average Annual Daily Traffic on Harmony Road: 19,833 vpd



Livable Delaware

(Source: Delaware Strategies for State Policies and Spending, July 2004)

Location with respect to the Strategies for State Policies and Spending Map of Delaware:

The proposed Newark Wawa - Kirkwood Highway is located within Investment Level 1.

Investment Level 1

These areas are often municipalities or urban/urbanizing places where density is generally higher than in surrounding areas. Areas classified as Investment Level 1 are population centers built around a traditional central business district, which offers a wide range of opportunities for employment, shopping and recreation. Investment Level 1 Areas are considered to drive Delaware's economy and therefore reinvestment and redevelopment are encouraged.

In Investment Level 1 Areas, state investments and policies should support and encourage a wide range of uses and densities, promote other transportation options, foster efficient use of existing public and private investments, and enhance community identity and integrity. Typical transportation projects included new or expanded facilities and services for all modes of transportation, including public transportation facilities and services. Projects will also include those that manage traffic flow and congestion, support economic development and redevelopment efforts, and encourage connections between communities and the use of local streets for local trips.

Proposed Development's Compatibility with Livable Delaware:

The proposed Newark Wawa - Kirkwood Highway development falls within Investment Level 1 and is to be developed as a convenience store / gas station plus additional retail space. Livable Delaware generally encourages development in Investment Level 1 areas, and the proposed development does not conflict with the character of those areas. It is therefore concluded that the proposed development generally complies with the policies stated in the 2004 update of the Livable Delaware "Strategies for State Policies and Spending."

Comprehensive Plan

New Castle County Comprehensive Plan: The proposed Newark Wawa - Kirkwood Highway is located in an area with future land use designated as Community Redevelopment, which calls for a mix of housing types, densities, and businesses that fit well into the surrounding community.

Additionally, the parcel is currently zoned CN (Neighborhood Commercial), and the developer does not plan to rezone the parcel. According to Section 40.02.231 of the New Castle County Unified Development Code (UDC), characteristics of CN zoning include:

- This district has a suburban character.
- The scale and intensity of the development is regulated to ensure that uses primarily serve the surrounding residential neighborhoods. Roof design and landscaping are intended to reinforce the compatibility of these uses with the neighborhoods.

- Size and spacing of this district is regulated to ensure this district does not promote strip commercial development that serves highway traffic or regional uses.

Proposed Development's Compatibility with Comprehensive Plan: The proposed Newark Wawa - Kirkwood Highway is planned as a convenience store / gas station plus additional retail space. It is generally compatible with the New Castle County Comprehensive Plan, in terms of both the future land use designation of Community Redevelopment and of CN zoning, as long as it adheres to the CN zoning characteristics listed above.

Transportation Analysis Zones (TAZ)

Transportation Analysis Zones (TAZ) where development would be located: 237

TAZ Boundaries:



Current employment estimate for TAZ: 513 jobs in 2005

Future employment estimate for TAZ: 511 jobs in 2030

Current population estimate for TAZ: 3,549 people in 2005

Future population estimate for TAZ: 3,721 people in 2030

Current household estimate for TAZ: 1,277 houses in 2005

Future household estimate for TAZ: 1,459 houses in 2030

Relevant committed developments in TAZ: None

Would the addition of committed developments to current estimates exceed future projections: N/A

Would the addition of committed developments and the proposed development to current estimates exceed future projections: No for population and households, yes for employment

Relevant Projects in the DelDOT Capital Transportation Program (FY 2010 – FY 2015)

DelDOT currently has one relevant project in the study area. It is the *SR 2 and Upper Pike Creek Road* Project (State Contract No. 28-007-12). This project was generated by DelDOT's Hazard Elimination Program (HEP). The intersection of Kirkwood Highway and Upper Pike Creek Road (New Castle Road 295) / Old Harmony Road (New Castle Road 355F) was evaluated as part of Site C of the 2003 HEP, and the committee developed a recommendation to address safety concerns. The project will close the median on Kirkwood Highway at that intersection, and provide left-turn access to and from Upper Pike Creek Road and Old Harmony Road via u-turns at the signalized intersections of Green Valley Circle and Harmony Road. It will also lengthen the westbound Kirkwood Highway left-turn lane at Harmony Road by 875 feet (to a total distance of nearly 1,500 feet including taper) and lengthen the eastbound Kirkwood Highway u-turn lane at Green Valley Circle by 250 feet (to a total distance of nearly 550 feet including taper). This project will affect the signal phasing at the intersection of Kirkwood Highway and Harmony Road by changing the Kirkwood Highway left-turn phasing from protected-permitted phasing to protected-only phasing. It will also widen the shoulder on westbound Kirkwood Highway at Green Valley Circle to better accommodate the increased volume of u-turns. Construction is scheduled to begin in the spring of 2011, and is anticipated to take approximately four months to complete.

Trip Generation

Trip generation for the proposed development was computed using comparable land uses and equations or rates contained in Trip Generation, Eighth Edition, published by the Institute of Transportation Engineers (ITE). Additionally, rates published in the article "Trip-Generation for Convenience Stores" (*ITE Journal*, August 2001) were also used. The following land use was utilized to estimate the amount of new traffic generated for this development:

- 4,770 square-foot convenience store with 16 fueling stations (ITE Land Use Code 853, with rates from *ITE Journal* article)
- 4,620 square-foot retail space (ITE Land Use Code 820)

Table 1
NEWARK WAWA - KIRKWOOD HIGHWAY PEAK HOUR TRIP GENERATION

Land Use	AM Peak Hour			PM Peak Hour			Saturday Mid-day		
	In	Out	Total	In	Out	Total	In	Out	Total
4,770 square foot convenience store with gas pumps	146	146	292	133	133	266	133	133	266
Pass-by Trips	111	111	222	101	101	202	101	101	202
Net External Trips	35	35	70	32	32	64	32	32	64
4,620 square feet of retail	3	2	5	8	9	17	12	11	23
Pass-by Trips	-	-	-	3	3	6	3	3	6
Net External Trips	3	2	5	5	6	11	9	8	17
Subtotal External Trips	38	37	75	37	38	75	41	40	81
Redevelopment Credit for Fitness Center	18	22	40	59	44	103	36	45	81
TOTAL NEW TRIPS	20	15	35	-22*	-6*	-28*	5	-5*	0

* For any net losses of new trips, the TOA did not remove vehicles from the roadway network. Instead, the TOA assumed a trip generation of zero new trips.

Table 2
NEWARK WAWA - KIRKWOOD HIGHWAY DAILY TRIP GENERATION

Land Use	Weekday ADT			Saturday ADT		
	In	Out	Total	In	Out	Total
4,770 square foot convenience store with gas pumps	2017	2017	4034	3454	3454	6908
4,620 square feet of retail	99	99	198	115	115	230
TOTAL TRIPS	2116	2116	4232	3569	3569	7138

Overview of TOA

Intersections examined:

- 1) Kirkwood Highway & East Site Entrance
- 2) Kirkwood Highway & West Site Entrance
- 3) Harmony Road & Site Entrance
- 4) Darwin Drive & Site Entrance
- 5) Kirkwood Highway & Darwin Drive
- 6) Kirkwood Highway & Harmony Road

Conditions examined:

- 1) 2010 existing conditions (Case 1)
- 2) 2012 without Newark Wawa - Kirkwood Highway (Case 2)
- 3) 2012 with Newark Wawa - Kirkwood Highway, with one right-in/right-out access on Kirkwood Highway (Case 3)
- 4) 2012 with Newark Wawa - Kirkwood Highway, with one rights-in only access (no rights out) on Kirkwood Highway (Case 4)
- 5) 2012 with Newark Wawa – Kirkwood Highway, with one right-in/right-out access on Kirkwood Highway, a right-in/right-out access on Harmony Road, and a right-in/right-out/left-in configuration (no lefts out) at the intersection of Darwin Drive and Kirkwood Highway (Case 5*)
- 6) 2012 with Newark Wawa – Kirkwood Highway, with one right-in/right-out access on Kirkwood Highway, a right-in/right-out access on Harmony Road, and all movements allowed at the intersection of Darwin Drive and Kirkwood Highway (Case 6*)

* Note: Cases 5 and 6 were not required for the TOA, and the TOA did not evaluate them. These cases were only evaluated by McCormick Taylor during our review of the TOA, based on traffic operations and site access concerns that arose during our evaluations of Cases 3 and 4.

Peak hours evaluated: Weekday morning and evening, and Saturday mid-day peak hours

Committed developments considered:

There are no committed developments.

Intersection Descriptions

1) Kirkwood Highway & East Site Entrance

Type of Control: two-way stop-controlled (right-in/right-out T-intersection)

Northbound approach: (East Site Entrance) one right-turn-only lane, stop controlled (no actual stop sign present)

Eastbound approach: (Kirkwood Highway) two through lanes and one right-turn lane

Westbound approach: (Kirkwood Highway) two through lanes and one left-turn lane (for left-turns at Darwin Drive), separated from eastbound lanes by mountable curb median

2) Kirkwood Highway & West Site Entrance

Type of Control: two-way stop-controlled (right-in/right-out T-intersection)

Northbound approach: (West Site Entrance) one right-turn-only lane, stop controlled (no actual stop sign present)

Eastbound approach: (Kirkwood Highway) two through lanes and one right-turn lane

Westbound approach: (Kirkwood Highway) two through lanes and one left-turn lane (for left-turns at Darwin Drive), separated from eastbound lanes by mountable curb median

- 3) **Harmony Road & Site Entrance**
Type of Control: two-way stop-controlled (T-intersection)
Northbound approach: (Harmony Road) one shared through/left-turn lane and two exclusive through lanes (these three lanes are actually marked as two left-turn lanes and one right-turn lane for the nearby downstream intersection with Kirkwood Highway)
Southbound approach: (Harmony Road) one shared through/right-turn lane
Eastbound approach: (Site Entrance) one right-turn-only lane, stop controlled (there is a NO LEFT TURN sign posted, but the traffic counts show that a small number of drivers make lefts out during each peak hour, so it is treated as a shared left/right turn-lane – except in Cases 5 and 6)

- 4) **Darwin Drive & Site Entrance**
Type of Control: two-way stop-controlled
Northbound approach: (Darwin Drive) one shared left/through/right-turn lane
Southbound approach: (Darwin Drive) one shared left/through/right-turn lane
Eastbound approach: (driveway for Darwin Professional Center; small office building) one shared left/through/right-turn lane, stop controlled (no actual stop sign present)
Westbound approach: (Site Entrance) one shared left/through/right-turn lane, stop controlled (no actual stop sign present)

- 5) **Kirkwood Highway & Darwin Drive**
Type of Control: two-way stop-controlled (T-intersection)
Northbound approach: (Darwin Drive) one shared left/right-turn lane, stop controlled
Eastbound approach: (Kirkwood Highway) one u-turn lane, two through lanes, and one right-turn lane
Westbound approach: (Kirkwood Highway) one left-turn lane and two through lanes

- 6) **Kirkwood Highway & Harmony Road**
Type of Control: signalized three-leg intersection
Northbound approach: (Harmony Road) two left-turn lanes and one right-turn lane
Eastbound approach: (Kirkwood Highway) one u-turn lane, two through lanes, and one right-turn lane
Westbound approach: (Kirkwood Highway) one left-turn lane and two through lanes
Note: This intersection is equipped with Red Light Enforcement cameras on the Kirkwood Highway approaches.

Safety Evaluation

Crash Data: Crash data was obtained for the years of 2007 through 2009 for the intersections in this study. The majority of crashes occurred at the signalized intersection of Kirkwood Highway & Harmony Road (or on its immediate approaches), where there were a total of 69 crashes over three years. Most of the crashes in that location were rear-end collisions or angle crashes (nearly 30 crashes each). There were also 15 crashes at the intersection of Kirkwood Highway & Darwin Drive. No fatal crashes were reported in the study area during this three-year period.

Sight Distance: Kirkwood Highway and Darwin Drive are both straight and generally flat roadways in this area, with adequate sight distance. The only concern on Darwin Drive is that it is a boulevard-type roadway with a 16-foot wide grass median with some landscaping grasses and trees and a large brick and wood neighborhood entrance sign, which can partially obscure drivers' views. Harmony Road has a slight horizontal curve and is on an uphill grade going from south to north (approaching Kirkwood Highway). There are also older trees nearby along the side of the road, and the nearby ground sits higher than the roadway surface, which can limit sight distance, especially for drivers exiting the site.

Transit, Pedestrian, and Bicycle Facilities

Existing transit service: The Delaware Transit Corporation (DTC) currently operates two bus routes near the proposed Newark Wawa - Kirkwood Highway development. DART Route 6 travels along Kirkwood Highway directly in front of the site, providing service between the Newark Transit Hub, along Kirkwood Highway to Price's Corner, and to the Wilmington Amtrak Station. It makes 40 round trips each weekday, along with 25 round trips each Saturday and 8 round trips each Sunday. There are signed bus stops along eastbound Kirkwood Highway approximately 350 feet west of Darwin Drive and on the far side of Harmony Road, and along westbound Kirkwood Highway at Harmony Road.

Planned transit service: Matthew Bressler of Traffic Planning & Design contacted Mr. Ivan Mitchell, a Service Development Planner for the DTC, on July 7, 2010 to determine whether DTC has any plans to extend the existing transit system in the vicinity of the development. Mr. Mitchell replied on July 22, 2010, stating DART Route 6 serves the property with two stops along eastbound Kirkwood Highway near Darwin Drive and Harmony Road. DTC determined that these stops can remain at their current locations and no upgrades will be required.

Existing bicycle and pedestrian facilities: According to the *New Castle County Bicycle Map*, Kirkwood Highway and Harmony Road are each designated as having above average cycling conditions with high traffic volumes (greater than 10,000 ADT). The site is also in close proximity to Delaware Bicycle Route 1. There are currently sidewalks in place along both sides of Kirkwood Highway and both sides of Darwin Drive through the project area. There are no sidewalks along Harmony Road. There are crosswalks at the intersections of Kirkwood Highway & Darwin Drive and Kirkwood Highway & Harmony Road. There are no bicycle lanes within the project area.

Planned bicycle and pedestrian facilities: DelDOT's Bicycle and Pedestrian Facilities Team indicated, in an email dated July 21, 2010 from Anthony Aglio to Matthew Bressler of Traffic Planning & Design, that the following bicycle and pedestrian facilities should be required. If the development does occur, the following requests should be incorporated into the project to facilitate bicycle and pedestrian transportation:

- a. Sidewalk should be built to connect the site with the existing sidewalk along Darwin Drive.
- b. If a turn lane is being added, an additional five feet of pavement will be needed for bicyclists. If no turn lane is being marked, then additional width is not needed.

Previous Comments

All comments from DelDOT's Scoping Letter, Traffic Count Review, Revised Traffic Count Review, and Preliminary TOA Review were addressed in the Final TOA submission.

General HCS Analysis Comments

(see table footnotes on the following pages for specific comments)

- 1) For unsignalized intersections, the TOA applied heavy vehicle factors (HV) by approach, whereas McCormick Taylor applied HV by movement. For signalized intersections, the TOA applied HV sometimes by approach and sometimes by movement, whereas McCormick Taylor applied HV by lane group. For future conditions, the TOA assumed future HV to be the same as existing HV. McCormick Taylor assumed future HV to be the same as existing HV unless significant changes in volumes are expected. In those cases, McCormick Taylor assumed a future HV of either existing HV or 3%, whichever was greater.
- 2) For existing conditions, the TOA applied peak hour factors (PHF) by lane group (based on the traffic count data), and generally used these existing PHF for future conditions as well. However, the TOA sometimes assumed a future PHF of 0.88 at unsignalized intersections if the lane group volume increased from the existing volume and if the existing PHF was lower than 0.88. McCormick Taylor determined an overall intersection PHF for each intersection and typically applied those PHFs to existing and future conditions, with a few minor adjustments where significant changes in volumes are expected, in which case an appropriate PHF was determined based on overall intersection volume.
- 3) The HCS analyses included in the TOA did not always reflect the lane widths observed in the field by McCormick Taylor. McCormick Taylor's HCS analyses incorporated the field-measured lane widths.
- 4) The TOA and McCormick Taylor used different cycle lengths and/or signal timing parameters when analyzing the signalized intersections in some cases.
- 5) The TOA included percent grade in their analysis. McCormick Taylor could not confirm the percent grade and did not take it into consideration.
- 6) The TOA input existing Right-Turn-on-Red (RTOR) volumes for signalized intersection analyses. McCormick Taylor input no RTOR volumes, but did analyze right-turn movements as overlapping the protected left-turn phases.

Table 3
PEAK HOUR LEVELS OF SERVICE (LOS)
based on Traffic Operational Analysis for Newark Wawa - Kirkwood Highway
Report dated September 3, 2010
Prepared by Traffic Planning and Design, Inc.

Unsignalized Intersection ¹ Two-Way Stop Control (T-intersection)	LOS per TOA			LOS per McCormick Taylor		
	Weekday AM	Weekday PM	Saturday Mid-day	Weekday AM	Weekday PM	Saturday Mid-day
Kirkwood Highway & East Site Entrance						
2010 Existing (Case 1)						
Northbound Site Entrance – Right	N/A	N/A	N/A	B (13.3)	B (13.5)	B (13.1)
2012 without Wawa (Case 2)						
Northbound Site Entrance – Right	N/A	N/A	N/A	B (13.6)	C (13.9)	B (13.4)

Unsignalized Intersection ¹ Two-Way Stop Control (T-intersection)	LOS per TOA			LOS per McCormick Taylor		
	Weekday AM	Weekday PM	Saturday Mid-day	Weekday AM	Weekday PM	Saturday Mid-day
Kirkwood Highway & West Site Entrance						
2010 Existing (Case 1)						
Northbound Site Entrance – Right	N/A	N/A	N/A	B (13.4)	B (14.3)	B (13.5)
2012 without Wawa (Case 2)						
Northbound Site Entrance – Right	N/A	N/A	N/A	B (13.7)	B (14.7)	B (13.8)

Unsignalized Intersection ¹ Two-Way Stop Control (T-intersection)	LOS per TOA			LOS per McCormick Taylor		
	Weekday AM	Weekday PM	Saturday Mid-day	Weekday AM	Weekday PM	Saturday Mid-day
Kirkwood Highway & Proposed Combined Site Entrance						
2012 with Wawa (Case 3)						
Northbound Site Entrance – Right	A (9.9)	B (10.1)	B (10.4)	B (14.4)	C (15.3)	B (14.5)
2012 with Wawa (Case 5)						
Northbound Site Entrance – Right	N/A	N/A	N/A	C (16.3)	C (17.9)	C (16.5)
2012 with Wawa (Case 6)						
Northbound Site Entrance – Right	N/A	N/A	N/A	B (14.8)	C (16.0)	B (14.9)

¹ For unsignalized analyses, the numbers in parentheses following levels of service are average delay per vehicle, measured in seconds. For signalized analyses, those numbers are X-critical, a composite volume-to-capacity ratio.

Table 4
PEAK HOUR LEVELS OF SERVICE (LOS)
based on Traffic Operational Analysis for Newark Wawa - Kirkwood Highway
Report dated September 3, 2010
Prepared by Traffic Planning and Design, Inc.

Unsignalized Intersection ² Two-Way Stop Control (T-intersection)	LOS per TOA			LOS per McCormick Taylor		
	Weekday AM	Weekday PM	Saturday Mid-day	Weekday AM	Weekday PM	Saturday Mid-day
Harmony Road & Site Entrance						
2010 Existing (Case 1)						
Northbound Harmony Road – Left	B (10.1)	B (10.2)	A (9.5)	A (9.7)	A (9.6)	A (9.0)
Eastbound Site Entrance	C (16.7)	C (19.4)	B (14.3)	C (16.7)	C (18.4)	B (14.3)
2012 without Wawa (Case 2)						
Northbound Harmony Road – Left	B (10.3)	B (10.4)	A (9.5)	A (9.8)	A (9.8)	A (9.0)
Eastbound Site Entrance	C (17.5)	C (20.8)	B (14.3)	C (17.3)	C (19.3)	B (14.4)
2012 with Wawa (Case 3)						
Northbound Harmony Road – Left	B (10.8)	B (10.8)	A (9.8)	B (10.4)	B (10.2)	A (9.4)
Eastbound Site Entrance	C (24.4)	D (32.1)	C (16.9)	D (27.1)	D (32.0)	C (18.7)
2012 with Wawa (Case 4)						
Northbound Harmony Road – Left	B (10.8)	B (10.8)	A (9.8)	B (10.4)	B (10.2)	A (9.4)
Eastbound Site Entrance	F (51.0)	F (114.4)	D (25.5)	F (63.0) ³	F (99.7) ⁴	D (31.0)
2012 with Wawa (Case 5)						
Eastbound Site Entrance – Right	N/A	N/A	N/A	C (18.3)	C (15.8)	B (13.5)
2012 with Wawa (Case 6)						
Eastbound Site Entrance – Right	N/A	N/A	N/A	C (18.3)	C (15.8)	B (13.5)

² For unsignalized analyses, the numbers in parentheses following levels of service are average delay per vehicle, measured in seconds. For signalized analyses, those numbers are X-critical, a composite volume-to-capacity ratio.

³ The 95th percentile queue length for the eastbound Site Entrance approach during the Case 4 AM peak hour is approximately 5 vehicles.

⁴ The 95th percentile queue length for the eastbound Site Entrance approach during the Case 4 PM peak hour is approximately 6 vehicles.

Table 5
PEAK HOUR LEVELS OF SERVICE (LOS)
based on Traffic Operational Analysis for Newark Wawa - Kirkwood Highway
Report dated September 3, 2010
Prepared by Traffic Planning and Design, Inc.

Unsignalized Intersection ⁵ Two-Way Stop Control	LOS per TOA			LOS per McCormick Taylor		
	Weekday AM	Weekday PM	Saturday Mid-day	Weekday AM	Weekday PM	Saturday Mid-day
Darwin Drive & Site Entrance						
2010 Existing (Case 1)						
Northbound Darwin Drive – Left	A (7.3)	A (7.4)	A (7.3)	A (7.2)	A (7.3)	A (7.3)
Southbound Darwin Drive – Left	A (7.4)	A (7.4)	A (7.4)	A (7.3)	A (7.4)	A (7.4)
Eastbound Driveway	A (9.4)	B (10.3)	B (10.4)	A (9.3)	B (10.0+)	B (10.3)
Westbound Site Entrance	A (9.3)	A (9.6)	A (9.0)	A (9.2)	A (9.3)	A (8.9)
2012 without Wawa (Case 2)						
Northbound Darwin Drive – Left	A (7.3)	A (7.4)	A (7.3)	A (7.2)	A (7.3)	A (7.3)
Southbound Darwin Drive – Left	A (7.4)	A (7.4)	A (7.4)	A (7.3)	A (7.4)	A (7.4)
Eastbound Driveway	A (9.4)	B (10.3)	B (10.4)	A (9.3)	B (10.0+)	B (10.3)
Westbound Site Entrance	A (9.3)	A (9.6)	A (9.0)	A (9.2)	A (9.3)	A (8.9)
2012 with Wawa (Case 3)						
Northbound Darwin Drive – Left	A (7.3)	A (7.4)	A (7.3)	A (7.2)	A (7.3)	A (7.3)
Southbound Darwin Drive – Left	A (7.4)	A (7.4)	A (7.4)	A (7.3)	A (7.4)	A (7.4)
Eastbound Driveway	A (9.6)	B (10.4)	B (10.4)	A (9.6)	B (10.1)	B (10.3)
Westbound Site Entrance	A (8.8)	A (9.4)	A (9.0)	A (8.8)	A (9.2)	A (8.9)
2012 with Wawa (Case 4)						
Northbound Darwin Drive – Left	A (7.3)	A (7.4)	A (7.4)	A (7.2)	A (7.3)	A (7.3)
Southbound Darwin Drive – Left	A (7.4)	A (7.4)	A (7.4)	A (7.3)	A (7.4)	A (7.4)
Eastbound Driveway	A (9.7)	B (10.4)	B (10.4)	A (9.6)	B (10.1)	B (10.3)
Westbound Site Entrance	A (8.8)	A (9.4)	A (9.0)	A (8.8)	A (9.2)	A (8.9)
2012 with Wawa (Case 5)						
Northbound Darwin Drive – Left	N/A	N/A	N/A	A (7.2)	A (7.3)	A (7.3)
Southbound Darwin Drive – Left	N/A	N/A	N/A	A (7.4)	A (7.5)	A (7.5)
Eastbound Driveway	N/A	N/A	N/A	A (9.9)	B (10.8)	B (11.1)
Westbound Site Entrance	N/A	N/A	N/A	A (10.0-)	B (10.6)	A (9.5)
2012 with Wawa (Case 6)						
Northbound Darwin Drive – Left	N/A	N/A	N/A	A (7.2)	A (7.3)	A (7.3)
Southbound Darwin Drive – Left	N/A	N/A	N/A	A (7.4)	A (7.5)	A (7.5)
Eastbound Driveway	N/A	N/A	N/A	B (10.2)	B (11.0)	B (11.1)
Westbound Site Entrance	N/A	N/A	N/A	A (8.9)	A (9.5)	A (9.0)

⁵ For unsignalized analyses, the numbers in parentheses following levels of service are average delay per vehicle, measured in seconds. For signalized analyses, those numbers are X-critical, a composite volume-to-capacity ratio.

Table 6
PEAK HOUR LEVELS OF SERVICE (LOS)
based on Traffic Operational Analysis for Newark Wawa - Kirkwood Highway
Report dated September 3, 2010
Prepared by Traffic Planning and Design, Inc.

Unsignalized Intersection ⁶ Two-Way Stop Control (T-intersection)	LOS per TOA			LOS per McCormick Taylor		
	Weekday AM	Weekday PM	Saturday Mid-day	Weekday AM	Weekday PM	Saturday Mid-day
Kirkwood Highway & Darwin Drive						
2010 Existing (Case 1)						
Northbound Darwin Drive	C (23.0)	E (35.2)	F (78.9)	D (30.3)	F (59.9)	F (78.3)
Eastbound Kirkwood Highway – u-turns	A (9.5)	A (10.0-)	B (10.3)	A (9.7)	B (11.9)	B (11.2)
Westbound Kirkwood Highway – Left	B (11.0)	B (11.7)	B (11.8)	B (12.6)	B (13.0)	B (13.3)
2012 without Wawa (Case 2)						
Northbound Darwin Drive	D (26.0)	F (52.7)	F (105.3)	D (33.9)	F (78.9)	F (104.8)
Eastbound Kirkwood Highway – u-turns	A (9.6)	B (10.4)	B (10.4)	A (9.8)	B (12.3)	B (11.5)
Westbound Kirkwood Highway – Left	B (11.3)	B (12.0)	B (12.2)	B (13.1)	B (13.5)	B (14.2)
2012 with Wawa (Case 3)						
Northbound Darwin Drive	F (182.0)	F (256.6)	F (440.1)	F (190.3) ⁷	F (381.0) ⁸	F (404.6) ⁹
Eastbound Kirkwood Highway – u-turns	A (9.5)	B (10.2)	B (10.3)	A (9.7)	B (12.1)	B (11.3)
Westbound Kirkwood Highway – Left	B (11.4)	B (12.0)	B (12.2)	B (13.1)	B (13.5)	B (14.2)
2012 with Wawa (Case 4)						
Northbound Darwin Drive	F (181.6)	F (256.6)	F (440.1)	F (185.9) ⁷	F (381.0) ⁸	F (404.6) ⁹
Eastbound Kirkwood Highway – u-turns	A (9.5)	B (10.2)	B (10.3)	A (9.7)	B (12.1)	B (11.3)
Westbound Kirkwood Highway – Left	B (11.4)	B (12.0)	B (12.2)	B (13.1)	B (13.5)	B (14.2)
2012 with Wawa (Case 5)						
Northbound Darwin Drive – Right	N/A	N/A	N/A	B (13.7)	B (14.5)	B (14.4)
Eastbound Kirkwood Highway – u-turns	N/A	N/A	N/A	A (9.9)	B (12.4)	B (11.6)
Westbound Kirkwood Highway – Left	N/A	N/A	N/A	B (13.9)	B (14.8)	C (15.3)
2012 with Wawa (Case 6)						
Northbound Darwin Drive	N/A	N/A	N/A	F (381.3) ⁷	F (815.8) ⁸	F (750.1) ⁹
Eastbound Kirkwood Highway – u-turns	N/A	N/A	N/A	A (9.6)	B (11.9)	B (11.2)
Westbound Kirkwood Highway – Left	N/A	N/A	N/A	B (13.9)	B (14.8)	C (15.3)

⁶ For unsignalized analyses, the numbers in parentheses following levels of service are average delay per vehicle, measured in seconds. For signalized analyses, those numbers are X-critical, a composite volume-to-capacity ratio.

⁷ The 95th percentile queue length for the northbound Darwin Drive approach during the AM peak hour is approximately 5 vehicles for Case 3 and Case 4, and approximately 7 vehicles for Case 6.

⁸ The 95th percentile queue length for the northbound Darwin Drive approach during the PM peak hour is approximately 9 vehicles for Case 3 and Case 4, and approximately 12 vehicles for Case 6.

⁹ The 95th percentile queue length for the northbound Darwin Drive approach during the Saturday peak hour is approximately 7 vehicles for Case 3 and Case 4, and approximately 10 vehicles for Case 6.

Table 7
PEAK HOUR LEVELS OF SERVICE (LOS)
based on Traffic Operational Analysis for Newark Wawa - Kirkwood Highway
Report dated September 3, 2010
Prepared by Traffic Planning and Design, Inc.

Signalized Intersection ¹⁰	LOS per TOA ¹¹			LOS per McCormick Taylor ¹¹		
	Weekday AM	Weekday PM	Saturday Mid-day	Weekday AM	Weekday PM	Saturday Mid-day
Kirkwood Highway & Harmony Road						
2010 Existing (Case 1)	D (45.5)	E (57.7)	D (46.8)	C (28.5)	D (39.3)	C (29.6)
2012 without Wawa (Case 2)	D (43.8)	E (68.4)	D (46.1)	C (30.0)	D (42.6)	C (29.9)
2012 with Wawa (Case 3)	D (48.6)	E (69.9)	D (46.7)	D (35.9) ¹²	D (43.5) ¹³	D (35.1) ¹⁴
2012 with Wawa (Case 4)	D (47.1)	E (68.6)	D (45.4)	D (35.8)	D (45.2)	C (34.8)
2012 with Wawa (Case 5)	N/A	N/A	N/A	D (37.7) ¹⁵	D (46.0) ¹⁶	D (37.5) ¹⁷
2012 with Wawa (Case 6)	N/A	N/A	N/A	D (36.6)	D (44.7)	D (36.3)

¹⁰ For unsignalized analyses, the numbers in parentheses following levels of service are average delay per vehicle, measured in seconds. For signalized analyses, those numbers are X-critical, a composite volume-to-capacity ratio.

¹¹ The TOA and McCormick Taylor analyzed this intersection with a different configuration, which affected the HCS analysis results. The TOA assumed a fourth leg at the intersection, which is a southbound approach with one shared left/through/right-turn lane and a permitted phase running concurrent with the Harmony Road northbound left-turn phase. While there is a residential driveway that could be considered a fourth leg to the intersection, it is not tied into the signal with any detection or signal heads, and is not included on the signal phasing/timing chart. McCormick Taylor ignored this driveway for the purpose of analysis. Even though the TOA assigned zero volume from this driveway, including the fourth leg in the HCS analysis had an affect on the results.

¹² The 95th percentile queue lengths for the Case 3 AM peak hour are approximately 49 vehicles for the westbound Kirkwood Highway left-turn lane and 11 vehicles for the northbound Harmony Road left-turn lanes.

¹³ The 95th percentile queue lengths for the Case 3 PM peak hour are approximately 48 vehicles for the westbound Kirkwood Highway left-turn lane and 22 vehicles for the northbound Harmony Road left-turn lanes.

¹⁴ The 95th percentile queue lengths for the Case 3 Saturday peak hour are approximately 47 vehicles for the westbound Kirkwood Highway left-turn lane and 12 vehicles for the northbound Harmony Road left-turn lanes.

¹⁵ The 95th percentile queue lengths for the Case 5 AM peak hour are approximately 49 vehicles for the westbound Kirkwood Highway left-turn lane and 13 vehicles for the northbound Harmony Road left-turn lanes.

¹⁶ The 95th percentile queue lengths for the Case 5 PM peak hour are approximately 48 vehicles for the westbound Kirkwood Highway left-turn lane and 25 vehicles for the northbound Harmony Road left-turn lanes.

¹⁷ The 95th percentile queue lengths for the Case 5 Saturday peak hour are approximately 47 vehicles for the westbound Kirkwood Highway left-turn lane and 14 vehicles for the northbound Harmony Road left-turn lanes.