9/8/2014 040 (3)

TOWN OF ACTON
472 Main Street
Acton, Massachusetts, 01720
Telephone (978) 929-6611
Fax (978) 929-6350

Michael J. Gowing
Chairman, Board of Selectmen

August 1, 2014

Please place the attached public hearing notice in the Legal Ad section of the Acton Beacon on Thursday, August 21, and 28, 2014:

Bill to:

Mark Bobrowski, Attorney
(for Concord School Committee)
9 Damonmill Square
Concord, MA 01742
(978) 371-2226

Please confirm and send tear sheet to ltomyl@acton-ma.gov

Regards,

Lisa Tomyl
Executive Assistant

SEL/37 KNOX TRAIL
LEGAL NOTICE
TOWN OF ACTON

The Acton Board of Selectmen will hold a public hearing notice on **September 8, 2014 at 7:50 PM** in the Francis Faulkner Hearing Room 204 at the Town Hall, 472 Main Street, Acton on the application of Concord Public Schools, 120 Meriam Road, Concord, MA for a **Site Plan Special Permit #7/03/14 – 450**, required under **Section 10.4.3.3,03.5.24, and 10.4.1.2 (1)** of the Acton Zoning Bylaw at 37 Knox Trail, Acton, AM 01720. The applicant is proposing to install approximately 610 square feet of additional new pavement to expand the existing driveway.
The application and accompanying plans can be inspected at Town Hall during normal business hours.

Acton Board of Selectmen
Selectmen Berry

AD#13158252
Acton Beacon 8/21, 8/28/14

LEGAL NOTICE
TOWN OF ACTON

The Acton Board of Selectmen will hold a public hearing notice on **September 8, 2014 at 7:50 PM** in the Francis Faulkner Hearing Room 204 at the Town Hall, 472 Main Street, Acton on the application of Concord Public Schools, 120 Meriam Road, Concord, MA for a **Site Plan Special Permit #7/03/14 – 450**, required under **Section 10.4.3.3,03.5.24, and 10.4.1.2 (1)** of the Acton Zoning Bylaw at 37 Knox Trail, Acton, AM 01720. The applicant is proposing to install approximately 610 square feet of additional new pavement to expand the existing driveway. The application and accompanying plans can be inspected at Town Hall during normal business hours.

Acton Board of Selectmen

Selectmen Berry

DRB Memorandum

Project Location: Knox Trail adjacent to Route 62, Acton, MA

In Attendance: Holly Ben-Joseph (HBJ), Peter Darlow (PD), Kim Montella (KM), David Honn (DH), DRB members; Janet Adachi (JA), BoS liaison

Proponent Representative:
None in attendance

- The Knox Trail bus parking project was discussed. The Town of Concord is proposing to park 4-5 school buses on this site when not in use. The following drawings prepared by Nitsch Engineering and dated July 3, 2014 were reviewed:

  C-0 Cover Sheet
  C-1.0 Site Plan (viewed online)
  C-2.0 Turning Movements
  C-3.0 Details

Comments:

a) It was agreed that there were no significant design issues to comment upon.
b) The revised turning radius appears appropriate for buses. Plantings for the proposed bioretention basin are appropriate.
c) Although not a design issue, it was noted that both Massachusetts and Federal law allows a maximum 5 minute idling time for buses. The DRB calls this to the BoS's attention so that some type of monitoring system may be implemented to ensure compliance. It was noted that penalties are $100 for the first violation and $500 for each subsequent violation. Enforcement is administered through the Acton Health Department.

- The meeting was adjourned at 8:45 pm.

Respectfully submitted,

Design Review Board

TOWN OF ACTON
472 Main Street
Acton, Massachusetts 01720
Telephone (978) 929-6631
Fax (978) 929-6340
www.acton-ma.gov
planning@acton-ma.gov
www.acton-ma.gov

Planning Department

INTERDEPARTMENTAL COMMUNICATION

To: Steven Ledoux, Town Manager ***Date:*** September 2, 2014

From: Scott A. Mutch, Zoning Enforcement Officer & Assistant Town Planner

Subject: Site Plan Special Permit Application #07/03/14-450

Location:	37 Knox Trail, Acton, MA
Applicant:	Concord Public Schools, 120 Meriam Road, Concord, MA 01742
Owner:	KT Realty Trust, c/o Brian Li, Trustee, 321 Church Street, Northborough, MA 01532
Engineer:	Nitsch Engineering, 2 Center Plaza, Suite 430, Boston, MA 02108
Zoning:	Technology District (TD) Groundwater Protection District Zone 3
Proposed FAR:	Maximum FAR – 0.20 Existing FAR – Unknown at this time Proposed FAR – No proposed changes to existing building at this time
Proposed Uses:	Transportation Services (3.5.24)
Map/Parcel:	J4-6
Hearing Date:	September 8, 2014
Decision Due:	December 7, 2014

Attached are the legal ad, application, plan sheets and interdepartmental review comments received to date. As of this date, comments have been received from the Town of Acton's Municipal Properties Director, Engineering Department and the Planning Department. Upon review of the project submission, and the interdepartmental reviews provided to date, it does not appear that there are significant obstacles to overcome before a decision could be granted.

The Site Plan:

The subject property is currently developed and consists of a two (2) story office building and a 41 space parking lot. There are no modifications and/or alterations currently proposed for the existing office building. The applicant, Concord Public Schools, is proposing to park and store five (5) school buses on the subject property and conduct general site work which would prepare the site to serve as the access point to abutting property within the Town of Concord which would be developed as a school bus depot facility. Personal vehicles belonging to the operators of the buses would be left at the subject property during the hours of the day when operators would be out on the road conducting their bus routes. The most significant improvement proposed for the site is the addition of approximately 934 square feet of new impervious asphalt pavement material which would widen the existing access drive into the property as well as extend the paved driveway up to the rear property line (also the Town Line between Acton & Concord).

The proposed relevant zoning information for the subject site is summarized in the following table:

By-Law Requirements	Required	Existing	Proposed
Min. Lot Area (ft^2)	40,000 ft^2	40,741 ft^2	40,741 ft^2
Min. Lot Frontage (ft)	100'-0"	420.76'	420.76'
Min. Front Yard (ft) - West	45'-0"	80.8'	Unknown (No Change)
Min. Side Yard (ft) – North	50'-0"	Unknown (>50'-0")	Unknown (No Change)
Min. Side Yard (ft) – South	50'-0"	20.1' *	Unknown (No Change) *
Min. Rear Yard (ft) – East	50'-0"	18.8' *	Unknown (No Change) *
Max. Building Height (ft)	40'-0"	Unknown *	Unknown (No Change) *
Max. F.A.R. (Floor Area Ratio)	0.20	Unknown *	Unknown (No Change) *
Open Space	35%	54% (22,071 ft^2)	55% (22,674 ft^2)
Parking Requirements	**Required**	**Existing**	**Proposed**
Use: Office Use (NFA Unknown) 1 space/250ft^2 of N.F.A.	Unknown	41	41
Bicycle Parking Requirements			
Zoning Bylaw Section 6.3.7.5 – one (1) bicycle parking space for each twenty (20) motor vehicle parking spaces in the facility, but never less than two (2) bicycle parking spaces			
		Required	**Proposed**
Number of Motor Vehicle Parking Spaces Provided:	41	3	0

* The existing office building is deemed to be pre-existing non-conforming to the current dimensional Zoning Bylaw requirements. When the building was originally constructed in approximately 1983, it presumably complied with the dimensional requirements of the Zoning Bylaw at that time. There are currently no proposed plans for any work to be done to the existing office building structure.

Planning Department Comments & Items to be Addressed

- Bicycle Parking

  The April 2014 Annual Town Meeting adopted a new section of the Zoning Bylaw (§6.3.7) which created the requirement that off-street parking facilities shall provide bicycle parking spaces. The Bylaw requires one (1) bicycle parking space for every twenty (20) motor vehicle parking spaces, but never less than two (2) bicycle parking spaces.

  In this particular instance, there are 41 motor vehicle parking spaces currently in existence and to remain on the subject property, which at the minimum Zoning Bylaw requirement identified within the preceding paragraph and Zoning Bylaw Section 6.3.7 requires that 3 bicycle parking spaces be provided. The plan as currently proposed, does not indicate or show any bicycle parking spaces being provided. Unfortunately, the Special Permit Granting Authority (in this instance, the Board of Selectmen) is not provided with any latitude in deviating from this requirement.

- New Impervious Asphalt Driveway

  As per Zoning Bylaw Section 6.7.2, no paved surface shall be located within 10'-0" of the side and rear lot lines. The plan as currently proposed, indicates that the existing access driveway will be extended all the way up to the rear property line. At this point in time, as the abutting land in Concord has not yet been improved, and remains in a primarily natural state, the extension of the paved access drive should comply with the 10'-0" minimum rear yard setback.

TOWN OF ACTON
472 Main Street
Acton, Massachusetts, 01720
Telephone (978) 929-6630
Fax (978) 929-6340

Engineering Department

INTERDEPARTMENTAL COMMUNICATION

To: **Board of Selectmen** ***Date:*** 8/1/2014

From: **Engineering Department**

Subject: **Site Plan Special Permit #07/03/14 - #450 – Concord Public Schools – 37 Knox Trail**

We have reviewed the plans titled "37 Knox Trail, Acton, Massachusetts" dated July 3, 2014 for the above mentioned special permit and have the following comments:

1. The property is located in both Zones 3 of the Groundwater Protection District. The drainage design does not utilize gas trap catch basins and clay lined detention basins required in the Groundwater District regulations however the use of a raingarden meets the intent of the regulations.

2. The drainage design does not address any pollution safeguards as required in section 4.3.6.4 of the Zoning Bylaw

3. The plans should show the location of the field test used to determine the maximum groundwater elevation as required by section 3.9.4 of the Rules and Regulations for Site Plan Special Permits. The applicant has estimated the groundwater elevation using USGS well data which is a good start to approximate the groundwater elevation. Given that the site is in Zone 3 of the Groundwater Protection District and that Acton's sole water supply is its groundwater, design standards for detention basins in Acton are similar to septic systems where the groundwater elevation is estimated by a qualified soil professional at a test pit location to ensure the design meets the minimum distance requirements to groundwater.

4. We request the applicant provide a post-development watershed map. Based on the proposed grading it appears that some of the runoff from existing site will enter into the raingarden. The drainage calculations do not model the post-development condition this way. The raingarden is sized to handle the runoff from the new pavement only. The raingarden should be sized appropriately to handle runoff from the existing site as well as the new pavement.

5. The elevations are referenced to the 1988 NAVD datum. Acton standards call for the datum to be the 1929 NGVD. A conversion factor on the plans would suffice in meeting this requirement.

6. Based on our turning templates, an emergency SU-30 vehicle (fire truck) can maneuver within the site. Recently on another development the Fire Department has commented that the Acton ladder trucks are a different size than the SU-30 vehicle. Our office was given a copy of the ladder truck template by the applicant of the other development and we will supply that template with this memo. It appears the ladder truck would be able to maneuver within the parking area. We will defer further comment to the Fire Department.

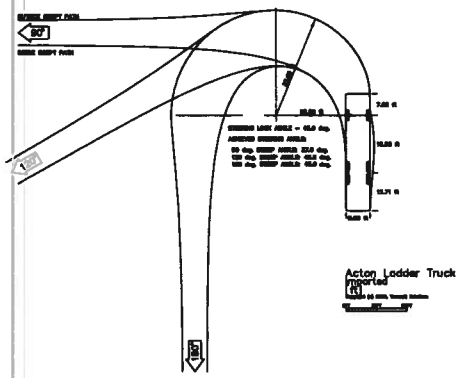
7. There should be an erosion & sedimentation control note that states the contractor is responsible to clean-up any sand, dirt or debris which erodes from the site onto Great Road or private property and to remove silt or debris that enters any existing drainage system immediately upon discovery.

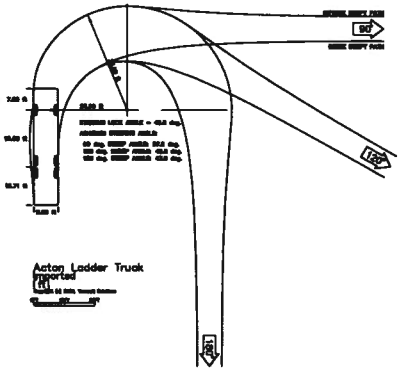
8. There should be a note on the plan forbidding the use of fill containing hazardous materials, require the cleaning of the catch basin sumps and stormwater basins following construction and annually thereafter and restrict the hauling of earth to or from the site to the hours between 9 a.m. and 4 p.m. on weekdays.

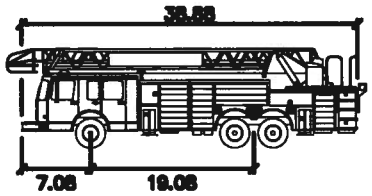
9. The pavement standards in Acton call for 3.5-inches of pavement in two courses: 2-inch for the binder and 1.5-inch for the wearing course.

10. The applicant has not addressed the sidewalk requirement in the application.

11. An as-built plan certified by a Massachusetts Licensed Surveyor showing the buildings, pavement, drainage, utilities, etc. should be required at the conclusion of construction. A Professional Engineer should also stamp the as-built plan to certify that the site has been completed in accordance with the approved site plan and that all features required on the site by the approved plans, decisions, etc... have been field inspected by the PE and conform with the approved design. Any non-conforming features shall be clearly noted.



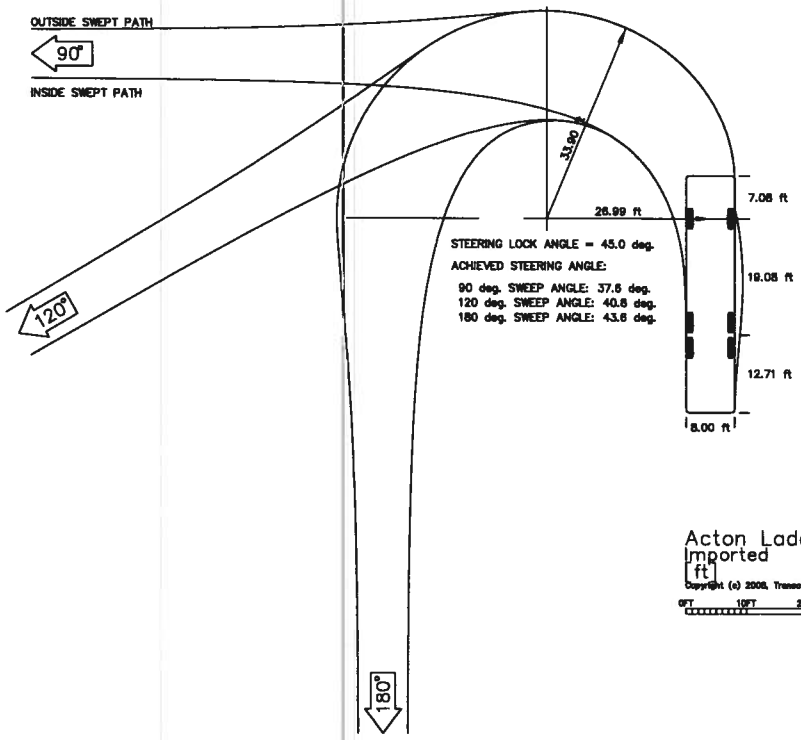


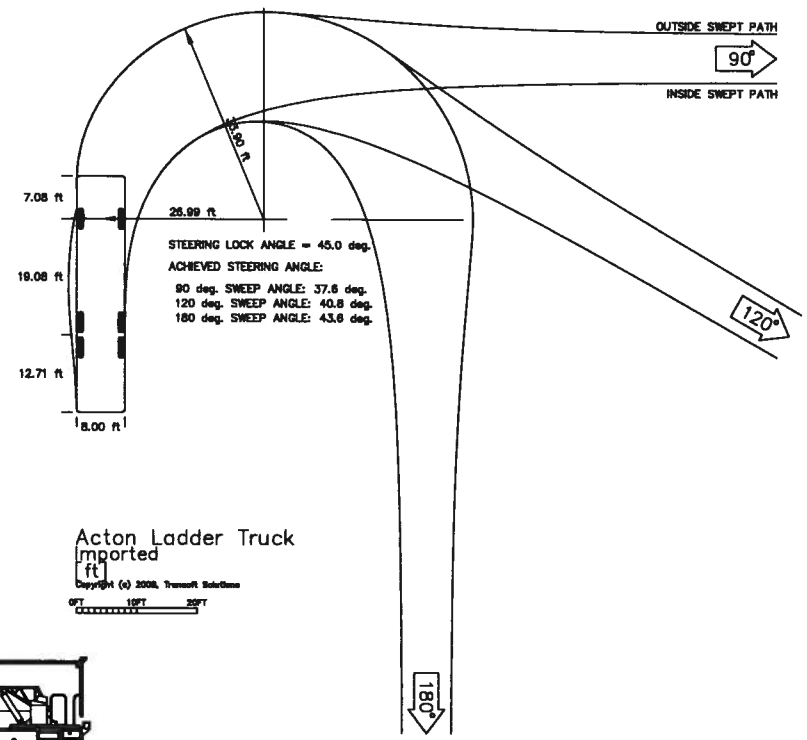


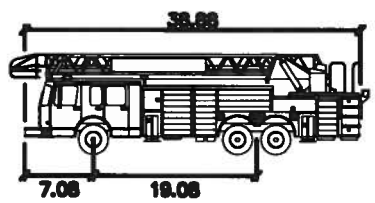
Acton Ladder Truck

	feet
Width	: 8.00
Track	: 7.46
Lock to Lock Time	: 6.00
Steering Angle	: 45.0

40 SCALE







Acton Ladder Truck

	Truck
Width	: 8.00
Track	: 7.46
Lock to Lock Time	: 6.00
Steering Angle	: 45.0

20 SCALE

ACTON MUNICIPAL PROPERTIES DEPARTMENT

INTERDEPARTMENTAL COMMUNICATION

To: **Planning Department** ***Date:*** July 17, 2014

From: **Dean A. Charter, Municipal Properties Director**

Subject: Review of SPSP # 07-03-14-450, 37 Knox Trail

I have reviewed the plans on file for the above noted Site Plan. The modifications are minor in nature, and in my opinion will have minimal if any impact upon the landscaping. Therefore, I have no comment.

Nitsch Engineering

2 Center Plaza, Suite 430
Boston, MA 02108-1928
T: 617-338-0063
F: 617-338-6472
www.nitscheng.com

July 3, 2014

Mike Gowing, Chair
Board of Selectman
Town of Acton
472 Main Street
Acton, MA 01720

RE: Nitsch Project #10079
Continuation of Use
37 Knox Trail
Acton, MA

Dear Mr. Gowing:

On behalf of Concord Public Schools, Nitsch Engineering is pleased to submit an Application for Continuation of Use at 37 Knox Trail in Acton, Massachusetts. Nitsch Engineering is also providing the following:

1. Site Plan Application;
2. Permit History (37 Knox Trail);
3. Acton GIS Map for 37 Knox Trail;
4. HydroCAD Output with summary of calculations;
5. USGS Well Data, Acton, MA;
6. Earth Removal Sketch;
7. Plan Set including the following:
    a. Cover Sheet - C0.0;
    b. Site Plan - C1.0;
    c. Bus Parking and Turning Movements - C2.0;
    d. Details - C3.0
    e. Topographic Plan of Land

The project site is currently in the Technology District (TD) and a Zone 3 Groundwater Protection District (GWPD). The site does not abut a Residential Zone and is not within a wetland resource buffer zone. The south west portion of the site is within the Riverfront Area but no new work is proposed within the Riverfront. The site is not within an Area of Critical Environmental Concern (ACEC) or Natural Heritage & Endangered Species Program (NHESP).

The project does not require a Special Permit under Section 4.3.8 (GWPD) or Section 10.4.1.2(3) Site Plan Special Permit of the current Zoning By-Law (June 2013) because the increase in impervious area is below the 1,200 square foot threshold and the use for the site is not changing. A water balance calculation is provided on Sheet C1.0.

The proposed project involves installing approximately 610 square feet of additional new pavement to expand the existing site driveway at 37 Knox Trail. This will allow access to the existing parking lot for approximately five (5) busses and five (5) bus driver's cars from the Concord School District to temporarily park in the existing parking lot. The new impervious area along with a new easement over the driveway will provide access to land in Concord, adjacent to the site, for a potential future bus depot for all of the Concord Public School busses on the Town of Concord land.

As part of the improvements, the Applicant proposes to install a bio-retention system (rain garden) adjacent to the driveway to mitigate the increase in stormwater flows based on the new impervious area. The rain garden is designed to capture and infiltrate the one (1) inch storm event and by-pass storm events greater than the

10-year storm. A HydroCAD output of the bio-retention system is provided with this letter. The soil maps indicate a well-drained Merrimac soil with a Hydraulic Soil Group (HSG) of A. The soil survey indicates that groundwater is generally greater than 80 inches below grade.

The latest United States Geological Survey (USGS) groundwater well data in Acton for well ACW-158 indicates a current groundwater elevation of 18.2 feet below grade. Historical data for the past year indicates that the groundwater elevation fluctuates between 14.04 feet and 21.86 feet below grade. The Acton well is approximately 4 miles from Knox Trail. The Acton well and 37 Knox Trail are at approximately the same elevation. USGS well information is attached with this letter.

There are no other improvements proposed for the site at this time.

Nitsch Engineering is providing, under separate cover, a quantitative traffic assessment associated with the potential Bus Depot off 37 Knox Trail.

Nitsch Engineering respectfully requests that the 37 Knox Trail project be placed on the next Board of Selectman's hearing agenda for July to discuss this project.

Please let me know if you have any questions.

Very truly yours,

Nitsch Engineering, Inc.

Steven Ventresca

Steven Ventresca, PE LEED® AP BD+C
Project Manager

SV/

Enclosures: Site Plan Application
Permit History (37 Knox Trail)
Acton GIS Map
HydroCAD Output
USGS Well Data, Acton, MA

cc: File, Concord Public Schools

Q:\10079 CPS Acton Depot\Civil Project Data\Special Permit Application\10079 BOS Letter 2014-07-03.docx

Permit History

Address: 37 Knox Trail

Building Permits			Electrical Permits		Plumbing Permits		Gas Permits		Board of Appeals	Site Plan Special Permits	Sign Permits
Permit #	Date	Description	Permit #	Date	Permit #	Date	Permit #	Date	Hearing #	Hearing #	Permit #
8559	4/12/1984	Office Building	10501	8/18/1986	426	9/19/1986				0235 8/24/83	
8981	2/19/1985	Alteration	10502	8/19/1986						0240 12/21/83	
			13061	4/7/1992							

Appendix B

TOWN OF ACTON
APPLICATION FOR SITE PLAN SPECIAL PERMIT

For Continuation of existing office use
Under Zoning Bylaw Section Section 8.3.1 Non-conforming Structures

Refer to the "Rules and Regulations for Site Plan Special Permits" available from the Building Department or the Planning Department for details on the information and fees required for this application. Contact the Planning Department at 978-929-6631 or Building Department at 978-929-6633 with any questions concerning the Rules. Incomplete applications may be denied.

Please type or print your application.

1. Location and Street Address of Site 37 Knox Trail, Acton, MA

2. Applicant's Name Concord Public Schools
   Address 120 Meriam Road, Concord, MA 01742
   Telephone 978-318-1500 Email John Flaherty jflaherty@colonial.net

3. Record Owner's Name KT Realty Trust, Brian Li, Trustee
   Address 321 Church Street, Northborough, MA
   Telephone _____ Email _____

4. Town Atlas Map(s)/Parcel Number(s) J4-6

5. Zoning District (s) of Parcel(s) Technology District (TD)

If any site plans have been filed previously for this site give file numbers: #0235 Aug 24, 1983
#0240 Dec 21, 1983

The undersigned hereby apply to the Board of Selectmen for a public hearing and a site plan special permit under Section 10.4 of the Zoning Bylaw approving the attached site plan.

The undersigned hereby certify that the information on this application and plans submitted herewith is correct, and that all applicable provisions of Statutes, Regulations, and Bylaws will be complied with. The above is subscribed to and executed by the undersigned under the penalties of perjury in accordance with Section 1-A of Chapter 268, General Laws of the Commonwealth of Massachusetts.

Date	Signature of Petitioner(s)	Signature of Petitioner(s)

RECORD OWNER'S KNOWLEDGE AND CONSENT

I hereby assert that I have knowledge of and give my consent to the application presented above.

Date	Signature of Record Owner(s)	Signature of Record Owner(s)

Appendix C

ACTON BOARD OF SELECTMEN

NOTICE OF PUBLIC HEARING

In accordance with the provisions of Massachusetts General Laws, Chapter 40 A, Section 9, the Acton Board of Selectmen will hold a public hearing on the petition of:

for a SITE PLAN SPECIAL PERMIT on a parcel located at: 37 KNOX TRAIL, ACTON MA

on _____ at _____ P.M.,

at the Town Hall, 472 Main Street, Acton, Massachusetts.

Such permits may be granted by the Board of Selectmen under Massachusetts General Law, Chapter 40A and the Acton Zoning Bylaw in accordance with the "Rules and Regulations for Site Plan Special Permits" all of which are available for review or purchase at the offices of the Board of Selectmen, the Planning Department, Building Department and the Town Clerk. A copy of the application is also available for review at these offices in Town Hall between 8:00 a.m. and 5:00 p.m., Monday through Friday.

The applicant or his/her representative will be at the hearing to present the reason(s) why the permit should be granted.

When the applicant or his/her representative has concluded their presentation, the Chairman of the Board will allow the Board members to speak to the matter under consideration or to raise questions and concerns. Subsequently, the Chairman will give the public the same opportunity to speak to the matter under consideration or to raise questions and concerns.

The Chairman will not allow any member of the public to interrupt anyone else while they are speaking. Each person wishing to speak at the hearing should be as brief as possible and should wait his/her turn. Each person speaking should avoid repeating the comments of those who preceded them. Each person speaking should state their name and address before they make their statement or ask questions.

Any party may appear in person, by agent, or by attorney at any hearing.

When all of the facts have been presented and all persons wishing to speak on the petition have been heard, the Chairman will close the hearing. In no case will the Board allow new evidence to be admitted after the close of the public hearing unless this evidence was requested by the Board prior to the close of the public hearing.

Appendix B

TOWN OF ACTON
APPLICATION FOR SITE PLAN SPECIAL PERMIT

For Continuation of existing office use
Under Zoning Bylaw Section Section 8.3.1 Non-conforming Structures

Refer to the "Rules and Regulations for Site Plan Special Permits" available from the Building Department or the Planning Department for details on the information and fees required for this application. Contact the Planning Department at 978-929-6631 or Building Department at 978-929-6633 with any questions concerning the Rules. Incomplete applications may be denied.

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   Address 120 Meriam Road, Concord, MA 01742
   Telephone 978-318-1500 Email John Flaherty jflaherty@colonial.net

3. Record Owner's Name KT Realty Trust, Brian Li, Trustee
   Address 321 Church Street, Northborough, MA
   Telephone 617 680 6216 Email brianLi10@gmail.com

4. Town Atlas Map(s)/Parcel Number(s) J4-6

5. Zoning District (s) of Parcel(s) Technology District (TD)

If any site plans have been filed previously for this site give file numbers: #0235 Aug 24, 1983
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6/26/14 Frank Bobrowski (for Concord School Comm.)
Date Signature of Petitioner(s) Signature of Petitioner(s)

RECORD OWNER'S KNOWLEDGE AND CONSENT

I hereby assert that I have knowledge of and give my consent to the application presented above.

6/26/14 Brian Li Trustee KT Realty Trust
Date Signature of Record Owner(s) Signature of Record Owner(s)

Nitsch Engineering

Concord Schools Bus Depot
Acton, MA

Quantitative Traffic Assessment

June, 2014

Prepared for:

Concord Public Schools
120 Meriam Road, Ripley Building
Concord, MA 01742

Submitted by:

Nitsch Engineering
2 Center Plaza, Suite 430
Boston, MA 02108

Nitsch Project #10079.1

Building better communities with you.

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1 INTRODUCTION

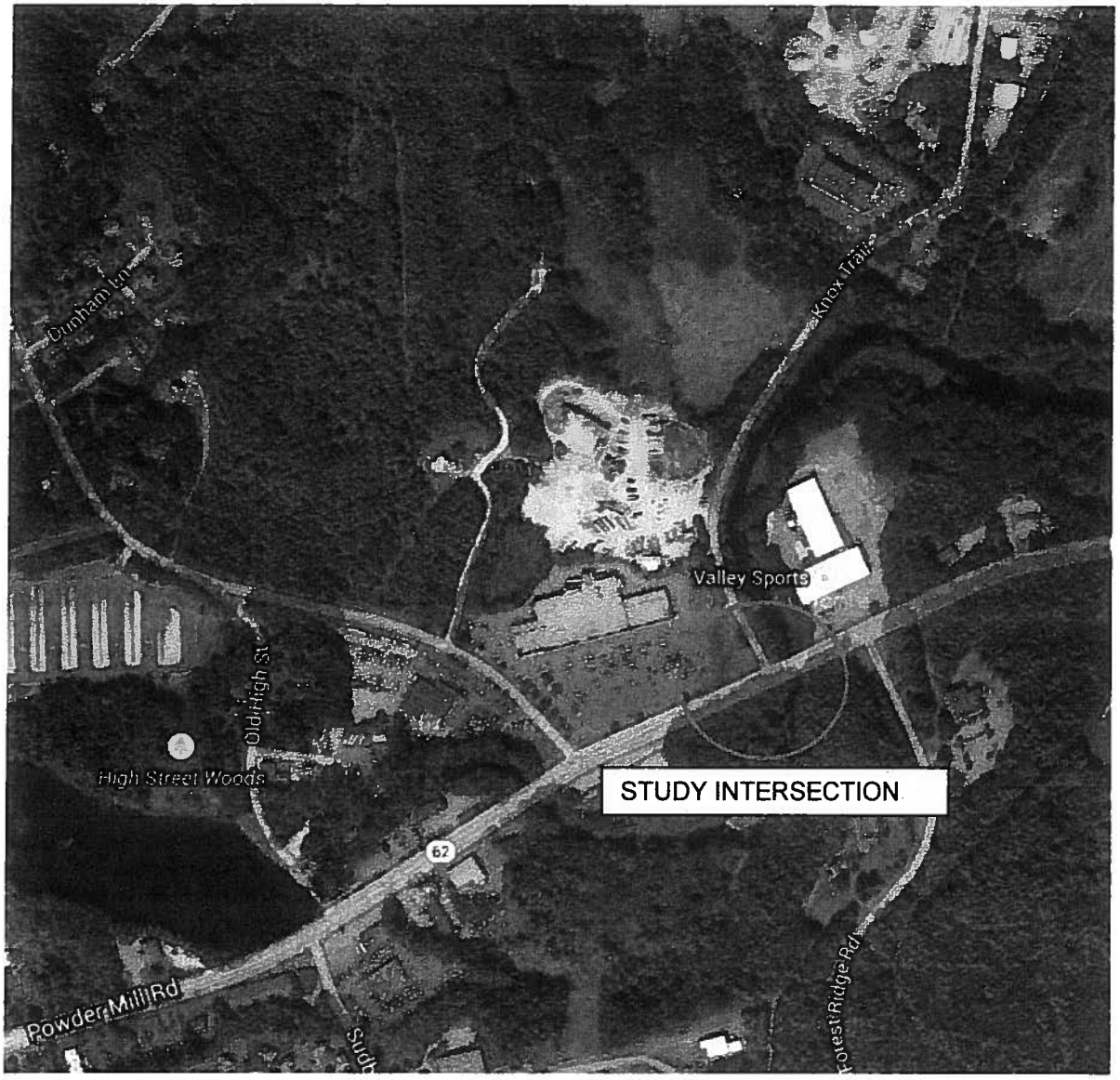
1.1 General/Site Location

Nitsch Engineering has been retained by Concord Public Schools to prepare a qualitative assessment of safety, and traffic access/egress, associated with the proposed Concord-Carlisle schools bus depot relocation in Acton, Massachusetts. This study is a summary of the existing conditions and evaluation of the traffic impacts after the proposed relocation.

The Project includes relocation of the Concord-Carlisle Regional High School (CCRHS) bus depot from the Concord-Carlisle High School to the Knox Trail site located in Acton, Massachusetts.

As seen in Figure 1, the major access roads within the study area are Powder Mill Road (Route 62) and Knox Trail. Powder Mill Road (Route 62) extends from Main Street in Concord to Waltham Street in Acton and runs in the east/west directions. Knox Trail extends from Powder Mill Road to the industrial park, and runs in the southwest/northeast directions.

Figure 1 – Locus Map

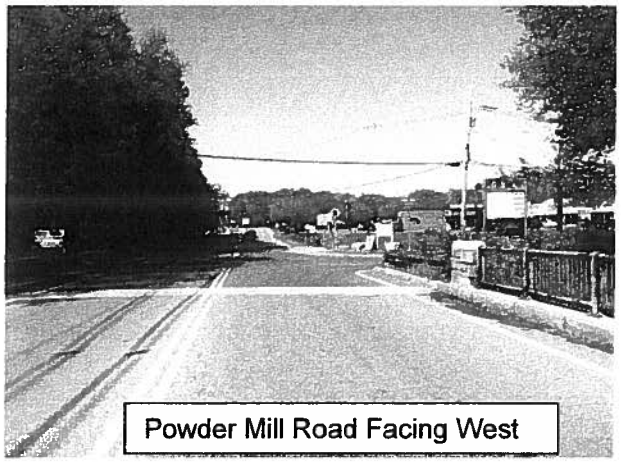


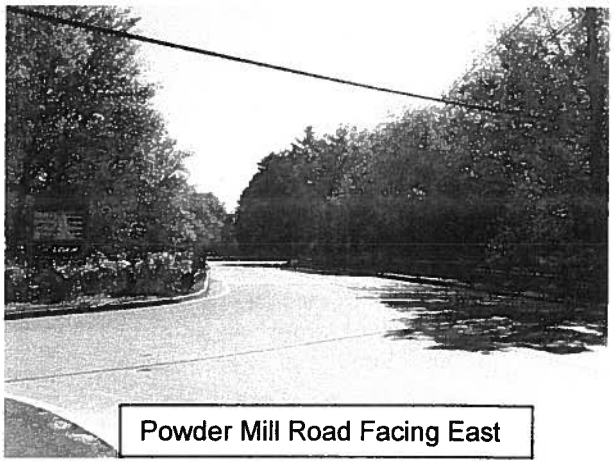
2 EXISTING CONDITIONS

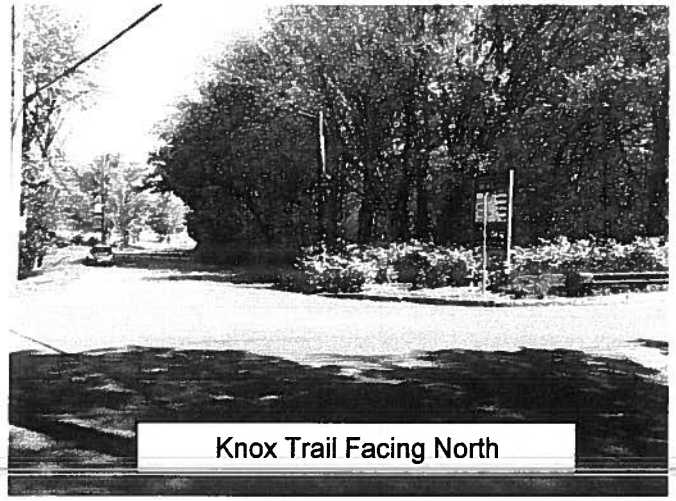
2.1 Field Reconnaissance

Nitsch Engineering conducted field reconnaissance on Tuesday, June 3, 2014 to observe traffic operations, geometric conditions, parking activity, pedestrian accommodations, signing, pavement markings, and overall roadway and intersection conditions at the intersection of Powder mill Road (Route 62) at Knox Trail.

Powder Mill Road (Route 62) at Knox Trail
Knox Trail and Powder Mill Road (Route 62) create three-legged unsignalized intersection with Powder Mill Road (Route 62) approaching from the east and west, and Knox Trail approaching from the north. Powder Mill Road (Route 62) consists of one general travel lane in each direction, separated by double yellow center line. Knox Trail consists of one lane in the northbound and southbound directions. There is no pavement marking present at Knox Trail. A sidewalk is present along the southerly side of Powder Mill Road. The posted speed limit on Powder Mill Road is 35 mph. Powder Mill Road operates as the free movement, and the Knox Trail operates under "STOP" control.


Powder Mill Road Facing West


Powder Mill Road Facing East


Knox Trail Facing North

2.2 Site Distance

Stopping sight distance (SSD) is defined as the distance needed for drivers to see an object on the roadway ahead and bring their vehicles to a safe stop before colliding with the object. The distances are derived for various design speeds based on assumptions for driver reaction time, the braking ability of most vehicles under wet pavement conditions, and the friction provided by most pavement surfaces, assuming good tires. Based on American Association of State Highway and Transportation Officials (AASHTO) Design Guidelines, the minimum SSD for 35 mph roadway is 250 feet, which is available at the intersection.

Intersection site distance (ISD) was also observed during the site visit. ISD refers to the line of sight between a driver on a roadway and a vehicle attempting to enter from a side street or driveway. This value is critical in determining where driveways or other access points should be located, or what traffic control devices are necessary, to ensure that adequate ISD is provided. When approaching Powder Mill Road on Knox Trail looking left you can only see 100 feet to the east on Powder Mill Road because of overgrown vegetation and roadway geometry, which is below the required minimum of 390 feet for a 35 mph roadway. However, if you pull the vehicle past the stop sign and closer to the intersection, you can see beyond the required site distance before entering Powder Mill Road.

2.3 Crash Data

Nitsch Engineering analyzed crash data for the study area intersections. Massachusetts Department of Transportation (MassDOT) requires that the crash data reviewed for a project include the latest three years of available data to identify safety deficiencies. Accordingly, we queried MassDOT's crash record database for the Towns of Acton and Concord from 2010 to 2012, and identified 2 crashes in 2010, 2 crashes in 2011, and 1 crashes in 2012 in the vicinity of the study area. None of the crashes occurred during the peak hours, and 20% of them occurred under wet or icy conditions. This does not indicate a significant safety problem at the intersection, and during inclement weather.

Table 1 - Crash Summary

Location	Number of Crashes			Severity				Type					Percent During	
	Year	Total	Ave per Year	PD[a]	PI[b]	NR[i]	F[c]	CM[d]	RE[e]	HO[f]	Ped[g]	Other[h]	Peak Hours	Wet/Icy Conditions
Powder Mill Road at Knox Trail	2010	2		2				1	1				0	50%
	2011	2		1	1			1				1	0	0
	2012	1		1				1					0	0
Total		**5**		**4**	**4**			**3**	**1**			**1**	**0**	**20%**

aProperty Damage Only; bPersonal Injury; cFatality; dCross Movement (or angle); eRear End; Head On; gPedestrian, jnot reported or unknown in term of severity; hsideswipe, opposite direction; sideswipe, same direction, single vehicle crash, not eported, unknown etc.

2.4 Traffic Volume Data

Nitsch Engineering completed a data collection effort for the study intersections on May 22, 2014. Data collected included Turning Movement Counts (TMCs) for cars, and heavy vehicles over a twelve hour period from 6:00 AM to 6:00 PM. Based on the counts, the AM peak hour is from 7:45 AM to 8:45 AM and the PM peak hour is from 5:00 PM to 6:00 PM. However, our analysis focused on the following three time periods:

Weekday Morning (6:00 – 700 AM)	*Every day the 29 school buses depart the proposed bus depot between 6:00 AM and 7:00 AM for morning student pick-up.*
Weekday Mid-Morning (8:45 - 9:15 AM)	*The buses return to the depot between 8:45 AM and 9:15 AM.*
Weekday Afternoon (1:45 - 12:15 PM)	*Every afternoon the buses depart between 1:45 PM and 2:15 PM.*

2.5 Intersection Operations

Level of Service (LOS) is a qualitative measure describing operational conditions within a traffic stream. Six (6) LOS criteria are used to describe the quality of traffic flow for any type of facility controls. LOS-A represents the best operating conditions and LOSF represents the worst operating conditions. LOS for signalized intersections is calculated using the operational analysis methodology of the Highway Capacity Manual (HCM). The methodology for signalized intersections assesses the effects of signal type, timing, phasing, progression, vehicle mix, and geometrics on average control delay. Control delay includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. Table 3 summarizes the relationship between LOS and average control delay for signalized intersections.

Table 2 – Level of Service Criteria for Signalized Intersections

Level of Service[1]	Control Delay per Vehicle[1] (Seconds)
A	0 to 10
B	>10 to 20
C	>20 to 35
D	>35 to 55
E	>55 to 80
F	Over 80
[1]Reference: 2010 Highway Capacity Manual, TRB	

2.6 2014 Existing Traffic Operations

Nitsch Engineering analyzed the existing year 2014 traffic operations at the study intersections. Table 3 summarizes the 2014 existing condition traffic operations.

Table 3 - Level of Service Summary – 2014 Existing Conditions

	INTERSECTION	MOVEMENT	V/C[1]	DELAY[2]	LOS[3]	50th Q[4]	95th Q[5]
WEEKDAY MORNING	Powder Mill Road (Route 62) @ Knox Trail	Knox Trail SB - RL	0.12	13.1	B	-	10
		Powder Mill Road (Route 62) EB - LT	0.02	0.7	A	-	2
		Powder Mill Road (Route 62) WB - TR	0.08	0	A	-	0
		Intersection	**0.12**	**1.5**	**A**		
WEEKDAY MID-MORNING	**INTERSECTION**	**MOVEMENT**	**V/C[1]**	**DELAY[2]**	**LOS[3]**	**50th Q[4]**	**95th Q[5]**
	Powder Mill Road (Route 62) @ Knox Trail	Knox Trail SB - RL	0.05	11.5	B	-	4
		Powder Mill Road (Route 62) EB - LT	0.02	0.6	A	-	1
		Powder Mill Road (Route 62) WB - TR	0.12	0	A	-	0
		Intersection	**0.12**	**0.9**	**A**		
WEEKDAY AFTERNOON	**INTERSECTION**	**MOVEMENT**	**V/C[1]**	**DELAY[2]**	**LOS[3]**	**50th Q[4]**	**95th Q[5]**
	Powder Mill Road (Route 62) @ Knox Trail	Knox Trail SB - RL	0.16	13.1	B	-	14
		Powder Mill Road (Route 62) EB - LT	0.04	1.4	A	-	3
		Powder Mill Road (Route 62) WB - TR	0.19	0	A	-	0
		Intersection	**0.19**	**2.1**	**A**		

[1] Volume to Capacity Ratio; [2] Vehicle Delay, measured in seconds; [3] Level Of Service; [4] 50th Percentile Queue (in feet); [5] 95th Percentile Queue (in feet) based upon 22 feet per vehicle; # = volume exceeds capacity, queue may be longer; m = 95th percentile queue is metered by upstream intersection

Table 3 shows that under the existing conditions, the intersection of Powder Mill Road (Route 62) and Knox Trail operates at LOS A during all three periods of analysis. All individual approaches at the intersection operate at LOS B or better. **Figure 2** shows the 2014 existing traffic volumes used in the traffic analyses.

Figure 2 - 2014 Existing Traffic Volumes

3 2014 FUTURE TRAFFIC OPERATIONS

Nitsch Engineering performed the analysis to compare traffic operations with the proposed relocation of the bus depot. Since the relocation is intended to be implemented on August 2014, We used the existing year, 2014 volumes for the analysis. Table 4 summarizes the result of the 2014 Future traffic analyses.

Table 4 - Level of Service Summary – 2014 Future Conditions

	INTERSECTION	MOVEMENT	V/C[1]	DELAY[2]	LOS[3]	50th Q[4]	95th Q[5]
WEEKDAY MORNING	Powder Mill Road (Route 62) @ Knox Trail	Knox Trail SB - RL	0.21	15.1	C	-	19
		Powder Mill Road (Route 62) EB - LT	0.02	0.7	A	-	2
		Powder Mill Road (Route 62) WB - TR	0.08	0	A	-	0
		Intesection	0.21	2.2	A		
WEEKDAY MID-MORNING	INTERSECTION	MOVEMENT	V/C[1]	DELAY[2]	LOS[3]	50th Q[4]	95th Q[5]
	Powder Mill Road (Route 62) @ Knox Trail	Knox Trail SB - RL	0.05	11.7	B	-	4
		Powder Mill Road (Route 62) EB - LT	0.02	0.6	A	-	1
		Powder Mill Road (Route 62) WB - TR	0.14	0	A	-	0
		Intesection	0.14	0.9	A		
WEEKDAY AFTERNOON	INTERSECTION	MOVEMENT	V/C[1]	DELAY[2]	LOS[3]	50th Q[4]	95th Q[5]
	Powder Mill Road (Route 62) @ Knox Trail	Knox Trail SB - RL	0.24	14.5	B	-	23
		Powder Mill Road (Route 62) EB - LT	0.04	1.4	A	-	3
		Powder Mill Road (Route 62) WB - TR	0.19	0	A	-	0
		Intesection	0.19	2.1	A		

[1] Volume to Capacity Ratio; [2] Vehicle Delay, measured in seconds; [3] Level Of Service; [4] 50th Percentile Queue (in feet); [5] 95th Percentile Queue (in feet) based upon 22 feet per vehicle; # = volume exceeds capacity, queue may be longer; m = 95th percentile queue is metered by upstream intersection

Table 4 shows that under Future conditions, all of the approaches operate at the same LOS as under existing conditions; with the exception of the Knox Trail southbound movement at the intersection that degrades from a LOS B to a LOS C during the morning peak hour.

Figure 3 shows the 2014 Future volumes used in the traffic analyses.

Figure 3 - 2014 Future Traffic Volumes

3.1 Warrant Analyses

Nitsch Engineering performed signal warrant analyses at the intersection of Powder Mill Road (Route 62)/Knox Trail, based on the standard procedures outlined in the Manual for Uniform Traffic Control Devices (MUTCD). The MUTCD lists eight warrants, one or more of which should be met to justify installation of a signal.

Warrant		Description
1	Eight-Hour Vehicular Volume	Traffic volume for 8 hours of an average day exceed the threshold given in the MUTCD.
2	Four-Hour Vehicular Volume.	Traffic volume for 4 hours of an average day exceed the threshold given in the MUTCD.
3	Peak Hour	Traffic volume for 1 hour of an average day exceed the threshold given in the MUTCD.
4	Pedestrian Volume	Pedestrian volume exceed the threshold given in the MUTCD.
5	School Crossing	School children cross the major street.
6	Coordinated Signal System	Insuring progressive movement in a coordinated system.
7	Crash Experience	Severety and frequency of crashes exceed the threshold given in the MUTCD.
8	Roadway Network.	Encourages concentration and organization of traffic flow on a roadway network.

The analyses were performed based on Future 2014 volumes as they represent the projected increase in traffic from additional bus activity to determine whether there was a need for a signal as a method of traffic control at the study intersection. Based on the volumes, the intersection did not meet the signal warrants.

4 CONCLUSIONS AND RECOMMENDATIONS

The intersection of Powder Mill Road/Knox Trail operates at acceptable level of service (LOS), and the analysis indicate that after the relocation of the bus depot and based on the number of buses that are proposed to be used by Concord-Carlisle school system, the Intersection will continue to operate at LOS A during all three periods of analysis with no significant delay.

The Intersection experiences a poor Intersection site distance (ISD) due to the existing roadway geometry and overgrown vegetation at the northeasterly corner of the intersection.

Nitsch Engineering makes the following recommendations for improvement at the intersection after the bus depot relocation is implemented:

- Provide pavement markings (double yellow center line and stop line) at the Knox Trail approach to the Intersection; and

- Trim the overgrown vegetation at the northeasterly corner of the inter section for a better ISD.

Nitsch Engineering

Concord Schools Bus Depot
Acton, MA

Technical Appendix

June, 2014

Prepared for:

Concord Public Schools
120 Meriam Road, Ripley Building
Concord, MA 01742

Submitted by:

Nitsch Engineering
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Boston, MA 02108

Nitsch Project #10079.1

Building better communities with you

CONTENTS

Section Number	DESCRIPTION
A-1	Turning Movement Counts (TMCs)
A-2	Crash Data
A-3	Capacity Analysis

Section A-1

Turning Movement Counts (TMCs)

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Traffic Counts with Precision

PRECISION DATA INDUSTRIES, LLC

Client:	Engineer:	Site Code:	Date:	PDI Job Number:	City, State:
Nitsch Engineering	N. Havan	10079	Thursday 5/22/2014	143908	Concord, MA

N: Knox Trail
E/W: Powder Mill Road (Route 62)
City, State: Concord, MA
Client: Nitsch Engineering/ N. Havan

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File Name : 143908 ,
Site Code : 10079
Start Date : 5/22/20
Page No : 1

Groups Printed- Cars - Heavy Vehicles

	Knox Tral From North			Powder Mill Road (Route 62) From East			Powder Mill Road (Route 62) From West			
Start Time	Right	Left	U-Turn	Right	Thru	U-Turn	Thru	Left	U-Turn	Int. Tota
06:00 AM	6	3	0	3	16	0	89	3	0	12
06:15 AM	4	1	0	8	18	0	121	8	0	16
06:30 AM	4	14	0	5	31	0	147	4	0	20
06:45 AM	11	14	0	5	39	0	153	16	0	23
Total	25	32	0	21	104	0	510	31	0	72
07:00 AM	11	3	0	10	45	0	191	8	0	268
07:15 AM	8	8	0	4	50	0	210	8	0	288
07:30 AM	8	7	0	7	61	0	155	12	0	250
07:45 AM	15	10	0	10	57	0	192	15	0	299
Total	42	28	0	31	213	0	748	43	0	1105
08:00 AM	7	14	0	8	58	0	176	6	0	269
08:15 AM	8	14	0	10	68	0	219	11	0	330
08:30 AM	2	11	0	15	66	0	152	5	0	251
08:45 AM	8	6	0	15	71	0	178	9	0	287
Total	25	45	0	48	263	0	725	31	0	1137
09:00 AM	3	9	0	22	86	0	140	10	0	270
09:15 AM	12	8	0	20	89	0	115	13	0	257
09:30 AM	10	12	0	17	80	0	105	13	0	237
09:45 AM	15	13	0	16	76	0	98	11	0	229
Total	40	42	0	75	331	0	458	47	0	993
10:00 AM	9	12	0	21	71	0	83	5	0	201
10:15 AM	9	12	0	17	66	0	102	10	0	216
10:30 AM	10	15	0	18	106	0	95	8	0	252
10:45 AM	11	14	0	24	89	0	80	8	0	226
Total	39	53	0	80	332	0	360	31	0	895
11:00 AM	8	14	0	17	93	0	73	3	0	208
11:15 AM	15	13	0	19	74	0	92	9	0	222
11:30 AM	6	14	0	23	95	0	88	8	0	234
11:45 AM	9	26	0	22	73	0	87	5	0	222
Total	38	67	0	81	335	0	340	25	0	886
12:00 PM	8	15	0	16	93	0	82	12	0	226
12:15 PM	12	13	0	10	101	0	104	10	0	250
12:30 PM	13	13	0	19	92	0	75	11	0	223
12:45 PM	12	13	0	12	90	0	82	7	0	216
Total	45	54	0	57	376	0	343	40	0	915
01:00 PM	14	20	0	17	92	0	102	9	0	254
01:15 PM	10	20	0	16	105	0	77	8	0	236
01:30 PM	10	10	0	22	80	0	88	9	0	219
01:45 PM	10	9	0	19	85	0	94	17	0	234
Total	44	59	0	74	362	0	361	43	0	943
02:00 PM	11	18	0	18	81	0	79	11	0	218
02:15 PM	17	13	0	19	72	0	83	12	0	216
02:30 PM	18	11	0	29	85	0	75	9	0	227
02:45 PM	19	12	0	15	95	0	90	9	0	240
Total	65	54	0	81	333	0	327	41	0	901
03:00 PM	15	9	0	22	86	0	96	15	0	243
03:15 PM	11	16	0	13	107	0	83	5	0	235
03:30 PM	19	11	0	30	120	0	88	11	0	279
03:45 PM	11	17	0	29	127	0	96	11	0	291
Total	56	53	0	94	440	0	363	42	0	1048

N: Knox Trail
E/W: Powder Mill Road (Route 62)
City, State: Concord, MA
Client: Nitsch Engineering/ N. Havan

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File Name : 143908 A
Site Code : 10079
Start Date : 5/22/201
Page No : 2

Groups Printed- Cars - Heavy Vehicles

	Knox Tral From North			Powder Mill Road (Route 62) From East			Powder Mill Road (Route 62) From West			
Start Time	Right	Left	U-Turn	Right	Thru	U-Turn	Thru	Left	U-Turn	Int. Total
04:00 PM	17	13	0	26	133	0	74	8	0	271
04:15 PM	11	8	0	25	133	0	81	7	0	265
04:30 PM	13	25	0	27	135	0	88	8	0	296
04:45 PM	13	14	0	25	162	0	102	7	0	323
Total	54	60	0	103	563	0	345	30	0	1155
05:00 PM	17	21	0	22	171	0	97	11	1	340
05:15 PM	13	18	0	22	144	0	97	13	0	307
05:30 PM	15	18	0	21	163	0	92	6	0	315
05:45 PM	17	11	0	22	167	0	118	6	0	341
Total	62	68	0	87	645	0	404	36	1	1303
Grand Total	535	615	0	832	4297	0	5284	440	1	12004
Apprch %	46.5	53.5	0	16.2	83.8	0	92.3	7.7	0	
Total %	4.5	5.1	0	6.9	35.8	0	44	3.7	0	
Cars	431	547	0	757	4190	0	5165	320	1	11411
% Cars	80.6	88.9	0	91	97.5	0	97.7	72.7	100	95.1
Heavy Vehicles	104	68	0	75	107	0	119	120	0	593
% Heavy Vehicles	19.4	11.1	0	9	2.5	0	2.3	27.3	0	4.9

	Knox Tral From North				Powder Mill Road (Route 62) From East				Powder Mill Road (Route 62) From West				
Start Time	Right	Left	U-Turn	App. Total	Right	Thru	U-Turn	App. Total	Thru	Left	U-Turn	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 12:00 PM - Peak 1 of 1													
Peak Hour for Entire Intersection Begins at 07:45 AM													
07:45 AM	**15**	10	0	**25**	10	57	0	67	192	**15**	0	207	299
08:00 AM	7	**14**	0	21	8	58	0	66	176	6	0	182	269
08:15 AM	8	14	0	22	10	**68**	0	78	**219**	11	0	**230**	**330**
08:30 AM	2	11	0	13	**15**	66	0	**81**	152	5	0	157	251
Total Volume	32	49	0	81	43	249	0	292	739	37	0	776	1149
% App. Total	39.5	60.5	0		14.7	85.3	0		95.2	4.8	0		
PHF	.533	.875	.000	.810	.717	.915	.000	.901	.844	.617	.000	.843	.870
Cars	28	39	0	67	37	238	0	275	721	27	0	748	1090
% Cars	87.5	79.6	0	82.7	86.0	95.6	0	94.2	97.6	73.0	0	96.4	94.9
Heavy Vehicles	4	10	0	14	6	11	0	17	18	10	0	28	59
% Heavy Vehicles	12.5	20.4	0	17.3	14.0	4.4	0	5.8	2.4	27.0	0	3.6	5.1
Peak Hour Analysis From 12:15 PM to 05:45 PM - Peak 1 of 1													
Peak Hour for Entire Intersection Begins at 05:00 PM													
05:00 PM	**17**	**21**	0	**38**	**22**	**171**	0	**193**	97	11	**1**	109	340
05:15 PM	13	18	0	31	22	144	0	166	97	**13**	0	110	307
05:30 PM	15	18	0	33	21	163	0	184	92	6	0	98	315
05:45 PM	17	11	0	28	22	167	0	189	**118**	6	0	**124**	**341**
Total Volume	62	68	0	130	87	645	0	732	404	36	1	441	1303
% App. Total	47.7	52.3	0		11.9	88.1	0		91.6	8.2	0.2		
PHF	912	810	.000	.855	.989	943	.000	.948	.856	.692	250	.889	955
Cars	61	66	0	127	87	642	0	729	395	33	1	429	1285
% Cars	98.4	97.1	0	97.7	100	99.5	0	99.6	97.8	91.7	100	97.3	98.6
Heavy Vehicles	1	2	0	3	0	3	0	3	9	3	0	12	18
% Heavy Vehicles	1.6	2.9	0	2.3	0	0.5	0	0.4	2.2	8.3	0	2.7	1.4

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Start Time	Right	Left	U-Turn	Right	Thru	U-Turn	Thru	Left	U-Turn	Int. Tota
06:00 AM	4	2	0	3	14	0	86	3	0	112
06:15 AM	2	1	0	8	18	0	120	8	0	157
06:30 AM	3	5	0	5	30	0	144	4	0	191
06:45 AM	9	11	0	5	38	0	153	16	0	232
Total	18	19	0	21	100	0	503	31	0	692
07:00 AM	5	3	0	7	43	0	190	7	0	255
07:15 AM	6	8	0	3	50	0	210	6	0	283
07:30 AM	3	6	0	6	60	0	152	8	0	235
07:45 AM	15	9	0	9	54	0	189	12	0	288
Total	29	26	0	25	207	0	741	33	0	1061
08:00 AM	5	10	0	6	56	0	173	4	0	254
08:15 AM	6	12	0	8	64	0	213	8	0	311
08:30 AM	2	8	0	14	64	0	146	3	0	237
08:45 AM	4	5	0	14	68	0	176	8	0	275
Total	17	35	0	42	252	0	708	23	0	1077
09:00 AM	3	8	0	22	84	0	139	8	0	264
09:15 AM	12	7	0	18	85	0	115	12	0	249
09:30 AM	7	11	0	16	78	0	103	8	0	223
09:45 AM	9	10	0	9	75	0	94	8	0	205
Total	31	36	0	65	322	0	451	36	0	941
10:00 AM	7	9	0	20	69	0	78	3	0	186
10:15 AM	7	10	0	15	66	0	101	4	0	203
10:30 AM	8	14	0	16	105	0	94	4	0	241
10:45 AM	8	11	0	22	83	0	80	7	0	211
Total	30	44	0	73	323	0	353	18	0	841
11:00 AM	7	14	0	15	89	0	69	1	0	195
11:15 AM	12	11	0	17	72	0	88	5	0	205
11:30 AM	3	10	0	18	90	0	83	5	0	209
11:45 AM	9	24	0	18	69	0	82	5	0	207
Total	31	59	0	68	320	0	322	16	0	816
12:00 PM	5	15	0	15	93	0	78	8	0	214
12:15 PM	10	10	0	9	96	0	103	7	0	235
12:30 PM	8	13	0	18	87	0	74	8	0	208
12:45 PM	12	12	0	11	85	0	78	4	0	202
Total	35	50	0	53	361	0	333	27	0	859
01:00 PM	10	16	0	14	88	0	99	4	0	231
01:15 PM	5	19	0	13	103	0	73	6	0	219
01:30 PM	6	10	0	22	77	0	84	8	0	207
01:45 PM	5	9	0	14	83	0	91	8	0	210
Total	26	54	0	63	351	0	347	26	0	867
02:00 PM	10	18	0	15	80	0	77	8	0	208
02:15 PM	12	12	0	16	69	0	80	6	0	195
02:30 PM	15	10	0	25	82	0	73	7	0	212
02:45 PM	17	11	0	14	92	0	85	5	0	224
Total	54	51	0	70	323	0	315	26	0	839
03:00 PM	13	8	0	22	83	0	95	8	0	229
03:15 PM	9	14	0	13	105	0	82	2	0	225
03:30 PM	16	10	0	28	117	0	85	9	0	265
03:45 PM	10	17	0	27	127	0	93	8	0	282
Total	48	49	0	90	432	0	355	27	0	1001

N: Knox Trail
E/W: Powder Mill Road (Route 62)
City, State: Concord, MA
Client: Nitsch Engineering/ N. Havea

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Groups Printed- Cars

	Knox Tral From North			Powder Mill Road (Route 62) From East			Powder Mill Road (Route 62) From West			
Start Time	Right	Left	U-Turn	Right	Thru	U-Turn	Thru	Left	U-Turn	Int. Total
04:00 PM	15	12	0	25	129	0	73	7	0	261
04:15 PM	10	8	0	25	133	0	81	4	0	261
04:30 PM	13	24	0	25	134	0	88	7	0	291
04:45 PM	13	14	0	25	161	0	100	6	0	319
Total	51	58	0	100	557	0	342	24	0	1132
05:00 PM	17	20	0	22	170	0	90	11	1	331
05:15 PM	12	18	0	22	143	0	96	12	0	303
05:30 PM	15	17	0	21	163	0	91	5	0	312
05:45 PM	17	11	0	22	166	0	118	5	0	339
Total	61	66	0	87	642	0	395	33	1	1285
Grand Total	431	547	0	757	4190	0	5165	320	1	11411
Apprch %	44.1	55.9	0	15.3	84.7	0	94.1	5.8	0	
Total %	3.8	4.8	0	6.6	36.7	0	45.3	2.8	0	

	Knox Tral From North				Powder Mill Road (Route 62) From East				Powder Mill Road (Route 62) From West				
Start Time	Right	Left	U-Turn	App. Total	Right	Thru	U-Turn	App. Total	Thru	Left	U-Turn	App. Total	Int. Total
Peak Hour Analysis From 06.00 AM to 12:00 PM - Peak 1 of 1													
Peak Hour for Entire Intersection Begins at 07:45 AM													
07:45 AM	**15**	9	0	**24**	9	54	0	63	189	**12**	0	201	288
08:00 AM	5	10	0	15	6	56	0	62	173	4	0	177	254
08:15 AM	6	**12**	0	18	8	**64**	0	72	**213**	8	0	**221**	**311**
08:30 AM	2	8	0	10	**14**	64	0	**78**	146	3	0	149	237
Total Volume	28	39	0	67	37	238	0	275	721	27	0	748	1090
% App. Total	41.8	58.2	0		13.5	86.5	0		96.4	3.6	0		
PHF	467	.813	.000	.698	.661	.930	.000	.881	.846	.563	.000	.846	.876
Peak Hour Analysis From 12:15 PM to 05:45 PM - Peak 1 of 1													
Peak Hour for Entire Intersection Begins at 05:00 PM													
05:00 PM	**17**	**20**	0	**37**	**22**	**170**	0	**192**	90	11	**1**	102	331
05:15 PM	12	18	0	30	22	143	0	165	96	**12**	0	108	303
05:30 PM	15	17	0	32	21	163	0	184	91	5	0	96	312
05:45 PM	17	11	0	28	22	166	0	188	**118**	5	0	**123**	**339**
Total Volume	61	66	0	127	87	642	0	729	395	33	1	429	1285
% App. Total	48	52	0		11.9	88.1	0		92.1	7.7	0.2		
PHF	897	825	.000	.858	.989	.944	.000	.949	.837	.688	.250	872	.948

N: Knox Trail
E/W: Powder Mill Road (Route 62)
City, State: Concord, MA
Client: Nitsch Engineering/ N. Havan

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File Name : 143908 A
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Groups Printed- Heavy Vehicles

	Knox Tral From North			Powder Mill Road (Route 62) From East			Powder Mill Road (Route 62) From West			
Start Time	Right	Left	U-Turn	Right	Thru	U-Turn	Thru	Left	U-Turn	Int. Tota
06:00 AM	2	1	0	0	2	0	3	0	0	8
06:15 AM	2	0	0	0	0	0	1	0	0	3
06:30 AM	1	9	0	0	1	0	3	0	0	14
06:45 AM	2	3	0	0	1	0	0	0	0	6
Total	7	13	0	0	4	0	7	0	0	31
07:00 AM	6	0	0	3	2	0	1	1	0	13
07:15 AM	2	0	0	1	0	0	0	2	0	5
07:30 AM	5	1	0	1	1	0	3	4	0	15
07:45 AM	0	1	0	1	3	0	3	3	0	11
Total	13	2	0	6	6	0	7	10	0	44
08:00 AM	2	4	0	2	2	0	3	2	0	15
08:15 AM	2	2	0	2	4	0	6	3	0	19
08:30 AM	0	3	0	1	2	0	6	2	0	14
08:45 AM	4	1	0	1	3	0	2	1	0	12
Total	8	10	0	6	11	0	17	8	0	60
09:00 AM	0	1	0	0	2	0	1	2	0	6
09:15 AM	0	1	0	2	4	0	0	1	0	8
09:30 AM	3	1	0	1	2	0	2	5	0	14
09:45 AM	6	3	0	7	1	0	4	3	0	24
Total	9	6	0	10	9	0	7	11	0	52
10:00 AM	2	3	0	1	2	0	5	2	0	15
10:15 AM	2	2	0	2	0	0	1	6	0	13
10:30 AM	2	1	0	2	1	0	1	4	0	11
10:45 AM	3	3	0	2	6	0	0	1	0	15
Total	9	9	0	7	9	0	7	13	0	54
11:00 AM	1	0	0	2	4	0	4	2	0	13
11:15 AM	3	2	0	2	2	0	4	4	0	17
11:30 AM	3	4	0	5	5	0	5	3	0	25
11:45 AM	0	2	0	4	4	0	5	0	0	15
Total	7	8	0	13	15	0	18	9	0	70
12:00 PM	3	0	0	1	0	0	4	4	0	12
12:15 PM	2	3	0	1	5	0	1	3	0	15
12:30 PM	5	0	0	1	5	0	1	3	0	15
12:45 PM	0	1	0	1	5	0	4	3	0	14
Total	10	4	0	4	15	0	10	13	0	56
01:00 PM	4	4	0	3	4	0	3	5	0	23
01:15 PM	5	1	0	3	2	0	4	2	0	17
01:30 PM	4	0	0	0	3	0	4	1	0	12
01:45 PM	5	0	0	5	2	0	3	9	0	24
Total	18	5	0	11	11	0	14	17	0	76
02:00 PM	1	0	0	3	1	0	2	3	0	10
02:15 PM	5	1	0	3	3	0	3	6	0	21
02:30 PM	3	1	0	4	3	0	2	2	0	15
02:45 PM	2	1	0	1	3	0	5	4	0	16
Total	11	3	0	11	10	0	12	15	0	62
03:00 PM	2	1	0	0	3	0	1	7	0	14
03:15 PM	2	2	0	0	2	0	1	3	0	10
03:30 PM	3	1	0	2	3	0	3	2	0	14
03:45 PM	1	0	0	2	0	0	3	3	0	9
Total	8	4	0	4	8	0	8	15	0	47

N: Knox Trail
E/W: Powder Mill Road (Route 62)
City, State: Concord, MA
Client: Nitsch Engineering/ N. Havan

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Groups Printed- Heavy Vehicles

	Knox Tral From North			Powder Mill Road (Route 62) From East			Powder Mill Road (Route 62) From West			
Start Time	Right	Left	U-Turn	Right	Thru	U-Turn	Thru	Left	U-Turn	Int. Total
04:00 PM	2	1	0	1	4	0	1	1	0	10
04:15 PM	1	0	0	0	0	0	0	3	0	4
04:30 PM	0	1	0	2	1	0	0	1	0	5
04:45 PM	0	0	0	0	1	0	2	1	0	4
Total	3	2	0	3	6	0	3	6	0	23
05:00 PM	0	1	0	0	1	0	7	0	0	9
05:15 PM	1	0	0	0	1	0	1	1	0	4
05:30 PM	0	1	0	0	0	0	1	1	0	3
05:45 PM	0	0	0	0	1	0	0	1	0	2
Total	1	2	0	0	3	0	9	3	0	18
Grand Total	104	68	0	75	107	0	119	120	0	593
Apprch %	60.5	39.5	0	41.2	58.8	0	49.8	50.2	0	
Total %	17.5	11.5	0	12.6	18	0	20.1	20.2	0	

	Knox Tral From North				Powder Mill Road (Route 62) From East				Powder Mill Road (Route 62) From West				
Start Time	Right	Left	U-Turn	App. Total	Right	Thru	U-Turn	App. Total	Thru	Left	U-Turn	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 12:00 PM - Peak 1 of 1													
Peak Hour for Entire Intersection Begins at 10:45 AM													
10:45 AM	**3**	3	0	6	2	**6**	0	8	0	1	0	1	15
11:00 AM	1	0	0	1	2	4	0	6	4	2	0	6	13
11:15 AM	3	2	0	5	2	2	0	4	4	**4**	0	**8**	17
11:30 AM	3	**4**	0	7	**5**	5	0	**10**	**5**	3	0	8	**25**
Total Volume	10	9	0	19	11	17	0	28	13	10	0	23	70
% App. Total	52.6	47.4	0		39.3	60.7	0		56.5	43.5	0		
PHF	.833	.563	.000	.679	.550	.708	.000	.700	.650	.625	.000	.719	.700
Peak Hour Analysis From 12:15 PM to 05:45 PM - Peak 1 of 1													
Peak Hour for Entire Intersection Begins at 01:00 PM													
01:00 PM	4	**4**	0	**8**	3	**4**	0	**7**	3	5	0	8	23
01:15 PM	**5**	1	0	6	3	2	0	5	**4**	2	0	6	17
01:30 PM	4	0	0	4	0	3	0	3	4	1	0	5	12
01:45 PM	5	0	0	5	**5**	2	0	7	3	**9**	0	**12**	**24**
Total Volume	18	5	0	23	11	11	0	22	14	17	0	31	76
% App. Total	78.3	21.7	0		50	50	0		45.2	54.8	0		
PHF	.900	.313	.000	.719	.550	.688	.000	.786	.875	.472	.000	.646	.792

N: Knox Trail
E/W: Powder Mill Road (Route 62)
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Client: Nitsch Engineering/ N. Havan

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File Name : 143908 A
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Groups Printed- Peds and Bicycles

	Knox Tral From North			Powder Mill Road (Route 62) From East			Powder Mill Road (Route 62) From West			
Start Time	Right	Left	Peds	Right	Thru	Peds	Thru	Left	Peds	Int. Tota
06:00 AM	0	0	0	0	0	0	0	0	0	0
06:15 AM	0	0	0	0	0	0	0	0	0	0
06:30 AM	0	0	0	0	0	0	0	0	0	0
06:45 AM	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0
07:00 AM	0	0	1	0	0	0	0	0	0	1
07:15 AM	0	0	0	0	0	0	0	0	0	0
07:30 AM	0	0	0	0	0	0	0	0	0	0
07:45 AM	0	0	0	0	1	0	0	0	0	1
Total	0	0	1	0	1	0	0	0	0	2
08:00 AM	0	0	0	0	0	0	0	0	0	0
08:15 AM	0	0	0	0	0	0	1	0	0	1
08:30 AM	0	0	0	0	0	0	0	0	0	0
08:45 AM	0	0	0	0	0	0	1	0	0	1
Total	0	0	0	0	0	0	2	0	0	2
09:00 AM	0	0	0	0	0	0	0	0	0	0
09:15 AM	0	0	0	0	0	0	0	0	0	0
09:30 AM	0	0	0	0	0	0	0	0	0	0
09:45 AM	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0
10:00 AM	0	0	0	0	0	0	1	0	0	1
10:15 AM	0	0	0	0	1	0	0	0	0	1
10:30 AM	0	0	0	0	0	0	0	0	0	0
10:45 AM	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	1	0	1	0	0	2
11:00 AM	0	0	0	0	0	0	0	0	0	0
11:15 AM	0	0	0	0	0	0	0	0	0	0
11:30 AM	0	0	0	0	1	0	0	0	0	1
11:45 AM	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	1	0	0	0	0	1
12:00 PM	0	0	0	0	0	0	0	0	0	0
12:15 PM	0	0	0	0	0	0	0	0	0	0
12:30 PM	0	0	0	0	0	0	1	0	0	1
12:45 PM	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	1	0	0	1
01:00 PM	0	0	0	0	0	0	0	0	0	0
01:15 PM	0	0	0	0	0	0	0	0	0	0
01:30 PM	0	0	0	0	0	0	0	0	0	0
01:45 PM	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0
02:00 PM	0	0	0	0	0	0	0	0	0	0
02:15 PM	0	0	0	0	0	0	0	0	0	0
02:30 PM	0	0	0	0	0	0	0	0	0	0
02:45 PM	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0
03:00 PM	0	0	0	0	0	0	0	0	0	0
03:15 PM	0	0	0	0	0	0	0	0	0	0
03:30 PM	0	0	0	0	0	0	0	0	0	0
03:45 PM	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0

N: Knox Trail
E/W: Powder Mill Road (Route 62)
City, State: Concord, MA
Client: Nitsch Engineering/ N. Havan

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Groups Printed- Peds and Bicycles

	Knox Tral From North			Powder Mill Road (Route 62) From East			Powder Mill Road (Route 62) From West			
Start Time	Right	Left	Peds	Right	Thru	Peds	Thru	Left	Peds	Int. Total
04:00 PM	0	0	0	0	0	0	0	0	0	0
04:15 PM	0	0	0	0	1	0	0	0	0	1
04:30 PM	0	0	0	0	0	0	0	0	0	0
04:45 PM	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	1	0	0	0	0	1
05:00 PM	0	0	0	0	1	0	0	0	0	1
05:15 PM	0	0	0	0	0	0	0	0	0	0
05:30 PM	0	0	0	0	0	0	0	0	0	0
05:45 PM	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	1	0	0	0	0	1
Grand Total	0	0	1	0	5	0	4	0	0	10
Apprch %	0	0	100	0	100	0	100	0	0	
Total %	0	0	10	0	50	0	40	0	0	

	Knox Tral From North				Powder Mill Road (Route 62) From East				Powder Mill Road (Route 62) From West				
Start Time	Right	Left	Peds	App. Total	Right	Thru	Peds	App. Total	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 12:00 PM - Peak 1 of 1													
Peak Hour for Entire Intersection Begins at 07:00 AM													
07:00 AM	0	0	1	1	0	0	0	0	0	0	0	0	1
07:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 AM	0	0	0	0	0	1	0	1	0	0	0	0	1
Total Volume	0	0	1	1	0	1	0	1	0	0	0	0	2
% App. Total	0	0	100		0	100	0		0	0	0		
PHF	.000	.000	.250	.250	.000	.250	.000	.250	.000	.000	.000	.000	.500
Peak Hour Analysis From 12:15 PM to 05:45 PM - Peak 1 of 1													
Peak Hour for Entire Intersection Begins at 04:15 PM													
04:15 PM	0	0	0	0	0	1	0	1	0	0	0	0	1
04:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0
04:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0
05:00 PM	0	0	0	0	0	1	0	1	0	0	0	0	1
Total Volume	0	0	0	0	0	2	0	2	0	0	0	0	2
% App. Total	0	0	0		0	100	0		0	0	0		
PHF	.000	.000	.000	.000	.000	.500	.000	.500	.000	.000	.000	.000	.500

N: Knox Trail
E/W: Powder Mill Road (Route 62)
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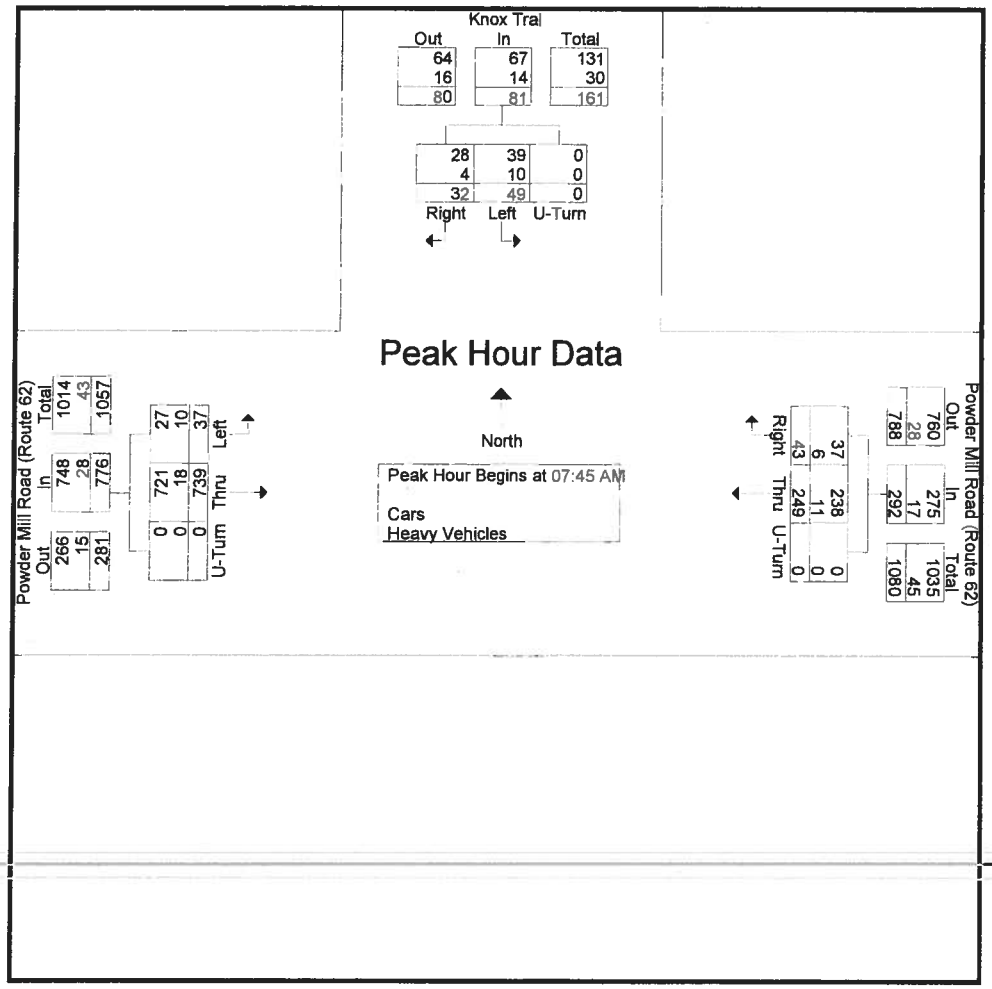
	Knox Tral From North				Powder Mill Road (Route 62) From East				Powder Mill Road (Route 62) From West				
Start Time	Right	Left	U-Turn	App. Total	Right	Thru	U-Turn	App. Total	Thru	Left	U-Turn	App. Total	Int. Tota
Peak Hour Analysis From 06:00 AM to 12:00 PM - Peak 1 of 1													
Peak Hour for Entire Intersection Begins at 07:45 AM													
07:45 AM	**15**	10	0	**25**	10	57	0	67	192	**15**	0	207	299
08:00 AM	7	**14**	0	21	8	58	0	66	176	6	0	182	269
08:15 AM	8	14	0	22	10	**68**	0	78	**219**	11	0	**230**	**330**
08:30 AM	2	11	0	13	**15**	66	0	**81**	152	5	0	157	251
Total Volume	32	49	0	81	43	249	0	292	739	37	0	776	1149
% App. Total	39.5	60.5	0		14.7	85.3	0		95.2	4.8	0		
PHF	.533	.875	.000	.810	.717	.915	.000	.901	.844	.617	.000	.843	.870
Cars	28	39	0	67	37	238	0	275	721	27	0	748	1090
% Cars	87.5	79.6	0	82.7	86.0	95.6	0	94.2	97.6	73.0	0	96.4	94.9
Heavy Vehicles	4	10	0	14	6	11	0	17	18	10	0	28	59
% Heavy Vehicles	12.5	20.4	0	17.3	14.0	4.4	0	5.8	2.4	27.0	0	3.6	5.1



N: Knox Trail
E/W: Powder Mill Road (Route 62)
City, State: Concord, MA
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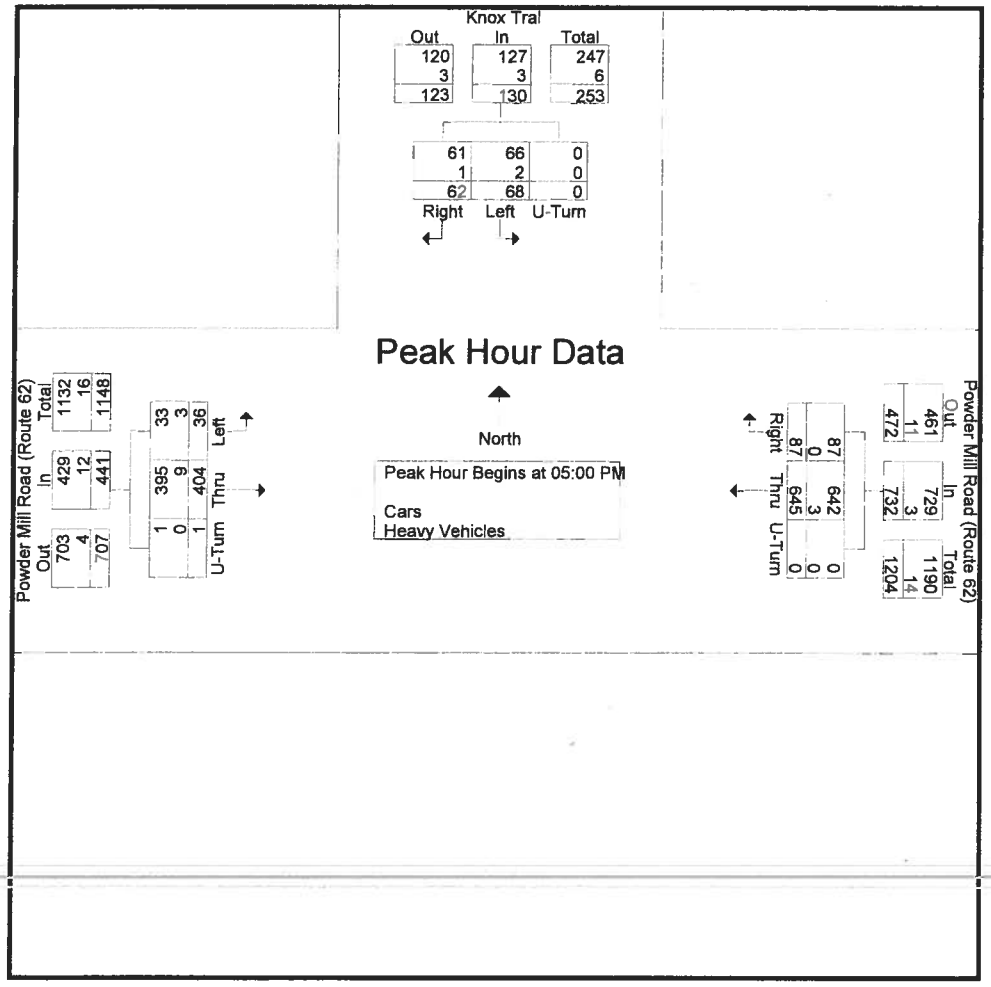
	Knox Tral From North				Powder Mill Road (Route 62) From East				Powder Mill Road (Route 62) From West				
Start Time	Right	Left	U-Turn	App. Total	Right	Thru	U-Turn	App. Total	Thru	Left	U-Turn	App. Total	Int. Total
Peak Hour Analysis From 12:15 PM to 05:45 PM - Peak 1 of 1													
Peak Hour for Entire Intersection Begins at 05:00 PM													
05:00 PM	**17**	**21**	0	**38**	**22**	**171**	0	**193**	97	11	**1**	109	340
05:15 PM	13	18	0	31	22	144	0	166	97	**13**	0	110	307
05:30 PM	15	18	0	33	21	163	0	184	92	6	0	98	315
05:45 PM	17	11	0	28	22	167	0	189	**118**	6	0	**124**	**341**
Total Volume	62	68	0	130	87	645	0	732	404	36	1	441	1303
% App. Total	47.7	52.3	0		11.9	88.1	0		91.6	8.2	0.2		
PHF	.912	.810	.000	.855	.989	.943	.000	.948	.856	.692	.250	.889	.955
Cars	61	66	0	127	87	642	0	729	395	33	1	429	1285
% Cars	98.4	97.1	0	97.7	100	99.5	0	99.6	97.8	91.7	100	97.3	98.6
Heavy Vehicles	1	2	0	3	0	3	0	3	9	3	0	12	18
% Heavy Vehicles	1.6	2.9	0	2.3	0	0.5	0	0.4	2.2	8.3	0	2.7	1.4



Section A-2

Crash Data

MassDOT

MassDOT Crash Report for ACTON and CONCORD for the year 2010

Crash Number	City/Town Name	Crash Date	Crash Time	Crash Severity	Number of Vehicles	Total Nonfatal Injuries	Total Fatal Injuries	Manner of Collision	Vehicle Action Prior to Crash	Vehicle Travel Direction	Most Harmful Event	Vehicle Configuration	Road Surface Condition	Ambient Light	Weather Condition	At Roadway Intersection
2619145	CONCORD	08-Jul-2010	6:36 PM	Property damage only (none injured)	2	0	0	Rear-end	V1: Traveling straight ahead / V2:Stopped or slowed in traffic	V1:Eastbound / V2:Eastbound	V1: Collision with motor vehicle in traffic / V2: Collision with motor vehicle in traffic	V1: Passenger car / V2:Light truck(van, mini-van, panel, pickup, sport utility) with only four tires	Dry	Daylight	Clear	
2678193	ACTON	22-Dec-2010	3:35 PM	Property damage only (none injured)	2	0	0	Angle	V1: Traveling straight ahead / V2:Turning right	V1:Westbound / V2:Westbound	V1: Collision with motor vehicle in traffic / V2: Collision with motor vehicle in traffic	V1: Passenger car / V2:Unknown heavy truck, cannot classify	Wet	Daylight	Snow	POWDER MILL ROAD / KNOX TRAIL

MassDOT

MassDOT Crash Report for ACTON and CONCORD for the year 2011

Crash Number	City/Town Name	Crash Date	Crash Time	Crash Severity	Number of Vehicles	Total Nonfatal Injuries	Total Fatal Injuries	Manner of Collision	Vehicle Action Prior to Crash	Vehicle Travel Directions	Most Harmful Events	Vehicle Configuration	Road Surface Condition	Ambient Light	Weather Condition	At Roadway Intersection
2792390	ACTON	06-Oct-2011	7:32 PM	Property damage only (none injured)	1	0	0	Single vehicle crash	V1: Traveling straight ahead	V1:Southbound	V1: Collision with tree	V1: Passenger car	Dry	Dark - roadway not lighted	Clear	
2808753	CONCORD	21-Nov-2011	6:54 PM	Non-fatal injury	2	1	0	Angle	V1: Traveling straight ahead / V2:Traveling straight ahead	V1:Westbound / V2:Eastbound	V1: Collision with motor vehicle in traffic / V2: Collision with motor vehicle in traffic	V1: Motorcycle / V2:Passenger car	Dry	Dark - roadway not lighted	Clear	

MassDOT

MassDOT Crash Report for ACTON and CONCORD for the year 2012

Crash Number	City/Town Name	Crash Date	Crash Time	Crash Severity	Number of Vehicles	Total Nonfatal Injuries	Total Fatal Injuries	Manner of Collision	Vehicle Action Prior to Crash	Vehicle Travel Directions	Most Harmful Events	Vehicle Configuration	Road Surface Condition	Ambient Light	Weather Condition	At Roadway Intersection
3147561	CONCORD	06 Jun 2012	7:58 AM	Property damage only (none injured)	2	0	0	Angle	V1: Traveling straight ahead / V2:Turning left	V1:Westbound / V2:Southbound	V1: Collision with motor vehicle in traffic / V2: Collision with motor vehicle in traffic	V1: Passenger car / V2:Passenger car	Dry	Daylight	Cloudy	

Section A-3

Capacity Analysis

Lanes, Volumes, Timings
3:

6/17/2014

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	0	0	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt						
Flt Protected						
Satd. Flow (prot)	0	0	0	0	0	0
Flt Permitted						
Satd. Flow (perm)	0	0	0	0	0	0
Right Turn on Red	Yes			Yes	Yes	Yes
Satd. Flow (RTOR)						
Link Speed (mph)		30	30		30	
Link Distance (ft)		352	313		352	
Travel Time (s)		8.0	7.1		8.0	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	0	0	0
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	0	0	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(ft)		0	0		0	
Link Offset(ft)		0	0		0	
Crosswalk Width(ft)		16	16		16	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15			9	15	9
Turn Type						
Protected Phases						
Permitted Phases						
Minimum Split (s)						
Total Split (s)						
Total Split (%)						
Maximum Green (s)						
Yellow Time (s)						
All-Red Time (s)						
Lost Time Adjust (s)						
Total Lost Time (s)						
Lead/Lag						
Lead-Lag Optimize?						
Act Effct Green (s)						
Actuated g/C Ratio						
v/c Ratio						
Control Delay						
Queue Delay						
Total Delay						
LOS						
Approach Delay						
Approach LOS						
Stops (vph)						

Lanes, Volumes, Timings
3: 6/17/2014

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Fuel Used(gal)						
CO Emissions (g/hr)						
NOx Emissions (g/hr)						
VOC Emissions (g/hr)						
Dilemma Vehicles (#)						
Queue Length 50th (ft)						
Queue Length 95th (ft)						
Internal Link Dist (ft)		272	233		272	
Turn Bay Length (ft)						
Base Capacity (vph)						
Starvation Cap Reductn						
Spillback Cap Reductn						
Storage Cap Reductn						
Reduced v/c Ratio						

Intersection Summary

Area Type: Other
Cycle Length: 80
Actuated Cycle Length: 80
Offset: 0 (0%), Referenced to phase 2: and 6:, Start of Green
Natural Cycle: 40
Control Type: Pretimed
Maximum v/c Ratio: 0.00
Intersection Signal Delay: 0.0 Intersection LOS: A
Intersection Capacity Utilization 0.0% ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 3:

Lanes, Volumes, Timings
6: 6/17/2014

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	31	510	104	21	32	25
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.977		0.941	
Flt Protected		0.997			0.973	
Satd. Flow (prot)	0	1857	1820	0	1706	0
Flt Permitted		0.997			0.973	
Satd. Flow (perm)	0	1857	1820	0	1706	0
Link Speed (mph)		35	35		30	
Link Distance (ft)		456	656		330	
Travel Time (s)		8.9	12.8		7.5	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	34	554	113	23	35	27
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	588	136	0	62	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(ft)		0	0		12	
Link Offset(ft)		0	0		0	
Crosswalk Width(ft)		16	16		16	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15			9	15	9
Sign Control		Free	Free		Stop	

Intersection Summary

Area Type: Other
Control Type: Unsignalized
Intersection Capacity Utilization 48.6% ICU Level of Service A
Analysis Period (min) 15

Lanes, Volumes, Timings
3: 6/17/2014

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	0	0	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt						
Flt Protected						
Satd. Flow (prot)	0	0	0	0	0	0
Flt Permitted						
Satd. Flow (perm)	0	0	0	0	0	0
Right Turn on Red	Yes			Yes	Yes	Yes
Satd. Flow (RTOR)						
Link Speed (mph)		30	30		30	
Link Distance (ft)		352	313		352	
Travel Time (s)		8.0	7.1		8.0	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	0	0	0
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	0	0	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(ft)		0	0		0	
Link Offset(ft)		0	0		0	
Crosswalk Width(ft)		16	16		16	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15			9	15	9
Turn Type						
Protected Phases						
Permitted Phases						
Minimum Split (s)						
Total Split (s)						
Total Split (%)						
Maximum Green (s)						
Yellow Time (s)						
All-Red Time (s)						
Lost Time Adjust (s)						
Total Lost Time (s)						
Lead/Lag						
Lead-Lag Optimize?						
Act Effct Green (s)						
Actuated g/C Ratio						
v/c Ratio						
Control Delay						
Queue Delay						
Total Delay						
LOS						
Approach Delay						
Approach LOS						
Stops (vph)						

Lanes, Volumes, Timings
3: 6/17/2014

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Fuel Used(gal)						
CO Emissions (g/hr)						
NOx Emissions (g/hr)						
VOC Emissions (g/hr)						
Dilemma Vehicles (#)						
Queue Length 50th (ft)						
Queue Length 95th (ft)						
Internal Link Dist (ft)		272	233		272	
Turn Bay Length (ft)						
Base Capacity (vph)						
Starvation Cap Reductn						
Spillback Cap Reductn						
Storage Cap Reductn						
Reduced v/c Ratio						

Intersection Summary

Area Type: Other
Cycle Length: 80
Actuated Cycle Length: 80
Offset: 0 (0%), Referenced to phase 2: and 6:, Start of Green
Natural Cycle: 40
Control Type: Pretimed
Maximum v/c Ratio: 0.00
Intersection Signal Delay: 0.0 Intersection LOS: A
Intersection Capacity Utilization 0.0% ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 3:

Lanes, Volumes, Timings
6:

6/17/2014

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	19	318	157	37	15	11
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.974		0.942	
Flt Protected		0.997			0.972	
Satd. Flow (prot)	0	1857	1814	0	1706	0
Flt Permitted		0.997			0.972	
Satd. Flow (perm)	0	1857	1814	0	1706	0
Link Speed (mph)		35	35		30	
Link Distance (ft)		456	656		330	
Travel Time (s)		8.9	12.8		7.5	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	21	346	171	40	16	12
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	367	211	0	28	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(ft)		0	0		12	
Link Offset(ft)		0	0		0	
Crosswalk Width(ft)		16	16		16	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15			9	15	9
Sign Control		Free	Free		Stop	

Intersection Summary

Area Type: Other
Control Type: Unsignalized
Intersection Capacity Utilization 41.6% ICU Level of Service A
Analysis Period (min) 15

Lanes, Volumes, Timings
3: 6/17/2014

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	0	0	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt						
Flt Protected						
Satd. Flow (prot)	0	0	0	0	0	0
Flt Permitted						
Satd. Flow (perm)	0	0	0	0	0	0
Right Turn on Red	Yes			Yes	Yes	Yes
Satd. Flow (RTOR)						
Link Speed (mph)		30	30		30	
Link Distance (ft)		352	313		352	
Travel Time (s)		8.0	7.1		8.0	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	0	0	0
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	0	0	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(ft)		0	0		0	
Link Offset(ft)		0	0		0	
Crosswalk Width(ft)		16	16		16	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15			9	15	9
Turn Type						
Protected Phases						
Permitted Phases						
Minimum Split (s)						
Total Split (s)						
Total Split (%)						
Maximum Green (s)						
Yellow Time (s)						
All-Red Time (s)						
Lost Time Adjust (s)						
Total Lost Time (s)						
Lead/Lag						
Lead-Lag Optimize?						
Act Effct Green (s)						
Actuated g/C Ratio						
v/c Ratio						
Control Delay						
Queue Delay						
Total Delay						
LOS						
Approach Delay						
Approach LOS						
Stops (vph)						

Lanes, Volumes, Timings
3: 6/17/2014

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Fuel Used(gal)						
CO Emissions (g/hr)						
NOx Emissions (g/hr)						
VOC Emissions (g/hr)						
Dilemma Vehicles (#)						
Queue Length 50th (ft)						
Queue Length 95th (ft)						
Internal Link Dist (ft)		272	233		272	
Turn Bay Length (ft)						
Base Capacity (vph)						
Starvation Cap Reductn						
Spillback Cap Reductn						
Storage Cap Reductn						
Reduced v/c Ratio						

Intersection Summary

Area Type: Other
Cycle Length: 80
Actuated Cycle Length: 80
Offset: 0 (0%), Referenced to phase 2: and 6:, Start of Green
Natural Cycle: 40
Control Type: Pretimed
Maximum v/c Ratio: 0.00
Intersection Signal Delay: 0.0 Intersection LOS: A
Intersection Capacity Utilization 0.0% ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 3:

Lanes, Volumes, Timings
6: 6/17/2014

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	40	256	238	56	40	38
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.974		0.934	
Flt Protected		0.993			0.975	
Satd. Flow (prot)	0	1850	1814	0	1696	0
Flt Permitted		0.993			0.975	
Satd. Flow (perm)	0	1850	1814	0	1696	0
Link Speed (mph)		35	35		30	
Link Distance (ft)		456	656		330	
Travel Time (s)		8.9	12.8		7.5	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	43	278	259	61	43	41
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	321	320	0	84	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(ft)		0	0		12	
Link Offset(ft)		0	0		0	
Crosswalk Width(ft)		16	16		16	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15			9	15	9
Sign Control		Free	Free		Stop	

Intersection Summary

Area Type: Other
Control Type: Unsignalized
Intersection Capacity Utilization 46.2% ICU Level of Service A
Analysis Period (min) 15

Lanes, Volumes, Timings
3: 6/17/2014

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	0	0	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt						
Flt Protected						
Satd. Flow (prot)	0	0	0	0	0	0
Flt Permitted						
Satd. Flow (perm)	0	0	0	0	0	0
Right Turn on Red	Yes			Yes	Yes	Yes
Satd. Flow (RTOR)						
Link Speed (mph)		30	30		30	
Link Distance (ft)		352	313		352	
Travel Time (s)		8.0	7.1		8.0	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	0	0	0
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	0	0	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(ft)		0	0		0	
Link Offset(ft)		0	0		0	
Crosswalk Width(ft)		16	16		16	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15			9	15	9
Turn Type						
Protected Phases						
Permitted Phases						
Minimum Split (s)						
Total Split (s)						
Total Split (%)						
Maximum Green (s)						
Yellow Time (s)						
All-Red Time (s)						
Lost Time Adjust (s)						
Total Lost Time (s)						
Lead/Lag						
Lead-Lag Optimize?						
Act Effct Green (s)						
Actuated g/C Ratio						
v/c Ratio						
Control Delay						
Queue Delay						
Total Delay						
LOS						
Approach Delay						
Approach LOS						
Stops (vph)						

Lanes, Volumes, Timings
3: 6/17/2014

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Fuel Used(gal)						
CO Emissions (g/hr)						
NOx Emissions (g/hr)						
VOC Emissions (g/hr)						
Dilemma Vehicles (#)						
Queue Length 50th (ft)						
Queue Length 95th (ft)						
Internal Link Dist (ft)		272	233		272	
Turn Bay Length (ft)						
Base Capacity (vph)						
Starvation Cap Reductn						
Spillback Cap Reductn						
Storage Cap Reductn						
Reduced v/c Ratio						

Intersection Summary

Area Type: Other
Cycle Length: 80
Actuated Cycle Length: 80
Offset: 0 (0%), Referenced to phase 2: and 6:, Start of Green
Natural Cycle: 40
Control Type: Pretimed
Maximum v/c Ratio: 0.00
Intersection Signal Delay: 0.0 Intersection LOS: A
Intersection Capacity Utilization 0.0% ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 3:

Lanes, Volumes, Timings
6: 6/17/2014

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	31	510	104	21	61	25
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.977		0.961	
Flt Protected		0.997			0.966	
Satd. Flow (prot)	0	1857	1820	0	1729	0
Flt Permitted		0.997			0.966	
Satd. Flow (perm)	0	1857	1820	0	1729	0
Link Speed (mph)		35	35		30	
Link Distance (ft)		456	656		330	
Travel Time (s)		8.9	12.8		7.5	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	34	554	113	23	66	27
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	588	136	0	93	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(ft)		0	0		12	
Link Offset(ft)		0	0		0	
Crosswalk Width(ft)		16	16		16	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15			9	15	9
Sign Control		Free	Free		Stop	

Intersection Summary

Area Type: Other
Control Type: Unsignalized
Intersection Capacity Utilization 50.2% ICU Level of Service A
Analysis Period (min) 15

Lanes, Volumes, Timings
3: 6/17/2014

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	0	0	0	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt						
Flt Protected						
Satd. Flow (prot)	0	0	0	0	0	0
Flt Permitted						
Satd. Flow (perm)	0	0	0	0	0	0
Right Turn on Red	Yes			Yes	Yes	Yes
Satd. Flow (RTOR)						
Link Speed (mph)		30	30		30	
Link Distance (ft)		352	313		352	
Travel Time (s)		8.0	7.1		8.0	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	0	0	0
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	0	0	0	0	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(ft)		0	0		0	
Link Offset(ft)		0	0		0	
Crosswalk Width(ft)		16	16		16	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15			9	15	9
Turn Type						
Protected Phases						
Permitted Phases						
Minimum Split (s)						
Total Split (s)						
Total Split (%)						
Maximum Green (s)						
Yellow Time (s)						
All-Red Time (s)						
Lost Time Adjust (s)						
Total Lost Time (s)						
Lead/Lag						
Lead-Lag Optimize?						
Act Effct Green (s)						
Actuated g/C Ratio						
v/c Ratio						
Control Delay						
Queue Delay						
Total Delay						
LOS						
Approach Delay						
Approach LOS						
Stops (vph)						

Lanes, Volumes, Timings
3: 6/17/2014

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Fuel Used(gal)						
CO Emissions (g/hr)						
NOx Emissions (g/hr)						
VOC Emissions (g/hr)						
Dilemma Vehicles (#)						
Queue Length 50th (ft)						
Queue Length 95th (ft)						
Internal Link Dist (ft)		272	233		272	
Turn Bay Length (ft)						
Base Capacity (vph)						
Starvation Cap Reductn						
Spillback Cap Reductn						
Storage Cap Reductn						
Reduced v/c Ratio						

Intersection Summary

Area Type: Other
Cycle Length: 80
Actuated Cycle Length: 80
Offset: 0 (0%), Referenced to phase 2: and 6:, Start of Green
Natural Cycle: 40
Control Type: Pretimed
Maximum v/c Ratio: 0.00
Intersection Signal Delay: 0.0 Intersection LOS: A
Intersection Capacity Utilization 0.0% ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 3:

Lanes, Volumes, Timings
6: 6/17/2014

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	19	318	157	66	15	11
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.960		0.942	
Flt Protected		0.997			0.972	
Satd. Flow (prot)	0	1857	1788	0	1706	0
Flt Permitted		0.997			0.972	
Satd. Flow (perm)	0	1857	1788	0	1706	0
Link Speed (mph)		35	35		30	
Link Distance (ft)		456	656		330	
Travel Time (s)		8.9	12.8		7.5	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	21	346	171	72	16	12
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	367	243	0	28	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(ft)		0	0		12	
Link Offset(ft)		0	0		0	
Crosswalk Width(ft)		16	16		16	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15			9	15	9
Sign Control		Free	Free		Stop	

Intersection Summary

Area Type: Other
Control Type: Unsignalized
Intersection Capacity Utilization 42.3% ICU Level of Service A
Analysis Period (min) 15

Lanes, Volumes, Timings
6: 6/17/2014

Lane Group	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (vph)	40	256	238	56	69	38
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.974		0.952	
Flt Protected		0.993			0.969	
Satd. Flow (prot)	0	1850	1814	0	1718	0
Flt Permitted		0.993			0.969	
Satd. Flow (perm)	0	1850	1814	0	1718	0
Link Speed (mph)		35	35		30	
Link Distance (ft)		456	656		330	
Travel Time (s)		8.9	12.8		7.5	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	43	278	259	61	75	41
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	321	320	0	116	0
Enter Blocked Intersection	No	No	No	No	No	No
Lane Alignment	Left	Left	Left	Right	Left	Right
Median Width(ft)		0	0		12	
Link Offset(ft)		0	0		0	
Crosswalk Width(ft)		16	16		16	
Two way Left Turn Lane						
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15			9	15	9
Sign Control		Free	Free		Stop	

Intersection Summary

Area Type: Other
Control Type: Unsignalized
Intersection Capacity Utilization 47.8% ICU Level of Service A
Analysis Period (min) 15

RECORD OWNER

KT REALTY TRUST
BRIAN LI, TRUSTEE
NORTHBOROUGH, MA

REFERENCE

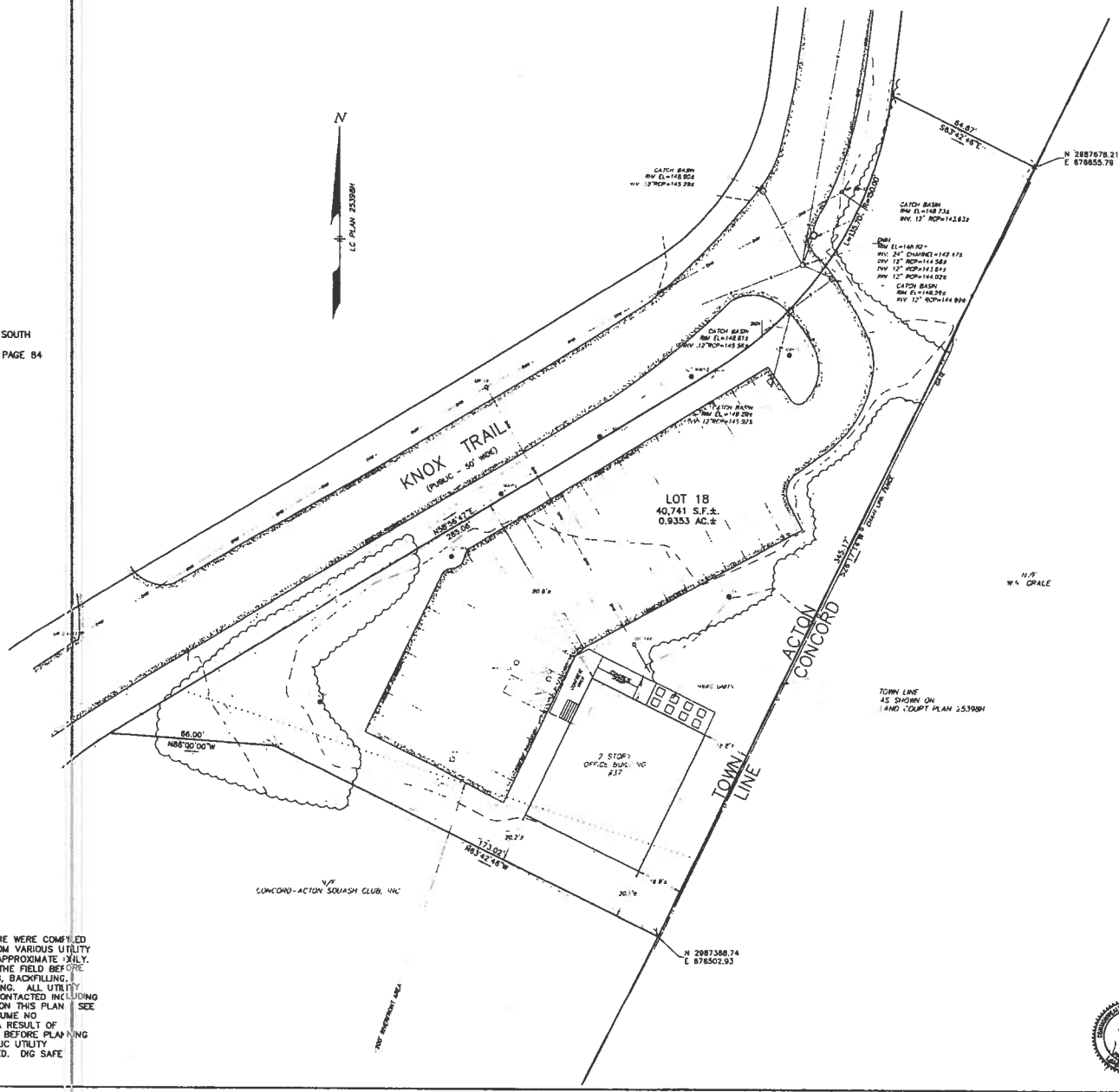
MIDDLESEX REGISTRY OF DEEDS SOUTH DISTRICT
LAND REGISTRATION BOOK 1417 PAGE 84
LAND COURT PLAN 25398H

DATUM

N.A.V.D OF 1988.

ZONING DISTRICT

TD (TECHNOLOGY DISTRICT)



LEGEND:

- N/F — NOW OR FORMERLY
- OVERHEAD WIRES
- TREE
- TREE LINE
- UP — UTILITY POLE
- GG — GAS GATE
- G — GAS SERVICE (BURIED)
- WG — WATER GATE
- W — WATER SERVICE (BURIED)
- DMH — DRAIN MANHOLE
- D — SUB-SURFACE DRAIN LINE
- EXISTING CONTOUR
- EXISTING CONTOUR
- LIGHTPOLE
- WETLAND FLAG
- 99.99 — SPOT ELEVATION
- STONE WALL

UTILITY NOTE:

ALL UNDERGROUND UTILITIES SHOWN HERE WERE COMPILED ACCORDING TO AVAILABLE RECORD PLANS FROM VARIOUS UTILITY COMPANIES AND PUBLIC AGENCIES AND ARE APPROXIMATE ONLY. ACTUAL LOCATIONS MUST BE DETERMINED IN THE FIELD BEFORE DESIGNING, EXCAVATING, BLASTING, INSTALLING, BACKFILLING, GRADING, PAVEMENT RESTORATION OR REPAIRING. ALL UTILITY COMPANIES, PUBLIC AND PRIVATE, MUST BE CONTACTED INCLUDING THOSE IN CONTROL OF UTILITIES NOT SHOWN ON THIS PLAN SEE CHAPTER 370, ACTS OF 1963 MASS. WE ASSUME NO RESPONSIBILITY FOR DAMAGES INCURRED AS A RESULT OF UTILITIES OMITTED OR INACCURATELY SHOWN. BEFORE PLANNING FUTURE CONNECTIONS THE APPROPRIATE PUBLIC UTILITY ENGINEERING DEPARTMENT MUST BE CONSULTED. DIG SAFE TELEPHONE No. 1-888-344-7233.

TOPOGRAPHIC
PLAN OF LAND
IN

CONCORD, MASSACHUSETTS

(MIDDLESEX COUNTY)

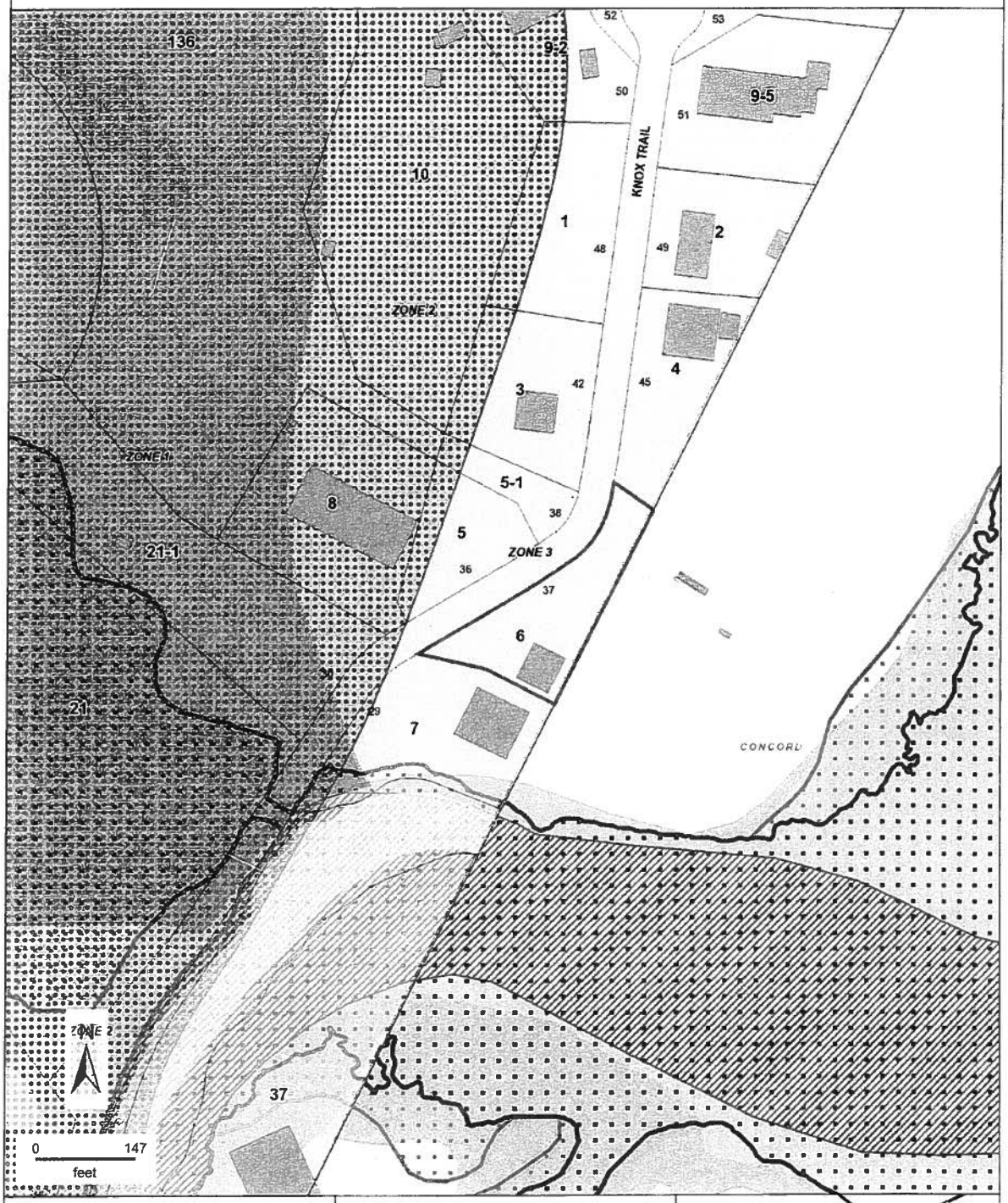
FOR: CONCORD PUBLIC SCHOOLS
SCALE: 1"=20' JUNE 13, 2014

STAMSKI AND MCNARY, INC.
1000 MAIN STREET ACTON, MASSACHUSETTS
ENGINEERING – PLANNING – SURVEYING

0 10 20 40 60 80 FT

(5263work.dwg) 37 Knox Trail SM-5263

37 Knox Trail

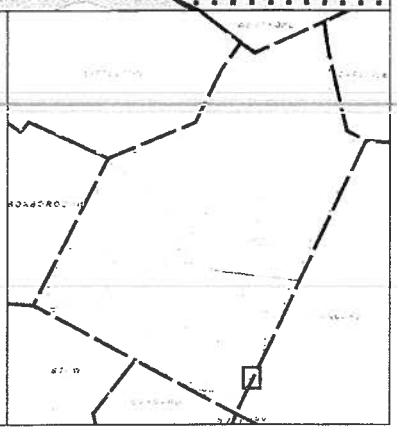


Property Information

Property ID J4-6
Location 37 KNOX TRL

MAP FOR REFERENCE ONLY
NOT A LEGAL DOCUMENT

This data set/map is for planning purposes only and should not be used for larger scale analysis. The Town of Acton shall not be held liable for any use of the data or images shown on this map, nor is any warranty of accuracy expressed. All uses of this data set/map are subject to field verification.



FLOOD ZONES

- 2014 FEMA Floodway
- 2014 FEMA Flood Zone - 100-year flood zone
- 2014 FEMA Flood Zone - 500-year flood zone
- 2010 FEMA Floodway
- 2010 FEMA Flood Zone- 100-year flood zone
- 2010 FEMA Flood Zone - 500-year flood zone

GROUNDWATER PROTECTION DISTRICTS

- OVERLAPPING ZONE 2

ZONES

- *ZONE 1*
- *ZONE 2*
- *ZONE 3*
- *ZONE 4*

NATURAL RESOURCES

- DEP RIVERS & STREAMS

DEP WETLANDS

- *WET AREAS*
- *PONDS*

BASE MAP

- POOLS

STRUCTURES

- *BUILDING*
- *DECK*
- *FOUNDATION*
- *FUEL TANK*
- *MOBILE*
- *PORCH*
- *RUINS*
- *SMOKESTACK*
- *WATERTANK*

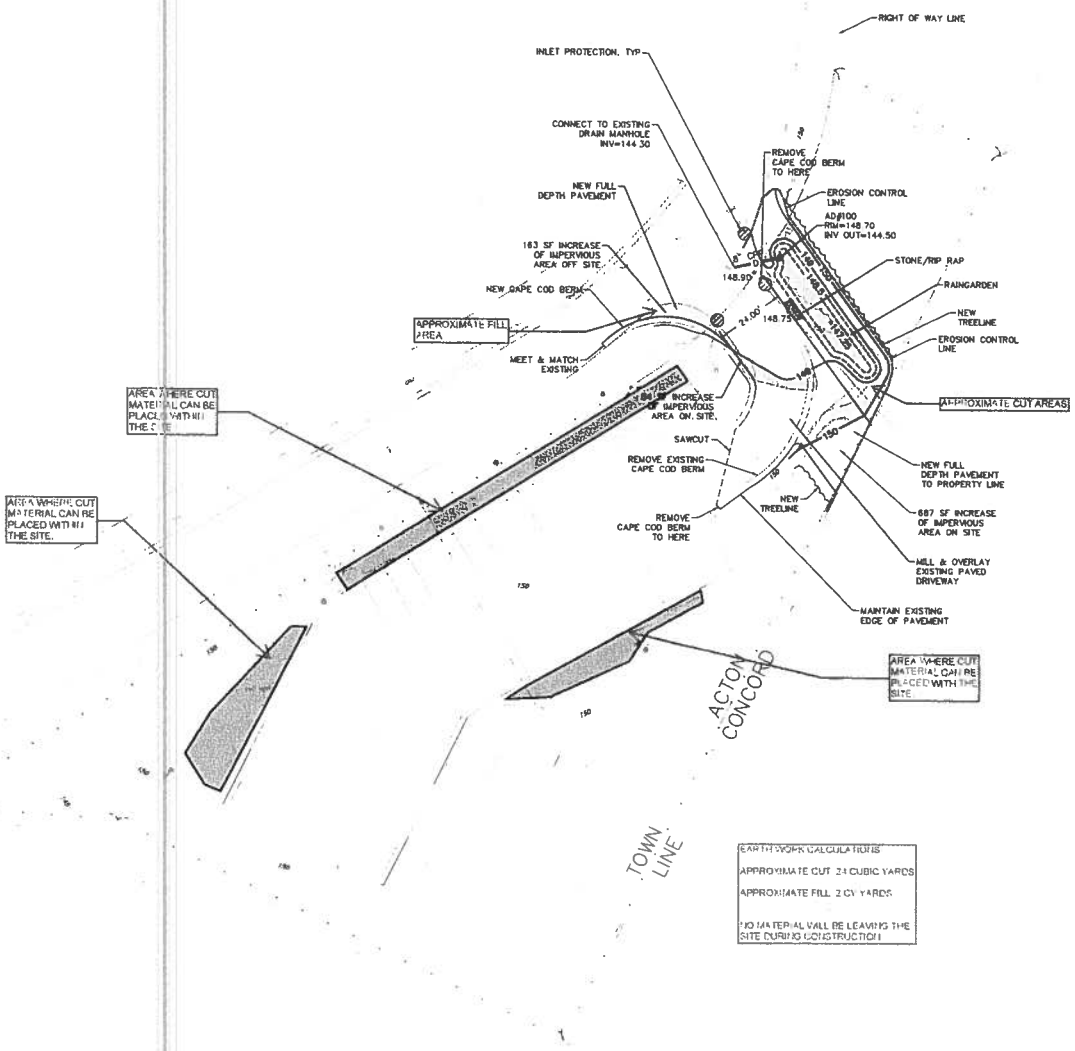
- SPORTS FACILITY / AREAS

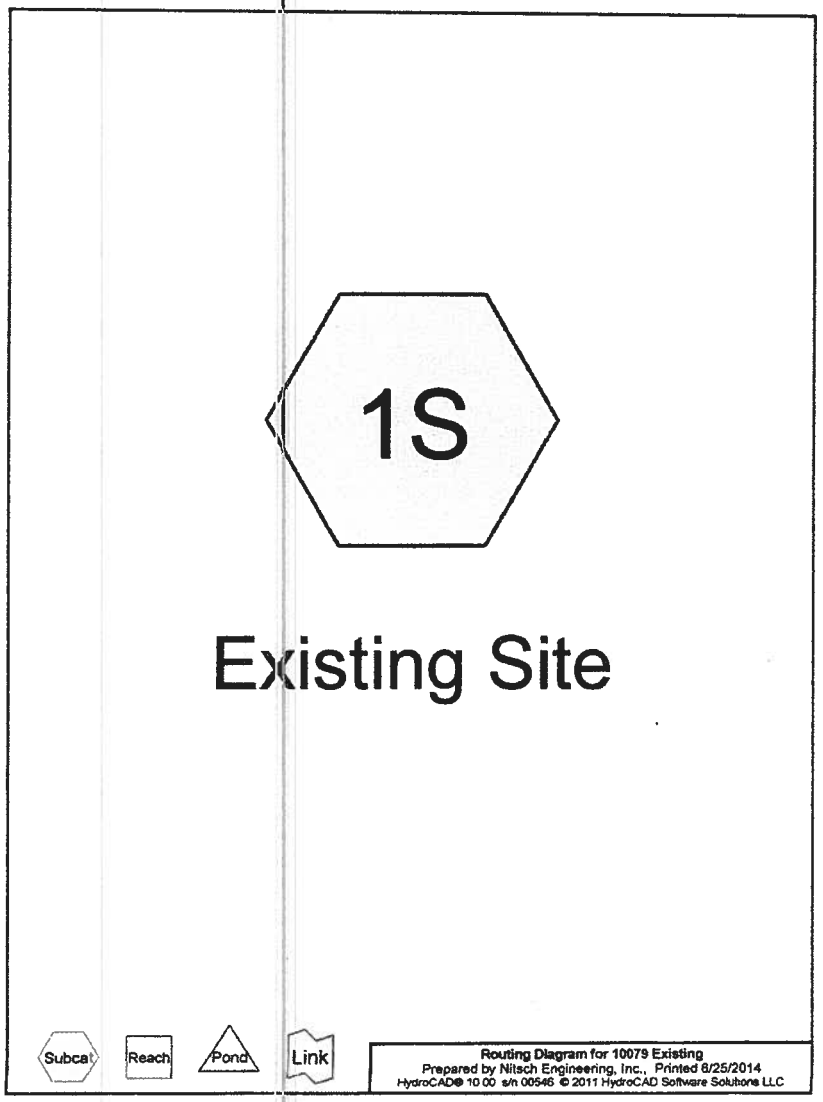
TOWN DATA

POINTS OF INTEREST

- *CONSERVATION*
- *HISTORICAL*
- *MUNICIPAL*
- *OTHER GOVERNMENT*
- *PUBLIC SAFETY*
- *RECREATION*
- *SCHOOL*

- PARCELS
- TOWN BOUNDARY


RIGHT OF WAY LINE
INLET PROTECTION, TYP
CONNECT TO EXISTING DRAIN MANHOLE INV=144.30
REMOVE CAPE COD BERM TO HERE
NEW FULL DEPTH PAVEMENT
EROSION CONTROL LINE
AD#100 RIM=148.70 INV OUT=144.50
163 SF INCREASE OF IMPERVIOUS AREA OFF SITE.
STONE/RIP RAP
NEW CAPE COD BERM
RAINGARDEN
APPROXIMATE FILL AREA
NEW TREELINE
EROSION CONTROL LINE
MEET & MATCH EXISTING
AREA WHERE CUT MATERIAL CAN BE PLACED WITHIN THE SITE
INCREASE OF IMPERVIOUS AREA ON SITE.
APPROXIMATE CUT AREAS
SAWCUT
REMOVE EXISTING CAPE COD BERM
NEW FULL DEPTH PAVEMENT TO PROPERTY LINE
AREA WHERE CUT MATERIAL CAN BE PLACED WITHIN THE SITE.
NEW TREELINE
REMOVE CAPE COD BERM TO HERE
687 SF INCREASE OF IMPERVIOUS AREA ON SITE
MILL & OVERLAY EXISTING PAVED DRIVEWAY
MAINTAIN EXISTING EDGE OF PAVEMENT
AREA WHERE CUT MATERIAL CAN BE PLACED WITHIN THE SITE
ACTON
CONCORD
TOWN LINE
EARTHWORK CALCULATIONS
APPROXIMATE CUT 24 CUBIC YARDS
APPROXIMATE FILL 2 CU YARDS
NO MATERIAL WILL BE LEAVING THE SITE DURING CONSTRUCTION



Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.507	30	Woods, Good, HSG A (1S)
0.429	98	Building and Parking Lot, HSG A (1S)
0.935	**61**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.935	HSG A	1S
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
0.935		TOTAL AREA

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.429	0.000	0.000	0.000	0.000	0.429	Building and Parking Lot	1S
0.507	0.000	0.000	0.000	0.000	0.507	Woods, Good	1S
0.935	0.000	0.000	0.000	0.000	0.935	TOTAL AREA	

Time span=0.00-24.00 hrs, dt=0.04 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Existing Site Runoff Area=40,741 sf 45.83% Impervious Runoff Depth>0.40"
Tc=5.0 min CN=61 Runoff=0.27 cfs 0.031 af

Total Runoff Area = 0.935 ac Runoff Volume = 0.031 af Average Runoff Depth = 0.40"
54.17% Pervious = 0.507 ac 45.83% Impervious = 0.429 ac

Summary for Subcatchment 1S: Existing Site

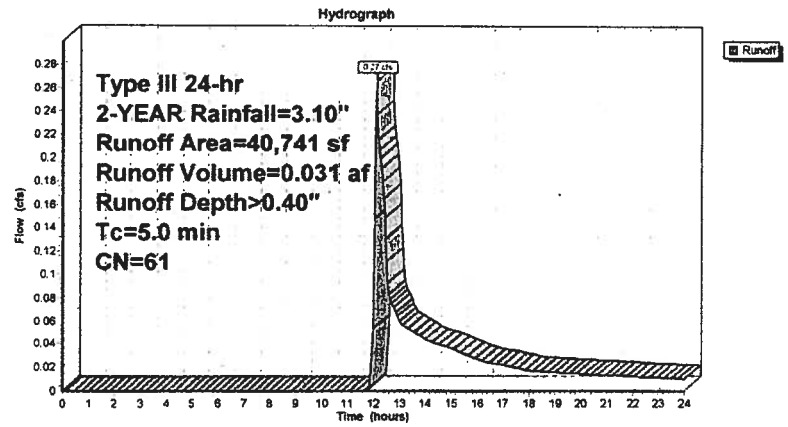
Runoff = 0.27 cfs @ 12.12 hrs, Volume= 0.031 af, Depth> 0.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-YEAR Rainfall=3.10"

	Area (sf)	CN	Description
*	18,670	98	Building and Parking Lot, HSG A
	22,071	30	Woods, Good, HSG A
	40,741	61	Weighted Average
	22,071		54.17% Pervious Area
	18,670		45.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Direct Entry**

Subcatchment 1S: Existing Site



Time span=0.00-24.00 hrs, dt=0.04 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Existing Site Runoff Area=40,741 sf 45.83% Impervious Runoff Depth>1.08"
Tc=5.0 min CN=61 Runoff=1.06 cfs 0.084 af

Total Runoff Area = 0.935 ac Runoff Volume = 0.084 af Average Runoff Depth = 1.08"
54.17% Pervious = 0.507 ac 45.83% Impervious = 0.429 ac

Summary for Subcatchment 1S: Existing Site

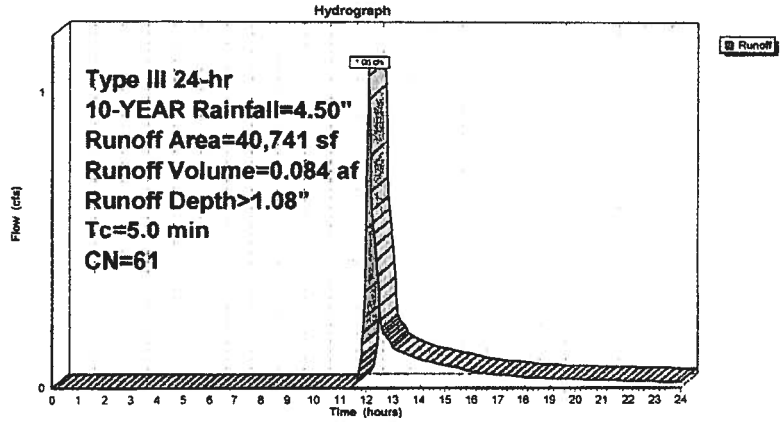
Runoff = 1.06 cfs @ 12.09 hrs, Volume= 0.084 af, Depth> 1.08"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-YEAR Rainfall=4.50"

	Area (sf)	CN	Description
*	18,670	98	Building and Parking Lot, HSG A
	22,071	30	Woods, Good, HSG A
	40,741	61	Weighted Average
	22,071		54.17% Pervious Area
	18,670		45.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Direct Entry**

Subcatchment 1S: Existing Site



Time span=0.00-24.00 hrs, dt=0.04 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Existing Site Runoff Area=40,741 sf 45.83% Impervious Runoff Depth>1.55"
Tc=5.0 min CN=61 Runoff=1.62 cfs 0.121 af

Total Runoff Area = 0.935 ac Runoff Volume = 0.121 af Average Runoff Depth = 1.55"
54.17% Pervious = 0.507 ac 45.83% Impervious = 0.429 ac

Summary for Subcatchment 1S: Existing Site

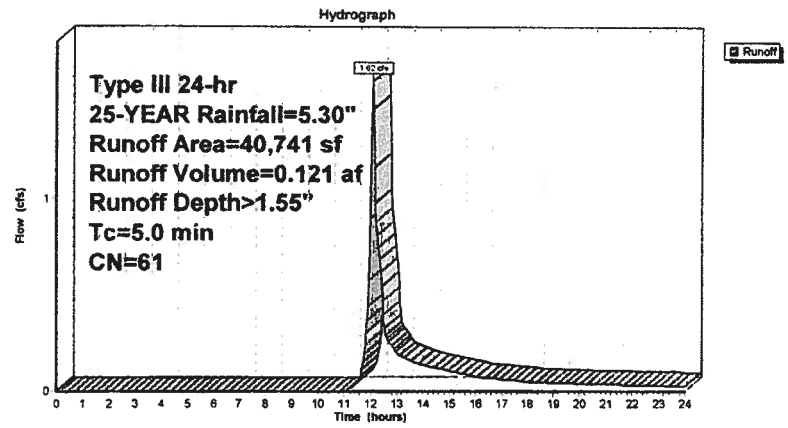
Runoff = 1.62 cfs @ 12.09 hrs, Volume= 0.121 af, Depth> 1.55"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-YEAR Rainfall=5.30"

	Area (sf)	CN	Description
*	18,670	98	Building and Parking Lot, HSG A
	22,071	30	Woods, Good, HSG A
	40,741	61	Weighted Average
	22,071		54.17% Pervious Area
	18,670		45.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Direct Entry**

Subcatchment 1S: Existing Site



Time span=0.00-24.00 hrs, dt=0.04 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Existing Site Runoff Area=40,741 sf 45.83% Impervious Runoff Depth>2.34"
Tc=5.0 min CN=61 Runoff=2.55 cfs 0.183 af

Total Runoff Area = 0.935 ac Runoff Volume = 0.183 af Average Runoff Depth = 2.34"
54.17% Pervious = 0.507 ac 45.83% Impervious = 0.429 ac

Summary for Subcatchment 1S: Existing Site

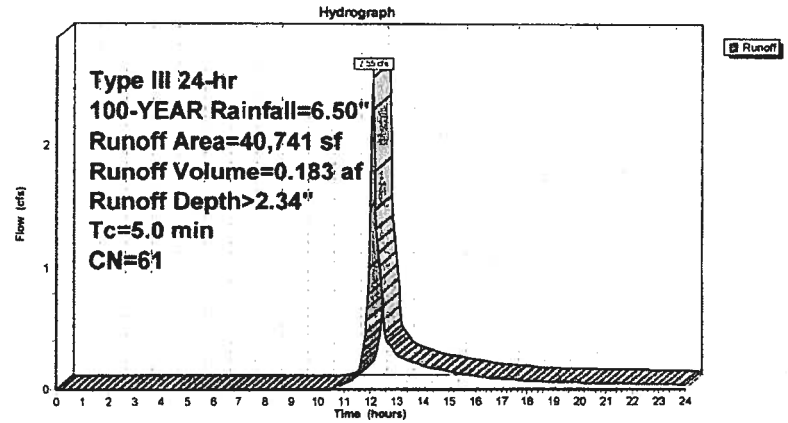
Runoff = 2.55 cfs @ 12.08 hrs, Volume= 0.183 af, Depth> 2.34"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-YEAR Rainfall=6.50"

	Area (sf)	CN	Description
*	18,670	98	Building and Parking Lot, HSG A
	22,071	30	Woods, Good, HSG A
	40,741	61	Weighted Average
	22,071		54.17% Pervious Area
	18,670		45.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Direct Entry**

Subcatchment 1S: Existing Site



Time span=0.00-24.00 hrs, dt=0.04 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Existing Site Runoff Area=40,741 sf 45.83% Impervious Runoff Depth=0.00"
Tc=5.0 min CN=61 Runoff=0.00 cfs 0.000 af

Total Runoff Area = 0.935 ac Runoff Volume = 0.000 af Average Runoff Depth = 0.00"
54.17% Pervious = 0.507 ac 45.83% Impervious = 0.429 ac

Summary for Subcatchment 1S: Existing Site

[45] Hint: Runoff=Zero

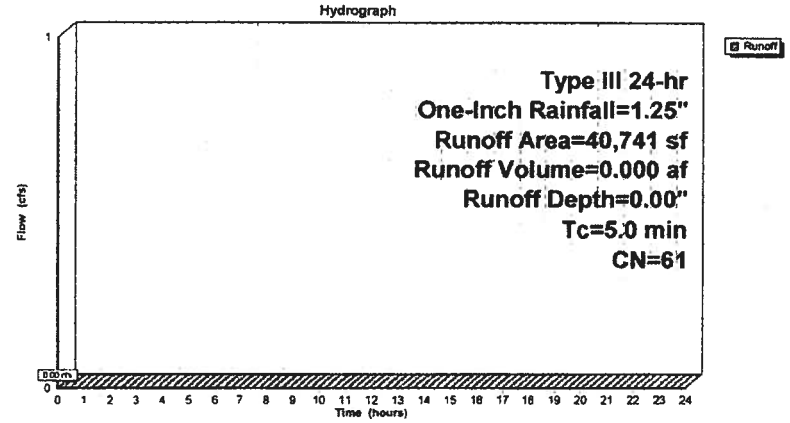
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

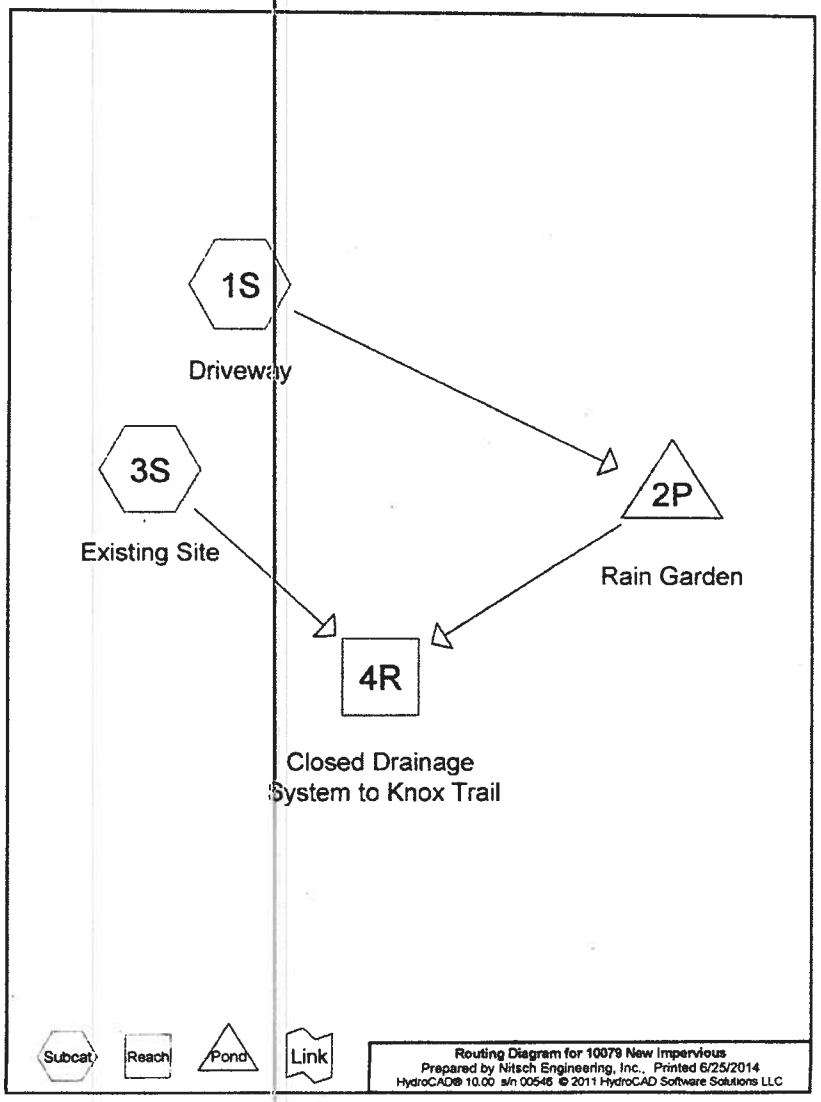
Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr One-Inch Rainfall=1.25"

	Area (sf)	CN	Description
*	18,670	98	Building and Parking Lot, HSG A
	22,071	30	Woods, Good, HSG A
	40,741	61	Weighted Average
	22,071		54.17% Pervious Area
	18,670		45.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Direct Entry**

Subcatchment 1S: Existing Site





Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.507	30	Woods, Good, HSG A (3S)
0.399	98	Building and Parking Lot, HSG A (3S)
0.030	98	Paved parking, HSG A (1S)
0.935	61	TOTAL AREA

SUMMARY OF CALCULATIONS

PURPOSE:
DESIGN RAIN GARDEN FOR WATER QUALITY FOR NEW DRIVEWAY AND PORTIONS OF EXISTING DRIVEWAY.
DESIGN REDUCES BOTH STORMWATER RATE AND VOLUME IN THE PRE- AND POST-CONSTRUCTION CONDITION.

	Storm Event – Rate, cfs				
	2-year	10-year	25-year	100-year	1 inch
Existing					
	0.27	1.06	1.62	2.55	0.00
Proposed					
	0.22	0.95	1.48	2.36	0.00

	Storm Event – volume, a/f				
	2-year	10-year	25-year	100-year	1 inch
Existing					
	0.031	0.084	0.121	0.183	0.00
Proposed					
	0.028	0.077	0.112	0.172	0.00

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.935	HSG A	1S, 3S
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
0.935		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.399	0.000	0.000	0.000	0.000	0.399	Building and Parking Lot	3S
0.030	0.000	0.000	0.000	0.000	0.030	Paved parking	1S
0.507	0.000	0.000	0.000	0.000	0.507	Woods, Good	3S
0.935	**0.000**	**0.000**	**0.000**	**0.000**	**0.935**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	2P	146.60	145.60	15.0	0.0667	0.013	8.0	0.0	0.0

Time span=0.00-24.00 hrs, dt=0.04 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Driveway Runoff Area=1,310 sf 100.00% Impervious Runoff Depth>2.87"
Tc=5.0 min CN=98 Runoff=0.09 cfs 0.007 af

Subcatchment 3S: Existing Site Runoff Area=39,431 sf 44.03% Impervious Runoff Depth>0.37"
Tc=5.0 min CN=60 Runoff=0.22 cfs 0.028 af

Reach 4R: Closed Drainage System to Knox Trail Inflow=0.22 cfs 0.028 af
Outflow=0.22 cfs 0.028 af

Pond 2P: Rain Garden Peak Elev=148.18' Storage=116 cf Inflow=0.09 cfs 0.007 af
Discarded=0.01 cfs 0.007 af Primary=0.00 cfs 0.000 af Outflow=0.01 cfs 0.007 af

Total Runoff Area = 0.935 ac Runoff Volume = 0.035 af Average Runoff Depth = 0.45"
54.17% Pervious = 0.507 ac 45.83% Impervious = 0.429 ac

Summary for Subcatchment 1S: Driveway

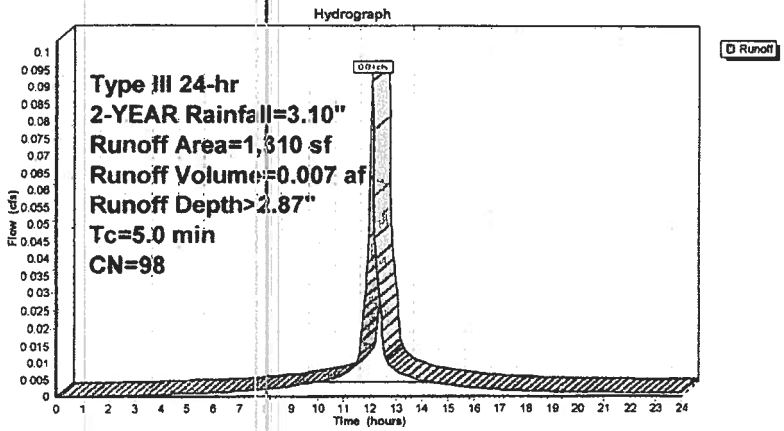
Runoff = 0.09 cfs @ 12.07 hrs, Volume= 0.007 af, Depth> 2.87"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-YEAR Rainfall=3.10"

Area (sf)	CN	Description
1,310	98	Paved parking, HSG A
1,310		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Direct Entry

Subcatchment 1S: Driveway



Summary for Subcatchment 3S: Existing Site

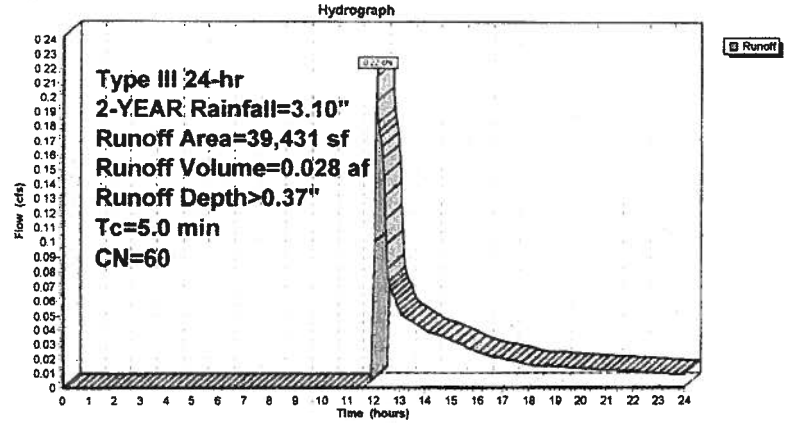
Runoff = 0.22 cfs @ 12.13 hrs, Volume= 0.028 af, Depth> 0.37"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-YEAR Rainfall=3.10"

Area (sf)	CN	Description
* 17,360	98	Building and Parking Lot, HSG A
22,071	30	Woods, Good, HSG A
39,431	60	Weighted Average
22,071		55.97% Pervious Area
17,360		44.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Direct Entry

Subcatchment 3S: Existing Site



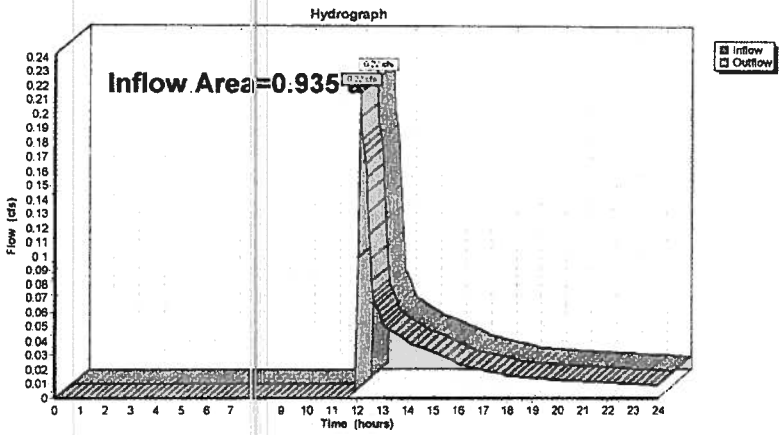
Summary for Reach 4R: Closed Drainage System to Knox Trail

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.935 ac, 45.83% Impervious, Inflow Depth > 0.36" for 2-YEAR event
Inflow = 0.22 cfs @ 12.13 hrs, Volume= 0.028 af
Outflow = 0.22 cfs @ 12.13 hrs, Volume= 0.028 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs

Reach 4R: Closed Drainage System to Knox Trail



Summary for Pond 2P: Rain Garden

Inflow Area = 0.030 ac,100.00% Impervious, Inflow Depth > 2.87" for 2-YEAR event
Inflow = 0.09 cfs @ 12.07 hrs, Volume= 0.007 af
Outflow = 0.01 cfs @ 12.55 hrs, Volume= 0.007 af, Atten= 85%, Lag= 28.6 min
Discarded = 0.01 cfs @ 12.55 hrs, Volume= 0.007 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 2
Peak Elev= 148.18' @ 12.55 hrs Surf.Area= 250 sf Storage= 116 cf

Plug-Flow detention time= 80.2 min calculated for 0.007 af (100% of inflow)
Center-of-Mass det. time= 79.3 min (835.1 - 755.8)

Volume	Invert	Avail.Storage	Storage Description
#1	147.25'	228 cf	**Rain Garden (Prismatic)** Listed below (Recalc)

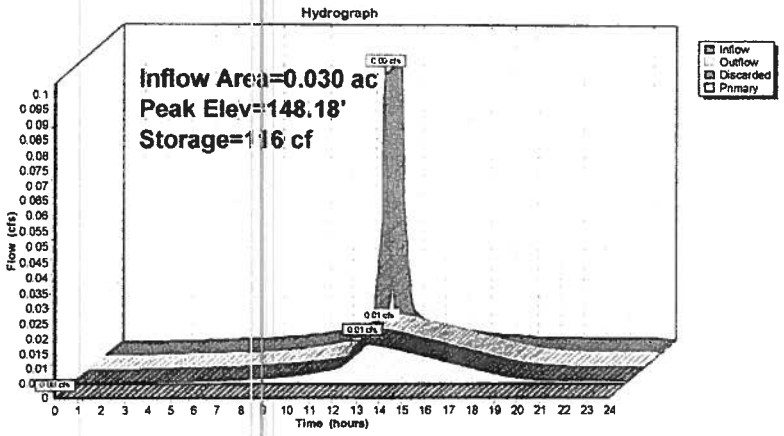
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
147.25	0	0	0
148.55	350	228	228

Device	Routing	Invert	Outlet Devices
#1	Discarded	147.25'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	146.60'	**8.0" Round New Drain to existing DMH** L= 15.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 146.60' / 145.60' S= 0.0667 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf
#3	Device 2	148.50'	**24.0" Horiz. Dome Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.01 cfs @ 12.55 hrs HW=148.18' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=147.25' (Free Discharge)
└**2=New Drain to existing DMH** (Passes 0.00 cfs of 0.75 cfs potential flow)
└**3=Dome Grate** (Controls 0.00 cfs)

Pond 2P: Rain Garden



Time span=0.00-24.00 hrs, dt=0.04 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Driveway Runoff Area=1,310 sf 100.00% Impervious Runoff Depth>4.26"
Tc=5.0 min CN=98 Runoff=0.13 cfs 0.011 af

Subcatchment 3S: Existing Site Runoff Area=39,431 sf 44.03% Impervious Runoff Depth>1.02"
Tc=5.0 min CN=60 Runoff=0.95 cfs 0.077 af

Reach 4R: Closed Drainage System to Knox Trail Inflow=0.95 cfs 0.077 af
Outflow=0.95 cfs 0.077 af

Pond 2P: Rain Garden Peak Elev=148.41' Storage=183 cf Inflow=0.13 cfs 0.011 af
Discarded=0.02 cfs 0.011 af Primary=0.00 cfs 0.000 af Outflow=0.02 cfs 0.011 af

Total Runoff Area = 0.935 ac Runoff Volume = 0.088 af Average Runoff Depth = 1.12"
54.17% Pervious = 0.507 ac 45.83% Impervious = 0.429 ac

Summary for Subcatchment 1S: Driveway

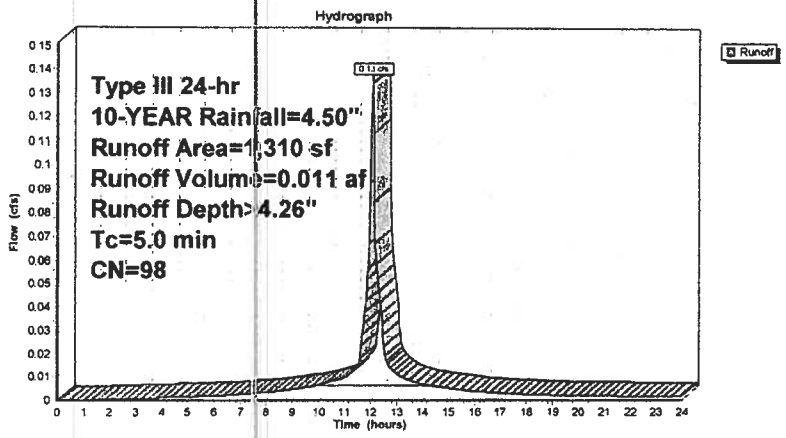
Runoff = 0.13 cfs @ 12.07 hrs, Volume= 0.011 af, Depth> 4.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-YEAR Rainfall=4.50"

Area (sf)	CN	Description
1,310	98	Paved parking, HSG A
1,310		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Direct Entry

Subcatchment 1S: Driveway



Summary for Subcatchment 3S: Existing Site

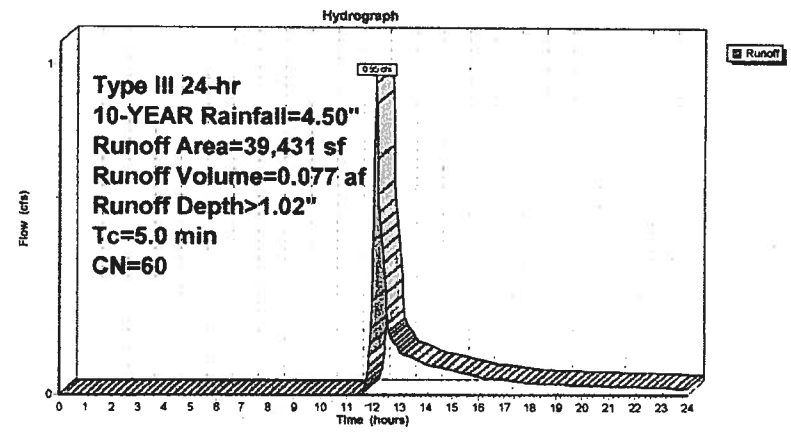
Runoff = 0.95 cfs @ 12.09 hrs, Volume= 0.077 af, Depth> 1.02"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-YEAR Rainfall=4.50"

Area (sf)	CN	Description
* 17,360	98	Building and Parking Lot, HSG A
22,071	30	Woods, Good, HSG A
39,431	60	Weighted Average
22,071		55.97% Pervious Area
17,360		44.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Direct Entry

Subcatchment 3S: Existing Site



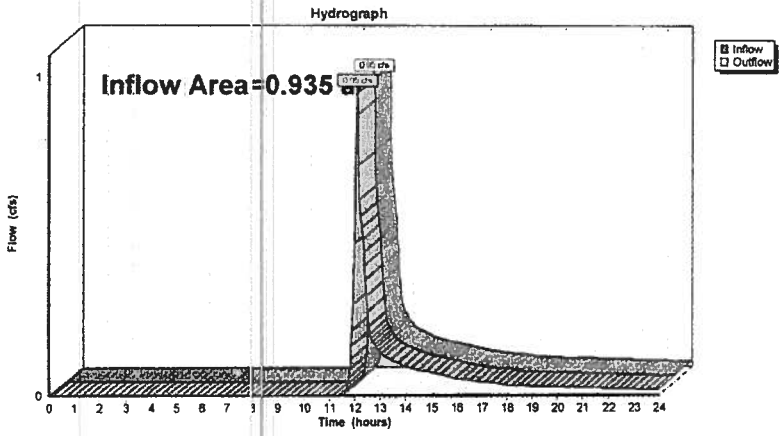
Summary for Reach 4R: Closed Drainage System to Knox Trail

[40] Hint: Not Described (Outflow= nflow)

Inflow Area = 0.935 ac, 45.83% Impervious, Inflow Depth > 0.99" for 10-YEAR event
Inflow = 0.95 cfs @ 12.09 hrs, Volume= 0.077 af
Outflow = 0.95 cfs @ 12.09 hrs, Volume= 0.077 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs

Reach 4R: Closed Drainage System to Knox Trail



Summary for Pond 2P: Rain Garden

Inflow Area = 0.030 ac, 100.00% Impervious, Inflow Depth > 4.26" for 10-YEAR event
Inflow = 0.13 cfs @ 12.07 hrs, Volume= 0.011 af
Outflow = 0.02 cfs @ 12.59 hrs, Volume= 0.011 af, Atten= 87%, Lag= 30.9 min
Discarded = 0.02 cfs @ 12.59 hrs, Volume= 0.011 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 2
Peak Elev= 148.41' @ 12.59 hrs Surf.Area= 314 sf Storage= 183 cf

Plug-Flow detention time= 104.7 min calculated for 0.011 af (100% of inflow)
Center-of-Mass det. time= 103.2 min (851.8 - 748.5)

Volume	Invert	Avail.Storage	Storage Description
#1	147.25'	228 cf	**Rain Garden (Prismatic)** Listed below (Recalc)

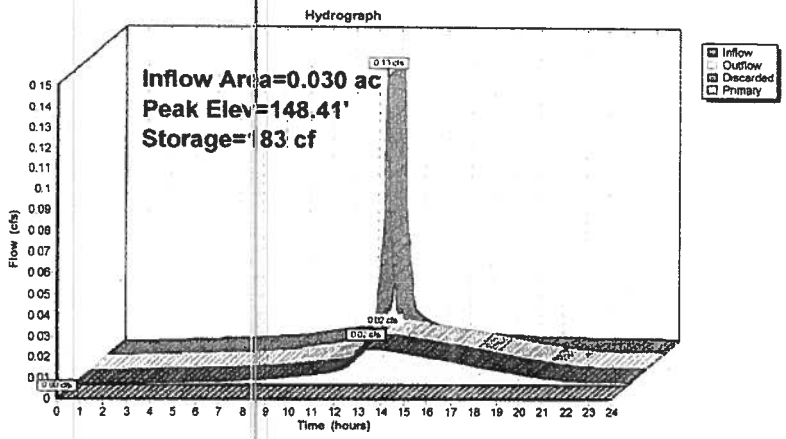
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
147.25	0	0	0
148.55	350	228	228

Device	Routing	Invert	Outlet Devices
#1	Discarded	147.25'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	146.60'	**8.0" Round New Drain to existing DMH** L= 15.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 146.60' / 145.60' S= 0.0667 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf
#3	Device 2	148.50'	**24.0" Horiz. Dome Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.02 cfs @ 12.59 hrs HW=148.41' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=147.25' (Free Discharge)
└─**2=New Drain to existing DMH** (Passes 0.00 cfs of 0.75 cfs potential flow)
└─**3=Dome Grate** (Controls 0.00 cfs)

Pond 2P: Rain Garden



Time span=0.00-24.00 hrs, dt=0.04 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Driveway Runoff Area=1,310 sf 100.00% Impervious Runoff Depth>5.06"
Tc=5.0 min CN=98 Runoff=0.16 cfs 0.013 af

Subcatchment 3S: Existing Site Runoff Area=39,431 sf 44.03% Impervious Runoff Depth>1.48"
Tc=5.0 min CN=60 Runoff=1.48 cfs 0.112 af

Reach 4R: Closed Drainage System to Knox Trail Inflow=1.48 cfs 0.112 af
Outflow=1.48 cfs 0.112 af

Pond 2P: Rain Garden Peak Elev=148.51' Storage=213 cf Inflow=0.16 cfs 0.013 af
Discarded=0.02 cfs 0.012 af Primary=0.02 cfs 0.000 af Outflow=0.04 cfs 0.013 af

Total Runoff Area = 0.935 ac Runoff Volume = 0.124 af Average Runoff Depth = 1.59"
54.17% Pervious = 0.507 ac 45.83% Impervious = 0.429 ac

Summary for Subcatchment 1S: Driveway

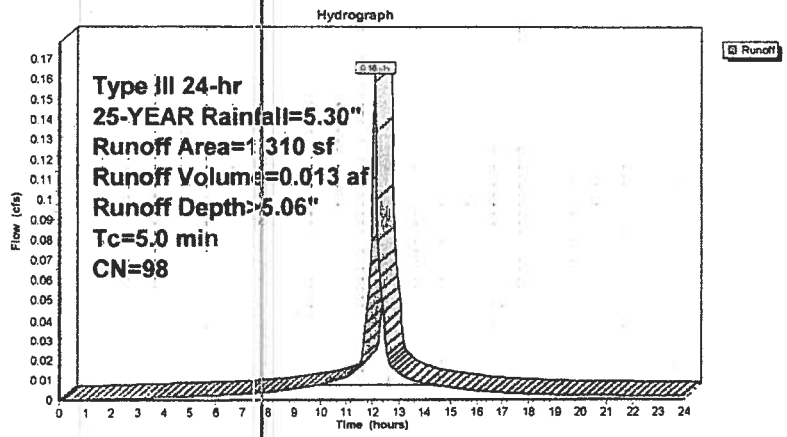
Runoff = 0.16 cfs @ 12.07 hrs, Volume= 0.013 af, Depth> 5.06"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-YEAR Rainfall=5.30"

Area (sf)	CN	Description
1,310	98	Paved parking, HSG A
1,310		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Direct Entry

Subcatchment 1S: Driveway



Summary for Subcatchment 3S: Existing Site

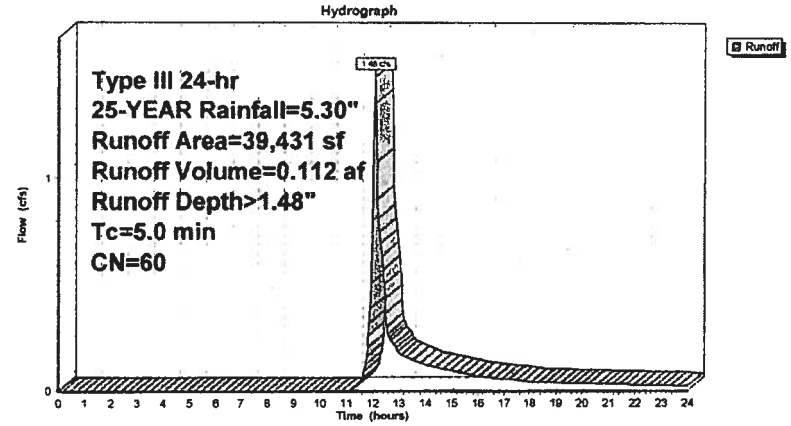
Runoff = 1.48 cfs @ 12.09 hrs, Volume= 0.112 af, Depth> 1.48"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-YEAR Rainfall=5.30"

Area (sf)	CN	Description
* 17,360	98	Building and Parking Lot, HSG A
22,071	30	Woods, Good, HSG A
39,431	60	Weighted Average
22,071		55.97% Pervious Area
17,360		44.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Direct Entry

Subcatchment 3S: Existing Site



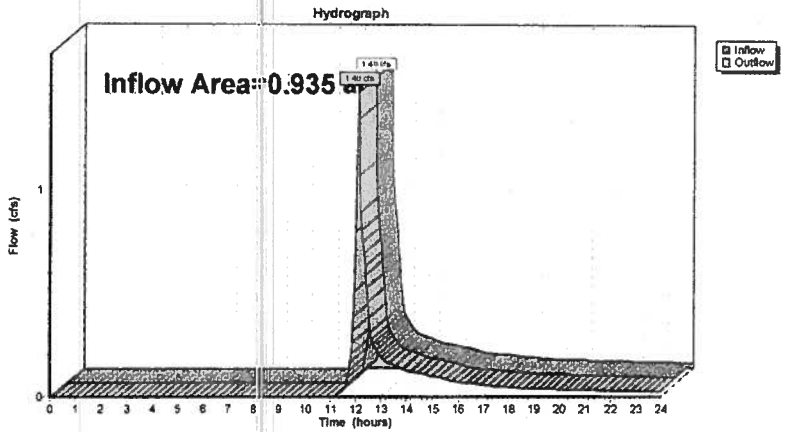
Summary for Reach 4R: Closed Drainage System to Knox Trail

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	0.935 ac,	45.83% Impervious,	Inflow Depth >	1.43"	for 25-YEAR event
Inflow =	1.48 cfs @	12.09 hrs,	Volume=	0.112 af	
Outflow =	1.48 cfs @	12.09 hrs,	Volume=	0.112 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs

Reach 4R: Closed Drainage System to Knox Trail



Summary for Pond 2P: Rain Garden

Inflow Area =	0.030 ac,	100.00% Impervious,	Inflow Depth >	5.06"	for 25-YEAR event
Inflow =	0.16 cfs @	12.07 hrs,	Volume=	0.013 af	
Outflow =	0.04 cfs @	12.44 hrs,	Volume=	0.013 af,	Atten= 76%, Lag= 22.3 min
Discarded =	0.02 cfs @	12.44 hrs,	Volume=	0.012 af	
Primary =	0.02 cfs @	12.44 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 2
Peak Elev= 148.51' @ 12.44 hrs Surf.Area= 339 sf Storage= 213 cf

Plug-Flow detention time= 112.2 min calculated for 0.013 af (100% of inflow)
Center-of-Mass det. time= 110.2 min (856.0 - 745.8)

Volume	Invert	Avail.Storage	Storage Description
#1	147.25'	228 cf	**Rain Garden (Prismatic)** Listed below (Recalc)

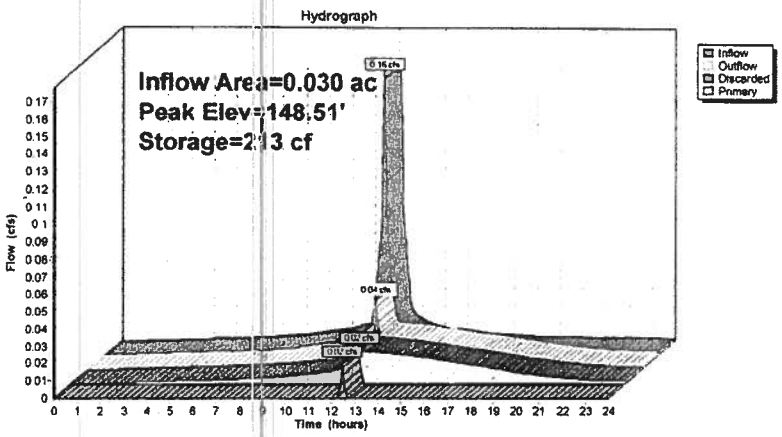
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
147.25	0	0	0
148.55	350	228	228

Device	Routing	Invert	Outlet Devices
#1	Discarded	147.25'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	146.60'	**8.0" Round New Drain to existing DMH** L= 15.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 146.60' / 145.60' S= 0.0667 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf
#3	Device 2	148.50'	**24.0" Hortz. Dome Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.02 cfs @ 12.44 hrs HW=148.51' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.02 cfs @ 12.44 hrs HW=148.51' (Free Discharge)
└─**2=New Drain to existing DMH** (Passes 0.02 cfs of 1.67 cfs potential flow)
└─**3=Dome Grate** (Weir Controls 0.02 cfs @ 0.31 fps)

Pond 2P: Rain Garden



Time span=0.00-24.00 hrs, dt=0.04 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Driveway Runoff Area=1,310 sf 100.00% Impervious Runoff Depth>6.26"
Tc=5.0 min CN=98 Runoff=0.20 cfs 0.016 af

Subcatchment 3S: Existing Site Runoff Area=39,431 sf 44.03% Impervious Runoff Depth>2.25"
Tc=5.0 min CN=60 Runoff=2.36 cfs 0.170 af

Reach 4R: Closed Drainage System to Knox Trail Inflow=2.36 cfs 0.172 af
Outflow=2.36 cfs 0.172 af

Pond 2P: Rain Garden Peak Elev=148.53' Storage=219 cf Inflow=0.20 cfs 0.016 af
Discarded=0.02 cfs 0.014 af Primary=0.09 cfs 0.002 af Outflow=0.10 cfs 0.016 af

Total Runoff Area = 0.935 ac Runoff Volume = 0.186 af Average Runoff Depth = 2.38"
54.17% Pervious = 0.507 ac 45.83% Impervious = 0.429 ac

Summary for Subcatchment 1S: Driveway

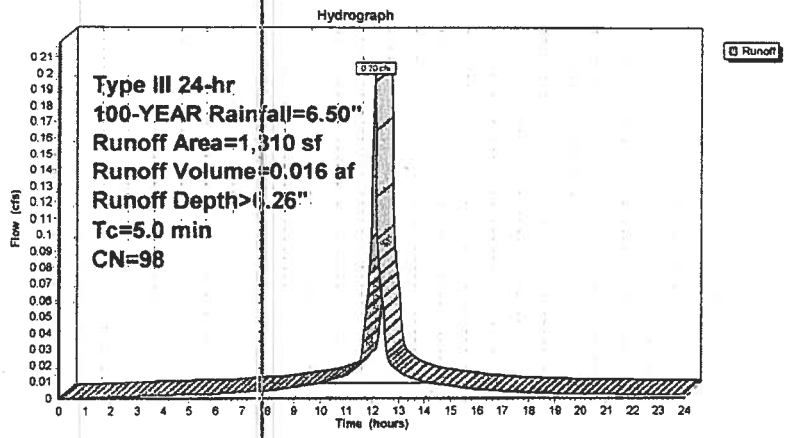
Runoff = 0.20 cfs @ 12.07 hrs, Volume= 0.016 af, Depth> 6.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-YEAR Rainfall=6.50"

Area (sf)	CN	Description
1,310	98	Paved parking, HSG A
1,310		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Direct Entry

Subcatchment 1S: Driveway



Summary for Subcatchment 3S: Existing Site

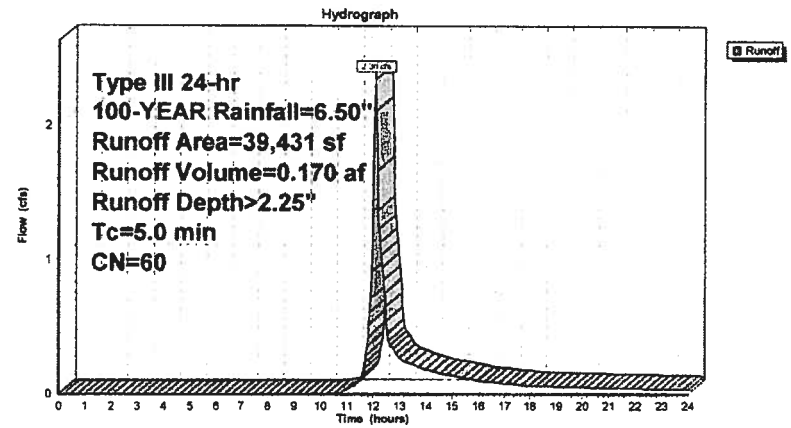
Runoff = 2.36 cfs @ 12.08 hrs, Volume= 0.170 af, Depth> 2.25"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-YEAR Rainfall=6.50"

Area (sf)	CN	Description
* 17,360	98	Building and Parking Lot, HSG A
22,071	30	Woods, Good, HSG A
39,431	60	Weighted Average
22,071		55.97% Pervious Area
17,360		44.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Direct Entry

Subcatchment 3S: Existing Site



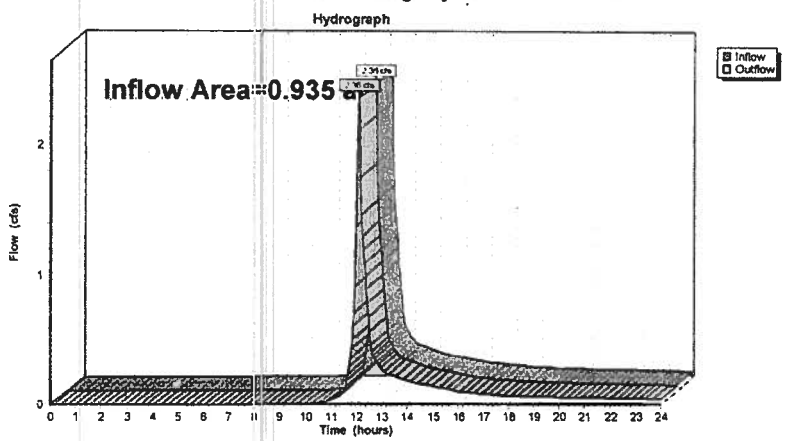
Summary for Reach 4R: Closed Drainage System to Knox Trail

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	0.935 ac,	45.83% Impervious,	Inflow Depth >	2.20"	for 100-YEAR event
Inflow =	2.36 cfs @	12.08 hrs,	Volume=	0.172 af	
Outflow =	2.36 cfs @	12.08 hrs,	Volume=	0.172 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs

Reach 4R: Closed Drainage System to Knox Trail



Summary for Pond 2P: Rain Garden

Inflow Area =	0.030 ac,	100.00% Impervious,	Inflow Depth >	6.26"	for 100-YEAR event
Inflow =	0.20 cfs @	12.07 hrs,	Volume=	0.016 af	
Outflow =	0.10 cfs @	12.20 hrs,	Volume=	0.016 af,	Atten= 46%, Lag= 7.7 min
Discarded =	0.02 cfs @	12.20 hrs,	Volume=	0.014 af	
Primary =	0.09 cfs @	12.20 hrs,	Volume=	0.002 af	

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 2
Peak Elev= 148.53' @ 12.20 hrs Surf.Area= 343 sf Storage= 219 cf

Plug-Flow detention time= 103.2 min calculated for 0.016 af (100% of inflow)
Center-of-Mass det. time= 101.6 min (844.3 - 742.7)

Volume	Invert	Avail.Storage	Storage Description
#1	147.25'	228 cf	**Rain Garden (Prismatic)** Listed below (Recalc)

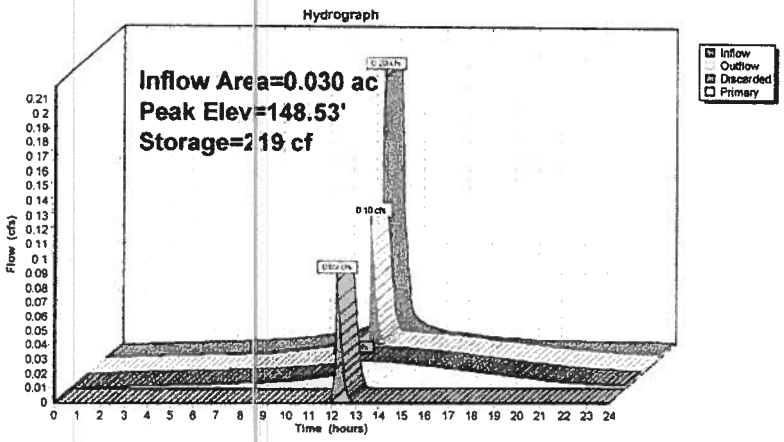
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
147.25	0	0	0
148.55	350	228	228

Device	Routing	Invert	Outlet Devices
#1	Discarded	147.25'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	146.60'	**8.0" Round New Drain to existing DMH** L= 15.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 146.60' / 145.60' S= 0.0667 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf
#3	Device 2	148.50'	**24.0" Horiz. Dome Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.02 cfs @ 12.20 hrs HW=148.53' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.08 cfs @ 12.20 hrs HW=148.53' (Free Discharge)
└─**2=New Drain to existing DMH** (Passes 0.08 cfs of 1.67 cfs potential flow)
└─**3=Dome Grate** (Weir Controls 0.08 cfs @ 0.52 fps)

Pond 2P: Rain Garden



Time span=0.00-24.00 hrs, dt=0.04 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Driveway Runoff Area=1,310 sf 100.00% Impervious Runoff Depth>1.03"
Tc=5.0 min CN=98 Runoff=0.04 cfs 0.003 af

Subcatchment 3S: Existing Site Runoff Area=39,431 sf 44.03% Impervious Runoff Depth=0.00"
Tc=5.0 min CN=60 Runoff=0.00 cfs 0.000 af

Reach 4R: Closed Drainage System to Knox Trail Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Pond 2P: Rain Garden Peak Elev=147.76' Storage=35 cf Inflow=0.04 cfs 0.003 af
Discarded=0.01 cfs 0.003 af Primary=0.00 cfs 0.000 af Outflow=0.01 cfs 0.003 af

Total Runoff Area = 0.935 ac Runoff Volume = 0.003 af Average Runoff Depth = 0.03"
54.17% Pervious = 0.507 ac 45.83% Impervious = 0.429 ac

Summary for Subcatchment 1S: Driveway

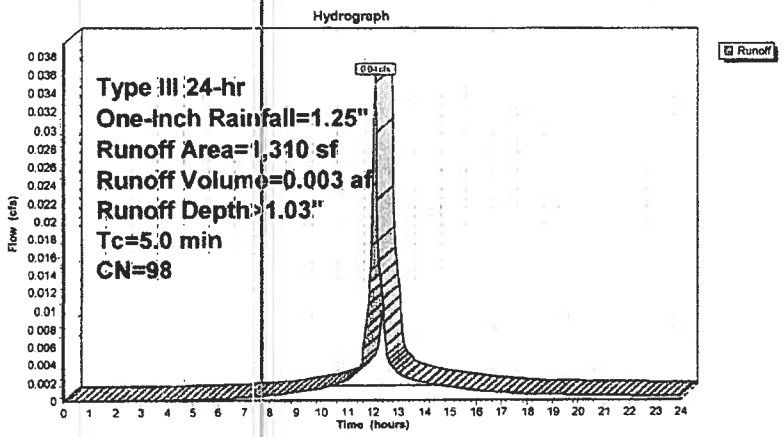
Runoff = 0.04 cfs @ 12.07 hrs, Volume= 0.003 af, Depth> 1.03"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr One-Inch Rainfall=1.25"

Area (sf)	CN	Description
1,310	98	Paved parking, HSG A
1,310		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Direct Entry

Subcatchment 1S: Driveway



Summary for Subcatchment 3S: Existing Site

[45] Hint: Runoff=Zero

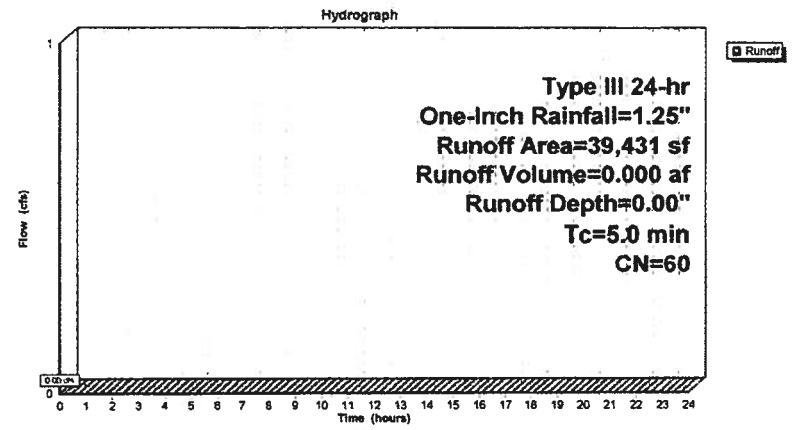
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr One-Inch Rainfall=1.25"

	Area (sf)	CN	Description
*	17,360	98	Building and Parking Lot, HSG A
	22,071	30	Woods, Good, HSG A
	39,431	60	Weighted Average
	22,071		55.97% Pervious Area
	17,360		44.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry, Direct Entry

Subcatchment 3S: Existing Site



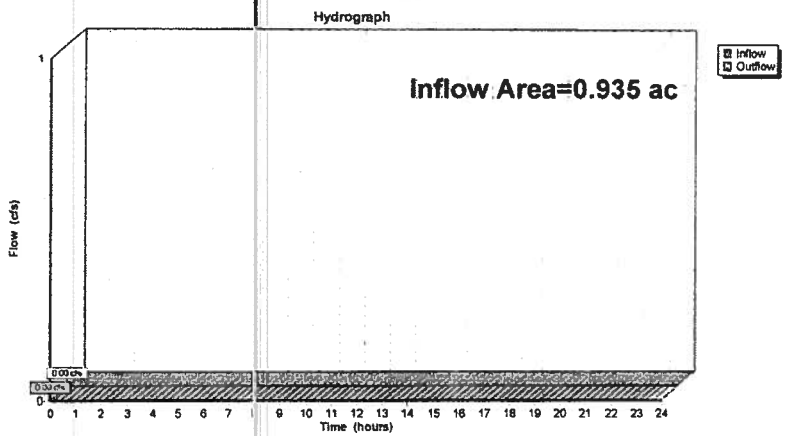
Summary for Reach 4R: Closed Drainage System to Knox Trail

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.935 ac, 45.83% Impervious, Inflow Depth = 0.00" for One-Inch event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs

Reach 4R: Closed Drainage System to Knox Trail



Summary for Pond 2P: Rain Garden

Inflow Area = 0.030 ac, 100.00% Impervious, Inflow Depth > 1.03" for One-Inch event
Inflow = 0.04 cfs @ 12.07 hrs, Volume= 0.003 af
Outflow = 0.01 cfs @ 12.47 hrs, Volume= 0.003 af, Atten= 78%, Lag= 24.0 min
Discarded = 0.01 cfs @ 12.47 hrs, Volume= 0.003 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 2
Peak Elev= 147.76' @ 12.47 hrs Surf.Area= 138 sf Storage= 35 cf

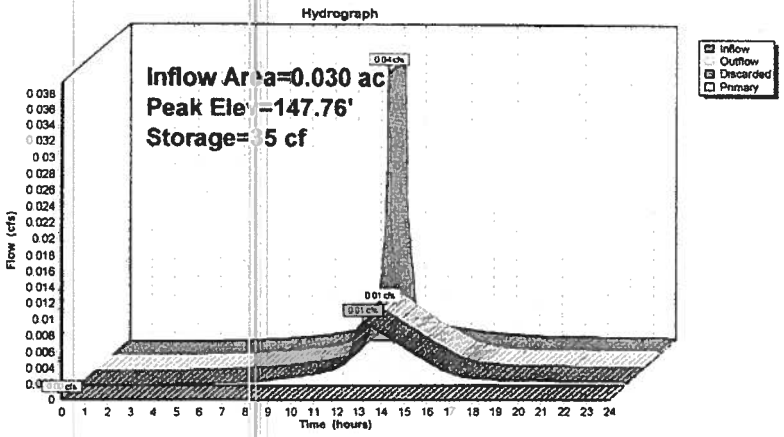
Plug-Flow detention time= 40.8 min calculated for 0.003 af (100% of inflow)
Center-of-Mass det. time= 40.3 min (819.7 - 779.4)

Volume	Invert	Avail.Storage	Storage Description
#1	147.25'	228 cf	**Rain Garden (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
147.25	0	0	0
148.55	350	228	228

Device	Routing	Invert	Outlet Devices
#1	Discarded	147.25'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	146.60'	**8.0" Round New Drain to existing DMH** L= 15.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 146.60' / 145.60' S= 0.0667 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf
#3	Device 2	148.50'	**24.0" Horiz. Dome Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.01 cfs @ 12.47 hrs HW=147.76' (Free Discharge)
└─1=**Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=147.25' (Free Discharge)
└─2=**New Drain to existing DMH** (Passes 0.00 cfs of 0.75 cfs potential flow)
  └─3=**Dome Grate** (Controls 0.00 cfs)

Pond 2P: Rain Garden