

A GIS Approach to a Distance-Based Pupil Transportation Eligibility System (PUTES)



Office of Pupil Transportation

Timothy Calabrese, Joanna Laroussi & Kevin Jenkins

Background Information

- Over 1.1 million students
- Approximately 450,000 receive MetroCards
- Yellow bus service provided daily to 90,000

Business Rule #1

- Eligibility for transportation based on grade and distance from school

| | | DISTANCE FROM RESIDENCE TO SCHOOL | | | |
|-------------|------|-----------------------------------|--|---|------------------------|
| | | Less than ½ mile A* | ½ mile or more, but less than 1 mile B* | 1 mile or more but less than 1½ miles C* | 1½ miles or more D* |
| GRADE LEVEL | K-2 | Not Eligible** | Eligible for Full Fare Transportation | | |
| | 3-6 | Transportation Not Provided | Not Eligible** | Eligible for Full Fare Transportation | |
| | 7-12 | | | | |

* The A, B, C, and D designations are used by DOE computers to indicate these distance groups.

** Students in these categories are not eligible for full fare transportation. These students may receive a half fare student MetroCard good for use on buses only. These half fare MetroCards are provided as a courtesy by the Metropolitan Transit Authority (MTA).

Business Rule #2

- Block Face Rule - students in the same grade range, attending the same school, and living on the same block must be eligible for the same level of service.



Components of PUTES

- ArcGIS with Network Analyst
- Street Centerline file
- Geocoding Service
- Transportation Eligibility Directory (TED)
- Student information system
- ArcGIS Server Web Application

TED

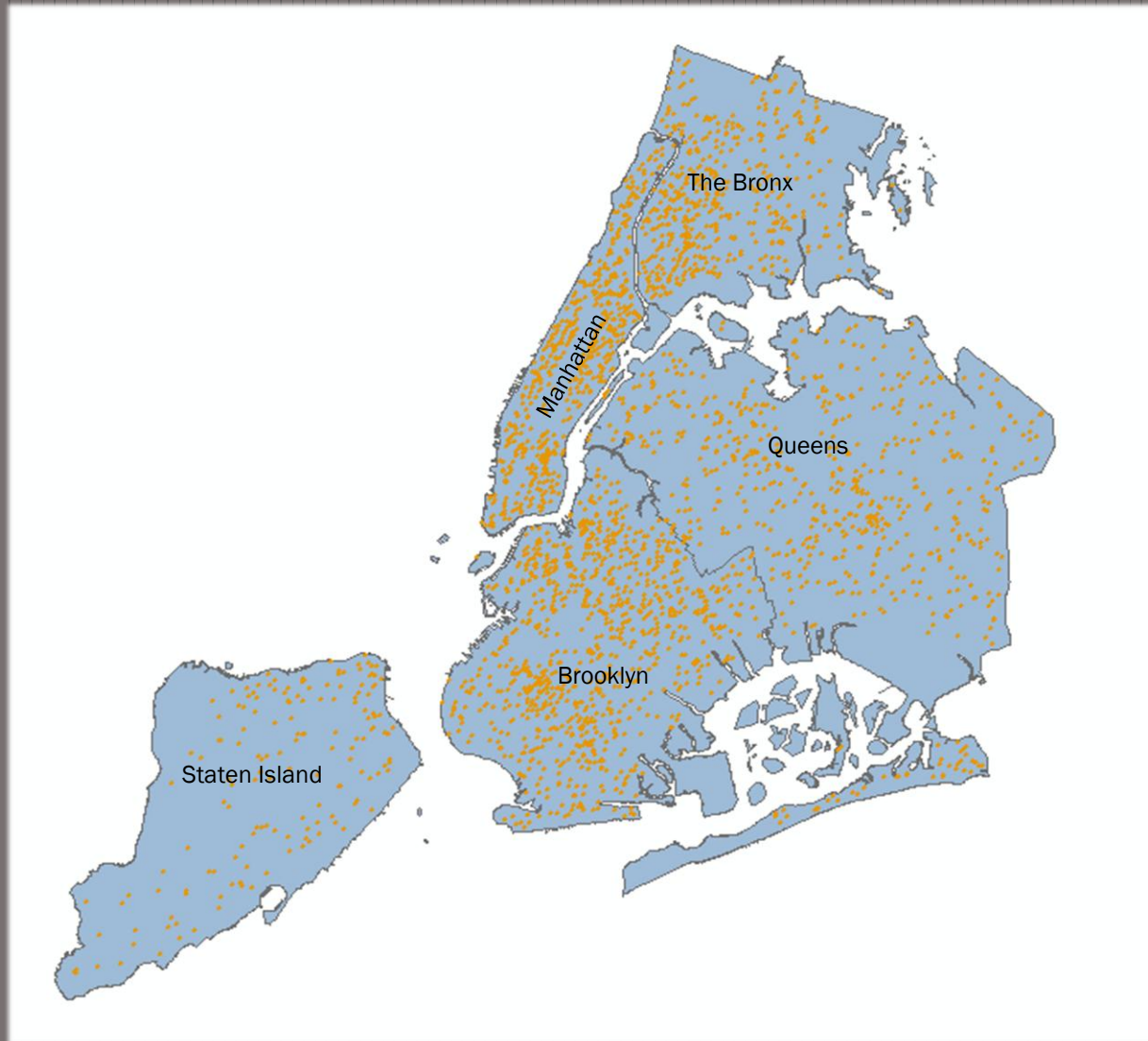
| Street | SegmentID | School #1 | School #2 | School #3 | School #4 | School #5 | School #6 | School #7 | School #8 | School #9 | School #10 |
|----------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|
| CHRISTIE STREET | 0164304 | B | B | A | C | A | B | B | C | C | C |
| RIVINGTON STREET | 0164351 | B | B | A | C | A | B | B | B | B | B |
| ORCHARD STREET | 0152193 | B | B | A | B | A | A | B | B | B | B |
| EAST BROADWAY | 0110640 | B | C | B | C | B | B | A | A | A | A |
| COOPER SQUARE | 0110949 | B | A | B | C | B | B | C | C | C | C |
| DELANCEY STREET | 0159165 | B | B | A | C | A | B | B | B | B | B |
| BARUCH PLACE | 0164930 | B | C | B | B | B | B | B | A | A | A |
| EAST 15 STREET | 0164995 | B | B | C | A | C | B | C | C | C | C |
| RIDGE STREET | 0164428 | B | C | A | B | B | B | A | A | A | A |
| BIALYSTOKER PLACE | 0164466 | B | C | B | B | B | B | A | A | A | A |
| EAST 6 STREET | 0132674 | B | B | B | C | A | B | C | C | C | C |
| EAST 20 STREET | 0137156 | B | B | C | B | C | B | <Null> | C | C | C |
| EAST 14 STREET | 9006531 | B | B | B | A | B | B | C | C | C | C |
| AVENUE C | 0146072 | B | B | C | A | C | B | C | C | C | C |
| DELANCEY STREET | 0189091 | B | C | B | C | C | B | B | A | A | A |
| AVENUE C | 0134767 | B | B | C | A | C | B | C | C | C | C |
| DELANCEY STREET | 0137642 | B | C | A | C | B | B | A | A | A | A |
| BIALYSTOKER PLACE | 0033189 | B | C | B | B | B | B | A | A | A | A |
| CANNON STREET | 0024750 | B | C | B | B | B | B | A | A | A | A |
| DELANCEY STREET | 9008175 | B | C | B | B | B | B | A | A | A | A |
| DELANCEY STREET | 9008175 | B | C | B | B | B | B | A | A | A | A |
| AVENUE D | 0034712 | B | B | C | A | C | B | C | B | C | C |
| AVENUE A | 0033246 | B | A | B | A | A | A | C | C | C | C |
| ABRAHAM KAZAN STREET | 0024740 | B | C | B | B | B | B | A | A | A | A |
| EAST 13 STREET | 0034618 | B | B | C | A | B | B | C | C | C | C |
| DELANCEY STREET | 0033047 | B | C | A | B | B | B | A | A | A | A |
| DELANCEY STREET | 0033047 | B | C | A | B | B | B | A | A | A | A |
| RIDGE STREET | 0164426 | B | C | A | B | B | B | A | A | A | A |
| PITT STREET | 0164432 | B | C | A | B | B | B | A | A | A | A |
| EAST 13 STREET | 9003352 | B | A | B | A | B | A | C | C | C | C |
| EAST 12 STREET | 0033122 | B | A | B | B | B | B | C | C | C | C |
| DELANCEY STREET | 9008162 | B | C | B | B | B | B | A | A | A | A |
| DELANCEY STREET | 9008162 | B | C | B | B | B | B | A | A | A | A |
| STANTON STREET | 9001843 | B | B | A | C | A | B | B | B | B | B |
| 2 AVENUE | 0032735 | B | B | A | C | A | B | C | C | C | C |
| MONTGOMERY STREET | 0024541 | B | C | B | C | B | B | A | A | A | A |
| COOPER SQUARE | 0032757 | B | A | B | B | B | B | C | C | C | C |

Elements Required for Creation of TED

- Schools Point Feature Class
- Network Dataset
- Service Area Polygons
- Python Script

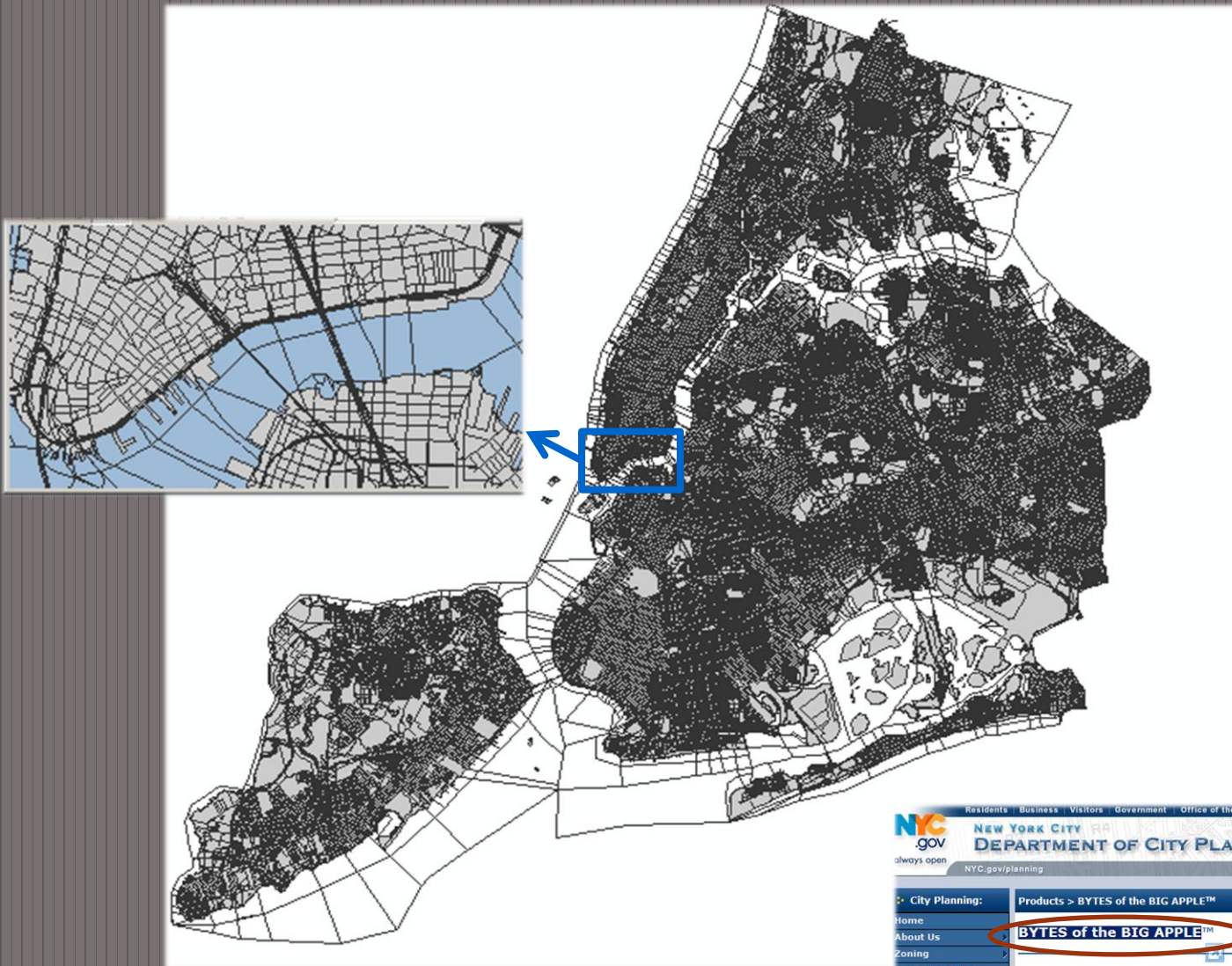
Schools Point Feature Class:

2914 Schools



LION street centerline file

210,579 segments



Residents · Business · Visitors · Government · Office of the Mayor · Search · Email Updates · Contact Us

NYC
gov
always open

NEW YORK CITY
DEPARTMENT OF CITY PLANNING

NYC.gov/planning Search DCP > Go

City Planning: Products > **BYTES of the BIG APPLE™**

Home
About Us
Zoning
Applicant Portal
Land Use Process
Projects/Proposals
Reference
Products
News

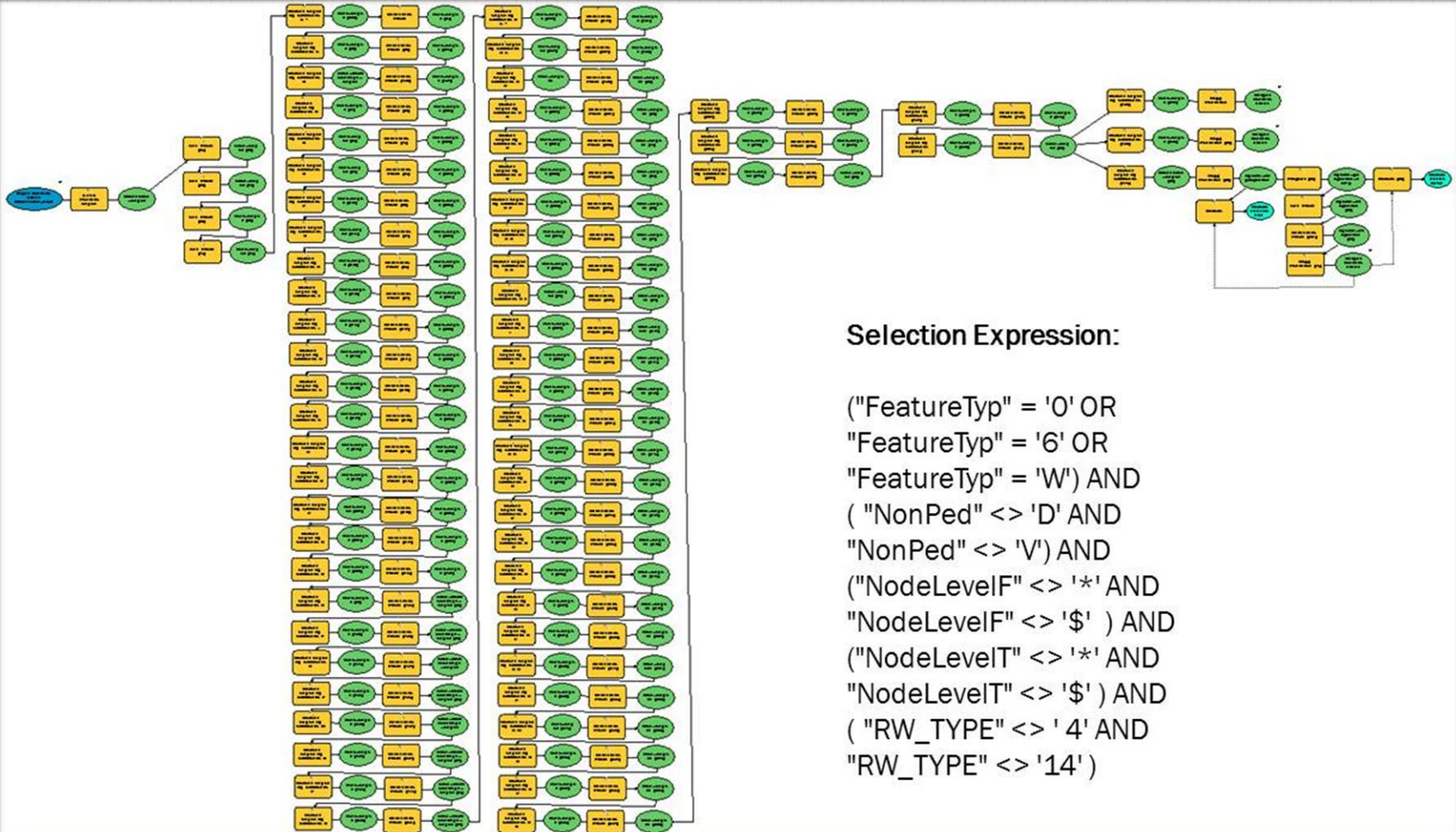
BYTES of the BIG APPLE™

BYTES of the BIG APPLE is a family of software, data and geographic base map files for the City of New York.

Subscribe to RSS

The Department of City Planning offers these data sets and application for
FREE Download.

ModelBuilder



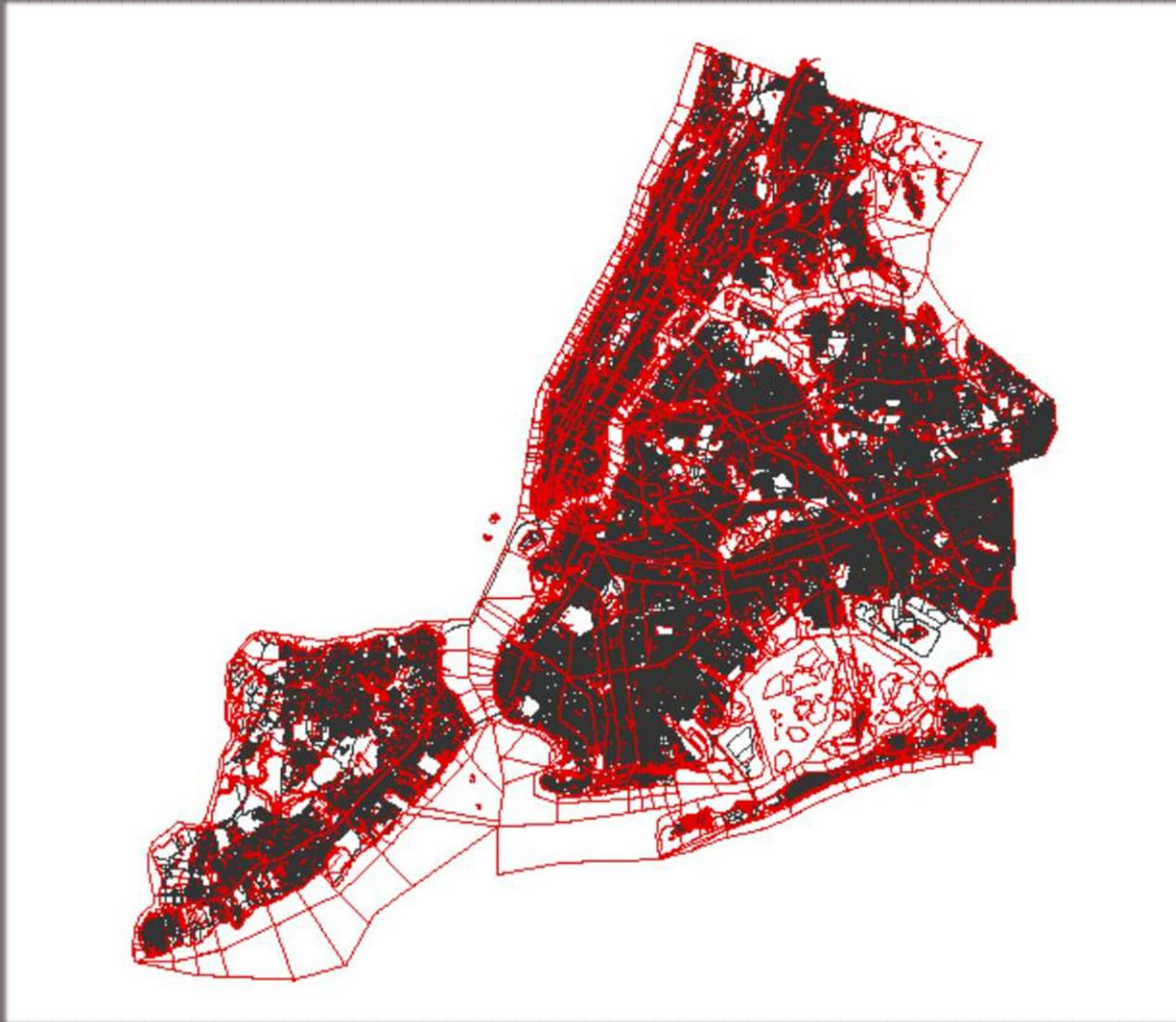
Selection Expression:

```
( "FeatureTyp" = 'O' OR
  "FeatureTyp" = '6' OR
  "FeatureTyp" = 'W') AND
( "NonPed" <> 'D' AND
  "NonPed" <> 'V') AND
( "NodeLevelF" <> '*' AND
  "NodeLevelF" <> '$' ) AND
( "NodeLevelT" <> '*' AND
  "NodeLevelT" <> '$' ) AND
( "RW_TYPE" <> '4' AND
  "RW_TYPE" <> '14' )
```

Full LION



Non-Street Features Selected



Non-Pedestrian Streets Selected



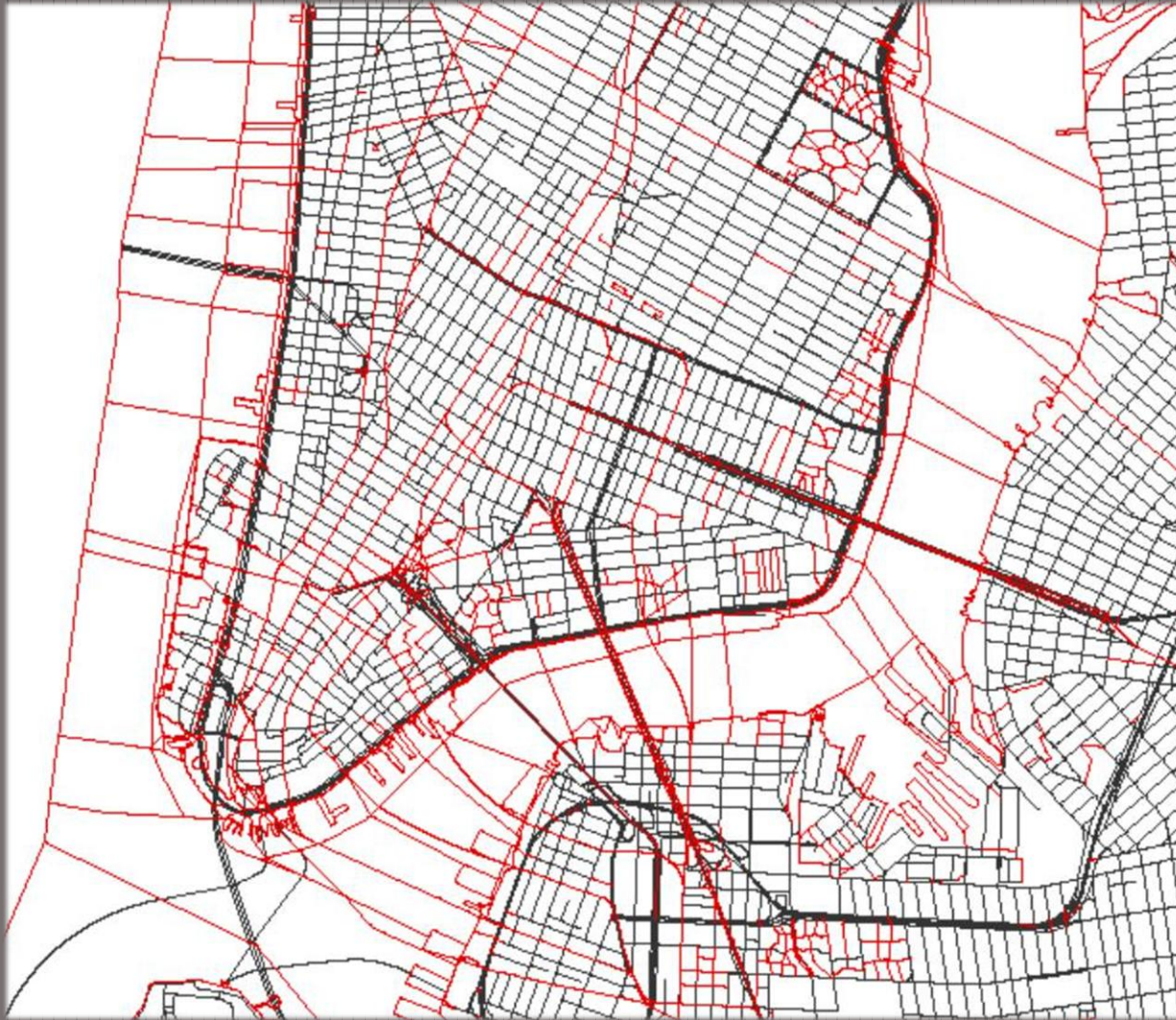
Pedestrian Network



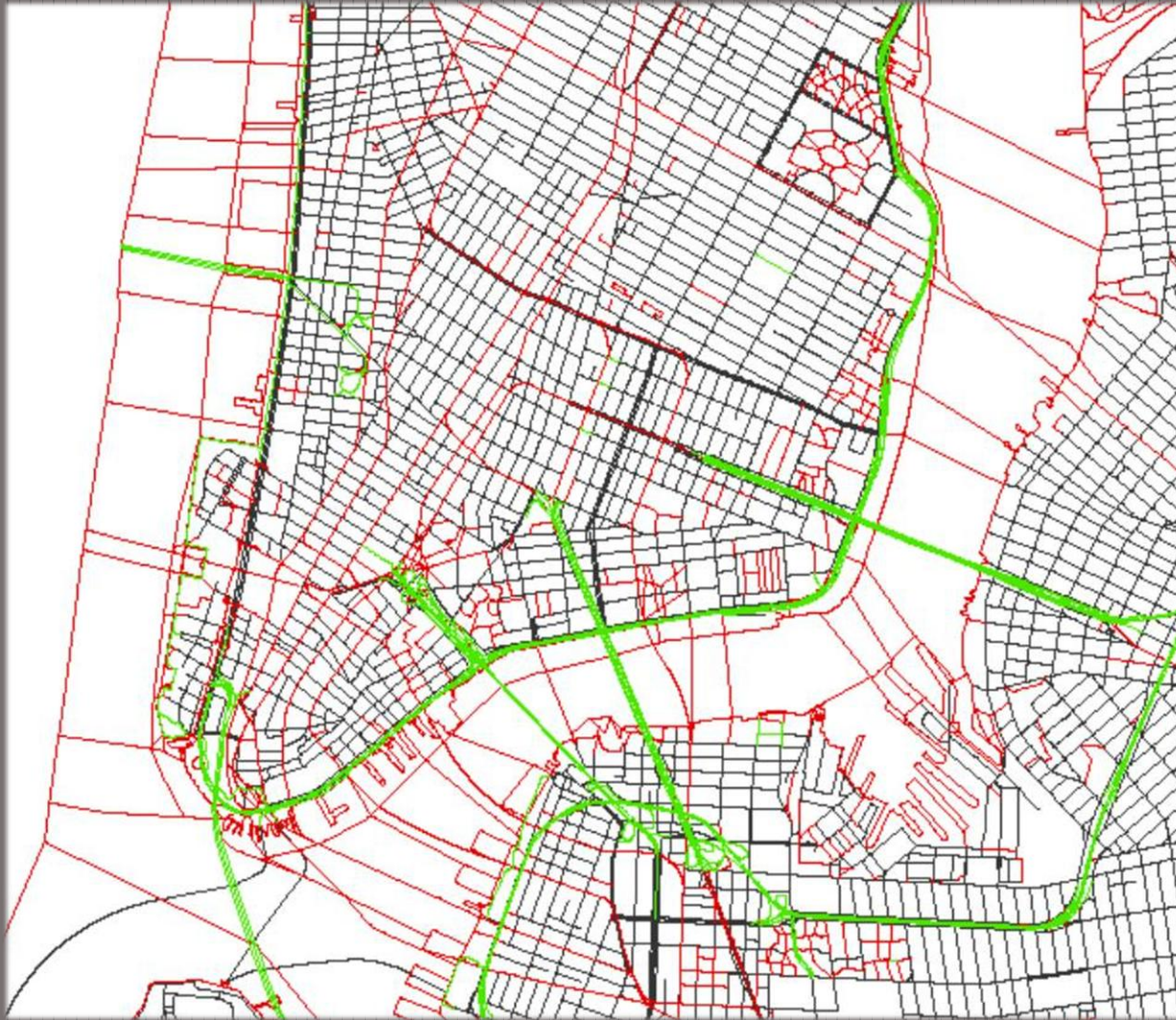
Downtown Zoom: Full LION



Downtown Zoom: Non-Street Features



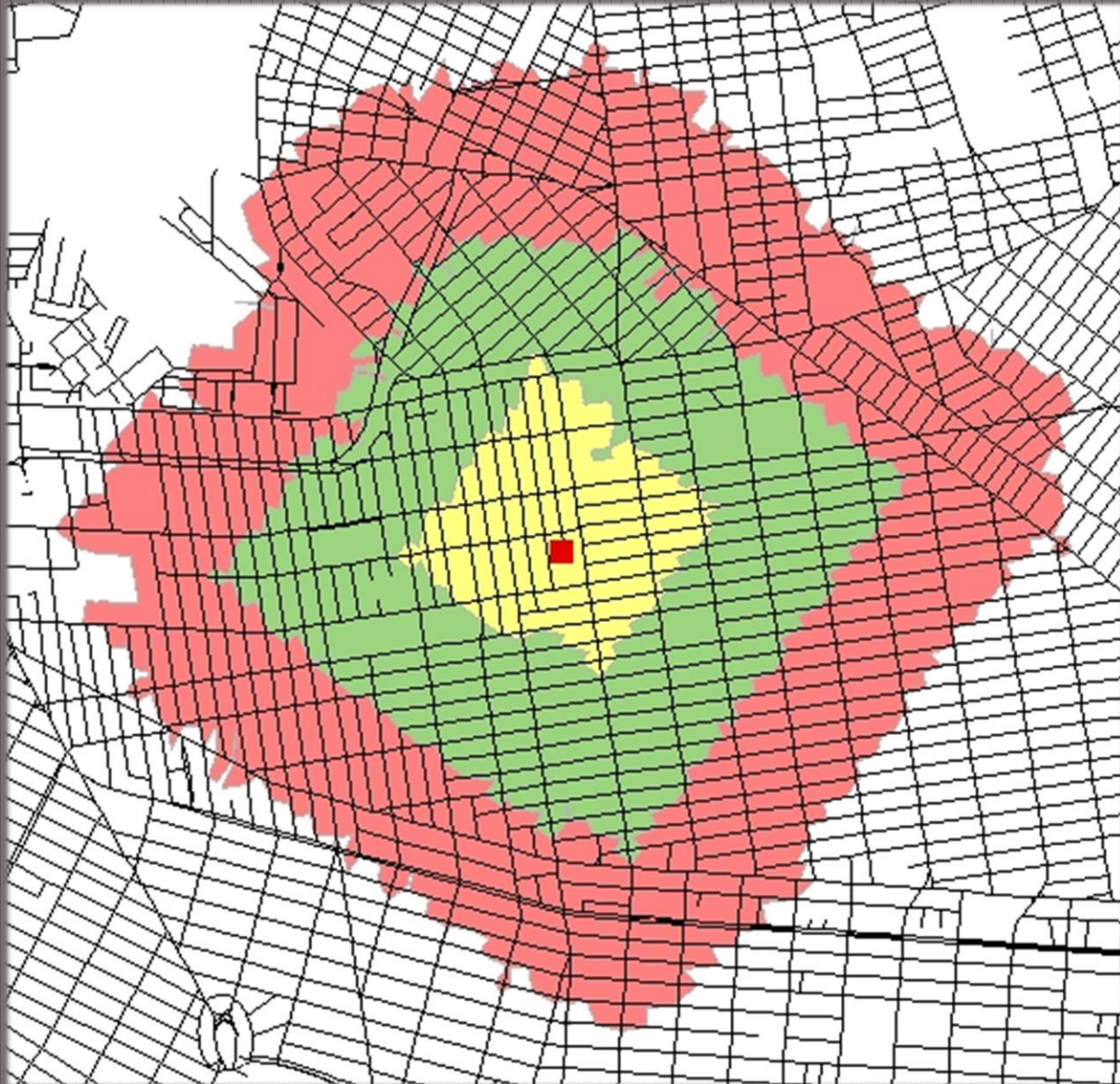
Downtown Zoom: Non-Pedestrian Streets



Downtown Zoom: Pedestrian Network



Service Area Polygon



Python Script

- Add field to TED for a school
- Measure the distance from each TED segment to that school
- Populate school column with A,B or C based on that measured distance and the block face rule
- Repeat for all 2914 schools

```
ABCpy.py - Z:\GIS\PUTES 2.0\ABCtool\ABCpy.py
File Edit Format Run Options Windows Help

#calculating distance C
#select 3 rows with the same code (but different distances) in Input_Polygons

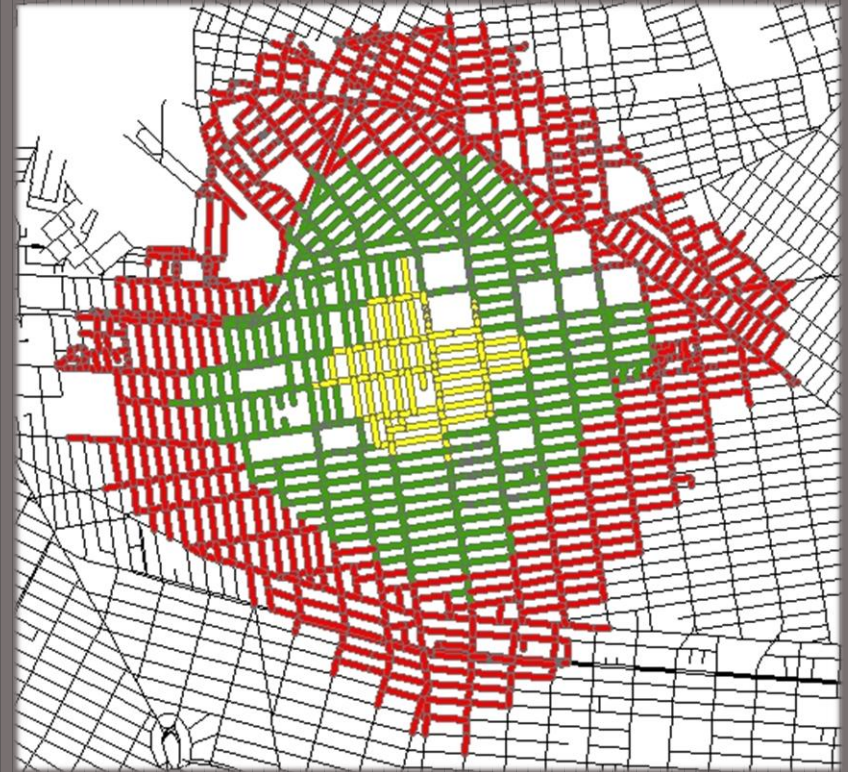
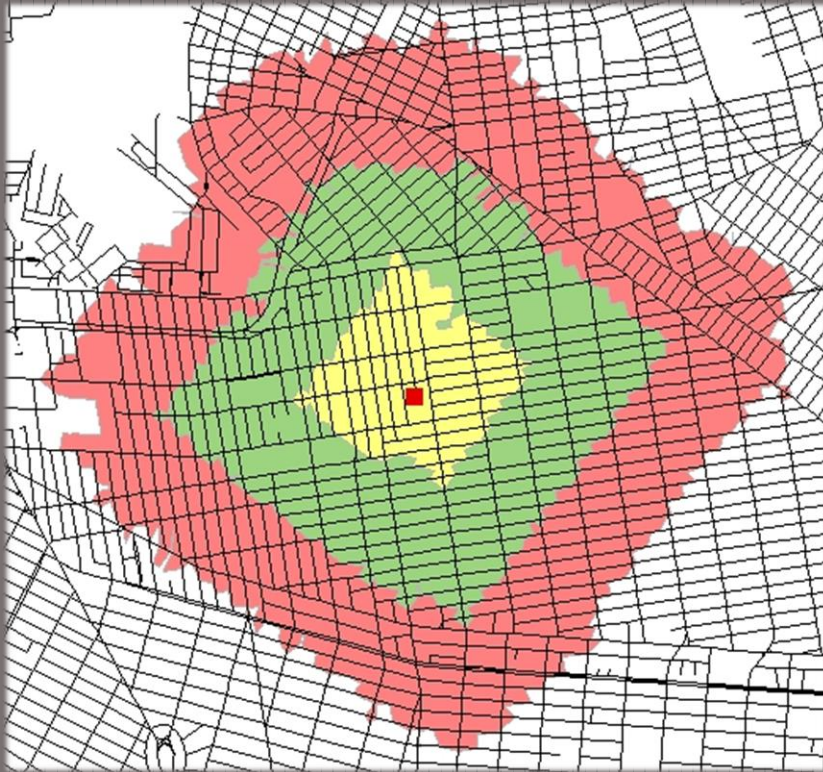
query = ("\"Name\" = '" + code + "' : " + distance3 + "' OR \"Name\" = '" + code + "' : " + distance2 + "' OR \"Name\" = '" + code + "' : " + distance1 + "'")
arcpy.SelectLayerByAttribute_management(Input_Polygons_lyr, "NEW_SELECTION", query)
#using selected features in Input_Polygons select rows in Input_Network
arcpy.SelectLayerByLocation_management (Input_Network_lyr, "WITHIN", Input_Polygons_lyr, "", "NEW_SELECTION")
#select 2 rows with the same code in Input_Polygons
query = ("\"Name\" = '" + code + "' : " + distance1 + "' OR \"Name\" = '" + code + "' : " + distance2 + "'")
arcpy.SelectLayerByAttribute_management (Input_Polygons_lyr, "NEW_SELECTION", query)
#using selected features in Input_Polygons select rows in Input_Network
arcpy.SelectLayerByLocation_management (Input_Network_lyr, "INTERSECT", Input_Polygons_lyr, "", "ADD_TO_SELECTION")
arcpy.CalculateField_management (Input_Network_lyr, school, "\"C\"")

#calculating distance B
#select 2 rows with the same code (but different distances) in Input_Polygons

query = ("\"Name\" = '" + code + "' : " + distance1 + "' OR \"Name\" = '" + code + "' : " + distance2 + "'")
arcpy.SelectLayerByAttribute_management (Input_Polygons_lyr, "NEW_SELECTION", query)
#using selected features in Input_Polygons select rows in Input_Network
arcpy.SelectLayerByLocation_management (Input_Network_lyr, "WITHIN", Input_Polygons_lyr, "", "SUBSET_SELECTION")
#select 1 row with the same code in Input_Polygons
query = ("\"Name\" = '" + code + "' : " + distance1 + "'")
arcpy.SelectLayerByAttribute_management (Input_Polygons_lyr, "NEW_SELECTION", query)
#using selected features in Input_Polygons select rows in Input_Network
arcpy.SelectLayerByLocation_management (Input_Network_lyr, "INTERSECT", Input_Polygons_lyr, "", "ADD_TO_SELECTION")
arcpy.CalculateField_management (Input_Network_lyr, school, "\"B\"")
```


Script overlaps SAP & Pedestrian Network

→ to produce TED feature class



| Street | SegmentID | School #1 | School #2 | School #3 | School #4 | School #5 | School #6 | School #7 | School #8 | School #9 |
|--------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| EAST 1 STREET | 0225298 | B | B | A | C | A | B | B | B | B |
| EAST 1 STREET | 0225299 | B | B | A | C | A | B | B | B | B |
| MADISON STREET | 0227650 | B | C | B | C | B | C | A | B | A |
| MADISON STREET | 0227651 | B | C | B | C | B | C | A | B | A |
| MADISON STREET | 0227651 | B | C | B | C | B | C | A | B | A |
| RIDGE STREET | 0230543 | B | C | A | B | B | B | A | A | A |
| RIDGE STREET | 0230544 | B | C | A | B | B | B | A | A | A |
| BALYSTOKER PLACE | 0230556 | B | C | B | B | B | B | A | A | A |
| BALYSTOKER PLACE | 0230557 | B | C | B | B | B | B | A | A | A |
| LEWIS STREET | 0230569 | B | C | B | B | B | B | A | A | A |
| LEWIS STREET | 0230570 | B | C | B | B | B | B | A | A | A |
| BARUCH PLACE | 0230575 | B | C | B | B | B | B | B | A | A |
| BARUCH PLACE | 0230576 | B | C | B | B | B | B | B | A | A |
| MANGIN STREET | 0230580 | B | C | B | B | C | B | B | A | A |
| MANGIN STREET | 0230589 | B | C | B | B | C | B | B | A | A |
| F D R DRIVE | 0230591 | B | C | B | B | C | B | B | A | A |
| F D R DRIVE | 0230592 | B | C | B | B | C | B | B | A | A |
| EAST 10 STREET PEDESTRIAN OVPS | 0240076 | B | B | C | A | C | B | C | B | C |
| EAST 10 STREET PEDESTRIAN OVPS | 0240077 | B | B | C | A | C | B | C | B | C |
| BIKE PATH | 0240115 | B | B | C | A | C | B | C | C | C |

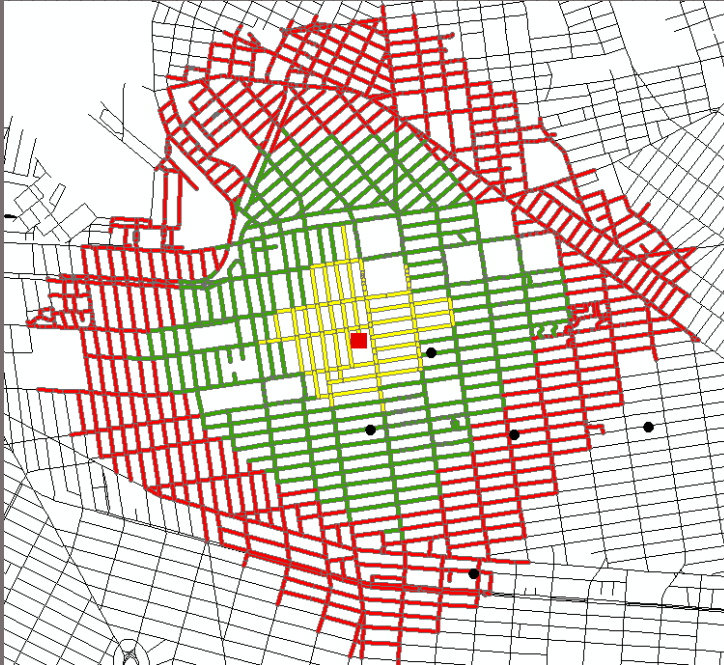
Student Information System

- TED is uploaded to OPT SQL Server:

Segments (134,000 rows)
Schools (2914 new columns)

- TED is sent to DOE student information system which “geocodes” each student to a street segment and assigns the eligibility code to the student’s record
- Schools use systems to assess the transportation needs of their students

Student Data



Geocode to LION

| Students_13054 | |
|----------------|-----------|
| Student_ID | SegmentID |
| 405668556 | 0164304 |
| 422056727 | 0164351 |
| 435668558 | 0152193 |
| 439668559 | 0110640 |
| 434668560 | 0110949 |

Relate to TED

| SegmentID | School #1 | School #2 | School #3 | School #4 | School #5 |
|-----------|-----------|-----------|-----------|-----------|-----------|
| 0225298 | B | B | A | C | A |
| 0225299 | B | B | A | C | A |
| 0227650 | B | C | B | C | B |
| 0227651 | B | C | B | C | B |
| 0227651 | B | C | B | C | B |

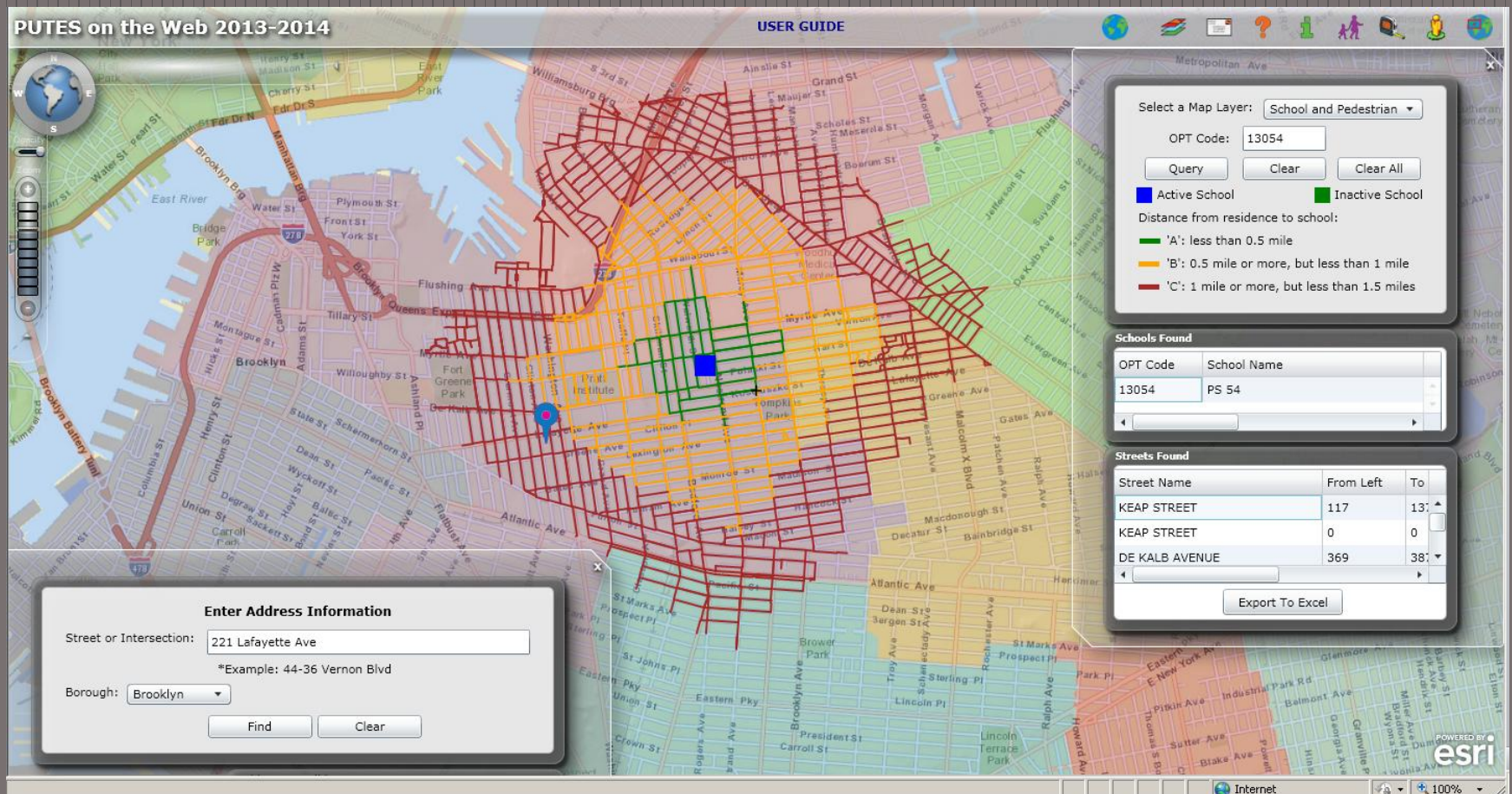
Display in Student Information System

| | | | | | | | | | | | | | |
|---|--------------------|--|-----------|----------|----------|--------|-----|-----------------|------|------------|--|---------------|--|
| PROFILE 22-K-XXXX | | New York City Public Schools | | | | | | | | | | DATE AND TIME | |
| TRAN 1012 | | Select Students By Grade Or Official Class | | | | | | | | | | USERNAME | |
| => | | | | | | | | | | | | PAGE X OF XX | |
| DIST: | | BORO: | | SCHOOL: | | GRADE: | | OFFICIAL CLASS: | | TRAN STAT: | | | |
| ACT | NAME | STUDENT ID | SEX | DOB | DST | GRD | OFF | TRAN | | | | | |
| CDE | | | | | CDE | FLG | CDE | CLS | STAT | | | | |
| | ACHAPELLE, BRANDON | 405668556 | M | 06/09/05 | D | V | 110 | F | 102 | AP | | | |
| | ADAMS, SAMARIE | 422056727 | F | 10/10/98 | D | V | 180 | F | 802 | AP | | | |
| | ALAMO, COOPER | 435668558 | M | 11/13/03 | D | V | 130 | F | 303 | AP | | | |
| | ALAMO, ZEYNAP | 439668559 | M | 06/01/00 | D | V | 160 | F | 601 | AP | | | |
| | ALTINORS, AMARIS | 434668560 | F | 01/29/07 | C | V | 350 | H | 352 | AT | | | |
| | ALVAREZ, LEVI | 438568561 | M | 06/14/02 | D | V | 140 | S | 401 | AB | | | |
| | ALVAREZ, JOSEPH | 416568562 | M | 09/22/97 | B | V | 180 | S | 802 | | | | |
| | ANDERSON, CID | 439568563 | M | 01/28/07 | B | V | 350 | | 353 | | | | |
| | ANGLADA, MARIANNE | 465668564 | F | 08/27/01 | D | V | 150 | F | 502 | AB | | | |
| | ANTONUCCI, CYRIL | 541668565 | M | 03/07/06 | C | V | 310 | F | 313 | AP | | | |
| ACT CDE: METROCARD REQUEST: T = 3 TRIP F = 4 TRIP CURRENT BUS / METROCARD: U = UPDATE D = DISPLAY X = DELETE H = HISTORY | | | | | | | | | | | | | |
| Press RIGHT CTRL/RED ENTER to continue | | | | | | | | | | | | | |
| F1/Help | F2/ | F3/Quit-return | F4/Lookup | F5/ | F6/ | | | | | | | | |
| F7/Back | F8/Forw | F9/Refresh | F10/ | F11/ | F12/Exit | | | | | | | | |

Schools assess transportation needs of students

PUTES on the Web

Displays Eligibility Zones



PUTES on the Web

Perform Distance Checks
Create Walking Paths

The screenshot displays the PUTES on the Web 2013-2014 application. The main map shows a street network in Brooklyn, with a highlighted walking path in blue and orange. Two locations are marked with red dots and numbered 1 and 2. A sidebar on the right contains a 'USER GUIDE' section and a 'Directions' panel. The 'Directions' panel lists the following steps:

1. Start at Location 1
2. Go north on WAVERLY AVENUE toward LAFAYETTE AVENUE
3. Turn right on LAFAYETTE AVENUE (2693 feet)
4. Turn left on FRANKLIN AVENUE (1326 feet)
5. Turn right on WILLOUGHBY AVENUE (1285 feet)

The 'Directions' panel also includes a 'Close Directions' button and a note: 'Use Shift key to select all directions and Ctrl C to export it to Word document'. The 'Total Distance' is displayed as 5727 feet (1.085 miles). The application is powered by ESRI.

PUTES on the Web 2013-2014

USER GUIDE

Click on the map to add stops

This shortest path is calculated by an algorithm that measures distances through the street centerline. It does not account for the width of the street or intersections. The shortest path approximates a pedestrian's path from home to school. It does not account for one way streets and some streets that are not considered pedestrian accessible are not included. The street centerline file is derived from NYC DCP LION 10C.

■ Hazards

Total Distance: 5727 feet (1.085 miles)

Directions

1. Start at Location 1
2. Go north on WAVERLY AVENUE toward LAFAYETTE AVENUE
3. Turn right on LAFAYETTE AVENUE (2693 feet)
4. Turn left on FRANKLIN AVENUE (1326 feet)
5. Turn right on WILLOUGHBY AVENUE (1285 feet)

Use Shift key to select all directions and Ctrl C to export it to Word document

esri

Internet 100%

Thank You



Office of Pupil Transportation

Contact: tcalabrese@schools.nyc.gov

BYTES of the BIG APPLE:

LION metadata:

PUTES on the Web:

www.nyc.gov/html/dcp/html/bytes/applbyte.shtml#lion

www.nyc.gov/html/dcp/html/bytes/meta_lion.shtml

<http://gis.opt-osfns.org/putes/default.html>

sample OPT School Code: 13270