Community Impact Study

Project M1

469 + 479 South Old Woodward Avenue
Birmingham, Michigan 48009

Prepared By

Christopher J. Longe, AIA
124 Peabody Street
Birmingham, Michigan 48009

Owner

Birmingham Towers Partners, LLC
251 East Merrill Street, Suite 205
Birmingham, Michigan 48009

Project M1

Birmingham, Michigan

Development Team

Owner:
Birmingham Towers Partners, LLC
251 East Merrill Street, Suite 205
Birmingham, Michigan 48009
(248) 892-2222
Contact: Doraid Markus

Civil Engineer:
PEA
2430 Rochester Court, Suite 100
Troy, Michigan 48083
(248) 689-9090 Ext 105
Contact: Paul Bater

Acoustical Engineer:
Kolano and Saha Engineers, Inc.
3559 Sashabaw Road
Waterford, Michigan 48329
(248) 674-4100
Contact: Darren Brown

Geotechnical Engineer:
SME
43980 Plymouth Oaks Boulevard
Plymouth, Michigan 48170
(734) 454-9900
Contact: Joel Rinkel

Architect:
Christopher J. Longe, AIA Architecture
124 Peabody Street
Birmingham, Michigan 48009
(248) 258-6940
Contact: Christopher Longe

Traffic Engineer:
Bergmann Associates
7050 West Saginaw Highway, Suite 200
Lansing, Michigan 48917
(517) 272-9835 Ext 600
Contact: Timothy Likens

MEP Engineer:
MA Engineering
400 S. Old Woodward Ave, Suite 100
Birmingham, Michigan 48009
(248) 258-1610
Contact: Salim Sessine

Structural Engineer:
Desai Nasr
6765 Daly Road
West Bloomfield, Michigan 48322
(248) 932-2010
Contact: Jay Desai

Table of Contents

Section 1

Combined CIS & Site Plan Review Application

City of Birmingham
A Walkable Community

Combined CIS & Site Plan Review Application

Planning Division

Form will not be processed until it is completely filled out.

1. Applicant

Name: Christopher J. Longe, AIA
Address: 124 Peabody Street
Birmingham, Michigan 48009
Phone Number: (248) 258-6940
Fax Number: (248) 258-5568
Email Address: cjlonge@cjlongeaia.com

Property Owner

Name: Birmingham Tower Partners, LLC
Address: 251 East Merrill Street, Suite 205
Birmingham, Michigan 48009
Phone Number: (248) 892-2222
Fax Number:
Email Address: dsmarkus@yahoo.com

2. Applicant's Attorney/Contact Person

Name: WWRP (Richard Rattner)
Address: 380 N. Old Woodward Suite 300
Birmingham, Michigan 48009
Phone Number: (248) 642-0333
Fax Number: (248) 642-0856
Email Address: rdr@wwrplaw.com

Project Designer/Developer

Name: Christopher J. Longe, AIA
Address: 124 Peabody Street
Birmingham, Michigan 48009
Phone Number: (248) 258-6940
Fax Number: (248) 258-5568
Email Address: cjlonge@cjlongeaia.com

3. Required Attachments

- Warranty Deed with legal description of property
- Required fee (see Fee Schedule for applicable amount)
- Two (2) folded copies of scaled plans including a site plan, certified land survey, color elevations showing all materials, landscape plan, photometric plan, and interior floor plan
- Catalog sheets for all proposed lighting, mechanical equipment & outdoor furniture
- Digital copy of plans
- Completed Checklist
- Samples of all materials to be used
- Photographs of existing site and buildings
- Additional information as required

4. Project Information

Address/Location of Property: 469 S. Old Woodward Avenue
+479 S. Old Woodward Avenue
Name of Development: Project M1
Sidwell #: 19-36-208-011 + 19-36-208-012
Current Use: B-3 / D-5 Overlay Proposed
Current Zoning: B-3 / D-4 Overlay
Is property located in the floodplain? No

Name of Historic District site is in, if any: N/A
Date of HDC Approval, if any:
Date of approval of DRB, if any:
Area in Acres: 0.423 Acres
Proposed Use: Mixed Use - Retail / Residential
Zoning of Adjacent Properties: B-3 / D-5 Overlay
Will proposed project require the division of platted lots? No

5. Details of the Proposed Development (Attach separate sheet if necessary)

9-Story mixed used development with 3 levels of underground parking. The project consists of retail / hotel lobby on the first level, with also, an entrance to the parking garage as well as a residential lobby. On floors 2-5, units will mixed throughout adding to a total of 94 hotel units. On floors 6-8, floor plates will be mixed with various sizes of apartments, with the 8th level having much larger apartments than the floors below. The top level is comprised of an amenity level for residents which includes a workout center, a pool, and an exterior terrace, as well as a mechanical screened portion for all HVAC units.

6. Buildings and Structures

Number of Buildings on site: 1
Height of Building & # of stories: 122 feet / 9 stories

Use of Buildings: Mixed use - Retail / Residential
Height of rooftop mechanical equipment: 122 feet

7. Floor Use and Area (in square feet)

Proposed Commercial Structures:

Total basement floor area: (3) parking levels at 18,260 SF = 54,780 SF
Number of square feet per upper floor: See Plans
Total floor area: 184,980 SF (including basement levels)
Floor area ratio (total floor area divided by total land area): N / A
Open space: N / A
Percent of open space: N / A

Office space: N / A
Retail space: 3,435 SF
Industrial space: N / A
Assembly space: N / A
Seating Capacity: N / A
Maximum Occupancy Load:

Proposed Residential Structures:

Total number of units: 94 Hotel, 29 Apartments
Number of one bedroom units: TBD
Number of two bedroom units: TBD
Number of three bedroom units: TBD
Open space:
Percent of open space:

Rental units or condominiums?: TBD
Size of one bedroom units: See Plans
Size of two bedroom units: See Plans
Size of three bedroom units: See Plans
Seating Capacity: N/A
Maximum Occupancy Load:

Proposed Additions:

Total basement floor area, if any, of addition:
Number of floors to be added:
Number of square feet added per floor:
Total floor are (including addition):
Floor area ratio (total floor area divided by total land area):
Open space:
Percent of open space:

Use of addition:
Height of addition:
Office space in addition:
Retail space in addition:
Industrial space in addition:
Assembly space in addition:
Maximum Occupancy Load (including addition):

8. Required and Proposed Setbacks

Required front setback: 0 feet
Required rear setback: 10 feet (no rear of building)
Required total side setback: 0 feet
Side setback: 0 feet

Proposed front setback: 0 feet on all front setbacks
Proposed rear setback: No rear of building
Proposed total side setback: 0 feet
Second side setback: 0 feet

9. Required and Proposed Parking

Required number of parking spaces: 148 spaces
Typical angle of parking spaces: 90 degrees
Typical width of maneuvering lanes: 22 feet (Varies)
Location of parking on the site: Underground Parking
Location of off site parking: See discussed 555 deal
Number of light standards in parking area: N/A
Screenwall material: N/A

Proposed number of parking spaces: 100 + 4 (street) = 104 spaces
Typical size of parking spaces: 9' x 20'
Number of spaces < 180 sq. ft.: None
Number of handicap spaces: Up to 8
Shared Parking Agreement?: See discussed 555 deal
Height of light standards in parking area: N/A
Height of screenwall: N/A

10. Landscaping

Location of landscape areas:
Two street trees and tree wells along South Old Woodward, and one street tree in curb of Woodward Avenue. Additional plants may be constructed along street facades.

Proposed landscape material:
Decorative flowering annuals, grasses, and shrubs. Located in planters constructed to match building material and foundation landscape.

11. Streetscape

Sidewalk width: 7'-6" on Hazel, 14'-8" on S. Old Woodward
Number of benches: None
Number of planters: TBD
Number of existing street trees: 0
Number of proposed street trees: 3
Streetscape Plan submitted?: TBD

Description of benches or planters: Planters to match building material
Species of existing street trees: N/A
Species of proposed street trees: Jack Select Pear and Streetspire Oak

12. Loading

Required number of loading spaces: 2
Typical angle of loading spaces:
Screenwall material:
Location of loading spaces on the site: Woodward loading

Proposed number of loading spaces: 2
Typical size of loading spaces: 12x40
Height of screenwall:

13. Exterior Trash Receptacles

Required number of trash receptacles: N / A
Location of trash receptacles:
Screenwall material:

Proposed number of trash receptacles:
Size of trash receptacles:
Height of screenwall:

14. Mechanical Equipment

Utilities & Transformers:

Number of ground mounted transformers: 1
Size of transformers (LxWxH): TBD
Number of utility easements:
Screenwall material: Metal Louver

Location of all utilities & easements: See site plan
Height of screenwall: TBD, but higher than transformer

Ground Mounted Mechanical Equipment:

Number of ground mounted units: N / A
Size of ground mounted units (LxWxH):
Screenwall material:

Location of all ground mounted units:
Height of screenwall:

Rooftop Mechanical Equipment:

Number of rooftop units: TBD
Type of rooftop units: Forced air roof top units
Screenwall material: Louvered aluminum
Location of screenwalls: See plans

Location of all rooftop units: See plans
Size of rooftop units (LxWxH): TBD
Height of screenwall:
Percentage of rooftop covered by mechanical units:
Distance from rooftop units to all screenwalls:

15. Accessory Buildings

Number of accessory buildings: N/A
Location of accessory buildings:

Size of accessory buildings:
Height of accessory buildings:

16. Building Lighting

Number of light standards on building: TBD

Type of light standards on building: ______

Size of light fixtures (LxWxH): ______

Height from grade: ______

Maximum wattage per fixture: ______

Proposed wattage per fixture: ______

Light level at each property line: ______

17. Site Lighting

Number of light fixtures: TBD

Type of light fixtures: ______

Size of light fixtures (LxWxH): ______

Height from grade: ______

Maximum wattage per fixture: ______

Proposed wattage per fixture: ______

Light level at each property line: ______

Number & location of holiday tree lighting receptacles: ______

The undersigned states the above information is true and correct, <u>and understands that it is the responsibility of the applicant to advise the Planning Division and / or Building Division of any additional changes made to an approved site plan</u>. The undersigned further states that they have reviewed the procedures and guidelines for site plan review in Birmingham, and have complied with same. The undersigned will be in attendance at the Planning Board meeting when this application will be discussed.

Signature of Owner: ______ Date: ______

Print Name: ______

Signature of Applicant: ______ Date: ______

Print Name: Christopher J. Longe

Signature of Architect: ______ Date: ______

Print Name: Christopher J. Longe

Office Use Only

Application #: ______ Date Received: ______ Fee: ______

Date of Approval: ______ Date of Denial: ______ Accepted by: ______

Section 2

CIS Checklist

City of Birmingham
A Walkable Community

COMBINED SITE PLAN REVIEW & COMMUNITY IMPACT STUDY APPLICATION CHECKLIST PLANNING DIVISION

Applicant: Christopher J. Longe Case #: ________ Date: 03/16/2018

Address: 469 + 479 South Old Woodward Avenue Project: Project M1

All site plans and elevation drawings prepared for approval shall be prepared in accordance with the following specifications and other applicable requirements of the City of Birmingham. If more than one page is used, each page shall be numbered sequentially. All plans must be legible and of sufficient quality to provide for quality reproduction or recording. Plans must be no larger than 24" x 36", and must be folded and stapled together. The address of the site must be clearly noted on all plans and supporting documentation.

Site Plan

A full site plan detailing the proposed changes for which approval is requested shall be drawn at a scale no smaller than 1" = 100' (unless the drawing will not fit on one 24" X 36" sheet) and shall include:

X 1. Name and address of applicant and proof of ownership;

X 2. Name of Development (if applicable);

X 3. Address of site and legal description of the real estate;

X 4. Name and address of the land surveyor;

X 5. Legend and notes, including a graphic scale, north point, and date;

X 6. A separate location map;

X 7. A map showing the boundary lines of adjacent land and the existing zoning of the area proposed to be developed as well as the adjacent land;

N/A 8. Details of all proposed site plan changes;

N/A 9. A chart indicating the dates of any previous approvals by the Planning Board, Board of Zoning Appeals, Design Review Board, or the Historic District Commission ("HDC");

X 10. Existing and proposed layout of streets, open space and other basic elements of the plan;

X 11. Existing and proposed utilities and easements and their purpose;

X 12. Location of natural streams, regulated drains, 100-year flood plains, floodway, water courses, marshes, wooded areas, isolated preservable trees, wetlands, historic features, existing structures, dry wells, utility lines, fire hydrants and any other significant feature(s) that may influence the design of the development;

X 13. General description, location, and types of structures on the site;

X 14. Details of existing or proposed lighting, signage and other pertinent development features;

X 15. Elevation drawings showing proposed design;

N/A 16. Screening to be utilized in concealing any exposed mechanical or electrical equipment and all trash receptacle areas;

X 17. Location of all exterior lighting fixtures;

X 18. A landscape plan showing all existing and proposed planting and screening materials, including the number, size, and type of plantings proposed and the method of irrigation; and

__X__ 19. Any other information requested in writing by the Planning Division, the Planning Board, or the Building Official deemed important to the development.

Elevation Drawings

Complete elevation drawings detailing the proposed changes for which approval is requested shall be drawn at a scale no smaller than 1" = 100' (unless the drawing will not fit on one 24" X 36" sheet) and shall include:

__X__ 20. Color elevation drawings showing the proposed design for each façade of the building;

__X__ 21. List of all materials to be used for the building, marked on the elevation drawings;

__N/A__ 22. Elevation drawings of all screenwalls to be utilized in concealing any exposed mechanical or electrical equipment, trash receptacle areas and parking areas;

__X__ 23. Details of existing or proposed lighting, signage and other pertinent development features;

__N/A__ 24. A list of any requested design changes;

__X__ 25. Itemized list of all materials to be used, including exact size specifications, color, style, and the name of the manufacturer;

__X__ 26. Location of all exterior lighting fixtures, exact size specifications, color, style and the name of the manufacturer of all fixtures, and a photometric analysis of all exterior lighting fixtures showing light levels to all property lines; and

__X__ 27. Any other information requested in writing by the Planning Division, the Planning Board, or the Building Official deemed important to the development.

City of Birmingham
A Walkable Community

COMMUNITY IMPACT STUDY CHECKLIST

PLANNING DIVISION

Applicant: Christopher J. Longe Case #: ________ Date: 03/16/18

Address: 469 + 479 South Old Woodward Avenue Project: Project M1

All Community Impact Studies prepared for approval must contain the following information:

General Information

X 1. Name and address of applicant and proof of ownership;

X 2. Name of Development (if applicable);

X 3. Address of site and legal description of the real estate;

X 4. Name and address of the land surveyor;

X 5. Legend and notes, including a graphic scale, north point, and date;

x 6. A separate location map;

x 7. A map showing the boundary lines of adjacent land and the existing zoning of the area proposed to be developed as well as the adjacent land;

N/A 8. Details of all proposed site plan changes;

Planning & Zoning Issues

x 9. Recommended land use of the subject property as designated on the future land use map of the city's Master Plan;

x 10. Goals and objectives of the city's Master Plans that demonstrate the city's support of the proposed development;

x 11. Whether or not the project site is located within an area of the city for which an Urban Design Plan has been adopted by the Planning Board in which special design criteria or other supplemental development requirements apply;

X 12. The current zoning classification of the subject property;

X 13. The zoning classification required for the proposed development;

X 14. The existing land uses adjacent to the proposed project;

X 15. Complete the attached "Zoning Requirements Analysis" chart;

Land Development Issues

X 16. A survey and site drainage plan;

X 17. Identify any sensitive soils on site that will require stabilization or alteration in order to support the proposed development;

X 18. Whether or not the proposed development will occur on a steep slope, and if so, the measures that will be taken to overcome potential erosion, slope stability and runoff;

X 19. The volume of excavated soils to be removed from the site and /or delivered to the site, and a map of the proposed haul routes;

X 20. Identify the potential hazards and nuisances that may be created by the proposed development and the suggested methods of mitigating such hazards;

Private Utilities

X 21. Indicate the source of all required private utilities to be provided;

X 22. Provide verification that all required utility easements have been secured for necessary private utilities;

Noise Levels

X 23. Provide a reading of existing ambient noise and estimated future noise levels on the site;

X 24. Indicate whether the project will be exposed to or cause noise levels which exceed those levels prescribed in Chapter 50, Division 4, Section 50-71 through 50-77 of the Birmingham City Code, as amended;

X 25. Indicate whether the site is appropriate for the proposed activities and facilities given the existing ambient noise and the estimated future noise levels of the site;

Air Quality

X 26. Indicate whether the project is located in the vicinity of a monitoring station where air quality violations have been registered and, if so, provide information as to whether the project will increase air quality problems in the area;

X 27. Indicate if the nature of the project or its potential users would be particularly sensitive to existing air pollution levels and, if so, indicate how the project has been designed to mitigate possible adverse effects;

X 28. Indicate whether the proposal will establish a trend which, if continued, may lead to violation of air quality standards in the future;

X 29. Indicate whether the proposed project will have parking facilities for more than 75 cars and indicate percentage of required parking that is proposed;

Environmental Design and Historic Values

X 30. Indicate whether there will be demonstrable destruction or physical alteration of the natural or human-made environment on site or in the right-of-way (ie. clearance of trees, substantial regrading etc.);

X 31. Indicate whether there will be an intrusion of elements out of character or scale with the existing physical environment (ie. significant changes in size, scale of building, floor levels, entrance patterns, height, materials, color or style from that of surrounding developments);

X 32. Indicate all elements of the project that are eligible for LEED points if the building were to be LEED certified (ie. Extensive use of natural daylight, use of low VOC paint, use of renewable/recycled resources, energy efficient mechanical systems, use of wind and solar power, geothermal heating etc.);

X 33. Indicate whether the proposed structure will block or degrade views, change the skyline or create a new focal point;

X 34. Indicate whether there will be objectionable visual pollution introduced directly or indirectly due to loading docks, trash receptacles or parking, and indicate mitigation measures for same;

X 35. Indicate whether there will be an interference with or impairment of ambient conditions necessary for the enjoyment of the physical environment (ie. vibration, dust, odor, heat, glare etc.);

X 36. Indicate whether the project area and environs contain any properties listed on the National Register of Historic Places or the city's inventory of historic structures;

X 37. Provide any information on the project area that the State Historic Preservation Office (SHPO) may have;

X 38. Indicate whether there will be other properties within the boundaries or in the vicinity of the project that appear to be historic and thus require consultation with the SHPO as to eligibility for the National register;

X 39. Indicate whether the Department of the Interior has been requested to make a determination of eligibility on properties the SHPO or HDC deems eligible and affected by the project;

X 40. Provide proof that the HDC has been given an opportunity to comment on properties that are listed on or have been found eligible for the National Register and which would be affected by the project;

Refuse

X 41. Indicate whether the existing or planned solid waste disposal system will adequately service the proposed development including space for separation of recyclable materials;

X 42. Indicate whether the design capacity of the existing or planned solid waste disposal system will be exceeded as a result of the project;

Sanitary Sewer

X 43. Indicate whether existing or planned waste water systems will be able to adequately service the proposed development;

X 44. Indicate whether the design capacity of these facilities will be exceeded as a result of the project;

X 45. Indicate the elements of the project that have been incorporated to reduce the amount of water entering the sewer system (such as low flush toilets, EnergyStar appliances, restricted flow faucets, greywater recycling etc.) ;

Storm Sewer

X 46. Indicate whether existing or planned storm water disposal and treatment systems will adequately serve the proposed development;

X 47. Indicate whether the design capacity of these facilities will be exceeded as a result of the project;

X 48. Indicate the elements of the project that have been incorporated to reduce the amount of storm water entering the sewer system (such as the use of pervious concrete, rain gardens, greywater recycling, green pavers etc.);

Water Service

X 49. Indicate whether either the municipal water utility or on-site water supply system is adequate to serve the proposed project;

X 50. Indicate whether the water quality is safe from both a chemical and bacteriological standpoint;

X 51. Indicate whether the intended location of the service will be compatible with the location and elevation of the main;

Public Safety

X 52. Whether or not the project location provides adequate access to police, fire and emergency medical services;

X 53. Whether or not the proposed project design provides easy access for emergency vehicles and individuals (ie. are there obstacles to access, such as one-way roads, narrow bridges etc.);

X 54. Whether or not there are plans for a security system which can be expanded, and whether approval for same has been granted by the police department;

X 55. Detailed description of all fire access to the building, site, fire hydrants and water connections;

X 56. Whether or not there are plans for adherence to all city and N.F.P.A. fire codes;

X 57. Proof that one elevator has been designed to accommodate a medical cart;

X 58. Detailed specifications on all fire lanes/parking lot surfaces/alleys/streets to demonstrate the ability to accommodate the weight of emergency / fire vehicles;

X 59. Detailed description of all fire suppression systems;

Transportation issues

X 60. Provide completed FORM A – Transportation Study Questionnaire (Abbreviated);

X 61. Provide completed FORM B – Transportation Study Questionnaire if required by the city's transportation consultant;

X 62. Indicate whether transportation facilities and services will be adequate to meet the needs of all users (i.e. access to public transportation, bicycle accommodations, pedestrian connections, disabled, elderly etc.);

X 63. Indicate how the project will improve the mobility of all groups by providing transportation choices;

X 64. Indicate how the users of the building will be encouraged to use public transit and non-motorized forms of transportation;

X 65. Indicate the elements that have been incorporated into the site and surrounding right-of-way to encourage mode shift away from private vehicle trips;

X 66. Indicate the elements of the project that have been provided to improve the comfort and safety of cyclists (such as secured or covered bicycle parking, lockers, bike lanes/paths, bicycle share program etc.);

X 67. Indicate the elements of the project that have been provided to improve the comfort and safety of pedestrians (such as wheelchair ramps, crosswalk markings, pedestrian activated signal lights, bulb outs, benches, landscaping, lighting etc.);

X 68. Indicate the elements of the project that have been provided to encourage the use of sustainable transportation modes (such as receptacles for electric vehicle charging, parking for scooters/Smart cars etc.);

Natural Features

X 69. Indicate whether there are any visual indicators of pond and / or stream water quality problems on or near the site;

X 70. Indicate whether the project will involve any increase in impervious surface area and, if so, indicate the runoff control measures that will be undertaken;

X 71. Indicate whether the project will affect surface water flows on water levels of ponds or other water bodies;

X 72. Indicate whether the project may affect or be affected by a wetland, flood plain, or floodway;

X 73. Indicate whether the project location or construction will adversely impact unique natural features on or near the site;

X 74. Indicate whether the project will either destroy or isolate a unique natural feature from public access;

X 75. Indicate whether any unique natural feature will pose safety hazards for the proposed development;

X 76. Indicate whether the project will damage or destroy existing wildlife habitats; and

Other Information

__X__ 77. Any other information as may reasonably be required by the city to assure an adequate analysis of all existing and proposed site features and conditions.

Professional Qualifications

The preparer(s) of the CIS must indicate their professional qualifications, which must include registration in the state of Michigan in their profession where licensing is a state requirement for the practice of the profession (i.e. engineer, surveyor, architect etc.). Where the state does not require licensing (ie. planner, urban designer, economist etc.), the preparer must demonstrate acceptable credentials including, but not limited to, membership in professional societies, university degrees, documentation illustrating professional experience in preparing CIS related materials for similar projects.

City of Birmingham
A Walkable Community

Notice Signs - Rental Application
Community Development

1. Applicant
Name: Christopher J. Longe, AIA
Address: 124 Peabody Street
Birmingham, Michigan 48009
Phone Number: (248) 258-6940
Fax Number: (248) 258-5568

Property Owner
Name: Birmingham Tower Partners, LLC
Address: 251 East Merrill Street, Suite 205
Birmingham, Michigan 48009
Phone Number: (248) 892-2222
Fax Number:

2. Project Information
Address/Location of Property: 469 + 479 S. Old Woodward Ave.
Name of Development: Project M1
Area in Acres: 0.423 Acres

Name of Historic District site is in, if any: N / A
Current Use: B3-D5 Overlay proposed
Current Zoning: B3-D4 Overlay

3. Date of Board Review
Board of Building Trades Appeals:
City Commission: TBD
Historic District Commission:
Planning Board: TBD

Board of Zoning Appeals:
Design Review Board:
Housing Board of Appeals:

The undersigned states the above information is true and correct, and understands that it is the responsibility of the applicant to post the Notice Sign(s) at least 15 days prior to the date on which the project will be reviewed by the appropriate board or commission, and to ensure that the Notice Sign(s) remains posted during the entire 15 day mandatory posting period. The undersigned further agrees to pay a rental fee and security deposit for the Notice Sign(s), and to remove all such signs on the day immediately following the date of the hearing at which the project was reviewed. The security deposit will be refunded when the Notice Sign(s) are returned undamaged to the Community Development Department. Failure to return the Notice Sign(s) and/or damage to the Notice Sign(s) will result in forfeiture of the security deposit.

Signature of Applicant: ______________________________ Date: ________________

Office Use Only

Application #: ________________ Date Received: ________________ Fee: ________________

Date of Approval: ________________ Date of Denial: ________________ Reviewed by: ________________

City of Birmingham
A Walkable Community

Fee Schedule

Administrative Approval	$100.00
Board of Zoning Appeals***** • Single Family Residential • All Others	 $310 $510
Community Impact Study Review*****	$2,050
Design Review*****	$350
Lot Division*****	$200 / parcel affected
Historic District Review***** • Single Family Residential District • All other zone districts	 No charge $350
Public Notice Sign	$100 / refundable deposit $50 fee
Site Plan Review***** • R4 through R8 zone district • Nonresidential districts	 $850 plus $50 per dwelling unit $1050 plus $50 per acre or portion of acre
Special Land Use Permit***** • Plus Site Plan Review • Plus Design Review • Plus Publish of Legal Notice • Plus sign rental and deposit	$800 $1050 $350 $450 $150 Total fee: $2800
Special Land Use Permit Annual Renewal Fee	$200.00
Temporary Use Permit	$100
Zoning Compliance Letter	$50

The fees for design review, site plan review, historic district review and special land use permits shall be double the listed amounts in the even the work is commenced prior to the filing of an application for review by the City of Birmingham.

Ordinance No. 1751 (Appendix A, Section 7.38 of the Birmingham City Code)

Section 3

CIS Checklist Supplemental Information

Project M1
469 + 479 South Old Woodward Avenue
Birmingham, Michigan 48009

Combined CIS & Site Plan Review Application
Planning Division

General Information

1. Name and address of applicant and proof of ownership;

Christopher J. Longe AIA Architecture
124 Peabody Street
Birmingham, Michigan 48009
248.258.6940 p.
248.258.5568 f.
Contact: Michael Testrake, mtestrake@cjlongeaia.com
Christopher Longe, cjlonge@cjlongeaia.com

2. Name of Development (if applicable);

Project M1

3. Address of site and legal description of the real estate;

469 South Old Woodward Avenue
479 South Old Woodward Avenue
See survey for legal description

4. Name and address of the land surveyor;

PEA, Inc
2430 Rochester Court, Suite 100
Troy, Michigan 48083
Contact: Paul Bater
248.689.9090 Ext. 105

5. Legend and notes, including a graphic scale, north point, and date;

See Site Plan

6. A separate location map;

Please refer to Appendix for Vicinity and Location map

7. A map showing the boundary lines of adjacent land and the existing zoning of the area proposed to be developed as well as the adjacent land;

Please refer to Appendix for Zoning Map

8. Details of all proposed site plan changes;

Original submission, no changes at this time

Planning & Zoning Issues

9. Recommended land use of the subject property as designated on the future land use map of the city's Master Plan;

Reference: Downtown Birmingham 2016 Plan

- **Recommended land use for this site is Flexible Use - D-4 Zone. (Appendix F-2, page 94)**
- **"Retail 3" (page 29)**

  Report recommends:

  In selecting an anchor tenant: it complements rather directly competes with neighboring commercial; it will be useful to Birmingham residents; it will attract customers from outside the primary trade area; and it will not have negative impacts on surrounding neighborhoods or the CBD.
- **"Retail 5" (pages 31-33)**

  Report recommends:

  Encourage anchor development at the spaces between the five primary shopping districts, as illustrated in Appendix D-1. At the edges of the CBD, encourage residential and office development, in addition to retail, restaurant, and service anchors.
- **"Retail 9" (Page 39-41)**

  Report recommends:

  Although this report specifically speaks about the Bowers-Hunter [Woodward Ave], this report identifies the need for "a significant landmark building that is either destination retail or destination entertainment-commercial." The report speaks to this destination building as developing the intersection to bring identity for the surround areas which include Hunter Boulevard [Woodward Ave], Bowers Street, and Woodward Ave [Old Woodward]. Project M1 tries to accomplish the same goals but focusing on Hazel and the under used surroundings of the area.
- **"Retail 11" (page 43)**

  Report recommends:

  Encourage future buildings to front Hunter Boulevard (Woodward Ave) so as to project a positive image of the City. Study the potential for extending the recommended streetscaping, landscaping, and signage improvements along Hunter Boulevard [Woodward Ave], thereby reinforcing its being a part of the CBD.

10. Goals and objectives of the city's Master Plans that demonstrate the city's support of the proposed development;

- **Proposed project is to be constructed within the boundaries of the Downtown Birmingham Overlay District and implement the Downtown Birmingham 2016 Plan**
- **Proposed project encourages a form of development that will achieve the physical qualities necessary to enhance the economic vitality of Downtown Birmingham and to maintain the desired character of the City of Birmingham as stated in the Downtown Birmingham 2016 Plan by introducing multiple uses as a destination anchor as well as location for more extended periods of stay within the city proper.**
- **Proposed project enhances the existing historical districts and is consistent with the existing architectural traditions and fabrics of Downtown Birmingham.**

11. Whether or not the project site is located within an area of the city for which an Urban Design Plan has been adopted by the Planning Board in which special design criteria or other supplemental development requirements apply;

Proposed project is within the Downtown Overlay District and complies with the Downtown Birmingham 2016 Plan.

12. The current zoning classification of the subject property;

B-3 / D-4 Overlay

13. The zoning classification required for the proposed development;

D-5 Overlay

14. The existing land uses adjacent to the proposed project;

• **Existing land use**	**Restaurant, Old bank/small parking garage**
• **North**	**Birmingham Place — Mixed use with apartments**
• **South**	**Street Frontage and then 555 building**
• **East**	**Street Frontage**
• **West**	**Street Frontage**

15. Complete the attached “Zoning Requirements Analysis” chart;

Refer to Appendix for Zoning Analysis chart

Land Development Issues

16. A survey and site drainage plan;

Refer to the enclosed Existing Conditions Plan for a survey of the site. In existing conditions, the entire site, including all of the impervious parking areas and buildings is conveyed to the existing 12-inch water main and 8-inch sanitary line on South Old Woodward. The current plan proposes to discharge the roof drainage from the proposed building to the existing 12-inch water main within the South Old Woodward right-of-way by means of a direct roof lead connection to this sewer.

17. Identify any sensitive soils on site that will require stabilization or alteration in order to support the proposed development;

Refer to the enclosed Geotechnical Investigation and Geophysical Investigation report for soil analysis. During the demolition and construction phases, there will be noise, dust, and vibration. The contractor will provide multiple means to reduce the impact of these activities. This can and will include: temporary barriers, specialized demolition equipment designed to minimize noise/vibration, stringent clean up procedures (including the use of water for dust control), and constant monitoring of the conditions within the work zone.

18. Whether or not the proposed development will occur on a steep slope, and if so, the measures that will be taken to overcome potential erosion, slope stability and runoff;

The proposed development will not occur on a steep slope.

19. The volume of excavated soils to be removed from the site and /or delivered to the site, and a map of the proposed haul routes;

Cut and fill volumes are currently being analyzed.

20. Identify the potential hazards and nuisances that may be created by the proposed development and the suggested methods of mitigating such hazards;

Based on preliminary analysis, the potential hazards would involve the construction of the earth retention system and its interference with the adjacent properties. The earth retention system is yet to be designed, but after preliminary discussion with the structural engineer and geotechnical consultant, there are multiple ways of allowing the site to achieve what is desired for the project.

Private Utilities

21. Indicate the source of all required private utilities to be provided;

Refer to the enclosed Existing Conditions Plan and new utility plan for approximate locations of the existing private utilities.

- **Electricity will be provided by DTE**
- **Natural Gas will be provided by CMS Energy**
- **Telephone / cable service will be provided by AT&T Communication / Comcast / etc.**

22. Provide verification that all required utility easements have been secured for necessary private utilities;

Verification for all required utility easements will be coordinated with the respective utility owner and determined during the site plan and building review process. Additional required easements to support the development will be proposed and secured prior to construction of the respective utility.

Noise Levels

23. Provide a reading of existing ambient noise and estimated future noise levels on the site;

Refer to the sound study completed by Kolano and Saha Consulting Engineers included in the Appendix.

24. Indicate whether the project will be exposed to or cause noise levels which exceed those levels prescribed in Chapter 50, Division 4, Section 50-71 through 50-77 of the Birmingham City Code, as amended;

All future activities associated with the project will not exceed the noise levels demanded in the Birmingham City Code. Given the developments occupancy, very little noise is anticipated. Any measurable noise will emanate from mechanical equipment such as heat pumps and exhaust fans. This equipment is typically very quiet. Emergency generators will be located underground and exhausted vertically.

25. Indicate whether the site is appropriate for the proposed activities and facilities given the existing ambient noise and the estimated future noise levels of the site;

There will be an increase in traffic from the existing development to the proposed, mostly from the idea around a destination anchor. The use and noise generated is similar to the existing uses to the north of the building at Birmingham Place.

Air Quality

26. Indicate whether the project is located in the vicinity of a monitoring station where air quality violations have been registered and, if so, provide information as to whether the project will increase air quality problems in the area;

Please refer to Appendix for Air Quality information. The projects property is located in the Southeast Michigan Air Quality District. Monitoring stations are located in Oak Park, Pontiac and Rochester. Current Ambient Air Quality Standards are well under existing minimum standards as set forth by the EPA.

27. Indicate if the nature of the project or its potential users would be particularly sensitive to existing air pollution levels and, if so, indicate how the project has been designed to mitigate possible adverse effects;

> **The project is consistent with the typical downtown Birmingham projects and some additional pollution from vehicles and HVAC units is anticipated. All new HVAC units will have filters and in the event a restaurant occupies the retail level, ownership will demand scrubbers on the vent fans.**

28. Indicate whether the proposal will establish a trend which, if continued, may lead to violation of air quality standards in the future;

> **The project will not establish a trend of any air quality standards as it will be similar in nature to the mixed use of Birmingham Place to north of the site. Most of the air pollution will emanate from the parking deck or existing adjacent street traffic.**

29. Indicate whether the proposed project will have parking facilities for more than 75 cars and indicate percentage of required parking that is proposed;

> **Proposed development will have 104 spaces, 100 of which are on site, which 4 are the existing street parking spaces along the South Old Woodward Avenue corridor. Our site requires a total parking of 148 spaces. This is a net deficiency of around 30%. That net deficiency is covered with an agreement with the 555 building that will be a part of the appendix.**

Environmental Design and Historic Values

30. Indicate whether there will be demonstrable destruction or physical alteration of the natural or human-made environment on site or in the right-of-way (ie. clearance of trees, substantial regrading etc.);

> **The existing buildings that are on site will be demolished. There will be no grade changes besides the alteration of adding three underground parking levels.**

31. Indicate whether there will be an intrusion of elements out of character or scale with the existing physical environment (ie. significant changes in size, scale of building, floor levels, entrance patterns, height, materials, color or style from that of surrounding developments);

> **The proposed development will be contextual and similar in height, character, and mass to the Birmingham Place and 555 buildings.**

32. Indicate all elements of the project that are eligible for LEED points if the building were to be LEED certified;

> **We have determined that LEED certification will not be a part of this development**

33. Indicate whether the proposed structure will block or degrade views, change the skyline or create a new focal point;

> **.The project will strive to advance the aesthetic of Woodward Avenue by creating a mass similar to that of Birmingham Place and 555. The new project seeks to fill in the void between the two buildings, solidifying a structured mass and frontage for the city as you approach from the south. Furthermore, the project should "Encourage future buildings to front Hunter Boulevard [Woodward Ave] so as to project a positive image of the City." Thus, this development should reinforce the focal point and character that the master plan was striving for.**

34. Indicate whether there will be objectionable visual pollution introduced directly or indirectly due to loading docks, trash receptacles or parking, and indicate mitigation measures for same;

All access to, loading, and trash are anticipated to be accessible along Woodward Avenue within the right-of-way. Parking will be accessed off of Hazel Street. All building services will be screened by the building.

35. Indicate whether there will be an interference with or impairment of ambient conditions necessary for the enjoyment of the physical environment (ie. vibration, dust, odor, heat, glare etc.);

Proposed development will not generate vibration, dust, odor, heat, glare or other noxious elements that would prohibit enjoyment of the existing environment.

36. Indicate whether the project area and environs contain any properties listed on the National Register of Historic Places or the city's inventory of historic structures;

This property does not appear on the National Register of Historic Places or the City's inventory of historic structures.

37. Provide any information on the project area that the State Historic Preservation Office (SHPO) may have;

This office is not aware of the subject property appearing on the State registered historic properties.

38. Indicate whether there will be other properties within the boundaries or in the vicinity of the project that appear to be historic and thus require consultation with the SHPO as to eligibility for the National register;

No surrounding properties appear to be historic.

39. Indicate whether the Department of the Interior has been requested to make a determination of eligibility on properties the SHPO or HDC deems eligible and affected by the project;

There is no indication that the Department of the Interior has been requested to make a determination on the historic value of the surrounding properties.

40. Provide proof that the HDC has been given an opportunity to comment on properties that are listed on or have been found eligible for the National Register and which would be affected by the project;

Does Not Apply

Refuse

41. Indicate whether the existing or planned solid waste disposal system will adequately service the proposed development including space for separation of recyclable materials;

Space for refuse areas for the residents and occupants will be provided in a similar fashion and size as other developments in the city and area. The project will include one designated trash chute on every floor that cumulates at a trash compactor on the main level. This has direct access to the Woodward Avenue right-of-way. Adjacent to the trash chute on each level there will be a location for recyclables and other building services. It is anticipated that the onsite building and custodial maintenance service will remove and relocate the recyclables to the general compactor area referenced above. The main level will have direct access or adjacent to the trash storage area. It is anticipated that the onsite building and custodial maintenance service will remove and relocate all trash and recyclables to the main level general trash area from the three lower level parking areas.

42. Indicate whether the design capacity of the existing or planned solid waste disposal system will be exceeded as a result of the project;

Solid waste generated from this facility will be standard and can be handled by local waste management companies.

Sanitary Sewer

43. Indicate whether existing or planned waste water systems will be able to adequately service the proposed development;

A 8-inch public combined gravity sanitary sewer exists within the South Old Woodward Avenue right-of-way along the frontage of the proposed development. The proposed development will plan to utilize the sewer within the right-of-way for wastewater discharge. It is anticipated that the existing sanitary sewer will have the capacity to adequately service the proposed development. The proposed development anticipates a 6-inch service lead for the building that will connect to the existing sewer main in the right-of-way. Per preliminary discussions with the City Engineer, the existing sewer along either frontage of the property has the capacity to handle the flows from the proposed development and there are no known existing capacity issues. The planned sewer service flow basis of design and capacity of the existing sewer will be reviewed and confirmed by the City Engineer prior to site plan approvals.

44. Indicate whether the design capacity of these facilities will be exceeded as a result of the project;

It is not anticipated that the design capacity of the existing sanitary sewer will be exceeded by the development. Per preliminary discussions with the City Engineer, the existing sewer along either frontage of the property has the capacity to handle the flows from the proposed development and there are no known existing capacity issues. The planned sewer service flow basis of design and capacity of the existing sewer will be reviewed and confirmed by the City Engineer prior to site plan approvals.

45. Indicate the elements of the project that have been incorporated to reduce the amount of water entering the sewer system (such as low flush toilets, Energy Star appliances, restricted flow faucets, greywater recycling etc.) ;

Building design will incorporate restricted flow plumbing fixtures and Energy Star appliances wherever possible.

Storm Sewer

46. Indicate whether existing or planned storm water disposal and treatment systems will adequately serve the proposed development;

A 12-inch public combined gravity storm sewer exists within the South Old Woodward Avenue right-of-way along the frontage of the proposed development. The proposed development will plan to utilize the sewer within the right-of-way for the rooftop stormwater discharge. Per preliminary discussion with the City Engineer, the existing sewer along either frontage of the property has the capacity to handle the flows from the proposed development and there are no known existing capacity issues. The proposed development anticipates a 10-inch roof lead for the building that will connect to the existing sewer. The existing site is covered entirely with impervious parking areas or buildings and no increase in impervious area is proposed with the re-development. The existing on-site vehicular use areas will be removed, providing for a potential decrease in pollutants typically found within runoff from these areas (oil, grit, trash, ect.) and to increase the quality of the storm water discharge. The planned storm sewer service flow basis of design and capacity of the existing storm sewer will be reviewed and confirmed by the City Engineer prior to the site plan approvals.

47. Indicate whether the design capacity of these facilities will be exceeded as a result of the project;

It is not anticipated that the design capacity of the municipal sewer system exceeded by the proposed development. Per preliminary discussion with the City Engineer, the existing sewer along either frontage of the property has the capacity to handle the flows from the proposed development and there are no known existing capacity issues. The planned storm sewer service flow basis of design and capacity of the existing storm sewer will be reviewed and confirmed by the City Engineer prior to the site plan approvals.

48. Indicate the elements of the project that have been incorporated to reduce the amount of storm water entering the sewer system (such as the use of pervious concrete, rain gardens, greywater recycling, green pavers etc.);

All care will be taken by ownership to use appropriate storm water management techniques, in accordance with the Birmingham Storm water Ordinance.

Water Service

49. Indicate whether either the municipal water utility or on-site water supply system is adequate to serve the proposed project;

Public water main exists within the South Old Woodward right-of-way and branches into Hazel Street along the frontage of the proposed development. The existing development utilizes this water main for domestic and fire protection service. It is anticipated that this existing water main will also have the capacity to adequately service the proposed development. Per preliminary discussions with the City Engineer, the existing 12-inch water main along the frontage of the property is a lopped system and has the capacity to handle the flows from the proposed development. There are no known existing capacity issues or complaints with the service pressures at the recent building re-development directly adjacent to the south. The proposed development currently anticipates a proposed 4" domestic service line and a fire suppression line for the building that will connect to the existing water main within the Hazel Street right-of-way. The planned water usage design and capacity of the existing water main will be reviewed and confirmed by the City Engineer prior to site plan approvals.

50. Indicate whether the water quality is safe from both a chemical and bacteriological standpoint;

It is not anticipated that there are any water quality concerns with the existing municipal system in this area.

51. Indicate whether the intended location of the service will be compatible with the location and elevation of the main;

The proposed water supply design is compatible with the existing system and will not require rerouting or significant alterations.

Public Safety

52. Whether or not the project location provides adequate access to police, fire and emergency medical services;

- **Building is directly on all three of the right of way lines and offers direct access for emergency personnel.**
- **Access to the residential units and commercial spaces is via the main entrance (either side) to the building, at grade, in the center of the structure.**
- **An elevator that will accommodate a stretcher is proposed.**

- **Building is open on the three street facing sides for firefighting access and rescue. The one other sides will be constructed in terms of the Michigan Building Code to ensure proper fire rating.**
- **A Fire Command Center will be provided**

53. Whether or not the proposed project design provides easy access for emergency vehicles and individuals (ie. are there obstacles to access, such as one-way roads, narrow bridges etc.);

Project located on two-way road with direct access to all local arteries.

54. Whether or not there are plans for a security system which can be expanded, and whether approval for same has been granted by the police department;

Project is considered to be the highest end of the commercial and residential market. The proposed security system will be the best the market has to offer and will be interfaced with the police department.

55. Detailed description of all fire access to the building, site, fire hydrants and water connections;

- **Fire department connection available at their direction**
- **Full fire suppression throughout**
- **Access to all floors via multiple fire stairs and elevators**
- **Fire Command Center**
- **Full state of the art alarm system**

56. Whether or not there are plans for adherence to all city and N.F.P.A. fire codes;

All NFPA codes will be followed or exceeded.

57. Proof that one elevator has been designed to accommodate a medical cart;

Medical Cart provided for. See proposed plans

58. Detailed specifications on all fire lanes/parking lot surfaces/alleys/streets to demonstrate the ability to accommodate the weight of emergency / fire vehicles;

See proposed site plan for all emergency access routes and designs.

59. Detailed description of all fire suppression systems;

The fire suppression system has not yet been designed, however the fire suppression system for the building will be designed to meet all applicable City and National fire (NFPA) codes.

Transportation issues

60. Provide completed FORM A – Transportation Study Questionnaire (Abbreviated);

See Appendix for Traffic Impact Assessment as prepared by Bergmann Associates.

61. Provide completed FORM B – Transportation Study Questionnaire if required by the city's transportation consultant;

Does Not Apply

62. Indicate whether transportation facilities and services will be adequate to meet the needs of all users (i.e. access to public transportation, bicycle accommodations, pedestrian connections, disabled, elderly etc.);

- **South bound bus stop located approximately 160 feet away from front door on South Old Woodward. North bound bus stop is located approximately 300 feet away from front door on South Old Woodward.**
- **Bicycle racks available for commercial employees**

- **Pedestrian access directly available at South Old Woodward Avenue and Hazel Street. Full Barrier free access to all levels of the building**

63. Indicate how the project will improve the mobility of all groups by providing transportation choices;

Occupants and visitors can easily access the facility by foot via sidewalks, by car from parking on the street, parking inside the underground facility, by bicycle where racks are available and by bus.

64. Indicate how the users of the building will be encouraged to use public transit and non-motorized forms of transportation;

SMART bus stops available 160 and 300 feet away. Bicycle racks available for residents and visitors.

65. Indicate the elements that have been incorporated into the site and surrounding right-of-way to encourage mode shift away from private vehicle trips;

SMART bus stops available 160 and 300 feet away. Bicycle racks available for residents and visitors.

66. Indicate the elements of the project that have been provided to improve the comfort and safety of cyclists (such as secured or covered bicycle parking, lockers, bike lanes/paths, bicycle share program etc.);

Bike racks are available for employees and visitors

67. Indicate the elements of the project that have been provided to improve the comfort and safety of pedestrians (such as wheelchair ramps, crosswalk markings, pedestrian activated signal lights, bulb outs, benches, landscaping, lighting etc.);

- **Wheelchair and all barrier free access provided**
- **Crosswalks available road intersections**
- **Pedestrian activated signals provided at road intersections**
- **Building and municipal path fully illuminated**
- **Planting areas and benches**

68. Indicate the elements of the project that have been provided to encourage the use of sustainable transportation modes (such as receptacles for electric vehicle charging, parking for scooters/Smart cars etc.);

Smart cars, scooter, and electric vehicle charging will be available for owners / lease holders.

Natural Features

69. Indicate whether there are any visual indicators of pond and / or stream water quality problems on or near the site;

N / A

70. Indicate whether the project will involve any increase in impervious surface area and, if so, indicate the runoff control measures that will be undertaken;

The project proposes to maintain the previous indication of impervious area. Previously, on the site, there was a full asphalt parking lot and two one story buildings all with links to the storm sewer drain. The proposed project will no longer have the ground level parking and instead will have a full building occupying the site with underground parking. The underground parking will be drained to the storm sewer and the building will occupy the ground level.

71. Indicate whether the project will affect surface water flows on water levels of ponds or other water bodies;

It is not anticipated that the development will impact any existing surface water flows of ponds or other water bodies.

72. Indicate whether the project may affect or be affected by a wetland, flood plain, or floodway;

The existing site is completely developed and there are no wetlands located onsite. There is no existing floodplain or floodway located onsite per FIRM Community Panel 26125C0537F, dated September 29, 2006. It is not anticipated that the development will be impacted or propose impact on any existing wetland, floodplain, or floodway.

73. Indicate whether the project location or construction will adversely impact unique natural features on or near the site;

It is not anticipated that the development will be impacted or propose impact on any existing wetland, floodplain, or floodway.

74. Indicate whether the project will either destroy or isolate a unique natural feature from public access;

Current site is private and the development will not impede the public access to amenities that surround it.

75. Indicate whether any unique natural feature will pose safety hazards for the proposed development;

No existing natural feature will pose any safety hazards for the development.

76. Indicate whether the project will damage or destroy existing wildlife habitats;

Proposed project will not destroy any existing wildlife or habitats.

Other Information

77. Any other information as may reasonably be required by the city to assure an adequate analysis of all existing and proposed site features and conditions.

Our office will be happy to supply all additional requested information by the city.

Professional Qualifications

The preparer(s) of the CIS must indicate their professional qualifications, which must include registration in the state of Michigan in their profession where licensing is a state requirement for the practice of the profession (i.e. engineer, surveyor, architect etc.). Where the state does not require licensing (ie. planner, urban designer, economist etc.), the preparer must demonstrate acceptable credentials including, but not limited to, membership in professional societies, university degrees, documentation illustrating professional experience in preparing CIS related materials for similar projects.

Preparer:

Michael Testrake, NCARB. State of Michigan Architectural Registration no. 65592

Section 4

Appendix

4.1 Proof of Ownership

OAKLAND COUNTY TREASURERS CERTIFICATE
This is to certify that there are no delinquent property taxes as of this date owed to our office on this property. No representation is made as to the status of any taxes, tax liens or titles owed to any other entities.

JUL 21 2017

ak

5.00 ANDREW E. MEISNER, County Treasurer
Sec. 135, Act 206, 1893 as amended

002886

142008
LIBER 50910 PAGE 828
$26.00 DEED - COMBINED
$4.00 REMONUMENTATION
$23,650.00 TRANSFER TX COMBINED
07/28/2017 03:40:56 P.M. RECEIPT# 87418
PAID RECORDED - OAKLAND COUNTY
LISA BROWN, CLERK/REGISTER OF DEEDS

COVENANT DEED

Mountain King Properties, LLC, a Michigan limited liability company,* whose address is 469 S. Old Woodward Ave., Birmingham, MI 48009 (the Grantor) Conveys to **Birmingham Tower Partners, LLC, a Michigan limited liability company,** whose address 251 E. Merrill St., Unit 205, Birmingham, MI 48009 (the Grantee) the premises in the **City of Birmingham**, County of **Oakland,** State of **Michigan** described as: *Hsiu Tzu Tsung, Sole Member

SEE LEGAL DESCRIPTION IN EXHIBIT A ATTACHED

Commonly known as:469 S. Old Woodward Ave
Parcel I.D. Number: **#19-36-208-011**

With all tenements, hereditaments, and appurtenances to it, subject, however, to all matters set forth for **SEE REAL ESTATE TRANSFER VALUATION AFFIDAVIT FILED** - with covenant to defend title to the property described herein against all persons and demands claiming by, through or under the grantor and no other persons and claims/demands whatsoever.

Seller makes no representations or warranties, of any kind or nature whatsoever, other than those set out above, whether expressed, implied, implied by law, or otherwise, concerning the condition of the title of the property prior to the date the seller acquired title.

Subject to the applicable zoning ordinances, those easements, building and use restrictions, covenants, conditions and other restrictions of record, and the lien of general real estate taxes for the year 2017 and subsequent years which are not yet due.

The Grantor grants to the Grantee the right to make any and all divisions under section 108 of the land division act, Act 288 of the Public Act of 1967.

This property may be located within the vicinity of farmland or farm operation. Generally accepted agricultural and management practices which may generate noise, dust, odors, and other associated conditions may be used and are protected by the Michigan Right to Farm Act.

2P
TCT

Dated: June 23, 2017

Mountain King Properties, LLC, a Michigan limited liability company

By: Tsung Hsiu Tzu
Hsiu Tzu Tsung, Sole Member

State of Michigan
County of Oakland

The foregoing instrument was acknowledged before me on this 22ND day of June, 2017, By **Mountain King Properties, LLC, a Michigan limited liability company** by **Hsiu Tzu Tsung, Sole Member.**

DONNA L. CURTIS
NOTARY PUBLIC, STATE OF MI
COUNTY OF MACOMB
MY COMMISSION EXPIRES Sep 12, 2020
ACTING IN COUNTY OF OAKLAND

Donna L. Curtis
Notary Public Donna L. Curtis
Macomb County, Acting in
My Commission Expires: Oakland
9-12-20

Instrument drafted without opinion by:	When recorded return to
Walter Quillico, ESQ **28470 W. 13 Mile Rd., Ste. 325** **Farmington Hills, MI 48334**	**Mountain King Properties, LLC, a Michigan limited lia bility company**

2017 JUL 21 PM 4:08
OAKLAND COUNTY
REGISTER OF DEEDS
RECEIVED

TC 03 - 69882
Recording Fees: $30.00

REVENUE TO BE AF
AFTER RECORDING

Exhibit A

LEGAL DESCRIPTION RIDER

TC13-69882

Land situated in the City of Birmingham, County of Oakland, State of Michigan
Described as follows:

The Northerly part of Lot 7 of ASSESSOR'S PLAT NO. 13, according to the plat thereof recorded in Liber 51 of Plats, page 15, Oakland County Records, City of Birmingham, Oakland County, Michigan, described as beginning at the Northwesterly corner of said Lot 7 on the Easterly line of 100 foot Woodward Avenue; thence Easterly along Northerly line of said Lot, a distance of 234.96 feet to the Westerly line of 200 foot Hunter Blvd. of the Northeast corner of said Lot 7; thence Southerly along the Westerly line of said Hunter Blvd. or Easterly line of said Lot 7, a distance of 21.15 feet to extension of North face of wall of garage building located on Southerly part of said Lot 7; thence Westerly along said extension of North face of wall and along said North face of wall 104.44 feet to a corner of said garage building; thence Southerly at right angles along Westerly face of wall of said garage building 8.40 feet to a corner of said garage building; thence Westerly at right angles along North face of wall of said garage building 65.37 feet to a corner of said garage building; thence Southerly at right angles along West face of wall of said garage building 14.96 feet to a corner of said garage building; thence Westerly at rights angles along North face of wall of said garage building and extension of same 58.90 feet to Westerly line of said Lot 7; thence Northerly along said Westerly line 40.28 feet to the point of beginning.

Commonly known as: 469 S. Old Woodward Ave
Birmingham, MI 48009

Parcel I.D. Number: 19-36-208-011

OAKLAND COUNTY TREASURERS CERTIFICATE
I HEREBY CERTIFY that there are no TAX LIENS or TITLES held by the state or any individual against the within description and all TAXES on same are paid for five years previous to the date of this instrument as appears by the records in the office except as stated.
Reviewed By: PO

Jun 27, 2017

5.00 E-FILE Sec. 135, Act 206, 1893 as amended
ANDREW E. MEISNER, County Treasurer

_____ Not Examined

LIBER 50810 PAGE 679
$21.00 DEED - COMBINED
$4.00 REMONUMENTATION
$5.00 AUTOMATION
$38,700.00 TRANSFER TX COMBINED
06/27/2017 06:45:33 PM RECEIPT# 74689
PAID RECORDED - Oakland County, MI
Lisa Brown, Clerk/Register of Deeds

STATE OF MICHIGAN REAL ESTATE TRANSFER TAX
OAKLAND
06/27/2017
74689
$4,950.00 CO
$33,750.00 ST
001114788

COVENANT DEED

KNOW ALL MEN BY THESE PRESENTS: E&G Partners, L.L.C., a Michigan limited liability company, ("Grantor"), whose address is 8625 Saint Vrain Way, Missoula, Montana 59808-9333 conveys to Birmingham Tower Partners, LLC ("Grantee") whose address is 251 E. Merrill St., Unit 205, Birmingham, Michigan 48009, the certain premises situated in the City of Birmingham, County of Oakland and State of Michigan more particularly described as follows:

> South part of Lot 7 of ASSESSOR'S PLAT NO. 13, City of Birmingham, according to the plat thereof, as recorded in Liber 51 of Plats, Page 15, Oakland County Records, described as beginning at the SW corner of Lot 7; thence Northerly on the West line of said lot 40.28 ft.; thence Easterly 58.9 ft.; thence Northerly at a right angle 14.96 ft.; thence Easterly at a right angle 65.37 ft.; thence Northerly at a right angle 8.4 ft.; thence Easterly at a right angle 104.44 ft. to the East lot line of Lot 7; thence Southerly along the East line of said lot 66.25 ft.; thence Westerly along the South lot line 211.66 ft. to the point of beginning.
>
> Commonly known as: 479 S. Old Woodward Ave., Birmingham, Michigan 48009
> Tax Parcel Identification No. 08-19-36-208-012

for the sum of Four Million Five Hundred Thousand Dollars ($4,500,000.00) subject to easements, building and use restrictions, covenants, conditions and other restrictions of record, applicable zoning ordinances, and the lien of general real estate taxes for the year 2017 and subsequent years which are not yet due.

Grantor covenants that Grantor has not previously done or committed or willingly suffered to be done or committed any act, matter or thing that would cause the premises or any part of them to be charged or encumbered in title, estate or otherwise.

Dated as of the 23rd day of June, 2017

E&G Partners, L.L.C., a Michigan limited liability company

By: Marsha R Katz
Marsha R. Katz

Its: Manager

State of Montana)
)ss
County of Missoula)

The foregoing instrument was acknowledged before me this 21st day of June, 2017 by Marsha R. Katz, the Manager of E&G Partners, L.L.C., a Michigan limited liability company, on behalf of said limited liability company.

ALECIA LANE
NOTARY PUBLIC for the
State of Montana
Residing at Missoula, Montana
My Commission Expires
August 08, 2017

Alecia Lane

Notary Public, Missoula County, Montana
Acting in Missoula County, Montana
My commission expires: August 08, 2017

State Transfer Tax: $33,750.00

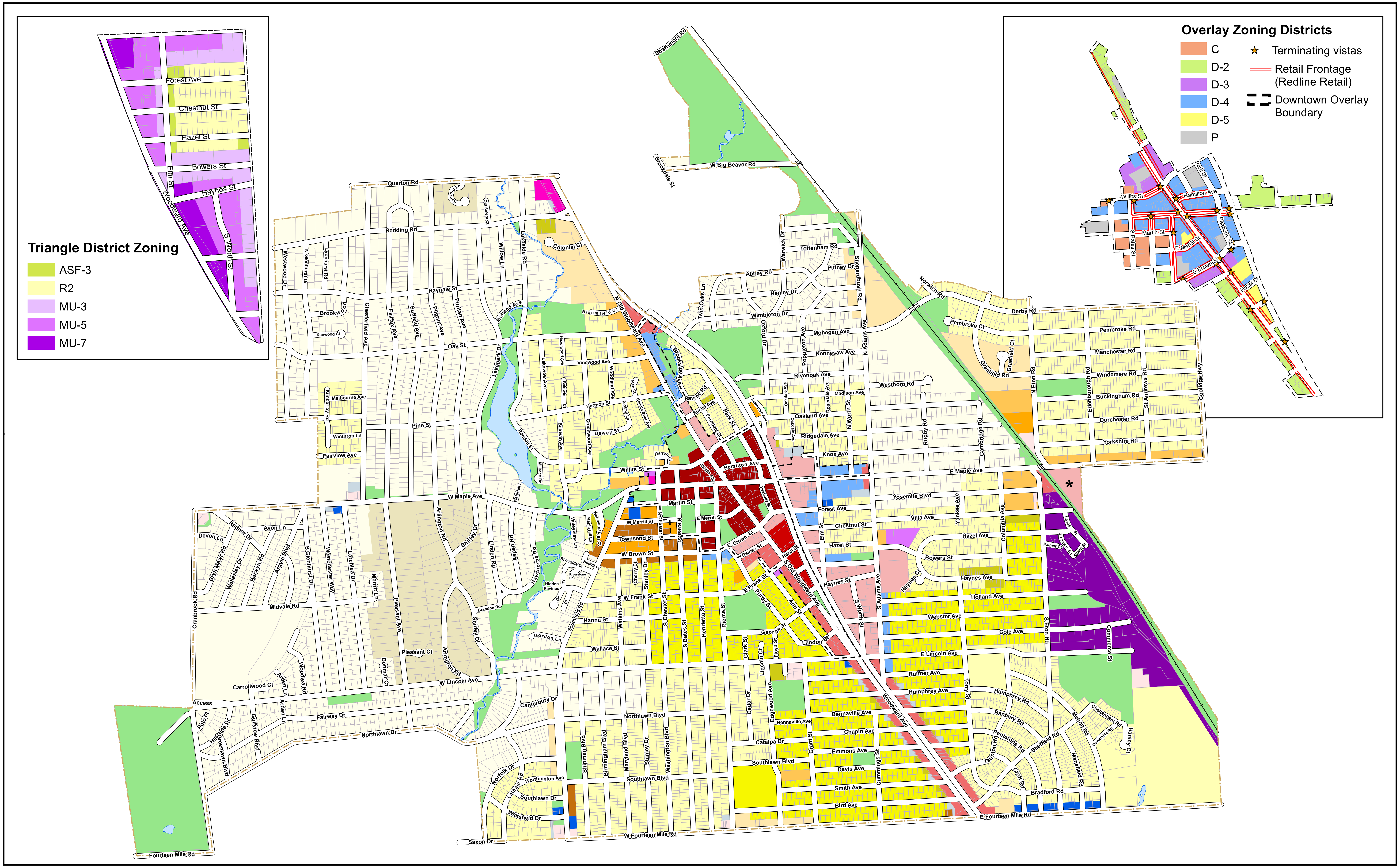
County Transfer Tax: $4,950.00

Recording Fees: $___________

Prepared by:	When recorded, return to: Grantee
James M. Dworman, Esq. Dean & Fulkerson, P.C. 801 W. Big Beaver, Ste. 500 Troy, Michigan 48084	251 E. Merrill St., Unit 205 Birmingham, Michigan 48009

County Treasurer's Certificate	Send Subsequent Tax Bills To: Grantee 251 E. Merrill St., Unit 205 Birmingham, Michigan 48009

4.2 Maps



City of Birmingham
A Walkable Community

1,500 750 0 1,500 Feet

N

Coordinate System: State Plane Coordinate System Michigan South Zone 2113 Projection: Lambert Conformal Conic, Units: International Feet, Datum: NAD83
Data Sources: Oakland County GIS Utility, City of Birmingham
Updated: February 17, 2017

City Of Birmingham
Zoning Map

Zoning Districts

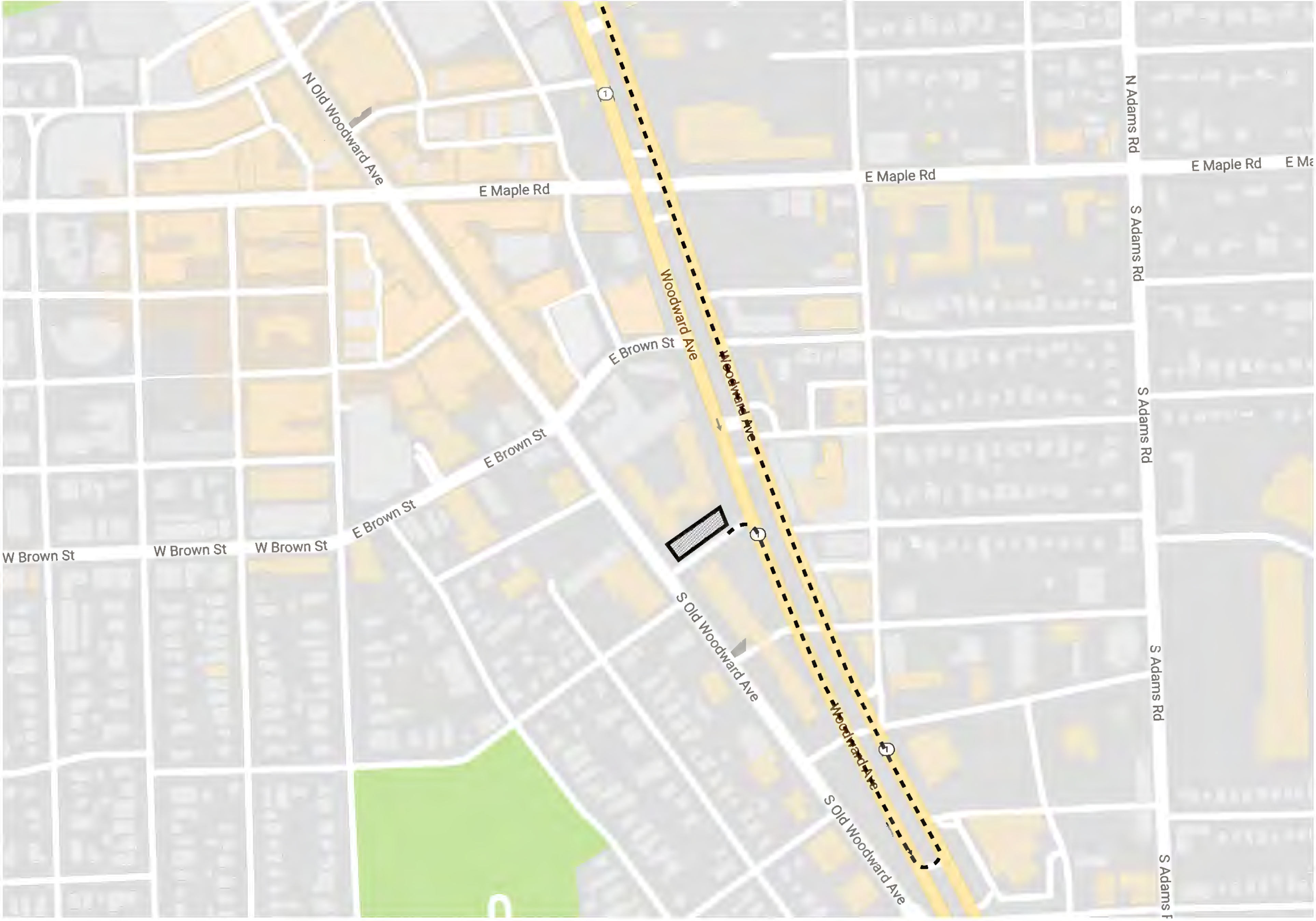
- ⬜ R1 Single-Family Residential
- ⬜ R1-A Single-Family Residential
- 🟨 R2 Single-Family Residential
- 🟨 R3 Single-Family Residential
- 🟨 R4 Two-Family Residential
- 🟧 R5 Multiple-Family Residential
- 🟧 R6 Multiple-Family Residential
- 🟧 R7 Multiple-Family Residential
- 🟫 R8 Multiple-Family Residential
- 🟪 TZ1 Transitional Zoning 1
- 🟪 TZ3 Transitional Zoning
- 🟪 MX Mixed-Use
- ⬜ B-1 Neighborhood Business
- 🟥 B-2 General Business
- * B-2 General Business Limited to Grocery Story Use
- 🟥 B-2B General Business
- 🟥 B-3 Office-Residential
- 🟥 B-4 Business-Residential
- 🟦 0-2 Office Commercial
- 🟦 0-1 Office
- ⬜ P Parking
- 🟩 PP Public Property
- ⬚ Downtown Overlay Boundary

City of Birmingham
A Walkable Community

City Of Birmingham
Zoning Map

Zoning Districts

⬜	R1	Single-Family Residential
⬜	R1-A	Single-Family Residential
🟨	R2	Single-Family Residential
🟨	R3	Single-Family Residential
🟩	R4	Two-Family Residential
🟨	R5	Multiple-Family Residential
🟧	R6	Multiple-Family Residential
🟧	R7	Multiple-Family Residential
🟫	R8	Multiple-Family Residential
🟪	TZ1	Transitional Zoning 1
🟪	TZ3	Transitional Zoning
🟪	MX	Mixed-Use
⬜	B-1	Neighborhood Business
🟥	B-2	General Business
▨	B-2	General Business Limited to Grocery Story Use
🟥	B-2B	General Business
🟥	B-3	Office-Residential
🟥	B-4	Business-Residential
🟦	0-2	Office Commercial
🟦	0-1	Office
🟦	P	Parking
🟩	PP	Public Property
▚		Downtown Overlay Boundary



Haul Route

Not to Scale

Site Boundary ▨

North Bound Route ▬ ▪ ▬ ▪

4.3 Zoning Requirements Analysis

ZONING REQUIREMENTS ANALYSIS

Development Standard	Required	Proposed	Variance Required
Zoning Classification	B3 – D4 Overlay	B3 - D5 Overlay	Yes
Front Setback	0’	0’	No
Rear Setback	10’	0' - No rear of building	No
Side Setback	0’	0’	No
FAR - Percentage	N / A	N / A	N / A
FAR - Square Footage	N / A	N / A	N / A
Open Space - Percentage	N / A	N / A	N / A
Open Space - Square Footage	N / A	N / A	N / A
Number of Residential Units	1	94 Hotel Units with 29 Apartments	No
Minimum Floor Area	1,000 s.f per unit	Greater than 1,000 s.f. per unit	No
Parking	See Parking distribution sheet	100 underground + 4 street parking = 104 spaces	No
Loading	2 usable loading space	2	No
Screening	DNA		

4.4 Noise Impact Study

K&S

Kolano and Saha Engineers, Inc.
Consultants in Acoustics, Noise and Vibration

2017-262
February 16, 2018

Mr. Doriad Markus
Birmingham Tower Partners, LLC
251 East Merrill Street, Suite 205
Birmingham, MI 48009

Subject: **Birmingham CIS - Sound Level Measurements and Noise Impact Assessment**
re: 469 S. Old Woodward
Birmingham, MI

Dear Mr. Markus:

At your request and authorization Kolano and Saha Engineers, Inc. (K&SE) conducted an updated investigation to review the environmental noise associated with the proposed 469 S. Old Woodward. This investigation includes a review of the measurements at the development site to understand the current ambient noise condition with an evaluation of the proposed development to help assess if noise associated with this development will be compatible at this location.

On-Site Sound Level Measurements

We conducted measurements using a Brüel & Kjær 2270 environmental noise analyzer with a precision outdoor microphone assembly. This instrumentation was calibrated before and after measurements using an acoustic calibrator traceable to the National Institute for Standards and Technology. It was set to measure for a continuous period from February 13th starting at 2:10 PM to February 14th at 5:00 PM. The measurement equipment was located 40 feet west of the closest lane of Woodward Ave. and approximately 60 feet north of Hazel St. The measurements were conducted at an elevation of approximately 8 feet above ground.

The results of the measurements are presented in a graph of sound level versus time in **Exhibit 1**. This graph contains three plot lines; the 5 minute L_{eq} (energy average level), the hourly L_{eq}, and the daytime and nighttime L_{eq}. The source of noise in the sound levels measured were primarily from local traffic on Woodward Ave.

From this data we calculated the DNL or day-night sound level average. The DNL is an average of both the daytime and nighttime sound levels where the nighttime sound levels have been raised by 10 dB to account for people's greater sensitivity to noise in the nighttime hours. Measurement results, in terms of the day-night sound level average (DNL), were determined and compared to U.S. Government guidelines promulgated by the U.S. Environmental Protection Agency (EPA) and the department of Housing and Urban Development (HUD).

EPA guidelines define DNL 55dB (or less) as desirable goal for residential land use; HUD guidelines consider outdoor noise levels up to DNL 65dB as "normally acceptable" for residential land use. HUD guidelines consider outdoor noise levels between 65dB and 75dB as "normally unacceptable" for residential land use. The results of our measurements on the site, indicate a measured sound level of **DNL 74dB**. This value is expected to be a worst case scenario as it represents a position closest to Woodward Ave. Moving up in elevation toward the hotel rooms and residential spaces, the sound level is expected to decrease more and more with height. To help the hotel and residential spaces be less impacted by traffic noise, we recommend a façade sound noise reduction performance of at least 30 dB to meet HUD interior traffic noise level guidelines.

City of Birmingham Noise Ordinance

The City of Birmingham addresses noise in their ordinance under *Part II – City Code, Chapter 50 – Environment, Article II. Nuisances, Division 4 – Noise.* This ordinance provides information of Definitions, general prohibitions, specific prohibitions, decibel level prohibitions, general exemptions and test procedures. The objective limits cited in this ordinance (as Table 1) are:

Use of Property Producing the Sound	Use of Property Receiving the Sound	Sunday to Saturday 7:00 a.m. to 7:00 p.m.	Sunday to Saturday 7:00 p.m. to 7:00 a.m.
Residential	Residential	75	60
Commercial	Residential	80	60
Residential	Commercial	80	60
Commercial	Commercial	90	75

Exemptions to these limits include power equipment operations between 7AM and 7PM that do not exceed 100 dB(A) at or beyond the property line, construction noise between 7AM and 7PM Monday-Saturday excluding holidays (with additional provisions), and snow removal which does not exceed 90 dB(A) at or beyond the property line.

Property to the north (The Birmingham Place) and to the south (555 S. Old Woodward), are mixed use with commercial spaces on the ground floor and residential spaces on the upper floors. Both residential and commercial property uses apply with the most critical nighttime noise limit criteria of 60 dB(A) and 75 dB(A) respectively. Property to the west and east are commercial.

Proposed Development Noise Impact

The proposed hotel, apartment and condominium building is generally similar to other hotels and residential buildings in Birmingham. The proposed 9 story building is expected to have bar, coffee shop, sundries store, gathering space and mechanical room on the first floor. Floors 2-4 are planned for hotel rooms. Floors 5 & 6 are planned to have apartments. Floors 7 & 8 are planned to have condominiums. The 9th floor is planned to have a workout room, pool, common room and mechanical space. The building is expected to include two levels of below ground parking. The sources of noise expected from the building include:

Building Wide Heating and Cooling Mechanical Systems

Like other large buildings in Birmingham, centralized heating and cooling equipment are expected to control the climate of building areas separate from individual guest rooms, apartments and condominiums. The bulk of this equipment is expected to be housed on the 9th floor in a mechanical space which has louvered vents that open toward the north. From the current drawings, it appears that these louvers will be within 50 feet of the residential building to the north. Deliberate noise control design will be needed to prevent the mechanical space noise from impacting the adjacent residents. The residential limit of 60 dB(A) would apply to this condition.

Below Grade Parking Exhaust Fans

To ventilate vehicle exhaust gasses, a fan is expected for the below ground parking. Careful selection of this fan (or fans), possibly a centrifugal or mixed flow, with appropriate noise control elements is recommended to help keep pedestrians on this parking level safe (to be able to hear approaching vehicles) as well to comply with the noise ordinance for the above-grade air intake and discharge.

Emergency Power Generator

It is expected that an emergency power generator will be part of the building mechanical systems. While generators have the potential for excessive noise, with proper location selection, provisions for adequate noise controls and exhaust muffling, and minimal actual operation time (weekly or bimonthly maintenance cycles are expected), we expect that a generator can be made to comply with the ordinance and create minimal noise impact. On this site, the optimal location of the generator may be on the east side of the building where it would face Woodward Avenue. This location can potentially shield nearby residential spaces and minimize exposure to adjacent businesses.

Delivery Vehicles

For general needs and food service, multiple deliveries are expected each week. These deliveries are expected to come from small to medium sized commercial vehicles. These deliveries are expected to be comparable to those for other hotels, small restaurants and other moderately sized businesses that already exist in the city.

Conclusion

Based on the information we have been provided and deliberate effort to minimize noisy equipment, we anticipate that the proposed development will be able to comply with the Birmingham Noise Ordinance limits.

Mr. Markus, you may also wish to engage our acoustical engineering services to help isolate potential noise concerns from the first floor to the above guest spaces, as well as sound isolation between the guest rooms, tenant spaces and mechanical rooms and equipment. We appreciate your calling us for this work. Should you have questions or need additional assistance on this matter, do not hesitate to call.

Sincerely,

KOLANO AND SAHA ENGINEERS, INC.

Darren Brown

Darren Brown, P.E.
INCE Board Certified
Consultant

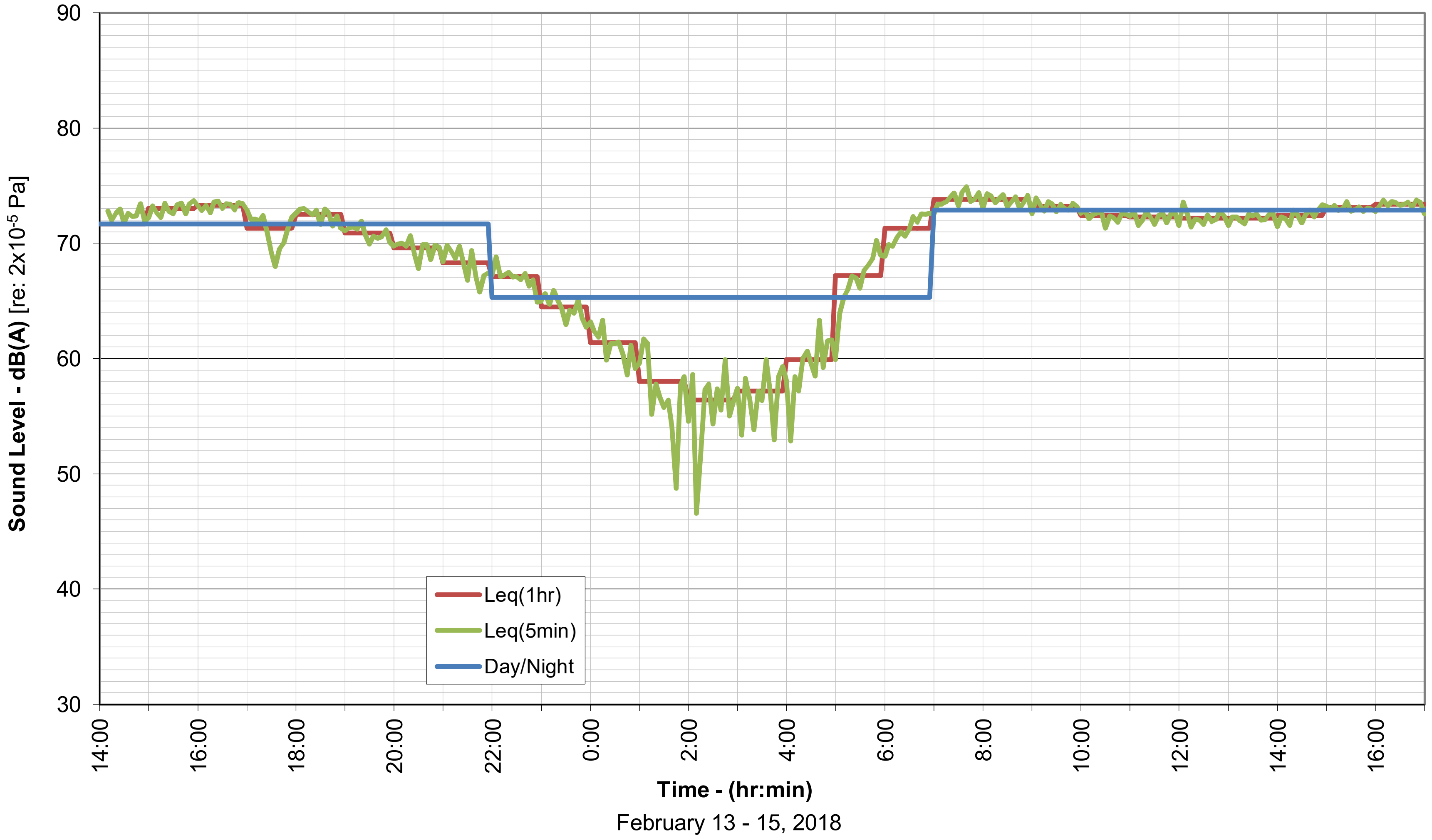
Kolano and Saha Engineers, Inc.
Project No.: 2017-262

EXHIBIT 1

Ambient Sound Levels at 469 S. Old Woodward

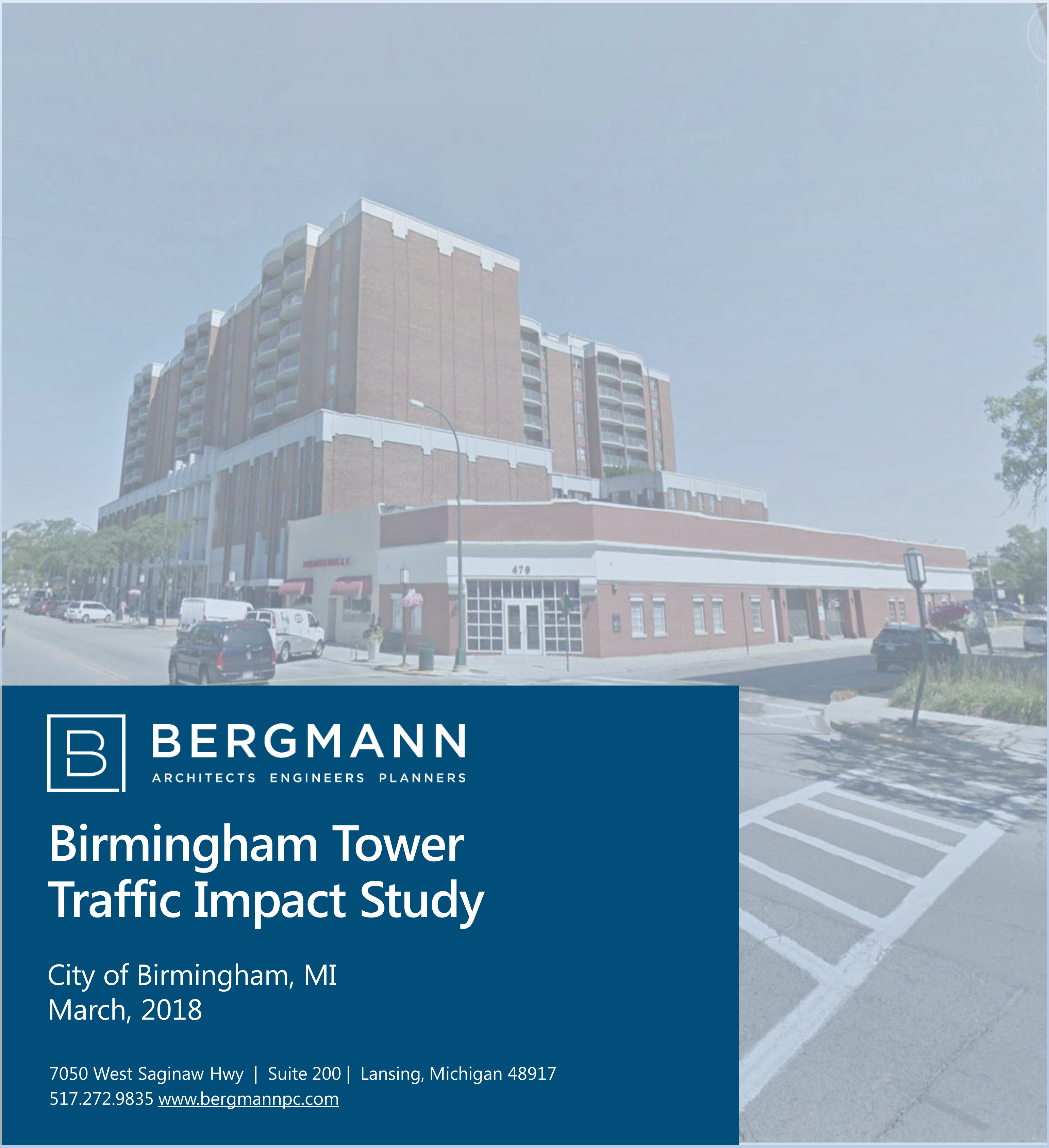
Measured 40 Feet West of Woodward Ave. and 60 North of Hazel St. at an Approximate Elevation of 8-Feet

Measurements Conducted for: Birmingham Tower Partners, LLC



2017-262 24Hr Meas Data - 2270 Env Meas 3Day from 5min Reports Template.xlsx

4.5 Traffic Impact Study



BERGMANN
ARCHITECTS ENGINEERS PLANNERS

Birmingham Tower Traffic Impact Study

City of Birmingham, MI
March, 2018

7050 West Saginaw Hwy | Suite 200 | Lansing, Michigan 48917
517.272.9835 www.bergmannpc.com

Table of Contents

Executive Summary

This Traffic Impact Study (TIS) was completed for the Birmingham Tower mixed-use development project in the City of Birmingham, Oakland County, Michigan. The project site is located on the north side of Hazel Street between Old Woodward and Woodward Avenue (M-1). The purpose of this study is to identify the traffic related impacts, if any, of the proposed project on the adjacent road network, and provide an evaluation of the proposed site access, valet, and parking operations. This study was conducted in accordance with accepted traffic engineering practice and guidelines published by the Institute of Transportation Engineers (ITE). The City of Birmingham Ordinance as well as MDOT standards were referenced as applicable.

The scope of this study was developed based on Bergmann's knowledge of the study area, professional experience, and review of information provided by the developer related to the proposed facility. Information related to the specific traffic study requirements was provided by the City's traffic engineering consultants, Fleis & VandenBrink (F&V). The study network includes the signalized intersections of Old Woodward Avenue & Brown Street and M-1 & Bowers Street, and the STOP controlled intersections of Old Woodward Avenue with Hazel Street and Bowers Street and M-1 with Hazel Street.

The project will include development of a 9-level building which will include 94 hotel rooms and 29 residential units, with supporting reception and coffee / bar services on the ground floor. The site was most recently occupied by a bank and restaurant which will be razed to construct the development. There will be three levels of below grade parking, supplemented by leased parking in the 555 building parking garage on the south side of Hazel Street. Access for the parking garage will be provided via a single access point to Hazel Street west of M-1. Parking at the 555 building will also be accessed via Hazel Street.

Traffic volumes that are expected to be generated by the development were forecast based on the rates and equations published by ITE in *Trip Generation*. Study analyses were conducted based on the methodologies presented in the *Highway Capacity Manual,* using Synchro and SimTraffic analysis software.

This report is intended for use by the City to guide decisions related to development project approvals, access permitting, and identifying future roadway improvement needs. The methodologies, analyses, results, and recommendations relevant to this study are described in detail herein. ***The opinions, findings, and conclusions expressed in this report are those of Bergmann Associates and not necessarily those of the City of Birmingham and/or MDOT.***

Prepared By:

Timothy J. Likens, PE, PTOE
Bergmann Associates

TIMOTHY J. LIKENS
ENGINEER
NO. 59642

Overall, the conclusions of this Traffic Impact Study are as follows:

1. Existing conditions analyses indicate that all study intersection approaches and movement currently operate acceptably at a LOS D or better during both peak periods.
2. Additional traffic volumes considering background developments and ambient traffic growth in the area will result in degraded operations for the intersection of Old Woodward Avenue & Brown Street during the AM peak hour.
3. Background conditions mitigation includes signal timing improvements at the intersection of Old Woodward Avenue & Brown Street in order to improve network operations to LOS D or better.
4. Parking for residents will be provided within the 100-space on-site parking garage.
5. Parking for hotel guests will be provided via a valet service which will utilize on-site and overflow off-site parking at the 555 building on the south side of Hazel Street.
6. Valet operations will result in a moderate increase to traffic volumes on the adjacent road network.
7. Traffic volumes generated by the proposed development would not have a significant impact on the adjacent road network.
8. A staff of four to five valet attendants during the peak hours would be necessary to contain vehicle queues within the valet service bay, not to extend back past the on-site parking deck access point or onto Hazel Street.

Based on the results of this study, the following should be considered to provide acceptable traffic operations due to existing network deficiencies, ***regardless of the proposed project:***

1. Optimize the signal timings at the intersection of Old Woodward Avenue & Brown Street.

Based on the results of this study, the following should be required to provide acceptable traffic operations ***with the proposed development:***

1. Provide four to five valet attendants during the AM and PM peak hours.
2. Allocate the four parking spaces on the main level of the on-site parking deck for vehicle loading and unloading to accommodate vehicle arrivals from the west on Hazel Street and any extended patron loading and unloading needs.

The improvements described in the analysis of background conditions should be installed in order to mitigate unacceptable traffic operations that would exist regardless of this project. No further off-site improvements should be required to maintain acceptable traffic operations.

Project Overview

This report presents the methodologies, analyses, results, and recommendations of a Traffic Impact Study (TIS) for the proposed Birmingham Tower mixed-use development in the City of Birmingham, Oakland County, Michigan. The project will include development of a 9-level building located on the north side of Hazel Street between Old Woodward and Woodward Avenue (M-1). The building will include 94 hotel rooms and 29 residential units, with supporting reception and coffee / bar services on the ground floor. The site was most recently occupied by a bank and restaurant which will be razed to construct the development. A study area map is shown on **Figure 1**.

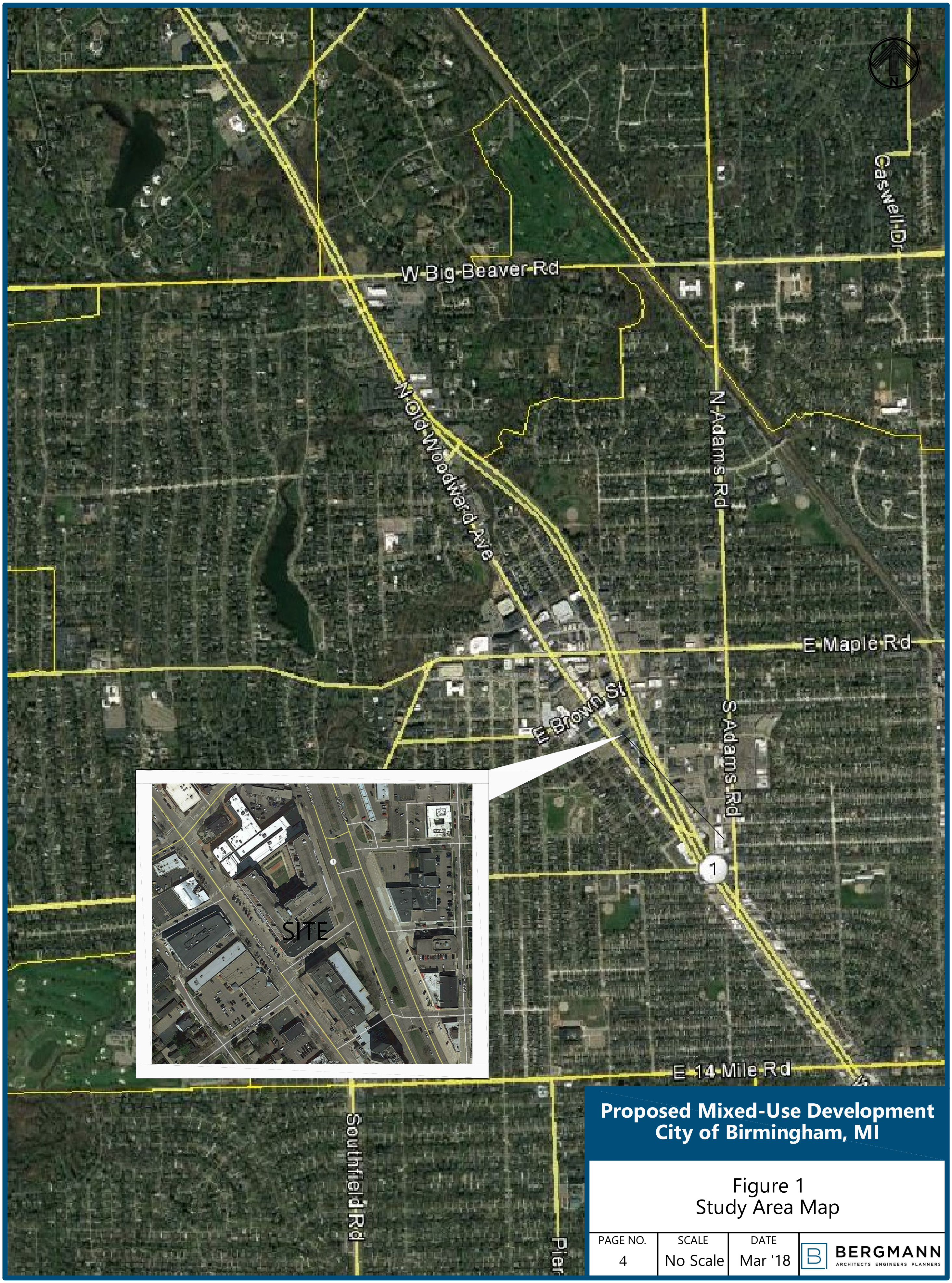
There will be three levels of below grade parking, supplemented by leased parking in the 555 building parking garage on the south side of Hazel Street. Access for the parking garage will be provided via a single access point to Hazel Street west of M-1. Parking at the 555 building will also be accessed via Hazel Street. All study roadways are under the jurisdiction of the City of Birmingham, except for M-1 which is under the jurisdiction of the Michigan Department of Transportation (MDOT).

In accordance with City Ordinance, a TIS has been required for permitting of site access and site plan approval. The purpose of this study is to identify the traffic related impacts, if any, of the proposed project on the adjacent road network, and provide an evaluation of the proposed site access, valet, and parking operations.

The scope of this study was developed based on Bergmann's knowledge of the study area, professional experience, and review of information provided by the developer related to the proposed facility. Additionally, we received information specifically related to the traffic study requirements as outlined by the City's traffic engineering consultants, Fleis & VandenBrink (F&V). Specifically, the following intersections were evaluated:

- Old Woodward Avenue & Brown Street;
- Old Woodward Avenue & Hazel Street;
- Old Woodward Avenue & Bowers Street;
- SB Woodward Avenue (M-1) & Bowers Street;
- SB Woodward Avenue (M-1) & Hazel Street; and
- Hazel Street & the proposed site access point.

This study was conducted in accordance with accepted traffic engineering practice and guidelines published by the Institute of Transportation Engineers (ITE). The City of Birmingham Ordinance as well as MDOT standards were referenced as applicable. This report is intended for use by the City to guide decisions related to development project approvals, access permitting, and identifying future roadway improvement needs.



Proposed Mixed-Use Development
City of Birmingham, MI

Figure 1
Study Area Map

PAGE NO.	SCALE	DATE
4	No Scale	Mar '18

BERGMANN
ARCHITECTS ENGINEERS PLANNERS

Background Data

Existing Road Network

Vehicle transportation for the proposed development will be provided primarily via M-1, which connects with I-696, I-75, and several other primary arterials facilitating connectivity to neighboring and regional communities. Local vehicle transportation will be provided by Old Woodward Avenue, Hazel Street, and Brown Street. Site access is proposed via a single access point to Hazel Street west of M-1. The roadway characteristics and design features pertinent to this traffic study are described in further detail below.

Woodward Avenue (M-1) is a principal arterial under the jurisdiction of MDOT, which runs generally in the northwest and southeast directions. In the vicinity of the site, M-1 is an eight lane divided boulevard with four lanes in each direction and a posted speed limit of 45 miles per hour (mph). M-1 has an Annual Average Daily Traffic (AADT) volume of approximately 55,000 adjacent to the site. These AADT values were obtained from the MDOT Traffic Monitoring Information System (TMIS).

The intersection of M-1 & Bowers Street is signalized, with left turn restrictions in all directions, which are accommodated by directional crossovers. M-1 is abutted by a variety of commercial and residential land uses in this area. Some parcels have direct access to M-1, and some are provided access via shared driveways and cross streets.

Old Woodward Avenue is a major collector under City jurisdiction, which runs generally in the northwest and southeast directions with a posted speed limit of 25 mph. According to data published by the Southeast Michigan Council of Governments (SEMCOG), Old Woodward Avenue has an AADT volume of approximately 8,800. In the vicinity of the site, Old Woodward Avenue currently has a two lane cross section with one lane in each direction and on-street parking on both sides of the road.

At its signalized intersection with Brown Street, exclusive left-turn lanes are provided on all approaches except the EB approach which is configured with a shared through / left turn lane and shared through / right turn lane. Old Woodward Avenue is abutted by a variety of commercial and residential land uses in this area.

Planned roadway improvements for the study section of Old Woodward Avenue to convert the existing generally two-lane roadway to a three lane roadway with center left turn lane between Willits Street / Oakland Avenue and M-1 have been developed by the City. Phase one of these improvements will be constructed in 2018 and will extend from Willits Street / Oakland Avenue to Brown Street. As part of phase one, geometric improvements will be constructed at the intersection of Old Woodward Avenue & Brown Street which will include elimination of the existing northbound right-turn lane. Phase three of the project will include the study section of Old Woodward Avenue between Brown Street and M-1 and is currently planned for 2022. City Engineering has confirmed that these improvements are appropriate to incorporate in the future conditions for this study.

Brown Street is a major collector under City jurisdiction, which runs generally in the east and west directions and extends from Southfield Road to M-1. The study section of Brown Street has an AADT volume of approximately 7,200 with a posted speed limit of 25 mph. Brown Street generally has a two lane cross section with one lane in each direction with on-street parking on the south side of the roadway. Brown Street is abutted by commercial and residential land uses in this area.

Hazel Street is a local road under City jurisdiction, which runs generally in the east and west directions, and has an unposted assumed speed limit of 25 mph. The study section of Hazel Street between Old Woodward Avenue and M-1 is a two lane road with five on-street parking spaces provided on the south side. Hazel Street is estimated to have an ADT of approximately 1,500 vehicles per day based on application of a 10% K-factor to PM peak hour turning movement count data collected

Multi Modal Transportation Faciliies

Relative to pedestrian access, both sides of Hazel Street are equipped with sidewalks, as are both sides of Old Woodward Avenue and M-1. There are zebra-bar crosswalks at the Old Woodward Avenue & Hazel Street intersection located on the east and south legs. There are currently no designated bike lanes or routes nearby; however, there are existing bike racks located along Old Woodward Avenue. Bus routes are provided along the study section of Old Woodward Avenue with stops located at Daines Street and Bowers Street.

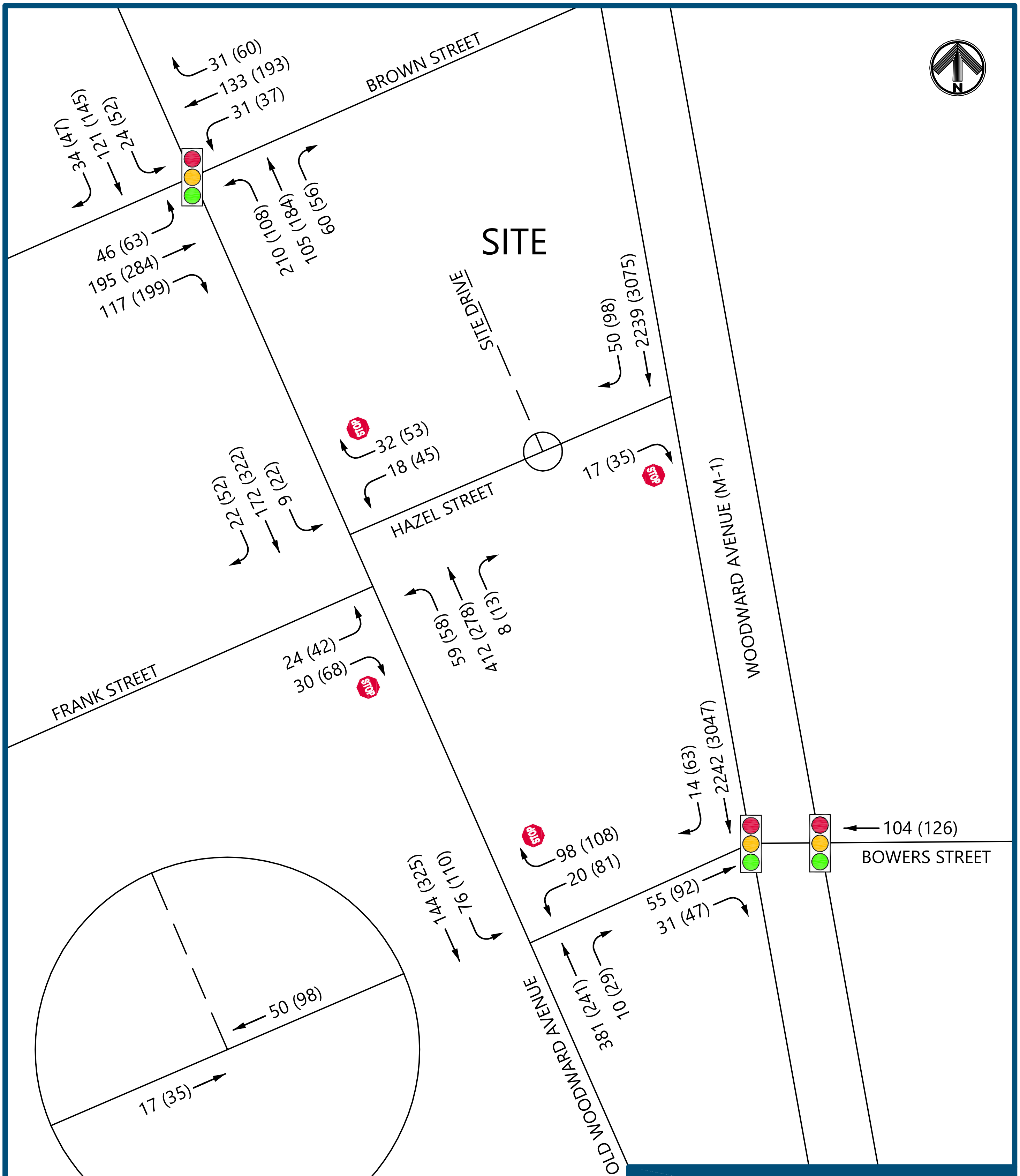
The City Multi Modal Transportation Plan (MMTP) indicates that shared use markings and curb extensions are recommended along Old Woodward Avenue. The curb extensions have been considered herein with respect to the programed roadway improvement projects described above. Shared use (bicycle / vehicle) pavement markings would have no bearing on this project. There are no other recommendations of the MMTP pertinent to this study.

Existing Traffic Counts

Existing traffic volume data were collected at the study intersections by Bergmann Associates subconsultant, Traffic Data Collection, LLC (TDC). Data were collected during typical weekday AM (7:00 to 9:00 AM) and PM (4:00 PM to 6:00 PM) peak periods. Data were collected in 15 minute intervals to establish the peak hour traffic volumes and peak hour factors (PHF).

These weekday data were collected on Wednesday, December 6th, 2017. Major weather events, holidays, and other local special events were avoided. In order to establish baseline 'Existing Conditions' volumes for this study, peak hour volumes for each intersection were identified based on the data collected. Volumes were balanced upward between adjacent intersections. The AM peak hour generally occurs from 8:00 AM to 9:00 AM, and the PM peak hour from 4:45 PM to 5:45 PM.

According to MDOT guidelines, PHF's were calculated by approach. Heavy vehicle volumes were also reviewed and calculated at each intersection by approach. All relevant traffic volume data are included in **Appendix A,** and the resulting Existing Traffic Volumes are shown on **Figure 2**.



AM PEAK HOUR VOLUME
(###) PM PEAK HOUR VOLUME

Proposed Mixed-Use Development
City of Birmingham, MI

Figure 2
Existing Traffic Volumes

PAGE NO.	SCALE	DATE	
7	No Scale	Mar '18	BERGMANN ARCHITECTS ENGINEERS PLANNERS

Existing Conditions Analysis

Existing 2017 Traffic Conditions

Existing peak hour vehicle delays and Levels of Service (LOS) were calculated at the study intersections using Synchro (Version 10) traffic analysis software. The results of the analysis of existing conditions were based on existing lane configurations and traffic control, the existing traffic volumes shown on **Figure 2**, and the methodologies presented in the *Highway Capacity Manual, 6th Edition (HCM6)*.

For the boulevard intersections on M-1, the HCM6 algorithms in Synchro are not capable of producing LOS and delay calculations. Therefore, previous Highway Capacity Manual (HCM) models were referenced as necessary. The acceptability of previous HCM methodologies have been approved by MDOT for situations where HCM6 calculations are limited in Synchro.

Typically, LOS D is considered acceptable, with LOS A representing minimal delay, LOS F indicating failing conditions, and LOS E representing conditions where demands are approaching capacity. Simulations of the study network were also observed using SimTraffic, in order to identify potential issues related to vehicle queuing, traffic flow between intersections, and the overall study network. The results of the analysis of existing conditions are presented in **Appendix B**, summarized in **Table 1,** and described in further detail below.

The results of the existing conditions analysis indicate that all approaches and movements at the study intersections currently operate acceptably at a LOS D or better during both peak periods. SimTraffic simulations also indicate acceptable traffic operations during the peak periods and significant vehicle queues are not observed.

this space left intentionally blank

Table 1. Existing 2017 Traffic Conditions

	AM Peak Hour					PM Peak Hour				
Intersection	**Approach**		↰	↑	↱	**Approach**		↰	↑	↱
1. Old Woodward Avenue & Brown Street Signalized 🚦	EB	21.0 C	20.7 C	21.3 C		EB	20.6 C	20.5 C	20.6 C	
	WB	20.8 C	24.0 C	20.2 C		WB	19.8 B	24.7 C	19.1 B	
	NB	17.5 B	21.3 C	12.9 B	12.7 B	NB	17.5 B	20.8 C	16.3 B	14.9 B
	SB	13.7 B	14.0 B	13.7 B		SB	16.9 B	18.9 B	16.3 B	
	Overall		**18.6**	**LOS**	**B**	**Overall**		**19.0**	**LOS**	**B**
2. M-1 SB & Bowers Street Signalized 🚦	EB	33.8 C		33.8 C		EB	32.7 C		32.7 C	
	WB	1.7 A		1.7 A		WB	1.4 A		1.4 A	
	SB	10.9 B		10.9 B		SB	14.4 B		14.4 B	
	Overall		**11.2**	**LOS**	**B**	**Overall**		**14.8**	**LOS**	**B**
3. M-1 SB & Hazel Street Minor STOP 🛑	EB	13.8 B			13.8 B	EB	19.5 C			19.5 C
	SB	Free				SB	Free			
4. Old Woodward Avenue & Bowers Street Minor STOP 🛑	WB	16.9 C	16.9 C			WB	26.0 D	26.0 D		
	NB	Free				NB	Free			
	SB	3.1 A	8.9 A	Free		SB	2.2 A	8.6 A	Free	
5. Old Woodward Avenue & Hazel Street Minor STOP 🛑	WB	14.8 B	14.8 B			WB	17.5 C	17.5 C		
	NB	Free				NB	Free			
	SB	0.4 A	8.7 A	Free		SB	0.5 A	8.3 A	Free	
6. Old Woodward Avenue & Frank Street Minor STOP 🛑	EB	14.5 B	14.5 B			EB	18.7 C	18.7 C		
	NB	1.0 A	7.9 A	Free		NB	1.4 A	8.6 A	Free	
	SB	Free				SB	Free			

Background Conditions Analysis

Background 2022 Traffic Volumes

The proposed development is planned to reach full buildout by early 2022. The analysis of background conditions typically includes other developments or ambient traffic growth that may occur prior to the buildout of this project.

For this study, one background development known as the Boutique Hotel was identified in the project area. The development site is located in the northwest corner of the Old Woodward & Brown Street intersection and will include a 126 room hotel with two restaurant / bars, banquet and meeting space, and 17 apartment units. The vehicle trips generated by the background development were forecast and assigned to the study road network based on the Traffic & Parking Study completed for the development by Giffels Webster dated May, 2017.

In order to determine the applicable traffic growth rate, historical traffic volumes along M-1 adjacent to the project site were reviewed. The results of this analysis indicate that overall, traffic volumes decreased at an annual rate of approximately 0.2% per year between 2010 and 2015; however, in recent years' traffic volumes have begun to increase. Therefore, based on a review of the historical traffic volumes and experience with MDOT projects in Southeast Michigan, a 0.5% per year growth rate was determined to be appropriate for this study. MDOT has consistently applied this growth rate for other projects in SE Michigan and across the State, and this rate was therefore applied to the existing traffic volumes for a period of five years. The resulting background peak hour traffic volumes are summarized on **Figure 3**.

Background 2022 Traffic Conditions

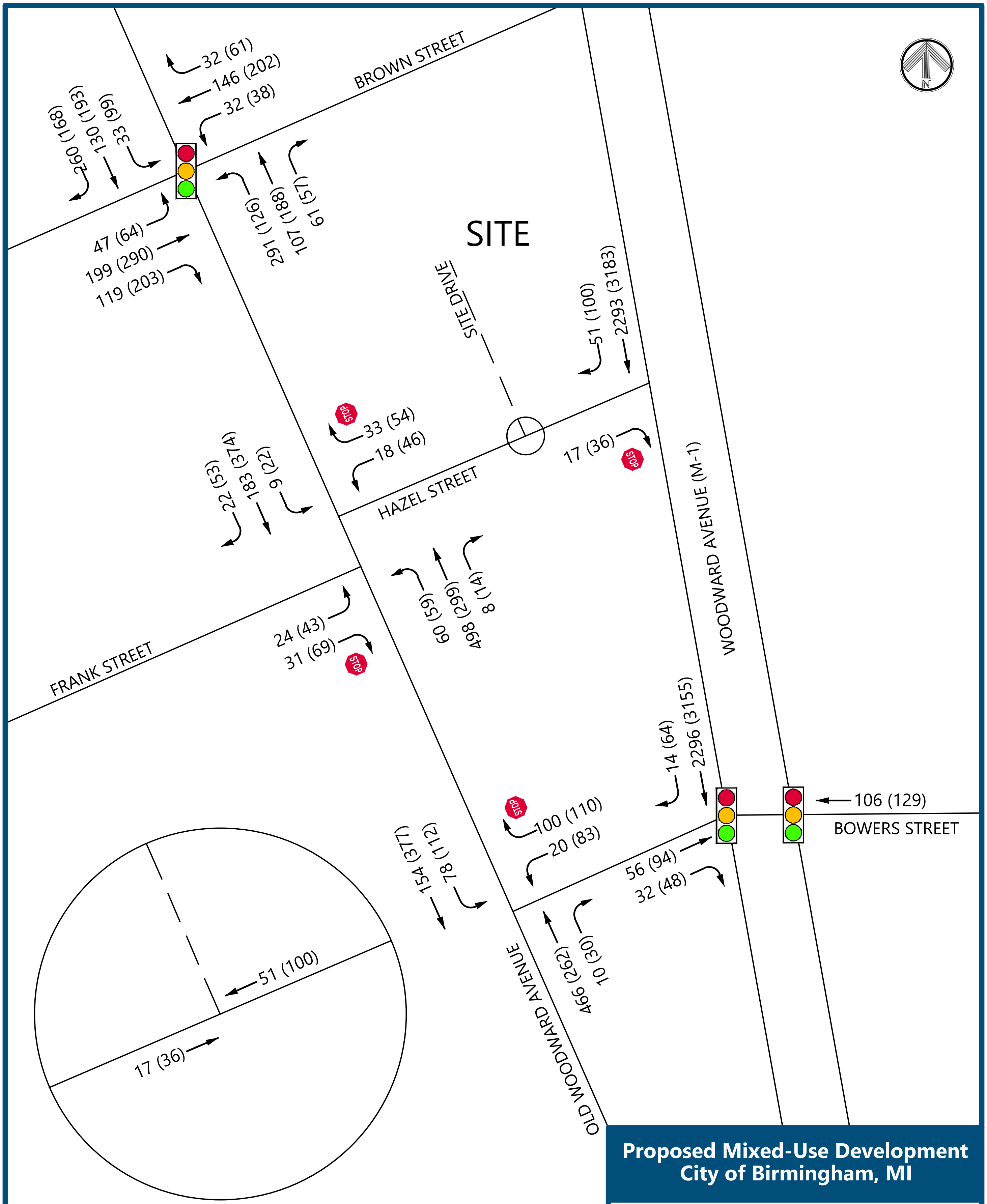
Background peak hour vehicle delays and LOS were calculated at the study intersections based on existing lane configurations and traffic control, the background traffic volumes shown on **Figure 3,** and the methodologies presented in the *HCM*. Additionally, the planned roadway improvements along Old Woodward Avenue previously identified were assumed complete. The results of the analysis of background conditions are presented in **Appendix C,** summarized in **Table 2**, and described in further detail below.

The results of the background conditions analysis indicate that all approaches and movements at the study intersections will continue to operate in a manner similar to existing conditions with the exception of the NB left turn movement at the intersection of Old Woodward Avenue & Brown Street which will be reduced to a LOS F during the AM peak hour.

SimTraffic simulations indicate acceptable traffic operations during the PM peak hour. During the AM peak hour, a long vehicle queue is observed for the NB left-turn movement at Old Woodward Avenue & Brown Street which exceeds available storage length and spills back into the through travel lane along Old Woodward Avenue resulting in queues that extend back past Hazel Street.

Table 2. Background 2022 Traffic Conditions

	AM Peak Hour					PM Peak Hour				
Intersection	**Approach**		↰	↑	↱	**Approach**		↰	↑	↱
1. Old Woodward Avenue & Brown Street Signalized 🚦	EB	21.2 C	20.9 C	21.5 C		EB	20.8 C	20.8 C	20.8 C	
	WB	21.1 C	24.2 C	20.5 C		WB	20.0 B	25.0 C	19.3 B	
	NB	69.9 E	101.7 F	14.4 B		NB	22.4 C	29.7 C	18.7 B	
	SB	19.4 B	16.5 B	19.6 B		SB	20.7 C	24.2 C	19.8 B	
	Overall		**36.3**	**LOS**	**D**	**Overall**		**21.0**	**LOS**	**C**
2. M-1 SB & Bowers Street Signalized 🚦	EB	33.7 C		33.7 C		EB	32.8 C		32.8 C	
	WB	1.7 A		1.7 A		WB	1.5 A		1.5 A	
	SB	11.1 B		11.1 B		SB	15.2 B		15.2 B	
	Overall		**11.4**	**LOS**	**B**	**Overall**		**15.4**	**LOS**	**B**
3. M-1 SB & Hazel Street Minor STOP STOP	EB	14.0 B			14.0 B	EB	20.4 C			20.4 C
	SB	Free				SB	Free			
4. Old Woodward Avenue & Bowers Street Minor STOP STOP	WB	20.5 C	20.5 C			WB	31.9 D	31.9 D		
	NB	Free				NB	Free			
	SB	3.2 A	9.4 A	Free		SB	2.0 A	8.7 A	Free	
5. Old Woodward Avenue & Hazel Street Minor STOP STOP	WB	16.7 C	16.7 C			WB	19.3 C	19.3 C		
	NB	Free				NB	Free			
	SB	0.4 A	9.1 A	Free		SB	0.4 A	8.4 A	Free	
6. Old Woodward Avenue & Frank Street Minor STOP STOP	EB	15.6 C	15.6 C			EB	21.1 C	21.1 C		
	NB	0.8 A	8.0 A	Free		NB	1.4 A	8.8 A	Free	
	SB	Free				SB	Free			



AM PEAK HOUR VOLUME

(###) PM PEAK HOUR VOLUME

Proposed Mixed-Use Development
City of Birmingham, MI

Figure 3
Background Traffic Volumes

PAGE NO.	SCALE	DATE	
12	No Scale	Mar '18	BERGMANN ARCHITECTS ENGINEERS PLANNERS

Background 2022 Improvements

In order to improve all approaches and movements to a LOS D or better in the background conditions, mitigation measures were investigated at the intersection of Old Woodward Avenue & Brown Street. The results of this analysis indicate that with signal timing optimization to provide more green time for Old Woodward Avenue, all approaches and movements at the intersection will operate acceptably at a LOS D or better as shown in **Table 3**. SimTraffic simulations also indicate acceptable traffic operations with the recommended signal timing improvements and significant vehicle queues are not observed.

Table 3. Background 2022 Traffic Conditions with Improvements

	AM Peak Hour				PM Peak Hour			
Intersection	**Approach**		**↰**	**↑ ↱**	**Approach**		**↰**	**↑ ↱**
1. Old Woodward Avenue & Brown Street	EB	41.8 D	42.9 D	40.7 D	EB	20.8 C	20.8 C	20.8 C
	WB	36.8 D	41.3 D	36.0 D	WB	20.0 B	25.0 C	19.3 B
Signalized 🚦	NB	17.1 B	23.2 C	6.6 A	NB	22.4 C	29.7 C	18.7 B
	SB	8.7 A	7.5 A	8.8 A	SB	20.7 C	24.2 B	19.8 B
	Overall		**23.3**	**LOS C**	**Overall**		**21.0**	**LOS C**

Future Conditions Analysis

Site-Generated Traffic

Trip Generation

The number of AM and PM peak hour vehicle trips that would be generated by the proposed development was forecast based on the rates and equations published by ITE in *Trip Generation, 10th Edition*. ITE publishes average trip generation rates for a wide variety of land uses, as well as regression equations for some. For some land uses, both rates and equations are available and selection of the appropriate method was based on the guidelines outlined in the ITE *Trip Generation Manual*.

The ITE land use category that most closely matches the operations of the proposed hotel is *Land Use #312, Business Hotel*, which is described as a place of lodging aimed toward the business traveler but also accommodates a growing number of recreational travelers. This land use was selected over *Land Use #310, Hotel*, due to the absence of supporting facilities such as restaurants and meeting / banquet space. The independent variable "occupied rooms" was conservatively chosen for forecasting hotel trips to analyze future traffic conditions assuming full occupancy of the hotel.

Furthermore, the hotel will include approximately 3,435 SF of coffee / bar / reception space on the first floor that will accommodate hotel guests and residents and will not attract outside patrons; however, as a conservative approach, this space was classified as "retail" and vehicle trips were generated for it using *Land Use #820, Shopping Center*. Given the small size of the retail space as compared to the ITE data set, the average rate was determined to be more appropriate than the regression equation for this land use. Considering the nature of the space and its direct relationship to serve the hotel guests and residents, no pass-by reductions were applied. The trip generation forecast for the proposed development based on the ITE data, is summarized in **Table 4**.

Table 4. Site Trip Generation Forecast

	ITE			Average	AM Peak Hour			PM Peak Hour		
Land Use	Code	Amount	Units	Daily	In	Out	Total	In	Out	Total
Retail	820	3,435	SF	130	2	1	3	6	7	13
Business Hotel	312	94	Occ Rooms	478	28	25	53	23	19	42
			Hotel Use TOTAL	608	30	26	56	29	26	55
Multifamily Mid-Rise	221	29	Dwellings	158	3	7	10	8	5	13
TOTAL SITE TRIPS				**766**	**33**	**33**	**66**	**37**	**31**	**68**

Traffic Assignments

The vehicle trips that would be generated by the proposed development were assigned to the study road network based on existing traffic patterns and ITE methodologies. This methodology indicates that new trips will return to their direction of origin.

Given the site location relative to downtown Birmingham and arterial roadways, the local study road network does not provide a complete representation of traffic in and out of downtown Birmingham. Therefore, a global distribution of traffic was developed based on the relative order of magnitude of traffic volumes currently on M-1, Old Woodward Avenue, Southfield Road, and Maple Road. This "gravity" distribution model is summarized in **Table** 5 and provides an accurate representation of how residents and patrons are expected to travel in and out of the City.

Table 5. Global Site Trip Distribution

To/From	Via	AM/PM
North	Old Woodward Avenue	5%
	M-1	30%
South	Old Woodward Avenue	5%
	M-1	30%
	Southfield Road	10%
East	Maple Road	10%
West	Maple Road	10%
		100%

Vehicle trips were assigned to the study road network based on the global trip distribution shown in **Table** 5, available routes from the development site to and from the arterial roadways, and the driver's perception of the quickest route of travel. The resulting trip distribution is summarized in **Table** 6 and shown on **Figure 5**.

Table 6. Site Trip Distribution

Direction	Via	AM/PM	
		To	From
North	Old Woodward Avenue	15%	25%
	M-1	15%	30%
South	Old Woodward Avenue	5%	5%
	M-1	30%	30%
East	Brown Street	25%	0%
West	Brown Street	10%	10%
		100%	100%

Valet Generated Traffic

As part of the development plans, 100 parking spaces will be provided on-site in three levels of below grade parking which will be supplemented by leased parking spaces in the adjacent 555 building parking deck. Resident parking will be provided on-site via reserved parking spaces, while parking for hotel guests will be provided primarily on-site, with off-site overflow parking in the adjacent 555 parking deck. In order to manage parking operations for the site and ensure optimum utilization of the on-site parking spaces, a valet service will be employed to park all vehicles associated with hotel guests, whereas all resident parking will be accomplished through self-parking.

The valet service bay will be located along the Hazel Street frontage and will provide stacking space for four vehicles without blocking the entrance/exit ramp to the on-site parking deck which will be located at the east end of the service bay. The valet service bay's location relative to both the on-site and off-site parking deck access points will result in additional vehicle trips on the adjacent road network. The trip generation and assignment of the additional traffic associated with the valet operations is further discussed below.

Trip Generation

The number of AM and PM peak hour valet trips that would result in additional traffic on the study road network was determined based on the number of parking spaces provided in the on-site deck, the valet service bay location, the on-site and off-site parking deck access points, and information provided by the developer.

The number of vehicles that would be parked on-site versus off-site was determined based on the number of non-resident available spaces in the on-site deck as compared to the parking required for hotel guests. A parking supply of 1.5 spaces per unit (44 spaces) will be provided and reserved for residents on-site, which leaves 56 spaces available for hotel vehicles. In order to accommodate arrivals from all directions as well as any longer loading and unloading needs, the four spaces on the ground level will be utilized as a staging area to compliment the valet. This provision will limit vehicle parking time in the valet service bay, and prevent vehicles from the west from having to make a U-turn on Hazel Street or drive around the block to approach the site from the east. These four spaces should be accounted for with respect to Ordinance requirements, and not as separate loading spaces, because they are accommodating peak parking demands generated by the hotel, thus freeing other spaces below ground while patrons load and unload. These spaces should be controlled with the service bay by the valet operation.

According to ITE *Parking Generation, 4th Edition* Land Use 310 (Hotel) and Land Use 312 (Business Hotel) experience a weekday peak parking demand of 0.89 and 0.60 vehicles per occupied room, respectively. As a conservative approach, we have assumed 1.0 vehicles per occupied room to account for the worst case scenario when the hotel is fully occupied and all guests arrive via automobile which results in 94 parked vehicles associated with the hotel. With 56 available spaces on-site, approximately 60% of hotel vehicles can be parked in the on-site garage during peak occupancy, while the remaining 40% will have to be parked in the 555 garage.

During typical day-to-day operations, all guests may be able to be parked on-site, with overflow only in the 555 garage. Conservatively, vehicle trips were assigned assuming peak occupancy of the hotel. The directional distribution of inbound vs. outbound trips during the peak periods associated with the hotel is fairly evenly balanced and arrival and departure patterns for hotel guests tends to be somewhat random. Therefore, this study assumes 40% of inbound and outbound vehicular trips associated with the hotel during the peaks are taken to / brought from the off-site 555 garage and result in added trips to the adjacent road network.

Additionally, given the valet service bay location relative to the on-site parking deck access point, all valet trips exiting the service bay destined for the on-site or off-site parking deck will have to utilize the adjacent street network to go around the block and reach their destination. Entering the valet service bay, only valet trips from the off-site deck will have to utilize the off-street network while valet trips from the on-site deck will be able to exit the deck directly into the service bay.

In order to minimize the impact to traffic on the adjacent road network, it is recommended that all vehicles arriving to the site from the west (that will utilize the four ground level spaces in the garage for loading and unloading) be parked in the on-site deck. The additional site-generated traffic volumes that are expected to be added to the off-site road network as a result of peak period valet operations are summarized in **Table 7**.

Table 7. Valet Off-Site Trip Generation Forecast

Land Use	ITE Code	Amount	Units	Average Daily	AM Peak Hour In	AM Peak Hour Out	AM Peak Hour Total	PM Peak Hour In	PM Peak Hour Out	PM Peak Hour Total
Hotel	310	94	Rooms	517	18	12	30	17	12	29
Multifamily Mid-Rise	221	29	Dwellings	0	0	0	0	0	0	0
OFF-SITE VALET TRIPS				**647**	**18**	**12**	**30**	**17**	**12**	**29**

Traffic Assignment

The valet vehicle trips that would be generated by the proposed development were assigned to the study road network based on the routes of travel to and from the valet service bay shown on **Figure 5**. These routes provide for a clockwise flow of traffic with only right turns to provide the least amount of intrusion on the adjacent road network as possible, while also minimizing delay incurred by valet driven vehicles to provide better service times for hotel guests. U-turns on Hazel Street for valet operations should not be permitted.

The site generated vehicle trips and valet generated vehicle trips are shown on **Figure 6** and were added to the background traffic volumes shown on **Figure 3** to calculate the total Future traffic volumes shown on **Figure 7** which are anticipated on the study network with full residential and hotel occupancy by the year 2022. The total future volumes include the existing traffic volumes, ambient background traffic growth, traffic volumes from the boutique hotel, and traffic volumes forecast to be generated by the proposed development.

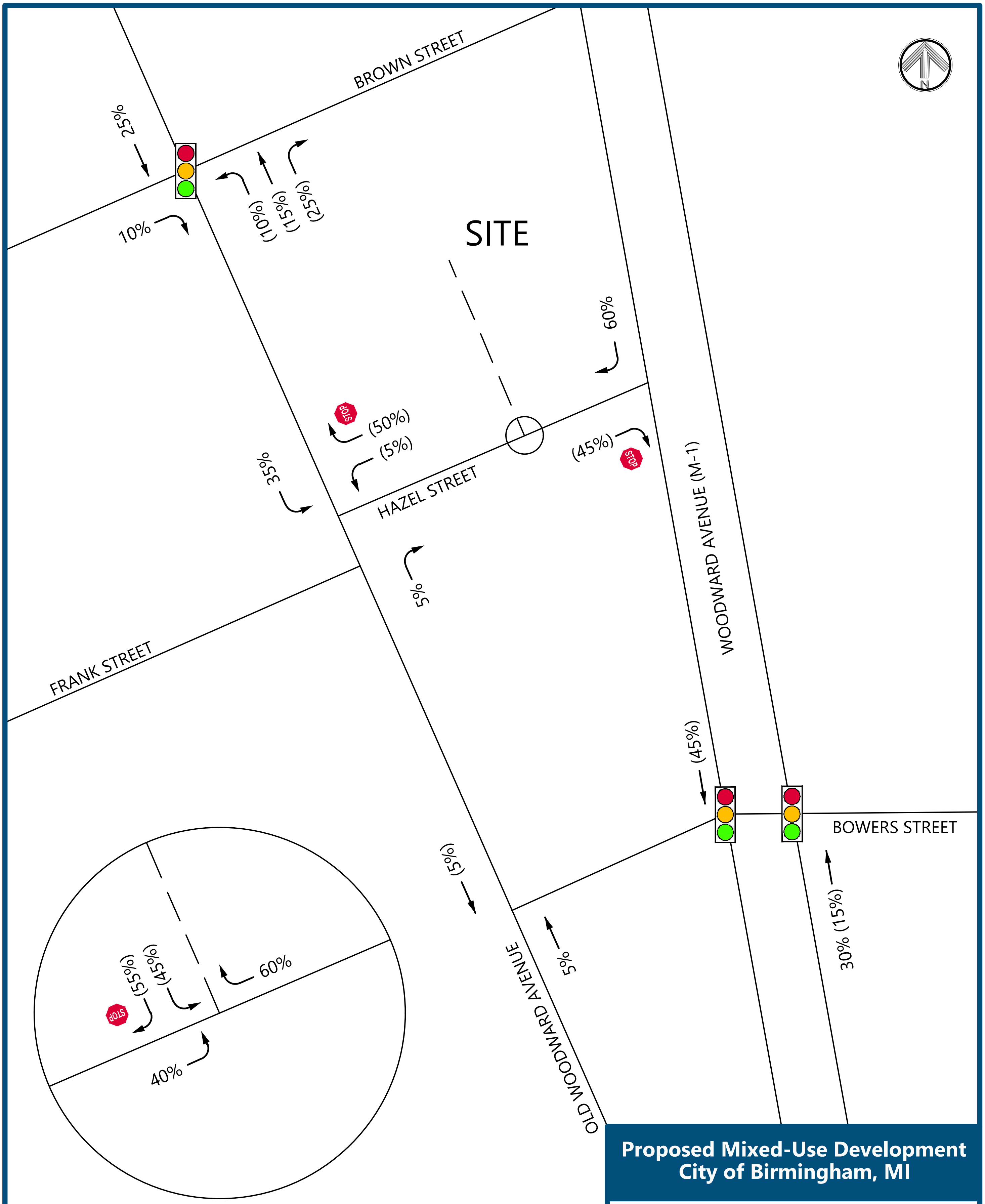
Future 2022 Traffic Conditions

Future peak hour vehicle delays and LOS ***with the proposed development*** were calculated based on existing lane configurations and traffic control, future traffic volumes shown on **Figure 7**, and HCM methodologies. Additionally, the planned roadway improvements along Old Woodward Avenue previously identified were assumed complete. SimTraffic simulations were also utilized to evaluate traffic flow and vehicle queues throughout the study network. The results of the future conditions analysis are presented in **Appendix D** and summarized in **Table 8**.

The results of the analysis of future traffic conditions indicates that the proposed development would not have a significant impact on the study intersections. Future vehicle delays and LOS as shown in **Table 8** will be similar to background conditions and minor increases in vehicle delays will not be discernable. At the signalized study intersections overall vehicle delays will increase by approximately two seconds during the peak periods, which is not significant. At the unsignalized study intersections, all approaches and movements will continue to operate acceptably at a LOS D or better during both peak periods.

Future traffic operations were also evaluated for the proposed parking deck access point to Hazel Street. The results of this analysis indicate that all approaches and movements at the site access point will operate acceptably at a LOS A during both peak periods.

SimTraffic simulations indicate acceptable traffic operations during the PM peak hour. During the AM peak hour, a long vehicle queue is observed for the NB left-turn movement at Old Woodward Avenue & Brown Street which exceeds available storage length and spills back into the through travel lane along Old Woodward Avenue resulting in queues that extend back past Hazel Street. This condition exists in the background condition, and is not created by the proposed development. Signal timing improvements recommended for the background condition would mitigate this condition as described below.



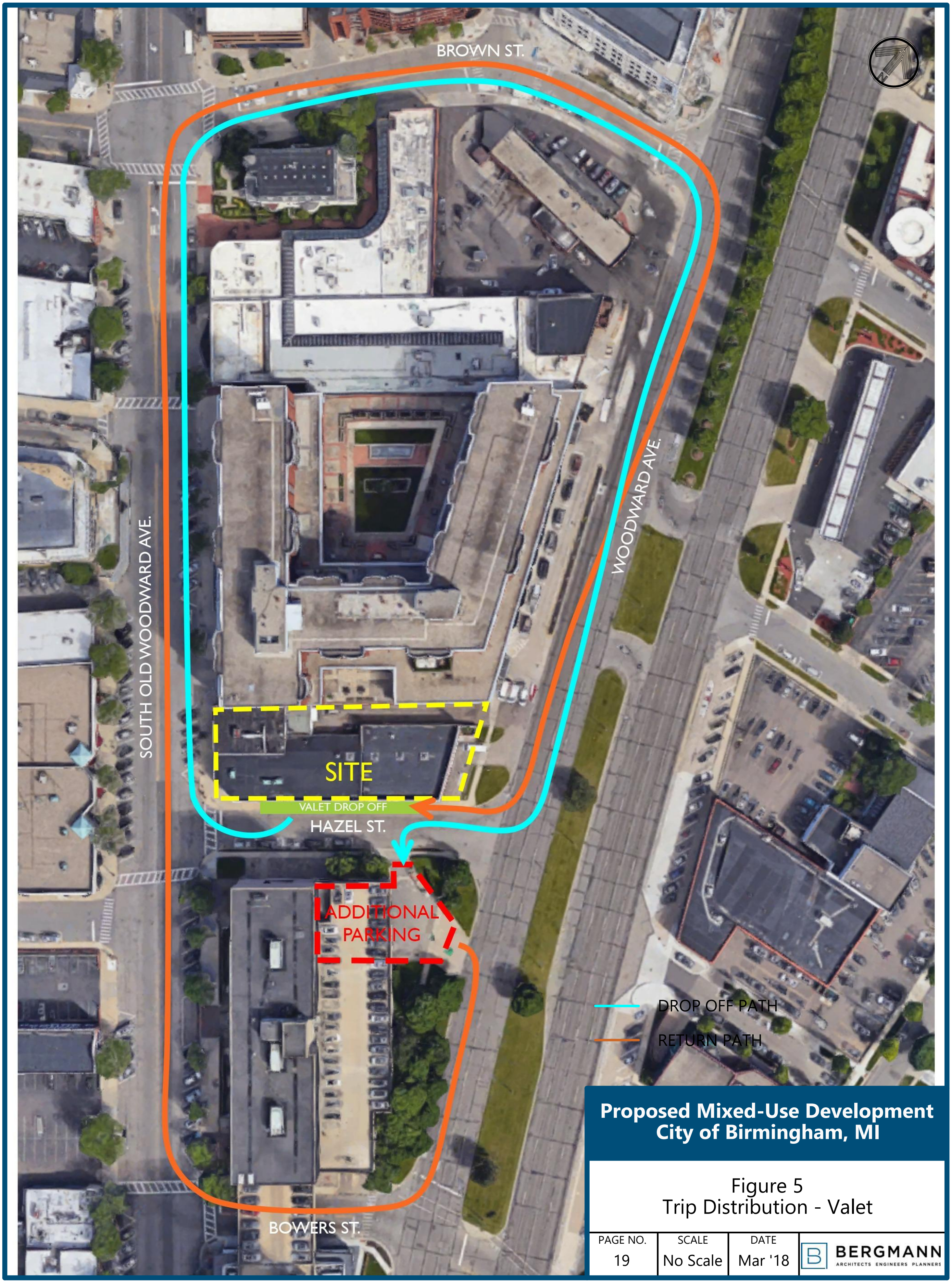
###	AM/PM PEAK HOUR INBOUND
(###)	AM/PM PEAK HOUR OUTBOUND

Proposed Mixed-Use Development
City of Birmingham, MI

Figure 4
Trip Distribution

PAGE NO.	SCALE	DATE
18	No Scale	Mar '18

BERGMANN
ARCHITECTS ENGINEERS PLANNERS

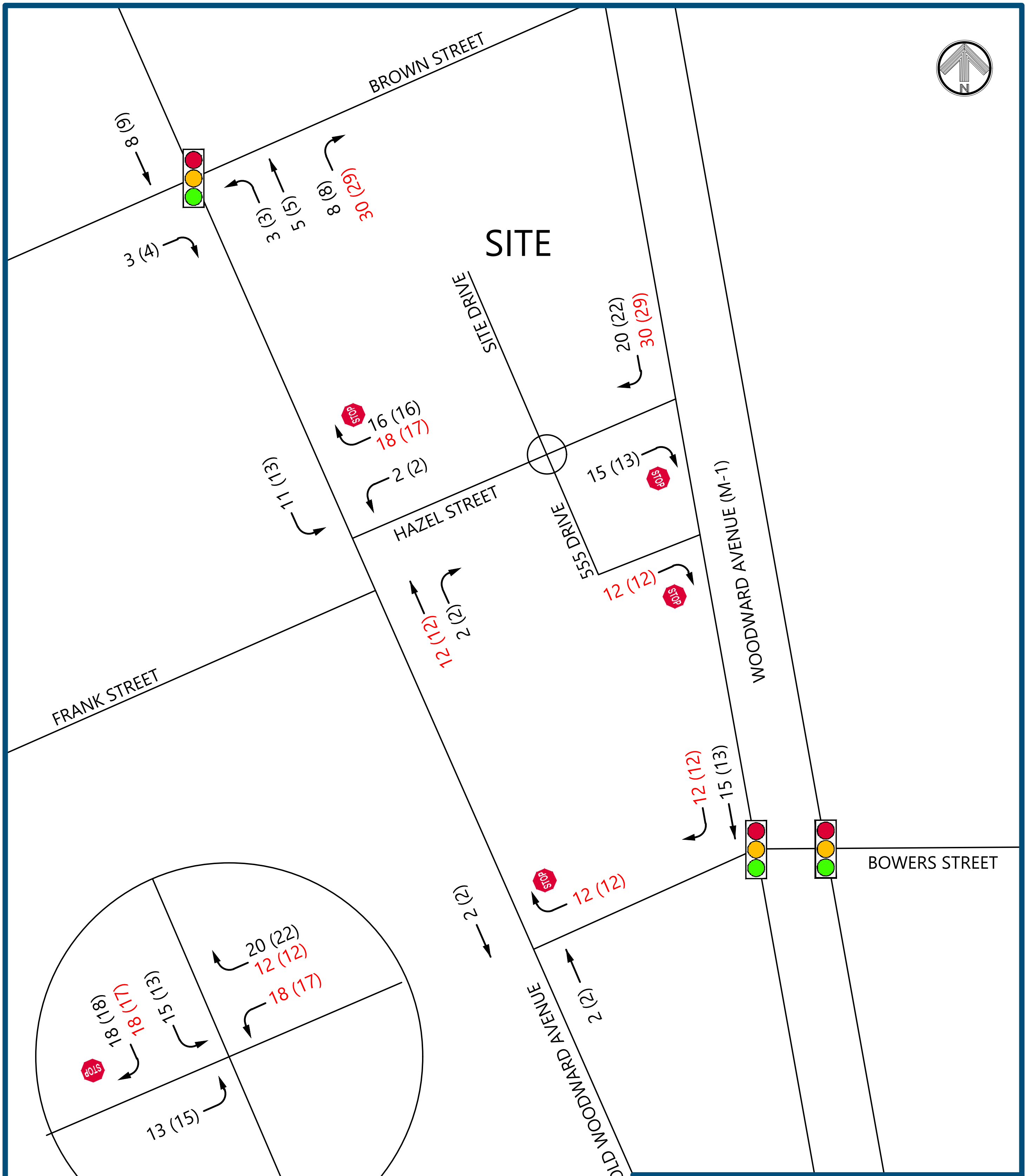


Proposed Mixed-Use Development
City of Birmingham, MI

Figure 5
Trip Distribution - Valet

PAGE NO.	SCALE	DATE
19	No Scale	Mar '18

BERGMANN
ARCHITECTS ENGINEERS PLANNERS



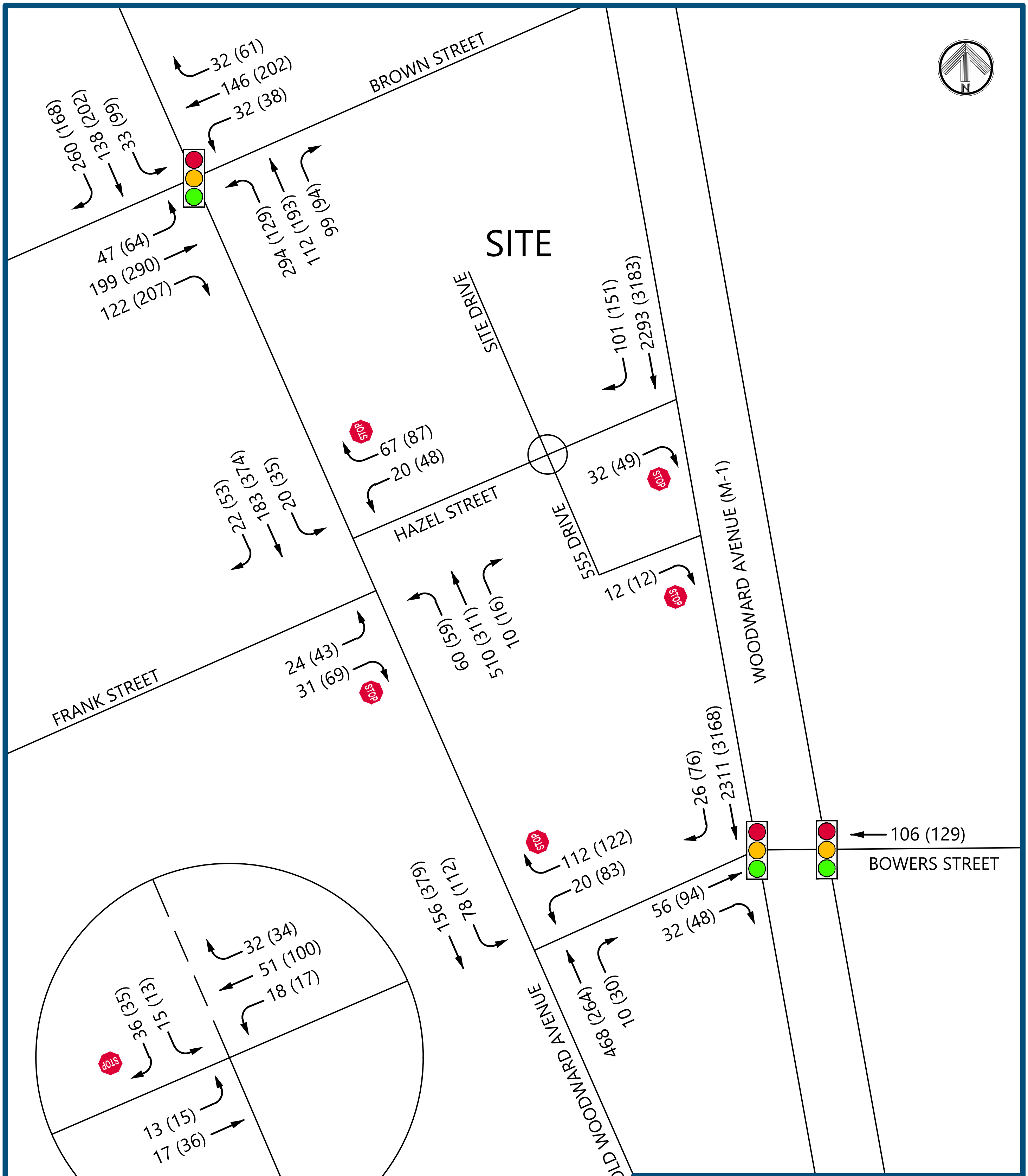
(###) AM (PM) SITE-GENERATED VOLUMES

(###) AM (PM) VALET GENERATED VOLUMES

Proposed Mixed-Use Development
City of Birmingham, MI

Figure 6
Site Generated Traffic Volumes

PAGE NO.	SCALE	DATE	
20	No Scale	Mar '18	BERGMANN ARCHITECTS ENGINEERS PLANNERS



AM PEAK HOUR VOLUME

(###) PM PEAK HOUR VOLUME

Proposed Mixed-Use Development
City of Birmingham, MI

Figure 7
Future Traffic Volumes

PAGE NO.	SCALE	DATE
21	No Scale	Mar '18

BERGMANN
ARCHITECTS ENGINEERS PLANNERS

Table 8. Future 2022 Traffic Conditions

	AM Peak Hour					PM Peak Hour				
Intersection	**Approach**		↰	↑	↱	**Approach**		↰	↑	↱
1. Old Woodward Avenue & Brown Street Signalized 🚦	EB	21.2 C	20.9 C	21.5 C		EB	20.9 C	20.9 C	20.9 C	
	WB	21.1 C	24.3 C	20.5 C		WB	20.0 B	25.1 C	19.3 B	
	NB	72.6 E	113.7 F	15.4 B		NB	23.3 C	30.4 C	20.1 C	
	SB	19.7 B	18.1 B	19.9 B		SB	21.4 C	26.7 C	20.0 C	
	Overall		**38.3**	**LOS**	**D**	**Overall**		**21.4**	**LOS**	**C**
2. M-1 SB & Bowers Street Signalized 🚦	EB	33.3 C		33.3 C		EB	32.8 C		32.8 C	
	WB	1.7 A		1.7 A		WB	1.5 A		1.5 A	
	SB	11.2 B		11.2 B		SB	15.3 B		15.3 B	
	Overall		**11.4**	**LOS**	**B**	**Overall**		**15.6**	**LOS**	**B**
3. M-1 SB & Hazel Street Minor STOP STOP	EB	15.0 C			15.0 C	EB	22.7 C			22.7 C
	SB	Free				SB	Free			
4. Old Woodward Avenue & Bowers Street Minor STOP STOP	WB	21.3 C	21.3 C			WB	33.0 D	33.0 D		
	NB	Free				NB	Free			
	SB	3.1 A	9.4 A	Free		SB	2.0 A	8.7 A	Free	
5. Old Woodward Avenue & Hazel Street Minor STOP STOP	WB	18.2 C	18.2 C			WB	21.5 C	21.5 C		
	NB	Free				NB	Free			
	SB	0.8 A	9.2 A	Free		SB	0.6 A	8.5 A	Free	
6. Old Woodward Avenue & Frank Street Minor STOP STOP	EB	15.9 C	15.9 C			EB	21.6 C	21.6 C		
	NB	0.8 A	8.0 A	Free		NB	1.3 A	8.8 A	Free	
	SB	Free				SB	Free			
7. Hazel Street & Site Drive / 555 Site Drive Minor STOP STOP	EB	3.2 A	7.4 A	Free		EB	2.2 A	7.5 A	Free	
	WB	Free				WB	Free			
	NB	0.0 A	0.0 A			NB	0.0 A	0.0 A		
	SB	9.2 A	9.2 A			SB	9.6 A	9.6 A		

Future 2022 Improvements

In order to improve all approaches and movements to a LOS D or better in the future conditions, the mitigation measures identified under background conditions were applied at the intersection of Old Woodward Avenue & Brown Street. The results of this analysis indicate that with the recommended signal timing optimization all approaches and movements at the intersection will operate acceptably at a LOS D or better as shown in **Table 9.** SimTraffic simulations also indicate acceptable traffic operations with the recommended signal timing improvements and significant vehicle queues are not observed.

Table 9. Future 2022 Traffic Conditions with Improvements

<table>
<tr><th rowspan="2">Intersection</th><th colspan="5">AM Peak Hour</th><th colspan="5">PM Peak Hour</th></tr>
<tr><th colspan="2">Approach</th><th>↰</th><th>↑</th><th>↱</th><th colspan="2">Approach</th><th>↰</th><th>↑</th><th>↱</th></tr>
<tr><td rowspan="5">1. Old Woodward Avenue & Brown Street
Signalized
🚦</td><td>EB</td><td>42.1
D</td><td>43.2
D</td><td colspan="2">41.0
D</td><td>EB</td><td>20.8
C</td><td>20.8
C</td><td colspan="2">20.8
C</td></tr>
<tr><td>WB</td><td>36.9
D</td><td>41.5
D</td><td colspan="2">36.0
D</td><td>WB</td><td>20.0
B</td><td>25.0
C</td><td colspan="2">19.3
B</td></tr>
<tr><td>NB</td><td>17.0
B</td><td>24.2
C</td><td colspan="2">7.1
A</td><td>NB</td><td>22.4
C</td><td>29.7
C</td><td colspan="2">18.7
B</td></tr>
<tr><td>SB</td><td>8.8
A</td><td>8.2
A</td><td colspan="2">8.8
A</td><td>SB</td><td>20.7
C</td><td>24.2
B</td><td colspan="2">19.8
B</td></tr>
<tr><td colspan="2">Overall</td><td>23.1</td><td>LOS</td><td>C</td><td colspan="2">Overall</td><td>19.0</td><td>LOS</td><td>B</td></tr>
</table>

Additionally, vehicle queue lengths were evaluated along Hazel Street with respect to the proposed on-site parking deck access point and valet service bay locations with the proposed signal timing optimization. The results of the queue analysis indicate that 95th percentile queue lengths for EB Hazel Street from its intersection with M-1 will be 47 feet (2 vehicles) or less during the peak periods and will extend back past the on-site parking deck access point for less than two minutes of the peak hours, which is not significant. Additionally, 95th percentile queue lengths for WB Hazel Street at Old Woodward Avenue are calculated to be less than three vehicles during the peak periods which will not typically block the valet service bay.

Valet Operational Analysis

As previously mentioned, the valet service bay will be large enough to accommodate four passenger vehicles without blocking the entrance / exit ramp to the on-site deck. To determine the number of valets needed to contain queuing of vehicles associated with valet operations within the service bay, a queuing analysis was performed.

The arrival rate, in vehicles per hour, was determined from the trip generation forecast shown in **Table 4**. As all hotel guests will be required to utilize the valet service, a total of 56 vehicles (30 inbound, 26 outbound) and 55 vehicles (29 inbound, 26 outbound) will be processed through the valet service bay during the AM and PM peak hours, respectively.

The service rate, in vehicles per hour, was determined based on calculated times for various stages of the valet process including time spent driving on the adjacent street network, time spent traveling to and from the valet service bay on foot, and time spent in the parking deck parking and retrieving vehicles. These times are summarized in **Table 10**. A weighted average service time was than calculated with respect to the corresponding number of trips associated with each service time during the peak hours. This results in a service time of 4.2 minutes per vehicle per valet and a service rate of 14.29 vehicles per valet per hour. Based on this weighted average service time, four valet attendants would be required to service the anticipated peak demands.

Table 10. Valet Service Times

Origin	Destination	Stage	Time (seconds)
Valet Service Bay	On-Site Garage	Driving Street Network	180
		Parking Car in Garage	60
		Pedestrian Trip to Valet	40
		TOTAL	**280**
Valet Service Bay	Off-Site Garage	Driving Street Network	180
		Parking Car in Garage	60
		Pedestrian Trip to Valet	50
		TOTAL	**290**
On-Site Garage	Valet Service Bay	Pedestrian Trip from Valet	40
		Exiting Garage	60
		Driving Street Network	0
		TOTAL	**100**
Off-Site Garage	Valet Service Bay	Pedestrian Trip from Valet	50
		Exiting Garage	60
		Driving Street Network	240
		TOTAL	**350**

This weighted average service calculation does not fully account for the randomness of arrivals and departures. Arrivals and departures are not typically congruent; that is, both rates vary over time, whereas four valet attendants may not be adequate to service a spike in activity within the peak hour. Queuing at any facility is a function of the rate of arrivals versus the rate of departures, or in this case, vehicles serviced through the valet. In order to evaluate expected queues, statistics and probabilities are typically employed to determine queue lengths that can be expected with a degree of confidence.

Queuing at a valet is slightly different than at a single point-of-sale system such as a fast food drive-through, as valet attendants are able to process multiple vehicles in parallel. Therefore, probabilities were calculated by scenario for integer number of valet attendants. Probabilities were calculated based on statistical distributions of arrival and service rates, and the average wait time, average queue, and probable number of vehicles in the system were calculated for each scenario. Probability calculations are included in **Appendix D**.

As shown in **Figure 8**, the probable outcomes for average wait time, average queue, and number of vehicles in the system converge in a quasi-negative exponential function. These probability driven results demonstrate that while intense arrivals to the valet may not be adequately serviced by four attendants, there is little tangible benefit to providing more than five valet attendants.

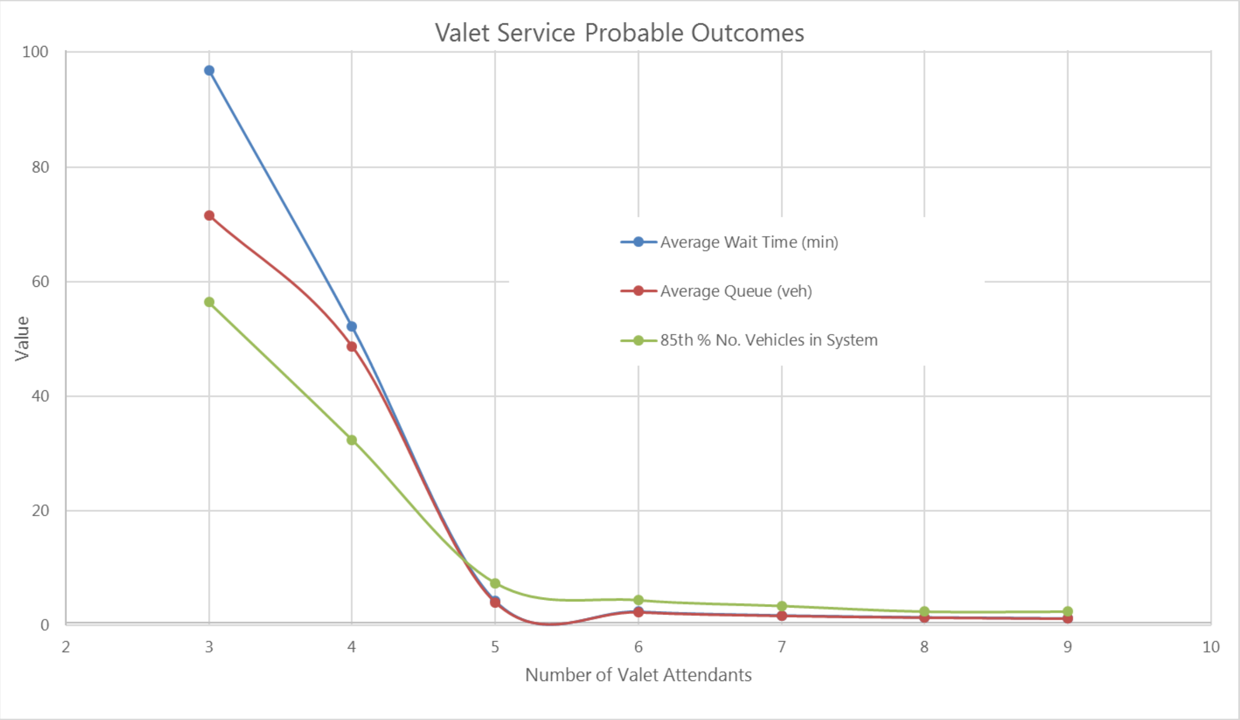


Figure 8: Valet Service Probable Outcomes

In addition to providing four to five valet attendance during peak periods, there are four parking spaces located on the ground level of the on-site parking garage. These four spaces should be controlled with the service bay by the valet operation in order to service vehicles approaching the site from the west, as well as provide overflow valet staging to prevent vehicle queues from blocking Hazel Street.

These four spaces can be utilized by the valet attendants to service patrons that have extended loading and unloading needs. These spaces should be accounted for with respect to Ordinance requirements, and not as separate loading spaces, because they are accommodating peak parking demands generated by the hotel, thus freeing other spaces below ground while patrons load and unload.

Conclusions & Recommendations

Overall, the conclusions of this Traffic Impact Study are as follows:

1. Existing conditions analyses indicate that all study intersection approaches and movement currently operate acceptably at a LOS D or better during both peak periods.
2. Additional traffic volumes considering background developments and ambient traffic growth in the area will result in degraded operations for the intersection of Old Woodward Avenue & Brown Street during the AM peak hour.
3. Background conditions mitigation includes signal timing improvements at the intersection of Old Woodward Avenue & Brown Street in order to improve network operations to LOS D or better.
4. Parking for residents will be provided within the 100-space on-site parking garage.
5. Parking for hotel guests will be provided via a valet service which will utilize on-site and overflow off-site parking at the 555 building on the south side of Hazel Street.
6. Valet operations will result in a moderate increase to traffic volumes on the adjacent road network.
7. Traffic volumes generated by the proposed development would not have a significant impact on the adjacent road network.
8. A staff of four to five valet attendants during the peak hours would be necessary to contain vehicle queues within the valet service bay, not to extend back past the on-site parking deck access point or onto Hazel Street.

Based on the results of this study, the following should be considered to provide acceptable traffic operations due to existing network deficiencies, ***regardless of the proposed project:***

1. Optimize the signal timings at the intersection of Old Woodward Avenue & Brown Street.

Based on the results of this study, the following should be required to provide acceptable traffic operations ***with the proposed development:***

1. Provide four to five valet attendants during the AM and PM peak hours.
2. Allocate the four parking spaces on the main level of the on-site parking deck for vehicle loading and unloading to accommodate vehicle arrivals from the west on Hazel Street and any extended patron loading and unloading needs.

The improvements described in the analysis of background conditions should be installed in order to mitigate unacceptable traffic operations that would exist regardless of this project. No further off-site improvements should be required to maintain acceptable traffic operations.

Appendix A

Traffic Count Data

Traffic Data Collection, LLC

tdccounts.com

Phone: (586) 786-5407

Traffic Study Peformed For:

Bergmann Associates

Project: Birmingham Traffic Impact Study
Study Type: 4 Hr. Video Turning Movement
Weather: Sunny / Cldy. Dry Temp 30's
Count By: Miovision Video SCU3HT SW

File Name : TMC_1 Brown & OldWoodward_12-6-17
Site Code : TMC_1
Start Date : 12/6/2017
Page No : 1

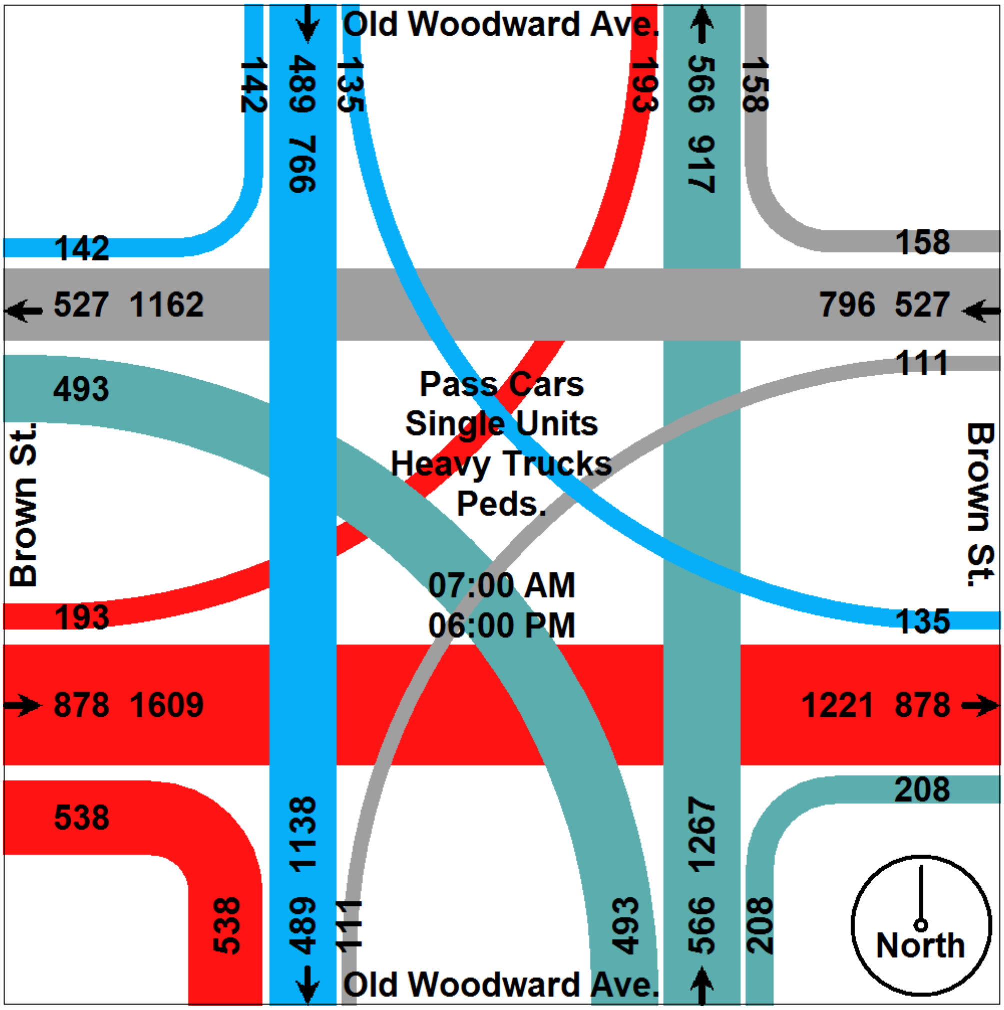
Groups Printed- Pass Cars - Single Units - Heavy Trucks - Peds.

	Old Woodward Ave. Southbound					Brown St. Westbound					Old Woodward Ave. Northbound					Brown St. Eastbound					
Start Time	Rgt	Thru	Left	Peds	App. Total	Rgt	Thru	Left	Peds	App. Total	Rgt	Thru	Left	Peds	App. Total	Rgt	Thru	Left	Peds	App. Total	Int. Total
07:00 AM	6	13	1	1	21	1	12	3	3	19	6	14	6	3	29	8	18	8	0	34	103
07:15 AM	2	16	4	4	26	5	10	1	4	20	5	12	8	1	26	9	36	12	2	59	131
07:30 AM	4	20	7	2	33	4	17	0	4	25	12	24	18	1	55	18	46	6	0	70	183
07:45 AM	7	14	2	7	30	6	38	6	3	53	11	29	31	4	75	22	39	5	1	67	225
Total	19	63	14	14	110	16	77	10	14	117	34	79	63	9	185	57	139	31	3	230	642
08:00 AM	14	30	8	3	55	7	39	5	8	59	15	28	45	4	92	20	44	14	6	84	290
08:15 AM	6	30	2	6	44	6	35	4	6	51	11	20	41	3	75	37	51	10	3	101	271
08:30 AM	6	40	9	3	58	13	25	6	7	51	15	27	59	0	101	30	41	7	0	78	288
08:45 AM	8	21	5	5	39	5	34	16	6	61	19	30	65	0	114	30	59	15	2	106	320
Total	34	121	24	17	196	31	133	31	27	222	60	105	210	7	382	117	195	46	11	369	1169
**** BREAK ****																					
04:00 PM	14	43	14	3	74	15	29	8	8	60	12	58	21	2	93	29	61	11	3	104	331
04:15 PM	9	47	11	1	68	9	25	8	4	46	17	48	27	4	96	38	66	19	5	128	338
04:30 PM	12	40	11	3	66	15	38	10	8	71	15	40	26	3	84	45	65	14	6	130	351
04:45 PM	7	30	9	6	52	12	32	7	6	57	14	52	38	0	104	53	68	9	7	137	350
Total	42	160	45	13	260	51	124	33	26	234	58	198	112	9	377	165	260	53	21	499	1370
05:00 PM	12	40	12	8	72	11	36	8	6	61	20	46	35	0	101	48	68	15	4	135	369
05:15 PM	8	38	11	4	61	14	48	10	12	84	14	44	27	5	90	52	76	10	0	138	373
05:30 PM	10	36	16	8	70	21	45	13	3	82	7	45	24	5	81	51	79	23	9	162	395
05:45 PM	17	31	13	2	63	14	64	6	8	92	15	49	22	1	87	48	61	15	5	129	371
Total	47	145	52	22	266	60	193	37	29	319	56	184	108	11	359	199	284	63	18	564	1508
**** BREAK ****																					
Grand Total	142	489	135	66	832	158	527	111	96	892	208	566	493	36	1303	538	878	193	53	1662	4689
Apprch %	17.1	58.8	16.2	7.9		17.7	59.1	12.4	10.8		16	43.4	37.8	2.8		32.4	52.8	11.6	3.2		
Total %	3	10.4	2.9	1.4	17.7	3.4	11.2	2.4	2	19	4.4	12.1	10.5	0.8	27.8	11.5	18.7	4.1	1.1	35.4	
Pass Cars	140	463	133	0	736	154	519	110	0	783	206	536	491	0	1233	532	871	189	0	1592	4344
% Pass Cars	98.6	94.7	98.5	0	88.5	97.5	98.5	99.1	0	87.8	99	94.7	99.6	0	94.6	98.9	99.2	97.9	0	95.8	92.6
Single Units	1	26	1	0	28	3	6	1	0	10	1	29	2	0	32	6	6	4	0	16	86
% Single Units	0.7	5.3	0.7	0	3.4	1.9	1.1	0.9	0	1.1	0.5	5.1	0.4	0	2.5	1.1	0.7	2.1	0	1	1.8
Heavy Trucks	1	0	1	0	2	1	2	0	0	3	1	1	0	0	2	0	1	0	0	1	8
% Heavy Trucks	0.7	0	0.7	0	0.2	0.6	0.4	0	0	0.3	0.5	0.2	0	0	0.2	0	0.1	0	0	0.1	0.2
Peds.	0	0	0	66	66	0	0	0	96	96	0	0	0	36	36	0	0	0	53	53	251
% Peds.	0	0	0	100	7.9	0	0	0	100	10.8	0	0	0	100	2.8	0	0	0	100	3.2	5.4

Comments: 4 hour video traffic study conducted during typical weekday (Wednesday) from 7:00-9:00 AM morning & 4:00-6:00 PM afternoon peak hours, while school was in session. Signalized intersection, ped. signals for all quadrants, no push buttons. Video SCU camera was located within SW intersection quadrant.

Project: Birmingham Traffic Impact Study
Study Type: 4 Hr. Video Turning Movement
Weather: Sunny / Cldy. Dry Temp 30's
Count By: Miovision Video SCU3HT SW

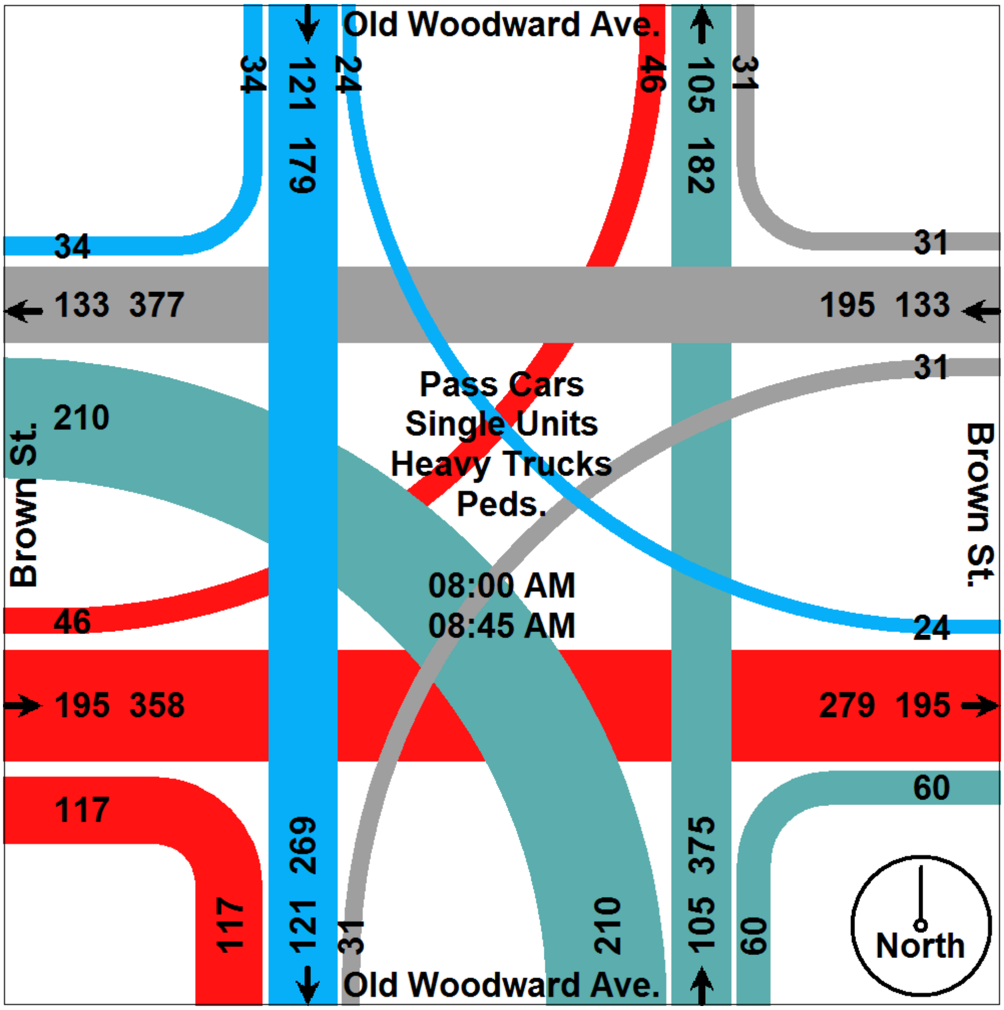
File Name : TMC_1 Brown & OldWoodward_12-6-17
Site Code : TMC_1
Start Date : 12/6/2017
Page No : 2



Project: Birmingham Traffic Impact Study
Study Type: 4 Hr. Video Turning Movement
Weather: Sunny / Cldy. Dry Temp 30's
Count By: Miovision Video SCU3HT SW

File Name : TMC_1 Brown & OldWoodward_12-6-17
Site Code : TMC_1
Start Date : 12/6/2017
Page No : 3

	Old Woodward Ave. Southbound				Brown St. Westbound				Old Woodward Ave. Northbound				Brown St. Eastbound				
Start Time	Rgt	Thru	Left	App. Total	Rgt	Thru	Left	App. Total	Rgt	Thru	Left	App. Total	Rgt	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 12:30 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 08:00 AM																	
08:00 AM	**14**	30	8	52	7	**39**	5	51	15	28	45	88	20	44	14	78	269
08:15 AM	6	30	2	38	6	35	4	45	11	20	41	72	**37**	51	10	98	253
08:30 AM	6	**40**	**9**	**55**	**13**	25	6	44	15	27	59	101	30	41	7	78	278
08:45 AM	8	21	5	34	5	34	**16**	**55**	**19**	**30**	**65**	**114**	30	**59**	**15**	**104**	**307**
Total Volume	34	121	24	179	31	133	31	195	60	105	210	375	117	195	46	358	1107
% App. Total	19	67.6	13.4		15.9	68.2	15.9		16	28	56		32.7	54.5	12.8		
PHF	.607	.756	.667	.814	.596	.853	.484	.886	.789	.875	.808	.822	.791	.826	.767	.861	.901
Pass Cars	33	113	22	168	29	128	31	188	59	96	208	363	116	193	45	354	1073
% Pass Cars	97.1	93.4	91.7	93.9	93.5	96.2	100	96.4	98.3	91.4	99.0	96.8	99.1	99.0	97.8	98.9	96.9
Single Units	1	8	1	10	2	5	0	7	1	9	2	12	1	2	1	4	33
% Single Units	2.9	6.6	4.2	5.6	6.5	3.8	0	3.6	1.7	8.6	1.0	3.2	0.9	1.0	2.2	1.1	3.0
Heavy Trucks	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1
% Heavy Trucks	0	0	4.2	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Peds.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Peds.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Traffic Data Collection, LLC

tdccounts.com

Phone: (586) 786-5407

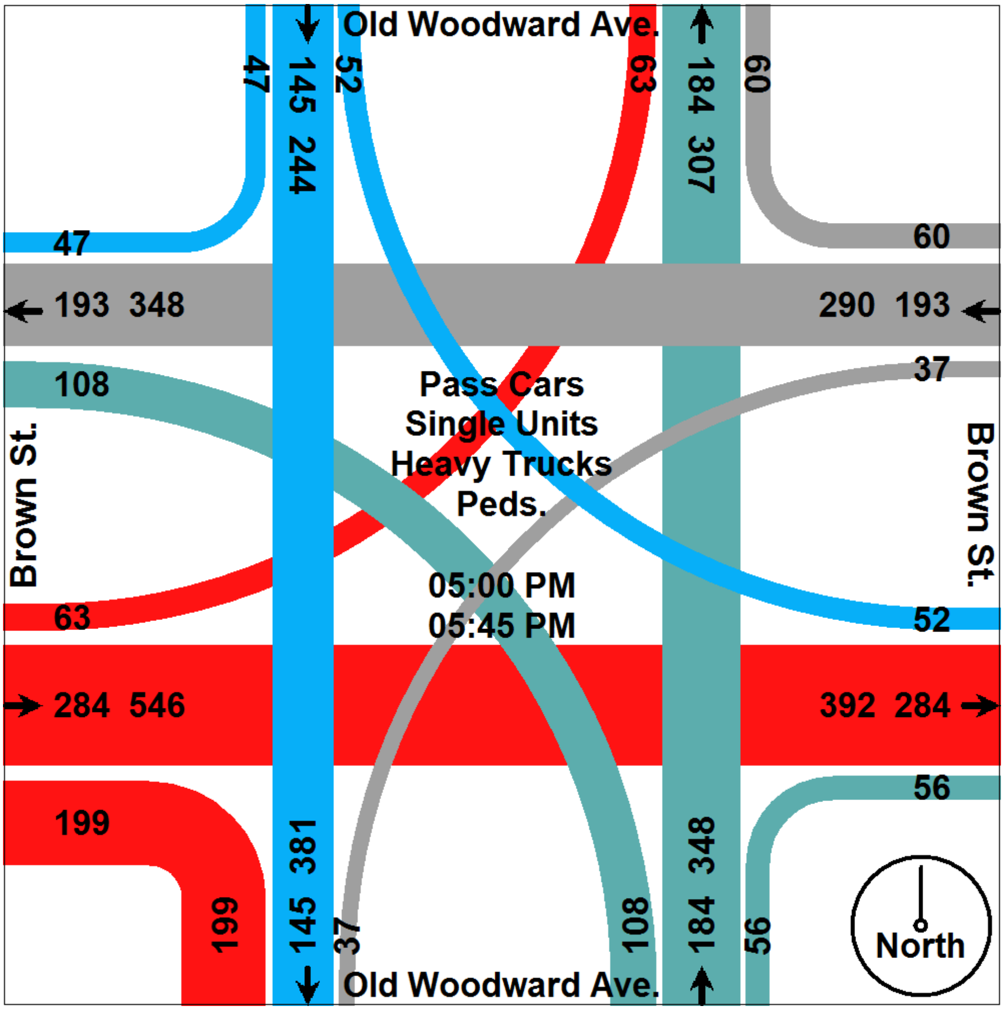
Traffic Study Peformed For:

Bergmann Associates

Project: Birmingham Traffic Impact Study
Study Type: 4 Hr. Video Turning Movement
Weather: Sunny / Cldy. Dry Temp 30's
Count By: Miovision Video SCU3HT SW

File Name : TMC_1 Brown & OldWoodward_12-6-17
Site Code : TMC_1
Start Date : 12/6/2017
Page No : 4

	Old Woodward Ave. Southbound				Brown St. Westbound				Old Woodward Ave. Northbound				Brown St. Eastbound				
Start Time	Rgt	Thru	Left	App. Total	Rgt	Thru	Left	App. Total	Rgt	Thru	Left	App. Total	Rgt	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 12:45 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 05:00 PM																	
05:00 PM	12	**40**	12	**64**	11	36	8	55	**20**	46	**35**	**101**	48	68	15	131	351
05:15 PM	8	38	11	57	14	48	10	72	14	44	27	85	**52**	76	10	138	352
05:30 PM	10	36	**16**	62	**21**	45	**13**	79	7	45	24	76	51	**79**	**23**	**153**	**370**
05:45 PM	**17**	31	13	61	14	**64**	6	**84**	15	**49**	22	86	48	61	15	124	355
Total Volume	47	145	52	244	60	193	37	290	56	184	108	348	199	284	63	546	1428
% App. Total	19.3	59.4	21.3		20.7	66.6	12.8		16.1	52.9	31		36.4	52	11.5		
PHF	.691	.906	.813	.953	.714	.754	.712	.863	.700	.939	.771	.861	.957	.899	.685	.892	.965
Pass Cars	47	139	52	238	60	193	37	290	56	175	108	339	196	283	62	541	1408
% Pass Cars	100	95.9	100	97.5	100	100	100	100	100	95.1	100	97.4	98.5	99.6	98.4	99.1	98.6
Single Units	0	6	0	6	0	0	0	0	0	9	0	9	3	1	1	5	20
% Single Units	0	4.1	0	2.5	0	0	0	0	0	4.9	0	2.6	1.5	0.4	1.6	0.9	1.4
Heavy Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Heavy Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peds.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Peds.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Traffic Data Collection, LLC

tdccounts.com
Phone: (586) 786-5407
Traffic Study Peformed For:

Bergmann Associates

Project: Birmingham Traffic Impact Study
Study Type: 4 Hr. Video Turning Movement
Weather: Sunny / Cldy. Dry Temp 30's
Count By: Miovision Video SCU4PU NE

File Name : TMC_2 Hazel_Frank & OldWoodward_12-6-17
Site Code : TMC_2
Start Date : 12/6/2017
Page No : 1

Groups Printed- Pass Cars - Single Units - Heavy Trucks - Peds.

	Old Woodward Ave. Southbound					Hazel St. Westbound					Old Woodward Ave. Northbound					Frank St. Eastbound					
Start Time	Rgt	Thru	Left	Peds	App. Total	Rgt	Thru	Left	Peds	App. Total	Rgt	Thru	Left	Peds	App. Total	Rgt	Thru	Left	Peds	App. Total	Int. Total
07:00 AM	1	22	2	1	26	1	1	0	1	3	0	14	2	0	16	5	0	4	2	11	56
07:15 AM	1	19	2	0	22	3	1	0	0	4	0	19	2	0	21	2	0	4	0	6	53
07:30 AM	1	28	1	0	30	2	0	0	1	3	2	52	2	0	56	2	0	10	1	13	102
07:45 AM	4	24	2	3	33	4	2	2	4	12	0	73	3	0	76	10	0	2	2	14	135
Total	7	93	7	4	111	10	4	2	6	22	2	158	9	0	169	19	0	20	5	44	346
08:00 AM	5	32	2	2	41	8	1	1	2	12	3	92	22	0	117	7	1	4	0	12	182
08:15 AM	2	50	3	4	59	5	0	5	10	20	0	82	17	0	99	8	0	7	5	20	198
08:30 AM	4	50	3	4	61	13	2	1	1	17	2	98	6	0	106	9	0	3	0	12	196
08:45 AM	6	42	1	1	50	6	2	6	5	19	1	130	12	0	143	6	1	8	1	16	228
Total	17	174	9	11	211	32	5	13	18	68	6	402	57	0	465	30	2	22	6	60	804
**** BREAK ****																					
04:00 PM	10	80	2	1	93	8	1	3	5	17	1	81	13	2	97	16	3	10	5	34	241
04:15 PM	10	70	4	2	86	12	3	3	2	20	1	75	13	1	90	9	1	7	1	18	214
04:30 PM	12	75	5	3	95	10	4	8	6	28	1	51	12	1	65	12	1	7	2	22	210
04:45 PM	12	71	8	1	92	12	2	2	3	19	3	88	12	1	104	23	1	11	1	36	251
Total	44	296	19	7	366	42	10	16	16	84	6	295	50	5	356	60	6	35	9	110	916
05:00 PM	7	84	9	2	102	15	2	4	5	26	2	60	14	2	78	20	0	13	4	37	243
05:15 PM	9	94	3	1	107	13	4	6	4	27	0	63	13	0	76	12	1	8	2	23	233
05:30 PM	5	92	2	7	106	9	11	11	2	33	4	56	16	0	76	13	1	7	5	26	241
05:45 PM	5	69	10	4	88	17	5	7	5	34	2	71	14	0	87	17	0	8	2	27	236
Total	26	339	24	14	403	54	22	28	16	120	8	250	57	2	317	62	2	36	13	113	953
Grand Total	94	902	59	36	1091	138	41	59	56	294	22	1105	173	7	1307	171	10	113	33	327	3019
Apprch %	8.6	82.7	5.4	3.3		46.9	13.9	20.1	19		1.7	84.5	13.2	0.5		52.3	3.1	34.6	10.1		
Total %	3.1	29.9	2	1.2	36.1	4.6	1.4	2	1.9	9.7	0.7	36.6	5.7	0.2	43.3	5.7	0.3	3.7	1.1	10.8	
Pass Cars	91	871	59	0	1021	138	41	58	0	237	22	1075	167	0	1264	169	9	111	0	289	2811
% Pass Cars	96.8	96.6	100	0	93.6	100	100	98.3	0	80.6	100	97.3	96.5	0	96.7	98.8	90	98.2	0	88.4	93.1
Single Units	3	31	0	0	34	0	0	1	0	1	0	30	5	0	35	2	1	2	0	5	75
% Single Units	3.2	3.4	0	0	3.1	0	0	1.7	0	0.3	0	2.7	2.9	0	2.7	1.2	10	1.8	0	1.5	2.5
Heavy Trucks	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1
% Heavy Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0.6	0	0.1	0	0	0	0	0	0
Peds.	0	0	0	36	36	0	0	0	56	56	0	0	0	7	7	0	0	0	33	33	132
% Peds.	0	0	0	100	3.3	0	0	0	100	19	0	0	0	100	0.5	0	0	0	100	10.1	4.4

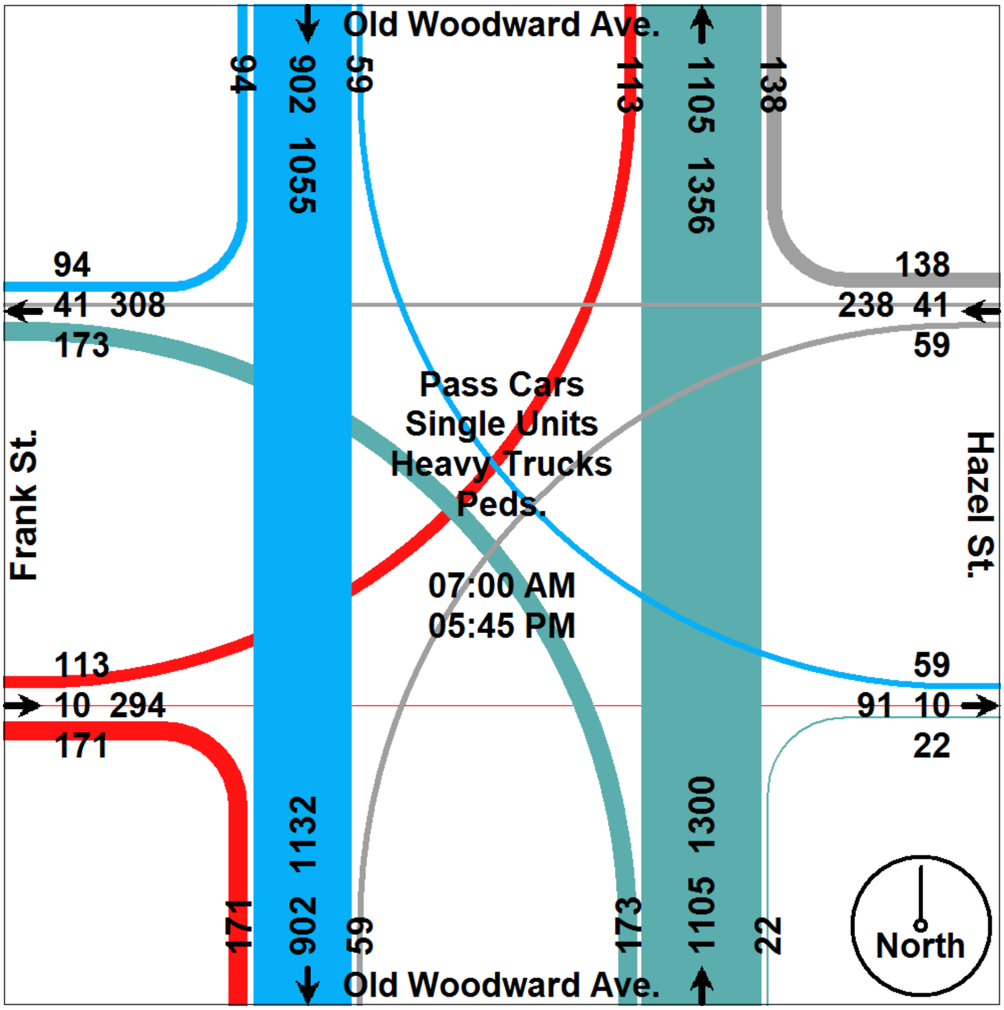
Comments: 4 hour video traffic study conducted during typical weekday (Wednesday) from 7:00-9:00 AM morning & 4:00-6:00 PM afternoon peak hours, while school was in session. Non-signalized intersection. Frank St. & Hazel St. are offset at their intersection with SB Woodward Ave. Video SCU camera was located within NE intersection quadrant.

Traffic Data Collection, LLC
tdccounts.com
Phone: (586) 786-5407

Traffic Study Peformed For:
Bergmann Associates

Project: Birmingham Traffic Impact Study
Study Type: 4 Hr. Video Turning Movement
Weather: Sunny / Cldy. Dry Temp 30's
Count By: Miovision Video SCU4PU NE

File Name : TMC_2 Hazel_Frank & OldWoodward_12-6-17
Site Code : TMC_2
Start Date : 12/6/2017
Page No : 2



Traffic Data Collection, LLC

tdccounts.com

Phone: (586) 786-5407

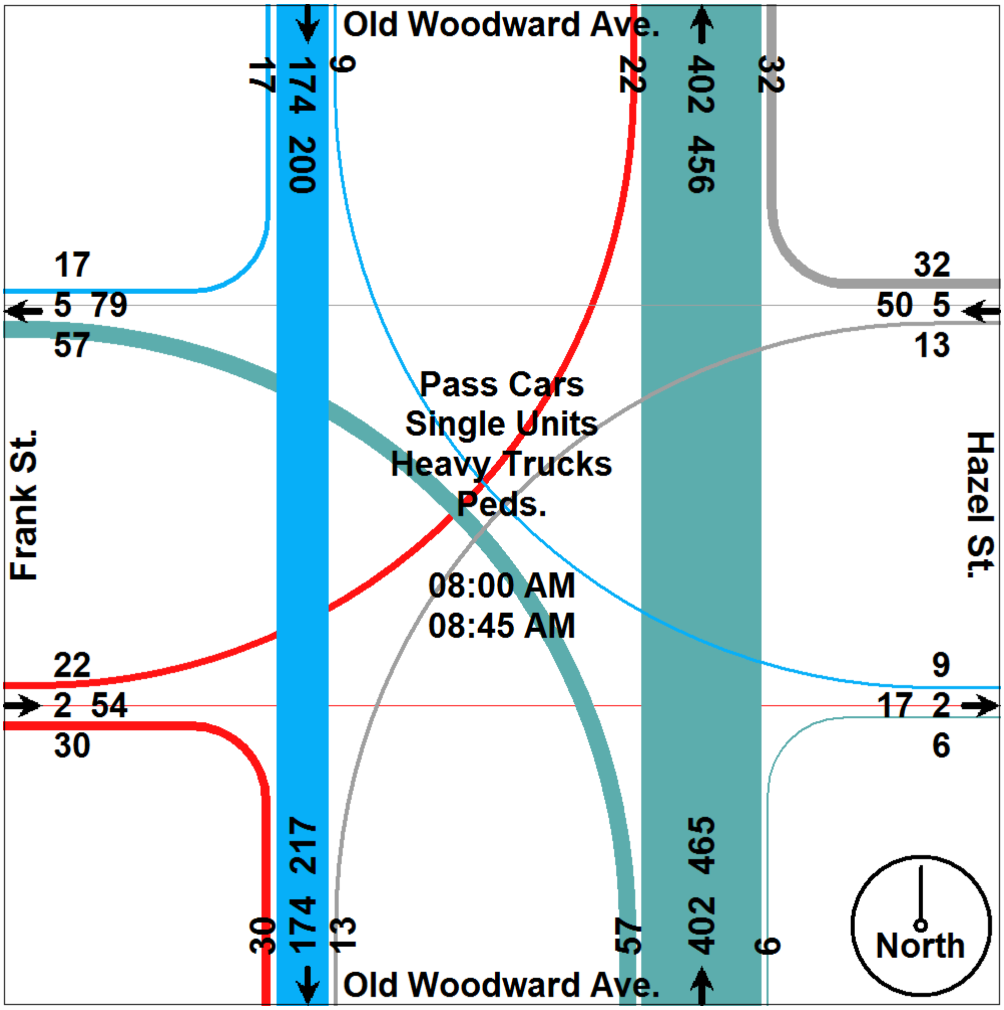
Traffic Study Peformed For:

Bergmann Associates

Project: Birmingham Traffic Impact Study
Study Type: 4 Hr. Video Turning Movement
Weather: Sunny / Cldy. Dry Temp 30's
Count By: Miovision Video SCU4PU NE

File Name : TMC_2 Hazel_Frank & OldWoodward_12-6-17
Site Code : TMC_2
Start Date : 12/6/2017
Page No : 3

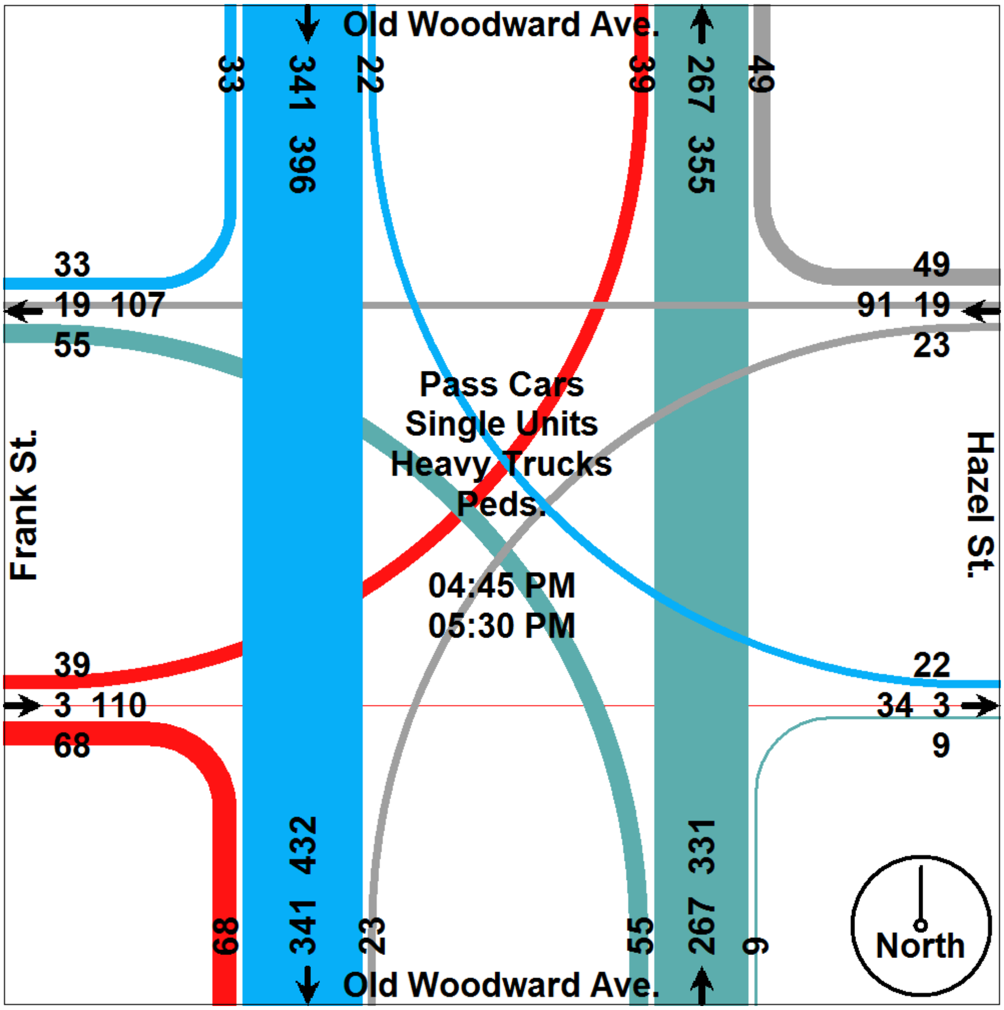
	Old Woodward Ave. Southbound				**Hazel St. Westbound**				**Old Woodward Ave. Northbound**				**Frank St. Eastbound**				
Start Time	Rgt	Thru	Left	App. Total	Rgt	Thru	Left	App. Total	Rgt	Thru	Left	App. Total	Rgt	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 12:30 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 08:00 AM																	
08:00 AM	5	32	2	39	8	1	1	10	**3**	92	**22**	117	7	**1**	4	12	178
08:15 AM	2	**50**	**3**	55	5	0	5	10	0	82	17	99	8	0	7	**15**	179
08:30 AM	4	50	3	**57**	**13**	**2**	1	**16**	2	98	6	106	**9**	0	3	12	191
08:45 AM	**6**	42	1	49	6	2	**6**	14	1	**130**	12	**143**	6	1	**8**	15	**221**
Total Volume	17	174	9	200	32	5	13	50	6	402	57	465	30	2	22	54	769
% App. Total	8.5	87	4.5		64	10	26		1.3	86.5	12.3		55.6	3.7	40.7		
PHF	.708	.870	.750	.877	.615	.625	.542	.781	.500	.773	.648	.813	.833	.500	.688	.900	.870
Pass Cars	17	164	9	190	32	5	12	49	6	391	54	451	30	2	22	54	744
% Pass Cars	100	94.3	100	95.0	100	100	92.3	98.0	100	97.3	94.7	97.0	100	100	100	100	96.7
Single Units	0	10	0	10	0	0	1	1	0	11	2	13	0	0	0	0	24
% Single Units	0	5.7	0	5.0	0	0	7.7	2.0	0	2.7	3.5	2.8	0	0	0	0	3.1
Heavy Trucks	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1
% Heavy Trucks	0	0	0	0	0	0	0	0	0	0	1.8	0.2	0	0	0	0	0.1
Peds.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Peds.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Project: Birmingham Traffic Impact Study
Study Type: 4 Hr. Video Turning Movement
Weather: Sunny / Cldy. Dry Temp 30's
Count By: Miovision Video SCU4PU NE

File Name : TMC_2 Hazel_Frank & OldWoodward_12-6-17
Site Code : TMC_2
Start Date : 12/6/2017
Page No : 4

	Old Woodward Ave. Southbound				Hazel St. Westbound				Old Woodward Ave. Northbound				Frank St. Eastbound				
Start Time	Rgt	Thru	Left	App. Total	Rgt	Thru	Left	App. Total	Rgt	Thru	Left	App. Total	Rgt	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 12:45 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 04:45 PM																	
04:45 PM	**12**	71	8	91	12	2	2	16	3	**88**	12	**103**	**23**	**1**	11	**35**	**245**
05:00 PM	7	84	**9**	100	**15**	2	4	21	2	60	14	76	20	0	**13**	33	230
05:15 PM	9	**94**	3	**106**	13	4	6	23	0	63	13	76	12	1	8	21	226
05:30 PM	5	92	2	99	9	**11**	**11**	**31**	**4**	56	**16**	76	13	1	7	21	227
Total Volume	33	341	22	396	49	19	23	91	9	267	55	331	68	3	39	110	928
% App. Total	8.3	86.1	5.6		53.8	20.9	25.3		2.7	80.7	16.6		61.8	2.7	35.5		
PHF	.688	.907	.611	.934	.817	.432	.523	.734	.563	.759	.859	.803	.739	.750	.750	.786	.947
Pass Cars	31	333	22	386	49	19	23	91	9	260	52	321	68	2	38	108	906
% Pass Cars	93.9	97.7	100	97.5	100	100	100	100	100	97.4	94.5	97.0	100	66.7	97.4	98.2	97.6
Single Units	2	8	0	10	0	0	0	0	0	7	3	10	0	1	1	2	22
% Single Units	6.1	2.3	0	2.5	0	0	0	0	0	2.6	5.5	3.0	0	33.3	2.6	1.8	2.4
Heavy Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Heavy Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peds.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Peds.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Traffic Data Collection, LLC

tdccounts.com

Phone: (586) 786-5407

Traffic Study Peformed For:

Bergmann Associates

Project: Birmingham Traffic Impact Study
Study Type: 4 Hr. Video Turning Movement
Weather: Sunny / Cldy. Dry Temp 30's
Count By: Miovision Video SCU 1TM NE

File Name : TMC_3 Hazel & SBWoodward_12-6-17
Site Code : TMC_3
Start Date : 12/6/2017
Page No : 1

Groups Printed- Pass Cars - Single Units - Heavy Trucks - Peds.

	SB Woodward Ave. (M-1) Southbound				SB Woodward Ave. (M-1) Northbound				Hazel St. Eastbound				
Start Time	Rgt	Thru	Peds	App. Total	Thru	Left	Peds	App. Total	Rgt	Left	Peds	App. Total	Int. Total
07:00 AM	2	392	0	394	0	0	0	0	1	0	0	1	395
07:15 AM	4	561	0	565	0	0	0	0	1	0	0	1	566
07:30 AM	2	562	0	564	0	0	0	0	2	0	0	2	566
07:45 AM	9	568	0	577	0	0	0	0	2	0	0	2	579
Total	17	2083	0	2100	0	0	0	0	6	0	0	6	2106
08:00 AM	11	548	0	559	0	0	0	0	4	0	0	4	563
08:15 AM	11	536	0	547	0	0	0	0	3	0	0	3	550
08:30 AM	15	524	0	539	0	0	0	0	2	0	0	2	541
08:45 AM	13	504	0	517	0	0	0	0	1	0	0	1	518
Total	50	2112	0	2162	0	0	0	0	10	0	0	10	2172
**** BREAK ****													
04:00 PM	12	604	0	616	0	0	0	0	6	0	0	6	622
04:15 PM	18	645	0	663	0	0	0	0	8	0	0	8	671
04:30 PM	20	673	0	693	0	0	0	0	6	0	0	6	699
04:45 PM	18	782	0	800	0	0	0	0	11	0	0	11	811
Total	68	2704	0	2772	0	0	0	0	31	0	0	31	2803
05:00 PM	23	814	0	837	0	0	0	0	9	0	0	9	846
05:15 PM	28	698	0	726	0	0	0	0	6	0	0	6	732
05:30 PM	29	781	0	810	0	0	0	0	5	0	0	5	815
05:45 PM	26	635	1	662	0	0	0	0	9	0	0	9	671
Total	106	2928	1	3035	0	0	0	0	29	0	0	29	3064
Grand Total	241	9827	1	10069	0	0	0	0	76	0	0	76	10145
Apprch %	2.4	97.6	0		0	0	0		100	0	0		
Total %	2.4	96.9	0	99.3	0	0	0	0	0.7	0	0	0.7	
Pass Cars	239	9663	0	9902	0	0	0	0	75	0	0	75	9977
% Pass Cars	99.2	98.3	0	98.3	0	0	0	0	98.7	0	0	98.7	98.3
Single Units	2	115	0	117	0	0	0	0	1	0	0	1	118
% Single Units	0.8	1.2	0	1.2	0	0	0	0	1.3	0	0	1.3	1.2
Heavy Trucks	0	49	0	49	0	0	0	0	0	0	0	0	49
% Heavy Trucks	0	0.5	0	0.5	0	0	0	0	0	0	0	0	0.5
Peds.	0	0	1	1	0	0	0	0	0	0	0	0	1
% Peds.	0	0	100	0	0	0	0	0	0	0	0	0	0

Comments: 4 hour video traffic study conducted during typical weekday (Wednesday) from 7:00-9:00 AM morning & 4:00-6:00 PM afternoon peak hours, while school was in session. Non-signalized "T" intersection. Video SCU camera was located within NE intersection quadrant.

Traffic Data Collection, LLC

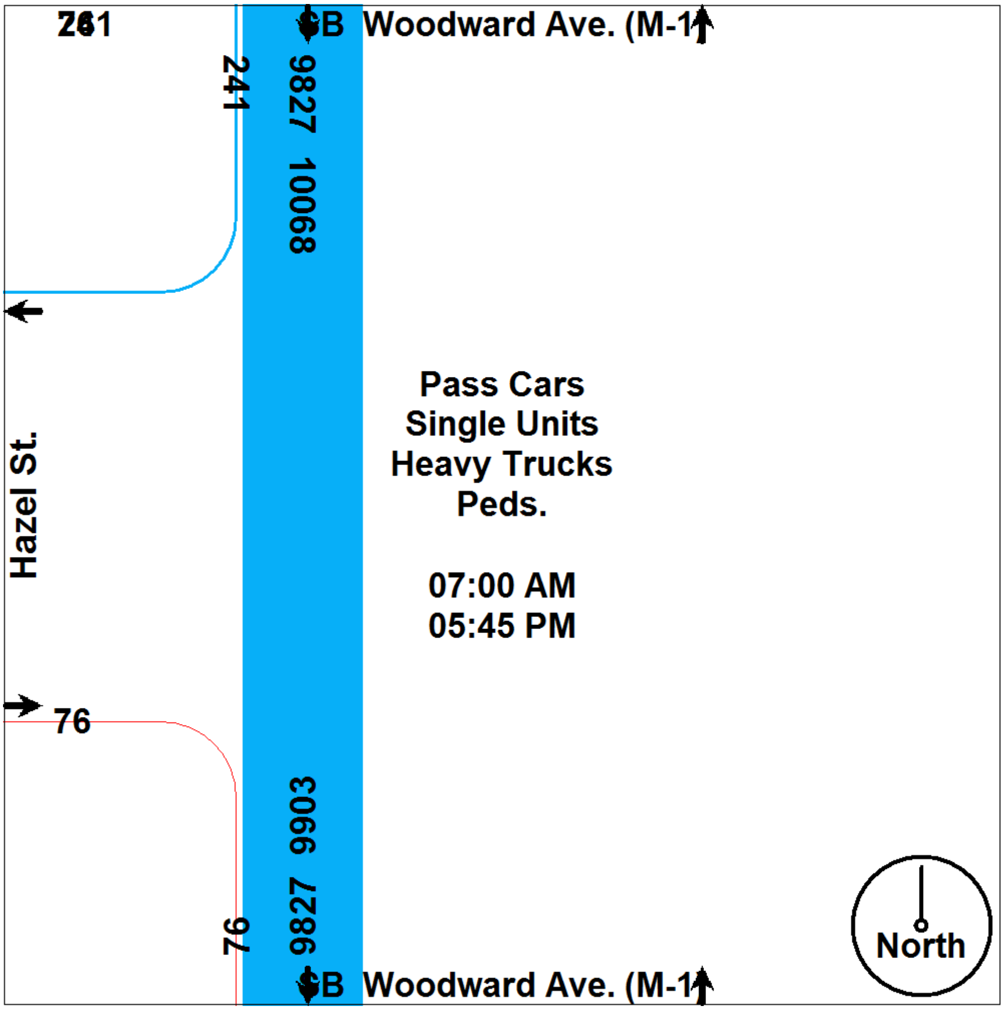
tdccounts.com

Phone: (586) 786-5407

Traffic Study Peformed For:

Bergmann Associates

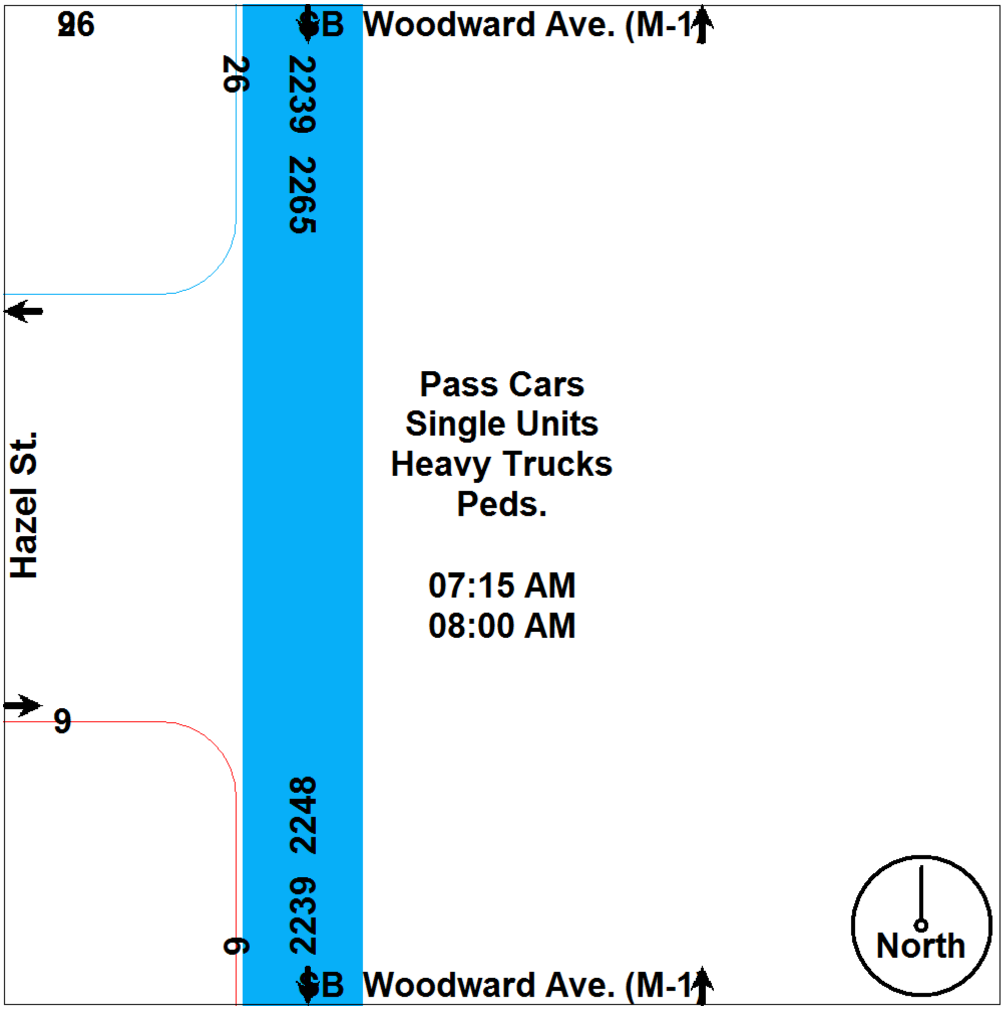
Project: Birmingham Traffic Impact Study	*File Name : TMC_3 Hazel & SBWoodward_12-6-17*
Study Type: 4 Hr. Video Turning Movement	*Site Code : TMC_3*
Weather: Sunny / Cldy. Dry Temp 30's	*Start Date : 12/6/2017*
Count By: Miovision Video SCU 1TM NE	*Page No : 2*



Project: Birmingham Traffic Impact Study
Study Type: 4 Hr. Video Turning Movement
Weather: Sunny / Cldy. Dry Temp 30's
Count By: Miovision Video SCU 1TM NE

File Name : TMC_3 Hazel & SBWoodward_12-6-17
Site Code : TMC_3
Start Date : 12/6/2017
Page No : 3

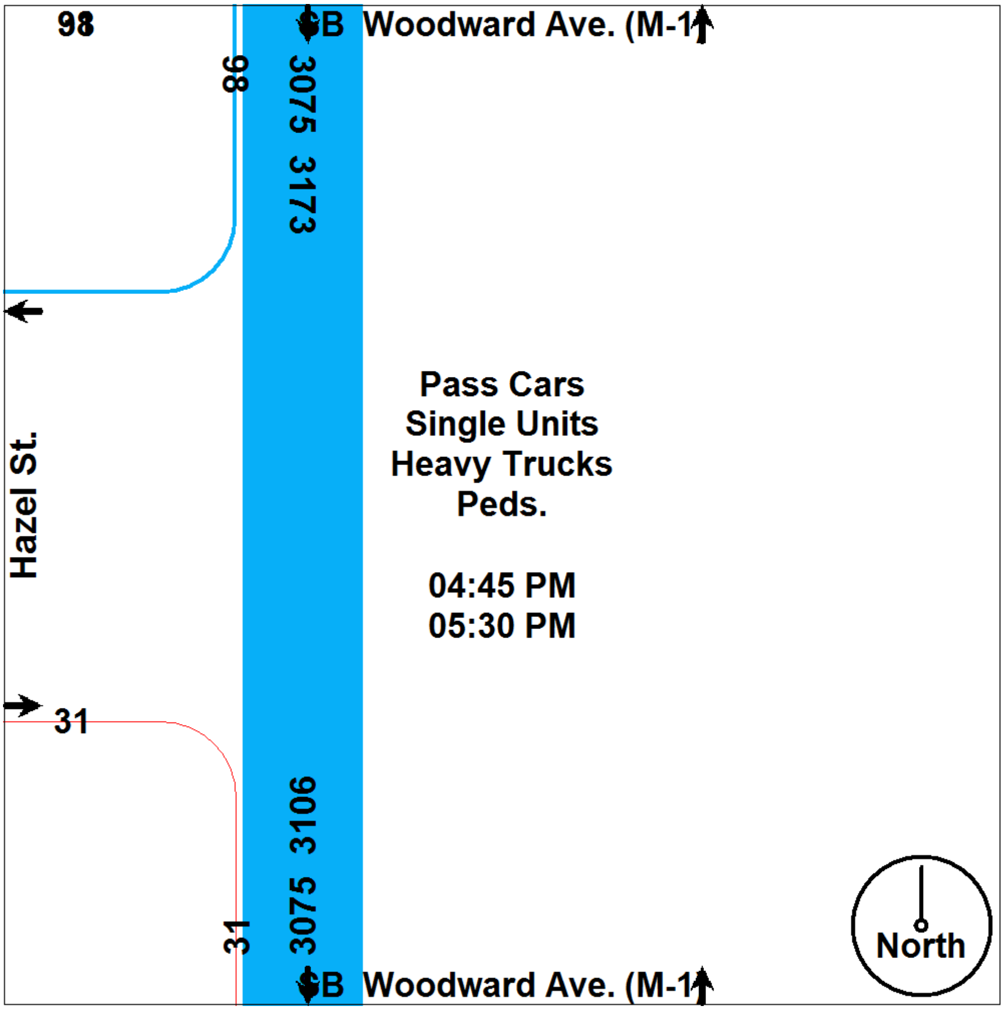
	SB Woodward Ave. (M-1) Southbound			SB Woodward Ave. (M-1) Northbound			Hazel St. Eastbound			
Start Time	Rgt	Thru	App. Total	Thru	Left	App. Total	Rgt	Left	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 12:30 PM - Peak 1 of 1										
Peak Hour for Entire Intersection Begins at 07:15 AM										
07:15 AM	4	561	565	0	0	0	1	0	1	566
07:30 AM	2	562	564	0	0	0	2	0	2	566
07:45 AM	9	**568**	**577**	0	0	0	2	0	2	**579**
08:00 AM	**11**	548	559	0	0	0	**4**	0	**4**	563
Total Volume	26	2239	2265	0	0	0	9	0	9	2274
% App. Total	1.1	98.9		0	0		100	0		
PHF	.591	.985	.981	.000	.000	.000	.563	.000	.563	.982
Pass Cars	25	2193	2218	0	0	0	9	0	9	2227
% Pass Cars	96.2	97.9	97.9	0	0	0	100	0	100	97.9
Single Units	1	24	25	0	0	0	0	0	0	25
% Single Units	3.8	1.1	1.1	0	0	0	0	0	0	1.1
Heavy Trucks	0	22	22	0	0	0	0	0	0	22
% Heavy Trucks	0	1.0	1.0	0	0	0	0	0	0	1.0
Peds.	0	0	0	0	0	0	0	0	0	0
% Peds.	0	0	0	0	0	0	0	0	0	0



Project: Birmingham Traffic Impact Study
Study Type: 4 Hr. Video Turning Movement
Weather: Sunny / Cldy. Dry Temp 30's
Count By: Miovision Video SCU 1TM NE

File Name : TMC_3 Hazel & SBWoodward_12-6-17
Site Code : TMC_3
Start Date : 12/6/2017
Page No : 4

	SB Woodward Ave. (M-1) Southbound			SB Woodward Ave. (M-1) Northbound			Hazel St. Eastbound			
Start Time	Rgt	Thru	App. Total	Thru	Left	App. Total	Rgt	Left	App. Total	Int. Total
Peak Hour Analysis From 12:45 PM to 05:45 PM - Peak 1 of 1										
Peak Hour for Entire Intersection Begins at 04:45 PM										
04:45 PM	18	782	800	0	0	0	**11**	0	**11**	811
05:00 PM	23	**814**	**837**	0	0	0	9	0	9	**846**
05:15 PM	28	698	726	0	0	0	6	0	6	732
05:30 PM	**29**	781	810	0	0	0	5	0	5	815
Total Volume	98	3075	3173	0	0	0	31	0	31	3204
% App. Total	3.1	96.9		0	0		100	0		
PHF	.845	.944	.948	.000	.000	.000	.705	.000	.705	.947
Pass Cars	98	3050	3148	0	0	0	30	0	30	3178
% Pass Cars	100	99.2	99.2	0	0	0	96.8	0	96.8	99.2
Single Units	0	21	21	0	0	0	1	0	1	22
% Single Units	0	0.7	0.7	0	0	0	3.2	0	3.2	0.7
Heavy Trucks	0	4	4	0	0	0	0	0	0	4
% Heavy Trucks	0	0.1	0.1	0	0	0	0	0	0	0.1
Peds.	0	0	0	0	0	0	0	0	0	0
% Peds.	0	0	0	0	0	0	0	0	0	0



Traffic Data Collection, LLC

tdccounts.com

Phone: (586) 786-5407

Traffic Study Peformed For:

Bergmann Associates

Project: Birmingham Traffic Impact Study
Study Type: 4 Hr. Video Turning Movement
Weather: Sunny / Cldy. Dry Temp 30's
Count By: Miovision Video SCU 4G2 SW

File Name : TMC_4 Bowers & OldWoodward_12-6-17
Site Code : TMC_4
Start Date : 12/6/2017
Page No : 1

Groups Printed- Pass Cars - Single Units - Heavy Trucks - Peds.

	Old Woodward Ave. Southbound				Bowers St. Westbound				Old Woodward Ave. Northbound				
Start Time	Thru	Left	Peds	App. Total	Rgt	Left	Peds	App. Total	Rgt	Thru	Peds	App. Total	Int. Total
07:00 AM	21	6	0	27	4	5	1	10	2	15	0	17	54
07:15 AM	14	9	0	23	5	5	0	10	4	16	0	20	53
07:30 AM	19	12	0	31	12	6	7	25	4	40	0	44	100
07:45 AM	19	13	0	32	16	7	3	26	5	62	0	67	125
Total	73	40	0	113	37	23	11	71	15	133	0	148	332
08:00 AM	32	10	0	42	38	1	0	39	1	76	0	77	158
08:15 AM	44	21	4	69	18	9	9	36	4	83	0	87	192
08:30 AM	32	26	0	58	18	5	0	23	0	95	0	95	176
08:45 AM	36	19	0	55	24	5	4	33	5	127	0	132	220
Total	144	76	4	224	98	20	13	131	10	381	0	391	746
**** BREAK ****													
04:00 PM	65	35	1	101	30	9	2	41	2	67	5	74	216
04:15 PM	63	20	1	84	23	13	3	39	3	64	0	67	190
04:30 PM	70	20	5	95	21	19	17	57	11	46	2	59	211
04:45 PM	69	23	3	95	27	20	10	57	7	87	4	98	250
Total	267	98	10	375	101	61	32	194	23	264	11	298	867
05:00 PM	82	30	4	116	22	19	7	48	6	56	0	62	226
05:15 PM	88	23	2	113	28	23	4	55	4	53	0	57	225
05:30 PM	83	31	1	115	31	19	5	55	10	45	1	56	226
05:45 PM	64	24	2	90	37	26	8	71	9	55	1	65	226
Total	317	108	9	434	118	87	24	229	29	209	2	240	903
**** BREAK ****													
Grand Total	801	322	23	1146	354	191	80	625	77	987	13	1077	2848
Apprch %	69.9	28.1	2		56.6	30.6	12.8		7.1	91.6	1.2		
Total %	28.1	11.3	0.8	40.2	12.4	6.7	2.8	21.9	2.7	34.7	0.5	37.8	
Pass Cars	792	301	0	1093	327	191	0	518	76	978	0	1054	2665
% Pass Cars	98.9	93.5	0	95.4	92.4	100	0	82.9	98.7	99.1	0	97.9	93.6
Single Units	9	21	0	30	27	0	0	27	1	8	0	9	66
% Single Units	1.1	6.5	0	2.6	7.6	0	0	4.3	1.3	0.8	0	0.8	2.3
Heavy Trucks	0	0	0	0	0	0	0	0	0	1	0	1	1
% Heavy Trucks	0	0	0	0	0	0	0	0	0	0.1	0	0.1	0
Peds.	0	0	23	23	0	0	80	80	0	0	13	13	116
% Peds.	0	0	100	2	0	0	100	12.8	0	0	100	1.2	4.1

Comments: 4 hour video traffic study conducted during typical weekday (Wednesday) from 7:00-9:00 AM morning & 4:00-6:00 PM afternoon peak hours, while school was in session. Non-signalized "T" intersection. Video SCU camera was located within SW intersection quadrant.

Traffic Data Collection, LLC

tdccounts.com

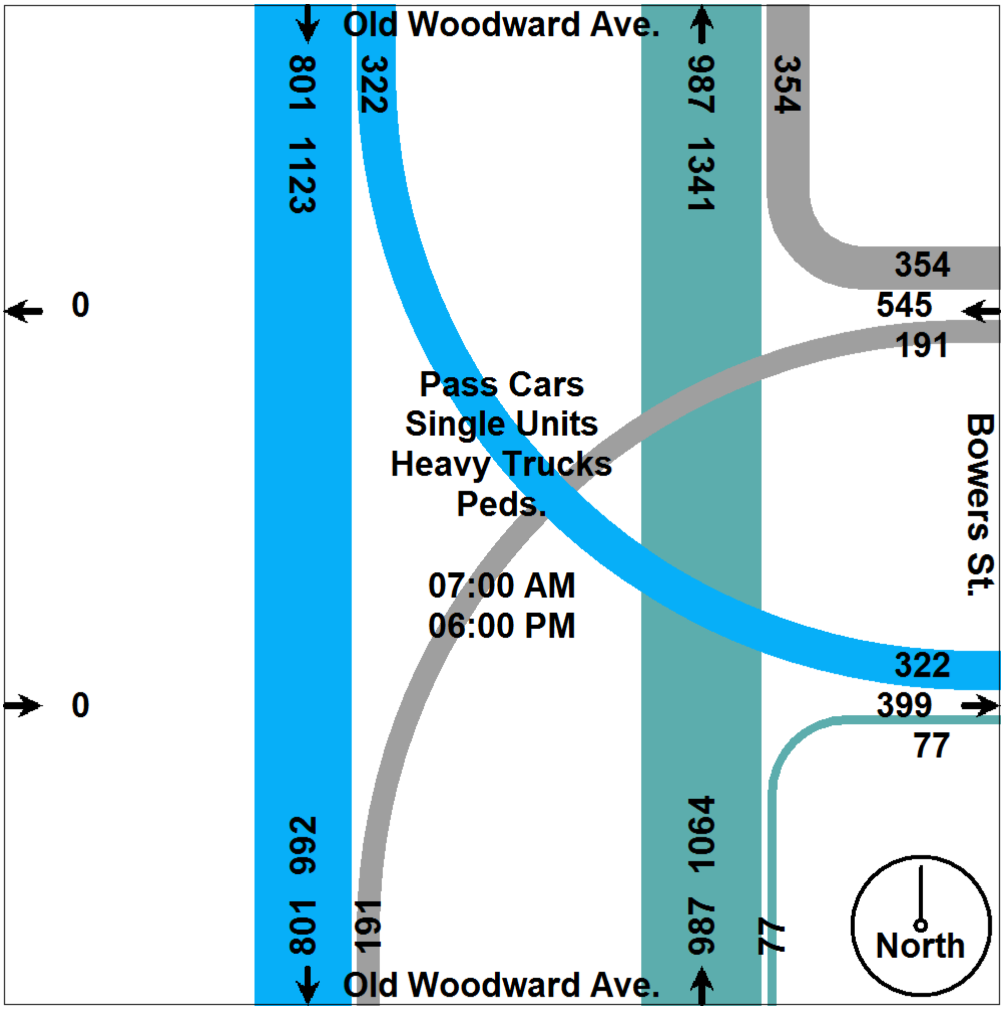
Phone: (586) 786-5407

Traffic Study Peformed For:

Bergmann Associates

Project: Birmingham Traffic Impact Study
Study Type: 4 Hr. Video Turning Movement
Weather: Sunny / Cldy. Dry Temp 30's
Count By: Miovision Video SCU 4G2 SW

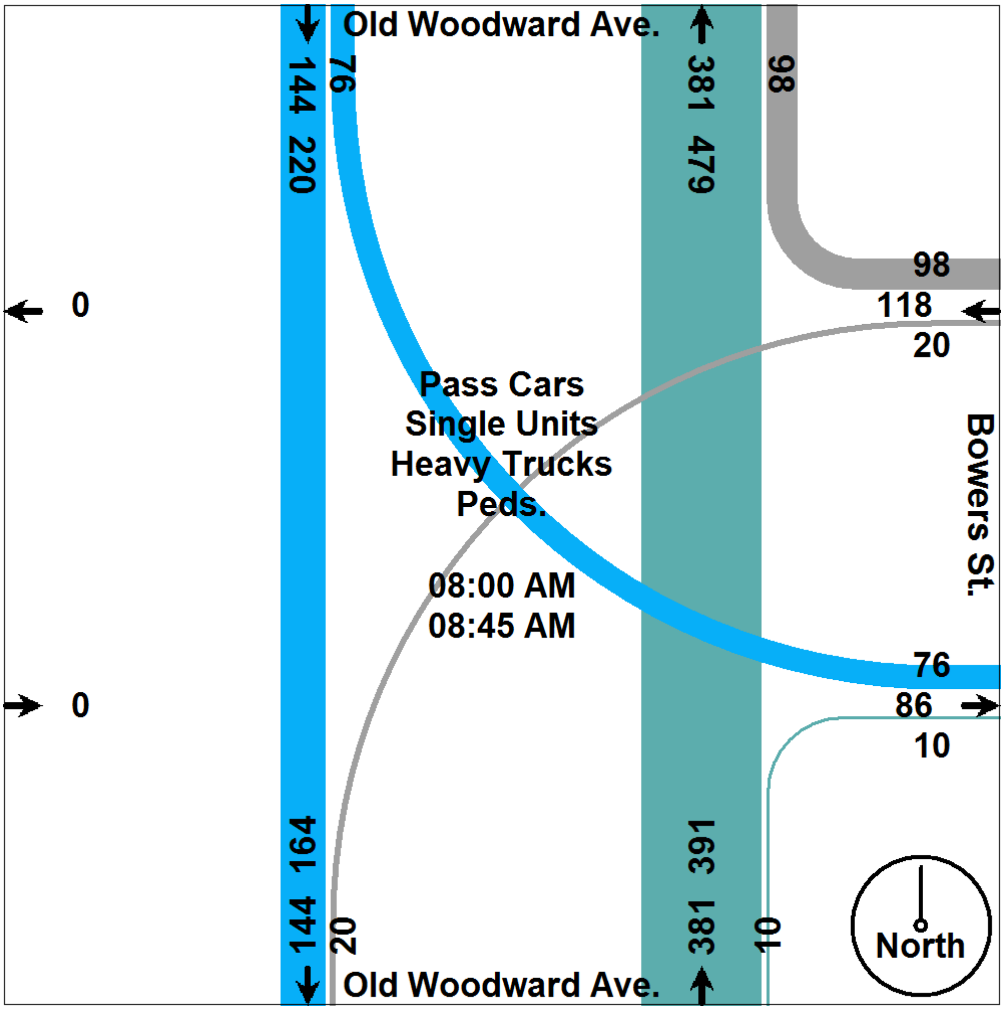
File Name : TMC_4 Bowers & OldWoodward_12-6-17
Site Code : TMC_4
Start Date : 12/6/2017
Page No : 2



Project: Birmingham Traffic Impact Study
Study Type: 4 Hr. Video Turning Movement
Weather: Sunny / Cldy. Dry Temp 30's
Count By: Miovision Video SCU 4G2 SW

File Name : TMC_4 Bowers & OldWoodward_12-6-17
Site Code : TMC_4
Start Date : 12/6/2017
Page No : 3

	Old Woodward Ave. **Southbound**			**Bowers St.** **Westbound**			**Old Woodward Ave.** **Northbound**			
Start Time	Thru	Left	App. Total	Rgt	Left	App. Total	Rgt	Thru	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 12:30 PM - Peak 1 of 1										
Peak Hour for Entire Intersection Begins at 08:00 AM										
08:00 AM	32	10	42	**38**	1	**39**	1	76	77	158
08:15 AM	**44**	21	**65**	18	**9**	27	4	83	87	179
08:30 AM	32	**26**	58	18	5	23	0	95	95	176
08:45 AM	36	19	55	24	5	29	**5**	**127**	**132**	**216**
Total Volume	144	76	220	98	20	118	10	381	391	729
% App. Total	65.5	34.5		83.1	16.9		2.6	97.4		
PHF	.818	.731	.846	.645	.556	.756	.500	.750	.741	.844
Pass Cars	140	71	211	90	20	110	10	375	385	706
% Pass Cars	97.2	93.4	95.9	91.8	100	93.2	100	98.4	98.5	96.8
Single Units	4	5	9	8	0	8	0	5	5	22
% Single Units	2.8	6.6	4.1	8.2	0	6.8	0	1.3	1.3	3.0
Heavy Trucks	0	0	0	0	0	0	0	1	1	1
% Heavy Trucks	0	0	0	0	0	0	0	0.3	0.3	0.1
Peds.	0	0	0	0	0	0	0	0	0	0
% Peds.	0	0	0	0	0	0	0	0	0	0



Traffic Data Collection, LLC

tdccounts.com

Phone: (586) 786-5407

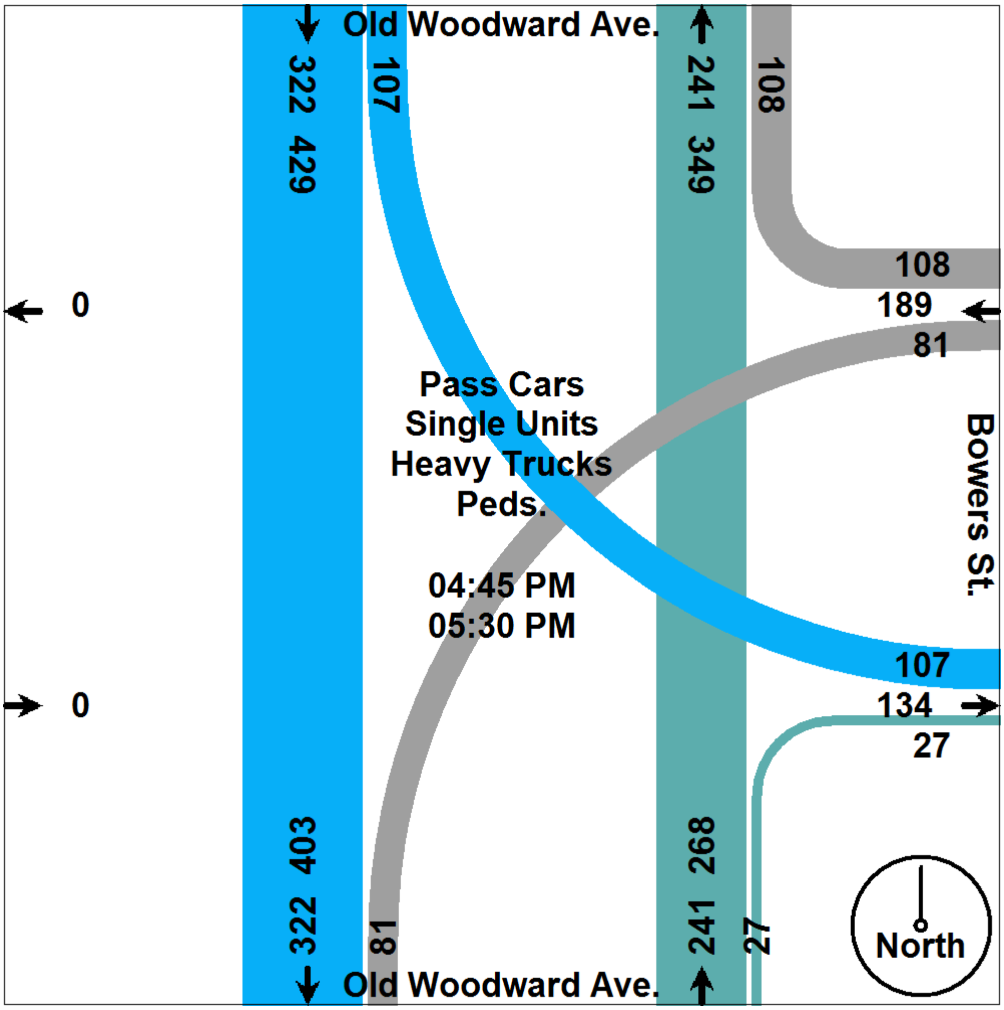
Traffic Study Peformed For:

Bergmann Associates

Project: Birmingham Traffic Impact Study
Study Type: 4 Hr. Video Turning Movement
Weather: Sunny / Cldy. Dry Temp 30's
Count By: Miovision Video SCU 4G2 SW

File Name : TMC_4 Bowers & OldWoodward_12-6-17
Site Code : TMC_4
Start Date : 12/6/2017
Page No : 4

	Old Woodward Ave. Southbound			Bowers St. Westbound			Old Woodward Ave. Northbound			
Start Time	Thru	Left	App. Total	Rgt	Left	App. Total	Rgt	Thru	App. Total	Int. Total
Peak Hour Analysis From 12:45 PM to 05:45 PM - Peak 1 of 1										
Peak Hour for Entire Intersection Begins at 04:45 PM										
04:45 PM	69	23	92	27	20	47	7	**87**	**94**	**233**
05:00 PM	82	30	112	22	19	41	6	56	62	215
05:15 PM	**88**	23	111	28	**23**	**51**	4	53	57	219
05:30 PM	83	**31**	**114**	**31**	19	50	**10**	45	55	219
Total Volume	322	107	429	108	81	189	27	241	268	886
% App. Total	75.1	24.9		57.1	42.9		10.1	89.9		
PHF	.915	.863	.941	.871	.880	.926	.675	.693	.713	.951
Pass Cars	321	101	422	97	81	178	26	241	267	867
% Pass Cars	99.7	94.4	98.4	89.8	100	94.2	96.3	100	99.6	97.9
Single Units	1	6	7	11	0	11	1	0	1	19
% Single Units	0.3	5.6	1.6	10.2	0	5.8	3.7	0	0.4	2.1
Heavy Trucks	0	0	0	0	0	0	0	0	0	0
% Heavy Trucks	0	0	0	0	0	0	0	0	0	0
Peds.	0	0	0	0	0	0	0	0	0	0
% Peds.	0	0	0	0	0	0	0	0	0	0



Traffic Data Collection, LLC

tdccounts.com

Phone: (586) 786-5407

Traffic Study Peformed For:

Bergmann Associates

Project: Birmingham Traffic Impact Study
Study Type: 4 Hr. Video Turning Movement
Weather: Sunny / Cldy. Dry Temp 30's
Count By: Miovision Video SCU 3FY SE

File Name : TMC_5 Bowers & SBWoodward_12-6-17
Site Code : TMC_5
Start Date : 12/6/2017
Page No : 1

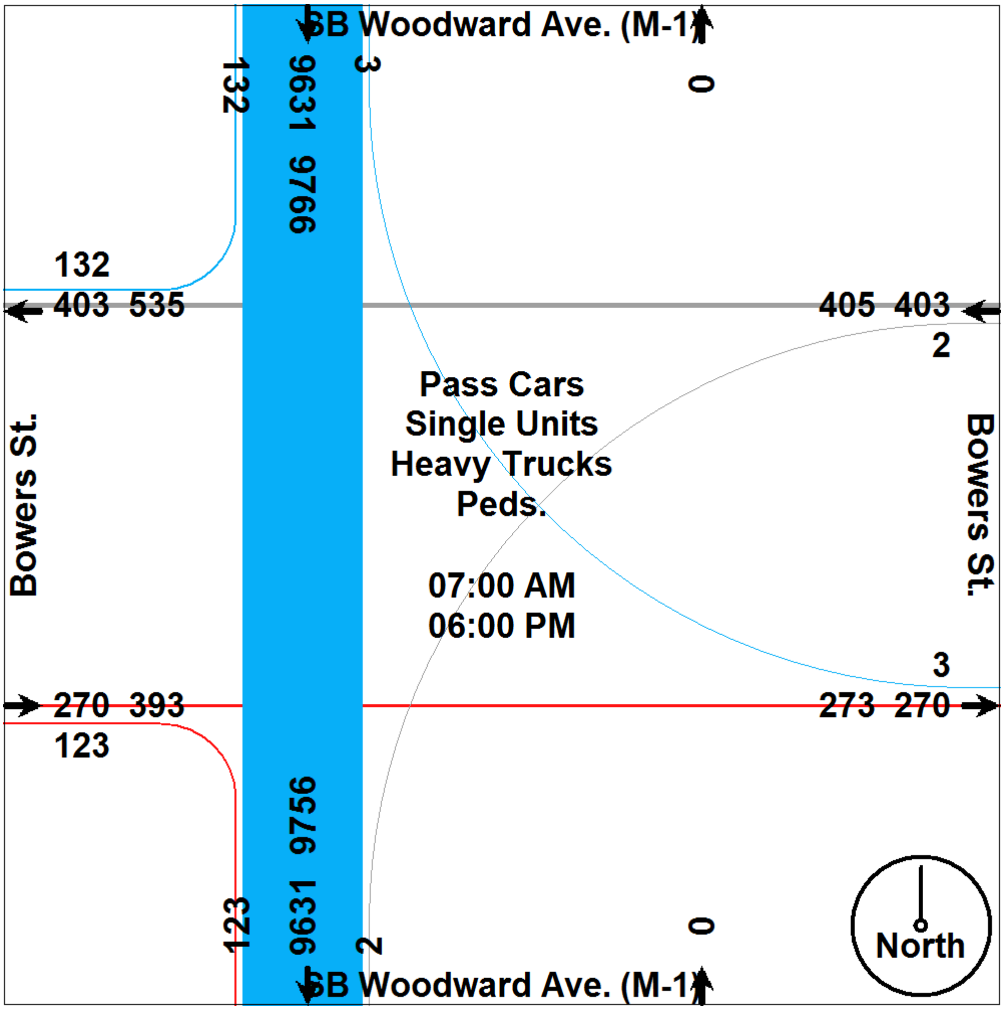
Groups Printed- Pass Cars - Single Units - Heavy Trucks - Peds.

	SB Woodward Ave. (M-1) Southbound					Bowers St. Westbound					SB Woodward Ave. (M-1) Northbound					Bowers St. Eastbound					
Start Time	Rgt	Thru	Left	Peds	App. Total	Rgt	Thru	Left	Peds	App. Total	Rgt	Thru	Left	Peds	App. Total	Rgt	Thru	Left	Peds	App. Total	Int. Total
07:00 AM	3	389	0	0	392	0	7	0	0	7	0	0	0	0	0	6	2	0	0	8	407
07:15 AM	3	553	0	0	556	0	10	0	0	10	0	0	0	0	0	6	7	0	0	13	579
07:30 AM	2	561	0	0	563	0	16	0	0	16	0	0	0	0	0	7	9	0	0	16	595
07:45 AM	2	571	0	0	573	0	23	0	0	23	0	0	0	0	0	4	12	0	0	16	612
Total	10	2074	0	0	2084	0	56	0	0	56	0	0	0	0	0	23	30	0	0	53	2193
08:00 AM	4	551	0	0	555	0	32	0	0	32	0	0	0	0	0	3	7	0	1	11	598
08:15 AM	5	522	0	2	529	0	24	0	0	24	0	0	0	0	0	2	21	0	0	23	576
08:30 AM	8	513	0	0	521	0	19	0	0	19	0	0	0	0	0	7	18	0	1	26	566
08:45 AM	9	501	0	0	510	0	24	0	0	24	0	0	0	0	0	4	13	0	0	17	551
Total	26	2087	0	2	2115	0	99	0	0	99	0	0	0	0	0	16	59	0	2	77	2291
**** BREAK ****																					
04:00 PM	9	587	0	1	597	0	29	0	0	29	0	0	0	0	0	14	26	0	1	41	667
04:15 PM	2	645	0	1	648	0	31	0	0	31	0	0	0	1	1	4	18	0	0	22	702
04:30 PM	7	661	0	2	670	0	28	1	0	29	0	0	0	0	0	8	18	0	0	26	725
04:45 PM	17	771	0	0	788	0	29	0	0	29	0	0	0	0	0	8	22	0	0	30	847
Total	35	2664	0	4	2703	0	117	1	0	118	0	0	0	1	1	34	84	0	1	119	2941
05:00 PM	15	785	1	0	801	0	23	0	0	23	0	0	0	0	0	16	24	0	0	40	864
05:15 PM	17	664	0	1	682	0	35	0	0	35	0	0	0	0	0	11	16	0	0	27	744
05:30 PM	11	756	0	0	767	0	33	1	0	34	0	0	0	0	0	12	30	0	0	42	843
05:45 PM	18	601	2	1	622	0	39	0	0	39	0	0	0	0	0	11	27	0	1	39	700
Total	61	2806	3	2	2872	0	130	1	0	131	0	0	0	0	0	50	97	0	1	148	3151
06:00 PM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Grand Total	132	9631	3	8	9774	0	403	2	0	405	0	0	0	1	1	123	270	0	4	397	10577
Apprch %	1.4	98.5	0	0.1		0	99.5	0.5	0		0	0	0	100		31	68	0	1		
Total %	1.2	91.1	0	0.1	92.4	0	3.8	0	0	3.8	0	0	0	0	0	1.2	2.6	0	0	3.8	
Pass Cars	128	9495	3	0	9626	0	380	2	0	382	0	0	0	0	0	106	268	0	0	374	10382
% Pass Cars	97	98.6	100	0	98.5	0	94.3	100	0	94.3	0	0	0	0	0	86.2	99.3	0	0	94.2	98.2
Single Units	4	95	0	0	99	0	22	0	0	22	0	0	0	0	0	17	2	0	0	19	140
% Single Units	3	1	0	0	1	0	5.5	0	0	5.4	0	0	0	0	0	13.8	0.7	0	0	4.8	1.3
Heavy Trucks	0	41	0	0	41	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	42
% Heavy Trucks	0	0.4	0	0	0.4	0	0.2	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0.4
Peds.	0	0	0	8	8	0	0	0	0	0	0	0	0	1	1	0	0	0	4	4	13
% Peds.	0	0	0	100	0.1	0	0	0	0	0	0	0	0	100	100	0	0	0	100	1	0.1

Comments: 4 hour video traffic study conducted during typical weekday (Wednesday) from 7:00-9:00 AM morning & 4:00-6:00 PM afternoon peak hours, while school was in session. Signalized intersection, ped. signals for north & west legs, no push buttons. Restriction for EB Turn Right Only. Video SCU camera was located within SW intersection quadrant.

Project: Birmingham Traffic Impact Study
Study Type: 4 Hr. Video Turning Movement
Weather: Sunny / Cldy. Dry Temp 30's
Count By: Miovision Video SCU 3FY SE

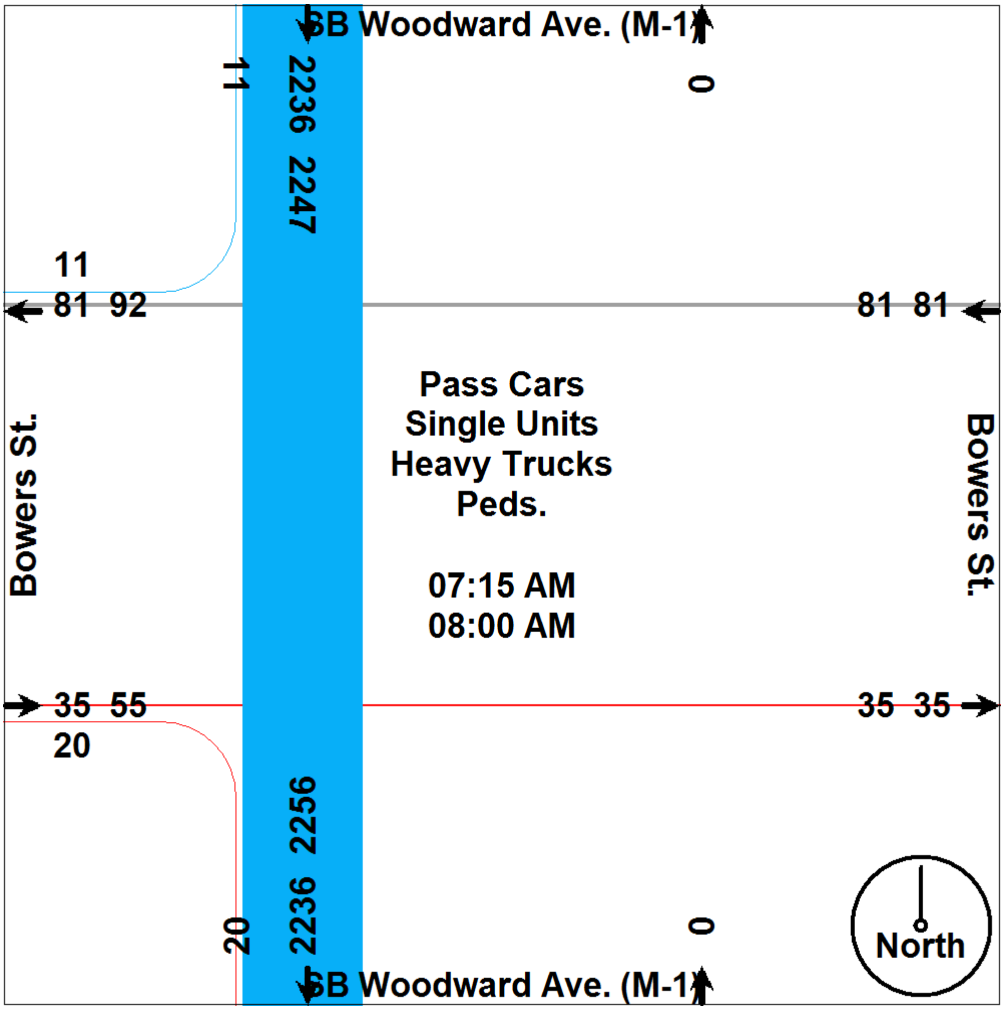
File Name : TMC_5 Bowers & SBWoodward_12-6-17
Site Code : TMC_5
Start Date : 12/6/2017
Page No : 2



Project: Birmingham Traffic Impact Study
Study Type: 4 Hr. Video Turning Movement
Weather: Sunny / Cldy. Dry Temp 30's
Count By: Miovision Video SCU 3FY SE

File Name : TMC_5 Bowers & SBWoodward_12-6-17
Site Code : TMC_5
Start Date : 12/6/2017
Page No : 3

	SB Woodward Ave. (M-1) Southbound				Bowers St. Westbound				SB Woodward Ave. (M-1) Northbound				Bowers St. Eastbound				
Start Time	Rgt	Thru	Left	App. Total	Rgt	Thru	Left	App. Total	Rgt	Thru	Left	App. Total	Rgt	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 12:30 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 07:15 AM																	
07:15 AM	3	553	0	556	0	10	0	10	0	0	0	0	6	7	0	13	579
07:30 AM	2	561	0	563	0	16	0	16	0	0	0	0	**7**	9	0	**16**	595
07:45 AM	2	**571**	0	**573**	0	23	0	23	0	0	0	0	4	**12**	0	16	**612**
08:00 AM	**4**	551	0	555	0	**32**	0	**32**	0	0	0	0	3	7	0	10	597
Total Volume	11	2236	0	2247	0	81	0	81	0	0	0	0	20	35	0	55	2383
% App. Total	0.5	99.5	0		0	100	0		0	0	0		36.4	63.6	0		
PHF	.688	.979	.000	.980	.000	.633	.000	.633	.000	.000	.000	.000	.714	.729	.000	.859	.973
Pass Cars	11	2202	0	2213	0	74	0	74	0	0	0	0	15	35	0	50	2337
% Pass Cars	100	98.5	0	98.5	0	91.4	0	91.4	0	0	0	0	75.0	100	0	90.9	98.1
Single Units	0	20	0	20	0	6	0	6	0	0	0	0	5	0	0	5	31
% Single Units	0	0.9	0	0.9	0	7.4	0	7.4	0	0	0	0	25.0	0	0	9.1	1.3
Heavy Trucks	0	14	0	14	0	1	0	1	0	0	0	0	0	0	0	0	15
% Heavy Trucks	0	0.6	0	0.6	0	1.2	0	1.2	0	0	0	0	0	0	0	0	0.6
Peds.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Peds.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

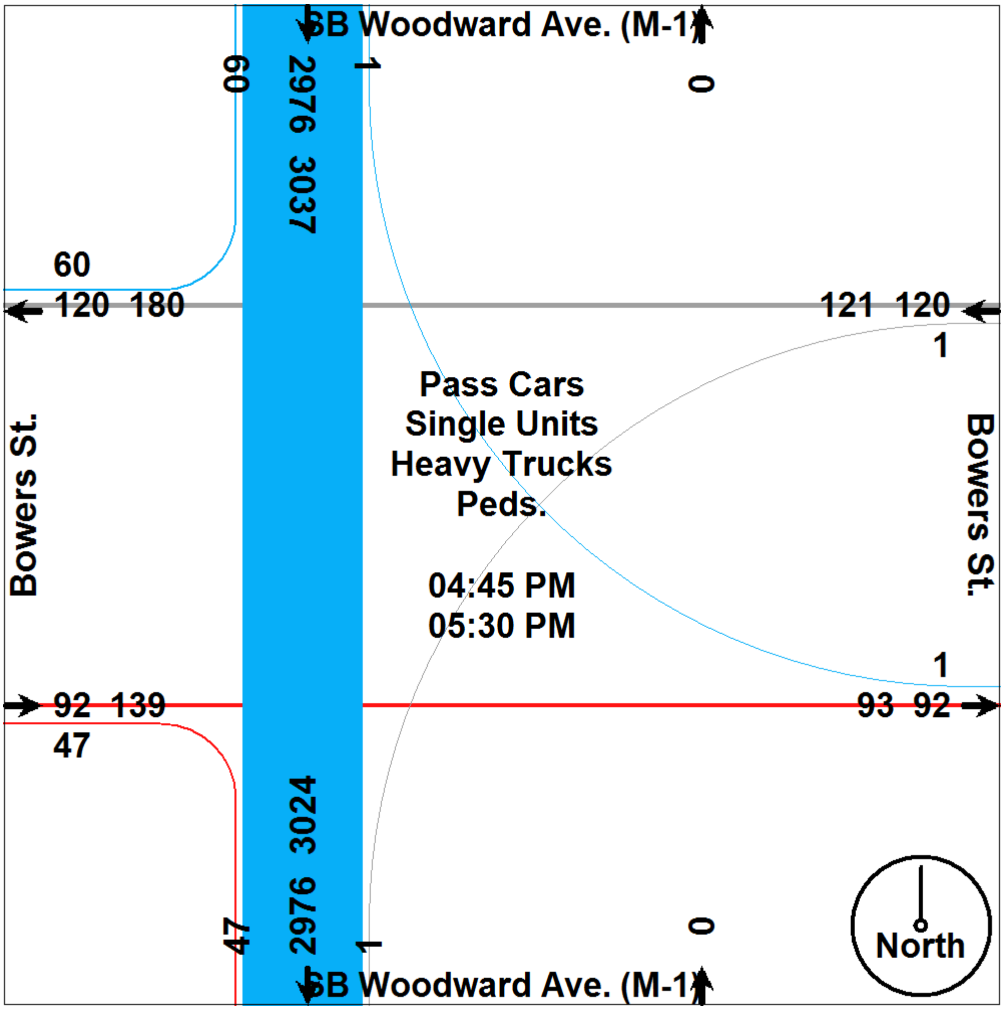


Traffic Data Collection, LLC
tdccounts.com
Phone: (586) 786-5407
Traffic Study Peformed For:
Bergmann Associates

Project: Birmingham Traffic Impact Study
Study Type: 4 Hr. Video Turning Movement
Weather: Sunny / Cldy. Dry Temp 30's
Count By: Miovision Video SCU 3FY SE

File Name : TMC_5 Bowers & SBWoodward_12-6-17
Site Code : TMC_5
Start Date : 12/6/2017
Page No : 4

	SB Woodward Ave. (M-1) Southbound				Bowers St. Westbound				SB Woodward Ave. (M-1) Northbound				Bowers St. Eastbound				
Start Time	Rgt	Thru	Left	App. Total	Rgt	Thru	Left	App. Total	Rgt	Thru	Left	App. Total	Rgt	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 12:45 PM to 05:45 PM - Peak 1 of 1																	
Peak Hour for Entire Intersection Begins at 04:45 PM																	
04:45 PM	**17**	771	0	788	0	29	0	29	0	0	0	0	8	22	0	30	847
05:00 PM	15	**785**	**1**	**801**	0	23	0	23	0	0	0	0	**16**	24	0	40	**864**
05:15 PM	17	664	0	681	0	**35**	0	**35**	0	0	0	0	11	16	0	27	743
05:30 PM	11	756	0	767	0	33	**1**	34	0	0	0	0	12	**30**	0	**42**	843
Total Volume	60	2976	1	3037	0	120	1	121	0	0	0	0	47	92	0	139	3297
% App. Total	2	98	0		0	99.2	0.8		0	0	0		33.8	66.2	0		
PHF	.882	.948	.250	.948	.000	.857	.250	.864	.000	.000	.000	.000	.734	.767	.000	.827	.954
Pass Cars	57	2955	1	3013	0	112	1	113	0	0	0	0	44	91	0	135	3261
% Pass Cars	95.0	99.3	100	99.2	0	93.3	100	93.4	0	0	0	0	93.6	98.9	0	97.1	98.9
Single Units	3	18	0	21	0	8	0	8	0	0	0	0	3	1	0	4	33
% Single Units	5.0	0.6	0	0.7	0	6.7	0	6.6	0	0	0	0	6.4	1.1	0	2.9	1.0
Heavy Trucks	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	3
% Heavy Trucks	0	0.1	0	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Peds.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Peds.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



SEMCOG | Southeast Michigan Council of Governments

Crash and Road Data

Road Segment Report

Old Woodward Ave S, (PR Number 613810)

From:	Brown St E 0.912 BMP
To:	Old Woodward Ave S 1.261 EMP
FALINK ID:	177
Community:	City of Birmingham
County:	Oakland
Functional Class:	5 - Major Collector
Direction:	1 Way
Length:	0.349 miles
Number of Lanes:	2
Posted Speed:	25 (source: MSP)
Route Classification:	Not a route
Annual Crash Average 2012-2016:	17
Traffic Volume (2016)*:	8,800 (Default AADT)
Pavement Type (2015):	Asphalt
Pavement Rating (2015):	Poor
Short Range (TIP) Projects:	No TIP projects for this segment.
Long Range (RTP) Projects:	(10576) Center Left Turn Lane (10578) Center Left Turn Lane

* AADT values are derived from **Traffic Counts**

Street View

SEMCOG | Southeast Michigan Council of Governments

Community Profiles

YOU ARE VIEWING DATA FOR:

City of Birmingham

151 Martin St
Birmingham, MI 48009-3368
http://www.bhamgov.org

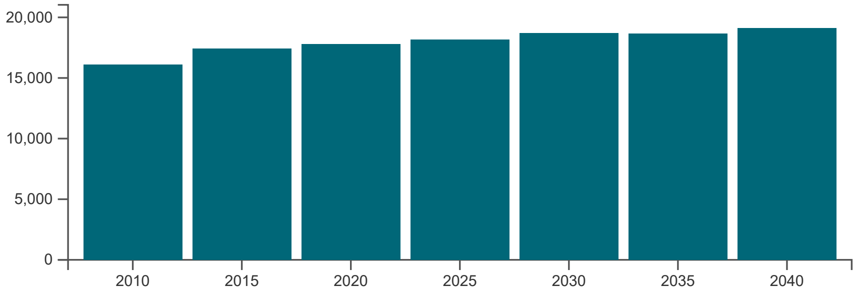
SEMCOG MEMBER

Census 2010 Population: 20,103
Area: 4.8 square miles

Economy & Jobs

Link to American Community Survey (ACS) Profiles: **Select a Year** 2012-2016 ▼ **Economic**

Forecasted Jobs



Source: **SEMCOG 2040 Forecast** produced in 2012.

Forecasted Jobs by Industry

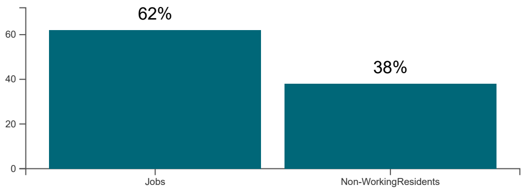
Forecasted Jobs By Industry	2010	2015	2020	2025	2030	2035	2040	Change 2010 - 2040
Natural Resources, Mining, & Construction	377	426	426	445	447	445	456	79
Manufacturing	204	212	217	213	206	191	192	-12
Wholesale Trade, Transportation, Warehousing, & Utilities	392	396	375	372	411	408	386	-6
Retail Trade	1,215	1,226	1,120	1,097	1,059	1,030	1,087	-128
Knowledge-based Services	6,311	7,026	7,358	7,422	7,709	7,701	7,799	1,488
Services to Households & Firms	2,960	3,255	3,437	3,501	3,604	3,569	3,716	756
Private Education & Healthcare	1,136	1,308	1,423	1,553	1,633	1,664	1,738	602
Leisure & Hospitality	2,464	2,550	2,407	2,517	2,552	2,556	2,655	191
Government	1,035	1,018	1,045	1,059	1,073	1,087	1,092	57
Total	16,094	17,417	17,808	18,179	18,694	18,651	19,121	3,027

Source: **SEMCOG 2040 Forecast** produced in 2012.

Note: "C" indicates data blocked due to confidentiality concerns of ES-202 files.

Daytime Population

Daytime Population	SEMCOG and ACS 2010
Jobs	16,094
Non-Working Residents	9,848
Age 15 and under	4,403
Not in labor force	5,029
Unemployed	416
Daytime Population	25,942



Source: **SEMCOG 2040 Forecast** produced in 2012, **U.S Census Bureau**, and **2010 American Community Survey 5-Year Estimates**.

Note: The number of residents attending school outside Southeast Michigan is not available. Likewise, the number of students commuting into Southeast Michigan to attend school is also not known.

SEMCOG | Southeast Michigan Council of Governments

Community Profiles

YOU ARE VIEWING DATA FOR:

City of Birmingham

151 Martin St
Birmingham, MI 48009-3368
http://www.bhamgov.org

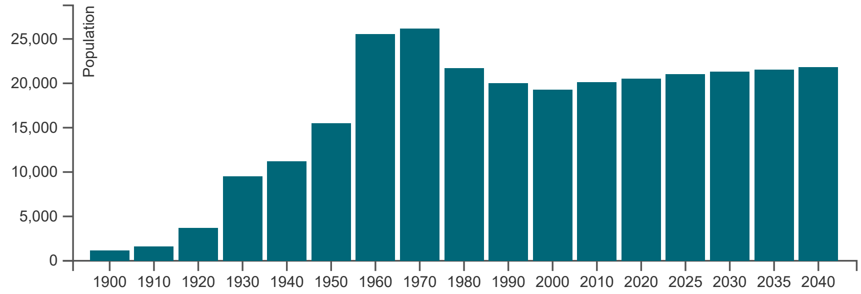
SEMCOG MEMBER

Census 2010 Population:
20,103
Area: 4.8 square miles

Population and Households

Link to American Community Survey (ACS) Profiles: **Select a Year** 2012-2016 ▼ **Social** | **Demographic**
Population and Household Estimates for Southeast Michigan, 2017

Population Forecast



Note for City of Birmingham : Incorporated in 1933 from Village of Birmingham. Population numbers prior to 1933 are of the village.

Population and Households

Population and Households	Census 2010	Change 2000-2010	Pct Change 2000-2010	SEMCOG Jul 2017	SEMCOG 2040
Total Population	20,103	812	4.2%	20,472	21,800
Group Quarters Population	1	-3	-75.0%	0	1
Household Population	20,102	815	4.2%	20,472	21,799
Housing Units	9,979	279	2.9%	10,051	-
Households (Occupied Units)	9,039	-92	-1.0%	9,553	9,309
Residential Vacancy Rate	9.4%	3.6%	-	5.0%	-
Average Household Size	2.22	0.11	-	2.14	2.34

Source: **U.S. Census Bureau** and **SEMCOG 2040 Forecast** produced in 2012.

Components of Population Change

Components of Population Change	2000-2005 Avg.	2006-2010 Avg.
Natural Increase (Births - Deaths)	138	109
Births	279	232
Deaths	141	123
Net Migration (Movement In - Movement Out)	-177	92
Population Change (Natural Increase + Net Migration)	-39	201

Source: **Michigan Department of Community Health** Vital Statistics **U.S. Census Bureau,** and **SEMCOG.**

MDOT - Bureau of Transportation Planning

Annual Average Daily Traffic Report

Selection Criteria: Year between 2010 and 2017, County= Oakland, Route= M-1

From	To	Section #	CS #	BMP	EMP	AADT	CAADT	DHV%	DF	Count	Class
Year 2010											
Route M - 1											
JCT I-75 BL PONTIAC	NCL BLOOMFIELD HILLS @GROVE RD	710	63051	0.00	0.61	37031	948	11.0	53		
NCL BLOOMFIELD HILLS @GROVE RD	BIG BEAVER RD; SCL BLMFLD HLS	720	63051	0.61	3.49	62977	948	11.0	53		
BIG BEAVER RD; SCL BLMFLD HLS	WIMBLETON ST	740	63051	3.49	4.24	59484	948	10.0	52		
WIMBLETON ST	SCL BIRMINGHAM @ 14 MILE RD	750	63051	4.24	5.97	55354	948	10.0	52		
NCL ROYAL OAK @ 14 MILE RD	SCL ROYAL OAK, NCL BERKLEY	760	63051	5.97	7.78	56630	948	10.0	50		
NCL BERKLEY, SCL ROYAL OAK	SCL BERKLEY @ 11 MILE RD	762	63051	7.78	9.58	65486	948	10.0	54		
NCL HUNTINGTON WOODS @ 11 MILE	SCL HUNTINGTON WOODS	764	63051	9.58	10.14	63488	948	9.0	55		
NCL ROYAL OAK. LINCOLN DR	JCT I-696 SCL ROYAL OAK	766	63051	10.14	10.78	59874	948	10.0	53		
JCT I-696 NCL PLEASANT RIDGE	SCL PLEASANT RIDGE @ OAK RIDGE	770	63051	10.78	11.37	52418	646	10.0	52		
NCL FERNDALE @ OAKRIDGE	JCT M-102 S CO L	780	63051	11.37	13.03	47445	603	10.0	58	Y	
Year 2011											
Route M - 1											
JCT I-75 BL PONTIAC	NCL BLOOMFIELD HILLS @GROVE RD	710	63051	0.00	0.61	36290	931	11.0	53		
NCL BLOOMFIELD HILLS @GROVE RD	BIG BEAVER RD; SCL BLMFLD HLS	720	63051	0.61	3.49	61717	931	11.0	53		
BIG BEAVER RD; SCL BLMFLD HLS	WIMBLETON ST	740	63051	3.49	4.24	58294	931	10.0	52		
WIMBLETON ST	SCL BIRMINGHAM @ 14 MILE RD	750	63051	4.24	5.97	54247	931	10.0	52		
NCL ROYAL OAK @ 14 MILE RD	SCL ROYAL OAK, NCL BERKLEY	760	63051	5.97	7.78	55497	931	10.0	50		
NCL BERKLEY, SCL ROYAL OAK	SCL BERKLEY @ 11 MILE RD	762	63051	7.78	9.58	64176	931	10.0	54		
NCL HUNTINGTON WOODS @ 11 MILE	SCL HUNTINGTON WOODS	764	63051	9.58	10.14	62218	931	9.0	55		
NCL ROYAL OAK. LINCOLN DR	JCT I-696 SCL ROYAL OAK	766	63051	10.14	10.78	58677	931	10.0	53		
JCT I-696 NCL PLEASANT RIDGE	SCL PLEASANT RIDGE @ OAK RIDGE	770	63051	10.78	11.37	51370	634	10.0	59	Y	
NCL FERNDALE @ OAKRIDGE	JCT M-102 S CO L	780	63051	11.37	13.03	46496	592	10.0	58	Y	
Year 2012											
Route M - 1											
JCT I-75 BL PONTIAC	NCL BLOOMFIELD HILLS @HIICKORY	710	63051	0.00	0.61	36092	944	11.0	53	Y	
NCL BLOOMFIELD HILLS @HICKORY	BIG BEAVER RD; SCL BLMFLD HLS	720	63051	0.61	3.49	55511	944	11.0	53	Y	
BIG BEAVER RD; SCL BLMFLD HLS	WIMBLETON ST	740	63051	3.49	4.24	58170	944	10.0	52	Y	
WIMBLETON ST	SCL BIRMINGHAM @ 14 MILE RD	750	63051	4.24	5.97	52936	944	10.0	52	Y	
NCL ROYAL OAK @ 14 MILE RD	SCL ROYAL OAK, NCL BERKLEY	760	63051	5.97	7.78	62515	944	10.0	50	Y	
NCL BERKLEY, SCL ROYAL OAK	SCL BERKLEY @ 11 MILE RD	762	63051	7.78	9.58	72530	944	10.0	54	Y	
NCL HUNTINGTON WOODS @ 11 MILE	SCL HUNTINGTON WOODS	764	63051	9.58	10.14	63405	944	9.0	55	Y	
NCL ROYAL OAK. LINCOLN DR	JCT I-696 SCL ROYAL OAK	766	63051	10.14	10.78	64863	944	10.0	53	Y	
JCT I-696 NCL PLEASANT RIDGE	SCL PLEASANT RIDGE @ OAK RIDGE	770	63051	10.78	11.37	52243	643	10.0	59		
NCL FERNDALE @ OAKRIDGE	JCT M-102 S CO L	780	63051	11.37	13.03	47286	600	10.0	58		

MDOT - Bureau of Transportation Planning

Annual Average Daily Traffic Report

Selection Criteria: Year between 2010 and 2017, County= Oakland, Route= M-1

From	To	Section #	CS #	BMP	EMP	AADT	CAADT	DHV%	DF	Count	Class
Year 2013											
Route M - 1											
JCT I-75 BL PONTIAC	NCL BLOOMFIELD HILLS @HIICKORY	710	63051	0.00	0.61	36561	966	11.0	53		
NCL BLOOMFIELD HILLS @HICKORY	BIG BEAVER RD; SCL BLMFLD HLS	720	63051	0.61	3.49	56233	966	11.0	53		
BIG BEAVER RD; SCL BLMFLD HLS	WIMBLETON ST	740	63051	3.49	4.24	58926	966	10.0	52		
WIMBLETON ST	SCL BIRMINGHAM @ 14 MILE RD	750	63051	4.24	5.97	50060	966	10.0	52	Y	
NCL ROYAL OAK @ 14 MILE RD	SCL ROYAL OAK, NCL BERKLEY	760	63051	5.97	7.78	58960	966	10.0	50	Y	
NCL BERKLEY, SCL ROYAL OAK	SCL BERKLEY @ 11 MILE RD	762	63051	7.78	9.58	60692	966	10.0	54	Y	
NCL HUNTINGTON WOODS @ 11 MILE	SCL HUNTINGTON WOODS	764	63051	9.58	10.14	64229	966	9.0	55	Y	
NCL ROYAL OAK. LINCOLN DR	JCT I-696 SCL ROYAL OAK	766	63051	10.14	10.78	53200	966	10.0	53	Y	
JCT I-696 NCL PLEASANT RIDGE	SCL PLEASANT RIDGE @ OAK RIDGE	770	63051	10.78	11.37	53200	658	10.0	59	Y	
NCL FERNDALE @ OAKRIDGE	JCT M-102 S CO L	780	63051	11.37	13.03	37999	614	10.0	58	Y	
Year 2014											
Route M - 1											
JCT I-75 BL PONTIAC	NCL BLOOMFIELD HILLS @HIICKORY	710	63051	0.00	0.61	37438	989	11.0	53		
NCL BLOOMFIELD HILLS @HICKORY	BIG BEAVER RD; SCL BLMFLD HLS	720	63051	0.61	3.49	57583	989	11.0	53		
BIG BEAVER RD; SCL BLMFLD HLS	WIMBLETON ST	740	63051	3.49	4.24	60340	989	10.0	52		
WIMBLETON ST	SCL BIRMINGHAM @ 14 MILE RD	750	63051	4.24	5.97	51261	989	10.0	52		
NCL ROYAL OAK @ 14 MILE RD	SCL ROYAL OAK, NCL BERKLEY	760	63051	5.97	7.78	60375	989	10.0	50		
NCL BERKLEY, SCL ROYAL OAK	SCL BERKLEY @ 11 MILE RD	762	63051	7.78	9.58	62149	989	10.0	54		
NCL HUNTINGTON WOODS @ 11 MILE	SCL HUNTINGTON WOODS	764	63051	9.58	10.14	65770	989	9.0	55		
NCL ROYAL OAK. LINCOLN DR	JCT I-696 SCL ROYAL OAK	766	63051	10.14	10.78	54477	989	10.0	53		
JCT I-696 NCL PLEASANT RIDGE	SCL PLEASANT RIDGE @ OAK RIDGE	770	63051	10.78	11.37	25420	674	10.0	59	Y	
NCL FERNDALE @ OAKRIDGE	JCT M-102 S CO L	780	63051	11.37	13.03	33162	629	10.0	58	Y	
Year 2015											
Route M - 1											
JCT I-75 BL PONTIAC	NCL BLOOMFIELD HILLS @HIICKORY	710	63051	0.00	0.61	39495	1005	11.0	53	Y	
NCL BLOOMFIELD HILLS @HICKORY	BIG BEAVER RD; SCL BLMFLD HLS	720	63051	0.61	3.49	52876	1005	11.0	53	Y	
BIG BEAVER RD; SCL BLMFLD HLS	WIMBLETON ST	740	63051	3.49	4.24	64850	1005	10.0	52	Y	
WIMBLETON ST	SCL BIRMINGHAM @ 14 MILE RD	750	63051	4.24	5.97	54869	1005	10.0	52	Y	
NCL ROYAL OAK @ 14 MILE RD	SCL ROYAL OAK, NCL BERKLEY	760	63051	5.97	7.78	63284	1005	10.0	50	Y	
NCL BERKLEY, SCL ROYAL OAK	SCL BERKLEY @ 11 MILE RD	762	63051	7.78	9.58	69416	1005	10.0	54	Y	
NCL HUNTINGTON WOODS @ 11 MILE	SCL HUNTINGTON WOODS	764	63051	9.58	10.14	64458	1005	9.0	55	Y	
NCL ROYAL OAK. LINCOLN DR	JCT I-696 SCL ROYAL OAK	766	63051	10.14	10.78	64713	1005	10.0	53	Y	
JCT I-696 NCL PLEASANT RIDGE	SCL PLEASANT RIDGE @ OAK RIDGE	770	63051	10.78	11.37	26233	685	10.0	59		
NCL FERNDALE @ OAKRIDGE	JCT M-102 S CO L	780	63051	11.37	13.03	36024	618	10.0	58	Y	Y

Appendix B

Existing Conditions Data

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱		↰	↑↱		↰	↑	↱	↰	↑↱	
Traffic Volume (veh/h)	46	195	117	31	133	31	210	105	60	24	121	34
Future Volume (veh/h)	46	195	117	31	133	31	210	105	60	24	121	34
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		0.98	0.99		0.98	0.98		0.98	0.99		0.97
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.85	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1984	1984	1984	1938	1938	1938	1953	1953	1953	1906	1906	1906
Adj Flow Rate, veh/h	53	227	136	35	149	35	256	128	73	30	149	42
Peak Hour Factor	0.86	0.86	0.86	0.89	0.89	0.89	0.82	0.82	0.82	0.81	0.81	0.81
Percent Heavy Veh, %	1	1	1	4	4	4	3	3	3	6	6	6
Cap, veh/h	176	720	415	368	570	134	579	955	676	592	694	196
Arrive On Green	0.38	0.38	0.38	0.38	0.38	0.38	0.49	0.49	0.49	0.49	0.49	0.49
Sat Flow, veh/h	336	1907	1099	995	1510	355	1162	1953	1384	1131	1420	400
Grp Volume(v), veh/h	221	0	195	35	0	184	256	128	73	30	0	191
Grp Sat Flow(s),veh/h/ln	1763	0	1578	995	0	1864	1162	1953	1384	1131	0	1821
Q Serve(g_s), s	0.9	0.0	7.9	2.3	0.0	6.1	14.5	3.2	2.6	1.3	0.0	5.4
Cycle Q Clear(g_c), s	7.1	0.0	7.9	10.2	0.0	6.1	19.9	3.2	2.6	4.6	0.0	5.4
Prop In Lane	0.24		0.70	1.00		0.19	1.00		1.00	1.00		0.22
Lane Grp Cap(c), veh/h	716	0	596	368	0	704	579	955	676	592	0	890
V/C Ratio(X)	0.31	0.00	0.33	0.10	0.00	0.26	0.44	0.13	0.11	0.05	0.00	0.21
Avail Cap(c_a), veh/h	716	0	596	368	0	704	579	955	676	592	0	890
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	19.6	0.0	19.9	23.5	0.0	19.3	18.8	12.6	12.4	13.8	0.0	13.1
Incr Delay (d2), s/veh	1.1	0.0	1.5	0.5	0.0	0.9	2.4	0.3	0.3	0.2	0.0	0.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.4	0.0	3.1	0.6	0.0	2.8	4.2	1.5	0.8	0.4	0.0	2.3
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	20.7	0.0	21.3	24.0	0.0	20.2	21.3	12.9	12.7	14.0	0.0	13.7
LnGrp LOS	C	A	C	C	A	C	C	B	B	B	A	B
Approach Vol, veh/h		416			219			457			221	
Approach Delay, s/veh		21.0			20.8			17.5			13.7	
Approach LOS		C			C			B			B	

Timer - Assigned Phs		2		4		6		8				
Phs Duration (G+Y+Rc), s		40.0		50.0		40.0		50.0				
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0				
Max Green Setting (Gmax), s		34.0		44.0		34.0		44.0				
Max Q Clear Time (g_c+I1), s		9.9		7.4		12.2		21.9				
Green Ext Time (p_c), s		2.8		1.4		1.2		2.0				

Intersection Summary			
HCM 6th Ctrl Delay			18.6
HCM 6th LOS			B

HCM Signalized Intersection Capacity Analysis
2: SB M-1 (Woodward Avenue) & Bowers Street

Existing Conditions
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↱			↑						↑↑↑↱	
Traffic Volume (vph)	0	55	31	0	104	0	0	0	0	0	2242	14
Future Volume (vph)	0	55	31	0	104	0	0	0	0	0	2242	14
Ideal Flow (vphpl)	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Total Lost time (s)		9.3			5.3						5.7	
Lane Util. Factor		1.00			1.00						0.86	
Frt		0.95			1.00						1.00	
Flt Protected		1.00			1.00						1.00	
Satd. Flow (prot)		1484			1835						6739	
Flt Permitted		1.00			1.00						1.00	
Satd. Flow (perm)		1484			1835						6739	
Peak-hour factor, PHF	0.86	0.86	0.86	0.63	0.63	0.63	0.92	0.92	0.92	0.95	0.95	0.95
Adj. Flow (vph)	0	64	36	0	165	0	0	0	0	0	2360	15
RTOR Reduction (vph)	0	4	0	0	0	0	0	0	0	0	1	0
Lane Group Flow (vph)	0	96	0	0	165	0	0	0	0	0	2374	0
Heavy Vehicles (%)	9%	9%	9%	9%	9%	9%	2%	2%	2%	2%	2%	2%
Parking (#/hr)		10										
Turn Type		NA			NA						NA	
Protected Phases		4			8						6	
Permitted Phases												
Actuated Green, G (s)		19.7			23.7						55.3	
Effective Green, g (s)		19.7			23.7						55.3	
Actuated g/C Ratio		0.22			0.26						0.61	
Clearance Time (s)		9.3			5.3						5.7	
Lane Grp Cap (vph)		324			483						4140	
v/s Ratio Prot		0.06			c0.09						c0.35	
v/s Ratio Perm												
v/c Ratio		0.30			0.34						0.57	
Uniform Delay, d1		29.4			26.8						10.3	
Progression Factor		1.07			0.00						1.00	
Incremental Delay, d2		2.3			1.7						0.6	
Delay (s)		33.8			1.7						10.9	
Level of Service		C			A						B	
Approach Delay (s)		33.8			1.7			0.0			10.9	
Approach LOS		C			A			A			B	

Intersection Summary			
HCM 2000 Control Delay	11.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	48.1%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
3: SB M-1 (Woodward Avenue) & Hazel Street

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations		↱			↑↑↑↱	
Traffic Volume (veh/h)	0	17	0	0	2239	50
Future Volume (Veh/h)	0	17	0	0	2239	50
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.60	0.60	0.92	0.92	0.95	0.95
Hourly flow rate (vph)	0	28	0	0	2357	53
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)				380		
pX, platoon unblocked						
vC, conflicting volume	2384	616	2410			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2384	616	2410			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	94	100			
cM capacity (veh/h)	29	439	201			

Direction, Lane #	EB 1	SB 1	SB 2	SB 3	SB 4
Volume Total	28	673	673	673	390
Volume Left	0	0	0	0	0
Volume Right	28	0	0	0	53
cSH	439	1700	1700	1700	1700
Volume to Capacity	0.06	0.40	0.40	0.40	0.23
Queue Length 95th (ft)	5	0	0	0	0
Control Delay (s)	13.8	0.0	0.0	0.0	0.0
Lane LOS	B				
Approach Delay (s)	13.8	0.0			
Approach LOS	B				

Intersection Summary			
Average Delay	0.2		
Intersection Capacity Utilization	41.6%	ICU Level of Service	A
Analysis Period (min)	15		

Intersection	
Int Delay, s/veh	3.6

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	Y		↱		↰	↑
Traffic Vol, veh/h	20	98	381	10	76	144
Future Vol, veh/h	20	98	381	10	76	144
Conflicting Peds, #/hr	0	4	0	13	13	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	25	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	76	76	74	74	85	85
Heavy Vehicles, %	7	7	2	2	4	4
Mvmt Flow	26	129	515	14	89	169

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	882	539	0	0	542	0
Stage 1	535	-	-	-	-	-
Stage 2	347	-	-	-	-	-
Critical Hdwy	6.47	6.27	-	-	4.14	-
Critical Hdwy Stg 1	5.47	-	-	-	-	-
Critical Hdwy Stg 2	5.47	-	-	-	-	-
Follow-up Hdwy	3.563	3.363	-	-	2.236	-
Pot Cap-1 Maneuver	310	533	-	-	1017	-
Stage 1	577	-	-	-	-	-
Stage 2	705	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	279	524	-	-	1004	-
Mov Cap-2 Maneuver	279	-	-	-	-	-
Stage 1	519	-	-	-	-	-
Stage 2	705	-	-	-	-	-

Approach	WB		NB		SB	
HCM Control Delay, s	16.9		0		3.1	
HCM LOS	C					

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	456	1004	-
HCM Lane V/C Ratio	-	-	0.34	0.089	-
HCM Control Delay (s)	-	-	16.9	8.9	-
HCM Lane LOS	-	-	C	A	-
HCM 95th %tile Q(veh)	-	-	1.5	0.3	-

Intersection	
Int Delay, s/veh	1.2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↱		↱			↰
Traffic Vol, veh/h	18	32	436	8	9	194
Future Vol, veh/h	18	32	436	8	9	194
Conflicting Peds, #/hr	11	0	0	18	18	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	78	78	81	81	88	88
Heavy Vehicles, %	2	2	3	3	5	5
Mvmt Flow	23	41	538	10	10	220

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	812	561	0	0	566	0
Stage 1	561	-	-	-	-	-
Stage 2	251	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.15	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.245	-
Pot Cap-1 Maneuver	348	527	-	-	991	-
Stage 1	571	-	-	-	-	-
Stage 2	791	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	334	518	-	-	974	-
Mov Cap-2 Maneuver	334	-	-	-	-	-
Stage 1	554	-	-	-	-	-
Stage 2	783	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	14.8	0	0.4
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	432	974	-
HCM Lane V/C Ratio	-	-	0.148	0.011	-
HCM Control Delay (s)	-	-	14.8	8.7	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0.5	0	-

Intersection	
Int Delay, s/veh	1.6

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	Y			↰	↱	
Traffic Vol, veh/h	24	30	59	420	190	22
Future Vol, veh/h	24	30	59	420	190	22
Conflicting Peds, #/hr	11	0	6	0	0	6
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	81	81	88	88
Heavy Vehicles, %	0	0	3	3	5	5
Mvmt Flow	27	33	73	519	216	25

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	911	235	247	0	-	0
Stage 1	235	-	-	-	-	-
Stage 2	676	-	-	-	-	-
Critical Hdwy	6.4	6.2	4.13	-	-	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	2.227	-	-	-
Pot Cap-1 Maneuver	307	809	1313	-	-	-
Stage 1	809	-	-	-	-	-
Stage 2	509	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	279	804	1305	-	-	-
Mov Cap-2 Maneuver	279	-	-	-	-	-
Stage 1	740	-	-	-	-	-
Stage 2	506	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	14.5	1	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1305	-	438	-	-
HCM Lane V/C Ratio	0.056	-	0.137	-	-
HCM Control Delay (s)	7.9	0	14.5	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0.2	-	0.5	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱		↰	↑↱		↰	↑	↱	↰	↑↱	
Traffic Volume (veh/h)	63	284	199	37	193	60	108	184	56	52	145	47
Future Volume (veh/h)	63	284	199	37	193	60	108	184	56	52	145	47
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		0.97	1.00		0.97	0.98		0.98	0.99		0.97
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.85	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1984	1984	1984	2000	2000	2000	1953	1953	1953	1953	1953	1953
Adj Flow Rate, veh/h	71	319	224	43	224	70	126	214	65	55	153	49
Peak Hour Factor	0.89	0.89	0.89	0.86	0.86	0.86	0.86	0.86	0.86	0.95	0.95	0.95
Percent Heavy Veh, %	1	1	1	0	0	0	3	3	3	3	3	3
Cap, veh/h	165	720	507	333	613	191	512	868	613	486	624	200
Arrive On Green	0.42	0.42	0.42	0.42	0.42	0.42	0.44	0.44	0.44	0.44	0.44	0.44
Sat Flow, veh/h	275	1704	1202	873	1451	453	1148	1953	1379	1080	1405	450
Grp Volume(v), veh/h	325	0	289	43	0	294	126	214	65	55	0	202
Grp Sat Flow(s),veh/h/ln	1630	0	1552	873	0	1904	1148	1953	1379	1080	0	1854
Q Serve(g_s), s	4.4	0.0	11.9	3.3	0.0	9.5	6.9	6.2	2.5	3.0	0.0	6.1
Cycle Q Clear(g_c), s	13.9	0.0	11.9	15.2	0.0	9.5	13.0	6.2	2.5	9.2	0.0	6.1
Prop In Lane	0.22		0.77	1.00		0.24	1.00		1.00	1.00		0.24
Lane Grp Cap(c), veh/h	737	0	655	333	0	804	512	868	613	486	0	824
V/C Ratio(X)	0.44	0.00	0.44	0.13	0.00	0.37	0.25	0.25	0.11	0.11	0.00	0.25
Avail Cap(c_a), veh/h	737	0	655	333	0	804	512	868	613	486	0	824
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	18.6	0.0	18.5	23.9	0.0	17.8	19.6	15.6	14.6	18.5	0.0	15.6
Incr Delay (d2), s/veh	1.9	0.0	2.2	0.8	0.0	1.3	1.1	0.7	0.3	0.5	0.0	0.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	5.3	0.0	4.6	0.8	0.0	4.4	2.0	2.9	0.8	0.8	0.0	2.7
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	20.5	0.0	20.6	24.7	0.0	19.1	20.8	16.3	14.9	18.9	0.0	16.3
LnGrp LOS	C	A	C	C	A	B	C	B	B	B	A	B
Approach Vol, veh/h		614			337			405			257	
Approach Delay, s/veh		20.6			19.8			17.5			16.9	
Approach LOS		C			B			B			B	

Timer - Assigned Phs		2		4		6		8				
Phs Duration (G+Y+Rc), s		44.0		46.0		44.0		46.0				
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0				
Max Green Setting (Gmax), s		38.0		40.0		38.0		40.0				
Max Q Clear Time (g_c+I1), s		15.9		11.2		17.2		15.0				
Green Ext Time (p_c), s		4.4		1.5		2.1		2.1				

Intersection Summary	
HCM 6th Ctrl Delay	19.0
HCM 6th LOS	B

HCM Signalized Intersection Capacity Analysis
2: SB M-1 (Woodward Avenue) & Bowers Street

Existing Conditions
PM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↱			↑						↑↑↑↱	
Traffic Volume (vph)	0	92	47	0	126	0	0	0	0	0	3047	63
Future Volume (vph)	0	92	47	0	126	0	0	0	0	0	3047	63
Ideal Flow (vphpl)	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Total Lost time (s)		9.3			5.3						5.7	
Lane Util. Factor		1.00			1.00						0.86	
Frt		0.95			1.00						1.00	
Flt Protected		1.00			1.00						1.00	
Satd. Flow (prot)		1575			1869						6791	
Flt Permitted		1.00			1.00						1.00	
Satd. Flow (perm)		1575			1869						6791	
Peak-hour factor, PHF	0.83	0.83	0.83	0.86	0.86	0.86	0.92	0.92	0.92	0.95	0.95	0.95
Adj. Flow (vph)	0	111	57	0	147	0	0	0	0	0	3207	66
RTOR Reduction (vph)	0	1	0	0	0	0	0	0	0	0	3	0
Lane Group Flow (vph)	0	167	0	0	147	0	0	0	0	0	3270	0
Heavy Vehicles (%)	3%	3%	3%	7%	7%	7%	2%	2%	2%	1%	1%	1%
Parking (#/hr)		10										
Turn Type		NA			NA						NA	
Protected Phases		4			8						6	
Permitted Phases												
Actuated Green, G (s)		19.7			23.7						55.3	
Effective Green, g (s)		19.7			23.7						55.3	
Actuated g/C Ratio		0.22			0.26						0.61	
Clearance Time (s)		9.3			5.3						5.7	
Lane Grp Cap (vph)		344			492						4172	
v/s Ratio Prot		c0.11			0.08						c0.48	
v/s Ratio Perm												
v/c Ratio		0.49			0.30						0.78	
Uniform Delay, d1		30.7			26.5						12.9	
Progression Factor		0.91			0.00						1.00	
Incremental Delay, d2		4.8			1.4						1.5	
Delay (s)		32.7			1.4						14.4	
Level of Service		C			A						B	
Approach Delay (s)		32.7			1.4			0.0			14.4	
Approach LOS		C			A			A			B	

Intersection Summary			
HCM 2000 Control Delay	14.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	62.8%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
3: SB M-1 (Woodward Avenue) & Hazel Street

Existing Conditions
PM Peak Hour

	↗	↘	↖	↑	↓	↙
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations		↱			↑↑↑↱	
Traffic Volume (veh/h)	0	35	0	0	3075	98
Future Volume (Veh/h)	0	35	0	0	3075	98
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.71	0.71	0.92	0.92	0.95	0.95
Hourly flow rate (vph)	0	49	0	0	3237	103
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)				380		
pX, platoon unblocked						
vC, conflicting volume	3288	861	3340			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	3288	861	3340			
tC, single (s)	6.9	7.0	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	83	100			
cM capacity (veh/h)	7	297	86			

Direction, Lane #	EB 1	SB 1	SB 2	SB 3	SB 4
Volume Total	49	925	925	925	565
Volume Left	0	0	0	0	0
Volume Right	49	0	0	0	103
cSH	297	1700	1700	1700	1700
Volume to Capacity	0.17	0.54	0.54	0.54	0.33
Queue Length 95th (ft)	15	0	0	0	0
Control Delay (s)	19.5	0.0	0.0	0.0	0.0
Lane LOS	C				
Approach Delay (s)	19.5	0.0			
Approach LOS	C				

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	53.9%	ICU Level of Service	A
Analysis Period (min)	15		

4: Old Woodward Avenue & Bowers Street

Intersection	
Int Delay, s/veh	6

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↱		↑↱		↰	↑
Traffic Vol, veh/h	81	108	241	29	110	325
Future Vol, veh/h	81	108	241	29	110	325
Conflicting Peds, #/hr	5	10	0	26	26	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	25	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	93	93	71	71	94	94
Heavy Vehicles, %	6	6	0	0	2	2
Mvmt Flow	87	116	339	41	117	346

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	971	396	0	0	406	0
Stage 1	386	-	-	-	-	-
Stage 2	585	-	-	-	-	-
Critical Hdwy	6.46	6.26	-	-	4.12	-
Critical Hdwy Stg 1	5.46	-	-	-	-	-
Critical Hdwy Stg 2	5.46	-	-	-	-	-
Follow-up Hdwy	3.554	3.354	-	-	2.218	-
Pot Cap-1 Maneuver	276	645	-	-	1153	-
Stage 1	678	-	-	-	-	-
Stage 2	549	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	240	623	-	-	1124	-
Mov Cap-2 Maneuver	240	-	-	-	-	-
Stage 1	593	-	-	-	-	-
Stage 2	546	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	26	0	2.2
HCM LOS	D		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	370	1124	-
HCM Lane V/C Ratio	-	-	0.549	0.104	-
HCM Control Delay (s)	-	-	26	8.6	-
HCM Lane LOS	-	-	D	A	-
HCM 95th %tile Q(veh)	-	-	3.2	0.3	-

Intersection	
Int Delay, s/veh	2.6

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	Y		↱			↰
Traffic Vol, veh/h	45	53	320	13	22	374
Future Vol, veh/h	45	53	320	13	22	374
Conflicting Peds, #/hr	11	0	0	14	14	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	73	73	80	80	93	93
Heavy Vehicles, %	0	0	3	3	3	3
Mvmt Flow	62	73	400	16	24	402

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	883	422	0	0	430	0
Stage 1	422	-	-	-	-	-
Stage 2	461	-	-	-	-	-
Critical Hdwy	6.4	6.2	-	-	4.13	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	-	-	2.227	-
Pot Cap-1 Maneuver	319	636	-	-	1124	-
Stage 1	666	-	-	-	-	-
Stage 2	639	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	303	628	-	-	1109	-
Mov Cap-2 Maneuver	303	-	-	-	-	-
Stage 1	639	-	-	-	-	-
Stage 2	633	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	17.5	0	0.5
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	421	1109	-
HCM Lane V/C Ratio	-	-	0.319	0.021	-
HCM Control Delay (s)	-	-	17.5	8.3	0
HCM Lane LOS	-	-	C	A	A
HCM 95th %tile Q(veh)	-	-	1.4	0.1	-

Intersection	
Int Delay, s/veh	3.1

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	Y			↰	↱	
Traffic Vol, veh/h	42	68	58	291	367	52
Future Vol, veh/h	42	68	58	291	367	52
Conflicting Peds, #/hr	11	0	12	0	0	12
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	79	79	80	80	93	93
Heavy Vehicles, %	2	2	3	3	3	3
Mvmt Flow	53	86	73	364	395	56

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	956	435	463	0	-	0
Stage 1	435	-	-	-	-	-
Stage 2	521	-	-	-	-	-
Critical Hdwy	6.42	6.22	4.13	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	2.227	-	-	-
Pot Cap-1 Maneuver	286	621	1093	-	-	-
Stage 1	653	-	-	-	-	-
Stage 2	596	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	256	614	1081	-	-	-
Mov Cap-2 Maneuver	256	-	-	-	-	-
Stage 1	591	-	-	-	-	-
Stage 2	589	-	-	-	-	-

Approach	EB		NB		SB
HCM Control Delay, s	18.7		1.4		0
HCM LOS	C				

Minor Lane/Major Mvmt		NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)		1081	-	400	-	-
HCM Lane V/C Ratio		0.067	-	0.348	-	-
HCM Control Delay (s)		8.6	0	18.7	-	-
HCM Lane LOS		A	A	C	-	-
HCM 95th %tile Q(veh)		0.2	-	1.5	-	-

1: Old Woodward Avenue & Brown Street Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vehicles Exited	48	208	115	29	137	35	215	101	55	23	122	37
Hourly Exit Rate	48	208	115	29	137	35	215	101	55	23	122	37
Input Volume	46	195	117	31	133	31	210	106	60	24	121	34
% of Volume	104	107	98	93	103	112	102	96	91	96	101	110

1: Old Woodward Avenue & Brown Street Performance by movement

Movement	All
Vehicles Exited	1125
Hourly Exit Rate	1125
Input Volume	1109
% of Volume	101

2: SB M-1 (Woodward Avenue) & Bowers Street Performance by movement

Movement	EBT	EBR	WBT	SBT	SBR	All
Vehicles Exited	58	32	108	2286	14	2498
Hourly Exit Rate	58	32	108	2286	14	2498
Input Volume	61	31	104	2245	14	2455
% of Volume	95	104	104	102	98	102

3: SB M-1 (Woodward Avenue) & Hazel Street Performance by movement

Movement	EBT	EBR	SBT	SBR	All
Vehicles Exited	3	15	2283	50	2351
Hourly Exit Rate	3	15	2283	50	2351
Input Volume	2	17	2239	50	2308
% of Volume	120	90	102	100	102

4: Old Woodward Avenue & Bowers Street Performance by movement

Movement	WBL	WBT	WBR	NBT	NBR	SBL	SBT	All
Vehicles Exited	20	8	104	369	11	73	143	728
Hourly Exit Rate	20	8	104	369	11	73	143	728
Input Volume	20	7	98	381	10	76	146	738
% of Volume	100	114	106	97	107	96	98	99

5: Old Woodward Avenue & Hazel Street Performance by movement

Movement	WBL	WBT	WBR	NBT	NBR	SBL	SBT	All
Vehicles Exited	18	3	33	424	9	7	193	687
Hourly Exit Rate	18	3	33	424	9	7	193	687
Input Volume	18	3	32	437	8	9	196	702
% of Volume	101	100	103	97	116	76	98	98

6: Old Woodward Avenue & Frank Street Performance by movement

Movement	EBL	EBR	NBL	NBT	SBT	SBR	All
Vehicles Exited	20	31	57	428	185	26	747
Hourly Exit Rate	20	31	57	428	185	26	747
Input Volume	24	30	59	433	190	22	758
% of Volume	83	103	97	99	97	118	99

21: NB M-1 (Woodward Avenue) & Bowers Street Performance by movement

Movement	EBT	WBT	All
Vehicles Exited	53	108	161
Hourly Exit Rate	53	108	161
Input Volume	55	104	159
% of Volume	96	104	101

9001: Dummy Node A & Old Woodward Avenue Performance by movement

Movement	NBT	NBR	SBT	SBR	All
Vehicles Exited	373	84	200	66	723
Hourly Exit Rate	373	84	200	66	723
Input Volume	378	93	205	66	741
% of Volume	99	91	98	100	98

Total Network Performance

Vehicles Exited	3665
Hourly Exit Rate	3665
Input Volume	12542
% of Volume	29

1: Old Woodward Avenue & Brown Street Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vehicles Exited	58	283	192	38	197	59	105	190	52	50	151	46
Hourly Exit Rate	58	283	192	38	197	59	105	190	52	50	151	46
Input Volume	63	284	199	37	193	60	108	188	56	52	145	47
% of Volume	92	100	96	103	102	98	97	101	93	96	104	98

1: Old Woodward Avenue & Brown Street Performance by movement

Movement	All
Vehicles Exited	1421
Hourly Exit Rate	1421
Input Volume	1431
% of Volume	99

2: SB M-1 (Woodward Avenue) & Bowers Street Performance by movement

Movement	EBT	EBR	WBT	SBT	SBR	All
Vehicles Exited	98	45	133	3082	69	3427
Hourly Exit Rate	98	45	133	3082	69	3427
Input Volume	96	47	126	3050	63	3383
% of Volume	102	95	106	101	110	101

3: SB M-1 (Woodward Avenue) & Hazel Street Performance by movement

Movement	EBT	EBR	SBT	SBR	All
Vehicles Exited	3	35	3111	99	3248
Hourly Exit Rate	3	35	3111	99	3248
Input Volume	2	35	3075	98	3210
% of Volume	133	101	101	101	101

4: Old Woodward Avenue & Bowers Street Performance by movement

Movement	WBL	WBT	WBR	NBT	NBR	SBL	SBT	All
Vehicles Exited	87	3	114	232	30	109	329	904
Hourly Exit Rate	87	3	114	232	30	109	329	904
Input Volume	81	3	108	241	29	110	332	904
% of Volume	107	109	106	96	103	99	99	100

5: Old Woodward Avenue & Hazel Street Performance by movement

Movement	WBL	WBT	WBR	NBT	NBR	SBL	SBT	All
Vehicles Exited	46	10	50	321	12	24	369	832
Hourly Exit Rate	46	10	50	321	12	24	369	832
Input Volume	45	8	53	320	13	22	375	836
% of Volume	103	118	95	100	92	110	98	100

6: Old Woodward Avenue & Frank Street Performance by movement

Movement	EBL	EBR	NBL	NBT	SBT	SBR	All
Vehicles Exited	44	68	58	295	369	47	881
Hourly Exit Rate	44	68	58	295	369	47	881
Input Volume	42	68	58	297	371	52	888
% of Volume	105	100	100	99	99	90	99

21: NB M-1 (Woodward Avenue) & Bowers Street Performance by movement

Movement	EBT	WBT	All
Vehicles Exited	93	132	225
Hourly Exit Rate	93	132	225
Input Volume	92	126	218
% of Volume	101	105	103

9001: Dummy Node A & Old Woodward Avenue Performance by movement

Movement	NBT	NBR	SBT	NER	All
Vehicles Exited	351	27	385	14	777
Hourly Exit Rate	351	27	385	14	777
Input Volume	354	25	386	15	780
% of Volume	99	109	100	92	100

Total Network Performance

Vehicles Exited	4858
Hourly Exit Rate	4858
Input Volume	16425
% of Volume	30

Intersection: 1: Old Woodward Avenue & Brown Street

Movement	EB	EB	WB	WB	NB	NB	NB	SB	SB
Directions Served	LT	TR	L	TR	L	T	R	L	TR
Maximum Queue (ft)	222	183	94	165	124	186	58	53	144
Average Queue (ft)	102	50	22	74	79	54	18	13	51
95th Queue (ft)	176	121	63	140	131	141	49	39	107
Link Distance (ft)	591			424		240			492
Upstream Blk Time (%)						0			
Queuing Penalty (veh)						0			
Storage Bay Dist (ft)		375	65		75		200	75	
Storage Blk Time (%)			1	11	15	2		0	3
Queuing Penalty (veh)			1	4	25	5		0	1

Intersection: 2: SB M-1 (Woodward Avenue) & Bowers Street

Movement	EB	WB	SB	SB	SB	SB
Directions Served	TR	T	T	T	T	TR
Maximum Queue (ft)	121	22	282	269	197	126
Average Queue (ft)	50	1	203	175	107	42
95th Queue (ft)	100	12	263	254	184	97
Link Distance (ft)	141	27	295	295	295	295
Upstream Blk Time (%)	0	1	0	0		
Queuing Penalty (veh)	0	1	0	0		
Storage Bay Dist (ft)						
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 3: SB M-1 (Woodward Avenue) & Hazel Street

Movement	EB
Directions Served	R
Maximum Queue (ft)	37
Average Queue (ft)	11
95th Queue (ft)	34
Link Distance (ft)	232
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 4: Old Woodward Avenue & Bowers Street

Movement	WB	NB	SB	SB
Directions Served	LR	TR	L	T
Maximum Queue (ft)	144	21	61	73
Average Queue (ft)	64	2	22	5
95th Queue (ft)	120	15	49	32
Link Distance (ft)	141	425		197
Upstream Blk Time (%)	0			
Queuing Penalty (veh)	0			
Storage Bay Dist (ft)			25	
Storage Blk Time (%)			3	0
Queuing Penalty (veh)			5	0

Intersection: 5: Old Woodward Avenue & Hazel Street

Movement	WB	NB	SB
Directions Served	LR	TR	LT
Maximum Queue (ft)	67	42	40
Average Queue (ft)	28	3	4
95th Queue (ft)	57	20	22
Link Distance (ft)	232	23	231
Upstream Blk Time (%)		0	
Queuing Penalty (veh)		1	
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 6: Old Woodward Avenue & Frank Street

Movement	EB	NB	SB
Directions Served	LR	LT	TR
Maximum Queue (ft)	58	57	38
Average Queue (ft)	27	12	1
95th Queue (ft)	52	45	14
Link Distance (ft)	284	197	23
Upstream Blk Time (%)			0
Queuing Penalty (veh)			0
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 21: NB M-1 (Woodward Avenue) & Bowers Street

Movement	WB
Directions Served	TR
Maximum Queue (ft)	167
Average Queue (ft)	59
95th Queue (ft)	132
Link Distance (ft)	222
Upstream Blk Time (%)	0
Queuing Penalty (veh)	0
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 9001: Dummy Node A & Old Woodward Avenue

Movement	NB
Directions Served	TR
Maximum Queue (ft)	15
Average Queue (ft)	1
95th Queue (ft)	11
Link Distance (ft)	231
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Network Summary

Network wide Queuing Penalty: 45

Intersection: 1: Old Woodward Avenue & Brown Street

Movement	EB	EB	WB	WB	NB	NB	NB	SB	SB
Directions Served	LT	TR	L	TR	L	T	R	L	TR
Maximum Queue (ft)	234	200	114	200	123	200	66	96	214
Average Queue (ft)	131	75	32	95	56	76	20	26	69
95th Queue (ft)	207	161	83	165	105	148	51	67	151
Link Distance (ft)	591			424		240			492
Upstream Blk Time (%)						0			
Queuing Penalty (veh)						1			
Storage Bay Dist (ft)		375	65		75		200	75	
Storage Blk Time (%)			1	18	8	10		0	7
Queuing Penalty (veh)			2	7	19	16		1	4

Intersection: 2: SB M-1 (Woodward Avenue) & Bowers Street

Movement	EB	WB	SB	SB	SB	SB
Directions Served	TR	T	T	T	T	TR
Maximum Queue (ft)	149	34	366	325	256	186
Average Queue (ft)	74	3	277	250	167	96
95th Queue (ft)	133	19	359	334	251	168
Link Distance (ft)	141	27	295	295	295	295
Upstream Blk Time (%)	1	3	4	1	0	
Queuing Penalty (veh)	2	4	29	8	0	
Storage Bay Dist (ft)						
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 3: SB M-1 (Woodward Avenue) & Hazel Street

Movement	EB	SB	SB
Directions Served	R	T	T
Maximum Queue (ft)	57	43	25
Average Queue (ft)	21	2	1
95th Queue (ft)	49	21	18
Link Distance (ft)	232	352	352
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 4: Old Woodward Avenue & Bowers Street

Movement	WB	NB	SB	SB
Directions Served	LR	TR	L	T
Maximum Queue (ft)	156	57	48	63
Average Queue (ft)	84	3	25	13
95th Queue (ft)	144	24	52	50
Link Distance (ft)	141	425		197
Upstream Blk Time (%)	1			
Queuing Penalty (veh)	2			
Storage Bay Dist (ft)			25	
Storage Blk Time (%)			5	0
Queuing Penalty (veh)			17	1

Intersection: 5: Old Woodward Avenue & Hazel Street

Movement	WB	NB	SB
Directions Served	LR	TR	LT
Maximum Queue (ft)	79	64	98
Average Queue (ft)	39	5	13
95th Queue (ft)	66	29	56
Link Distance (ft)	232	23	231
Upstream Blk Time (%)		0	
Queuing Penalty (veh)		1	
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 6: Old Woodward Avenue & Frank Street

Movement	EB	NB	SB
Directions Served	LR	LT	TR
Maximum Queue (ft)	92	99	53
Average Queue (ft)	42	26	8
95th Queue (ft)	72	69	35
Link Distance (ft)	284	197	23
Upstream Blk Time (%)			1
Queuing Penalty (veh)			2
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 21: NB M-1 (Woodward Avenue) & Bowers Street

Movement	WB
Directions Served	TR
Maximum Queue (ft)	177
Average Queue (ft)	71
95th Queue (ft)	140
Link Distance (ft)	222
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 9001: Dummy Node A & Old Woodward Avenue

Movement	NB	NE
Directions Served	TR	R
Maximum Queue (ft)	21	35
Average Queue (ft)	1	12
95th Queue (ft)	12	37
Link Distance (ft)	231	175
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Network Summary

Network wide Queuing Penalty: 114

Appendix C

Background Conditions Data

1: Old Woodward Avenue & Brown Street

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱		↰	↑↱		↰	↑↱		↰	↑↱	
Traffic Volume (veh/h)	47	199	119	32	146	32	291	107	61	33	130	260
Future Volume (veh/h)	47	199	119	32	146	32	291	107	61	33	130	260
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		0.98	0.99		0.98	1.00		0.98	0.99		0.97
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.85	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1984	1984	1984	1938	1938	1938	1953	1953	1953	1906	1906	1906
Adj Flow Rate, veh/h	55	231	138	36	164	36	355	130	74	41	160	321
Peak Hour Factor	0.86	0.86	0.86	0.89	0.89	0.89	0.82	0.82	0.82	0.81	0.81	0.81
Percent Heavy Veh, %	1	1	1	4	4	4	3	3	3	6	6	6
Cap, veh/h	176	708	411	364	579	127	334	482	275	545	271	544
Arrive On Green	0.38	0.38	0.38	0.38	0.38	0.38	0.49	0.49	0.49	0.49	0.49	0.49
Sat Flow, veh/h	335	1875	1089	990	1532	336	903	986	562	1130	555	1114
Grp Volume(v), veh/h	224	0	200	36	0	200	355	0	204	41	0	481
Grp Sat Flow(s),veh/h/ln	1719	0	1580	990	0	1868	903	0	1548	1130	0	1669
Q Serve(g_s), s	1.3	0.0	8.1	2.4	0.0	6.7	25.4	0.0	7.0	2.0	0.0	18.6
Cycle Q Clear(g_c), s	8.0	0.0	8.1	10.5	0.0	6.7	44.0	0.0	7.0	9.0	0.0	18.6
Prop In Lane	0.25		0.69	1.00		0.18	1.00		0.36	1.00		0.67
Lane Grp Cap(c), veh/h	699	0	597	364	0	706	334	0	757	545	0	816
V/C Ratio(X)	0.32	0.00	0.34	0.10	0.00	0.28	1.06	0.00	0.27	0.08	0.00	0.59
Avail Cap(c_a), veh/h	699	0	597	364	0	706	334	0	757	545	0	816
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	19.7	0.0	20.0	23.7	0.0	19.5	35.3	0.0	13.5	16.2	0.0	16.5
Incr Delay (d2), s/veh	1.2	0.0	1.5	0.5	0.0	1.0	66.4	0.0	0.9	0.3	0.0	3.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.5	0.0	3.2	0.6	0.0	3.1	13.6	0.0	2.6	0.6	0.0	7.5
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	20.9	0.0	21.5	24.2	0.0	20.5	101.7	0.0	14.4	16.5	0.0	19.6
LnGrp LOS	C	A	C	C	A	C	F	A	B	B	A	B
Approach Vol, veh/h		424			236			559			522	
Approach Delay, s/veh		21.2			21.1			69.9			19.4	
Approach LOS		C			C			E			B	

Timer - Assigned Phs	2	4	6	8
Phs Duration (G+Y+Rc), s	40.0	50.0	40.0	50.0
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	34.0	44.0	34.0	44.0
Max Q Clear Time (g_c+I1), s	10.1	20.6	12.5	46.0
Green Ext Time (p_c), s	2.9	3.9	1.3	0.0

Intersection Summary	
HCM 6th Ctrl Delay	36.3
HCM 6th LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↱			↑						↑↑↑↱	
Traffic Volume (vph)	0	56	32	0	106	0	0	0	0	0	2296	14
Future Volume (vph)	0	56	32	0	106	0	0	0	0	0	2296	14
Ideal Flow (vphpl)	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Total Lost time (s)		9.3			5.3						5.7	
Lane Util. Factor		1.00			1.00						0.86	
Frt		0.95			1.00						1.00	
Flt Protected		1.00			1.00						1.00	
Satd. Flow (prot)		1483			1835						6739	
Flt Permitted		1.00			1.00						1.00	
Satd. Flow (perm)		1483			1835						6739	
Peak-hour factor, PHF	0.86	0.86	0.86	0.63	0.63	0.63	0.92	0.92	0.92	0.95	0.95	0.95
Adj. Flow (vph)	0	65	37	0	168	0	0	0	0	0	2417	15
RTOR Reduction (vph)	0	4	0	0	0	0	0	0	0	0	1	0
Lane Group Flow (vph)	0	98	0	0	168	0	0	0	0	0	2431	0
Heavy Vehicles (%)	9%	9%	9%	9%	9%	9%	2%	2%	2%	2%	2%	2%
Parking (#/hr)		10										
Turn Type		NA			NA						NA	
Protected Phases		4			8						6	
Permitted Phases												
Actuated Green, G (s)		19.7			23.7						55.3	
Effective Green, g (s)		19.7			23.7						55.3	
Actuated g/C Ratio		0.22			0.26						0.61	
Clearance Time (s)		9.3			5.3						5.7	
Lane Grp Cap (vph)		324			483						4140	
v/s Ratio Prot		0.07			c0.09						c0.36	
v/s Ratio Perm												
v/c Ratio		0.30			0.35						0.59	
Uniform Delay, d1		29.4			26.9						10.5	
Progression Factor		1.07			0.00						1.00	
Incremental Delay, d2		2.3			1.7						0.6	
Delay (s)		33.7			1.7						11.1	
Level of Service		C			A						B	
Approach Delay (s)		33.7			1.7			0.0			11.1	
Approach LOS		C			A			A			B	

Intersection Summary

HCM 2000 Control Delay	11.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	49.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

3: SB M-1 (Woodward Avenue) & Hazel Street

AM Peak Hour

	↗	↘	↖	↑	↓	↙
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations		↱			↑↑↑↱	
Traffic Volume (veh/h)	0	17	0	0	2293	51
Future Volume (Veh/h)	0	17	0	0	2293	51
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.60	0.60	0.92	0.92	0.95	0.95
Hourly flow rate (vph)	0	28	0	0	2414	54
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)				380		
pX, platoon unblocked						
vC, conflicting volume	2441	630	2468			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2441	630	2468			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	93	100			
cM capacity (veh/h)	27	429	191			

Direction, Lane #	EB 1	SB 1	SB 2	SB 3	SB 4
Volume Total	28	690	690	690	399
Volume Left	0	0	0	0	0
Volume Right	28	0	0	0	54
cSH	429	1700	1700	1700	1700
Volume to Capacity	0.07	0.41	0.41	0.41	0.23
Queue Length 95th (ft)	5	0	0	0	0
Control Delay (s)	14.0	0.0	0.0	0.0	0.0
Lane LOS	B				
Approach Delay (s)	14.0	0.0			
Approach LOS	B				

Intersection Summary			
Average Delay	0.2		
Intersection Capacity Utilization	42.4%	ICU Level of Service	A
Analysis Period (min)	15		

4: Old Woodward Avenue & Bowers Street

Intersection	
Int Delay, s/veh	3.8

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	⅄		↱		↰	↑
Traffic Vol, veh/h	20	100	466	10	78	154
Future Vol, veh/h	20	100	466	10	78	154
Conflicting Peds, #/hr	0	4	0	13	13	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	75	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	76	76	74	74	85	85
Heavy Vehicles, %	7	7	2	2	4	4
Mvmt Flow	26	132	630	14	92	181

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1015	654	0	0	657	0
Stage 1	650	-	-	-	-	-
Stage 2	365	-	-	-	-	-
Critical Hdwy	6.47	6.27	-	-	4.14	-
Critical Hdwy Stg 1	5.47	-	-	-	-	-
Critical Hdwy Stg 2	5.47	-	-	-	-	-
Follow-up Hdwy	3.563	3.363	-	-	2.236	-
Pot Cap-1 Maneuver	258	458	-	-	921	-
Stage 1	510	-	-	-	-	-
Stage 2	691	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	229	451	-	-	910	-
Mov Cap-2 Maneuver	229	-	-	-	-	-
Stage 1	453	-	-	-	-	-
Stage 2	691	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	20.5	0	3.2
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	388	910	-
HCM Lane V/C Ratio	-	-	0.407	0.101	-
HCM Control Delay (s)	-	-	20.5	9.4	-
HCM Lane LOS	-	-	C	A	-
HCM 95th %tile Q(veh)	-	-	1.9	0.3	-

Intersection	
Int Delay, s/veh	1.2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↱		↱		↰	↑
Traffic Vol, veh/h	18	33	522	8	9	205
Future Vol, veh/h	18	33	522	8	9	205
Conflicting Peds, #/hr	11	0	0	18	18	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	125	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	78	78	81	81	88	88
Heavy Vehicles, %	2	2	3	3	5	5
Mvmt Flow	23	42	644	10	10	233

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	931	667	0	0	672	0
Stage 1	667	-	-	-	-	-
Stage 2	264	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.15	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.245	-
Pot Cap-1 Maneuver	296	459	-	-	905	-
Stage 1	510	-	-	-	-	-
Stage 2	780	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	285	451	-	-	889	-
Mov Cap-2 Maneuver	285	-	-	-	-	-
Stage 1	496	-	-	-	-	-
Stage 2	772	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	16.7	0	0.4
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	374	889	-
HCM Lane V/C Ratio	-	-	0.175	0.012	-
HCM Control Delay (s)	-	-	16.7	9.1	-
HCM Lane LOS	-	-	C	A	-
HCM 95th %tile Q(veh)	-	-	0.6	0	-

6: Old Woodward Avenue & Frank Street

Intersection	
Int Delay, s/veh	1.5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	↰↱		↰	↑	↱	
Traffic Vol, veh/h	24	31	60	506	201	22
Future Vol, veh/h	24	31	60	506	201	22
Conflicting Peds, #/hr	11	0	6	0	0	6
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	50	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	81	81	88	88
Heavy Vehicles, %	0	0	3	3	5	5
Mvmt Flow	27	34	74	625	228	25

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1031	247	259	0	-	0
Stage 1	247	-	-	-	-	-
Stage 2	784	-	-	-	-	-
Critical Hdwy	6.4	6.2	4.13	-	-	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	2.227	-	-	-
Pot Cap-1 Maneuver	261	797	1300	-	-	-
Stage 1	799	-	-	-	-	-
Stage 2	453	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	243	792	1293	-	-	-
Mov Cap-2 Maneuver	243	-	-	-	-	-
Stage 1	749	-	-	-	-	-
Stage 2	450	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	15.6	0.8	0
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1293	-	399	-	-
HCM Lane V/C Ratio	0.057	-	0.153	-	-
HCM Control Delay (s)	8	-	15.6	-	-
HCM Lane LOS	A	-	C	-	-
HCM 95th %tile Q(veh)	0.2	-	0.5	-	-

HCM 6th Signalized Intersection Summary
1: Old Woodward Avenue & Brown Street

Background Conditions
PM Peak Hour

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱		↰	↱		↰	↱		↰	↱	
Traffic Volume (veh/h)	64	290	203	38	202	61	126	188	57	99	193	168
Future Volume (veh/h)	64	290	203	38	202	61	126	188	57	99	193	168
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		0.97	1.00		0.97	0.99		0.98	0.99		0.97
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.85	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1984	1984	1984	2000	2000	2000	1953	1953	1953	1953	1953	1953
Adj Flow Rate, veh/h	72	326	228	44	235	71	147	219	66	104	203	177
Peak Hour Factor	0.89	0.89	0.89	0.86	0.86	0.86	0.86	0.86	0.86	0.95	0.95	0.95
Percent Heavy Veh, %	1	1	1	0	0	0	3	3	3	3	3	3
Cap, veh/h	162	715	506	328	618	187	368	541	163	427	421	367
Arrive On Green	0.42	0.42	0.42	0.42	0.42	0.42	0.44	0.44	0.44	0.44	0.44	0.44
Sat Flow, veh/h	269	1693	1198	865	1464	442	985	1218	367	1077	947	825
Grp Volume(v), veh/h	331	0	295	44	0	306	147	0	285	104	0	380
Grp Sat Flow(s),veh/h/ln	1608	0	1552	865	0	1906	985	0	1585	1077	0	1772
Q Serve(g_s), s	4.7	0.0	12.2	3.4	0.0	9.9	11.2	0.0	11.0	6.5	0.0	13.7
Cycle Q Clear(g_c), s	14.7	0.0	12.2	15.7	0.0	9.9	24.8	0.0	11.0	17.5	0.0	13.7
Prop In Lane	0.22		0.77	1.00		0.23	1.00		0.23	1.00		0.47
Lane Grp Cap(c), veh/h	728	0	655	328	0	805	368	0	705	427	0	787
V/C Ratio(X)	0.45	0.00	0.45	0.13	0.00	0.38	0.40	0.00	0.40	0.24	0.00	0.48
Avail Cap(c_a), veh/h	728	0	655	328	0	805	368	0	705	427	0	787
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	18.8	0.0	18.6	24.1	0.0	17.9	26.5	0.0	16.9	22.9	0.0	17.7
Incr Delay (d2), s/veh	2.0	0.0	2.2	0.9	0.0	1.4	3.2	0.0	1.7	1.3	0.0	2.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	5.4	0.0	4.7	0.8	0.0	4.6	2.9	0.0	4.2	1.8	0.0	5.9
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	20.8	0.0	20.8	25.0	0.0	19.3	29.7	0.0	18.7	24.2	0.0	19.8
LnGrp LOS	C	A	C	C	A	B	C	A	B	C	A	B
Approach Vol, veh/h		626			350			432			484	
Approach Delay, s/veh		20.8			20.0			22.4			20.7	
Approach LOS		C			B			C			C	

Timer - Assigned Phs		2		4		6		8				
Phs Duration (G+Y+Rc), s		44.0		46.0		44.0		46.0				
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0				
Max Green Setting (Gmax), s		38.0		40.0		38.0		40.0				
Max Q Clear Time (g_c+I1), s		16.7		19.5		17.7		26.8				
Green Ext Time (p_c), s		4.4		3.0		2.2		2.1				

Intersection Summary			
HCM 6th Ctrl Delay			21.0
HCM 6th LOS			C

2: SB M-1 (Woodward Avenue) & Bowers Street

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↱			↑						↑↑↑↱	
Traffic Volume (vph)	0	94	48	0	129	0	0	0	0	0	3155	64
Future Volume (vph)	0	94	48	0	129	0	0	0	0	0	3155	64
Ideal Flow (vphpl)	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Total Lost time (s)		9.3			5.3						5.7	
Lane Util. Factor		1.00			1.00						0.86	
Frt		0.95			1.00						1.00	
Flt Protected		1.00			1.00						1.00	
Satd. Flow (prot)		1575			1869						6792	
Flt Permitted		1.00			1.00						1.00	
Satd. Flow (perm)		1575			1869						6792	
Peak-hour factor, PHF	0.83	0.83	0.83	0.86	0.86	0.86	0.92	0.92	0.92	0.95	0.95	0.95
Adj. Flow (vph)	0	113	58	0	150	0	0	0	0	0	3321	67
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	3	0
Lane Group Flow (vph)	0	171	0	0	150	0	0	0	0	0	3385	0
Heavy Vehicles (%)	3%	3%	3%	7%	7%	7%	2%	2%	2%	1%	1%	1%
Parking (#/hr)		10										
Turn Type		NA			NA						NA	
Protected Phases		4			8						6	
Permitted Phases												
Actuated Green, G (s)		19.7			23.7						55.3	
Effective Green, g (s)		19.7			23.7						55.3	
Actuated g/C Ratio		0.22			0.26						0.61	
Clearance Time (s)		9.3			5.3						5.7	
Lane Grp Cap (vph)		344			492						4173	
v/s Ratio Prot		c0.11			0.08						c0.50	
v/s Ratio Perm												
v/c Ratio		0.50			0.30						0.81	
Uniform Delay, d1		30.8			26.6						13.3	
Progression Factor		0.90			0.00						1.00	
Incremental Delay, d2		5.0			1.5						1.8	
Delay (s)		32.8			1.5						15.2	
Level of Service		C			A						B	
Approach Delay (s)		32.8			1.5			0.0			15.2	
Approach LOS		C			A			A			B	

Intersection Summary			
HCM 2000 Control Delay	15.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	64.4%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

3: SB M-1 (Woodward Avenue) & Hazel Street

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations		↱			↑↑↑↱	
Traffic Volume (veh/h)	0	36	0	0	3183	100
Future Volume (Veh/h)	0	36	0	0	3183	100
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.71	0.71	0.92	0.92	0.95	0.95
Hourly flow rate (vph)	0	51	0	0	3351	105
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)				380		
pX, platoon unblocked						
vC, conflicting volume	3404	890	3456			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	3404	890	3456			
tC, single (s)	6.9	7.0	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	82	100			
cM capacity (veh/h)	5	284	77			

Direction, Lane #	EB 1	SB 1	SB 2	SB 3	SB 4
Volume Total	51	957	957	957	584
Volume Left	0	0	0	0	0
Volume Right	51	0	0	0	105
cSH	284	1700	1700	1700	1700
Volume to Capacity	0.18	0.56	0.56	0.56	0.34
Queue Length 95th (ft)	16	0	0	0	0
Control Delay (s)	20.4	0.0	0.0	0.0	0.0
Lane LOS	C				
Approach Delay (s)	20.4	0.0			
Approach LOS	C				

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	55.4%	ICU Level of Service	B
Analysis Period (min)	15		

Intersection	
Int Delay, s/veh	6.7

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↱		↱		↰	↑
Traffic Vol, veh/h	83	110	262	30	112	377
Future Vol, veh/h	83	110	262	30	112	377
Conflicting Peds, #/hr	5	10	0	26	26	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	75	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	93	93	71	71	94	94
Heavy Vehicles, %	6	6	0	0	2	2
Mvmt Flow	89	118	369	42	119	401

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1060	426	0	0	437	0
Stage 1	416	-	-	-	-	-
Stage 2	644	-	-	-	-	-
Critical Hdwy	6.46	6.26	-	-	4.12	-
Critical Hdwy Stg 1	5.46	-	-	-	-	-
Critical Hdwy Stg 2	5.46	-	-	-	-	-
Follow-up Hdwy	3.554	3.354	-	-	2.218	-
Pot Cap-1 Maneuver	244	620	-	-	1123	-
Stage 1	657	-	-	-	-	-
Stage 2	515	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	211	599	-	-	1095	-
Mov Cap-2 Maneuver	211	-	-	-	-	-
Stage 1	571	-	-	-	-	-
Stage 2	512	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	31.9	0	2
HCM LOS	D		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	334	1095	-
HCM Lane V/C Ratio	-	-	0.621	0.109	-
HCM Control Delay (s)	-	-	31.9	8.7	-
HCM Lane LOS	-	-	D	A	-
HCM 95th %tile Q(veh)	-	-	3.9	0.4	-

Intersection	
Int Delay, s/veh	2.7

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↱		↱		↰	↑
Traffic Vol, veh/h	46	54	342	14	22	427
Future Vol, veh/h	46	54	342	14	22	427
Conflicting Peds, #/hr	11	0	0	14	14	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	125	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	73	73	80	80	93	93
Heavy Vehicles, %	0	0	3	3	3	3
Mvmt Flow	63	74	428	18	24	459

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	969	451	0	0	460	0
Stage 1	451	-	-	-	-	-
Stage 2	518	-	-	-	-	-
Critical Hdwy	6.4	6.2	-	-	4.13	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	-	-	2.227	-
Pot Cap-1 Maneuver	284	613	-	-	1096	-
Stage 1	646	-	-	-	-	-
Stage 2	602	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	272	605	-	-	1081	-
Mov Cap-2 Maneuver	272	-	-	-	-	-
Stage 1	623	-	-	-	-	-
Stage 2	596	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	19.3	0	0.4
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	387	1081	-
HCM Lane V/C Ratio	-	-	0.354	0.022	-
HCM Control Delay (s)	-	-	19.3	8.4	-
HCM Lane LOS	-	-	C	A	-
HCM 95th %tile Q(veh)	-	-	1.6	0.1	-

6: Old Woodward Avenue & Frank Street

Intersection	
Int Delay, s/veh	3.3

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	Y		↰	↑	↱	
Traffic Vol, veh/h	43	69	59	313	420	53
Future Vol, veh/h	43	69	59	313	420	53
Conflicting Peds, #/hr	11	0	12	0	0	12
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	50	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	79	79	80	80	93	93
Heavy Vehicles, %	2	2	3	3	3	3
Mvmt Flow	54	87	74	391	452	57

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1043	493	521	0	-	0
Stage 1	493	-	-	-	-	-
Stage 2	550	-	-	-	-	-
Critical Hdwy	6.42	6.22	4.13	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	2.227	-	-	-
Pot Cap-1 Maneuver	254	576	1040	-	-	-
Stage 1	614	-	-	-	-	-
Stage 2	578	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	231	569	1028	-	-	-
Mov Cap-2 Maneuver	231	-	-	-	-	-
Stage 1	564	-	-	-	-	-
Stage 2	572	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	21.1	1.4	0
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1028	-	364	-	-
HCM Lane V/C Ratio	0.072	-	0.389	-	-
HCM Control Delay (s)	8.8	-	21.1	-	-
HCM Lane LOS	A	-	C	-	-
HCM 95th %tile Q(veh)	0.2	-	1.8	-	-

Intersection: 1: Old Woodward Avenue & Brown Street

Movement	EB	EB	WB	WB	NB	NB	SB	SB
Directions Served	LT	TR	L	TR	L	TR	L	TR
Maximum Queue (ft)	192	159	90	154	175	279	81	269
Average Queue (ft)	100	46	22	78	156	180	16	111
95th Queue (ft)	168	108	66	142	209	338	52	216
Link Distance (ft)	591			423		237		492
Upstream Blk Time (%)						25		
Queuing Penalty (veh)						120		
Storage Bay Dist (ft)		375	65		125		75	
Storage Blk Time (%)			0	12	52	2	0	14
Queuing Penalty (veh)			1	4	89	7	0	5

Intersection: 2: SB M-1 (Woodward Avenue) & Bowers Street

Movement	EB	WB	SB	SB	SB	SB
Directions Served	TR	T	T	T	T	TR
Maximum Queue (ft)	110	20	277	264	195	108
Average Queue (ft)	47	4	198	170	103	39
95th Queue (ft)	96	22	260	240	175	90
Link Distance (ft)	141	27	295	295	295	295
Upstream Blk Time (%)	0	9	0	0		
Queuing Penalty (veh)	0	11	0	0		
Storage Bay Dist (ft)						
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 3: SB M-1 (Woodward Avenue) & Hazel Street

Movement	EB	SB	SB
Directions Served	R	T	TR
Maximum Queue (ft)	32	112	145
Average Queue (ft)	10	18	23
95th Queue (ft)	33	127	151
Link Distance (ft)	226	352	352
Upstream Blk Time (%)		0	1
Queuing Penalty (veh)		0	0
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 4: Old Woodward Avenue & Bowers Street

Movement	WB	NB	SB	SB
Directions Served	LR	TR	L	T
Maximum Queue (ft)	154	217	68	53
Average Queue (ft)	76	33	24	4
95th Queue (ft)	145	196	59	43
Link Distance (ft)	141	425		198
Upstream Blk Time (%)	7	3		0
Queuing Penalty (veh)	10	0		1
Storage Bay Dist (ft)			75	
Storage Blk Time (%)			1	
Queuing Penalty (veh)			2	

Intersection: 5: Old Woodward Avenue & Hazel Street

Movement	WB	NB	SB	SB
Directions Served	LR	TR	L	T
Maximum Queue (ft)	172	114	62	63
Average Queue (ft)	65	27	7	4
95th Queue (ft)	184	97	37	44
Link Distance (ft)	226	23		231
Upstream Blk Time (%)	9	14		0
Queuing Penalty (veh)	4	80		0
Storage Bay Dist (ft)			125	
Storage Blk Time (%)				1
Queuing Penalty (veh)				0

Intersection: 6: Old Woodward Avenue & Frank Street

Movement	EB	NB	NB	SB
Directions Served	LR	L	T	TR
Maximum Queue (ft)	196	70	223	44
Average Queue (ft)	65	18	51	3
95th Queue (ft)	196	59	205	23
Link Distance (ft)	279		198	23
Upstream Blk Time (%)	7		8	1
Queuing Penalty (veh)	0		50	2
Storage Bay Dist (ft)		50		
Storage Blk Time (%)		0	13	
Queuing Penalty (veh)		1	8	

Intersection: 21: NB M-1 (Woodward Avenue) & Bowers Street

Movement	WB
Directions Served	TR
Maximum Queue (ft)	214
Average Queue (ft)	75
95th Queue (ft)	185
Link Distance (ft)	222
Upstream Blk Time (%)	6
Queuing Penalty (veh)	0
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 9001: Old Woodward Avenue & Dummy Node A

Movement	NB
Directions Served	TR
Maximum Queue (ft)	325
Average Queue (ft)	135
95th Queue (ft)	355
Link Distance (ft)	231
Upstream Blk Time (%)	19
Queuing Penalty (veh)	113
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Network Summary

Network wide Queuing Penalty: 510

Intersection: 1: Old Woodward Avenue & Brown Street

Movement	EB	EB	WB	WB	NB	NB	SB	SB
Directions Served	LT	TR	L	TR	L	TR	L	TR
Maximum Queue (ft)	259	218	101	227	171	206	129	246
Average Queue (ft)	140	91	26	106	76	88	44	120
95th Queue (ft)	229	189	73	193	144	161	96	216
Link Distance (ft)	591			423		237		492
Upstream Blk Time (%)						0		
Queuing Penalty (veh)						0		
Storage Bay Dist (ft)		375	65		125		75	
Storage Blk Time (%)			0	18	2	2	2	18
Queuing Penalty (veh)			0	7	5	3	6	18

Intersection: 2: SB M-1 (Woodward Avenue) & Bowers Street

Movement	EB	WB	SB	SB	SB	SB
Directions Served	TR	T	T	T	T	TR
Maximum Queue (ft)	141	25	390	339	300	218
Average Queue (ft)	73	2	304	264	199	114
95th Queue (ft)	130	16	391	342	291	195
Link Distance (ft)	141	27	295	295	295	295
Upstream Blk Time (%)	1	3	7	2	0	
Queuing Penalty (veh)	2	4	54	13	1	
Storage Bay Dist (ft)						
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 3: SB M-1 (Woodward Avenue) & Hazel Street

Movement	EB	SB	SB
Directions Served	R	T	T
Maximum Queue (ft)	58	102	62
Average Queue (ft)	22	10	3
95th Queue (ft)	49	57	34
Link Distance (ft)	226	352	352
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 4: Old Woodward Avenue & Bowers Street

Movement	WB	NB	SB	SB
Directions Served	LR	TR	L	T
Maximum Queue (ft)	157	76	77	66
Average Queue (ft)	85	4	26	5
95th Queue (ft)	146	33	59	31
Link Distance (ft)	141	425		198
Upstream Blk Time (%)	2			
Queuing Penalty (veh)	4			
Storage Bay Dist (ft)			75	
Storage Blk Time (%)			0	0
Queuing Penalty (veh)			1	0

Intersection: 5: Old Woodward Avenue & Hazel Street

Movement	WB	NB	SB	SB
Directions Served	LR	TR	L	T
Maximum Queue (ft)	89	42	35	56
Average Queue (ft)	37	3	8	4
95th Queue (ft)	68	21	31	24
Link Distance (ft)	226	23		231
Upstream Blk Time (%)		0		
Queuing Penalty (veh)		1		
Storage Bay Dist (ft)			125	
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 6: Old Woodward Avenue & Frank Street

Movement	EB	NB	NB	SB
Directions Served	LR	L	T	TR
Maximum Queue (ft)	126	43	62	48
Average Queue (ft)	45	19	3	7
95th Queue (ft)	83	44	25	31
Link Distance (ft)	279		198	23
Upstream Blk Time (%)				0
Queuing Penalty (veh)				2
Storage Bay Dist (ft)		50		
Storage Blk Time (%)		0	0	
Queuing Penalty (veh)		0	0	

Intersection: 21: NB M-1 (Woodward Avenue) & Bowers Street

Movement	WB
Directions Served	TR
Maximum Queue (ft)	158
Average Queue (ft)	70
95th Queue (ft)	137
Link Distance (ft)	222
Upstream Blk Time (%)	0
Queuing Penalty (veh)	0
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 9001: Dummy Node A & Old Woodward Avenue

Movement	NB	NE
Directions Served	TR	R
Maximum Queue (ft)	15	39
Average Queue (ft)	1	13
95th Queue (ft)	11	38
Link Distance (ft)	231	169
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Network Summary

Network wide Queuing Penalty: 122

HCM 6th Signalized Intersection Summary

1: Old Woodward Avenue & Brown Street

Background Conditions W / Improvements

AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱		↰	↑↱		↰	↑↱		↰	↑↱	
Traffic Volume (veh/h)	47	199	119	32	146	32	291	107	61	33	130	260
Future Volume (veh/h)	47	199	119	32	146	32	291	107	61	33	130	260
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.98		0.96	0.98		0.96	0.99		0.99	0.99		0.98
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.85	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1984	1984	1984	1938	1938	1938	1953	1953	1953	1906	1906	1906
Adj Flow Rate, veh/h	55	231	138	36	164	36	355	130	74	41	160	321
Peak Hour Factor	0.86	0.86	0.86	0.89	0.89	0.89	0.82	0.82	0.82	0.81	0.81	0.81
Percent Heavy Veh, %	1	1	1	4	4	4	3	3	3	6	6	6
Cap, veh/h	99	348	223	171	322	71	546	648	369	763	366	734
Arrive On Green	0.21	0.21	0.21	0.21	0.21	0.21	0.66	0.66	0.66	0.66	0.66	0.66
Sat Flow, veh/h	233	1650	1055	981	1526	335	902	988	562	1132	558	1119
Grp Volume(v), veh/h	219	0	205	36	0	200	355	0	204	41	0	481
Grp Sat Flow(s),veh/h/ln	1374	0	1564	981	0	1861	902	0	1551	1132	0	1677
Q Serve(g_s), s	6.1	0.0	10.7	3.1	0.0	8.6	28.2	0.0	4.7	1.3	0.0	12.5
Cycle Q Clear(g_c), s	14.7	0.0	10.7	13.8	0.0	8.6	40.7	0.0	4.7	6.0	0.0	12.5
Prop In Lane	0.25		0.67	1.00		0.18	1.00		0.36	1.00		0.67
Lane Grp Cap(c), veh/h	340	0	330	171	0	393	546	0	1017	763	0	1099
V/C Ratio(X)	0.65	0.00	0.62	0.21	0.00	0.51	0.65	0.00	0.20	0.05	0.00	0.44
Avail Cap(c_a), veh/h	340	0	330	171	0	393	546	0	1017	763	0	1099
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	33.8	0.0	32.2	38.5	0.0	31.4	17.3	0.0	6.1	7.3	0.0	7.5
Incr Delay (d2), s/veh	9.1	0.0	8.5	2.8	0.0	4.7	5.9	0.0	0.4	0.1	0.0	1.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	5.4	0.0	4.8	0.9	0.0	4.3	6.4	0.0	1.5	0.3	0.0	4.4
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	42.9	0.0	40.7	41.3	0.0	36.0	23.2	0.0	6.6	7.5	0.0	8.8
LnGrp LOS	D	A	D	D	A	D	C	A	A	A	A	A
Approach Vol, veh/h		424			236			559			522	
Approach Delay, s/veh		41.8			36.8			17.1			8.7	
Approach LOS		D			D			B			A	

Timer - Assigned Phs		2		4		6		8				
Phs Duration (G+Y+Rc), s		25.0		65.0		25.0		65.0				
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0				
Max Green Setting (Gmax), s		19.0		59.0		19.0		59.0				
Max Q Clear Time (g_c+I1), s		16.7		14.5		15.8		42.7				
Green Ext Time (p_c), s		0.6		4.3		0.4		3.2				

Intersection Summary			
HCM 6th Ctrl Delay			23.3
HCM 6th LOS			C

Intersection: 1: Old Woodward Avenue & Brown Street

Movement	EB	EB	WB	WB	NB	NB	SB	SB
Directions Served	LT	TR	L	TR	L	TR	L	TR
Maximum Queue (ft)	249	199	104	212	175	277	63	213
Average Queue (ft)	132	84	28	102	108	74	13	80
95th Queue (ft)	212	172	76	178	184	221	58	158
Link Distance (ft)	591			423		237		492
Upstream Blk Time (%)						4		
Queuing Penalty (veh)						23		
Storage Bay Dist (ft)		375	65		125		75	
Storage Blk Time (%)			1	25	15	0	0	6
Queuing Penalty (veh)			2	8	27	0	0	2

Intersection: 2: SB M-1 (Woodward Avenue) & Bowers Street

Movement	EB	WB	SB	SB	SB	SB
Directions Served	TR	T	T	T	T	TR
Maximum Queue (ft)	131	5	316	295	208	115
Average Queue (ft)	46	0	206	177	105	48
95th Queue (ft)	97	4	277	262	175	104
Link Distance (ft)	141	27	295	295	295	295
Upstream Blk Time (%)	0	0	0	0		
Queuing Penalty (veh)	0	0	1	0		
Storage Bay Dist (ft)						
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 3: SB M-1 (Woodward Avenue) & Hazel Street

Movement	EB
Directions Served	R
Maximum Queue (ft)	33
Average Queue (ft)	13
95th Queue (ft)	36
Link Distance (ft)	226
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 4: Old Woodward Avenue & Bowers Street

Movement	WB	NB	SB	SB
Directions Served	LR	TR	L	T
Maximum Queue (ft)	147	87	58	22
Average Queue (ft)	65	5	24	1
95th Queue (ft)	122	57	53	11
Link Distance (ft)	141	425		198
Upstream Blk Time (%)	1			
Queuing Penalty (veh)	2			
Storage Bay Dist (ft)			75	
Storage Blk Time (%)			0	
Queuing Penalty (veh)			0	

Intersection: 5: Old Woodward Avenue & Hazel Street

Movement	WB	NB	SB	SB
Directions Served	LR	TR	L	T
Maximum Queue (ft)	81	64	44	52
Average Queue (ft)	31	4	5	2
95th Queue (ft)	64	31	26	22
Link Distance (ft)	226	23		231
Upstream Blk Time (%)		1		
Queuing Penalty (veh)		6		
Storage Bay Dist (ft)			125	
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 6: Old Woodward Avenue & Frank Street

Movement	EB	NB	NB	SB
Directions Served	LR	L	T	TR
Maximum Queue (ft)	87	51	130	22
Average Queue (ft)	31	12	9	1
95th Queue (ft)	63	39	70	10
Link Distance (ft)	279		198	23
Upstream Blk Time (%)			1	0
Queuing Penalty (veh)			4	0
Storage Bay Dist (ft)		50		
Storage Blk Time (%)		0	1	
Queuing Penalty (veh)		1	1	

Intersection: 21: NB M-1 (Woodward Avenue) & Bowers Street

Movement	WB
Directions Served	TR
Maximum Queue (ft)	147
Average Queue (ft)	53
95th Queue (ft)	117
Link Distance (ft)	222
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 9001: Old Woodward Avenue & Dummy Node A

Movement	NB
Directions Served	TR
Maximum Queue (ft)	206
Average Queue (ft)	25
95th Queue (ft)	137
Link Distance (ft)	231
Upstream Blk Time (%)	2
Queuing Penalty (veh)	12
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Network Summary

Network wide Queuing Penalty: 91

Appendix D

Future Conditions Data

HCM 6th Signalized Intersection Summary
1: Old Woodward Avenue & Brown Street

Future Conditions
AM Peak Hour

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱		↰	↑↱		↰	↑↱		↰	↑↱	
Traffic Volume (veh/h)	47	199	122	32	146	32	294	112	99	33	138	260
Future Volume (veh/h)	47	199	122	32	146	32	294	112	99	33	138	260
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		0.98	0.99		0.98	1.00		0.98	0.99		0.97
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.85	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1984	1984	1984	1938	1938	1938	1953	1953	1953	1906	1906	1906
Adj Flow Rate, veh/h	55	231	142	36	164	36	359	137	121	41	170	321
Peak Hour Factor	0.86	0.86	0.86	0.89	0.89	0.89	0.82	0.82	0.82	0.81	0.81	0.81
Percent Heavy Veh, %	1	1	1	4	4	4	3	3	3	6	6	6
Cap, veh/h	175	703	419	362	579	127	327	394	348	494	283	535
Arrive On Green	0.38	0.38	0.38	0.38	0.38	0.38	0.49	0.49	0.49	0.49	0.49	0.49
Sat Flow, veh/h	332	1861	1109	986	1532	336	895	806	712	1078	579	1094
Grp Volume(v), veh/h	226	0	202	36	0	200	359	0	258	41	0	491
Grp Sat Flow(s),veh/h/ln	1726	0	1576	986	0	1868	895	0	1518	1078	0	1673
Q Serve(g_s), s	1.3	0.0	8.2	2.4	0.0	6.7	24.9	0.0	9.4	2.2	0.0	19.1
Cycle Q Clear(g_c), s	8.0	0.0	8.2	10.7	0.0	6.7	44.0	0.0	9.4	11.6	0.0	19.1
Prop In Lane	0.24		0.70	1.00		0.18	1.00		0.47	1.00		0.65
Lane Grp Cap(c), veh/h	702	0	595	362	0	706	327	0	742	494	0	818
V/C Ratio(X)	0.32	0.00	0.34	0.10	0.00	0.28	1.10	0.00	0.35	0.08	0.00	0.60
Avail Cap(c_a), veh/h	702	0	595	362	0	706	327	0	742	494	0	818
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	19.7	0.0	20.0	23.8	0.0	19.5	35.6	0.0	14.2	17.7	0.0	16.6
Incr Delay (d2), s/veh	1.2	0.0	1.5	0.5	0.0	1.0	78.1	0.0	1.3	0.3	0.0	3.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.5	0.0	3.2	0.6	0.0	3.1	14.4	0.0	3.4	0.6	0.0	7.8
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	20.9	0.0	21.5	24.3	0.0	20.5	113.7	0.0	15.4	18.1	0.0	19.9
LnGrp LOS	C	A	C	C	A	C	F	A	B	B	A	B
Approach Vol, veh/h		428			236			617			532	
Approach Delay, s/veh		21.2			21.1			72.6			19.7	
Approach LOS		C			C			E			B	

Timer - Assigned Phs		2		4		6		8				
Phs Duration (G+Y+Rc), s		40.0		50.0		40.0		50.0				
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0				
Max Green Setting (Gmax), s		34.0		44.0		34.0		44.0				
Max Q Clear Time (g_c+I1), s		10.2		21.1		12.7		46.0				
Green Ext Time (p_c), s		2.9		3.9		1.3		0.0				

Intersection Summary			
HCM 6th Ctrl Delay			38.3
HCM 6th LOS			D

HCM Signalized Intersection Capacity Analysis
2: SB M-1 (Woodward Avenue) & Bowers Street

Future Conditions
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↱			↑						↑↑↑↱	
Traffic Volume (vph)	0	56	32	0	106	0	0	0	0	0	2311	26
Future Volume (vph)	0	56	32	0	106	0	0	0	0	0	2311	26
Ideal Flow (vphpl)	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Total Lost time (s)		9.3			5.3						5.7	
Lane Util. Factor		1.00			1.00						0.86	
Frt		0.95			1.00						1.00	
Flt Protected		1.00			1.00						1.00	
Satd. Flow (prot)		1483			1835						6734	
Flt Permitted		1.00			1.00						1.00	
Satd. Flow (perm)		1483			1835						6734	
Peak-hour factor, PHF	0.86	0.86	0.86	0.63	0.63	0.63	0.92	0.92	0.92	0.95	0.95	0.95
Adj. Flow (vph)	0	65	37	0	168	0	0	0	0	0	2433	27
RTOR Reduction (vph)	0	3	0	0	0	0	0	0	0	0	2	0
Lane Group Flow (vph)	0	99	0	0	168	0	0	0	0	0	2458	0
Heavy Vehicles (%)	9%	9%	9%	9%	9%	9%	2%	2%	2%	2%	2%	2%
Parking (#/hr)		10										
Turn Type		NA			NA						NA	
Protected Phases		4			8						6	
Permitted Phases												
Actuated Green, G (s)		19.7			23.7						55.3	
Effective Green, g (s)		19.7			23.7						55.3	
Actuated g/C Ratio		0.22			0.26						0.61	
Clearance Time (s)		9.3			5.3						5.7	
Lane Grp Cap (vph)		324			483						4137	
v/s Ratio Prot		0.07			c0.09						c0.37	
v/s Ratio Perm												
v/c Ratio		0.31			0.35						0.59	
Uniform Delay, d1		29.4			26.9						10.5	
Progression Factor		1.05			0.00						1.00	
Incremental Delay, d2		2.3			1.7						0.6	
Delay (s)		33.3			1.7						11.2	
Level of Service		C			A						B	
Approach Delay (s)		33.3			1.7			0.0			11.2	
Approach LOS		C			A			A			B	

Intersection Summary			
HCM 2000 Control Delay	11.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	49.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

3: SB M-1 (Woodward Avenue) & Hazel Street

	↗	↘	↖	↑	↓	↙
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations		↱			↑↑↑↱	
Traffic Volume (veh/h)	0	32	0	0	2293	101
Future Volume (Veh/h)	0	32	0	0	2293	101
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.60	0.60	0.92	0.92	0.95	0.95
Hourly flow rate (vph)	0	53	0	0	2414	106
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)				380		
pX, platoon unblocked						
vC, conflicting volume	2467	656	2520			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	2467	656	2520			
tC, single (s)	6.8	6.9	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	87	100			
cM capacity (veh/h)	26	413	182			

Direction, Lane #	EB 1	SB 1	SB 2	SB 3	SB 4
Volume Total	53	690	690	690	451
Volume Left	0	0	0	0	0
Volume Right	53	0	0	0	106
cSH	413	1700	1700	1700	1700
Volume to Capacity	0.13	0.41	0.41	0.41	0.27
Queue Length 95th (ft)	11	0	0	0	0
Control Delay (s)	15.0	0.0	0.0	0.0	0.0
Lane LOS	C				
Approach Delay (s)	15.0	0.0			
Approach LOS	C				

Intersection Summary			
Average Delay	0.3		
Intersection Capacity Utilization	43.2%	ICU Level of Service	A
Analysis Period (min)	15		

Intersection	
Int Delay, s/veh	4.2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↱		↑↱		↰	↑
Traffic Vol, veh/h	20	112	468	10	78	156
Future Vol, veh/h	20	112	468	10	78	156
Conflicting Peds, #/hr	0	4	0	13	13	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	75	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	76	76	74	74	85	85
Heavy Vehicles, %	7	7	2	2	4	4
Mvmt Flow	26	147	632	14	92	184

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1020	656	0	0	659	0
Stage 1	652	-	-	-	-	-
Stage 2	368	-	-	-	-	-
Critical Hdwy	6.47	6.27	-	-	4.14	-
Critical Hdwy Stg 1	5.47	-	-	-	-	-
Critical Hdwy Stg 2	5.47	-	-	-	-	-
Follow-up Hdwy	3.563	3.363	-	-	2.236	-
Pot Cap-1 Maneuver	257	457	-	-	920	-
Stage 1	509	-	-	-	-	-
Stage 2	689	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	228	450	-	-	909	-
Mov Cap-2 Maneuver	228	-	-	-	-	-
Stage 1	452	-	-	-	-	-
Stage 2	689	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	21.3	0	3.1
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	392	909	-
HCM Lane V/C Ratio	-	-	0.443	0.101	-
HCM Control Delay (s)	-	-	21.3	9.4	-
HCM Lane LOS	-	-	C	A	-
HCM 95th %tile Q(veh)	-	-	2.2	0.3	-

Intersection	
Int Delay, s/veh	2.2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↱		↑↱		↰	↑
Traffic Vol, veh/h	20	67	534	10	20	205
Future Vol, veh/h	20	67	534	10	20	205
Conflicting Peds, #/hr	11	0	0	18	18	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	125	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	78	78	81	81	88	88
Heavy Vehicles, %	2	2	3	3	5	5
Mvmt Flow	26	86	659	12	23	233

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	973	683	0	0	689	0
Stage 1	683	-	-	-	-	-
Stage 2	290	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.15	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.245	-
Pot Cap-1 Maneuver	280	449	-	-	891	-
Stage 1	502	-	-	-	-	-
Stage 2	759	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	265	441	-	-	876	-
Mov Cap-2 Maneuver	265	-	-	-	-	-
Stage 1	480	-	-	-	-	-
Stage 2	751	-	-	-	-	-

Approach	WB		NB		SB
HCM Control Delay, s	18.2		0		0.8
HCM LOS	C				

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	383	876	-
HCM Lane V/C Ratio	-	-	0.291	0.026	-
HCM Control Delay (s)	-	-	18.2	9.2	-
HCM Lane LOS	-	-	C	A	-
HCM 95th %tile Q(veh)	-	-	1.2	0.1	-

Intersection	
Int Delay, s/veh	1.5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	↰↱		↰	↑	↱	
Traffic Vol, veh/h	24	31	60	520	203	22
Future Vol, veh/h	24	31	60	520	203	22
Conflicting Peds, #/hr	11	0	6	0	0	6
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	50	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	81	81	88	88
Heavy Vehicles, %	0	0	3	3	5	5
Mvmt Flow	27	34	74	642	231	25

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1051	250	262	0	-	0
Stage 1	250	-	-	-	-	-
Stage 2	801	-	-	-	-	-
Critical Hdwy	6.4	6.2	4.13	-	-	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	2.227	-	-	-
Pot Cap-1 Maneuver	253	794	1296	-	-	-
Stage 1	796	-	-	-	-	-
Stage 2	445	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	236	789	1289	-	-	-
Mov Cap-2 Maneuver	236	-	-	-	-	-
Stage 1	746	-	-	-	-	-
Stage 2	442	-	-	-	-	-

Approach	EB		NB		SB
HCM Control Delay, s	15.9		0.8		0
HCM LOS	C				

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1289	-	390	-	-
HCM Lane V/C Ratio	0.057	-	0.157	-	-
HCM Control Delay (s)	8	-	15.9	-	-
HCM Lane LOS	A	-	C	-	-
HCM 95th %tile Q(veh)	0.2	-	0.6	-	-

Intersection	
Int Delay, s/veh	3.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✣			✣			✣			✣	
Traffic Vol, veh/h	13	17	0	18	51	32	0	0	0	15	0	36
Future Vol, veh/h	13	17	0	18	51	32	0	0	0	15	0	36
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	72	72	72	86	86	86	92	92	92	92	92	92
Heavy Vehicles, %	0	1	0	0	2	0	0	0	0	0	0	0
Mvmt Flow	18	24	0	21	59	37	0	0	0	16	0	39

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	96	0	0	24	0	0	199	198	24	180	180	78
Stage 1	-	-	-	-	-	-	60	60	-	120	120	-
Stage 2	-	-	-	-	-	-	139	138	-	60	60	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1510	-	-	1604	-	-	764	701	1058	786	717	988
Stage 1	-	-	-	-	-	-	957	849	-	889	800	-
Stage 2	-	-	-	-	-	-	869	786	-	957	849	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1510	-	-	1604	-	-	719	683	1058	770	698	988
Mov Cap-2 Maneuver	-	-	-	-	-	-	719	683	-	770	698	-
Stage 1	-	-	-	-	-	-	946	839	-	878	789	-
Stage 2	-	-	-	-	-	-	823	775	-	946	839	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	3.2	1.3	0	9.2
HCM LOS			A	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1510	-	-	1604	-	-	912
HCM Lane V/C Ratio	-	0.012	-	-	0.013	-	-	0.061
HCM Control Delay (s)	0	7.4	0	-	7.3	0	-	9.2
HCM Lane LOS	A	A	A	-	A	A	-	A
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	0.2

HCM 6th Signalized Intersection Summary
1: Old Woodward Avenue & Brown Street

Future Conditions
PM Peak Hour

	↗	→	↘	↙	←	↖	↖	↑	↗	↘	↓	↙
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↑↱		↰	↱		↰	↱		↰	↱	
Traffic Volume (veh/h)	64	290	207	38	202	61	129	193	94	99	202	168
Future Volume (veh/h)	64	290	207	38	202	61	129	193	94	99	202	168
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		0.97	1.00		0.97	0.99		0.98	0.99		0.97
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.85	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1984	1984	1984	2000	2000	2000	1953	1953	1953	1953	1953	1953
Adj Flow Rate, veh/h	72	326	233	44	235	71	150	224	109	104	213	177
Peak Hour Factor	0.89	0.89	0.89	0.86	0.86	0.86	0.86	0.86	0.86	0.95	0.95	0.95
Percent Heavy Veh, %	1	1	1	0	0	0	3	3	3	3	3	3
Cap, veh/h	161	710	513	325	618	187	361	465	226	383	431	358
Arrive On Green	0.42	0.42	0.42	0.42	0.42	0.42	0.44	0.44	0.44	0.44	0.44	0.44
Sat Flow, veh/h	267	1682	1215	861	1464	442	976	1047	509	1032	970	806
Grp Volume(v), veh/h	334	0	297	44	0	306	150	0	333	104	0	390
Grp Sat Flow(s),veh/h/ln	1615	0	1549	861	0	1906	976	0	1557	1032	0	1776
Q Serve(g_s), s	4.8	0.0	12.3	3.5	0.0	9.9	11.6	0.0	13.6	7.1	0.0	14.1
Cycle Q Clear(g_c), s	14.7	0.0	12.3	15.8	0.0	9.9	25.7	0.0	13.6	20.7	0.0	14.1
Prop In Lane	0.22		0.78	1.00		0.23	1.00		0.33	1.00		0.45
Lane Grp Cap(c), veh/h	730	0	654	325	0	805	361	0	692	383	0	789
V/C Ratio(X)	0.46	0.00	0.45	0.14	0.00	0.38	0.42	0.00	0.48	0.27	0.00	0.49
Avail Cap(c_a), veh/h	730	0	654	325	0	805	361	0	692	383	0	789
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	18.8	0.0	18.6	24.2	0.0	17.9	26.9	0.0	17.7	25.0	0.0	17.8
Incr Delay (d2), s/veh	2.1	0.0	2.3	0.9	0.0	1.4	3.5	0.0	2.4	1.7	0.0	2.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	5.5	0.0	4.7	0.8	0.0	4.6	3.0	0.0	5.2	1.9	0.0	6.1
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	20.9	0.0	20.9	25.1	0.0	19.3	30.4	0.0	20.1	26.7	0.0	20.0
LnGrp LOS	C	A	C	C	A	B	C	A	C	C	A	C
Approach Vol, veh/h		631			350			483			494	
Approach Delay, s/veh		20.9			20.0			23.3			21.4	
Approach LOS		C			B			C			C	

Timer - Assigned Phs		2		4		6		8				
Phs Duration (G+Y+Rc), s		44.0		46.0		44.0		46.0				
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0				
Max Green Setting (Gmax), s		38.0		40.0		38.0		40.0				
Max Q Clear Time (g_c+I1), s		16.7		22.7		17.8		27.7				
Green Ext Time (p_c), s		4.4		3.0		2.2		2.4				

Intersection Summary	
HCM 6th Ctrl Delay	21.4
HCM 6th LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↱			↑						↑↑↑↱	
Traffic Volume (vph)	0	94	48	0	129	0	0	0	0	0	3168	76
Future Volume (vph)	0	94	48	0	129	0	0	0	0	0	3168	76
Ideal Flow (vphpl)	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Total Lost time (s)		9.3			5.3						5.7	
Lane Util. Factor		1.00			1.00						0.86	
Frt		0.95			1.00						1.00	
Flt Protected		1.00			1.00						1.00	
Satd. Flow (prot)		1575			1869						6788	
Flt Permitted		1.00			1.00						1.00	
Satd. Flow (perm)		1575			1869						6788	
Peak-hour factor, PHF	0.83	0.83	0.83	0.86	0.86	0.86	0.92	0.92	0.92	0.95	0.95	0.95
Adj. Flow (vph)	0	113	58	0	150	0	0	0	0	0	3335	80
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	3	0
Lane Group Flow (vph)	0	171	0	0	150	0	0	0	0	0	3412	0
Heavy Vehicles (%)	3%	3%	3%	7%	7%	7%	2%	2%	2%	1%	1%	1%
Parking (#/hr)		10										
Turn Type		NA			NA						NA	
Protected Phases		4			8						6	
Permitted Phases												
Actuated Green, G (s)		19.7			23.7						55.3	
Effective Green, g (s)		19.7			23.7						55.3	
Actuated g/C Ratio		0.22			0.26						0.61	
Clearance Time (s)		9.3			5.3						5.7	
Lane Grp Cap (vph)		344			492						4170	
v/s Ratio Prot		c0.11			0.08						c0.50	
v/s Ratio Perm												
v/c Ratio		0.50			0.30						0.82	
Uniform Delay, d1		30.8			26.6						13.5	
Progression Factor		0.90			0.00						1.00	
Incremental Delay, d2		5.0			1.5						1.9	
Delay (s)		32.8			1.5						15.3	
Level of Service		C			A						B	
Approach Delay (s)		32.8			1.5			0.0			15.3	
Approach LOS		C			A			A			B	

Intersection Summary			
HCM 2000 Control Delay	15.6	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	64.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Unsignalized Intersection Capacity Analysis
3: SB M-1 (Woodward Avenue) & Hazel Street

Future Conditions
PM Peak Hour

	↗	↘	↖	↑	↓	↙
Movement	**EBL**	**EBR**	**NBL**	**NBT**	**SBT**	**SBR**
Lane Configurations		↱			↑↑↑↱	
Traffic Volume (veh/h)	0	49	0	0	3183	151
Future Volume (Veh/h)	0	49	0	0	3183	151
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.71	0.71	0.92	0.92	0.95	0.95
Hourly flow rate (vph)	0	69	0	0	3351	159
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)				380		
pX, platoon unblocked						
vC, conflicting volume	3430	917	3510			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	3430	917	3510			
tC, single (s)	6.9	7.0	4.1			
tC, 2 stage (s)						
tF (s)	3.5	3.3	2.2			
p0 queue free %	100	75	100			
cM capacity (veh/h)	5	272	73			

Direction, Lane #	EB 1	SB 1	SB 2	SB 3	SB 4
Volume Total	69	957	957	957	638
Volume Left	0	0	0	0	0
Volume Right	69	0	0	0	159
cSH	272	1700	1700	1700	1700
Volume to Capacity	0.25	0.56	0.56	0.56	0.38
Queue Length 95th (ft)	25	0	0	0	0
Control Delay (s)	22.7	0.0	0.0	0.0	0.0
Lane LOS	C				
Approach Delay (s)	22.7	0.0			
Approach LOS	C				

Intersection Summary			
Average Delay	0.4		
Intersection Capacity Utilization	56.2%	ICU Level of Service	B
Analysis Period (min)	15		

Intersection	
Int Delay, s/veh	7.2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↱		↱		↰	↑
Traffic Vol, veh/h	83	122	264	30	112	379
Future Vol, veh/h	83	122	264	30	112	379
Conflicting Peds, #/hr	5	10	0	26	26	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	75	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	93	93	71	71	94	94
Heavy Vehicles, %	6	6	0	0	2	2
Mvmt Flow	89	131	372	42	119	403

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1065	429	0	0	440	0
Stage 1	419	-	-	-	-	-
Stage 2	646	-	-	-	-	-
Critical Hdwy	6.46	6.26	-	-	4.12	-
Critical Hdwy Stg 1	5.46	-	-	-	-	-
Critical Hdwy Stg 2	5.46	-	-	-	-	-
Follow-up Hdwy	3.554	3.354	-	-	2.218	-
Pot Cap-1 Maneuver	242	618	-	-	1120	-
Stage 1	655	-	-	-	-	-
Stage 2	514	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	209	597	-	-	1092	-
Mov Cap-2 Maneuver	209	-	-	-	-	-
Stage 1	569	-	-	-	-	-
Stage 2	511	-	-	-	-	-

Approach	WB		NB		SB	
HCM Control Delay, s	33		0		2	
HCM LOS	D					

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	341	1092	-
HCM Lane V/C Ratio	-	-	0.646	0.109	-
HCM Control Delay (s)	-	-	33	8.7	-
HCM Lane LOS	-	-	D	A	-
HCM 95th %tile Q(veh)	-	-	4.3	0.4	-

Intersection	
Int Delay, s/veh	3.7

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	Y		↱		↰	↑
Traffic Vol, veh/h	48	87	354	16	35	427
Future Vol, veh/h	48	87	354	16	35	427
Conflicting Peds, #/hr	11	0	0	14	14	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	125	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	73	73	80	80	93	93
Heavy Vehicles, %	0	0	3	3	3	3
Mvmt Flow	66	119	443	20	38	459

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1013	467	0	0	477	0
Stage 1	467	-	-	-	-	-
Stage 2	546	-	-	-	-	-
Critical Hdwy	6.4	6.2	-	-	4.13	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	-	-	2.227	-
Pot Cap-1 Maneuver	267	600	-	-	1080	-
Stage 1	635	-	-	-	-	-
Stage 2	584	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	252	592	-	-	1066	-
Mov Cap-2 Maneuver	252	-	-	-	-	-
Stage 1	604	-	-	-	-	-
Stage 2	578	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	21.5	0	0.6
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	400	1066	-
HCM Lane V/C Ratio	-	-	0.462	0.035	-
HCM Control Delay (s)	-	-	21.5	8.5	-
HCM Lane LOS	-	-	C	A	-
HCM 95th %tile Q(veh)	-	-	2.4	0.1	-

Intersection	
Int Delay, s/veh	3.3

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	Y		↰	↑	↱	
Traffic Vol, veh/h	43	69	59	327	422	53
Future Vol, veh/h	43	69	59	327	422	53
Conflicting Peds, #/hr	11	0	12	0	0	12
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	50	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	79	79	80	80	93	93
Heavy Vehicles, %	2	2	3	3	3	3
Mvmt Flow	54	87	74	409	454	57

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1063	495	523	0	-	0
Stage 1	495	-	-	-	-	-
Stage 2	568	-	-	-	-	-
Critical Hdwy	6.42	6.22	4.13	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	2.227	-	-	-
Pot Cap-1 Maneuver	247	575	1038	-	-	-
Stage 1	613	-	-	-	-	-
Stage 2	567	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	224	568	1026	-	-	-
Mov Cap-2 Maneuver	224	-	-	-	-	-
Stage 1	563	-	-	-	-	-
Stage 2	561	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	21.6	1.3	0
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1026	-	357	-	-
HCM Lane V/C Ratio	0.072	-	0.397	-	-
HCM Control Delay (s)	8.8	-	21.6	-	-
HCM Lane LOS	A	-	C	-	-
HCM 95th %tile Q(veh)	0.2	-	1.8	-	-

Intersection	
Int Delay, s/veh	2.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		✥			✥			✥			✥	
Traffic Vol, veh/h	15	36	0	17	100	34	0	0	0	13	0	35
Future Vol, veh/h	15	36	0	17	100	34	0	0	0	13	0	35
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	80	80	80	84	84	84	92	92	92	92	92	92
Heavy Vehicles, %	0	3	0	0	1	0	0	0	0	0	0	0
Mvmt Flow	19	45	0	20	119	40	0	0	0	14	0	38

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	159	0	0	45	0	0	281	282	45	262	262	139
Stage 1	-	-	-	-	-	-	83	83	-	179	179	-
Stage 2	-	-	-	-	-	-	198	199	-	83	83	-
Critical Hdwy	4.1	-	-	4.1	-	-	7.1	6.5	6.2	7.1	6.5	6.2
Critical Hdwy Stg 1	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.1	5.5	-	6.1	5.5	-
Follow-up Hdwy	2.2	-	-	2.2	-	-	3.5	4	3.3	3.5	4	3.3
Pot Cap-1 Maneuver	1433	-	-	1576	-	-	675	630	1031	695	646	915
Stage 1	-	-	-	-	-	-	930	830	-	827	755	-
Stage 2	-	-	-	-	-	-	808	740	-	930	830	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1433	-	-	1576	-	-	633	612	1031	680	628	915
Mov Cap-2 Maneuver	-	-	-	-	-	-	633	612	-	680	628	-
Stage 1	-	-	-	-	-	-	917	818	-	815	744	-
Stage 2	-	-	-	-	-	-	764	730	-	917	818	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	2.2	0.8	0	9.6
HCM LOS			A	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	-	1433	-	-	1576	-	-	837
HCM Lane V/C Ratio	-	0.013	-	-	0.013	-	-	0.062
HCM Control Delay (s)	0	7.5	0	-	7.3	0	-	9.6
HCM Lane LOS	A	A	A	-	A	A	-	A
HCM 95th %tile Q(veh)	-	0	-	-	0	-	-	0.2

Intersection: 1: Old Woodward Avenue & Brown Street

Movement	EB	EB	WB	WB	NB	NB	SB	SB
Directions Served	LT	TR	L	TR	L	TR	L	TR
Maximum Queue (ft)	249	209	114	218	172	236	148	330
Average Queue (ft)	135	85	29	104	87	110	53	138
95th Queue (ft)	217	166	80	184	160	193	111	252
Link Distance (ft)	591			423		237		492
Upstream Blk Time (%)						0		
Queuing Penalty (veh)						1		
Storage Bay Dist (ft)		375	65		125		75	
Storage Blk Time (%)			1	19	6	5	3	20
Queuing Penalty (veh)			2	7	17	7	11	20

Intersection: 2: SB M-1 (Woodward Avenue) & Bowers Street

Movement	EB	WB	SB	SB	SB	SB
Directions Served	TR	T	T	T	T	TR
Maximum Queue (ft)	145	34	206	228	218	190
Average Queue (ft)	71	2	194	196	165	108
95th Queue (ft)	129	18	203	225	221	178
Link Distance (ft)	141	27	191	191	191	191
Upstream Blk Time (%)	1	3	14	8	2	0
Queuing Penalty (veh)	2	4	111	67	14	2
Storage Bay Dist (ft)						
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 3: SB M-1 (Woodward Avenue) & Hazel Street

Movement	EB	SB	SB
Directions Served	R	T	T
Maximum Queue (ft)	48	240	187
Average Queue (ft)	25	86	33
95th Queue (ft)	47	209	137
Link Distance (ft)	38	352	352
Upstream Blk Time (%)	3	0	
Queuing Penalty (veh)	1	0	
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 4: Old Woodward Avenue & Bowers Street

Movement	WB	NB	SB	SB
Directions Served	LR	TR	L	T
Maximum Queue (ft)	154	57	61	54
Average Queue (ft)	82	3	24	6
95th Queue (ft)	140	24	50	30
Link Distance (ft)	141	425		198
Upstream Blk Time (%)	2			
Queuing Penalty (veh)	4			
Storage Bay Dist (ft)			75	
Storage Blk Time (%)			0	0
Queuing Penalty (veh)			0	0

Intersection: 5: Old Woodward Avenue & Hazel Street

Movement	WB	NB	SB	SB
Directions Served	LR	TR	L	T
Maximum Queue (ft)	120	38	44	46
Average Queue (ft)	39	2	15	5
95th Queue (ft)	72	17	41	26
Link Distance (ft)	132	23		231
Upstream Blk Time (%)	0	0		
Queuing Penalty (veh)	0	1		
Storage Bay Dist (ft)			125	
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 6: Old Woodward Avenue & Frank Street

Movement	EB	NB	NB	SB
Directions Served	LR	L	T	TR
Maximum Queue (ft)	91	54	39	61
Average Queue (ft)	45	20	3	7
95th Queue (ft)	77	48	20	35
Link Distance (ft)	279		198	23
Upstream Blk Time (%)				0
Queuing Penalty (veh)				2
Storage Bay Dist (ft)		50		
Storage Blk Time (%)		0	0	
Queuing Penalty (veh)		1	0	

Intersection: 7: 555 Garage Drive/Site Drive & Hazel Street

Movement	EB	WB	SB
Directions Served	LTR	LTR	LTR
Maximum Queue (ft)	40	17	58
Average Queue (ft)	5	1	27
95th Queue (ft)	24	11	50
Link Distance (ft)	132	38	187
Upstream Blk Time (%)		0	
Queuing Penalty (veh)		0	
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 8: SB M-1 (Woodward Avenue) & 555 Garage Exit

Movement	EB	SB	SB	SB	SB
Directions Served	R	T	T	T	T
Maximum Queue (ft)	30	157	136	76	18
Average Queue (ft)	7	124	59	6	1
95th Queue (ft)	28	173	131	38	8
Link Distance (ft)	153	60	60	60	60
Upstream Blk Time (%)		18	5	0	
Queuing Penalty (veh)		144	38	2	
Storage Bay Dist (ft)					
Storage Blk Time (%)					
Queuing Penalty (veh)					

Intersection: 21: NB M-1 (Woodward Avenue) & Bowers Street

Movement	EB	WB
Directions Served	T	TR
Maximum Queue (ft)	5	156
Average Queue (ft)	0	67
95th Queue (ft)	3	131
Link Distance (ft)	27	222
Upstream Blk Time (%)	0	
Queuing Penalty (veh)	0	
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 9001: Old Woodward Avenue & Dummy Node A

Movement	EB	NB
Directions Served	R	TR
Maximum Queue (ft)	44	22
Average Queue (ft)	12	1
95th Queue (ft)	38	10
Link Distance (ft)	169	231
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Network Summary

Network wide Queuing Penalty: 460

Intersection: 1: Old Woodward Avenue & Brown Street

Movement	EB	EB	WB	WB	NB	NB	SB	SB
Directions Served	LT	TR	L	TR	L	TR	L	TR
Maximum Queue (ft)	202	153	105	190	174	288	153	291
Average Queue (ft)	105	47	22	76	162	207	21	112
95th Queue (ft)	170	109	63	143	204	341	74	219
Link Distance (ft)	591			423		237		492
Upstream Blk Time (%)						34		
Queuing Penalty (veh)						179		
Storage Bay Dist (ft)		375	65		125		75	
Storage Blk Time (%)			1	13	63	3	0	15
Queuing Penalty (veh)			2	4	137	9	0	5

Intersection: 2: SB M-1 (Woodward Avenue) & Bowers Street

Movement	EB	WB	SB	SB	SB	SB
Directions Served	TR	T	T	T	T	TR
Maximum Queue (ft)	125	44	204	214	215	162
Average Queue (ft)	50	8	171	154	106	54
95th Queue (ft)	100	35	257	242	202	142
Link Distance (ft)	141	27	191	191	191	191
Upstream Blk Time (%)	0	12	6	3	1	1
Queuing Penalty (veh)	0	16	35	17	9	5
Storage Bay Dist (ft)						
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 3: SB M-1 (Woodward Avenue) & Hazel Street

Movement	EB	SB	SB	SB	SB
Directions Served	R	T	T	T	TR
Maximum Queue (ft)	45	242	222	277	289
Average Queue (ft)	17	36	45	112	138
95th Queue (ft)	43	200	235	373	417
Link Distance (ft)	38	352	352	352	352
Upstream Blk Time (%)	3	2	2	12	22
Queuing Penalty (veh)	1	0	0	0	0
Storage Bay Dist (ft)					
Storage Blk Time (%)					
Queuing Penalty (veh)					

Intersection: 4: Old Woodward Avenue & Bowers Street

Movement	WB	NB	SB	SB
Directions Served	LR	TR	L	T
Maximum Queue (ft)	157	235	67	11
Average Queue (ft)	81	29	27	0
95th Queue (ft)	154	157	58	8
Link Distance (ft)	141	425		198
Upstream Blk Time (%)	9	0		
Queuing Penalty (veh)	14	0		
Storage Bay Dist (ft)			75	
Storage Blk Time (%)			0	
Queuing Penalty (veh)			0	

Intersection: 5: Old Woodward Avenue & Hazel Street

Movement	WB	NB	SB	SB
Directions Served	LR	TR	L	T
Maximum Queue (ft)	136	115	74	72
Average Queue (ft)	83	41	20	6
95th Queue (ft)	162	120	62	41
Link Distance (ft)	132	23		231
Upstream Blk Time (%)	36	22		
Queuing Penalty (veh)	32	125		
Storage Bay Dist (ft)			125	
Storage Blk Time (%)				0
Queuing Penalty (veh)				0

Intersection: 6: Old Woodward Avenue & Frank Street

Movement	EB	NB	NB	SB
Directions Served	LR	L	T	TR
Maximum Queue (ft)	200	72	227	40
Average Queue (ft)	71	24	75	3
95th Queue (ft)	199	70	240	22
Link Distance (ft)	279		198	23
Upstream Blk Time (%)	4		10	1
Queuing Penalty (veh)	0		63	1
Storage Bay Dist (ft)		50		
Storage Blk Time (%)		0	19	
Queuing Penalty (veh)		1	12	

Intersection: 7: 555 Garage Drive/Site Drive & Hazel Street

Movement	EB	WB	SB
Directions Served	LTR	LTR	LTR
Maximum Queue (ft)	45	52	142
Average Queue (ft)	4	20	63
95th Queue (ft)	24	59	166
Link Distance (ft)	132	38	187
Upstream Blk Time (%)		34	13
Queuing Penalty (veh)		34	0
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 8: SB M-1 (Woodward Avenue) & 555 Garage Exit

Movement	EB	SB	SB	SB	SB
Directions Served	R	T	T	T	T
Maximum Queue (ft)	35	140	99	87	28
Average Queue (ft)	9	64	19	10	4
95th Queue (ft)	32	148	88	67	41
Link Distance (ft)	153	60	60	60	60
Upstream Blk Time (%)		7	3	2	1
Queuing Penalty (veh)		38	16	9	5
Storage Bay Dist (ft)					
Storage Blk Time (%)					
Queuing Penalty (veh)					

Intersection: 21: NB M-1 (Woodward Avenue) & Bowers Street

Movement	EB	WB
Directions Served	T	TR
Maximum Queue (ft)	6	228
Average Queue (ft)	0	78
95th Queue (ft)	4	197
Link Distance (ft)	27	222
Upstream Blk Time (%)	0	9
Queuing Penalty (veh)	0	0
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 9001: Old Woodward Avenue & Dummy Node A

Movement	NB
Directions Served	TR
Maximum Queue (ft)	320
Average Queue (ft)	183
95th Queue (ft)	407
Link Distance (ft)	231
Upstream Blk Time (%)	30
Queuing Penalty (veh)	187
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Network Summary

Network wide Queuing Penalty: 958

HCM 6th Signalized Intersection Summary
1: Old Woodward Avenue & Brown Street

Future Conditions W / Improvements
AM Peak Hour

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰↱		↰	↱		↰	↱		↰	↱	
Traffic Volume (veh/h)	47	199	122	32	146	32	294	112	99	33	138	260
Future Volume (veh/h)	47	199	122	32	146	32	294	112	99	33	138	260
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.98		0.96	0.98		0.96	0.99		0.99	0.99		0.98
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.85	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1984	1984	1984	1938	1938	1938	1953	1953	1953	1906	1906	1906
Adj Flow Rate, veh/h	55	231	142	36	164	36	359	137	121	41	170	321
Peak Hour Factor	0.86	0.86	0.86	0.89	0.89	0.89	0.82	0.82	0.82	0.81	0.81	0.81
Percent Heavy Veh, %	1	1	1	4	4	4	3	3	3	6	6	6
Cap, veh/h	99	344	227	169	322	71	539	530	468	711	382	721
Arrive On Green	0.21	0.21	0.21	0.21	0.21	0.21	0.66	0.66	0.66	0.66	0.66	0.66
Sat Flow, veh/h	230	1630	1074	978	1526	335	894	808	713	1079	582	1099
Grp Volume(v), veh/h	222	0	206	36	0	200	359	0	258	41	0	491
Grp Sat Flow(s),veh/h/ln	1376	0	1559	978	0	1861	894	0	1521	1079	0	1681
Q Serve(g_s), s	6.2	0.0	10.8	3.1	0.0	8.6	29.4	0.0	6.3	1.5	0.0	12.8
Cycle Q Clear(g_c), s	14.8	0.0	10.8	13.9	0.0	8.6	42.2	0.0	6.3	7.8	0.0	12.8
Prop In Lane	0.25		0.69	1.00		0.18	1.00		0.47	1.00		0.65
Lane Grp Cap(c), veh/h	340	0	329	169	0	393	539	0	997	711	0	1102
V/C Ratio(X)	0.65	0.00	0.63	0.21	0.00	0.51	0.67	0.00	0.26	0.06	0.00	0.45
Avail Cap(c_a), veh/h	340	0	329	169	0	393	539	0	997	711	0	1102
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	33.9	0.0	32.3	38.6	0.0	31.4	17.8	0.0	6.4	8.0	0.0	7.5
Incr Delay (d2), s/veh	9.3	0.0	8.7	2.9	0.0	4.7	6.4	0.0	0.6	0.2	0.0	1.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	5.5	0.0	4.8	0.9	0.0	4.3	6.7	0.0	2.0	0.4	0.0	4.5
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	43.2	0.0	41.0	41.5	0.0	36.0	24.2	0.0	7.1	8.2	0.0	8.8
LnGrp LOS	D	A	D	D	A	D	C	A	A	A	A	A
Approach Vol, veh/h		428			236			617			532	
Approach Delay, s/veh		42.1			36.9			17.0			8.8	
Approach LOS		D			D			B			A	

Timer - Assigned Phs		2		4		6		8				
Phs Duration (G+Y+Rc), s		25.0		65.0		25.0		65.0				
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0				
Max Green Setting (Gmax), s		19.0		59.0		19.0		59.0				
Max Q Clear Time (g_c+I1), s		16.8		14.8		15.9		44.2				
Green Ext Time (p_c), s		0.6		4.4		0.4		3.5				

Intersection Summary			
HCM 6th Ctrl Delay			23.1
HCM 6th LOS			C

Queuing and Blocking Report
Future Conditions W / Improvements

03/07/2018

Intersection: 1: Old Woodward Avenue & Brown Street

Movement	EB	EB	WB	WB	NB	NB	SB	SB
Directions Served	LT	TR	L	TR	L	TR	L	TR
Maximum Queue (ft)	241	228	114	223	174	252	56	177
Average Queue (ft)	140	91	32	106	103	69	13	74
95th Queue (ft)	223	190	81	183	172	185	41	144
Link Distance (ft)	591			423		237		492
Upstream Blk Time (%)						1		
Queuing Penalty (veh)						8		
Storage Bay Dist (ft)		375	65		125		75	
Storage Blk Time (%)			3	25	8	0	0	6
Queuing Penalty (veh)			5	8	19	1	1	2

Intersection: 2: SB M-1 (Woodward Avenue) & Bowers Street

Movement	EB	WB	SB	SB	SB	SB
Directions Served	TR	T	T	T	T	TR
Maximum Queue (ft)	122	24	203	214	188	103
Average Queue (ft)	52	1	188	164	105	45
95th Queue (ft)	101	16	214	217	176	97
Link Distance (ft)	141	27	191	191	191	191
Upstream Blk Time (%)	0	1	4	1	0	
Queuing Penalty (veh)	0	1	24	7	0	
Storage Bay Dist (ft)						
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 3: SB M-1 (Woodward Avenue) & Hazel Street

Movement	EB	SB	SB
Directions Served	R	T	T
Maximum Queue (ft)	38	49	24
Average Queue (ft)	19	2	1
95th Queue (ft)	42	20	17
Link Distance (ft)	38	352	352
Upstream Blk Time (%)	1		
Queuing Penalty (veh)	0		
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 4: Old Woodward Avenue & Bowers Street

Movement	WB	NB	SB
Directions Served	LR	TR	L
Maximum Queue (ft)	145	27	57
Average Queue (ft)	66	1	24
95th Queue (ft)	120	14	52
Link Distance (ft)	141	425	
Upstream Blk Time (%)	0		
Queuing Penalty (veh)	0		
Storage Bay Dist (ft)			75
Storage Blk Time (%)			0
Queuing Penalty (veh)			0

Intersection: 5: Old Woodward Avenue & Hazel Street

Movement	WB	NB	SB	SB
Directions Served	LR	TR	L	T
Maximum Queue (ft)	80	35	40	25
Average Queue (ft)	38	3	10	1
95th Queue (ft)	67	19	34	16
Link Distance (ft)	132	23		231
Upstream Blk Time (%)	0	0		
Queuing Penalty (veh)	0	1		
Storage Bay Dist (ft)			125	
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 6: Old Woodward Avenue & Frank Street

Movement	EB	NB	NB	SB
Directions Served	LR	L	T	TR
Maximum Queue (ft)	62	50	57	27
Average Queue (ft)	33	12	4	1
95th Queue (ft)	57	39	25	13
Link Distance (ft)	279		198	23
Upstream Blk Time (%)				0
Queuing Penalty (veh)				0
Storage Bay Dist (ft)		50		
Storage Blk Time (%)		0	0	
Queuing Penalty (veh)		1	0	

Intersection: 7: 555 Garage Drive/Site Drive & Hazel Street

Movement	EB	SB
Directions Served	LTR	LTR
Maximum Queue (ft)	30	44
Average Queue (ft)	1	26
95th Queue (ft)	12	48
Link Distance (ft)	132	187
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 8: SB M-1 (Woodward Avenue) & 555 Garage Exit

Movement	EB	SB	SB
Directions Served	R	T	T
Maximum Queue (ft)	44	132	45
Average Queue (ft)	8	58	4
95th Queue (ft)	32	119	22
Link Distance (ft)	153	60	60
Upstream Blk Time (%)		4	0
Queuing Penalty (veh)		22	0
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 21: NB M-1 (Woodward Avenue) & Bowers Street

Movement	WB
Directions Served	TR
Maximum Queue (ft)	170
Average Queue (ft)	56
95th Queue (ft)	122
Link Distance (ft)	222
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 9001: Old Woodward Avenue & Dummy Node A

Movement	NB
Directions Served	TR
Maximum Queue (ft)	138
Average Queue (ft)	8
95th Queue (ft)	76
Link Distance (ft)	231
Upstream Blk Time (%)	0
Queuing Penalty (veh)	2
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Network Summary

Network wide Queuing Penalty: 102

Birmingham Tower
Valet Queue Probability

Demand (λ) =	56	# of Valets	2
Service Rate (μ) =	28.58	rate per valet	14.29
Intensity (ρ) =	1.959	EXPONENTIAL	

ρ^n	n	P(n) = $\rho^n(1-\rho)$	ΣP(n)
1.0000	0	-95.94%	-96%
1.9594	1	-187.99%	-284%
3.8393	2	-368.35%	-652%
7.5228	3	-721.74%	-1374%
14.7402	4	-1414.19%	-2788%
28.8821	5	-2770.99%	-5559%
56.5920	6	-5429.50%	-10989%
110.8870	7	-10638.63%	-21627%
217.2733	8	-20845.47%	-42473%
425.7280	9	-40844.86%	-83318%
834.1766	10	-80031.92%	-163350%
1634.4959	11	-156815.52%	-320165%
3202.6511	12	-307266.25%	-627431%
6275.3136	13	-602061.23%	-1229493%

Average Queue E(n) = **-2.04 vehicles**
Average Wait Time in Valet E(v) = **-2.19 minutes**

Demand (λ) =	56	# of Valets	3
Service Rate (μ) =	42.87	rate per valet	14.29
Intensity (ρ) =	1.306	EXPONENTIAL	

ρ^n	n	P(n) = $\rho^n(1-\rho)$	ΣP(n)
1.0000	0	-30.63%	-31%
1.3063	1	-40.01%	-71%
1.7064	2	-52.26%	-123%
2.2290	3	-68.27%	-191%
2.9116	4	-89.18%	-280%
3.8034	5	-116.49%	-397%
4.9683	6	-152.17%	-549%
6.4900	7	-198.77%	-748%
8.4777	8	-259.65%	-1007%
11.0742	9	-339.17%	-1347%
14.4659	10	-443.05%	-1790%
18.8964	11	-578.75%	-2368%
24.6839	12	-756.01%	-3124%
32.2440	13	-987.55%	-4112%

Average Queue E(n) = **-4.27 vehicles**
Average Wait Time in Valet E(v) = **-4.57 minutes**

Demand (λ) =	56	# of Valets	4
Service Rate (μ) =	57.16	rate per valet	14.29
Intensity (ρ) =	0.980	OK	

ρ^n	n	P(n) = $\rho^n(1-\rho)$	ΣP(n)
1.0000	0	2.03%	2%
0.9797	1	1.99%	4%
0.9598	2	1.95%	6%
0.9403	3	1.91%	8%
0.9213	4	1.87%	10%
0.9026	5	1.83%	12%
0.8842	6	1.79%	13%
0.8663	7	1.76%	15%
0.8487	8	1.72%	17%
0.8315	9	1.69%	19%
0.8146	10	1.65%	20%
0.7981	11	1.62%	22%
0.7819	12	1.59%	23%
0.7660	13	1.55%	25%

Average Queue E(n) = **48.28 vehicles**
Average Wait Time in Valet E(v) = **51.72 minutes**

Demand (λ) =	56	# of Valets	5
Service Rate (μ) =	71.45	rate per valet	14.29
Intensity (ρ) =	0.784	OK	

ρ^n	n	P(n) = $\rho^n(1-\rho)$	ΣP(n)
1.0000	0	21.62%	22%
0.7838	1	16.95%	39%
0.6143	2	13.28%	52%
0.4815	3	10.41%	62%
0.3773	4	8.16%	70%
0.2958	5	6.40%	77%
0.2318	6	5.01%	82%
0.1817	7	3.93%	86%
0.1424	8	3.08%	89%
0.1116	9	2.41%	91%
0.0875	10	1.89%	93%
0.0686	11	1.48%	95%
0.0537	12	1.16%	96%
0.0421	13	0.91%	97%

Average Queue E(n) = **3.62 vehicles**
Average Wait Time in Valet E(v) = **3.88 minutes**

Demand (λ) =	56	# of Valets	6
Service Rate (μ) =	85.74	rate per valet	14.29
Intensity (ρ) =	0.653	OK	

ρ^n	n	P(n) = $\rho^n(1-\rho)$	ΣP(n)
1.0000	0	34.69%	35%
0.6531	1	22.65%	57%
0.4266	2	14.80%	72%
0.2786	3	9.66%	82%
0.1820	4	6.31%	88%
0.1189	5	4.12%	92%
0.0776	6	2.69%	95%
0.0507	7	1.76%	97%
0.0331	8	1.15%	98%
0.0216	9	0.75%	99%
0.0141	10	0.49%	99%
0.0092	11	0.32%	99%
0.0060	12	0.21%	100%
0.0039	13	0.14%	100%

Average Queue E(n) = **1.88 vehicles**
Average Wait Time in Valet E(v) = **2.02 minutes**

Demand (λ) =	56	# of Valets	7
Service Rate (μ) =	100.03	rate per valet	14.29
Intensity (ρ) =	0.560	OK	

ρ^n	n	P(n) = $\rho^n(1-\rho)$	ΣP(n)
1.0000	0	44.02%	44%
0.5598	1	24.64%	69%
0.3134	2	13.80%	82%
0.1755	3	7.72%	90%
0.0982	4	4.32%	95%
0.0550	5	2.42%	97%
0.0308	6	1.36%	98%
0.0172	7	0.76%	99%
0.0096	8	0.42%	99%
0.0054	9	0.24%	100%
0.0030	10	0.13%	100%
0.0017	11	0.07%	100%
0.0009	12	0.04%	100%
0.0005	13	0.02%	100%

Average Queue E(n) = **1.27 vehicles**
Average Wait Time in Valet E(v) = **1.36 minutes**

Demand (λ) =	56	# of Valets	8
Service Rate (μ) =	114.32	rate per valet	14.29
Intensity (ρ) =	0.490	OK	

ρ^n	n	P(n) = $\rho^n(1-\rho)$	ΣP(n)
1.0000	0	51.01%	51%
0.4899	1	24.99%	76%
0.2400	2	12.24%	88%
0.1175	3	6.00%	94%
0.0576	4	2.94%	97%
0.0282	5	1.44%	99%
0.0138	6	0.70%	99%
0.0068	7	0.35%	100%
0.0033	8	0.17%	100%
0.0016	9	0.08%	100%
0.0008	10	0.04%	100%
0.0004	11	0.02%	100%
0.0002	12	0.01%	100%
0.0001	13	0.00%	100%

Average Queue E(n) = **0.96 vehicles**
Average Wait Time in Valet E(v) = **1.03 minutes**

Demand (λ) =	56	# of Valets	9
Service Rate (μ) =	128.61	rate per valet	14.29
Intensity (ρ) =	0.435	OK	

ρ^n	n	P(n) = $\rho^n(1-\rho)$	ΣP(n)
1.0000	0	56.46%	56%
0.4354	1	24.58%	81%
0.1896	2	10.70%	92%
0.0826	3	4.66%	96%
0.0359	4	2.03%	98%
0.0157	5	0.88%	99%
0.0068	6	0.38%	100%
0.0030	7	0.17%	100%
0.0013	8	0.07%	100%
0.0006	9	0.03%	100%
0.0002	10	0.01%	100%
0.0001	11	0.01%	100%
0.0000	12	0.00%	100%
0.0000	13	0.00%	100%

Average Queue E(n) = **0.77 vehicles**
Average Wait Time in Valet E(v) = **0.83 minutes**

BERGMANN

ARCHITECTS ENGINEERS PLANNERS

4.6 555 Building Parking Agreement

4.7 Abbreviated Phase I Environmental Site Assessment

Environmental & Engineering Services Nationwide

PHASE I ENVIRONMENTAL SITE ASSESSMENT

469 and 479 South Old Woodward Avenue | Birmingham, Michigan
PM Project Number 01-8456-0-0001

Prepared for:

Markus Associates, LLC
4036 Telegraph Road, Suite 205
Bloomfield Hills, Michigan 48302

Prepared by:

PM Environmental, Inc.
4080 West Eleven Mile Road
Berkley, Michigan 48072

ENVIRONMENTAL SERVICES

BUILDING ARCHITECTURE,
ENGINEERING & SCIENCE

INDUSTRIAL HYGIENE SERVICES

BROWNFIELDS & ECONOMIC
INCENTIVES CONSULTING

Know Your Risk.
Take Control.
Work with the Experts.

www.pmenv.com

PM
ENVIRONMENTAL
Risk Well Managed

Corporate Headquarters
Lansing, Michigan
3340 Ranger Road, Lansing, MI 48906
f: 877.884.6775
t: 517.321.3331

Michigan Locations
Berkley **Bay City**
Grand Rapids **Detroit**
Chesterfield **Lansing**

May 22, 2017

Mr. Doraid Markus
Markus Associates, LLC
4036 Telegraph Road, Suite 205
Bloomfield Hills, Michigan 48302

Re: Phase I Environmental Site Assessment of the Commercial Property
Located at 469 and 479 South Old Woodward Avenue, Birmingham, Michigan
PM Environmental, Inc. Project No. 01-8456-0-0001

Dear Mr. Markus:

PM Environmental, Incorporated (PM) has completed the Phase I Environmental Site Assessment (ESA) of the above referenced property. This Phase I ESA was conducted in accordance with (1) the United States Environmental Protection Agency (USEPA) Standards and Practices for All Appropriate Inquiries {(AAI), 40 CFR Part 312} and (2) guidelines established by the American Society for Testing and Materials (ASTM) in the *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process / Designation E 1527-13* (ASTM Standard Practice E 1527-13).

The Phase I ESA for the above referenced property represents the product of PM's professional expertise and judgment in the environmental consulting industry, and it is reasonable for **MARKUS MANAGEMENT GROUP, LLC ON BEHALF OF AN ENTITY TO BE FORMED** AND **MICHIGAN BUSINESS CONNECTION, LC, ITS SUCCESSORS, ASSIGNS AND CREDIT UNION LENDERS** to rely on PM's Phase I ESA report.

If you have any questions related to this report please do not hesitate to contact our office at 248.336.9988.

Sincerely,
PM ENVIRONMENTAL, INC.

Christopher Johnstone
Staff Consultant

Beth Sexton
National Due Diligence Manager

EXECUTIVE SUMMARY

PM Environmental, Inc., (PM) was retained to conduct a Phase I Environmental Site Assessment (ESA) of the Commercial Property located at 469 and 479 South Old Woodward Avenue, Birmingham, Oakland County, Michigan (hereafter referred to as the "subject property"). This Phase I ESA was conducted in accordance with (1) the United States Environmental Protection Agency (USEPA) Standards and Practices for All Appropriate Inquiries {(AAI), 40 CFR Part 312} and (2) guidelines established by the American Society for Testing and Materials (ASTM) in the *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process / Designation E 1527-13* (ASTM Standard Practice E 1527-13).

THIS REPORT WAS PREPARED FOR THE EXCLUSIVE USE OF MARKUS MANAGEMENT GROUP, LLC ON BEHALF OF AN ENTITY TO BE FORMED AND MICHIGAN BUSINESS CONNECTION, LC, ITS SUCCESSORS, ASSIGNS AND CREDIT UNION LENDERS, EACH OF WHOM MAY RELY ON THE REPORT'S CONTENTS.

Item	Comments
Number of Parcels and Acreage	Two parcels totaling 0.41 acres
Number of Building(s) and Square Footage	One single story building containing 2,882 square feet and one single story building containing 10,541 square feet
Current Property Use	469 South Old Woodward is occupied by a Chinese restaurant. 479 South Old Woodward is currently unoccupied and has no current business operations.

Reasonably ascertainable records for the subject property extended back to approximately 1921. Data failure occurred prior to that date. In PM's professional opinion, this data failure does not represent a significant data gap.

Standard and other historical sources were able to document that the first developed use of the subject property occurred prior to 1921 with a two-story residential dwelling, the first floor of which was converted to a store by 1926. The original building was demolished between 1926 and 1931, when the southern portion of the property was redeveloped with the western and central portions of the current building (479 South Old Woodward). An addition was constructed to the eastern portion in 1946 and 1947. The southern portion of the property was occupied by an automotive dealership from at least 1931 until between 1984 and 1988, when the building was converted to a bank. The southern building was occupied by a bank until 2014, and has been vacant since 2015.

The northern portion of the property was developed with the western portion of the current building (476 South Old Woodward) between 1940 and 1949. An addition was constructed to the eastern portion in 1953. The northern subject building has been occupied by a restaurant since at least 1951.

The following table summarizes the conditions identified as part of this assessment. Affirmative answers are further discussed below the table:

Type of Condition	Identified During the Course of this Assessment
De Minimis Condition	No
Significant Data Gap	No
Historical Recognized Environmental Condition (HREC)	No
Recognized Environmental Conditions (RECs)	Yes
Controlled Recognized Environmental Condition (CREC)	No
Significant Non-ASTM Scope Considerations and/or Business Environmental Risks	Yes

Recognized Environmental Conditions

We have performed a Phase I Environmental Site Assessment in conformance with the scope and limitations of ASTM Practice E 1527-13 of the Commercial Property located at 469 and 479 South Old Woodward Avenue, Birmingham, Oakland County, Michigan, the property. Any exceptions to, or deletions from, this practice are described in Section 1.4 of this report. This assessment has revealed no evidence of recognized environmental conditions connected with the property except the following:

- The southern portion of the subject property was formerly occupied by an automotive dealership and service garage from at least 1931 until at least in 1984. Historical interior waste streams associated with the former automotive dealership included service and painting operations, which would have consisted of general hazardous substances and/or petroleum products. This time period preceded major environmental regulations and current waste management and disposal procedures. The historical waste management practices associated with the former automotive service and painting operations are unknown and may be a source of subsurface contamination.

- The former automotive dealership and service garage contained at least five in-ground hydraulic hoists. In-ground hoists have an underground reservoir for hydraulic fluids, which can contain polychlorinated biphenyls (PCBs). The potential exists that a release occurred from the former hydraulic hoist system and/or underground reservoir. Additionally, the potential exists for orphaned reservoirs to be present on the subject property.

- Review of City of Birmingham Fire and Building Department records and Michigan Department of Environmental Quality (MDEQ) records documents the removal of one 1,000-gallon waste oil underground storage tank (UST), one 1,500-gallon UST, and one 300-gallon UST in September 1988. PM was unable to confirm the installation date and/or location of the former 1,000-gallon waste oil UST and/or the 1,500-gallon and 300-gallon USTs removed in September 1988. Additionally, PM was unable to locate any sampling completed in the area of the former USTs. Additional USTs may have also historically been associated with the former dealership and automotive service operations. The potential exists for orphan USTs to be present on the property and/or for a release to have occurred.

The following adjoining and/or nearby RECs have been identified:

- The north adjoining property, identified as 411 South Old Woodward Avenue, was formerly occupied by an automotive service garage from at least 1926 until at least in 1974. Historical interior waste streams associated with the former service garage operations would have consisted of general hazardous substances and/or petroleum products. Based on the close proximity to the subject property (i.e. along the northern property boundary) and long term service operations (i.e. 48 years), the potential exists a release occurred on this property and migrated onto the subject property.

- The south adjoining property, identified as 555 South Old Woodward Avenue, was formerly occupied by a gasoline dispensing station and automotive service garage from at least 1926 until at least in 1974. Historical interior waste streams associated with the former service garage operations would have consisted of general hazardous substances and/or petroleum products. Based on the close proximity to the subject property (i.e. approximately 50 feet) and long term gasoline dispensing and/or service operations (i.e. 48 years), the potential exists a release occurred on this property and migrated onto the subject property.

Non-ASTM Scope Considerations and Business Environmental Risks (BERS)

PM has included a discussion of Non-ASTM Scope Considerations based upon industry standards and lender requirements. A Business Environmental Risk is defined as a risk which can have a material environmental or environmentally-driven impact on the business associated with the current or planned use of a parcel of commercial real estate, not necessarily limited to those environmental issues required to be investigated in this practice. The following significant Non-ASTM Scope Considerations and/or BERs were identified during completion of this Phase I ESA:

- Based upon PM's limited visual observation during the site reconnaissance, suspect ACBMs identified included acoustical ceiling tile, drywall walls, vinyl floor tile, and air cell pipe wrap. The materials appeared to be in fair condition.

Recommendations

These RECs have been brought to the attention of the client within the requirements of the ASTM Standard Designation E-1527-13. Parts 201 and 213 of the 1994 Michigan Natural Resources Environmental Protection Act (NREPA) provide liability protection for off-site migration of contamination to the subject property. Legal counsel should be consulted regarding issues related to potential off-site migration of contaminants.

PM has been retained by the client to complete a subsurface investigation to assess these RECs and the results will be provided under separate cover.

Additionally, it is understood that the subject buildings will be demolished. Therefore, PM recommends the completion of a pre-demolition asbestos survey to determine if asbestos is present in building materials. PM can provide a proposal for the pre-demolition survey at the request of the client.

The summary presented above is general in nature and should not be considered apart from the entire text of the report, which contains the qualifications, considerations and subject property details mentioned herein. Details of findings and conclusions are elaborated upon in this report.

This report has been reviewed for its completeness and accuracy. Please feel free to contact our office at 248.336.9988 to discuss this report.

REPORT PREPARED BY:
PM Environmental, Inc.

Christopher Johnstone
Staff Consultant

REPORT REVIEWED BY:
PM Environmental, Inc.

Kristin Gable
Regional Due Diligence Manager

Sexton

Beth Sexton
National Due Diligence Manager

TABLE OF CONTENTS

FIGURES

APPENDICES

1.0 INTRODUCTION

This Phase I ESA was conducted in accordance with (1) the United States Environmental Protection Agency (USEPA) Standards and Practices for All Appropriate Inquiries {(AAI), 40 CFR Part 312} and (2) guidelines established by the American Society for Testing and Materials (ASTM) in the *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process / Designation E 1527-13* (ASTM Standard Practice E 1527-13).

THIS REPORT WAS PREPARED FOR THE EXCLUSIVE USE OF MARKUS MANAGEMENT GROUP, LLC ON BEHALF OF AN ENTITY TO BE FORMED AND MICHIGAN BUSINESS CONNECTION, LC, ITS SUCCESSORS, ASSIGNS AND CREDIT UNION LENDERS, EACH OF WHOM MAY RELY ON THE REPORT'S CONTENTS.

PM acknowledges that this party may rely on the contents and conclusions presented in this report. Unless stated otherwise in writing, PM makes no other warranty, representation, or extension of reliance upon the findings of this report to any other entity or third party.

1.1: Property Overview

Subject Property Location/Address	469 and 479 South Old Woodward Avenue, Birmingham, Oakland County, Michigan
Number of Parcels and Acreage	Two parcels totaling 0.41 acres
Number of Building(s) and Square Footage	Two single story buildings containing 2,882 square feet and 10,541 square feet
Current Property Use	469 South Old Woodward is occupied by a Chinese restaurant. 479 South Old Woodward is currently unoccupied and has no current business operations.
Current Zoning	B-3: Office Residential

The subject property location is depicted on Figure 1, Site Location Map. A diagram of the subject property and adjoining properties is included as Figure 2, Generalized Diagram of the Subject Property and Adjoining Properties. Photographs taken during the site reconnaissance are included in Appendix A.

1.2: Purpose and Scope of Services

The purpose of this Phase I ESA was to evaluate the current and historical conditions of the subject property in an effort to identify *recognized environmental conditions* (RECs), *controlled recognized environmental conditions (CRECs),* and *historical recognized environmental conditions* (HRECs) in connection with the subject property. This Phase I ESA is intended to reduce, but not eliminate, uncertainty regarding the potential for RECs, CRECs, and HRECs in connection with the subject property.

Acronyms and terms used in this report are described in Appendix F. Additionally, PM's scope of services is included in Appendix F.

1.3: Significant Assumptions

Pursuant to ASTM Standard Practice E 1527-13, PM assumes that the information provided by all sources and parties, including the User, is accurate and complete, except where obvious inconsistencies or inaccuracies were identified.

1.4: Limitations, Deviations, and Special Terms and Conditions

There are no deviations from the ASTM Standard. Non-ASTM Scope considerations are included in Section 11.0. Any physical limitations identified during the completion of this report are referenced in Section 7.0.

Due to changing environmental regulatory conditions and potential on-site or adjacent activities occurring after this assessment, the client may not presume the continuing applicability to the subject property of the conclusions in this assessment for more than 180 days after the report's issuance date, per ASTM Standard Practice E 1527-13.

To the best of PM's knowledge, no special terms or conditions apply to the preparation of this Phase I ESA that would deviate the scope of work from the ASTM Standard Practice E 1527-13.

PM was not provided with a copy of the recorded land title records for subject property by the client and was not requested to complete a title search. Therefore, PM cannot comment on any potential relevant information that may have been obtained through review of these records.

2.0 USER PROVIDED INFORMATION

The ASTM Standard defines a User as "the party seeking to use Practice E 1527 to complete an environmental site assessment. A User may include, without limitation, a potential purchaser of property, a potential tenant of property, an owner of property, a lender, or a property manager." The User has specific obligations for completing a successful application of this practice as outlined in Section 6 of the ASTM Standard Practice E 1527-13.

In order to qualify for one of the Landowner Liability Protections (LLPs) offered by the Small Business Liability Relief and Brownfield's Revitalization Act of 2001 (the "Brownfield's Amendments") (if desired), the User must provide certain information (if available) identified in the User Questionnaire to the environmental professional. Failure to provide this information could result in a determination that "all appropriate inquiry" is not complete.

The following responses were provided by the User. A copy of the completed User Questionnaire is included in Appendix B.

Question	Response
Name of Preparer and User Entity	Mr. Doraid Markus, Markus Management Group, LLC
Are you aware of any environmental cleanup liens against the property that are filed or recorded under federal, tribal, state or local law?	No

Question	Response
Are you aware of any Activity and Use Limitations, such as engineering controls, land use restrictions or institutional controls that are in place at the site and/or have been filed or recorded in a registry under federal, tribal, state or local law?	No
As the user of this ESA do you have any specialized knowledge or experience related to the property or nearby properties? For example, are you involved in the same line of business as the current or former occupants of the property or an adjoining property so that you would have specialized knowledge of the chemicals and processes used by this type of business?	No
Does the purchase price being paid for this property reasonably reflect the fair market value of the property?	Yes
If you conclude that there is a difference, have you considered whether the lower purchase price is because contamination is known or believed to be present at the property?	Not applicable
Are you aware of commonly known or reasonably ascertainable information about the property that would help the environmental professional to identify conditions indicative of releases or threatened releases? For example, as user:	
Do you know the past uses of the property?	No
Do you know of specific chemicals that are present or once were present at the property?	No
Do you know of spills or other chemical releases that have taken place at the property?	No
Do you know of any environmental cleanups that have taken place at the property?	No
As the user of this ESA, based on your knowledge and experience related to the property are there any obvious indicators that point to the presence or likely presence of contamination at the property?	No

2.1: Recorded Land Title Records

PM was not provided with land title records for the subject property by the User and was not requested to complete a chain of title for the subject property. PM reviewed reasonably ascertainable environmental liens and activity and use limitation documents, which are further discussed in Section 4.10. Based upon the information reviewed as part of this Phase I ESA, PM has not identified the lack of provided land title records as a data failure that represents a significant data gap.

2.2: Reason for Performing this Phase I ESA

According to the User, this Phase I ESA was conducted as part of environmental due diligence related to purchasing the subject property.

3.0 PHYSICAL SETTING

PHYSICAL SETTING INFORMATION FOR THE SUBJECT PROPERTY AND SURROUNDING AREA		SOURCE
Topography: Refer to Figure 1 for an excerpt of the Topographic Map		
Site Elevation	765 feet above mean sea level (msl)	United States Geological Survey Division (U.S.G.S.) 7.5-Minute Topographic Map of the Birmingham, Michigan Quadrangle, 1968 (photo revised in 1981)
Topographic Gradient	South-southeast	
Closest Surface Water	The Rouge River located approximately 2,500 feet northwest of the subject property at an elevation 720 msl	
General Soil Characteristics: Refer to Appendix B for a copy of the soil survey map and soil type descriptions		
Soil Type	Udorthents and Udipsamments, nearly level to hilly	United States Department of Agriculture, Custom Soil Survey of Oakland County, Michigan (survey area data: February 13, 2017)
Description	A typical soil profile consists of silt loam to a depth of 8.0 inches below ground surface (bgs), underlain by clay loam to 80.0 inches bgs. Soils are well drained. Risk of corrosion is low to moderate for uncoated steel and low for concrete.	
Area Specific Geology/Hydrogeology Characteristics:		
Geology	Geology consists of gravelly sand, clayey sand, or sand to a depth of 2.0 to 5.0 feet bgs, underlain by stiff clay to a depth of 20.0 feet bgs.	Previous site investigations for a property located approximately 150 feet northwest of the subject property (2014)
Hydrogeology	Limited, perched, discontinuous groundwater was encountered at a depth of 12.0 bgs. Groundwater flow direction was not calculated.	
Oil and Gas Wells:		
Current Oil and Gas Wells on Subject Property	None identified	MDEQ Geologic Survey Division (GSD) web site
Historical Oil and Gas Wells On Subject property	None identified	

4.0 RECORDS REVIEW

PM reviewed reasonably ascertainable records to identify obvious uses of the subject property from the present, back to the property's obvious first developed use, or back to 1940, whichever is earlier. Reasonably ascertainable records reviewed as part of this Phase I ESA documented the use of the property back to 1921. Data failure occurred prior to that date. In PM's professional opinion, this data failure does not represent a significant data gap.

4.1: Aerial Photographs and Sanborn Maps

PM reviewed reasonably ascertainable aerial photographs for the subject property area. The sources and years reviewed are identified in the table below. Relevant aerial photographs are included in Appendix B.

PM reviewed reasonably ascertainable Sanborn Fire Insurance Maps for the subject property area, which were obtained from EDR. The sources and years reviewed are identified in the table below. Relevant Sanborn Maps are included in Appendix B.

The following table summarizes the sources reviewed and the information obtained about the subject property from these sources. Information obtained about the adjoining properties from these sources is summarized in Section 8.0.

Aerial and Sanborn Summary for the Subject Property

Year and Source	Summary of Information
1921 Sanborn Map (EDR)	The property is developed with a two-story dwelling.
1926 Sanborn Map (EDR)	Similar to the previous Sanborn year; except the first floor is now identified as a store.
1931 Sanborn Map (EDR)	The dwelling/store has been demolished, and the property has been redeveloped with the western and central portions of the current southern building, which is identified as auto sales and service.
1940 Aerial (MSU)	Due to resolution, definitive details could not be identified; however, the layout appears to be similar to the previous Sanborn year.
1949 Sanborn Map (EDR)	An addition has been constructed at the eastern portion of the auto sales and service building. The current building in the northwestern portion is depicted and identified as an unfinished store.
1952 Aerial (WSU)	Layout is similar to the previous Sanborn year.
1957 Aerial (WSU)	Similar to the previous aerial and Sanborn years.
1960 Sanborn Map (EDR)	A small addition is visible east of the northern building and the northern building is now identified as a restaurant. Appears similar to the current layout.
1963 Aerial (Oakland County)	Layout is similar to the previous Sanborn year and the current layout.
1967 Aerial (WSU)	Similar to the previous aerial and Sanborn years.
1974 Aerial (Oakland County)	Similar to the previous aerial and Sanborn years.
1980 Aerial (Oakland County)	Similar to the previous aerial and Sanborn years.
1990 Aerial (Oakland County)	Similar to the previous aerial and Sanborn years.
1997 Aerial (Oakland County)	Similar to the previous aerial and Sanborn years.
2000 Aerial (Oakland County)	Similar to the previous aerial and Sanborn years.
2005 Aerial (Oakland County)	Similar to the previous aerial and Sanborn years.
2010 Aerial (Oakland County)	Similar to the previous aerial and Sanborn years.

Year and Source	Summary of Information
2015 Aerial (Oakland County)	Similar to the previous aerial and Sanborn years.

A summary of this information along with other historical sources is included in Section 6.0.

4.2: Local Street Directories

Reasonably ascertainable local street directories for Birmingham, Michigan were researched. Directories were available from 1937 to 2014. Directories were researched in at least five-year increments, when available. It should not be construed that the earliest date represented is the initial date of occupancy.

Subject Property: 469 South Old Woodward Avenue

2014-1998	Mountain King Chinese Restaurant
1996-1954	Pearls Garden
1951	Pearls Chop Suey
1947-1937	Not Listed

Subject Property: 479 South Old Woodward Avenue

2014-2011	First Place Bank
2008	First Place Bank Franklin Bank
2006-1993	Franklin Bank
1990-1989	G Fisher Construction
1987-1986	Not Listed
1984-1981	Birmingham Motors Volvo Motors Ltd.
1979-1977	Birmingham Motors Volvo Motors Ltd. E&G Sales
1976-1975	Fiske Motors Ltd. Volvo of Fiske Motor
1973-1969	Not Listed
1967-1966	B Borst Lincoln & Mercury
1964-1963	Borst Lincoln & Mercury
1961-1957	Bob Frost Inc.
1955-1954	Kock Keller Inc. Keller Koch Inc.
1951	Welch Mike Inc., Autos
1947	Carkner Motor Sales, Auto Dealers
1944	DeVoll, Autos
1940	Templeton Motors
1937	Oldershaw Motor Sales

The subject property was identified as 315 South Old Woodward prior to 1931. However, based on the lack of local street directory coverage prior to 1937, a summary of occupants associated with the former store building was not available. PM requested municipal records associated with the historical address, which is discussed further below.

A summary of this information along with other historical sources is included in Section 6.0.

PM also reviewed listings for adjoining commercial properties. Information from the listings reviewed is included in Section 8.0.

4.3: Assessing Department

Reasonably ascertainable assessment information provided by the City of Birmingham Treasurer's Office and the Oakland County Equalization Division was obtained and reviewed. Assessing records document that the subject property consists of two parcels containing 0.41 acres and is developed with one single story building containing 2,882 square feet, constructed in 1968 and with one single story building containing 10,541 square feet, constructed in 1968. However, based on review of other historical sources, the subject buildings were constructed between the 1920s and 1940s. Assessing records only documented the current assessment information for the subject property. No historical field cards were available for review. Copies of available assessment records for the subject property and the current legal description are included in Appendix B.

4.4: Building Department

Reasonably ascertainable assessment information provided by the City of Birmingham Community Development Department was obtained and reviewed. Department records document alterations to the original dealership building (Carkner Motor Sales) in March 1946 and additions in November 1947 and January 1948. A metal building was also moved to the property from the west side of Woodward in July 1946. The former dealership at 479 South Old Woodward was renovated into a bank in 1988. An interior alteration was completed in January 1951 and an addition was constructed in May 1953 to 469 South Old Woodward.

Building records also document water and sewer connection permits dated April 1948 (479 South Old Woodward) and February 1951 (469 South Old Woodward), which are discussed further in Sections 4.7.1 and 4.7.2. Oil burner permits also document the installation of two 275-gallon fuel oil tanks in the basement at the subject property (479 Woodward) in October 1949, which were replaced in March 1965. However, a natural gas heating system was installed in 1963, and therefore, the 1965 permit may have been associated with removal of the former oil system. Historical fuel oil use is further discussed in Section 4.7.3.

Additionally, Building Department records for 479 South Old Woodward document the removal of 1,000-gallon waste oil underground storage tank (UST) in September 1988. Refer to Section 4.8 for additional information.

4.5: Fire Department

PM reviewed available City of Birmingham Fire Department files for the subject property. Fire Department records documented the former service garage operations associated with the property, which are discussed throughout this report. Additionally, Fire Department records documented the removal of one 1,500-gallon UST and one 300-gallon UST from 479 South Old Woodward in September 1988, which are further discussed in Section 4.8. Additional records cite violations for the continued use of gasoline for parts washers and reveal the former presence of a spray booth. Refer to Section 6.0 for additional information regarding the historical automotive service operations.

4.6: Health Department

PM submitted a Freedom of Information Act (FOIA) request to the Oakland County Health Division to review records for the subject property. PM did not receive a response within the time constraints of this report. If PM does receive a response, and it changes the findings of the report, the client will be notified.

4.7: Utilities

4.7.1: Municipal Water/Water Wells

The subject property is currently connected to municipal water. PM interviewed a representative of the City of Birmingham Department of Public Service, who indicated 469 South Old Woodward was connected to municipal water in 1951 and 479 South Old Woodward was connected to municipal water in 1948, which is also consistent with Building Department records. However, review of Sanborn maps document municipal water has been available to the subject property since at least 1921. Therefore, the subject property has likely been connected to municipal water since at least 1921. No records of private water wells have been identified through review of reasonably ascertainable information.

4.7.2: Sanitary Sewer/Septic System

The subject property is currently connected to municipal sewer. PM interviewed a representative of the City of Birmingham Department of Public Service, who indicated both buildings on the subject property were connected to municipal sewer in 1948, which is also consistent with Building Department records. However, municipal sewer has likely been available as long as municipal water, since at least 1921. Based on this information and the high urban area, the subject property was most likely tapped to municipal sewer during construction of the former residential dwelling. No records of private septic fields have been identified through review of reasonably ascertainable information.

4.7.3: Heat Source

The subject property is connected to natural gas, which is supplied by Consumers Energy. Review of the Consumers Energy SIMS website indicates the current buildings were connected to natural gas in in 1951 (469 South Old Woodward) and 1965 (479 South Old Woodward), which is generally consistent with Building Department records. The 1951 connection date associated with 469 South Old Woodward is likely associated with the original occupation of the building (constructed by 1949, but noted as unfinished) and PM has not identified any historical heat sources associated with 469 South Old Woodward. However, Building Department records document historical fuel oil use associated with the building located at 479 South Old Woodward. However, the fuel oil was stored in two 275-gallon aboveground storage tanks (ASTs) in the basement. Based on the aboveground storage, PM has not identified the historical fuel oil usage as a REC.

Consumers Energy also documents the former dwelling/store was connected to natural gas in at least 1929. Prior to 1929, the former dwelling/store was likely heated via coal, wood, or electricity.

4.8: Underground Storage Tank (UST) Systems

The subject property contained at least three former USTs. The following table indicates the size of the UST, contents, location (if known), the dates of installation and removal, and the source of the information.

Historical UST Information

Size	Contents	Location	Date Installed	Date Removed	Source
1,000-gallons	Waste Oil	479 South Old Woodward (specific location unknown)	Unknown	September 1988	Building Dept. & MDEQ
1,500-gallons*	Unknown	479 South Old Woodward (specific location unknown)	Unknown	September 1988	Fire Dept.
300-gallons	Unknown	479 South Old Woodward (specific location unknown)	Unknown	September 1988	Fire Dept.

*The 1,500-gallon UST referenced in Fire Department records may be the same 1,000-gallon UST referenced in Building Department and MDEQ records, however without confirmation of additional records, PM is identifying these as separate USTs.

PM was unable to confirm the installation date and/or location of the former 1,000-gallon waste oil UST and/or the 1,500-gallon and 300-gallon USTs removed in September 1988. Additionally, PM was unable to locate any sampling completed in the area of the former USTs. Additional USTs may have also historically been associated with the former dealership and automotive service operations. **The potential exists for orphan USTs to be present on the property and/or for a release to have occurred, which represents a REC.**

MDEQ records also document the former service operations utilized at least five in-ground hydraulic hoists. Refer to Section 6.0 for additional information.

4.9: Previous Environmental Reports

No previous site investigations were identified by PM for the subject property. Previous reports may exist for the subject property, however, none were provided to PM by the client or owner of the property, and none were available with the appropriate state regulatory agencies.

4.10: Environmental Liens, Activity and Use Limitations, and Government Institutional and Engineering Controls

PM has not identified any record of environmental liens, activity and use limitations, or institutional controls or engineering controls associated with the subject property through review of reasonable ascertainable records.

5.0 INTERVIEWS

The objective of completing interviews with knowledgeable site contacts is to obtain information about the uses and physical characteristics of the property. In general, interviewees supported the information reviewed from other historical sources (i.e. aerial photos, city records, etc.).

Represents	Interviewed	Name and Title	Length of Time Associated with Subject Property	Comments
Current Property Owner	Yes	Mr. Steve Tsong, Owner of Mountain King Chinese Restaurant (469 South Old Woodward)	17 years	Mr. Tsong provided similar historical information for the subject property as researched for the completion of this Phase I ESA. Mr. Tsong indicated that 469 South Old Woodward has been a restaurant for at least 50 years and that 479 South Old Woodward was formerly a service garage prior to becoming a bank in the late 1980s.
Current Property Owner	No	E&G Partners, LLC (479 South Old Woodward)	Since at least 2004	PM was not able to conduct an interview with the Current Property Owner for 479 south Old Woodward because the site contact, Mr. Scott LaFond, would not readily offer PM contact information for the Current Property Owner. PM has not identified the lack of an interview as a significant data gap.
Former Property Owner	No	Not applicable	Not applicable	Contact information for the former owner was not reasonably ascertainable or provided by the User.
Key Site Manager	Yes	Mr. Steve Tsong, Owner of Mountain King Chinese Restaurant	17 years	Refer to the summary for Current Property Owner.
Current Occupant(s)	Yes	Mr. Steve Tsong, Owner of Mountain King Chinese Restaurant	17 years	Refer to the summary for Current Property Owner.

Represents	Interviewed	Name and Title	Length of Time Associated with Subject Property	Comments
Former Occupant(s)	No	Not applicable	Not applicable	Contact information for the former occupants was not reasonably ascertainable or provided by the User.
Other(s)	No	Not applicable	Not applicable	No other relevant interviews were conducted as part of this Phase I ESA.

6.0 SUMMARY OF HISTORICAL USE

Standard and other historical sources were able to document that the first developed use of the subject property occurred prior to 1921 with a two-story residential dwelling, and the first floor was converted to a store by 1926. The dwelling and store was demolished between 1926 and 1931, when the southern portion of the property was redeveloped with the western and central portions of the current building (479 South Old Woodward). An addition was constructed to the eastern portion in 1946 and 1947. The southern portion of the property was occupied by an automotive dealership from at least 1931 until between 1984 and 1988, when the building was converted to a bank. The southern building was occupied by a bank until 2014, and has been vacant since 2015.

The northern portion of the property was developed with the western portion of the current building (476 South Old Woodward) between 1940 and 1949. An addition was constructed to the eastern portion in 1953. The northern subject building has been occupied by a restaurant since at least 1951.

Historical interior waste streams associated with the former automotive dealership included service and painting operations, which would have consisted of general hazardous substances and/or petroleum products. This time period preceded major environmental regulations and current waste management and disposal procedures. **The historical waste management practices associated with the former automotive service and painting operations are unknown and may be a source of subsurface contamination, which represents a REC.**

The former automotive dealership and service garage contained at least five in-ground hydraulic hoists. In-ground hoists have an underground reservoir for hydraulic fluids, which can contain PCBs. **The potential exists that a release occurred from the former hydraulic hoist system and/or underground reservoir. Additionally, the potential exists for orphaned reservoirs to be present on the subject property, which represents a REC.**

7.0 SUBJECT PROPERTY RECONNAISSANCE

Reconnaissance Information	
PM Field Personnel:	Mr. Chris Johnstone
Site Reconnaissance Date:	May 5, 2017
Escort:	Mr. Steve Tsong, current owner (469 South Old Woodward) and Mr. Scott LaFond (realtor associated with 469 South Old Woodward)

Limitations:	PM requested access to any basement areas and the escorts indicated there were no basements present. However, Building Department records reference a basement associated with 479 South Old Woodward, which PM did not access. This limitation does not represent a significant data gap.

7.1: Subject Property Observations

The subject property is developed with a restaurant building (469 South Old Woodward) and a vacant bank branch (479 South Old Woodward).

The restaurant building contains 2,882 square feet which is divided into dining areas, a kitchen, an office, storage areas, and a restroom. Interior finish materials include carpeting, quarry tile, vinyl floor tile, ceramic tile, drywall walls, concrete masonry unit (CMU) walls, and acoustical ceiling tiles. The building is on a poured concrete foundation. Parking is provided in an alleyway at the eastern exterior of the building.

The vacant bank branch contains 10,541 square feet which is divided into seating areas, offices, a bank vault, teller areas, and storage areas. Interior finish materials include ceramic floor tile, carpeting, vinyl floor tile, drywall walls, and acoustical ceiling tiles. The eastern portion of the building is a single-story parking garage, which is partially finished with acoustical ceiling tiles, cinder block and brick walls, and asphalt or concrete floors.

The following table summarizes the site observations. Affirmative responses are discussed in more detail following the table.

Category	Feature	Observed
Interior Equipment	Elevators	No
	Air Compressors	No
	Incinerators	No
	Waste Treatment Systems	No
	Presses/Stamping Equipment	No
	Press Pits and/or In-ground Pits	No
	Hydraulic Lifts or In-ground hoists	No
	Paint Booth	No
	Plating Tanks	No
	Parts Washers	No
	Lathes, Screw Machines, etc.	No
Aboveground Chemical or Other Waste Storage or Waste Streams	Aboveground Storage Tanks (ASTs)	No
	Drums, Barrels and/or Containers > 5 gallons	No
	Chip Hoppers	No
	Hazardous or Petroleum Waste Streams	No
Underground Chemical or Waste Storage, Drainage or Collection Systems	Underground Storage Tanks	No
	Fuel Dispensers	No
	Sumps or Cisterns	No
	Dry Wells	No
	Oil/Water Separators	No
	Floor Drains, Trench Drains, etc.	Yes
	Pipeline Markers	No
Exterior Observations	Stressed Vegetation	No
	Stained Soil or Pavement	No

Category	Feature	Observed
	Monitoring Wells	No
	Pad or Pole Mounted Transformers and/or Capacitors	No
	Soil Piles of Unknown Origin	No
	Exterior Dumpsters with Staining	No
	Leachate or Other Waste Seeps	No
	Trash, Debris, and/or Other Waste Materials	No
	Uncontrolled Dumping or Disposal Areas	No
	Surface Water Discoloration, Sheen or Free Product	No
	Strong, Pungent or Noxious Odors	No
	Storm water retention or detention ponds	No
	Pits, Ponds, Lagoons	No

Floor Drains, Trench Drains, etc.: PM observed floor drains in the restaurant kitchen as well as the restrooms and storage areas associated with each building. No staining or evidence of poor waste management practices was observed in connection to the floor drains.

7.1.1: Current Operations

Operations at 469 South Old Woodward are consistent with typical restaurant activities. There are currently no occupants at 479 South Old Woodward. As such, there are currently no business operations.

8.0 ADJOINING PROPERTIES

The following paragraphs provide information about the adjoining properties obtained during the site reconnaissance and through review of reasonably ascertainable information.

North Adjoining Property

The north adjoining property, identified as 411 South Old Woodward Avenue, is occupied by an apartment complex with first floor retail including attorneys' offices, a realtor and a yoga studio. Review of historical records documents that the property was developed prior to 1921 with four residential dwellings and an office in its western portion as well as three garages and a lumber shed in the eastern portion. The eastern portion of the property also contained a railroad siding, likely associated with the pickup/drop-off of lumber to the lumber shed. An automotive service garage was constructed on the property at the northwest border of the subject property between 1921 and 1926. A store was also constructed in the center of the western portion of the property, and the lumber shed and garages in the eastern portion of the property were redeveloped into a larger building associated with the lumber operations during this time period. The northern portion of the new lumber building also contained an automotive paint shop. The entire northern and eastern portions of the property were redeveloped between 1926 and 1931 with a garage and offices associated Greyhound Station and Eastern Michigan Railways. The bus station is labeled as heated via coal. Additionally, aboveground gasoline tanks totaling 50,000 gallons were depicted in the northeastern corner of the property next to the railroad tracks in at least 1931. The rail road tracks and aboveground tanks were removed from the property between 1931 and 1949; however, two gasoline USTs were installed in the same area at the northeastern portion of the property during this same time period. The residential dwellings in the northern and central portions of the property were also demolished during this time period. The front of the automotive service garage at the southern boundary of the property was converted into a restaurant between 1931 and 1949. An addition was also constructed at the office located in the center of the western portion of the property between 1949 and 1960. The two remaining residential dwellings were demolished between 1967 and 1974. The entire property was cleared of all buildings and structures between 1974 and 1980 and was redeveloped with the current apartment complex and retail spaces between 1983 and 1984. The property has been occupied by the apartment complex since at least 1984. Historical interior waste streams associated with the former service garage operations would have consisted of general hazardous substances and/or petroleum products. **Based on the close proximity to the subject property (i.e. along the northern property boundary) and long term service and fueling operations (i.e. 48 years), the potential exists a release occurred on this property and migrated onto the subject property.**

East Adjoining Properties, across Woodward Avenue

The northeast adjoining property, identified as 34660 Woodward Avenue, is occupied by Village Players, Inc. Review of historical records documents that the property was developed prior to 1921 with a lumber and coal yard. The property was redeveloped in 1926 with the current building. The building was occupied by Village Players, Inc. since initial construction in 1926.

The east adjoining property, identified as 34602 Woodward Avenue, is occupied by Audi of Birmingham. Review of historical records documents that the property was developed prior to 1921 with a lumber and coal yard. The property was redeveloped between 1931 and 1940 with the current building. The building was occupied by a bakery from at least 1951 until at least 1964 and by various automotive dealerships since at least 1970. This site is identified in the regulatory database. Refer to Section 9.2 for additional information.

South Adjoining Property, across Hazel Street

The south adjoining property, identified as 555 South Old Woodward Avenue, is occupied by an apartment building. Review of historical records documents that the property was developed prior to 1921 with three residential dwellings and one garage. The residential dwelling at the center of the western portion was demolished between 1921 and 1926, and a gasoline dispensing station with three USTs was constructed in its place. An additional dwelling was constructed at the center of the western portion of the property during this same time period. The gasoline dispensing station expanded into an automotive service garage between 1926 and 1931. The dwellings and associated garages were demolished between 1931 and 1949 when an automotive service garage and used automotive sales lot were constructed at the northern portion of the property. The gasoline dispensing station at the center of the western portion of was demolished between 1949 and 1960. An additional commercial structure was constructed in the southern portion of the property by at least 1952 and was occupied by an automotive leasing company. This building also expanded into the central portion of the property between 1952 and 1957. The entire property was cleared of buildings and structures between 1974 and 1980 when the property was redeveloped with the current apartment building and parking garage. Historical interior waste streams associated with the former service garage and gasoline dispensing operations would have consisted of general hazardous substances and/or petroleum products. **Based on the close proximity to the subject property (i.e. approximately 50 feet) and long term gasoline dispensing and/or service operations (i.e. 48 years), the potential exists a release occurred on this property and migrated onto the subject property.**

West Adjoining Property, across South Old Woodward

The west adjoining property, identified as 444 South Old Woodward Avenue is occupied by a shopping center. Review of historical records documents that the property was developed prior to 1921 with four residential dwellings and associated garages. A gasoline dispensing station was constructed in the southwest portion of the property between 1921 and 1926. The residential dwellings in the northern portion of the property were demolished between 1926 and 1931 when a large garage consisting of automotive sales and painting operations was constructed. Additionally, an automotive service station was constructed north of the gasoline dispensing station located in the southeast portion of the property. The gasoline dispensing station and automotive service garage were demolished between 1931 and 1949 when a used automotive sales lot was developed in the southeastern portion of the property. Additionally, the garage associated with the residential dwelling located in the southwestern portion of the property was renovated into a print shop during this same time period. The residential dwelling in the central portion of the property was demolished between 1949 and 1960, and the print shop expanded into a new structure as the southwestern corner of the property. The remaining residential dwelling next to the print shop was demolished between 1974 and 1980. The property was redeveloped with the current building and layout between 1990 and 1997 and has been occupied by a video store, clothing store, and pharmacy since construction. This site is identified in the regulatory database. Refer to Section 9.2 for additional information.

9.0 REGULATORY RECORDS REVIEW

PM retained EDR to provide current regulatory database information compiled by a variety of federal and state regulatory agencies. A copy of the complete database is included in Appendix D. The following information was obtained:

Type	Regulatory Agency Database	Approximate Minimum Search Distance (AMSD)	Number of Sites within AMSD
Federal	National Priority List (NPL) Sites	1 mile	0
Federal	Delisted National Priority List (DNPL) Sites	½ mile	0
Federal	Superfund Enterprise Management System (SEMS) (formerly CERCLIS – renamed in 2015) Sites	½ mile	0
Federal	SEMS-Archive Sites (formerly CERLIS-NFRAP – renamed 2015)	½ mile	0
Federal	Resource Conservation and Recovery Act (RCRA) Corrective Action Report (CORRACTS) Sites	1 mile	0
Federal	RCRA non-CORRACTS Treatment, Storage or Disposal Facilities (TSDF) Sites	½ mile	0
Federal	RCRA Large Quantity Generators (LQG) Sites	subject property and adjoining properties	0
Federal	RCRA Small Quantity Generators (SQG) Sites	subject property and adjoining properties	0
Federal	RCRA Conditionally Exempt Small Quantity Generators (CESQG) Sites	subject property and adjoining properties	2
Federal	RCRA Non-Generators (NON-GEN) Sites	subject property and adjoining properties	1
Federal	Institutional Control / Engineering Control Registries	subject property	0
Federal	Environmental Response and Notification System (ERNS)	subject property	0

Type	Regulatory Agency Database	Approximate Minimum Search Distance (AMSD)	Number of Sites within AMSD
State & Tribal	Hazardous Waste Sites (HWS) (equivalents to NPL and CERCLIS)	1 mile	0
State & Tribal	Solid Waste Facilities/Landfill Sites (SWF/LF)	½ mile	0
State & Tribal	Leaking Underground Storage Tank (LUST) Sites	½ mile	19
State & Tribal	Registered Underground Storage Tank (UST) Sites	subject property and adjoining properties	2
State & Tribal	Institutional Control / Engineering Control Registries	subject property	0
State & Tribal	Brownfield Sites	½ mile	4
State & Tribal	Michigan Inventory of Facilities (Includes Part 201 Sites and Baseline Environmental Assessment {BEA} Sites)	½ mile	42
Either	Unmappable Database Listings (a.k.a. Orphan Sites)	database-dependent	1

9.1: Subject Property and Occupant Listings

The regulatory database report identified the following listings for the subject property or its known occupants on the referenced databases:

Franklin Savings Bank – The subject property is identified as a UST site. Refer to Section 4.8 for additional information regarding the status of the former UST systems.

9.2: Adjoining and Nearby Sites

PM's review of the referenced databases also considered the potential or likelihood of contamination from adjoining and nearby sites. To evaluate which of the adjoining and nearby sites identified in the regulatory database report present an environmental risk to the subject property, PM considered the following criteria:

- The type of database on which the site is identified.
- The topographic position of the identified site relative to the subject property.
- The direction and distance of the identified site from the subject property.
- Local soil conditions in the subject property area.
- The known or inferred groundwater flow direction in the subject property area.
- The status of the respective regulatory agency-required investigation(s) of the identified site, if any.
- Surface and subsurface obstructions and diversions (e.g., buildings, roads, sewer systems, utility service lines, rivers, lakes, and ditches) located between the identified site and the subject property.

Only those sites that are judged to present a potential environmental risk to the subject property and/or warrant additional clarification are further evaluated. Using the referenced criteria, and based upon a review of readily available information contained within the regulatory database report, PM did not identify adjoining (i.e., bordering) or nearby sites (e.g., properties within a ¼-

mile radius) listed in the regulatory database report that were judged to present a potential environmental risk to the subject property, with the exception of the following:

Woodward Detroit CVS – This site is identified as 444 South Old Woodward Avenue and is the west adjoining property. Review of the regulatory database indicates this site is identified as a RCRA-CESQG of hazardous waste with no reported violations. The site was formerly registered as a RCRA-LQG of hazardous waste in 2014 and 2015, as a RCRA-SQG of hazardous waste in 2014 and 2015, and as a RCRA-CESQG of hazardous waste in 2015. PM requested to review MDEQ files associated with the RCRA status; however, PM received a response indicating that no files were available. The RCRA status is likely associated with the disposal of light bulbs, damaged retail items, and/or pharmaceutical waste. Based on this information, PM has not identified this site as a REC.

Fred Lavery Company – This site is identified as 34602 Woodward Avenue and is the east adjoining property. Review of the regulatory database indicates that the tenant is a registered RCRA-CESQG of hazardous waste with two reported violations. The site was formerly registered as a RCRA-SQG in 1991, 1998, 2002, 2008, and 2009 and as a RCRA-CESQG of hazardous waste in 2009. PM reviewed available MDEQ files for the RCRA status, which document that the violations were related to the waste water from vehicle washing at the dealership. Other documentation included permits for the removal and transport of waste oil from the property. Based on distance (approximately 230 feet east across Woodward Avenue) from the subject property, the lack of groundwater to act as a transport mechanism, and the topographic gradient (south-southeast) away from the subject property, PM has not identified this site as a REC.

Estate Motors Limited – This property is identified as 464 South Old Woodward Avenue (currently 444 South Old Woodward Avenue) and is the west adjoining property. Review of the regulatory database indicates this property is identified as a closed LUST site with two reported releases in 1991 and 1992, which were granted closure in 1993 and 1994, respectively. Review of information available in PM's archives documents the 1991 release was granted a former Type-A Closure and the 1992 release was granted a former Type-B Closure, indicating little-to-no residual contamination or metals with limited mobility in soil remain on-site. Based upon this information, closed LUST status, redevelopment of the property, extensive sampling to identify contamination at the subject property, and distance of former UST basin from the subject property (approximately 125 feet) PM has not identified this property as a REC.

Speedway LLC – This property is identified as 34750 Woodward Avenue and is located within one eighth of a mile northeast of the subject property. Review of the regulatory database indicates this property is identified as a closed LUST site with one reported release in 1991 and granted closure in 1996, and as an open LUST site with one reported release in 2014. Review of MDEQ records indicates the most recent groundwater sampling was completed in February 2016, which documents groundwater flow at this property is to the southwest. Soil and groundwater analytical results identified contamination above MDEQ Part 213 Risk Based Screening Levels (RBSLs), which is not delineated towards the subject property. However, based on the distance of contamination from the subject property (at least 600 feet across multiple right-of-ways) and extensive sampling to identify contamination at the subject property, PM has not identified this property as a REC.

Jax Kar Wash #048 – This property is identified as 34745 Woodward Avenue and is located within one eighth of a mile northeast of the subject property. Review of the regulatory database indicates this property is identified as an open LUST site with one reported release in 2000 and a BEA site. Review of information available in PM's archives indicates multiple site investigations were completed between 2001 and 2005, which document soil and groundwater contamination are present above MDEQ Part 213 RBSLs, which is not delineated towards the subject property. However, based on the distance of contamination from the subject property (approximately 310 feet across South Old Woodward Avenue) and extensive sampling to identify contamination at the subject property, PM has not identified this property as a REC.

Green's Art Supply – This property is identified as 400 South Old Woodward Avenue and is located within one-eighth of a mile northwest of the subject property. Review of the regulatory database indicates this property is identified as a Brownfield site and a BEA site. Review of previous site investigations document the assessment of RECs associated with former gasoline dispensing and service garage operations at the property. Soil remediation activities were completed and VSR sampling indicated target analyte concentrations were below MDEQ Part 201 Generic Cleanup Criteria for unrestricted residential use. Although the property is listed as a BEA site, remediation activities completed in 2015 document soil contaminant concentrations are no longer present above the most restrictive Part 201 GCC. Based on the extensive sampling for contamination at the property, extensive remediation activities, and distance from the subject property (approximately 175 feet northwest), PM has not identified this property as a REC.

Weiss Samona / Woodward Brown Associates – This site is identified as 34901 Woodward Avenue and is located within one-eighth of a mile north of the subject property. The property is identified as a Brownfields and BEA site, which is likely associated with the former service operations and previous site activities. A review of previous site investigations indicates that the property is considered a "facility" based on concentrations above Part 201 for tetrachloroethelyne, xylenes, arsenic, lead, selenium, and boron and groundwater concentrations above the residential cleanup criteria for arsenic, lead, selenium, and boron. Based on the distance of the contamination from the subject property (approximately 650 feet north), PM has not identified this site as a REC.

Mally, C. Lane Prop / Golling Motors, Inc. – This site is identified as 34500 Woodward Avenue (historically 575 Hunter Boulevard) and is located within one-eighth of a mile southeast of the subject property. Review of the regulatory database indicates this site is identified as a BEA site. PM reviewed available MDEQ file documentation for this site, which indicates that hydrocarbon contamination is present that is due to the past use of this property for various operations including machine shops, automotive repair and painting, and a gasoline service station. The contamination, which was limited to the soil, consisted of ethylbenzene and xylenes detected at levels exceeding the applicable MDEQ Generic Residential Cleanup Criteria. No groundwater was encountered to at least 10.0 feet bgs, the maximum depth explored. Based on the distance (approximately 340 feet southeast) from the subject property and the lack of shallow groundwater, PM has not identified this site as a REC.

10.0 FINDINGS, OPINIONS AND CONCLUSIONS

10.1: De Minimis Condition

A de minimis condition, as defined in the ASTM Standard, is a condition that generally does not present a threat to human health or the environment and generally would not be the subject of an enforcement action if brought to the attention of appropriate governmental agencies.

Conditions determined to be de minimis are not RECs or CRECs. No de minimis conditions were identified during this assessment.

10.2: Significant Data Gaps

A data gap, as defined in the ASTM Standard, is a lack of or inability to obtain information required by the ASTM Standard despite good faith efforts by the environmental professional to gather such information. The environmental professional must then determine whether these gaps are significant. PM did not identify or encounter any instances of significant data gaps during the course of this ESA.

10.3: Historical Recognized Environmental Conditions (HRECs)

An HREC, as defined in the ASTM Standard, is a past release of hazardous substances or petroleum products that has occurred in connection with the subject property and has been addressed to the satisfaction of the applicable regulatory authority or meeting unrestricted residential use criteria established by a regulatory authority, without subjecting the subject property to any required controls. PM has not identified any HRECs in association with the subject property.

10.4: Recognized Environmental Conditions (RECs)

Recognized Environmental Condition

We have performed a Phase I Environmental Site Assessment in conformance with the scope and limitations of ASTM Practice E 1527-13 of the Commercial Property located at 469 and 479 South Old Woodward Avenue, Birmingham, Oakland County, Michigan, the property. Any exceptions to, or deletions from, this practice are described in Section 1.4 of this report. This assessment has revealed no evidence of recognized environmental conditions connected with the property except the following:

- The southern portion of the subject property was formerly occupied by an automotive dealership and service garage from at least 1931 until at least in 1984. Historical interior waste streams associated with the former automotive dealership included service and painting operations, which would have consisted of general hazardous substances and/or petroleum products. This time period preceded major environmental regulations and current waste management and disposal procedures. The historical waste management practices associated with the former automotive service and painting operations are unknown and may be a source of subsurface contamination.

- The former automotive dealership and service garage contained at least five in-ground hydraulic hoists. In-ground hoists have an underground reservoir for hydraulic fluids, which can contain polychlorinated biphenyls (PCBs). The potential exists that a release occurred from the former hydraulic hoist system and/or underground reservoir. Additionally, the potential exists for orphaned reservoirs to be present on the subject property.

- Review of City of Birmingham Fire and Building Department records and Michigan Department of Environmental Quality (MDEQ) records documents the removal of one 1,000-gallon waste oil underground storage tank (UST), one 1,500-gallon UST, and one

300-gallon UST in September 1988. PM was unable to confirm the installation date and/or location of the former 1,000-gallon waste oil UST and/or the 1,500-gallon and 300-gallon USTs removed in September 1988. Additionally, PM was unable to locate any sampling completed in the area of the former USTs. Additional USTs may have also historically been associated with the former dealership and automotive service operations. The potential exists for orphan USTs to be present on the property and/or for a release to have occurred.

The following adjoining and/or nearby RECs have been identified:

- The north adjoining property, identified as 411 South Old Woodward Avenue, was formerly occupied by an automotive service garage from at least 1926 until at least in 1974. Historical interior waste streams associated with the former service garage operations would have consisted of general hazardous substances and/or petroleum products. Based on the close proximity to the subject property (i.e. along the northern property boundary) and long term service and fueling operations (i.e. 48 years), the potential exists a release occurred on this property and migrated onto the subject property.

- The south adjoining property, identified as 555 South Old Woodward Avenue, was formerly occupied by a gasoline dispensing station and automotive service garage from at least 1926 until at least in 1974. Historical interior waste streams associated with the former service garage operations would have consisted of general hazardous substances and/or petroleum products. Based on the close proximity to the subject property (i.e. approximately 50 feet) and long term gasoline dispensing and/or service operations (i.e. 48 years), the potential exists a release occurred on this property and migrated onto the subject property.

10.5: Controlled Recognized Environmental Conditions (CRECs)

A CREC, as defined in the ASTM Standard, is a recognized environmental condition (REC) resulting from a past release of hazardous substances or petroleum products that has been addressed to the satisfaction of the applicable regulatory authority with hazardous substances or petroleum products allowed to remain in place subject to the implementation of required controls. PM has not identified any CRECs in association with the subject property.

10.6: Recommendations

We have performed a Phase I Environmental Site Assessment in conformance with the scope and limitations of ASTM Practice E 1527-13 of the Commercial Property located at 469 and 479 South Old Woodward Avenue, Birmingham, Oakland County, Michigan, the property. Any exceptions to, or deletions from, this practice are described in Section 1.4 of this report. This assessment has revealed no evidence of recognized environmental conditions connected with the property except as listed in Section 10.5 of this report.

Parts 201 and 213 of the 1994 Michigan Natural Resources Environmental Protection Act (NREPA) provide liability protection for off-site migration of contamination to the subject property. Legal counsel should be consulted regarding issues related to potential off-site migration of contaminants.

PM has been retained by the client to complete a subsurface investigation to assess these RECs and the results will be provided under separate cover.

11.0 NON-ASTM SCOPE CONSIDERATIONS/BUSINESS ENVIRONMENTAL RISKS

PM has included a discussion of Non-ASTM Scope Considerations based upon industry standards and lender requirements. A Business Environmental Risk is defined as a risk which can have a material environmental or environmentally-driven impact on the business associated with the current or planned use of a parcel of commercial real estate, not necessarily limited to those environmental issues required to be investigated in this practice.

Non-ASTM Item	Observations or Information
Potential Asbestos Containing Materials (ACMs)	Based upon PM's limited visual observation during the site reconnaissance, suspect ACBMs identified included acoustical ceiling tile, drywall walls, vinyl floor tile, and air cell pipe wrap. The materials appeared to be in fair condition. Additionally, it is understood that the subject buildings will be demolished. Therefore, PM recommends the completion of a pre-demolition asbestos survey to determine if asbestos is present in building materials. PM can provide a proposal for the pre-demolition survey at the request of the client.
Lead Based Paint (LBP)	Based on the age of the subject buildings, the building may have lead based/containing paint. Since the buildings are slated for demolition, the contractor preforming decommissioning activities should be made aware and use adequate work practices to avoid any employee exposure exceedances and comply with all applicable State and Federal regulations.
Visual Mold or Significant Moisture Damage	PM performed a limited visual assessment for the presence of mold, conditions conducive to mold, and evidence of moisture in readily accessible interior areas of the subject property. PM did not note obvious visual indications of the presence of mold, conditions conducive to mold, or evidence of moisture in readily accessible interior areas of the subject property.

12.0 SIGNATURE(S) OF ENVIRONMENTAL PROFESSIONAL(S)

We declare that, to the best of our professional knowledge and belief, we meet the definition of *Environmental professional* as defined in §312.10 of 40 CFR 312 and we have the specific qualifications based on education, training, and experience to assess a property of the nature, history, and setting of the subject property. We have developed and performed the all appropriate inquires in conformance with the standards and practices set forth in 40 CFR Part 312.

Sexton

Kristin Gable
Regional Due Diligence Manager

Beth Sexton
National Due Diligence Manager

13.0 REFERENCES

The following published sources were utilized during completion of this Phase I ESA:

- *Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process,* ASTM, ASTM Designation E 1527-13, Published November 2013.

- Bresser's Cross-Index City Directories, Bresser's in Detroit, Michigan. City: Birmingham. Years: 1952-2014.

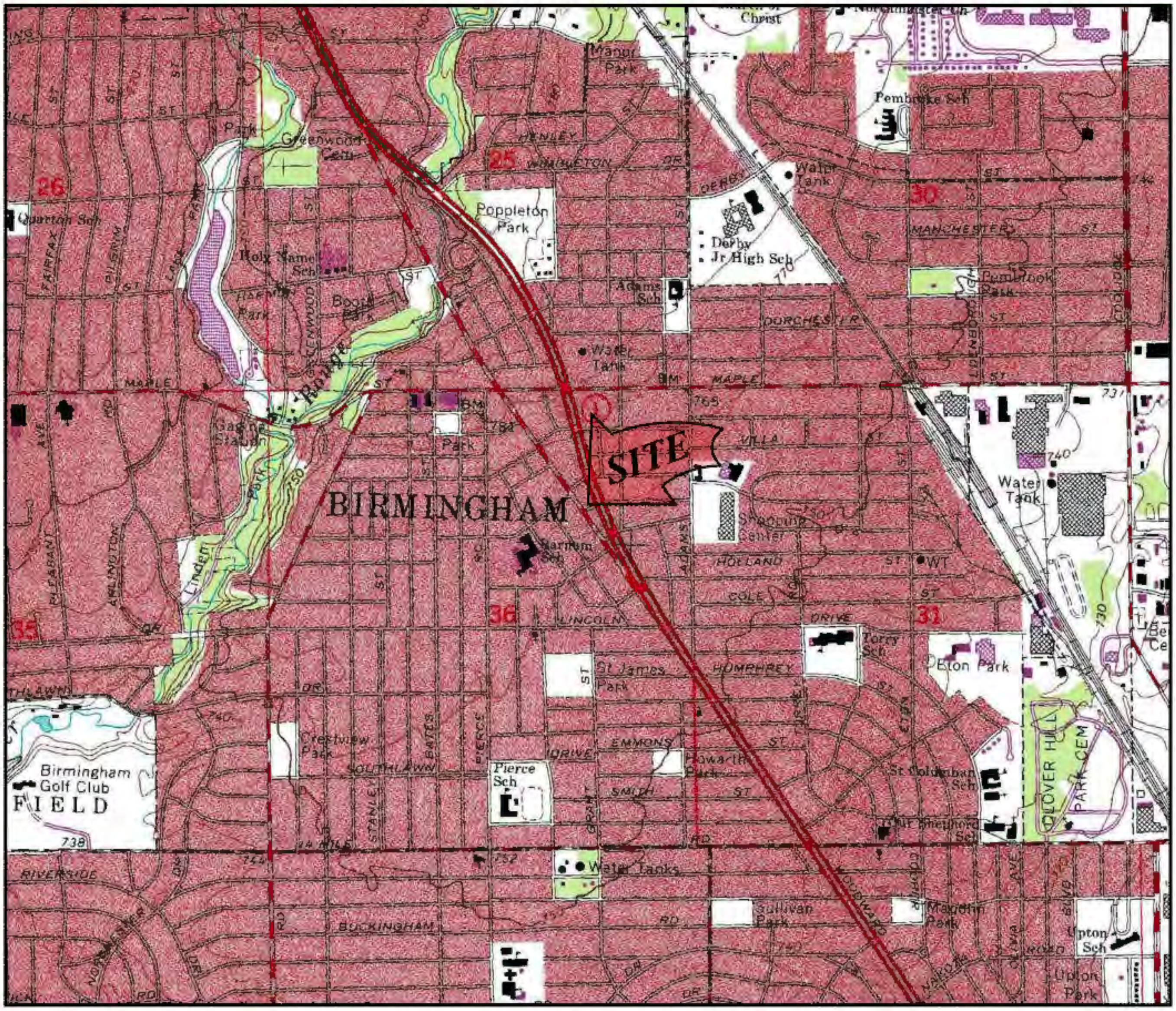
- R.L. Polk's Directories, obtained from the State of Michigan Library in Lansing, Michigan. City: Birmingham. Years: 1937-1951.

- United States Geological Survey Division (U.S.G.S.) 7.5 Minute Topographic Map Birmingham, Michigan Quadrangle, 1968 (photo-revised 1981).

- *Custom Soil Resource Report of Oakland County, Michigan*, U.S. Department of Agriculture, February 2017.

Figures

PM ENVIRONMENTAL
Environmental
& Engineering
Services



OAKLAND COUNTY

SCALE 1:24,000

1 MILE 1/2 MILE 0 1 MILE

FIGURE 1

PROPERTY VICINITY MAP

USGS, 7.5 MINUTE SERIES

BIRMINGHAM, MI QUADRANGLE, 1968. PHOTO REVISED 1981.

PM ENVIRONMENTAL

Environmental & Engineering Services

PROJ:
COMMERCIAL PROPERTY
469 AND 479 SOUTH OLD
WOODWARD AVENUE
BIRMINGHAM, MI

THIS IS NOT A LEGAL SURVEY

VERIFY SCALE

0 2,000'

IF NOT 1" ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

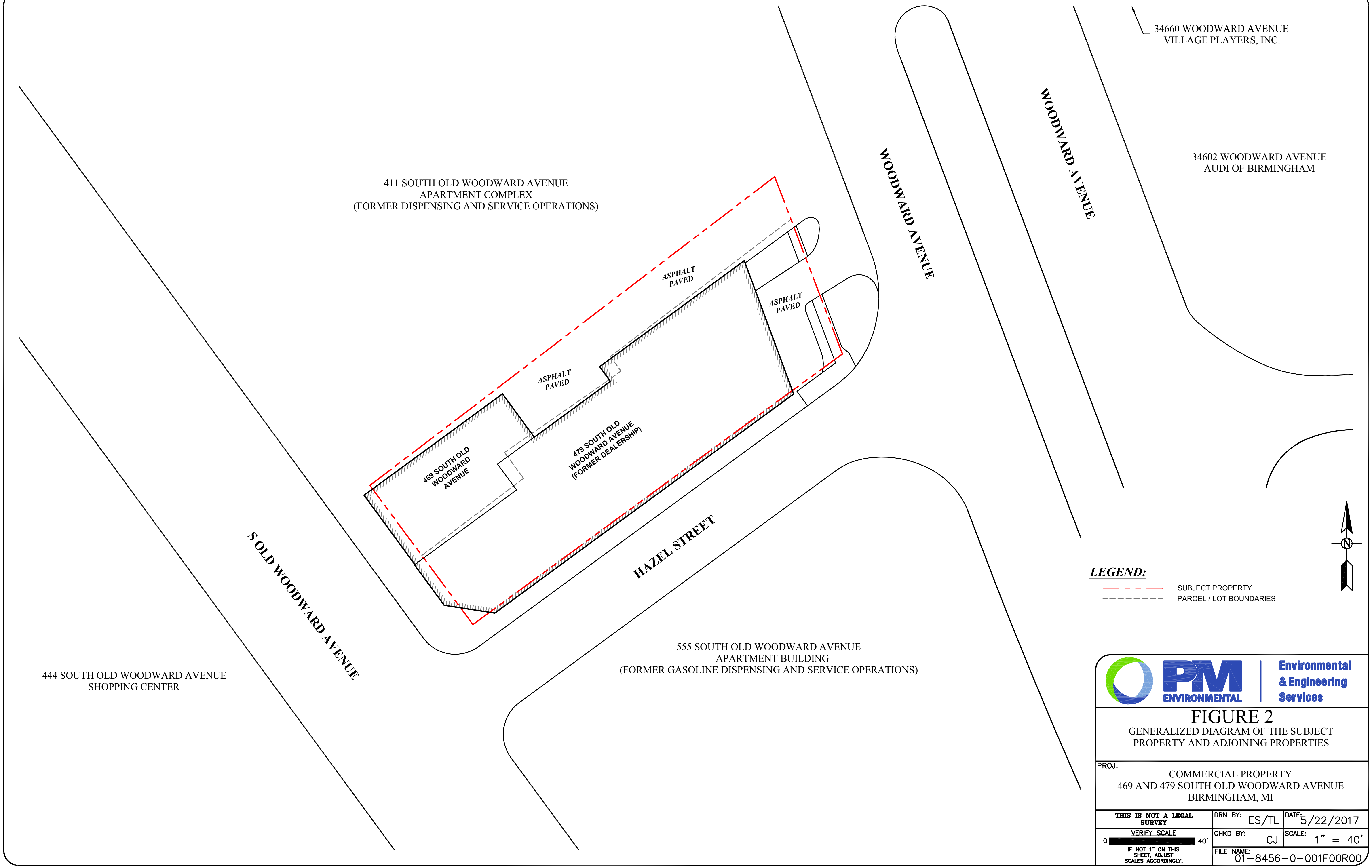
DRN BY: ES/TL

DATE: 5/22/2017

CHKD BY: CJ

SCALE: 1" = 2,000'

FILE NAME: 01-8456-0-001F01R00



PM ENVIRONMENTAL | Environmental & Engineering Services

FIGURE 2

GENERALIZED DIAGRAM OF THE SUBJECT PROPERTY AND ADJOINING PROPERTIES

PROJ:

COMMERCIAL PROPERTY
469 AND 479 SOUTH OLD WOODWARD AVENUE
BIRMINGHAM, MI

THIS IS NOT A LEGAL SURVEY	DRN BY: ES/TL	DATE: 5/22/2017
VERIFY SCALE 0 40' IF NOT 1" ON THIS SHEET, ADJUST SCALES ACCORDINGLY.	CHKD BY: CJ	SCALE: 1" = 40'
	FILE NAME: 01–8456–0–001F00R00	

Appendix A

PM ENVIRONMENTAL
Environmental
& Engineering
Services

SITE PHOTOGRAPHS

Photograph 1

Subject property

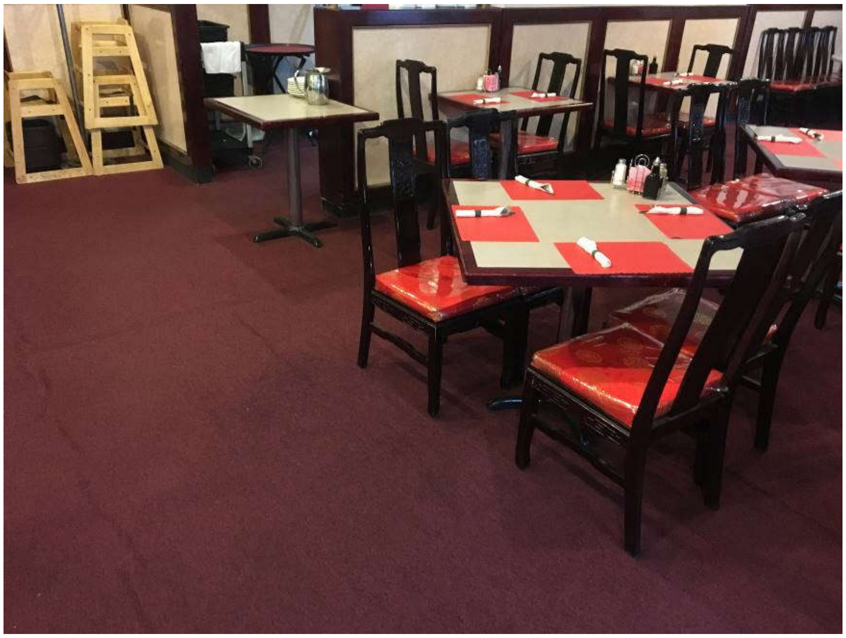
Photograph 2

East facing façade of 469 South Old Woodward Avenue

Photograph 3

West facing façade of both 469 and 479 South Old Woodward Avenue

Photograph 4

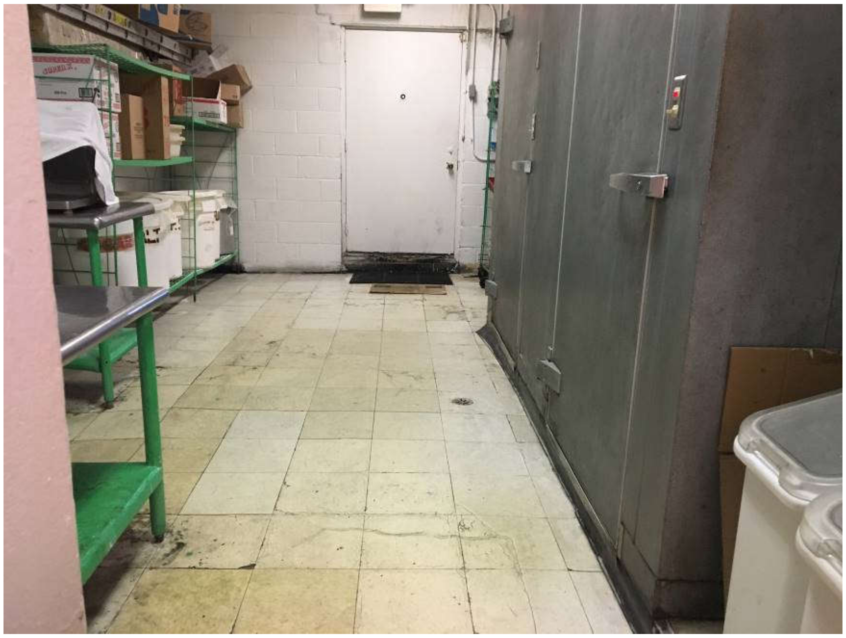


View of the dining area of 469 South Old Woodward Avenue

Photograph 5

View of the kitchen area of 469 South Old Woodward Avenue

Photograph 6

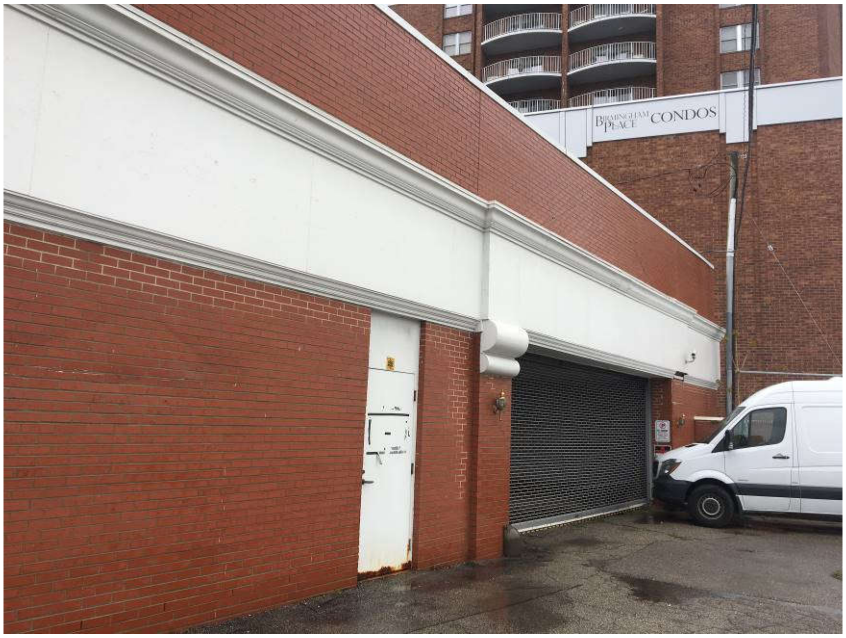


View of the storage area of 469 South Old Woodward Avenue

Photograph 7

View of the north facing façade of 479 South Old Woodward Avenue

Photograph 8



View of the east facing façade of 479 South Old Woodward Avenue

Photograph 9

View of the south facing façade of 479 South Old Woodward Avenue

Photograph 10

View of the former bank lobby at 479 South Old Woodward Avenue

Photograph 11

View of the teller area of 479 South Old Woodward Avenue

Photograph 12

View of the parking garage associated with 479 South Old Woodward Avenue

Photograph 13

View of the north adjoining apartment complex property

Photograph 14

View of the east adjoining Audi of Birmingham property

Photograph 15

View of the south adjoining apartment building property

Photograph 16

View of the west adjoining shopping center property

Appendix B

PM ENVIRONMENTAL
Environmental & Engineering Services

USER QUESTIONNAIRE

Phase I ESA - ASTM User Questionnaire

Project Address: **467 and 479 South Old Woodward Avenue, Birmingham, Michigan**

The ASTM Standard defines a User as "the party seeking to use Practice E 1527 to complete an environmental site assessment. A User may include, without limitation, a potential purchaser of property, a potential tenant of property, an owner of property, a lender, or a property manager.

In order to qualify for one of the Landowner Liability Protections (LLPs) offered by the Small Business Liability Relief and Brownfield's Revitalization Act of 2001 (the "Brownfield's Amendments") the **User** must provide the following information (if available) to the environmental professional. Failure to provide this information could result in a determination that "all appropriate inquiry" is not complete.

Please answer the following questions to the best of your knowledge and return to PM Environmental, Inc. (PM) with the signed copy of your proposal.

1. Environmental Clean-up liens that are filed or recorded against the site (40 CFR 312.25)

Are you aware of any environmental cleanup liens against the property that are filed or recorded under federal, tribal, state or local law? **Yes** [✓ **No**]

If so, please describe the type of liens: ______________________

____

2. Activity and land use limitations that are in place on the site or that have been filed in a registry (40 CFR 312.26)

Are you aware of any Activity and Use Limitations (AULs), such as engineering controls, land use restrictions, or institutional controls that are in place at the site and/or have been filed or recorded in a registry under federal, tribal, state, or local law? **Yes** [✓ **No**]

If yes, what type of AULs are you aware of? ______________________

____

3. Specialized knowledge or experience of the person seeking to qualify for a LLP (40 CFR 312.28)

As the user of this ESA do you have any specialized knowledge or experience related to the property or nearby properties? For example, are you involved in the same line of business as the current or former occupants of the property or an adjoining property so that you would have specialized knowledge of the chemicals and the processes used by this type of business? **Yes** [✓ **No**]

If yes, what type of business are you associated with? ______________________

What types of chemicals are used in your business? ______________________

____

Initial here ☐

Phase I ESA - ASTM User Questionnaire

Project Address: **467 and 479 South Old Woodward Avenue, Birmingham, Michigan**

4. Relationship to the purchase price to the fair market value of the property if it were not contaminated (40 CFR 312.29)

Does the purchase price being paid for this property reasonably reflect the fair market value of the property? [✓ **Yes**] **No**

If you conclude that there is a difference, have you considered whether the lower purchase price is because contamination is known or believed to be present at the property? **Yes** **No**

5. Commonly known or reasonably ascertainable information about the property (40 CFR 312.30)

Are you aware of commonly known or reasonably ascertainable information about the property that would help the environmental professional to identify conditions indicative of releases or threatened releases? For example as a user:

a. Do you know of the past uses of the property? **Yes** [✓ **No**]

If yes, please list what past uses you are aware of? ______________________

b. Do you know of specific chemicals that are present or once were present at the property? **Yes** [✓ **No**]

If yes, please list what chemicals you are aware of? ______________________

c. Do you know of spills or other chemical releases that have taken place on the property? **Yes** [✓ **No**]

d. Do you know of any environmental cleanups which have taken place on the property? **Yes** [✓ **No**]

If yes, do you have copies of any of the reports documenting the work? **Yes** [✓ **No**]

If you have any documentation of the previous environmental clean-up please provide copies to PM when you return this questionnaire.

Initial here DGM

Phase I ESA - ASTM User Questionnaire

Project Address:	**467 and 479 South Old Woodward Avenue, Birmingham, Michigan**

6. The degree of the obviousness of the presence or likely presence of contamination at the property and the ability to detect the contamination by appropriate investigation (40CFR 312.31)

As the user of this ESA, based on your knowledge and experience related to the property are there any obvious indicators that point to the presence or likely presence of contamination on the property? **Yes** [✓ **No**]

If yes, please comment on what those indicators are (i.e. lower purchase price, areas of staining, poor housekeeping, etc).:

User Name: MArkus Management Group, LLC

Company Name property is being purchased under: on behalf of an entity to be formed.

Street Address: 251 E. Merrill, Suite 205

City, State, Zip code: Birmingham, MI 48009

User Phone Number: 248-203-9090

Signature of the User:

Date Questionnaire was completed on: 5/1/17

SOIL SURVEY INFORMATION

United States
Department of
Agriculture

NRCS

Natural
Resources
Conservation
Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Oakland County, Michigan

May 3, 2017

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map

Map Scale: 1:550 if printed on A landscape (11" x 8.5") sheet.

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

Area of Interest (AOI)

- ▭ Area of Interest (AOI)

Soils

- 🟧 Soil Map Unit Polygons
- Soil Map Unit Lines
- ■ Soil Map Unit Points

Special Point Features

- Blowout
- ⊠ Borrow Pit
- ✖ Clay Spot
- Closed Depression
- ✕ Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- ◎ Miscellaneous Water
- ○ Perennial Water
- Rock Outcrop
- + Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- +++ Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Oakland County, Michigan
Survey Area Data: Version 15, Feb 13, 2017

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 14, 2012—Mar 21, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Oakland County, Michigan (MI125)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
EtmaaE	Udorthents and Udipsamments, nearly level to hilly	0.5	100.0%
Totals for Area of Interest		**0.5**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Oakland County, Michigan

EtmaaE—Udorthents and Udipsamments, nearly level to hilly

Map Unit Setting

National map unit symbol: 2m785
Elevation: 680 to 1,000 feet
Mean annual precipitation: 31 to 32 inches
Mean annual air temperature: 47 to 47 degrees F
Frost-free period: 137 to 179 days
Farmland classification: Not prime farmland

Map Unit Composition

Udorthents and similar soils: 60 percent
Udipsamments and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udorthents

Setting

Landform: Ground moraines
Landform position (three-dimensional): Rise
Down-slope shape: Concave
Across-slope shape: Convex
Parent material: Loamy till

Typical profile

A - 0 to 8 inches: silt loam
C - 8 to 39 inches: clay loam
Cd - 39 to 80 inches: clay loam

Properties and qualities

Slope: 0 to 30 percent
Depth to restrictive feature: About 39 inches to densic material
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to low (0.00 to 0.01 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 30 percent
Available water storage in profile: Moderate (about 6.5 inches)

Description of Udipsamments

Setting

Landform: Ground moraines
Landform position (three-dimensional): Rise
Down-slope shape: Concave
Across-slope shape: Convex
Parent material: Sandy glaciofluvial deposits

Typical profile

A - 0 to 4 inches: fine sandy loam
C1 - 4 to 12 inches: loamy fine sand

C2 - 12 to 30 inches: loamy fine sand
C3 - 30 to 80 inches: gravelly loamy fine sand

Properties and qualities

Slope: 0 to 30 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): High to very high (2.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 35 percent
Available water storage in profile: Low (about 4.5 inches)

Soil Information for All Uses

Soil Reports

The Soil Reports section includes various formatted tabular and narrative reports (tables) containing data for each selected soil map unit and each component of each unit. No aggregation of data has occurred as is done in reports in the Soil Properties and Qualities and Suitabilities and Limitations sections.

The reports contain soil interpretive information as well as basic soil properties and qualities. A description of each report (table) is included.

Soil Qualities and Features

This folder contains tabular reports that present various soil qualities and features. The reports (tables) include all selected map units and components for each map unit. Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Soil Features

This table gives estimates of various soil features. The estimates are used in land use planning that involves engineering considerations.

A *restrictive layer* is a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers. The table indicates the hardness and thickness of the restrictive layer, both of which significantly affect the ease of excavation. *Depth to top* is the vertical distance from the soil surface to the upper boundary of the restrictive layer.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence generally results from either desiccation and shrinkage, or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. The table shows the expected initial subsidence, which usually is a result of drainage, and total subsidence, which results from a combination of factors.

Potential for frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, saturated hydraulic conductivity (Ksat), content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel or concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel or concrete in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion also is expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Soil Features–Oakland County, Michigan									
Map symbol and soil name	Restrictive Layer				Subsidence		Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness	Initial	Total		Uncoated steel	Concrete
		Low-RV-High	*Range*		*Low-High*	*Low-High*			
		In	*In*		*In*	*In*			
EtmaaE—Udorthents and Udipsamments, nearly level to hilly									
Udorthents	Densic material	- 39-	—	Very strongly cemented	—	—	Moderate	Moderate	Low
Udipsamments		—	—		—	—	Low	Low	Low

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

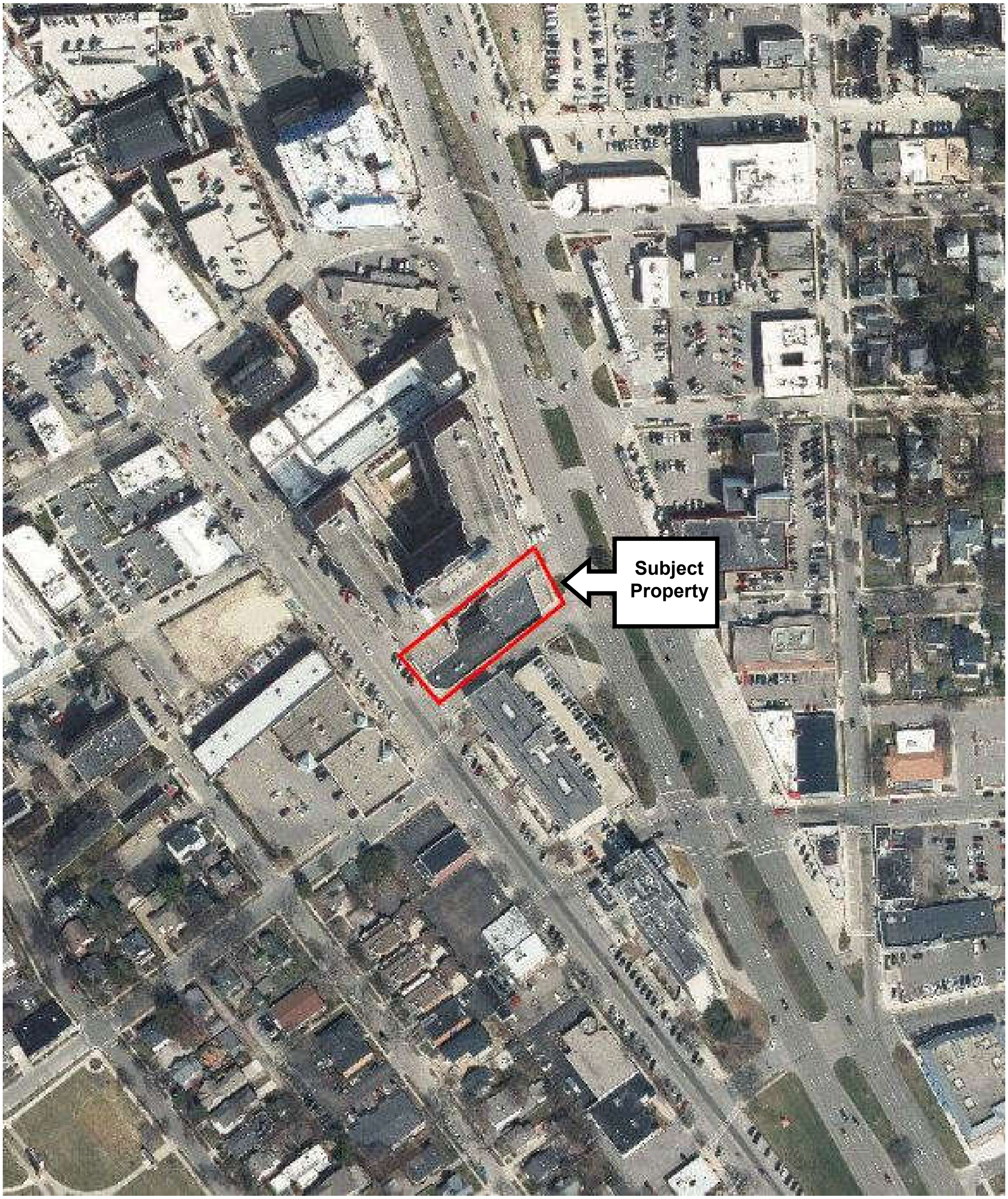
United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

AERIAL PHOTOGRAPHS

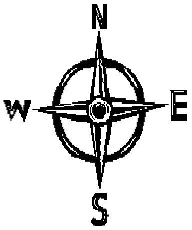


Location: 469 and 479 Old Woodward Avenue, Birmingham, Michigan

PM Project No. 01-8456-0-0001

Aerial Year: 2015

Source: Oakland County



Appendix D

PM ENVIRONMENTAL
Environmental
& Engineering
Services

ENVIRONMENTAL DATABASE SEARCH

469 & 479 S. Old Woodward Ave
469 & 479 S. Old Woodward Ave
Birmingham, MI 48009

Inquiry Number: 04926467.2r
May 04, 2017

The EDR Radius Map™ Report

6 Armstrong Road, 4th floor
Shelton, CT 06484
Toll Free: 800.352.0050
www.edrnet.com

TABLE OF CONTENTS

SECTION **PAGE**

GEOCHECK ADDENDUM

GeoCheck - Not Requested

Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

Disclaimer - Copyright and Trademark Notice

This Report contains certain information obtained from a variety of public and other sources reasonably available to Environmental Data Resources, Inc. It cannot be concluded from this Report that coverage information for the target and surrounding properties does not exist from other sources. **NO WARRANTY EXPRESSED OR IMPLIED, IS MADE WHATSOEVER IN CONNECTION WITH THIS REPORT. ENVIRONMENTAL DATA RESOURCES, INC. SPECIFICALLY DISCLAIMS THE MAKING OF ANY SUCH WARRANTIES, INCLUDING WITHOUT LIMITATION, MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE OR PURPOSE. ALL RISK IS ASSUMED BY THE USER. IN NO EVENT SHALL ENVIRONMENTAL DATA RESOURCES, INC. BE LIABLE TO ANYONE, WHETHER ARISING OUT OF ERRORS OR OMISSIONS, NEGLIGENCE, ACCIDENT OR ANY OTHER CAUSE, FOR ANY LOSS OF DAMAGE, INCLUDING, WITHOUT LIMITATION, SPECIAL, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES. ANY LIABILITY ON THE PART OF ENVIRONMENTAL DATA RESOURCES, INC. IS STRICTLY LIMITED TO A REFUND OF THE AMOUNT PAID FOR THIS REPORT.** Purchaser accepts this Report "AS IS". Any analyses, estimates, ratings, environmental risk levels or risk codes provided in this Report are provided for illustrative purposes only, and are not intended to provide, nor should they be interpreted as providing any facts regarding, or prediction or forecast of, any environmental risk for any property. Only a Phase I Environmental Site Assessment performed by an environmental professional can provide information regarding the environmental risk for any property. Additionally, the information provided in this Report is not to be construed as legal advice.

Copyright 2017 by Environmental Data Resources, Inc. All rights reserved. Reproduction in any media or format, in whole or in part, of any report or map of Environmental Data Resources, Inc., or its affiliates, is prohibited without prior written permission.

EDR and its logos (including Sanborn and Sanborn Map) are trademarks of Environmental Data Resources, Inc. or its affiliates. All other trademarks used herein are the property of their respective owners.

EXECUTIVE SUMMARY

A search of available environmental records was conducted by Environmental Data Resources, Inc (EDR). The report was designed to assist parties seeking to meet the search requirements of EPA’s Standards and Practices for All Appropriate Inquiries (40 CFR Part 312), the ASTM Standard Practice for Environmental Site Assessments (E 1527-13) or custom requirements developed for the evaluation of environmental risk associated with a parcel of real estate.

TARGET PROPERTY INFORMATION

ADDRESS

469 & 479 S. OLD WOODWARD AVE
BIRMINGHAM, MI 48009

COORDINATES

Latitude (North):	42.5438830 - 42˚ 32’ 37.97’’
Longitude (West):	83.2107160 - 83˚ 12’ 38.57’’
Universal Tranverse Mercator:	Zone 17
UTM X (Meters):	318472.1
UTM Y (Meters):	4712320.0
Elevation:	765 ft. above sea level

USGS TOPOGRAPHIC MAP ASSOCIATED WITH TARGET PROPERTY

Target Property Map:	6066350 BIRMINGHAM, MI
Version Date:	2014

AERIAL PHOTOGRAPHY IN THIS REPORT

Portions of Photo from:	20140628
Source:	USDA

MAPPED SITES SUMMARY

Target Property Address:
469 & 479 S. OLD WOODWARD AVE
BIRMINGHAM, MI 48009

Click on Map ID to see full detail.

MAP ID	SITE NAME	ADDRESS	DATABASE ACRONYMS	RELATIVE ELEVATION	DIST (ft. & mi.) DIRECTION
A1	FRANKLIN SAVINGS BAN	479 S OLD WOODWARD A	UST		TP
A2	ESTATE MOTORS LTD	464 S OLD WOODWARD A	LUST, WDS	Higher	95, 0.018, WSW
A3	ESTATE MOTORS	464 S WOODWARD AVE	UST	Higher	95, 0.018, WSW
A4	ESTATE MOTORS LTD	464 S OLD WOODWARD A	RCRA NonGen / NLR, FINDS, ECHO	Higher	121, 0.023, WSW
A5		458 S OLD WOODWARD A	EDR Hist Cleaner	Higher	124, 0.023, WSW
A6		401 S OLD WOODWARD A	EDR Hist Auto	Higher	134, 0.025, NNW
A7	WOODWARD DETROIT CVS	444 S OLD WOODWARD A	RCRA-CESQG	Higher	136, 0.026, West
B8		555 S OLD WOODWARD A	EDR Hist Auto	Lower	189, 0.036, South
C9	GREEN’S ART SUPPLY	400 SOUTH OLD WOODWA	US BROWNFIELDS	Higher	275, 0.052, West
C10	GREEN’S ART SUPPLY	400 SOUTH OLD WOODWA	INVENTORY	Higher	275, 0.052, West
C11	FORMER GASOLINE DISP	400 S OLD WOODWARD	UST	Higher	275, 0.052, West
D12	FRED LAVERY CO	34602 WOODWARD AVE	RCRA-CESQG, FINDS, ECHO	Lower	324, 0.061, ENE
E13	SPEEDWAY LLC	34750 WOODWARD AVE	RCRA-CESQG, LUST, UST, INVENTORY, FINDS, ECHO	Higher	371, 0.070, NNE
E14		34750 WOODWARD AVE	EDR Hist Auto	Higher	371, 0.070, NNE
D15	CARMAN TILLARD	910 N HUNTER BLVD	LUST	Higher	371, 0.070, NE
F16	GOLLING MOTORS, INC.	34500 WOODWARD	INVENTORY, BEA	Lower	399, 0.076, ESE
F17	GOLLING MOTORS, INC.	34500 WOODWARD AVENU	INVENTORY	Lower	399, 0.076, ESE
E18	MALLY, C . LANE PROP	575 SOUTH HUNTER BLV	BEA	Higher	408, 0.077, NE
G19	JAX KAR WASH #048	34745 WOODWARD	LUST, UST, INVENTORY, BEA, WDS	Higher	416, 0.079, NNW
B20		606 S OLD WOODWARD A	EDR Hist Cleaner	Lower	435, 0.082, SSE
E21	FRED LAVERY CO	499 S HUNTER BLVD	UST	Higher	440, 0.083, NE
H22		608 S OLD WOODWARD A	EDR Hist Cleaner	Lower	450, 0.085, South
H23	VILLAGE JEEP EAGLE	666 S WOODWARD	UST	Lower	516, 0.098, SSE
E24		121 N HUNTER BLVD	EDR Hist Auto	Higher	541, 0.102, NE
H25	VILLAGE AMC/JEEP INC	666 S OLD WOODWARD A	RCRA NonGen / NLR, FINDS, ECHO	Lower	559, 0.106, SSE
G26	WOODWARD BROWN ASSOC	34901 WOODWARD AVENU	BEA	Higher	589, 0.112, NNW
G27	WEISS SAMONA	34901 WOODWARD AVENU	US BROWNFIELDS, FINDS	Higher	589, 0.112, NNW
G28	WOODWARD BROWN ASSOC	34901 WOODWARD	INVENTORY	Higher	589, 0.112, NNW
I29	JIMMIES RUSTICS	690 SOUTH OLD WOODWA	BEA	Lower	725, 0.137, SSE
J30	ESSCO OF BIRMINGHAM	255 S OLD WOODWARD A	RCRA-CESQG	Higher	738, 0.140, NW
K31	HOLIDAY INN	34952 WOODWARD AVE	RCRA-CESQG	Higher	744, 0.141, North
32	BROWN STREET OFFICE	200 EAST BROWN	BEA	Higher	775, 0.147, West
L33	HALBEISEN TOM INC	835 HAYNES ST	RCRA-CESQG, FINDS, ECHO	Lower	793, 0.150, SE
L34	GOODYEAR TIRE CENTER	835 HAYNES ST	LUST, UST, WDS	Lower	793, 0.150, SE
K35	34965 WOODWARD AVENU	34965 WOODWARD AVENU	INVENTORY	Higher	793, 0.150, NNW
I36	VIRGINIA C CLOHSET T	784 S OLD WOODWARD A	RCRA NonGen / NLR	Lower	826, 0.156, SSE
J37	UPTOWN ENTERTAINMENT	211 S OLD WOODWARD A	RCRA NonGen / NLR	Higher	836, 0.158, NNW
I38	WOODWARD AND GEORGE,	772-784 SOUTH OLD WO	INVENTORY	Lower	844, 0.160, SSE
I39	WOODWARD AND GEORGE,	772-784 SOUTH OLD WO	BEA	Lower	844, 0.160, SSE

MAPPED SITES SUMMARY

Target Property Address:
469 & 479 S. OLD WOODWARD AVE
BIRMINGHAM, MI 48009

Click on Map ID to see full detail.

MAP ID	SITE NAME	ADDRESS	DATABASE ACRONYMS	RELATIVE ELEVATION	DIST (ft. & mi.) DIRECTION
40	BARNUM HEALTH CENTER	746 PURDY ST	UST	Lower	851, 0.161, SSW
K41	SHELL - HUNTER	34977 WOODWARD AVE	LUST, UST, INVENTORY	Higher	920, 0.174, NNW
K42	CATALYST DEVELOPMENT	34977 WOODWARD AVE	RCRA-CESQG, FINDS, ECHO	Higher	920, 0.174, NNW
K43	CATALYST DEVELOPMENT	34977 WOODWARD AVE	AUL, SPILLS, BEA, WDS	Higher	920, 0.174, NNW
L44	FRED LAVERY COMPANY	907 AND 911 HAYNES S	INVENTORY	Lower	921, 0.174, ESE
L45	LAVERY MI DEALERSHIP	907 AND 911 HAYNES S	INVENTORY	Lower	921, 0.174, ESE
M46	J C & C ENTERPRISES	700 E MAPLE RD	RCRA NonGen / NLR	Higher	922, 0.175, NNE
N47	CATALYST DEVELOPMENT	34977 WOODWARD AVENU	INVENTORY	Higher	957, 0.181, NNW
M48	JERRY BURNS CLEANERS	615 E MAPLE RD	RCRA NonGen / NLR, FINDS, ECHO	Higher	997, 0.189, North
M49	KROGER CO OF MICHIGA	685 E MAPLE RD	RCRA-CESQG	Higher	1005, 0.190, North
M50	MAPLE ELM DEVELOPMEN	820 E MAPLE	RCRA NonGen / NLR, FINDS, ECHO	Higher	1051, 0.199, NNE
51	WALGREENS CO #15391	34300 WOODWARD AVE	RCRA-CESQG, FINDS, ECHO	Lower	1054, 0.200, SE
52	HAMILTON FUNERAL HOM	820 EAST MAPLE ROAD	INVENTORY, BEA	Higher	1055, 0.200, NNE
53	BURTON KATZMAN	336 E MAPLE RD	RCRA NonGen / NLR	Higher	1098, 0.208, NNW
O54	BIRMINGHAM CAMERA SH	168 S OLD WOODWARD A	RCRA NonGen / NLR, FINDS, ECHO	Higher	1099, 0.208, NW
N55	SUNOCO SERVICE STATI	35001 WOODWARD AVE	RCRA NonGen / NLR, FINDS, ECHO	Higher	1123, 0.213, NNW
N56	SUNOCO #0008-4178	35001 WOODWARD AVE	LUST, UST, INVENTORY, BEA, WDS	Higher	1123, 0.213, NNW
57	AMERICAR	860 S WOODWARD	LUST, UST, WDS	Lower	1196, 0.227, SSE
O58	FULLER CENTRAL PARK	111 S OLD WOODWARD	RCRA-CESQG, FINDS, ECHO	Higher	1272, 0.241, NW
P59	BUDGET RENT-A-CAR	1000 E MAPLE	LUST, UST, INVENTORY, WDS	Higher	1291, 0.245, NE
60	WM BEAUMONT HOSPITAL	35046 WOODWARD AVE	RCRA-CESQG, FINDS, ECHO	Higher	1296, 0.245, North
61	PERRY DRUG STORES IN	597 S ADAMS RD	RCRA-CESQG	Lower	1306, 0.247, East
P62	OSOS TONTOS LLC	985 EAST MAPLE	BEA	Higher	1325, 0.251, NE
P63	PARKING LOT (DIETZ C	985 E MAPLE RD	LUST, INVENTORY, BEA	Higher	1331, 0.252, NE
P64	ELMWOOD PROPERTIES I	920-970 EAST MAPLE R	BEA	Higher	1343, 0.254, NE
65	THE PLANT STATION	720 ADAMS	LUST, UST	Lower	1475, 0.279, ESE
P66	BIRMINGHAM STANDARD	1088 E MAPLE RD	LUST, UST, WDS	Lower	1499, 0.284, NE
Q67	912 SOUTH OLD WOODWA	912 SOUTH OLD WOODWA	US BROWNFIELDS, FINDS	Lower	1532, 0.290, SSE
Q68	912 OLD WOODWARD, LL	912 SOUTH OLD WOODWA	INVENTORY	Lower	1532, 0.290, SSE
Q69	912 OLD WOODWARD, LL	912 SOUTH OLD WOODWA	INVENTORY	Lower	1532, 0.290, SSE
70	MOBIL OIL CORP	1065 E MAPLE RD	INVENTORY, AIRS, WDS	Higher	1568, 0.297, NE
Q71	OFFICE BUILDING & PA	1000 SOUTH OLD WOODW	BEA	Lower	1621, 0.307, SSE
Q72	WOODLINC/MICH LTD PA	1050 S OLD WOODWARD	LUST, INVENTORY	Lower	1636, 0.310, SSE
R73	QUARTON WOODWARD SER	1599 S WOODWARD AVE	LUST, UST, AUL, INVENTORY, WDS	Lower	1781, 0.337, SSE
R74	MOBIL SS #03-KPV	1991 S WOODWARD AVE	LUST, UST	Lower	1962, 0.372, SSE
75	COMERICA BANK BIRMIN	322 N. OLD WOODWARD	INVENTORY	Higher	2041, 0.387, NW
76	PROPOSED BALDWIN HOU	200 CHESTER	LUST, UST, WDS	Higher	2076, 0.393, WNW
77	BIRMINGHAM PUBLIC SC	550 W MERRILL	LUST, INVENTORY	Higher	2362, 0.447, WNW
78	FIRST CHURCH OF CHRI	191 N. CHESTER ST.	INVENTORY	Higher	2397, 0.454, WNW

MAPPED SITES SUMMARY

Target Property Address:
469 & 479 S. OLD WOODWARD AVE
BIRMINGHAM, MI 48009

Click on Map ID to see full detail.

MAP ID	SITE NAME	ADDRESS	DATABASE ACRONYMS	RELATIVE ELEVATION	DIST (ft. & mi.) DIRECTION
S79	NEIGHBORHOOD PRO HAR	33801 WOODWARD AVENU	INVENTORY, BEA	Lower	2570, 0.487, SSE
S80	FORMER GASOLINE STAT	33801 WOODWARD	LUST, INVENTORY	Lower	2570, 0.487, SSE
81	BIRMINGHAM CLEANERS	33866 WOODWARD AVE	LUST, UST, BROWNFIELDS, RCRA NonGen / NLR, FINDS,...	Lower	2609, 0.494, SE

EXECUTIVE SUMMARY

TARGET PROPERTY SEARCH RESULTS

The target property was identified in the following records. For more information on this property see page 8 of the attached EDR Radius Map report:

Site	Database(s)	EPA ID
FRANKLIN SAVINGS BAN 479 S OLD WOODWARD A BIRMINGHAM, MI 48009	UST Database: UST, Date of Government Version: 10/21/2016 Tank Status: Removed from Ground Facility Type: CLOSED Facility Id: 00013244	N/A

DATABASES WITH NO MAPPED SITES

No mapped sites were found in EDR's search of available ("reasonably ascertainable ") government records either on the target property or within the search radius around the target property for the following databases:

STANDARD ENVIRONMENTAL RECORDS

Federal NPL site list

NPL	National Priority List
Proposed NPL	Proposed National Priority List Sites
NPL LIENS	Federal Superfund Liens

Federal Delisted NPL site list

Delisted NPL	National Priority List Deletions

Federal CERCLIS list

FEDERAL FACILITY	Federal Facility Site Information listing
SEMS	Superfund Enterprise Management System

Federal CERCLIS NFRAP site list

SEMS-ARCHIVE	Superfund Enterprise Management System Archive

Federal RCRA CORRACTS facilities list

CORRACTS	Corrective Action Report

Federal RCRA non-CORRACTS TSD facilities list

RCRA-TSDF	RCRA - Treatment, Storage and Disposal

Federal RCRA generators list

RCRA-LQG	RCRA - Large Quantity Generators

RCRA-SQG	RCRA - Small Quantity Generators

__Federal institutional controls / engineering controls registries__

LUCIS	Land Use Control Information System
US ENG CONTROLS	Engineering Controls Sites List
US INST CONTROL	Sites with Institutional Controls

__Federal ERNS list__

ERNS	Emergency Response Notification System

__State- and tribal - equivalent CERCLIS__

SHWS	This state does not maintain a SHWS list. See the Federal CERCLIS list and Federal NPL list.

__State and tribal landfill and/or solid waste disposal site lists__

SWF/LF	Solid Waste Facilities Database

__State and tribal leaking storage tank lists__

INDIAN LUST	Leaking Underground Storage Tanks on Indian Land

__State and tribal registered storage tank lists__

FEMA UST	Underground Storage Tank Listing
AST	Aboveground Tanks
INDIAN UST	Underground Storage Tanks on Indian Land

__State and tribal voluntary cleanup sites__

INDIAN VCP	Voluntary Cleanup Priority Listing

ADDITIONAL ENVIRONMENTAL RECORDS

__Local Lists of Landfill / Solid Waste Disposal Sites__

SWRCY	Recycling Facilities
HIST LF	Inactive Solid Waste Facilities
INDIAN ODI	Report on the Status of Open Dumps on Indian Lands
DEBRIS REGION 9	Torres Martinez Reservation Illegal Dump Site Locations
ODI	Open Dump Inventory
IHS OPEN DUMPS	Open Dumps on Indian Land

__Local Lists of Hazardous waste / Contaminated Sites__

US HIST CDL	Delisted National Clandestine Laboratory Register
PART 201	Part 201 Site List
CDL	Clandestine Drug Lab Listing
DEL PART 201	Delisted List of Contaminated Sites
US CDL	National Clandestine Laboratory Register

__Local Land Records__

LIENS	Lien List

LIENS 2	CERCLA Lien Information

Records of Emergency Release Reports

HMIRS	Hazardous Materials Information Reporting System
SPILLS	Pollution Emergency Alerting System

Other Ascertainable Records

FUDS	Formerly Used Defense Sites
DOD	Department of Defense Sites
SCRD DRYCLEANERS	State Coalition for Remediation of Drycleaners Listing
US FIN ASSUR	Financial Assurance Information
EPA WATCH LIST	EPA WATCH LIST
2020 COR ACTION	2020 Corrective Action Program List
TSCA	Toxic Substances Control Act
TRIS	Toxic Chemical Release Inventory System
SSTS	Section 7 Tracking Systems
ROD	Records Of Decision
RMP	Risk Management Plans
RAATS	RCRA Administrative Action Tracking System
PRP	Potentially Responsible Parties
PADS	PCB Activity Database System
ICIS	Integrated Compliance Information System
FTTS	FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
MLTS	Material Licensing Tracking System
COAL ASH DOE	Steam-Electric Plant Operation Data
COAL ASH EPA	Coal Combustion Residues Surface Impoundments List
PCB TRANSFORMER	PCB Transformer Registration Database
RADINFO	Radiation Information Database
HIST FTTS	FIFRA/TSCA Tracking System Administrative Case Listing
DOT OPS	Incident and Accident Data
CONSENT	Superfund (CERCLA) Consent Decrees
INDIAN RESERV	Indian Reservations
FUSRAP	Formerly Utilized Sites Remedial Action Program
UMTRA	Uranium Mill Tailings Sites
LEAD SMELTERS	Lead Smelter Sites
US AIRS	Aerometric Information Retrieval System Facility Subsystem
US MINES	Mines Master Index File
ABANDONED MINES	Abandoned Mines
FINDS	Facility Index System/Facility Registry System
DOCKET HWC	Hazardous Waste Compliance Docket Listing
UXO	Unexploded Ordnance Sites
ECHO	Enforcement & Compliance History Information
FUELS PROGRAM	EPA Fuels Program Registered Listing
AIRS	Permit and Emissions Inventory Data
COAL ASH	Coal Ash Disposal Sites
DRYCLEANERS	Drycleaning Establishments
LEAD	Lead Safe Housing Registry
NPDES	List of Active NPDES Permits
UIC	Underground Injection Wells Database
WDS	Waste Data System

EDR HIGH RISK HISTORICAL RECORDS

EDR Exclusive Records

EDR MGP	EDR Proprietary Manufactured Gas Plants

EXECUTIVE SUMMARY

EDR RECOVERED GOVERNMENT ARCHIVES

Exclusive Recovered Govt. Archives

RGA PART 201	Recovered Government Archive State Hazardous Waste Facilities List
RGA LF	Recovered Government Archive Solid Waste Facilities List
RGA LUST	Recovered Government Archive Leaking Underground Storage Tank

SURROUNDING SITES: SEARCH RESULTS

Surrounding sites were identified in the following databases.

Elevations have been determined from the USGS Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified. Sites with an elevation equal to or higher than the target property have been differentiated below from sites with an elevation lower than the target property.
Page numbers and map identification numbers refer to the EDR Radius Map report where detailed data on individual sites can be reviewed.

Sites listed in ***bold italics*** are in multiple databases.

Unmappable (orphan) sites are not considered in the foregoing analysis.

STANDARD ENVIRONMENTAL RECORDS

Federal RCRA generators list

RCRA-CESQG: RCRAInfo is EPA’s comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Conditionally exempt small quantity generators (CESQGs) generate less than 100 kg of hazardous waste, or less than 1 kg of acutely hazardous waste per month.

A review of the RCRA-CESQG list, as provided by EDR, and dated 12/12/2016 has revealed that there are 12 RCRA-CESQG sites within approximately 0.25 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
WOODWARD DETROIT CVS	444 S OLD WOODWARD A	W 0 - 1/8 (0.026 mi.)	A7	12
SPEEDWAY LLC	***34750 WOODWARD AVE***	***NNE 0 - 1/8 (0.070 mi.)***	***E13***	***25***
ESSCO OF BIRMINGHAM	255 S OLD WOODWARD A	NW 1/8 - 1/4 (0.140 mi.)	J30	49
HOLIDAY INN	34952 WOODWARD AVE	N 1/8 - 1/4 (0.141 mi.)	K31	50
CATALYST DEVELOPMENT	***34977 WOODWARD AVE***	***NNW 1/8 - 1/4 (0.174 mi.)***	***K42***	***63***
KROGER CO OF MICHIGA	685 E MAPLE RD	N 1/8 - 1/4 (0.190 mi.)	M49	71
FULLER CENTRAL PARK	***111 S OLD WOODWARD***	***NW 1/8 - 1/4 (0.241 mi.)***	***O58***	***87***
WM BEAUMONT HOSPITAL	***35046 WOODWARD AVE***	***N 1/8 - 1/4 (0.245 mi.)***	***60***	***91***

Lower Elevation	Address	Direction / Distance	Map ID	Page
FRED LAVERY CO	***34602 WOODWARD AVE***	***ENE 0 - 1/8 (0.061 mi.)***	***D12***	***22***
HALBEISEN TOM INC	***835 HAYNES ST***	***SE 1/8 - 1/4 (0.150 mi.)***	***L33***	***52***
WALGREENS CO #15391	***34300 WOODWARD AVE***	***SE 1/8 - 1/4 (0.200 mi.)***	***51***	***74***
PERRY DRUG STORES IN	597 S ADAMS RD	E 1/8 - 1/4 (0.247 mi.)	61	93

State and tribal leaking storage tank lists

LUST: The Leaking Underground Storage Tank Incident Reports contain an inventory of reported leaking underground storage tank incidents. The data come from the Department of Environmental Quality’s Leaking Underground Storage Tank (LUST) Database.

A review of the LUST list, as provided by EDR, and dated 01/05/2017 has revealed that there are 19 LUST sites within approximately 0.5 miles of the target property.

Equal/Higher Elevation	**Address**	**Direction / Distance**	**Map ID**	**Page**
ESTATE MOTORS LTD Release Status: Closed Substance Release: Unknown Substance Release: Gasoline Facility Id: 00015180	***464 S OLD WOODWARD A***	***WSW 0 - 1/8 (0.018 mi.)***	***A2***	***8***
SPEEDWAY LLC Release Status: Open Release Status: Closed Substance Release: Gasoline,Gasoline,Gasoline,Diesel Substance Release: Unknown Facility Id: 00016370	***34750 WOODWARD AVE***	***NNE 0 - 1/8 (0.070 mi.)***	***E13***	***25***
CARMAN TILLARD Release Status: Closed Facility Id: 50001216	910 N HUNTER BLVD	NE 0 - 1/8 (0.070 mi.)	D15	31
JAX KAR WASH #048 Release Status: Open Substance Release: Unknown Facility Id: 00001952	***34745 WOODWARD***	***NNW 0 - 1/8 (0.079 mi.)***	***G19***	***33***
SHELL - HUNTER Release Status: Closed Release Status: Open Substance Release: Unknown,Unknown Substance Release: Used Oil Substance Release: Gasoline Facility Id: 00002267	***34977 WOODWARD AVE***	***NNW 1/8 - 1/4 (0.174 mi.)***	***K41***	***60***
SUNOCO #0008-4178 Release Status: Closed Substance Release: Unknown Facility Id: 00005935	***35001 WOODWARD AVE***	***NNW 1/8 - 1/4 (0.213 mi.)***	***N56***	***83***
BUDGET RENT-A-CAR Release Status: Open Facility Id: 00007720	***1000 E MAPLE***	***NE 1/8 - 1/4 (0.245 mi.)***	***P59***	***89***
PARKING LOT (DIETZ C Release Status: Open Substance Release: Unknown Facility Id: 50002129	***985 E MAPLE RD***	***NE 1/4 - 1/2 (0.252 mi.)***	***P63***	***95***
PROPOSED BALDWIN HOU Release Status: Closed Substance Release: Heating Oil Facility Id: 00037464	***200 CHESTER***	***WNW 1/4 - 1/2 (0.393 mi.)***	***76***	***113***
BIRMINGHAM PUBLIC SC	***550 W MERRILL***	***WNW 1/4 - 1/2 (0.447 mi.)***	***77***	***114***

Release Status: Open
Facility Id: 50000584

Lower Elevation	Address	Direction / Distance	Map ID	Page
GOODYEAR TIRE CENTER Release Status: Closed Substance Release: Used Oil Facility Id: 00021777	***835 HAYNES ST***	***SE 1/8 - 1/4 (0.150 mi.)***	***L34***	***54***
AMERICAR Release Status: Closed Facility Id: 00034958	***860 S WOODWARD***	***SSE 1/8 - 1/4 (0.227 mi.)***	***57***	***86***
THE PLANT STATION Release Status: Closed Substance Release: Gasoline,Unknown Facility Id: 00018613	***720 ADAMS***	***ESE 1/4 - 1/2 (0.279 mi.)***	***65***	***96***
BIRMINGHAM STANDARD Release Status: Closed Facility Id: 00001897	***1088 E MAPLE RD***	***NE 1/4 - 1/2 (0.284 mi.)***	***P66***	***98***
WOODLINC/MICH LTD PA Release Status: Open Substance Release: Gasoline Facility Id: 00039226	***1050 S OLD WOODWARD***	***SSE 1/4 - 1/2 (0.310 mi.)***	***Q72***	***106***
QUARTON WOODWARD SER Release Status: Open Substance Release: Gasoline Facility Id: 00033030	***1599 S WOODWARD AVE***	***SSE 1/4 - 1/2 (0.337 mi.)***	***R73***	***107***
MOBIL SS #03-KPV Release Status: Closed Facility Id: 00016687	***1991 S WOODWARD AVE***	***SSE 1/4 - 1/2 (0.372 mi.)***	***R74***	***111***
FORMER GASOLINE STAT Release Status: Open Substance Release: Unknown Facility Id: 50005898	***33801 WOODWARD***	***SSE 1/4 - 1/2 (0.487 mi.)***	***S80***	***116***
BIRMINGHAM CLEANERS Release Status: Closed Substance Release: Other,Unknown Facility Id: 00018874	***33866 WOODWARD AVE***	***SE 1/4 - 1/2 (0.494 mi.)***	***81***	***117***

State and tribal registered storage tank lists

UST: The Underground Storage Tank database contains registered USTs. USTs are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA). The data come from the Department of Environmental Quality’s Michigan UST database.

A review of the UST list, as provided by EDR, has revealed that there are 12 UST sites within approximately 0.25 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
ESTATE MOTORS Database: UST 2, Date of Government Version: 10/18/2016	464 S WOODWARD AVE	WSW 0 - 1/8 (0.018 mi.)	A3	9

Facility ID: 00015180

FORMER GASOLINE DISP Database: UST, Date of Government Version: 10/21/2016 Tank Status: Removed from Ground Facility Type: CLOSED Facility Id: 00042635	400 S OLD WOODWARD	W 0 - 1/8 (0.052 mi.)	C11	21
SPEEDWAY LLC Database: UST, Date of Government Version: 10/21/2016 Tank Status: Removed from Ground Tank Status: Currently In Use Facility Type: ACTIVE Facility Id: 00016370	***34750 WOODWARD AVE***	***NNE 0 - 1/8 (0.070 mi.)***	***E13***	***25***
JAX KAR WASH #048 Database: UST, Date of Government Version: 10/21/2016 Tank Status: Removed from Ground Facility Type: CLOSED Facility Id: 00001952	***34745 WOODWARD***	***NNW 0 - 1/8 (0.079 mi.)***	***G19***	***33***
FRED LAVERY CO Database: UST, Date of Government Version: 10/21/2016 Tank Status: Removed from Ground Tank Status: Currently In Use Facility Type: ACTIVE Facility Id: 00014864	499 S HUNTER BLVD	NE 0 - 1/8 (0.083 mi.)	E21	35
SHELL - HUNTER Database: UST, Date of Government Version: 10/21/2016 Tank Status: Removed from Ground Facility Type: CLOSED Facility Id: 00002267	***34977 WOODWARD AVE***	***NNW 1/8 - 1/4 (0.174 mi.)***	***K41***	***60***
SUNOCO #0008-4178 Database: UST, Date of Government Version: 10/21/2016 Tank Status: Removed from Ground Facility Type: CLOSED Facility Id: 00005935	***35001 WOODWARD AVE***	***NNW 1/8 - 1/4 (0.213 mi.)***	***N56***	***83***
BUDGET RENT-A-CAR Database: UST, Date of Government Version: 10/21/2016 Tank Status: Removed from Ground Facility Type: CLOSED Facility Id: 00007720	***1000 E MAPLE***	***NE 1/8 - 1/4 (0.245 mi.)***	***P59***	***89***

Lower Elevation	Address	Direction / Distance	Map ID	Page
VILLAGE JEEP EAGLE Database: UST, Date of Government Version: 10/21/2016 Tank Status: Removed from Ground Tank Status: Currently In Use Facility Type: ACTIVE Facility Id: 00005612	666 S WOODWARD	SSE 0 - 1/8 (0.098 mi.)	H23	39
GOODYEAR TIRE CENTER Database: UST, Date of Government Version: 10/21/2016 Tank Status: Removed from Ground Facility Type: CLOSED Facility Id: 00021777	***835 HAYNES ST***	***SE 1/8 - 1/4 (0.150 mi.)***	***L34***	***54***
BARNUM HEALTH CENTER Database: UST, Date of Government Version: 10/21/2016	746 PURDY ST	SSW 1/8 - 1/4 (0.161 mi.)	40	59

Tank Status: Temporarily out of Use
Facility Type: ACTIVE
Facility Id: 00017691

AMERICAR	***860 S WOODWARD***	***SSE 1/8 - 1/4 (0.227 mi.)***	***57***	***86***

Database: UST, Date of Government Version: 10/21/2016
Tank Status: Removed from Ground
Facility Type: CLOSED
Facility Id: 00034958

State and tribal institutional control / engineering control registries

AUL: A listing of sites with institutional and/or engineering controls in place.

A review of the AUL list, as provided by EDR, and dated 02/28/2017 has revealed that there are 2 AUL sites within approximately 0.5 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
CATALYST DEVELOPMENT	***34977 WOODWARD AVE***	***NNW 1/8 - 1/4 (0.174 mi.)***	***K43***	***65***

Facility ID: 00002267

Lower Elevation	Address	Direction / Distance	Map ID	Page
QUARTON WOODWARD SER	***1599 S WOODWARD AVE***	***SSE 1/4 - 1/2 (0.337 mi.)***	***R73***	***107***

Facility ID: 00033030

State and tribal Brownfields sites

BROWNFIELDS: Brownfields and USTfield Site Database.

A review of the BROWNFIELDS list, as provided by EDR, has revealed that there is 1 BROWNFIELDS site within approximately 0.5 miles of the target property.

Lower Elevation	Address	Direction / Distance	Map ID	Page
BIRMINGHAM CLEANERS	***33866 WOODWARD AVE***	***SE 1/4 - 1/2 (0.494 mi.)***	***81***	***117***

Database: BROWNFIELDS, Date of Government Version: 01/15/2016
Facility Id: 00018874

ADDITIONAL ENVIRONMENTAL RECORDS

Local Brownfield lists

US BROWNFIELDS: The EPA’s listing of Brownfields properties from the Cleanups in My Community program, which provides information on Brownfields properties for which information is reported back to EPA, as well as areas served by Brownfields grant programs.

A review of the US BROWNFIELDS list, as provided by EDR, and dated 03/02/2017 has revealed that there are 3 US BROWNFIELDS sites within approximately 0.5 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
GREEN'S ART SUPPLY	400 SOUTH OLD WOODWA	W 0 - 1/8 (0.052 mi.)	C9	15
WEISS SAMONA	***34901 WOODWARD AVENU***	***NNW 0 - 1/8 (0.112 mi.)***	***G27***	***43***

Lower Elevation	Address	Direction / Distance	Map ID	Page
912 SOUTH OLD WOODWA	***912 SOUTH OLD WOODWA***	***SSE 1/4 - 1/2 (0.290 mi.)***	***Q67***	***101***

Local Lists of Hazardous waste / Contaminated Sites

INVENTORY: The Inventory of Facilities has three data sources: Facilities under Part 201, Environmental Remediation, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA) identified through state funded or private party response activities (Projects); Facilities under Part 213, Leaking Underground Storage Tanks of the NREPA; and Facilities identified through submittals of Baseline Environmental Assessments (BEA) submitted pursuant to Part 201 or Part 213 of the NREPA. The Part 201 Projects Inventory does not include all of the facilities that are subject to regulation under Part 201 because owners are not required to inform the Department of Environmental Quality (DEQ) about the facilities and can pursue cleanup independently. Facilities that are not known to DEQ are not on the Inventory, nor are locations with releases that resulted in low environmental impact. Part 213 facilities listed here may have more than one release; a list of releases for which corrective actions have been completed and list of releases for which corrective action has not been completed is located on the Leaking Underground Storage Tanks Site Search webpage. The DEQ may or may not have reviewed and concurred with the conclusion that the corrective actions described in a closure report meets criteria. A BEA is a document that new or prospective property owners/operations disclose to the DEQ identifying the property as a facility pursuant to Part 201 and Part 213. The Inventory of BEA Facilities overlaps in part with the Part 201 Projects facilities and Part 213 facilities. There may be more than one BEA for each facility.

A review of the INVENTORY list, as provided by EDR, and dated 01/24/2017 has revealed that there are 26 INVENTORY sites within approximately 0.5 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
GREEN'S ART SUPPLY	400 SOUTH OLD WOODWA	W 0 - 1/8 (0.052 mi.)	C10	21
SPEEDWAY LLC Facility ID: 00016370	***34750 WOODWARD AVE***	***NNE 0 - 1/8 (0.070 mi.)***	***E13***	***25***
JAX KAR WASH #048 Facility ID: 00001952	***34745 WOODWARD***	***NNW 0 - 1/8 (0.079 mi.)***	***G19***	***33***
WOODWARD BROWN ASSOC Facility ID: 63005920	34901 WOODWARD	NNW 0 - 1/8 (0.112 mi.)	G28	48
34965 WOODWARD AVENU Facility ID: 63006065	34965 WOODWARD AVENU	NNW 1/8 - 1/4 (0.150 mi.)	K35	55
SHELL - HUNTER Facility ID: 00002267	***34977 WOODWARD AVE***	***NNW 1/8 - 1/4 (0.174 mi.)***	***K41***	***60***
CATALYST DEVELOPMENT Facility ID: 63005889	34977 WOODWARD AVENU	NNW 1/8 - 1/4 (0.181 mi.)	N47	69
HAMILTON FUNERAL HOM	***820 EAST MAPLE ROAD***	***NNE 1/8 - 1/4 (0.200 mi.)***	***52***	***75***
SUNOCO #0008-4178	***35001 WOODWARD AVE***	***NNW 1/8 - 1/4 (0.213 mi.)***	***N56***	***83***
BUDGET RENT-A-CAR Facility ID: 00007720	***1000 E MAPLE***	***NE 1/8 - 1/4 (0.245 mi.)***	***P59***	***89***
PARKING LOT (DIETZ C	***985 E MAPLE RD***	***NE 1/4 - 1/2 (0.252 mi.)***	***P63***	***95***

Facility ID: 50002129				
MOBIL OIL CORP	***1065 E MAPLE RD***	***NE 1/4 - 1/2 (0.297 mi.)***	***70***	***104***
COMERICA BANK BIRMIN	322 N. OLD WOODWARD	NW 1/4 - 1/2 (0.387 mi.)	75	113
Facility ID: 63005254				
BIRMINGHAM PUBLIC SC	***550 W MERRILL***	***WNW 1/4 - 1/2 (0.447 mi.)***	***77***	***114***
Facility ID: 50000584				
FIRST CHURCH OF CHRI	191 N. CHESTER ST.	WNW 1/4 - 1/2 (0.454 mi.)	78	115
Facility ID: 63005278				

Lower Elevation	Address	Direction / Distance	Map ID	Page
GOLLING MOTORS, INC.	***34500 WOODWARD***	***ESE 0 - 1/8 (0.076 mi.)***	***F16***	***32***
Facility ID: 63005949				
GOLLING MOTORS, INC.	34500 WOODWARD AVENU	ESE 0 - 1/8 (0.076 mi.)	F17	32
Facility ID: 63005949				
WOODWARD AND GEORGE,	772-784 SOUTH OLD WO	SSE 1/8 - 1/4 (0.160 mi.)	I38	58
FRED LAVERY COMPANY	907 AND 911 HAYNES S	ESE 1/8 - 1/4 (0.174 mi.)	L44	67
LAVERY MI DEALERSHIP	907 AND 911 HAYNES S	ESE 1/8 - 1/4 (0.174 mi.)	L45	68
912 OLD WOODWARD, LL	912 SOUTH OLD WOODWA	SSE 1/4 - 1/2 (0.290 mi.)	Q68	104
Facility ID: 63006025				
912 OLD WOODWARD, LL	912 SOUTH OLD WOODWA	SSE 1/4 - 1/2 (0.290 mi.)	Q69	104
Facility ID: 63006025				
WOODLINC/MICH LTD PA	***1050 S OLD WOODWARD***	***SSE 1/4 - 1/2 (0.310 mi.)***	***Q72***	***106***
Facility ID: 00039226				
QUARTON WOODWARD SER	***1599 S WOODWARD AVE***	***SSE 1/4 - 1/2 (0.337 mi.)***	***R73***	***107***
Facility ID: 00033030				
NEIGHBORHOOD PRO HAR	***33801 WOODWARD AVENU***	***SSE 1/4 - 1/2 (0.487 mi.)***	***S79***	***115***
FORMER GASOLINE STAT	***33801 WOODWARD***	***SSE 1/4 - 1/2 (0.487 mi.)***	***S80***	***116***
Facility ID: 50005898				

Other Ascertainable Records

RCRA NonGen / NLR: RCRAInfo is EPA’s comprehensive information system, providing access to data supporting the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments (HSWA) of 1984. The database includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). Non-Generators do not presently generate hazardous waste.

A review of the RCRA NonGen / NLR list, as provided by EDR, and dated 12/12/2016 has revealed that there are 10 RCRA NonGen / NLR sites within approximately 0.25 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
ESTATE MOTORS LTD	***464 S OLD WOODWARD A***	***WSW 0 - 1/8 (0.023 mi.)***	***A4***	***9***
UPTOWN ENTERTAINMENT	211 S OLD WOODWARD A	NNW 1/8 - 1/4 (0.158 mi.)	J37	57
J C & C ENTERPRISES	700 E MAPLE RD	NNE 1/8 - 1/4 (0.175 mi.)	M46	68
JERRY BURNS CLEANERS	***615 E MAPLE RD***	***N 1/8 - 1/4 (0.189 mi.)***	***M48***	***69***
MAPLE ELM DEVELOPMEN	***820 E MAPLE***	***NNE 1/8 - 1/4 (0.199 mi.)***	***M50***	***72***
BURTON KATZMAN	336 E MAPLE RD	NNW 1/8 - 1/4 (0.208 mi.)	53	76
BIRMINGHAM CAMERA SH	***168 S OLD WOODWARD A***	***NW 1/8 - 1/4 (0.208 mi.)***	***O54***	***77***
SUNOCO SERVICE STATI	***35001 WOODWARD AVE***	***NNW 1/8 - 1/4 (0.213 mi.)***	***N55***	***79***

EXECUTIVE SUMMARY

Lower Elevation	Address	Direction / Distance	Map ID	Page
VILLAGE AMC/JEEP INC	***666 S OLD WOODWARD A***	***SSE 0 - 1/8 (0.106 mi.)***	***H25***	***41***
VIRGINIA C CLOHSET T	784 S OLD WOODWARD A	SSE 1/8 - 1/4 (0.156 mi.)	I36	56

BEA: A BEA is a document that new or prospective property owners/operations disclose to the DEQ identifying the property as a facility pursuant to Part 201 and Part 213. The Inventory of BEA Facilities overlaps in part with the Part 201 Projects facilities and Part 213 facilities. There may be more than one BEA for each facility.

A review of the BEA list, as provided by EDR, and dated 08/21/2013 has revealed that there are 16 BEA sites within approximately 0.5 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
MALLY, C . LANE PROP	575 SOUTH HUNTER BLV	NE 0 - 1/8 (0.077 mi.)	E18	33
JAX KAR WASH #048	***34745 WOODWARD***	***NNW 0 - 1/8 (0.079 mi.)***	***G19***	***33***
WOODWARD BROWN ASSOC	34901 WOODWARD AVENU	NNW 0 - 1/8 (0.112 mi.)	G26	42
BROWN STREET OFFICE	200 EAST BROWN	W 1/8 - 1/4 (0.147 mi.)	32	52
CATALYST DEVELOPMENT	***34977 WOODWARD AVE***	***NNW 1/8 - 1/4 (0.174 mi.)***	***K43***	***65***
HAMILTON FUNERAL HOM	***820 EAST MAPLE ROAD***	***NNE 1/8 - 1/4 (0.200 mi.)***	***52***	***75***
SUNOCO #0008-4178	***35001 WOODWARD AVE***	***NNW 1/8 - 1/4 (0.213 mi.)***	***N56***	***83***
OSOS TONTOS LLC	985 EAST MAPLE	NE 1/4 - 1/2 (0.251 mi.)	P62	95
PARKING LOT (DIETZ C	***985 E MAPLE RD***	***NE 1/4 - 1/2 (0.252 mi.)***	***P63***	***95***
ELMWOOD PROPERTIES I	920-970 EAST MAPLE R	NE 1/4 - 1/2 (0.254 mi.)	P64	96

Lower Elevation	Address	Direction / Distance	Map ID	Page
GOLLING MOTORS, INC.	***34500 WOODWARD***	***ESE 0 - 1/8 (0.076 mi.)***	***F16***	***32***
JIMMIES RUSTICS	690 SOUTH OLD WOODWA	SSE 1/8 - 1/4 (0.137 mi.)	I29	48
WOODWARD AND GEORGE,	772-784 SOUTH OLD WO	SSE 1/8 - 1/4 (0.160 mi.)	I39	59
OFFICE BUILDING & PA	1000 SOUTH OLD WOODW	SSE 1/4 - 1/2 (0.307 mi.)	Q71	106
NEIGHBORHOOD PRO HAR	***33801 WOODWARD AVENU***	***SSE 1/4 - 1/2 (0.487 mi.)***	***S79***	***115***
BIRMINGHAM CLEANERS	***33866 WOODWARD AVE***	***SE 1/4 - 1/2 (0.494 mi.)***	***81***	***117***

EDR HIGH RISK HISTORICAL RECORDS

EDR Exclusive Records

EDR Hist Auto: EDR has searched selected national collections of business directories and has collected listings of potential gas station/filling station/service station sites that were available to EDR researchers. EDR’s review was limited to those categories of sources that might, in EDR’s opinion, include gas station/filling station/service station establishments. The categories reviewed included, but were not limited to gas, gas station, gasoline station, filling station, auto, automobile repair, auto service station, service station, etc. This database falls within a category of information EDR classifies as "High Risk Historical Records", or HRHR. EDR’s HRHR effort presents unique and sometimes proprietary data about past sites and operations that typically create environmental concerns, but may not show up in current government records searches.

A review of the EDR Hist Auto list, as provided by EDR, has revealed that there are 4 EDR Hist Auto sites within approximately 0.125 miles of the target property.

EXECUTIVE SUMMARY

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
Not reported	401 S OLD WOODWARD A	NNW 0 - 1/8 (0.025 mi.)	A6	12
Not reported	34750 WOODWARD AVE	NNE 0 - 1/8 (0.070 mi.)	E14	31
Not reported	121 N HUNTER BLVD	NE 0 - 1/8 (0.102 mi.)	E24	41

Lower Elevation	Address	Direction / Distance	Map ID	Page
Not reported	555 S OLD WOODWARD A	S 0 - 1/8 (0.036 mi.)	B8	15

EDR Hist Cleaner: EDR has searched selected national collections of business directories and has collected listings of potential dry cleaner sites that were available to EDR researchers. EDR's review was limited to those categories of sources that might, in EDR's opinion, include dry cleaning establishments. The categories reviewed included, but were not limited to dry cleaners, cleaners, laundry, laundromat, cleaning/laundry, wash & dry etc. This database falls within a category of information EDR classifies as "High Risk Historical Records", or HRHR. EDR's HRHR effort presents unique and sometimes proprietary data about past sites and operations that typically create environmental concerns, but may not show up in current government records searches.

A review of the EDR Hist Cleaner list, as provided by EDR, has revealed that there are 3 EDR Hist Cleaner sites within approximately 0.125 miles of the target property.

Equal/Higher Elevation	Address	Direction / Distance	Map ID	Page
Not reported	458 S OLD WOODWARD A	WSW 0 - 1/8 (0.023 mi.)	A5	11

Lower Elevation	Address	Direction / Distance	Map ID	Page
Not reported	606 S OLD WOODWARD A	SSE 0 - 1/8 (0.082 mi.)	B20	35
Not reported	608 S OLD WOODWARD A	S 0 - 1/8 (0.085 mi.)	H22	38

EXECUTIVE SUMMARY

Due to poor or inadequate address information, the following sites were not mapped. Count: 1 records.

Site Name	Database(s)
TIFFANY FLORIST	LUST, UST, INVENTORY

4.8 Abbreviated Phase II Environmental Site Assessment

Environmental & Engineering Services Nationwide

PHASE II ENVIRONMENTAL SITE ASSESSMENT

467 and 479 South Old Woodward Avenue | Birmingham, Michigan
PM Project Number 01-8456-0-0002

Prepared for:

Markus Associates, LLC
4036 Telegraph Road, Suite 205
Bloomfield Hills, Michigan 48302

Prepared by:

PM Environmental, Inc.
4080 West Eleven Mile Road
Berkley, Michigan 48072

ENVIRONMENTAL SERVICES

BUILDING ARCHITECTURE,
ENGINEERING & SCIENCE

INDUSTRIAL HYGIENE SERVICES

BROWNFIELDS & ECONOMIC
INCENTIVES CONSULTING

Know Your Risk.
Take Control.
Work with the Experts.

www.pmenv.com

PM ENVIRONMENTAL
Risk Well Managed

Detroit
4080 W. 11 Mile Road
Berkley, MI 48072
f: 877.884.6775
t: 248.336.9988

Lansing
3340 Ranger Road
Lansing, MI 48906
f: 877.884.6775
t: 517.321.3331

Grand Rapids
560 5th Street NW,
Suite 301
Grand Rapids, MI 49504
f: 877.884.6775
t: 616.285.8857

May 25, 2017

Mr. Doraid Markus
Markus Associates, LLC
4036 Telegraph Road, Suite 205
Bloomfield Hills, Michigan 48302

**Re: Phase II Environmental Site Assessment of the Commercial Property
Located at 469 and 479 South Old Woodward Avenue, Birmingham, Michigan
Parcel IDs: 08-19-36-208-011 and 08-19-36-208-012
PM Environmental, Inc. Project No. 01-8456-0-0002**

Dear Mr. Markus:

PM Environmental, Inc. (PM) completed a Phase II Environmental Site Assessment (ESA) of the commercial property located at 469 and 479 South Old Woodward Avenue, Birmingham, Oakland County, Michigan (hereafter referred to as the "subject property") in general accordance with ASTM Standard Practice E1903-11 to assess the Recognized Environmental Condition (RECs) identified in PM's May 22, 2017 Phase I ESA. This Phase II ESA Report summarizes the activities conducted by PM in May 2017, the geology encountered, and the sample analytical results.

THIS PHASE II ESA REPORT WAS PERFORMED FOR THE EXCLUSIVE USE OF <u>MARKUS MANAGEMENT GROUP, LLC ON BEHALF OF AN ENTITY TO BE FORMED</u> AND <u>MICHIGAN BUSINESS CONNECTION, LC, ITS SUCCESSORS, ASSIGNS AND CREDIT UNION LENDERS</u>, EACH OF WHOM MAY RELY ON THE REPORT'S CONTENTS.

INTRODUCTION AND BACKGROUND

The subject property consists of two parcels (Parcel IDs: 08-19-36-208-011 and 08-19-36-208-012) totaling 0.41 acres, and is located on the east side of South Old Woodward Avenue, west of Woodward Avenue, north of Hazel Street, and south of East Brown Street (Figure 1). The subject property is developed with one single-story commercial building and parking garage totaling 10,541 square feet (479 South Old Woodward Avenue), which is currently vacant of occupants, and one single-story restaurant building totaling 2,882 square feet (469 South Old Woodward Avenue), which is currently occupied by a Chinese restaurant. The remainder of the subject property consists of an asphalt paved alley located north of the 479 South Old Woodward Avenue subject building, and an asphalt paved parking garage driveway located east of the 479 South Old Woodward Avenue subject building (Figure 2).

Standard and other historical sources were able to document that the first developed use of the subject property occurred prior to 1921 with a two-story residential dwelling, the first floor of which was converted to a store by 1926. The original building was demolished between 1926 and 1931, when the southern portion of the property was redeveloped with the western and central portions of the current building (479 South Old Woodward). An addition was constructed to the eastern portion in 1946 and 1947. The southern portion of the property was occupied by an automotive dealership from at least 1931 until between 1984 and 1988, when the building was converted to a bank. The southern building was occupied by a bank until 2014, and has been vacant since 2015.

The northern portion of the property was developed with the western portion of the current building (historically identified as 476 South Old Woodward) between 1940 and 1949. An addition was constructed to the eastern portion in 1953. The northern subject building has been occupied by a restaurant since at least 1951.

PHASE I ESA

PM completed a Phase I ESA for the subject property dated May 22, 2017, in conformance with the scope and limitations of ASTM Practice E 1527-13 (i.e., the 'ASTM Standard').

The following onsite RECs were identified in PM's May 2017 Phase I ESA:

- The southern portion of the subject property was formerly occupied by an automotive dealership and service garage from at least 1931 until at least in 1984. Historical interior waste streams associated with the former automotive dealership included service and painting operations, which would have consisted of general hazardous substances and/or petroleum products. This time period preceded major environmental regulations and current waste management and disposal procedures. The historical waste management practices associated with the former automotive service and painting operations are unknown and may be a source of subsurface contamination.

- The former automotive dealership and service garage contained at least five in-ground hydraulic hoists. In-ground hoists have an underground reservoir for hydraulic fluids, which can contain polychlorinated biphenyls (PCBs). The potential exists that a release occurred from the former hydraulic hoist system and/or underground reservoir. Additionally, the potential exists for orphaned reservoirs to be present on the subject property.

- Review of City of Birmingham Fire and Building Department records and Michigan Department of Environmental Quality (MDEQ) records documents the removal of one 1,000-gallon waste oil underground storage tank (UST), one 1,500-gallon UST, and one 300-gallon UST in September 1988. PM was unable to confirm the installation date and/or location of the former 1,000-gallon waste oil UST and/or the 1,500-gallon and 300-gallon USTs removed in September 1988. Additionally, PM was unable to locate any sampling completed in the area of the former USTs. Additional USTs may have also historically been associated with the former dealership and automotive service operations. The potential exists for orphan USTs to be present on the property and/or for a release to have occurred.

The following adjoining and/or nearby RECs were identified:

- The north adjoining property, identified as 411 South Old Woodward Avenue, was formerly occupied by an automotive service garage from at least 1926 until at least in 1974. Historical interior waste streams associated with the former service garage operations would have consisted of general hazardous substances and/or petroleum products. Based on the close proximity to the subject property (i.e. along the northern property boundary) and long term service operations (i.e. 48 years), the potential exists a release occurred on this property and migrated onto the subject property.

- The south adjoining property, identified as 555 South Old Woodward Avenue, was formerly occupied by a gasoline dispensing station and automotive service garage from at least 1926 until at least in 1974. Historical interior waste streams associated with the former service garage operations would have consisted of general hazardous substances and/or petroleum products. Based on the close proximity to the subject property (i.e. approximately 50 feet) and long term gasoline dispensing and/or service operations (i.e. 48 years), the potential exists a release occurred on this property and migrated onto the subject property.

PREVIOUS SITE INVESTIGATIONS

No previous site investigations were identified by PM for the subject property. Previous reports may exist for the subject property, however, none were provided to PM by the client or owner of the property, and none were available with the appropriate state regulatory agencies.

GEOPHYSICAL SURVEY INVESTIGATION

On May 15, 2017, PM completed a geophysical survey investigation utilizing ground penetrating radar (GPR) to investigate the potential for orphan USTs and/or in-ground hydraulic hoists on the subject property and to clear soil boring locations of private utilities. One anomaly consistent with the presence of an orphan in-ground hydraulic hoist was identified in the northeast corner of the parking garage (479 South Old Woodward Avenue). The complete Geophysical Survey Investigation report is included in Appendix A.

Redevelopment activities are anticipated in the future, therefore, PM recommends that the potential orphan in-ground hydraulic hoist be removed from the subject property for proper disposal during redevelopment activities.

CURRENT SITE INVESTIGATION

Prior to the commencement of field activities, MISSDIG, a utility locating service, was contacted to locate utilities on or adjacent to the subject property. Utilities were marked by the respective utility companies where they entered or were located adjacent to the subject property.

On May 17, 2017, PM completed subsurface investigation activities at the subject property that consisted of advancing nine soil borings (SB-1 through SB-9), installing three temporary monitoring wells (TMW-4, TMW-6, and TMW-8), and collecting 11 soil samples and three groundwater samples for laboratory analysis. The soil and groundwater samples were submitted to Brighton Analytical, LLC (Brighton), Brighton, Michigan, for laboratory analysis of volatile organic compounds (VOCs), polynuclear aromatic hydrocarbons (PNAs), PCBs, cadmium, chromium, and lead, or some combination thereof. The location of the soil boring/temporary monitoring well locations are depicted on Figures 3 and 4.

The soil borings were advanced to the desired depth using either a hand auger equipped with a stainless steel bucket and/or a Geoprobe® model 6712DT drill rig. Soil sampling was performed for soil classification, verification of subsurface geologic conditions, and for investigating the potential and/or extent of soil and/or groundwater contamination at the subject property. Soil samples were generally collected on a continuous basis using a stainless steel bucket in the case of the hand auger or a 5-foot long macro-core sampler in the case of the Geoprobe® drill rig.

During drilling operations, the drilling equipment was cleaned to minimize the possibility of cross contamination. These procedures included cleaning equipment with a phosphate free solution (i.e., Alkanox®) and rinsing with distilled water after each sample collection. Drilling and sampling equipment was also cleaned in this manner prior to initiating field activities.

Soil collected from 1-foot sample intervals was screened using a photoionization detector (PID) to determine if VOCs were present. Soil from specific depths was placed in plastic bags and allowed to volatilize. The headspace within each bag was then monitored with the PID, which is able to detect trace levels of organic compounds in the air space within the plastic bag. Soil samples were collected from the soil boring based upon the highest PID reading, visual/olfactory evidence, a change in geology, surficial soil, and/or directly above saturated soil.

Soil samples for VOC analysis were preserved with methanol, in accordance with United States Environmental Protection Agency (USEPA) method 5035.

Temporary monitoring wells (TMW-4, TMW-6, and TMW-8) were installed at three of the soil boring locations for groundwater sample collection. At the monitoring well locations, a new well assembly, consisting of a 5-foot 0.010-inch slot, schedule 40, poly-vinyl chloride (PVC) screen and PVC casing was lowered into the borehole to intersect the water table. After the screen for the wells were set to the desired depth, an artificial sand pack or natural sands were allowed to collapse around the well screen. Groundwater samples were generally collected using low flow sampling methods and protocols using a peristaltic pump equipped with new, chemically inert, 3/8-inch diameter polyethylene and silicon tubing. The samples were collected directly from the tubing into preserved vials/bottles or within unpreserved bottles/jars, as applicable for the analyte and/or method. Purge water was maintained separate and returned to the wells.

Soil and groundwater samples were placed in appropriately labeled containers with Teflon lined lids and/or sanitized glass jars, placed in an ice packed cooler, and transported under chain of custody procedures for laboratory analysis within applicable holding times to Brighton.

Upon completion of the investigation, the temporary monitoring well materials were removed from the boreholes, which were abandoned by placing the soil cuttings back into the boreholes, filling the voids with bentonite chips, hydrating the chips, resurfacing and returning the area to its pre-drilling condition.

The table below summarizes the Phase II ESA activities including total boring depth, objective of the soil borings, and sample justification:

Description of the Soil Boring/Temporary Monitoring Well Locations

Location (feet bgs)	Sample/Screen Depth (feet bgs)	Analysis	Objectives	Sample Selection (justification)
SB-1 (6.0)	**Soil:** 0.5-1.5	VOCs, PNAs, PCBs, cadmium, chromium, and lead	Assess former onsite service operations, former USTs, and former in-ground hydraulic hoists	**Soil:** Based on the lack of field evidence of impact, a sample was collected from the gravelly sand/sandy clay interface. **Groundwater:** Not encountered.

Location (feet bgs)	Sample/Screen Depth (feet bgs)	Analysis	Objectives	Sample Selection (justification)
SB-2 (20.0)	**Soil:** 3.5-4.5	VOCs, PNAs, PCBs, cadmium, chromium, and lead	Assess former onsite service operations, former USTs and in-ground hydraulic hoists, and south adjoining property	**Soil:** Based on the lack of field evidence of impact, a sample was collected from the sandy clay/clay interface. **Groundwater:** Not encountered.
SB-3 (20.0)	**Soil:** 4.0-5.0 and 17.0-18.0	VOCs, PNAs, PCBs, cadmium, chromium, and lead	Assess former onsite service operations, former USTs and in-ground hydraulic hoists, and south adjoining property	**Soil:** Samples were collected from the sandy clay/clay interface and below, from the interval with the highest PID reading (38.0 ppm) **Groundwater:** Not encountered.
SB/TMW-4 (20.0)	**Soil:** 4.0-5.0	VOCs, PNAs, PCBs, cadmium, chromium, and lead	Assess former onsite service operations and potential orphan in-ground hydraulic hoist	**Soil:** A sample was collected from the approximate depth of the potential orphan in-ground hydraulic hoist, which was the interval with the highest PID reading (1.6 ppm). **Groundwater:** Sampled.
	Groundwater: 11.72-16.72	VOCs, PNAs, cadmium, chromium, and lead		
SB-5 (20.0)	**Soil:** 2.0-3.0	VOCs, PNAs, PCBs, cadmium, chromium, and lead	Assess former onsite service operations, former USTs, and former in-ground hydraulic hoists	**Soil:** Based on the lack of field evidence of impact, a sample was collected from the sand/sandy clay interface. **Groundwater:** Not encountered.
SB/TMW-6 (6.0)	**Soil:** 0.5-1.5	VOCs, PNAs, PCBs, cadmium, chromium, and lead	Assess former onsite service operations, former USTs, and former in-ground hydraulic hoists	**Soil:** A shallow sample was collected from beneath the concrete slab, which was the interval with the highest PID reading (3.1 ppm). **Groundwater:** Sampled.
	Groundwater: 0.25-5.25	VOCs, PNAs, cadmium, chromium, and lead		
SB-7 (20.0)	**Soil:** 1.5-2.5	VOCs, PNAs, PCBs, cadmium, chromium, and lead	Assess former USTs and north adjoining property	**Soil:** Based on the lack of field evidence of impact, a shallow sample was collected. **Groundwater:** Not encountered.
SB/TMW-8 (20.0)	**Soil:** 5.0-6.0	VOCs, PNAs, PCBs, cadmium, chromium, and lead	Assess former USTs, and north adjoining property	**Soil:** A sample was collected from above the saturated zone. **Groundwater:** Sampled.
	Groundwater: 4.45-9.45	VOCs, PNAs, cadmium, chromium, and lead		

Location (feet bgs)	Sample/Screen Depth (feet bgs)	Analysis	Objectives	Sample Selection (justification)
SB-9 (20.0)	**Soil:** 2.0-3.0 and 6.0-7.0	VOCs, PNAs, PCBs, cadmium, chromium, and lead	Assess former USTs and north adjoining property	**Soil:** Samples were collected from the sand/sandy clay interface, which was the interval with the highest PID reading (105 ppm), and below for vertical extent. **Groundwater:** Not encountered.

bgs - below ground surface PID – photoionization detector ppm – parts per million

GEOLOGY/HYDROGEOLOGY

Based on review of the soil boring logs, the soil stratigraphy at the subject property generally consists of clay and sandy clay with intermittent sand seams to a depth of at least 20.0 bgs, the maximum depth explored. Perched groundwater was encountered in three of the soil borings (SB/TMW-4, SB/TMW-6, and SB/TMW-8) advanced on the subject property at depths between 3.0 and 14.0 feet bgs.

PM's soil boring/temporary monitoring well logs are included in Appendix B, which summarize site-specific geology, sample depths, and PID readings.

ANALYTICAL RESULTS

The analytical results for the soil and groundwater samples collected by PM in May 2017 were compared with the MDEQ Cleanup Criteria and Screening Levels as presented Cleanup Criteria Requirements for Response Activity (R 299.1 – R 299.50)" dated December 30, 2013, entitled "Cleanup Criteria Requirements for Response Activity", in accordance with Section 20120a(1) using the Residential and Nonresidential cleanup criteria. PM also compared the analytical results from the soil and groundwater samples collected from the subject property with the MDEQ vapor intrusion screening levels (VISLs) in accordance with the May 2013 Guidance Document for the Vapor Intrusion Pathway. Figures 3 and 4, and Tables 1 and 2 summarize the soil and groundwater analytical results.

Appendix C contains the complete laboratory analytical report.

Soil Analytical Results

PM's soil analytical results are summarized on Figure 3 and in Table 1.

A concentration of 1,2,4-trimethylbenzene was detected in the soil sample analyzed from SB-3 (4.0-5.0 feet bgs) above laboratory method detection limits (MDLs), but below the most restrictive Part 201 Residential cleanup criteria and Residential VISLs. A concentration of chlorobenzene was detected in the soil sample analyzed from SB-4 (4.0-5.0 feet bgs) above laboratory MDLs, but below the most restrictive Part 201 Residential cleanup criteria and Residential VISLs. No concentrations of other VOCs were detected in any of the soil samples analyzed from the subject property above laboratory MDLs.

No concentrations of PNAs and PCBs were detected in any of the soil samples analyzed from the subject property above laboratory MDLs.

Concentrations of cadmium, chromium, and lead were detected in each of the soil samples analyzed from the subject property above laboratory MDLs, but below the Statewide Default Background Levels (SDBLs) for soils in Michigan and/or the most restrictive Part 201 Residential cleanup criteria.

Groundwater Analytical Results

PM's groundwater analytical results are summarized on Figure 4 and in Table 2.

No concentrations of VOCs, PNAs, cadmium, chromium, and lead were detected in any of the groundwater samples analyzed from the subject property above laboratory MDLs.

CONCLUSIONS AND RECOMMENDATIONS

On May 15, 2017, PM completed a geophysical survey investigation utilizing GPR to investigate the potential for orphan USTs and/or in-ground hydraulic hoists on the subject property and to clear soil boring locations of private utilities. One anomaly consistent with the presence of an orphan in-ground hydraulic hoist was identified in the northeast corner of the parking garage (479 South Old Woodward Avenue).

On May 15, 2017, PM completed subsurface investigation activities at the subject property that consisted of advancing nine soil borings (SB-1 through SB-9), installing three temporary monitoring wells (TMW-4, TMW-6, and TMW-8), and collecting 11 soil samples and three groundwater samples to assess the RECs identified in PM's May 22, 2017 Phase I ESA.

No concentrations of VOCs, PNAs, PCBs, cadmium, chromium, and/or lead were detected in any of the soil and groundwater samples analyzed from the subject property above laboratory MDLs, SDBLs, and/or the most restrictive Part 201 Residential cleanup criteria.

Based on the absence of target analytes detected at the subject property above the most restrictive Part 201 Residential cleanup criteria, the subject property is not a "facility" as defined in Section 20101(1)(r) of Part 201, of P.A. 451 of 1994, as amended. In addition, per Section 20126(4)(c) of Michigan Part 201, an owner or operator of property onto which contamination has migrated is not a liable party and as such, has no obligation for further assessment or response activities.

The RECs associated with the subject property identified in PM's May 22, 2017 Phase I ESA have been adequately assessed and no further investigation is warranted. However, PM recommends that the potential orphan in-ground hydraulic hoist be removed from the subject property for proper disposal during redevelopment activities.

If you have any questions related to this report, contact our office at (248) 336-9988.

Sincerely,
PM Environmental, Inc.

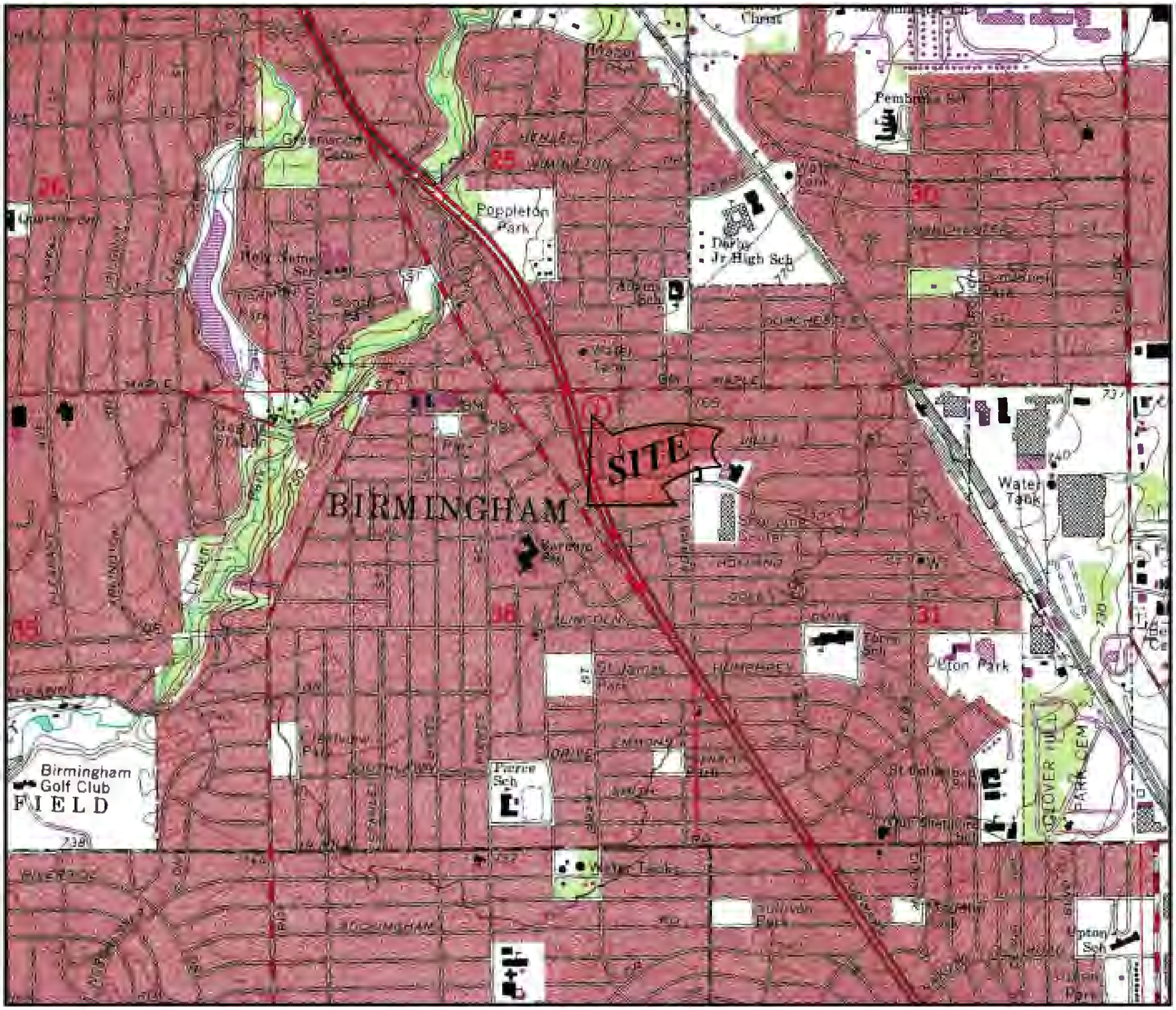
REPORT PREPARED BY:	**REPORT REVIEWED BY:**
	J. Ritchie
Aaron Snow	Jennifer Ritchie, CPG
Staff Scientist	Regional Manager

FIGURES

TABLES

APPENDICES

Figures



MICHIGAN QUADRANGLE LOCATION

OAKLAND COUNTY

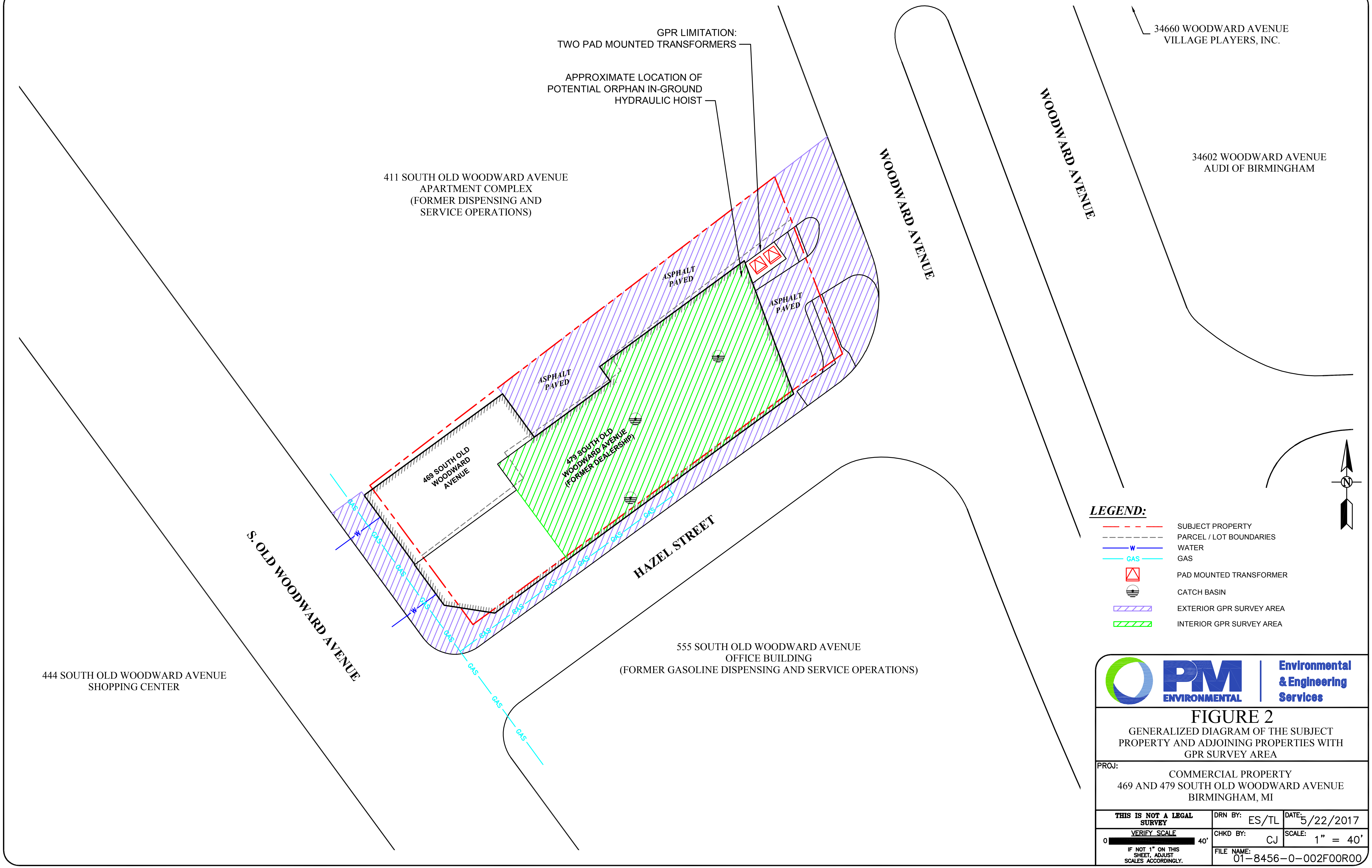
FIGURE 1

PROPERTY VICINITY MAP

USGS, 7.5 MINUTE SERIES

BIRMINGHAM, MI QUADRANGLE, 1968. PHOTO REVISED 1981.

PM ENVIRONMENTAL Environmental & Engineering Services	PROJ: COMMERCIAL PROPERTY 469 AND 479 SOUTH OLD WOODWARD AVENUE BIRMINGHAM, MI	THIS IS NOT A LEGAL SURVEY	DRN BY: ES/TL	DATE: 5/22/2017
		VERIFY SCALE 0 2,000' IF NOT 1" ON THIS SHEET, ADJUST SCALES ACCORDINGLY.	CHKD BY: CJ	SCALE: 1" = 2,000'
			FILE NAME: 01-8456-0-002F01R00	



Environmental
& Engineering
Services

FIGURE 2

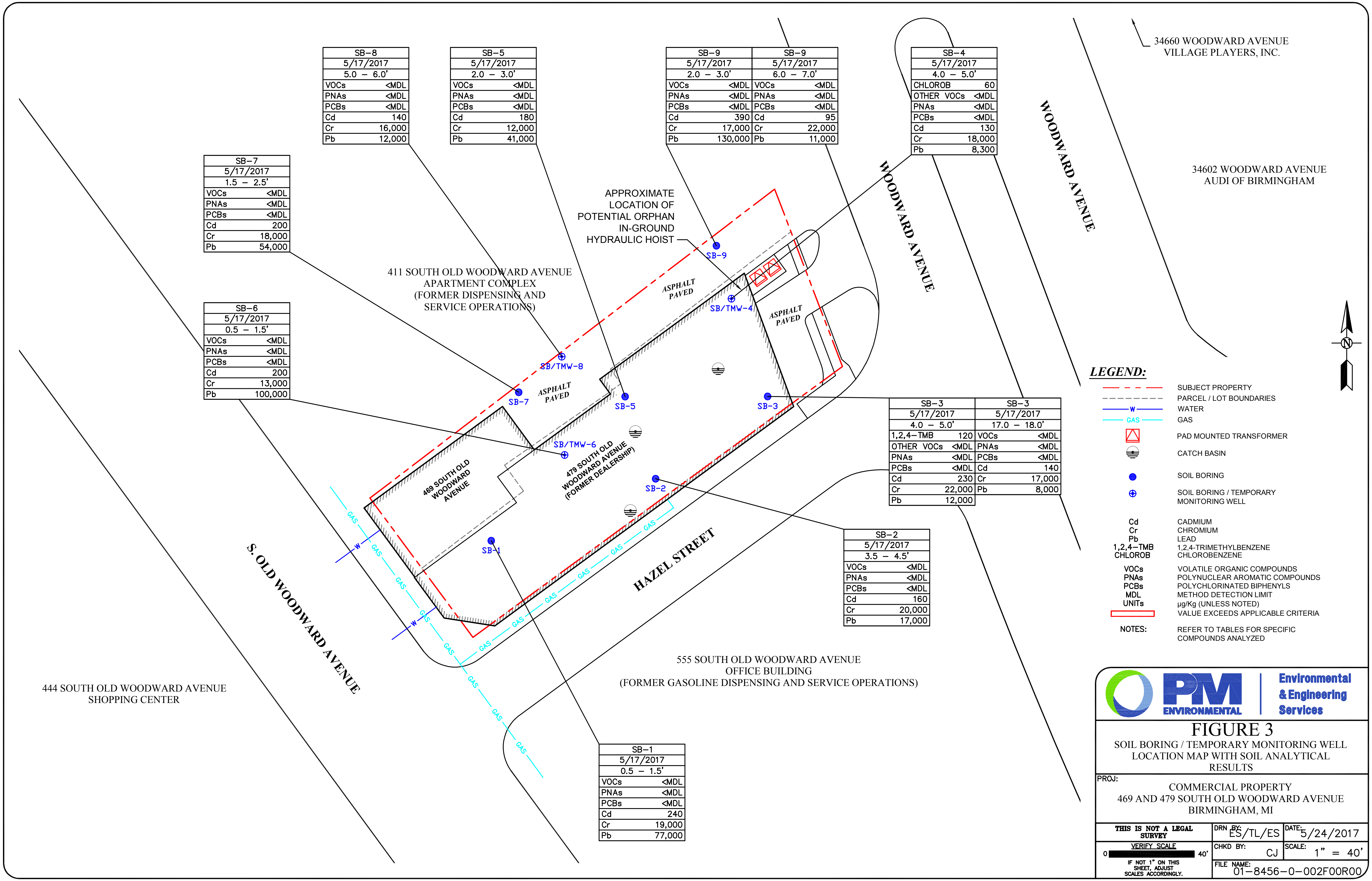
GENERALIZED DIAGRAM OF THE SUBJECT
PROPERTY AND ADJOINING PROPERTIES WITH
GPR SURVEY AREA

PROJ:
COMMERCIAL PROPERTY
469 AND 479 SOUTH OLD WOODWARD AVENUE
BIRMINGHAM, MI

THIS IS NOT A LEGAL SURVEY

VERIFY SCALE
0 40'
IF NOT 1" ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DRN BY: ES/TL
DATE: 5/22/2017
CHKD BY: CJ
SCALE: 1" = 40'
FILE NAME: 01-8456-0-002F00R00



SB-8	
5/17/2017	
5.0 – 6.0'	
VOCs	<MDL
PNAs	<MDL
PCBs	<MDL
Cd	140
Cr	16,000
Pb	12,000

SB-5	
5/17/2017	
2.0 – 3.0'	
VOCs	<MDL
PNAs	<MDL
PCBs	<MDL
Cd	180
Cr	12,000
Pb	41,000

SB-9		SB-9	
5/17/2017		5/17/2017	
2.0 – 3.0'		6.0 – 7.0'	
VOCs	<MDL	VOCs	<MDL
PNAs	<MDL	PNAs	<MDL
PCBs	<MDL	PCBs	<MDL
Cd	390	Cd	95
Cr	17,000	Cr	22,000
Pb	130,000	Pb	11,000

SB-4	
5/17/2017	
4.0 – 5.0'	
CHLOROB	60
OTHER VOCs	<MDL
PNAs	<MDL
PCBs	<MDL
Cd	130
Cr	18,000
Pb	8,300

SB-7	
5/17/2017	
1.5 – 2.5'	
VOCs	<MDL
PNAs	<MDL
PCBs	<MDL
Cd	200
Cr	18,000
Pb	54,000

SB-6	
5/17/2017	
0.5 – 1.5'	
VOCs	<MDL
PNAs	<MDL
PCBs	<MDL
Cd	200
Cr	13,000
Pb	100,000

SB-3		SB-3	
5/17/2017		5/17/2017	
4.0 – 5.0'		17.0 – 18.0'	
1,2,4–TMB	120	VOCs	<MDL
OTHER VOCs	<MDL	PNAs	<MDL
PNAs	<MDL	PCBs	<MDL
PCBs	<MDL	Cd	140
Cd	230	Cr	17,000
Cr	22,000	Pb	8,000
Pb	12,000		

SB-2	
5/17/2017	
3.5 – 4.5'	
VOCs	<MDL
PNAs	<MDL
PCBs	<MDL
Cd	160
Cr	20,000
Pb	17,000

SB-1	
5/17/2017	
0.5 – 1.5'	
VOCs	<MDL
PNAs	<MDL
PCBs	<MDL
Cd	240
Cr	19,000
Pb	77,000

LEGEND:

🟥 – – –	SUBJECT PROPERTY
– – – –	PARCEL / LOT BOUNDARIES
—W—	WATER
—GAS—	GAS
△	PAD MOUNTED TRANSFORMER
⊜	CATCH BASIN
●	SOIL BORING
⊕	SOIL BORING / TEMPORARY MONITORING WELL
Cd	CADMIUM
Cr	CHROMIUM
Pb	LEAD
1,2,4–TMB	1,2,4-TRIMETHYLBENZENE
CHLOROB	CHLOROBENZENE
VOCs	VOLATILE ORGANIC COMPOUNDS
PNAs	POLYNUCLEAR AROMATIC COMPOUNDS
PCBs	POLYCHLORINATED BIPHENYLS
MDL	METHOD DETECTION LIMIT
UNITs	µg/Kg (UNLESS NOTED)
▭	VALUE EXCEEDS APPLICABLE CRITERIA
NOTES:	REFER TO TABLES FOR SPECIFIC COMPOUNDS ANALYZED

PM ENVIRONMENTAL | Environmental & Engineering Services

FIGURE 3

SOIL BORING / TEMPORARY MONITORING WELL LOCATION MAP WITH SOIL ANALYTICAL RESULTS

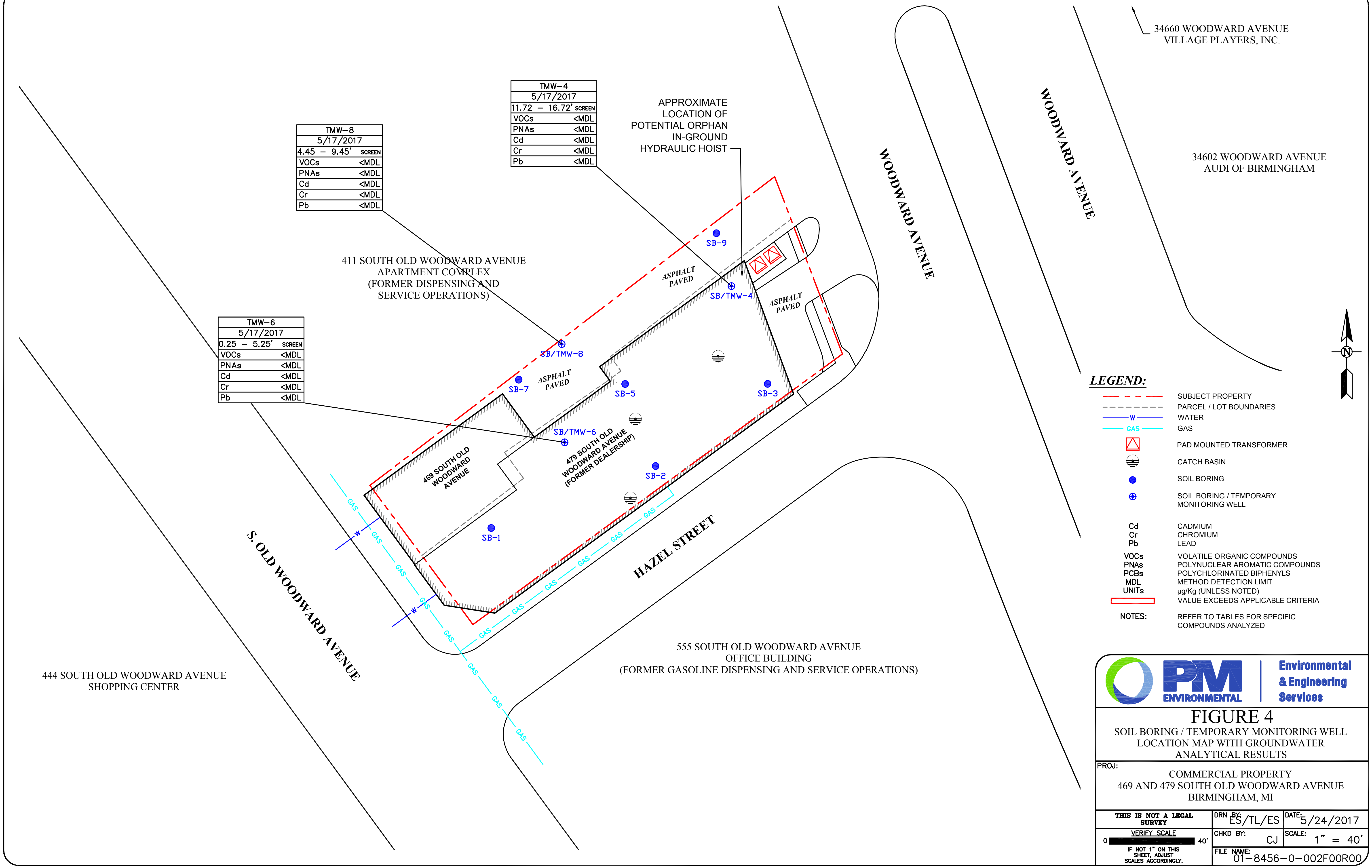
PROJ:
COMMERCIAL PROPERTY
469 AND 479 SOUTH OLD WOODWARD AVENUE
BIRMINGHAM, MI

THIS IS NOT A LEGAL SURVEY

DRN BY: ES/TL/ES
DATE: 5/24/2017

VERIFY SCALE
0 40'
IF NOT 1" ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

CHKD BY: CJ
SCALE: 1" = 40'
FILE NAME: 01–8456–0–002F00R00



TMW-8	
5/17/2017	
4.45 – 9.45'	SCREEN
VOCs	<MDL
PNAs	<MDL
Cd	<MDL
Cr	<MDL
Pb	<MDL

TMW-4	
5/17/2017	
11.72 – 16.72'	SCREEN
VOCs	<MDL
PNAs	<MDL
Cd	<MDL
Cr	<MDL
Pb	<MDL

TMW-6	
5/17/2017	
0.25 – 5.25'	SCREEN
VOCs	<MDL
PNAs	<MDL
Cd	<MDL
Cr	<MDL
Pb	<MDL

LEGEND:

🟥 – –	SUBJECT PROPERTY
– – – –	PARCEL / LOT BOUNDARIES
—W—	WATER
—GAS—	GAS
⊠	PAD MOUNTED TRANSFORMER
⊜	CATCH BASIN
●	SOIL BORING
⊕	SOIL BORING / TEMPORARY MONITORING WELL
Cd Cr Pb	CADMIUM CHROMIUM LEAD
VOCs PNAs PCBs MDL UNITs	VOLATILE ORGANIC COMPOUNDS POLYNUCLEAR AROMATIC COMPOUNDS POLYCHLORINATED BIPHENYLS METHOD DETECTION LIMIT µg/Kg (UNLESS NOTED)
☐	VALUE EXCEEDS APPLICABLE CRITERIA
NOTES:	REFER TO TABLES FOR SPECIFIC COMPOUNDS ANALYZED

PM ENVIRONMENTAL | Environmental & Engineering Services

FIGURE 4

SOIL BORING / TEMPORARY MONITORING WELL LOCATION MAP WITH GROUNDWATER ANALYTICAL RESULTS

PROJ:
COMMERCIAL PROPERTY
469 AND 479 SOUTH OLD WOODWARD AVENUE
BIRMINGHAM, MI

THIS IS NOT A LEGAL SURVEY

VERIFY SCALE
0 ▬▬▬ 40'
IF NOT 1" ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DRN BY: ES/TL/ES
DATE: 5/24/2017
CHKD BY: CJ
SCALE: 1" = 40'
FILE NAME: 01-8456-0-002F00R00

Tables

TABLE 1
SUMMARY OF SOIL ANALYTICAL RESULTS: VOCs, PNAs, PCBs, AND METALS
469 AND 479 SOUTH OLD WOODWARD AVENUE, BIRMINGHAM, MICHIGAN
PM PROJECT # 01-8456-0-0002

VOLATILE ORGANIC COMPOUNDS (VOCs), POLYNUCLEAR AROMATIC HYDROCARBONS (PNAs), POLYChLORINATED BIPHENYLS (PCBs), AND METALS (µg/Kg)			Chlorobenzene	1,2,4-Trimethylbenzene	Other VOCs	PNAs	PCBs	Cadmium	Chromium	Lead
Chemical Abstract Service Number (CAS#)			108907	95636	Various	Various	1336363	7440439	16065831	7439921
Sample ID	**Sample Date**	**Sample Depth (feet bgs)**	**VOCs**			**PNAs**	**PCBs**	**Metals**		
SB-1	05/17/17	0.5-1.5	<50	<50	<MDL	<MDL	<330	240	19,000	77,000
SB-2	05/17/17	3.5-4.5	<50	<50	<MDL	<MDL	<330	160	20,000	17,000
SB-3	05/17/17	4.0-5.0	<50	120	<MDL	<MDL	<330	230	22,000	12,000
SB-3	05/17/17	17.0-18.0	<50	<50	<MDL	<MDL	<330	140	17,000	8,000
SB-4	05/17/17	4.0-5.0	60	<50	<MDL	<MDL	<330	130	18,000	8,300
SB-5	05/17/17	2.0-3.0	<50	<50	<MDL	<MDL	<330	180	12,000	41,000
SB-6	05/17/17	0.5-1.5	<50	<50	<MDL	<MDL	<330	200	13,000	100,000
SB-7	05/17/17	1.5-2.5	<50	<50	<MDL	<MDL	<330	200	18,000	54,000
SB-8	05/17/17	5.0-6.0	<50	<50	<MDL	<MDL	<330	140	16,000	12,000
SB-9	05/17/17	2.0-3.0	<50	<50	<MDL	<MDL	<330	390	17,000	130,000
SB-9	05/17/17	6.0-7.0	<50	<50	<MDL	<MDL	<330	95	22,000	11,000
Cleanup Criteria Requirements for Response Activity (R 299.1 - R 299.50) Generic Soil Cleanup Criteria Tables 2 and 3: Residential and Non-Residential Part 201 Generic Cleanup Criteria and Screening Levels/Part 213 Risk-Based Screening Levels, December 30, 2013 MDEQ Guidance Document For The Vapor Intrusion Pathway, Policy and Procedure Number: 09-017, Appendix D Vapor Intrusion Screening Values, May 2013										
Residential (µg/Kg)										
Statewide Default Background Levels			NA	NA	NA	NA	NA	1,200	18,000	21,000
Drinking Water Protection (Res DWP)			2,000	2,100	Various	Various	NLL	6,000	30,000	7.00E+05
Groundwater Surface Water Interface Protection (GSIP)			500	570	Various	Various	NLL	3,800 {G,X}	3.2E+09 {G,X}	3.2E+06 {G,X}
Soil Volatilization to Indoor Air Inhalation (Res SVII)			1.20E+05	4.3E+06 {C}	Various	Various	3.0E+06	NLV	NLV	NLV
Ambient Air Infinite Source Volatile Soil Inhalation (Res VSI)			7.70E+05	2.10E+07	Various	Various	2.40E+05	NLV	NLV	NLV
Ambient Air Finite VSI for 5 Meter Source Thickness			9.90E+05	5.00E+08	Various	Various	7.9E+06	NLV	NLV	NLV
Ambient Air Finite VSI for 2 Meter Source Thickness			2.10E+06	5.00E+08	Various	Various	7.9E+06	NLV	NLV	NLV
Ambient Air Particulate Soil Inhalation (Res PSI)			4.70E+09	8.20E+10	Various	Various	5.2E+06	1.70E+06	2.60E+05	1.0E+08
Direct Contact (Res DC)			4.3E+06 {C}	3.2E+07 {C}	Various	Various	{T}	5.50E+05	2.50E+06	4.00E+05
Nonresidential (µg/Kg)										
Drinking Water Protection (Nonres DWP)			2,000	2,100	Various	Various	NLL	6,000	30,000	7.00E+05
Soil Volatilization to Indoor Air Inhalation (Nonres SVII)			2.20E+05	8.0E+06 {C}	Various	Various	1.6E+07	NLV	NLV	NLV
Ambient Air Infinite Source Volatile Soil Inhalation (Nonres VSI)			9.20E+05	2.50E+07	Various	Various	8.10E+05	NLV	NLV	NLV
Ambient Air Finite VSI for 5 Meter Source Thickness			1.10E+06	6.00E+08	Various	Various	2.8E+07	NLV	NLV	NLV
Ambient Air Finite VSI for 2 Meter Source Thickness			2.10E+06	6.00E+08	Various	Various	2.8E+07	NLV	NLV	NLV
Ambient Air Particulate Soil Inhalation (Nonres PSI)			2.10E+09	3.60E+10	Various	Various	6.5E+06	2.2E+06	2.40E+05	4.4E+07
Direct Contact (Nonres DC)			1.4E+07 {C}	1.0E+08 {C}	Various	Various	{T}	2.1E+06	9.2E+06	9.00E+05 (DD)
Screening Levels (µg/Kg)										
Soil Saturation Concentration Screening Levels (Csat)			2.60E+05	1.10E+05	Various	Various	NA	NA	NA	NA
Residential Vapor Intrusion Soil Screening Levels (S_{VI-res})			350	2,200	Various	Various	1,900	NL	NL	NL
Nonresidential Vapor Intrusion Soil Screening Levels (S_{VI-nr})			5,900	37,000	Various	Various	39,000	NL	NL	NL

☐	Applicable Criterion/RBSL Exceeded
BOLD	Value Exceeds Applicable Criterion/RBSL
ug/Kg	Micrograms per Kilogram
bgs	Below Ground Surface (feet)
<MDL	Non-detected at levels above laboratory method detection limit (MDL)
NA	Not Applicable
NL	Not Listed
NLL	Not Likely to Leach
NLV	Not Likely to Volatilize
ID	Insufficient Data

{G} Metal GSIP Criteria for Surface Water Not Protected for Drinking Water Use based on 165 mg/L CaCO3 Hardness: Station ID 630663, Pine Lake, Bloomfield Township, MI.

TABLE 2
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS: VOCs, PNAs, AND METALS
469 AND 479 SOUTH OLD WOODWARD AVENUE, BIRMINGHAM, MICHIGAN
PM PROJECT # 01-8456-0-0002

VOLATILE ORGANIC COMPOUNDS (VOCs), POLYNUCLEAR AROMATIC HYDROCARBONS (PNAs), AND METALS (µg/L)				VOCs	PNAs	Cadmium	Chromium	Lead
Chemical Abstract Service Number (CAS#)				Various	Various	7440439	16065831	7439921
Sample ID	**Sample Date**	**Screen Depth (feet bgs)**	**Depth to Groundwater (feet bgs)**	**VOCs**	**PNAs**	**Metals**		
TMW-4	05/17/17	11.72-16.72	13.98	<MDL	<MDL	<0.2	<5	<3
TMW-6	05/17/17	0.25-5.25	3.78	<MDL	<MDL	<0.2	<5	<3
TMW-8	05/17/17	4.45-9.45	6.12	<MDL	<MDL	<0.2	<5	<3
Cleanup Criteria Requirements for Response Activity (R 299.1 - R 299.50) Generic Groundwater Cleanup Criteria Table 1: Residential and Non-Residential Part 201 Generic Cleanup Criteria and Screening Levels/Part 213 Risk-Based Screening Levels, December 30, 2013 MDEQ Guidance Document For The Vapor Intrusion Pathway, Policy and Procedure Number: 09-017, Appendix D Vapor Intrusion Screening Values, May 2013								
Residential/Nonresidential (µg/L)								
Residential Drinking Water (Res DW) [1]				Various	Various	5.0 {A}	100 {A}	4.0 {L}
Residential Health Based Drinking Water Values				Various	Various	NL	NL	NL
Nonresidential Drinking Water (Nonres DW) [1]				Various	Various	5.0 {A}	100 {A}	4.0 {L}
Nonresidential Health Based Drinking Water Values				Various	Various	NL	NL	NL
Groundwater Surface Water Interface (GSI)				Various	Various	3.2 {G,X}	110 {G,X}	18 {G,X}
Residential Groundwater Volatilization to Indoor Air Inhalation (Res GVII) [2]				Various	Various	NLV	NLV	NLV
Nonresidential Groundwater Volatilization to Indoor Air Inhalation (Nonres GVII) [2]				Various	Various	NLV	NLV	NLV
Screening Levels (µg/L)								
Residential Groundwater Vapor Intrusion Screening Levels (GW_{VI-res}) [3]				Various	Various	NL	NL	NL
Nonresidential Groundwater Vapor Intrusion Screening Levels (GW_{VI-nr}) [3]				Various	Various	NL	NL	NL
Residential Vapor Intrusion Shallow Groundwater Screening Levels ($GW_{VI-sump-res}$) [4]				Various	Various	NL	NL	NL
Nonresidential Vapor Intrusion Shallow Groundwater Screening Levels ($GW_{VI-sump-nr}$) [4]				Various	Various	NL	NL	NL
Water Solubility				Various	Various	NA	NA	NA
Flammability and Explosivity Screening Level				Various	Various	ID	ID	ID
Acute Vapor Intrusion Screening Levels for Groundwater (µg/L)								
IRASL Groundwater (AGW_{vi})				Various	Various	NL	NL	NL
IRASL Groundwater In Contact With Structure ($AGW_{vi-sump}$)				Various	Various	NL	NL	NL

▭	Applicable Criteria/RBSL Exceeded
BOLD	Value Exceeds Applicable Criteria
bgs	Below Ground Surface (feet)
ug/L	Micrograms per Liter
<MDL	Not detected at levels above the laboratory Method Detection Limit (MDL) or Minimum Quantitative Level (MQL)
[1]	Rule 323.1057 of Part 4 Water Quality Standards
[2]	Tier 1 GVII Criteria based on 3 meter (or greater) groundwater depth
[3]	(2013 Vapor Intrusion Guidance) Screening Levels based on depth to groundwater less than 1.5 meters and not in contact with building foundation
[4]	(2013 Vapor Intrusion Guidance) Screening levels based on groundwater in contact with the building foundation or within a sump
NA	Not Applicable
NL	Not Listed
NLV	Not Likely to Volatilize
ID	Insufficient Data

{G} Metal GSI Criteria for Surface Water Not Protected for Drinking Water Use based on 165 mg/L CaCO3 Hardness: Station ID 630663, Lake ????, Pine Lake, Bloomfield Township, MI.

4.9 Geophysical Survey Investigation Report

PM ENVIRONMENTAL
Risk Well Managed

Environmental & Engineering Services Nationwide

GEOPHYSICAL SURVEY INVESTIGATION REPORT

467 and 479 South Old Woodward Avenue | Birmingham, Michigan
PM Project Number 01-8456-0-0002

Prepared for:

Markus Associates, LLC
4036 Telegraph Road, Suite 205
Bloomfield Hills, Michigan 48302

Prepared by:

PM Environmental, Inc.
4080 West Eleven Mile Road
Berkley, Michigan 48072

ENVIRONMENTAL SERVICES

BUILDING ARCHITECTURE, ENGINEERING & SCIENCE

INDUSTRIAL HYGIENE SERVICES

BROWNFIELDS & ECONOMIC INCENTIVES CONSULTING

Know Your Risk.
Take Control.
Work with the Experts.

www.pmenv.com

PM
ENVIRONMENTAL
Risk Well Managed

Detroit
607 Shelby,
Suite 650
Detroit, MI 48226
f: 877.884.6775
t: 248.414.1416

Berkley
4080 W. 11 Mile Road
Berkley, MI 48072
f: 877.884.6775
t: 248.336.9988

Lansing
3340 Ranger Road
Lansing, MI 48906
f: 877.884.6775
t: 517.321.3331

Grand Rapids
560 5th Street NW,
Suite 301
Grand Rapids, MI 49504
f: 877.884.6775
t: 616.285.8857

May 22, 2017

Mr. Doraid Markus
Markus Associates, LLC
4036 Telegraph Road, Suite 205
Bloomfield Hills, Michigan 48302

Re: Geophysical Survey Investigation Report of the Commercial Property Located at 467 and 479 South Old Woodward Avenue, Birmingham, Michigan PM Environmental, Inc. Project No. 01-8456-0-0002

Dear Mr. Markus:

PM Environmental, Inc. (PM) has completed the geophysical survey investigation report for the commercial property located at 467 and 479 South Old Woodward Avenue, Birmingham, Michigan. The attached report is a summary of the field investigative techniques and results of the geophysical survey activities.

THIS GEOPHYSICAL SURVEY INVESTIGATION REPORT WAS PERFORMED FOR THE EXCLUSIVE USE OF MARKUS MANAGEMENT GROUP, LLC ON BEHALF OF AN ENTITY TO BE FORMED AND MICHIGAN BUSINESS CONNECTION, LC, ITS SUCCESSORS, ASSIGNS AND CREDIT UNION LENDERS, WHO MAY RELY ON ITS CONTENTS AND CONCLUSIONS.

If you have any question or concerns, please feel free to contact our office at (248) 336-9988.

Sincerely,
PM Environmental, Inc.

Tom Dawda
Field Scientist

PM Environmental, Inc.

Casey Armstrong
Regional Manager – Contract Services

Enclosure

LIMITATIONS

This Geophysical Survey Investigation Report is a property-specific assessment that is related to the environmental conditions of the subject property only. PM Environmental, Inc. (PM) performed its services in conformance with the care and skill ordinarily used by other reputable environmental consulting firms practicing under similar conditions, at the same time, and in the same or similar locality. In preparing the assessment report, PM may have relied on information obtained from or provided by others. PM makes no representation or warranty regarding the accuracy or completeness of this information gathered through outside sources or subcontracted services. No single page of this report should be relied upon alone, rather only the report in its entirety. No warranty, guarantee, or certification of any kind, expressed or implied, at common law or created by statute, is extended, made, or intended by rendering these environmental consulting services or by furnishing this written report. Environmental conditions and regulations are subject to constant change and reinterpretation. One should not assume that any on-site conditions and/or regulatory statutes or rules will remain constant in the future, after PM has completed the scope of work for this project. Furthermore, because of the facts stated in this report are subject to professional interpretation, differing conclusions could be reached by other professionals.

Ground penetrating radar (GPR) limitations that may preclude data acquisition and interpretation include reduced signal penetration from overburden attenuation properties, complicated overburden, standing water, proximity to the metal siding on the building or other large metal objects, high power electrical lines, and dense, reinforced concrete pavements or foundations. The most that PM can do is prepare a logical assessment program to reduce the client's risk of discovering unknown subsurface objects. This risk may be reduced by more extensive exploration on the property. Even with additional exploration, it is not possible to completely eliminate the risk of discovering subsurface objects onsite. It cannot be assumed that conditions observed are representative of an area that has not been investigated. Tests and other data collected for the report were obtained only for the sole purposes stated in this report, and they should not be used for purposes or reasons other than those intended.

Some environmental assessments are undertaken to satisfy due diligence, all appropriate inquiry, or other regulatory requirements provided in federal, state, or local law. The level of investigation necessary to demonstrate due diligence or all appropriate inquiry has not been legislatively defined. Although PM strives to investigate a property in accordance with the scope of work, it cannot warrant that the work undertaken for this report will satisfy due diligence, all appropriate inquiry, or any other similar standard under any federal, state, or local law. Due to changing environmental regulatory conditions and potential on-site or off-site activities occurring after this assessment, the client may not presume the continuing applicability to the property of the conclusions in this assessment for more than 180 days after the report’s issuance date.

Any reports, field data, field notes, laboratory testing, calculations, estimates or other documents prepared by or relied upon by PM are the property of PM. If any of these documents are released or obtained by a party other than the client, PM may not discuss the project with that party unless the original contracted client notifies PM of the same and PM is authorized to disclose the information and to discuss the project with others. Except as otherwise agreed with the client, PM further states that it disclaims any duty of any kind or nature to any person or entity other than the client in preparing this report.PM does not assume liability for any losses or damages that the client or third party incur due to the results or conclusions provided in this assessment.

TABLE OF CONTENTS

FIGURES

APPENDICES

1.0 INTRODUCTION AND PURPOSE OF GEOPHYSICAL SURVEY

PM Environmental, Inc. (PM) has completed geophysical survey activities using Ground Penetrating Radar (GPR) at the commercial property located at 467 and 479 South Old Woodward Avenue, Birmingham, Oakland County, Michigan (hereafter referred to as the "subject property"). Figure 1 depicts the location of the subject property and Figure 2 is a generalized diagram of the subject property and adjoining properties with GPR survey area.

1.1 Site Description and Background Information

The subject property consists of two parcels (Parcel IDs: 08-19-36-208-011 and 08-19-36-208-012) totaling 0.41 acres, and is located on the east side of South Old Woodward Avenue, west of Woodward Avenue, north of Hazel Street, and south of East Brown Street (Figure 1). The subject property is developed with one single-story commercial building and parking garage totaling 10,541 square feet (479 South Old Woodward Avenue), which is currently vacant of occupants, and one single-story restaurant building totaling 2,882 square feet (469 South Old Woodward Avenue), which is currently occupied by a Chinese restaurant. The remainder of the subject property consists of an asphalt paved alley located north of the 479 South Old Woodward Avenue subject building, and an asphalt paved parking garage driveway located east of the 479 South Old Woodward Avenue subject building (Figure 2).

Standard and other historical sources were able to document that the first developed use of the subject property occurred prior to 1921 with a two-story residential dwelling, the first floor of which was converted to a store by 1926. The original building was demolished between 1926 and 1931, when the southern portion of the property was redeveloped with the western and central portions of the current building (479 South Old Woodward). An addition was constructed to the eastern portion in 1946 and 1947. The southern portion of the property was occupied by an automotive dealership from at least 1931 until between 1984 and 1988, when the building was converted to a bank. The southern building was occupied by a bank until 2014, and has been vacant since 2015.

The northern portion of the property was developed with the western portion of the current building (historically identified as 476 South Old Woodward) between 1940 and 1949. An addition was constructed to the eastern portion in 1953. The northern subject building has been occupied by a restaurant since at least 1951.

1.2 Purpose of Geophysical Survey

PM prepared a Phase I Environmental Site Assessment (ESA) of the subject property dated May 22, 2017, which identified the following onsite Recognized Environmental Condition (REC) suggestive of the potential for underground storage tanks (USTs) and in-ground hoists.

- The former automotive dealership and service garage contained at least five in-ground hydraulic hoists. In-ground hoists have an underground reservoir for hydraulic fluids, which can contain polychlorinated biphenyls (PCBs). The potential exists that a release occurred from the former hydraulic hoist system and/or underground reservoir. Additionally, the potential exists for orphaned reservoirs to be present on the subject property.

- Review of City of Birmingham Fire and Building Department records and Michigan Department of Environmental Quality (MDEQ) records documents the removal of one

1,000-gallon waste oil UST, one 1,500-gallon UST, and one 300-gallon UST in September 1988. PM was unable to confirm the installation date and/or location of the former 1,000-gallon waste oil UST and/or the 1,500-gallon and 300-gallon USTs removed in September 1988. Additionally, PM was unable to locate any sampling completed in the area of the former USTs. Additional USTs may have also historically been associated with the former dealership and automotive service operations. The potential exists for orphan USTs to be present on the property and/or for a release to have occurred.

2.0 GEOPHYSICAL SURVEY

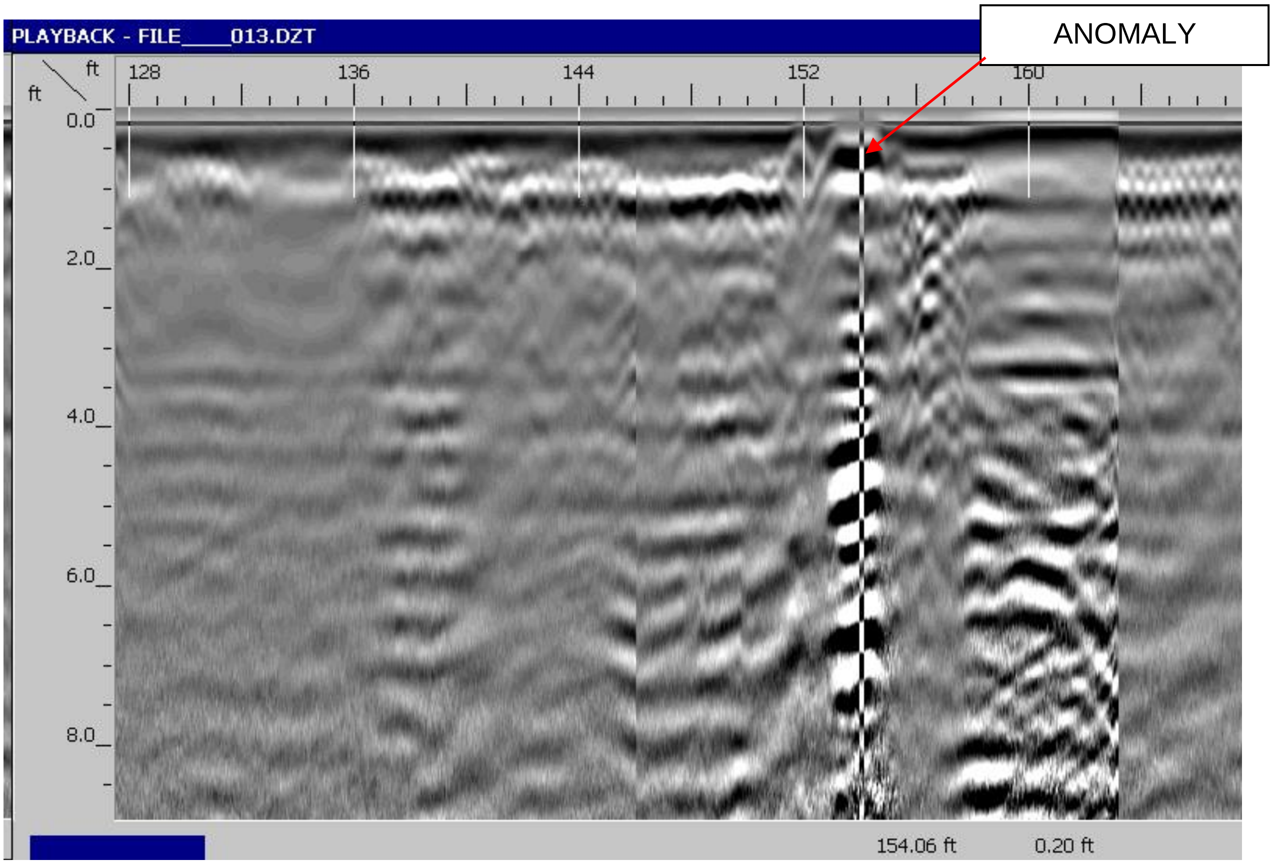
On May 15, 2017, PM completed a GPR survey at the subject property (Figure 2) to investigate the potential for orphan USTs and in-ground hoists. At the time of the survey, weather conditions were approximately 70^{o} F and sunny. Photographs from the geophysical survey investigation are included as Appendix A.

The GPR survey was completed using a GSSI® SIR-3000 radar control unit equipped with a 400 megahertz (MHz) antenna. The survey was completed utilizing 2-dimensional scanning methods in a 2 foot surface grid pattern (i.e., in north-south and east-west directions), to a maximum depth of 4.0 feet below ground surface (bgs).

PM encountered the following project specific conditions that limited its ability to assess the subject property:

- Dumpsters are present along the northwestern portion of the GPR survey area (Photograph #4).

One anomaly consistent with an orphan in-ground hoist was identified during the GPR survey. The anomaly is located in the northeast corner of the parking garage (479 South Old Woodward Avenue). The anomaly is approximately 2.0 feet in length, 1.5 feet in width, and located approximately .25 feet bgs. A commercial metal detector (schonstedt) was used to verify that the anomaly was metallic in nature. The following is an example data set collected from the subject property depicting the anomaly.



PM recommends further investigation of the anomaly to determine if it is an orphan in-ground hoist. If the anomaly is determined to be an orphan in-ground hoist it is recommended the in-ground hoist be removed.

Other anomalies not consistent with USTs (i.e., those consistent with subsurface utilities, rebar, etc.) may have been observed; however are not included within this report.

3.0 CONCLUSIONS

On May 15, 2017, PM completed a GPR survey on the subject property to investigate the presence of any potential orphan USTs and in-ground hoists.

One anomaly consistent with an in-ground hoist was identified during the GPR survey. The anomaly is located in the northeast corner of the parking garage (479 South Old Woodward Avenue). The anomaly is approximately 2.0 feet in length, 1.5 feet in width, and located approximately .25 feet bgs. A commercial metal detector (schonstedt) was used to verify that the anomaly was metallic in nature.

PM recommends further investigation of the anomaly to determine if it is an orphan in-ground hoist. If the anomaly is determined to be an orphan in-ground hoist it is recommended the in-ground hoist and any impacted soil be removed during redevelopment activities.

Please feel free to contact our office at (248) 336-9988 to discuss this report.

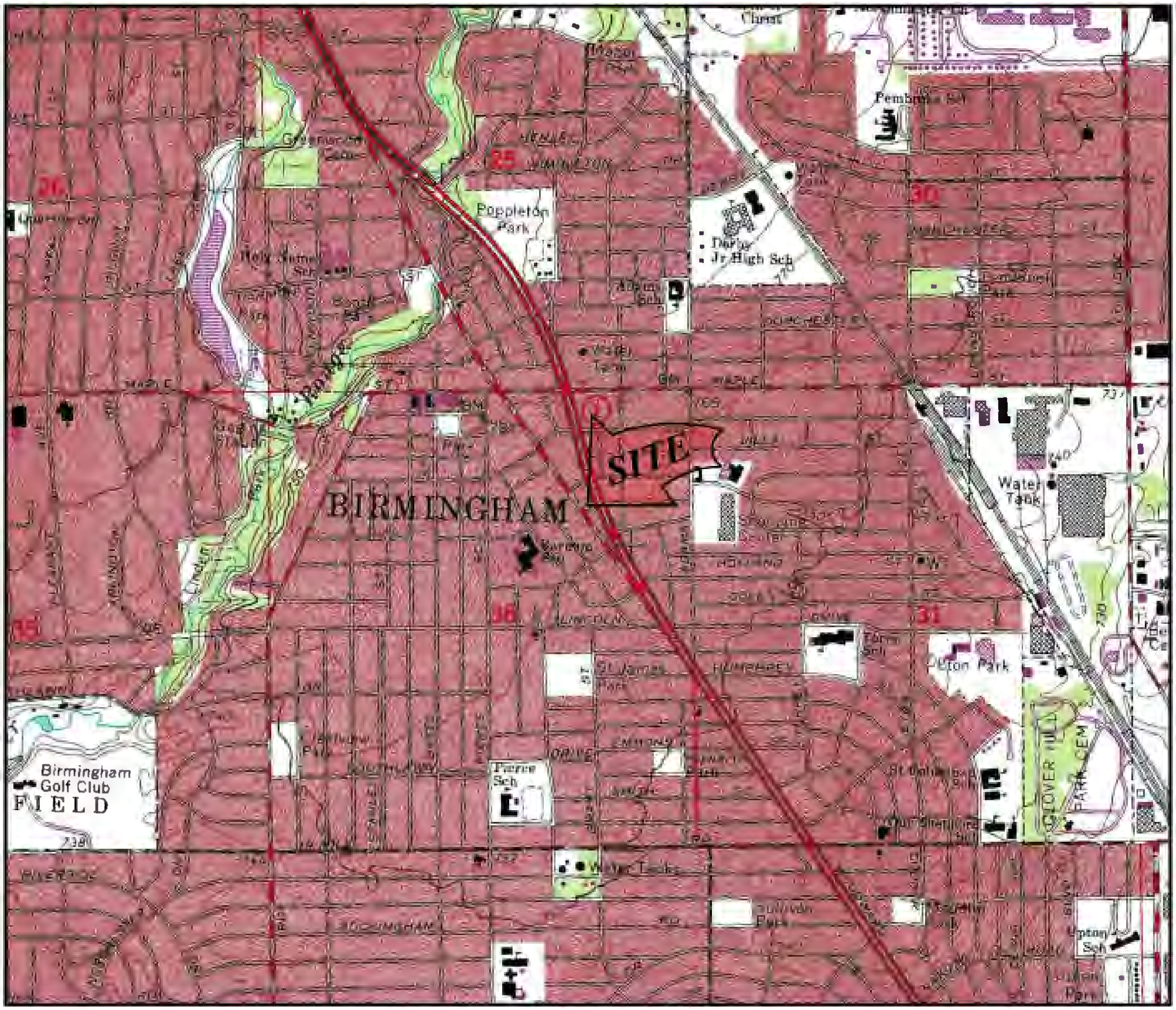
REPORT PREPARED BY:
PM Environmental, Inc.

Tom Dawda
Field Scientist

REPORT REVIEWED BY:
PM Environmental, Inc.

Casey Armstrong
Regional Manager – Contract Services

Figures



OAKLAND COUNTY


MICHIGAN QUADRANGLE LOCATION

SCALE 1:24,000

1 MILE 1/2 MILE 0 1 MILE

FIGURE 1

PROPERTY VICINITY MAP

USGS, 7.5 MINUTE SERIES

BIRMINGHAM, MI QUADRANGLE, 1968. PHOTO REVISED 1981.

PM ENVIRONMENTAL | Environmental & Engineering Services

PROJ:
COMMERCIAL PROPERTY
469 AND 479 SOUTH OLD
WOODWARD AVENUE
BIRMINGHAM, MI

THIS IS NOT A LEGAL SURVEY

VERIFY SCALE

0 2,000'

IF NOT 1" ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

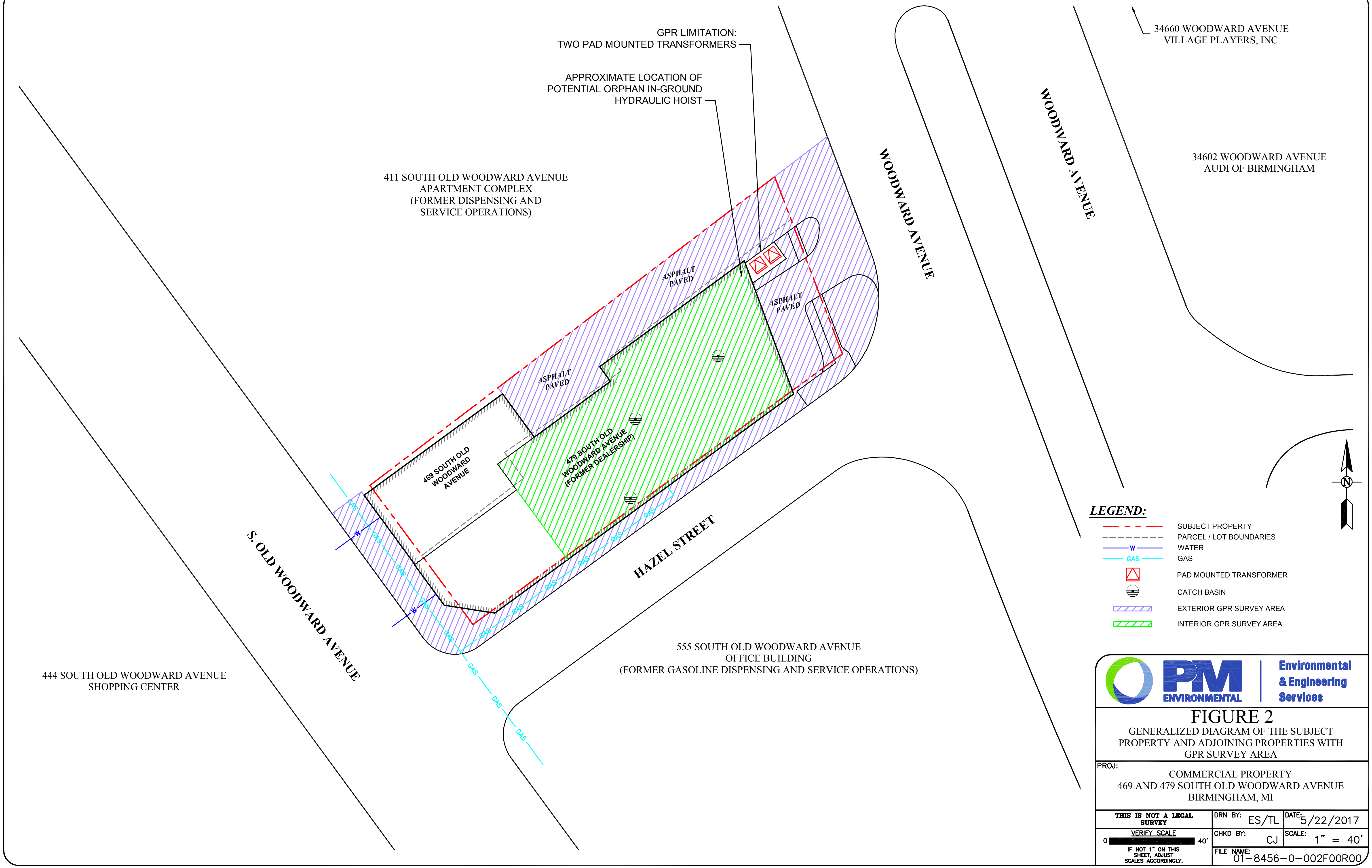
DRN BY: ES/TL

DATE: 5/22/2017

CHKD BY: CJ

SCALE: 1" = 2,000'

FILE NAME: 01-8456-0-002F01R00



PM ENVIRONMENTAL | Environmental & Engineering Services

FIGURE 2

GENERALIZED DIAGRAM OF THE SUBJECT
PROPERTY AND ADJOINING PROPERTIES WITH
GPR SURVEY AREA

PROJ:
COMMERCIAL PROPERTY
469 AND 479 SOUTH OLD WOODWARD AVENUE
BIRMINGHAM, MI

THIS IS NOT A LEGAL SURVEY

VERIFY SCALE
0 40'
IF NOT 1" ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DRN BY: ES/TL
DATE: 5/22/2017
CHKD BY: CJ
SCALE: 1" = 40'
FILE NAME: 01-8456-0-002F00R00

Appendix A

Photograph 1

View of the southwestern portion of the ground penetrating radar (GPR) survey area, facing north.

Photograph 2

View of the southeastern portion GPR survey area, facing northeast.

Photographs from the Geophysical Survey Investigation
PM Project No. 01-8456-0-0002
Location: 467 and 479 South Old Woodward Avenue, Birmingham, Michigan

Photograph 3

View of the northern portion of the GPR survey area, facing south.

Photograph 4

View of the northwestern portion of the GPR survey area, facing east. Note the dumpster limitations.

Photograph 5

View of the interior portion of the GPR survey area, facing southwest.

Photograph 6

View of the northeastern portion of the interior GPR survey area, facing north. Note the anomaly outlined in orange marking paint.

Appendix B

PM ENVIRONMENTAL
Environmental
& Engineering
Services

Boring Log .

Project No.: 01-8456-0-002

Boring No.: SB-1

Project Name: Commercial Property

Date Drilled: 5/17/2017

Facility ID#:

Drill Rig: HA

Logged By: JO/JP

Sampling Method: Grab

SUBSURFACE PROFILE			SAMPLE			
Depth (ft.)	Boring Profile	Description and Comments	Sample # Depth	Blow Counts	PID (ppm)	No Well Installed
		Ground Surface				
0	■	***CONCRETE/ASPHALT***		-	0.0	
	▨	***SW- (Loose) GRAVELLY SAND (moist)*** Gray/Brown, fine to coarse	SS-1 0.5 - 1.5'			
	▨	***CL- (Stiff) SANDY CLAY (moist)*** Gray/Brown, trace gravel		-	0.0	
2	▨			-	0.0	
	▨			-	0.0	
4	▨			-	0.0	
	▨	***CL- (Medium Stiff) CLAY (moist)*** Brown, trace gravel		-	0.0	
6		***REFUSAL @ 6' BGS***				

Completion Notes: EOB @ 6' bgs. Hole filled with soil cuttings and bentonite.

1. The indicated stratification lines are approximate in situ. The transitions between materials may be gradual.
2. Boring backfilled with natural soils unless otherwise noted.

Sheet: 1 of 1

Boring Log .

Project No.: 01-8456-0-002
Boring No.: SB-2
Project Name: Commercial Property
Date Drilled: 5/17/2017
Facility ID#:
Drill Rig: 6712 DT
Logged By: JO/JP
Sampling Method: 2.125 MC Tube

SUBSURFACE PROFILE			SAMPLE			
Depth (ft.)	Boring Profile	Description and Comments	Sample # Depth	Blow Counts	PID (ppm)	No Well Installed
		Ground Surface				
0		***CONCRETE/ASPHALT*** ***CL- (Medium Soft) SANDY CLAY (moist)*** Gray/Brown, trace gravel		-	0.0	
				-	0.0	
2				-	0.0	
			SS-1	-	0.0	
4		***CL- (Stiff) CLAY (moist)*** Brown, trace gravel	3.5 - 4.5'	-	0.0	
				-	0.0	
6				-	0.0	
				-	0.0	
8				-	0.0	
				-	0.0	
10				-	0.0	
		CL- (Stiff) CLAY (moist) Gray, trace gravel		-	0.0	
12				-	0.0	
				-	0.0	
14				-	0.0	
		CL- (Medium Stiff) CLAY (moist) Gray, trace gravel		-	0.0	
16				-	0.0	
				-	0.0	
18				-	0.0	
				-	0.0	
20						

Completion Notes: EOB @ 20' bgs. Hole filled with soil cuttings and bentonite.

1. The indicated stratification lines are approximate in situ.
   The transitions between materials may be gradual.
2. Boring backfilled with natural soils unless otherwise noted.

PM ENVIRONMENTAL

Boring Log .

Project No.: 01-8456-0-002

Boring No.: SB-3

Project Name: Commercial Property

Date Drilled: 5/17/2017

Facility ID#:

Drill Rig: 6712 DT

Logged By: JO/JP

Sampling Method: 2.125 MC Tube

SUBSURFACE PROFILE			SAMPLE			
Depth (ft.)	Boring Profile	Description and Comments	Sample # Depth	Blow Counts	PID (ppm)	No Well Installed
		Ground Surface				
0	■	**CONCRETE/ASPHALT**		-	0.0	
	▨	**CL- (Medium Soft) SANDY CLAY (moist)** Gray/Brown, trace gravel		-	0.0	
2	▨			-	0.4	
	▨			-	5.2	
4	▨		SS-1 4.0 - 5.0'	-	11.0	
	▨	**CL- (Medium Stiff) CLAY (moist)** Gray, trace gravel		-	2.6	
6	▨			-	0.2	
	▨	**CL- (Stiff) CLAY (moist)** Brown, trace gravel		-	0.0	
8	▨			-	0.0	
	▨			-	0.0	
10	▨			-	0.0	
	▨			-	0.5	
12	▨			-	3.2	
	▨			-	7.2	
14	▨	**CL- (Medium Stiff) CLAY (moist)** Gray, trace gravel		-	29.1	
	▨			-	3.0	
16	▨			-	10.0	
	▨		SS-2 17.0 - 18.0'	-	38.0	
18	▨			-	12.4	
	▨			-	7.7	
20						

Completion Notes: EOB @ 20' bgs. Hole filled with soil cuttings and bentonite.

1. The indicated stratification lines are approximate in situ.
   The transitions between materials may be gradual.
2. Boring backfilled with natural soils unless otherwise noted.

Sheet: 1 of 1

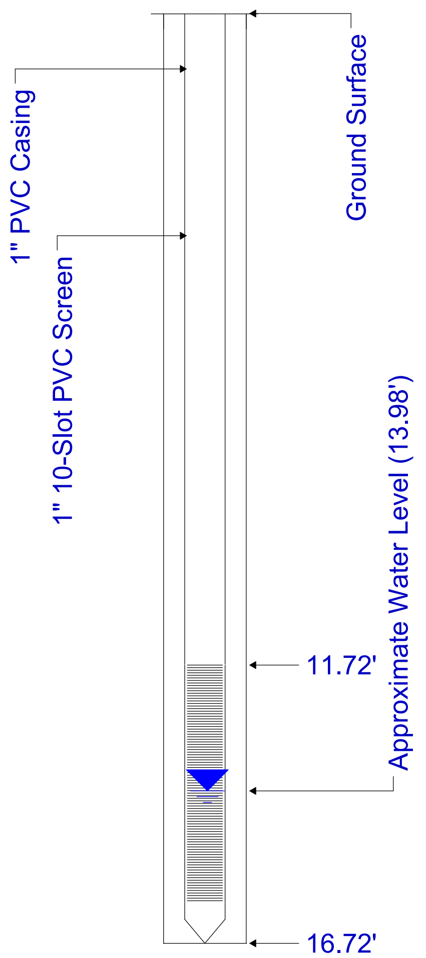
Well Log .

Project No.: 01-8456-0-002
Well No.: SB/TMW-4
Project Name: Commercial Property
Date Drilled: 5/17/2017
Facility ID#:
Drill Rig: 6712 DT
Logged By: JO/JP
Sampling Method: 2.125 MC Tube

SUBSURFACE PROFILE / SAMPLE

Depth (ft.)	Boring Profile	Description and Comments	Sample # Depth	Blow Counts	PID (ppm)
0		Ground Surface **CONCRETE/ASPHALT** **CL- (Medium Soft) SANDY CLAY (moist)** Gray/Brown, trace gravel		-	0.0
				-	0.0
2				-	0.0
				-	0.0
4		**CL- (Stiff) SANDY CLAY (moist)** Gray/Brown, trace gravel	SS-1 4.0 - 5.0'	-	1.6
				-	0.5
6				-	0.0
				-	0.0
8				-	0.0
				-	0.0
10				-	0.0
				-	0.0
12				-	0.0
				-	0.0
14		**SP- (Loose) SAND (saturated)** Brown, fine		-	0.0
		CL- (Medium Stiff) CLAY (moist) Gray, trace gravel		-	0.0
16				-	0.0
				-	0.0
18		**SP- (Loose) SAND (saturated)** Gray, fine		-	0.0
		CL- (Stiff) CLAY (moist) Gray, trace gravel		-	0.0
20					

Groundwater
Well Completion Details



Completion Notes: EOB @ 20' bgs. Hole filled with soil cuttings and bentonite.

1. The indicated stratification lines are approximate in situ.
   The transitions between materials may be gradual.
2. Boring backfilled with natural soils unless otherwise noted.

Sheet: 1 of 1

Boring Log .

Project No.: 01-8456-0-002
Boring No.: SB-5
Project Name: Commercial Property
Date Drilled: 5/17/2017
Facility ID#:
Drill Rig: 6712 DT
Logged By: JO/JP
Sampling Method: 2.125 MC Tube

SUBSURFACE PROFILE			SAMPLE			
Depth (ft.)	Boring Profile	Description and Comments	Sample # Depth	Blow Counts	PID (ppm)	No Well Installed
		Ground Surface				
0	■ ░	**CONCRETE/ASPHALT** **SW- (Loose) SAND (moist)** Brown, medium fine, trace gravel		-	0.0	
				-	0.0	
2	▨	**CL- (Medium Soft) SANDY CLAY (moist)** Gray, trace gravel	SS-1 2.0 - 3.0'	-	0.0	
				-	0.0	
4				-	0.0	
	▨	**CL- (Stiff) CLAY (moist)** Gray, trace gravel		-	0.0	
6				-	0.0	
				-	0.0	
8				-	0.0	
				-	0.0	
10				-	0.0	
	▨	**CL- (Medium Soft) CLAY (moist)** Gray, trace gravel		-	0.0	
12				-	0.0	
				-	0.0	
14				-	0.0	
				-	0.0	
16				-	0.0	
				-	0.0	
18				-	0.0	
				-	0.0	
20						

Completion Notes: EOB @ 20' bgs. Hole filled with soil cuttings and bentonite.

1. The indicated stratification lines are approximate in situ.
   The transitions between materials may be gradual.
2. Boring backfilled with natural soils unless otherwise noted.

Sheet: 1 of 1

PM ENVIRONMENTAL

Well Log .

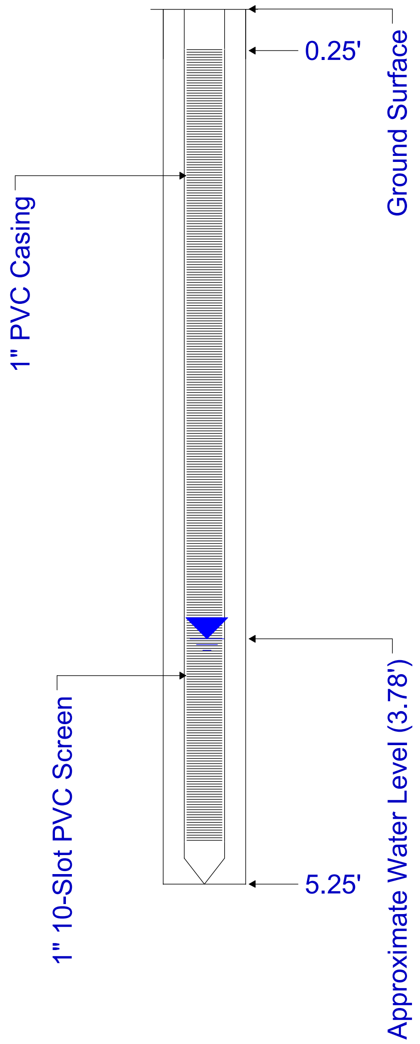
Project No.: 01-8456-0-002
Well No.: SB/TMW-6
Project Name: Commercial Property
Date Drilled: 5/17/2017
Facility ID#:
Drill Rig: HA
Logged By: JO/JP
Sampling Method: Grab

SUBSURFACE PROFILE

SAMPLE

Depth (ft.)	Boring Profile	Description and Comments	Sample # Depth	Blow Counts	PID (ppm)
		Ground Surface			
0	■	**CONCRETE/ASPHALT**			
	▨	**CL- (Medium Soft) SANDY CLAY (moist)** Gray, with gravel	SS-1 0.5 - 1.5'	- -	3.1 1.7
2	▨	**CL- (Medium Soft) SANDY CLAY (moist)** Brown, trace gravel		-	1.9
4	▨	**SC- (Medium Loose) CLAYEY SAND (saturated)** Brown, fine, medium dense, trace gravel		- -	2.1 1.3
	▨	**CL- (Medium Soft) CLAY (moist)** Brown, trace gravel		-	-
6		**REFUSAL @ 6' BGS**			

Groundwater
Well Completion Details



Completion Notes: EOB @ 6' bgs. Hole filled with soil cuttings and bentonite.

1. The indicated stratification lines are approximate in situ.
   The transitions between materials may be gradual.
2. Boring backfilled with natural soils unless otherwise noted.

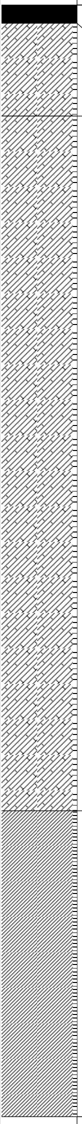
Sheet: 1 of 1

PM ENVIRONMENTAL

Boring Log .

Project No.: 01-8456-0-002
Boring No.: SB-7
Project Name: Commercial Property
Date Drilled: 5/17/2017
Facility ID#:
Drill Rig: 6712 DT
Logged By: JO/JP
Sampling Method: 2.125 MC Tube

SUBSURFACE PROFILE



Depth (ft.)	Description and Comments
	Ground Surface
0	**CONCRETE/ASPHALT**
	CL- (Soft) SANDY CLAY (moist) Gray, trace gravel
2	**CL- (Stiff) SANDY CLAY (moist)** Brown, trace gravel
4	
6	
8	
10	
12	
14	
	CL- (Medium Stiff) CLAY (moist) Gray, trace gravel
16	
18	
20	

SAMPLE

Sample # Depth	Blow Counts	PID (ppm)
	-	0.0
SS-1 1.5 - 2.5'	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0

No Well Installed

Completion Notes: EOB @ 20' bgs. Hole filled with soil cuttings and bentonite.

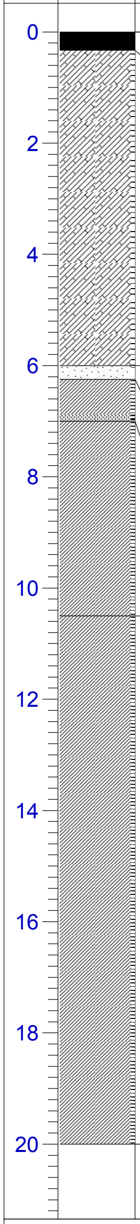
1. The indicated stratification lines are approximate in situ.
   The transitions between materials may be gradual.
2. Boring backfilled with natural soils unless otherwise noted.

Well Log .

Project No.: 01-8456-0-002
Well No.: SB/TMW-8
Project Name: Commercial Property
Date Drilled: 5/17/2017
Facility ID#:
Drill Rig: 6712 DT
Logged By: JO/JP
Sampling Method: 2.125 MC Tube

SUBSURFACE PROFILE

Depth (ft.) | Boring Profile | Description and Comments



Ground Surface

CONCRETE/ASPHALT

CL- (Stiff) SANDY CLAY (moist)
Gray/Brown, trace gravel

SP- (Loose) SAND (saturated)
Brown, fine

CL- (Medium Stiff) CLAY (moist)
Gray, trace gravel

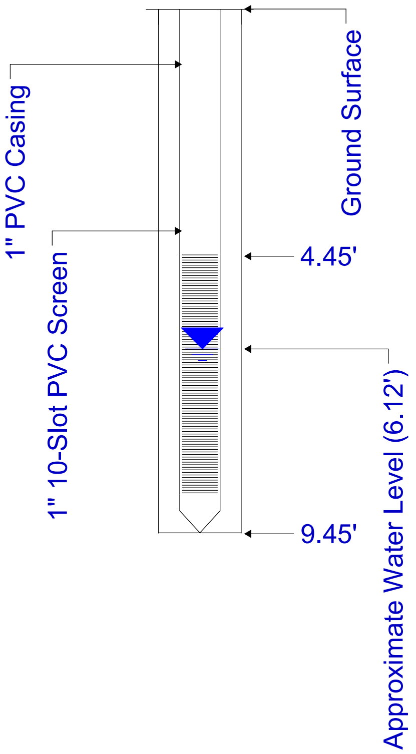
CL- (Medium Stiff) CLAY (moist)
Brown, trace gravel

CL- (Stiff) CLAY (moist)
Gray, trace gravel

SAMPLE

Sample # Depth	Blow Counts	PID (ppm)
	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0
SS-1 5.0 - 6.0'	-	0.0
	-	42.0
	-	38.7
	-	35.2
	-	10.1
	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0
	-	0.0

Groundwater
Well Completion Details



Completion Notes: EOB @ 20' bgs. Hole filled with soil cuttings and bentonite.

1. The indicated stratification lines are approximate in situ.
   The transitions between materials may be gradual.
2. Boring backfilled with natural soils unless otherwise noted.

Sheet: 1 of 1

Boring Log .

Project No.: 01-8456-0-002

Boring No.: SB-9

Project Name: Commercial Property

Date Drilled: 5/17/2017

Facility ID#:

Drill Rig: 6712 DT

Logged By: JO/JP

Sampling Method: 2.125 MC Tube

SUBSURFACE PROFILE			SAMPLE			
Depth (ft.)	Boring Profile	Description and Comments	Sample # Depth	Blow Counts	PID (ppm)	No Well Installed
		Ground Surface				
0	■ ░	**CONCRETE/ASPHALT** **SP- (Loose) SAND (moist)** Brown, fine		-	38.2	
	░			-	65.8	
2	▨	**CL- (Stiff) SANDY CLAY (moist)** Gray/Brown, trace gravel	SS-1 2.0 - 3.0'	-	105	
	▨			-	24.7	
4	▨			-	0.7	
	▨			-	0.0	
6	▨		SS-2 6.0 - 7.0'	-	0.0	
	▧	**CL- (Stiff) CLAY (moist)** Gray, trace gravel		-	0.0	
8	▧			-	0.0	
	▧			-	0.0	
10	▧			-	0.0	
	▧			-	0.0	
12	▧			-	0.0	
	▧			-	0.0	
14	▧			-	0.0	
	▧			-	0.0	
16	▧			-	0.0	
	▧			-	0.0	
18	▧			-	0.0	
	▧			-	0.0	
20						

Completion Notes: EOB @ 20' bgs. Hole filled with soil cuttings and bentonite.

1. The indicated stratification lines are approximate in situ.
   The transitions between materials may be gradual.
2. Boring backfilled with natural soils unless otherwise noted.

Sheet: 1 of 1

Appendix C

PM ENVIRONMENTAL

Environmental
& Engineering
Services

Brighton
Analytical
L.L.C.™
2105 Pless Drive · Brighton, Michigan 48114 · Phone (810) 229-7575 · Fax (810) 229-8650 · E-mail bai-brighton@sbcglobal.net

May 23, 2017

PM Environmental, Inc.
4080 W. 11 Mile Rd.
Berkley, MI 48072

Subject: Commercial Property
01-8456-0-0002

Dear Mr. Snow :

Thank you for making Brighton Analytical, L.L.C. your laboratory of choice. Attached are the results for the samples submitted on 05/18/2017 for the above mentioned project. NELAP/TNI Accredited Analysis and MDEQ Drinking Water Certified Analysis will be identified in their respective reporting formats. Hard copies can be supplied at your request for a fee of $20.00 per copy.

The invoice for this project will be emailed separately. If you have any questions concerning the data or invoice, please don't hesitate to contact our office. We welcome your comments and suggestions to improve our quality systems. Please reference Brighton Analytical, L.L.C. Project ID 45358 when calling or emailing. We thank you for this opportunity to partner with you on this project and hope to work with you again in the future.

Sincerely,
Brighton Analytical, L.L.C.

Brighton Analytical, L.L.C.™
Email: bai-brighton@sbcglobal.net
2105 Pless Drive
Brighton, MI 48114
Phone: 810-229-7575
Fax: 810-229-8650

BA PROJECT #: 45358

PAGE 1 OF 2

PROJECT NAME: Commercial Property

PROJECT #: 01-8456-0-0002

PO #: (PLEASE NOTE IF DIFFERENT BILLING ADDRESS)

Sample collected by: Joseph Ciai Joseph Ciai

ABBREVIATIONS FOR MATRIX
S = Solid
L = Liquid
DW = Drinking H_2O
O = Oil
P = Wipe
A = Air (Tedlar Bag)
F = Filter
T = Tube
M = Misc.

COMPANY/MAILING ADDRESS:
PM Environmental
4080 W. 11mile Rd.
Berkley, MI. 48072
ATTN: Aaron Snow
PHONE: 248-336-9988
FAX OR EMAIL: Snow@pmenv.com

Samples received within hold time? yes ☒ no ☐
Temperature of samples °C: On ice/4.0
pHs verified in login? yes ☐ no ☐
Headspace/bubbles in VOA's? yes ☐ no ☐ n/a ☐
Sample containers and COC match? yes ☐ no ☐

REQUESTED TURNAROUND: (circle one)
Rush: 1 -3 business days (verify with lab & specify date needed)
1 Day = 2.5X Cost 2 Day = 2X Cost 3 Day = 1.5X Cost
[✓ **Standard:** 5 business days]

If RUSH, approved by: ______

Container Type & Quantity / **Analysis Requested/Method**

Brighton ID #	Sample Description	Sample Coll. Date	Sample Coll. Time	VOA'S (PRES) Y N N/A	HDPE UNPRESERVED	HDPE HNO3	HDPE H2SO4	HDPE NAOH	AMBER PRESERVED?	GLASS, NO PRESERVATIVE	STERILIZED BACTERIA	MEOH Preserved [✓ Y] N	Sample Matrix	VOCs, PNAs	Cd, Cr, Pb	PCBs					Hold
1) 6375	SB-1 0.5'-1.5'	5/17/17	11:40							1		1	S	X	X	X					
2) 76	SB-1 4.5'-5.5'	↓	11:45							1		1	S	↓	↓	↓					X
3) 77	SB-2 3.5'-4.5'	↓	13:50							1		1	S	↓	↓	↓					
4) 78	SB-3 4'-5'	↓	09:40							1		1	S	↓	↓	↓					
5) 79	SB-3 14'-15'	↓	09:45							1		1	S	↓	↓	↓					X
6) 80	SB-3 17'-18'	↓	09:55							1		1	S	↓	↓	↓					
7) 81	SB-4 4'-5'	↓	12:20							1		1	S	↓	↓	↓					
8) 82	SB-5 2'-3'	↓	13:30							1		1	S	↓	↓	↓					
9) 83	SB-6 0.5'-1.5'	↓	10:10							1		1	S	↓	↓	↓					
10) 84	SB-7 1.5'-2.5'	↓	14:20							1		1	S	↓	↓	↓					

BILLING ADDRESS (IF REQUIRED):

METHANOL
EPA 5035 15
PMC

Drinking H_2O:
Fax to LCHD? yes ☐ no ☐
Chlorinated Water Supply? yes ☐ no ☐
AMT.: ______

MCL Failure: yes ☐ no ☐
Client Notified (date/time/initials): ______

Special Instructions:

Please fill out the Chain of Custody completely and review. Incorrect or incomplete information will result in a "hold" an all analyses.

Trans. #	RELINQUISHED BY:	RECEIVED BY:	DATE:	TIME:	Trans. #	RELINQUISHED BY:	RECEIVED BY:	DATE:	TIME:
1	Joseph Ciai	PM Storage	5/17/17	16:30	3			5/18/17	12:10
2	Storage		5/18/17	11:20	4				

Brighton Analytical, L.L.C.™
Email: bai-brighton@sbcglobal.net
2105 Pless Drive
Brighton, MI 48114
Phone: 810-229-7575
Fax: 810-229-8650

BA PROJECT #: 45358

ABBREVIATIONS FOR MATRIX
S = Solid
L = Liquid
DW = Drinking H_2O
O = Oil
P = Wipe
A = Air (Tedlar Bag)
F = Filter
T = Tube
M = Misc.

PAGE 2 OF 2

COMPANY/MAILING ADDRESS:
PM Environmental
4080 W. 11mile Rd.
Berkley, MI. 48072
ATTN: Aaron Snow
PHONE: 248-336-9988
FAX OR EMAIL: Snow@pmenv.com

PROJECT NAME: Commercial Property

PROJECT #: 01-8456-0-0002

PO #: (PLEASE NOTE IF DIFFERENT BILLING ADDRESS)

Sample collected by: Joseph Cicci Joseph Cicci

REQUESTED TURNAROUND: (circle one)
Rush: 1-3 business days (verify with lab & specify date needed)
1 Day = 2.5X Cost 2 Day = 2X Cost 3 Day = 1.5X Cost
[✓ **Standard:** 5 business days]

If RUSH, approved by: ______

Brighton ID #	Sample Description	Sample Coll. Date	Sample Coll. Time	VOA'S (PRES) [✓ Y] N/A	HDPE UNPRESERVED	HDPE HNO_3	HDPE H_2SO_4	HDPE NAOH	AMBER PRESERVED?	GLASS, NO PRESERVATIVE	STERILIZED BACTERIA	MEOH Preserve [✓ Y] N	Sample Matrix	VOCs, PNAs	Cd, Cr, Pb	PCBs					Hold
1) 6385	SB-7 14'-15'	5/17/17	14:25							1		1	S	X	X	X					X
2) 86	SB-8 5-6'	|	15:00							1		1	S	|	|	|					
3) 87	SB-8 6'-7'	|	15:05							1		1	S	|	|	|					X
4) 88	SB-9 2-3'	|	15:55							1		1	S	|	|	|					
5) 89	SB-9 6'-7'	|	16:00							1		1	S	↓	↓	↓					
6) 90	TMW-4	|	14:00	3		1			1				L	X	X						
7) 91	TMW-6	|	10:30	3		1			1				L	|	|					
8) 92	TMW-8	↓	15:25	3		1			1				L	↓	↓						
9)																					
10)																					

Samples received within hold time? yes ☐ no ☐
Temperature of samples °C:
pHs verified in login? yes ☐ no ☐
Headspace/bubbles in VOA's? yes ☐ no ☐ n/a ☐
Sample containers and COC match? yes ☐ no ☐

BILLING ADDRESS (IF REQUIRED):

METHANOL
EPA 5035 15 PMC

Drinking H_2O:
Fax to LCHD? yes ☐ no ☐
Chlorinated Water Supply? yes ☐ no ☐
AMT.: ______

MCL Failure: yes ☐ no ☐
Client Notified (date/time/initials): ______

Special Instructions:

Please fill out the Chain of Custody completely and review. Incorrect or incomplete information will result in a "hold" on all analyses.

Trans. #	RELINQUISHED BY:	RECEIVED BY:	DATE:	TIME:	Trans. #	RELINQUISHED BY:	RECEIVED BY:	DATE:	TIME:
1	Joseph Cicci	PM Storage	5/17/17	16:30	3			5/18/17	12:20
2	Storage		5/18/17	11:20	4				

4.10 Preliminary Geotechnical Investigation

PRELIMINARY GEOTECHNICAL EVALUATION REPORT

PROPOSED MIXED USE BUILDING
SOUTH OLD WOODWARD AVENUE
BIRMINGHAM, MICHIGAN

SME Project 078171.00
February 15, 2018

SME

SME

The Kramer Building
43980 Plymouth Oaks Blvd.
Plymouth, MI 48170-2584

T (734) 454-9900

www.sme-usa.com

February 15, 2018

Mr. Christopher J. Longe, AIA
Christopher J. Longe, AIA, Architecture & Interiors
124 Peabody
Birmingham, Michigan 48009

Via electronic mail: cjlonge@cjlongeaia.com (pdf file)
mtestrake@cjlongeaia.com (pdf file)

RE: Preliminary Geotechnical Evaluation Report
Proposed Mixed Use Building
South Old Woodward Avenue
Birmingham, Michigan
SME Project 078171.00

Dear Mr. Longe:

We have completed our preliminary geotechnical evaluation for the referenced site. This report presents the results of our observations and analyses, our preliminary geotechnical recommendations for general site preparation and earthwork, reuse of onsite soils as engineered fill, foundation design, seismic design, below-grade walls, design/development comments, temporary earth retention and slope stability, and general construction considerations based on the information disclosed by the borings.

We appreciate the opportunity to be of service. If you have questions or require additional information, please contact me.

Very truly yours,

SME

Joel W. Rinkel Date: 2018.02.15
14:09:05 -05'00'

Joel W. Rinkel, PE
Senior Consultant

TABLE OF CONTENTS

SUMMARY

We summarized the report conclusions and recommendations as follows:

1. The subsurface conditions encountered at the borings consist of surficial asphalt underlain by existing clay fill, overlying natural clays to the explored depths. We encountered groundwater during drilling at boring B1 at 6 feet below the existing ground surface. The depth of existing fill varied between about 3.5 and 5 feet at the 2 borings performed for this evaluation.

2. After excavation to the planned basement level, we anticipate the subgrade for grade slabs will consist of natural clays. We consider these soils adequate for grade slab support, provided the subgrade is properly prepared during construction. The exposed subgrade will be sensitive to disturbance from exposure to wet periods and traffic and will need to be protected during earthwork operations. We recommend placing a 6 to 9 inch layer of MDOT 6A limestone followed by a 3 inch course of MDOT 21AA limestone to protect the subgrade during below-grade construction. This working platform can also be used as the leveling course for the basement slab-on-grade, provided that it is protected from disturbance.

3. We recommend supporting the new structure on a mat foundation or deep foundation system. Preliminarily, individual shallow spread type foundations are also considered feasible for column loads of roughly 900 kips or less.

4. For a mat foundation option, we consider a mat foundation with dimensions approximately equal to the building footprint to be feasible.

5. For a deep foundation option, we recommend augercast piles. We anticipate that the piles will need to extend several feet into the dense/very dense natural sands encountered at about 94 feet below the existing ground surface (at boring B2) to develop sufficient capacity. Preliminarily, for 75 foot piles extending to a depth of 100 feet below the existing ground surface, we estimate that allowable design capacities can be up to about 350 kips. Additional deep borings should be performed on site after the existing building has been demolished to establish the design capacities.

6. We expect that construction of the new building will require a temporary earth retention system (TERS) to maximize the building footprint. We recommend temporary (or permanent) earth retention systems consist of pre-drilled solider pile and lagging wall construction. SME would be pleased to assist the project team with the TERS design.

7. Groundwater from perched sources will likely be encountered in some below-grade excavations. In addition, we anticipate the contractor will encounter water from precipitation, surface runoff, or from other events/sources during construction. We anticipate the groundwater can be controlled using conventional sump pit and pump methods. In addition, it may also be necessary to place of a layer of crushed stone/aggregate (where required) in areas where water accumulates to protect the subgrade from disturbance.

The summary presented above includes selected elements of our findings and recommendations and provided solely for purposes of overview. It does not present crucial details needed for the proper application of our findings and recommendations. Do not consider it apart from the entire text of this report and appendices, with all of the qualifications and considerations mentioned therein which are best evaluated with the active participation of SME.

REPORT PREPARED BY:	**REPORT REVIEWED BY:**
Alex Kuisell, EIT Senior Staff Engineer	Joel W. Rinkel Senior Consultant

1. INTRODUCTION

This report presents the results of the preliminary geotechnical evaluation by SME for the subject project. We prepared this report per your authorization and based on our proposal P00065.18, dated January 11, 2018.

1.1 SITE CONDITIONS

The project site is located on the northwest side of Hazel Street between S Old Woodward Ave and Woodward Ave in Birmingham, Michigan. The site is currently occupied by a single-story building divided into three parcels. The building is surrounded by concrete sidewalks with a small asphalt paved entrance drive on the east side of the building. An alleyway is located on the north side of the building, which separates the building from the neighboring Birmingham Place, a high-rise structure. Based on aerial imagery available through Google Earth Pro, existing site grades are relatively flat around the site, varying from about 762 to 765 feet.

1.2 PROJECT DESCRIPTION

We understand the project consists of the demolition of the existing building onsite, and the design and construction of a nine-story mixed use building with two levels of below grade parking. The building will be constructed for both residential and commercial use. Due to the depth of the below-grade parking, an earth retention system will be required to facilitate the proposed construction and protect the neighboring structures/roadways.

As the project is currently in the preliminary phase, structural loads for the proposed building are not available. However, based on our experience with similar structures/projects, we anticipate that column loads will be up to 1,600 kips, with maximum wall loads of about 25 kips per lineal foot. You requested that SME explore the subsurface conditions on the site to provide preliminary geotechnical recommendations for the planned development. Our recommendations presented in this report are intended to provide preliminary geotechnical information for project planning, and follow-up subsurface evaluations will be required once specific project site plans (e.g., building layout and size, proposed site grades, structural loads, etc.) are available.

2. EVALUATION PROCEDURES

2.1 FIELD EXPLORATION

SME determined the number, locations, and depths of the borings based on the proposed construction and existing site constraints. SME staked the boring locations prior to the field exploration using existing site features for reference. SME explored subsurface site conditions with two (2) borings (B1 and B2) extending to depths of 40 and 120 feet below the existing ground surface, respectively, for a total of 160 lineal feet of drilling. The boring logs and Boring Location Plan are included in Appendix A.

SME drilled and sampled the borings in accordance with ASTM Standards. The borings were performed using a truck-mounted drill rig and were advanced using continuous-flight, solid-stem augers or hollow-stem augers with rotary wash methods. SME measured and recorded groundwater depth (or lack thereof) during and immediately after completion of each boring. After completing the borings, we took the recovered soil samples to the SME laboratory for further observation and testing.

2.2 LABORATORY TESTING

The laboratory testing program consisted of visual soil classification on recovered samples along with moisture content and hand penetrometer shear tests on portions of cohesive samples obtained. We also performed four Unconfined Compressive Strength tests on recovered clay samples. The Laboratory Testing Procedures in Appendix B provide descriptions of the laboratory tests given above.

Upon completion of the laboratory testing, we prepared boring logs including materials encountered, penetration resistances, pertinent field observations made during the drilling operations, and the results of certain laboratory tests. We developed the soil descriptions included on the boring logs from both visual classification and the results of certain laboratory tests.

Soil samples retained over a long time, even sealed in jars, are subject to moisture loss and are no longer representative of the conditions initially encountered in the field. Therefore, we retain soil samples in our laboratory for 60 days unless instructed otherwise.

3. SUBSURFACE CONDITIONS

3.1 SOIL CONDITIONS

The soil conditions encountered at the borings generally consist of surficial asphalt pavement underlain by existing clay fill, overlying natural clays to the explored depths of the borings. The following is a summary of the materials encountered at the boring locations, beginning at the existing ground surface and proceeding downward.

Stratum 1: Surficial Materials. We encountered about 2 to 3 inches of asphalt pavement beginning at the existing ground surface. At boring B1, we encountered about 16 inches of aggregate base below the asphalt pavement.

Stratum 2: Existing Fill Soils. We encountered existing clay fill below the surficial materials at each boring, extending about 3.5 to 5 feet below the existing ground surface. We encountered some construction debris (concrete/slag pieces) within the existing fill at boring B2. Measured shear strengths of the existing clay were about 1.25 kips per square-foot (ksf), with corresponding moisture contents of about 15 percent. The clay fill was in a stiff condition.

Stratum 3: Natural Clays. We encountered natural clays with varying sand, silt and gravel content below the surficial materials and fill at the borings, extending to the explored depths. At the deeper boring (B2), we encountered a stratum of natural sand within the natural clays, from about 94 to 103 feet below the existing ground surface. Standard Penetration Test (SPT), or N-values, of the sands ranged from about 43 to 56 blows per foot (bpf) indicating a dense to very dense condition. We also encountered sand seams/layers within the natural clays at other locations in the soil profile. Refer to the boring logs for more information.

Regarding the natural clays, measured shear strengths of the natural clays ranged from 1.25 to greater than 4.5 ksf, with corresponding moisture contents of 10 to 27 percent. The natural clays encountered were in a stiff to hard condition. At boring B2, we encountered a stratum of natural silt within the clays (in a very stiff to hard condition), from about 18.5 to 27.5 feet below the existing ground surface.

We recovered four Shelby tube samples in the natural clays at boring B2 and performed an unconfined compressive strength test (and unit weight measurement) in the laboratory. Refer to the table below.

LABORATORY TEST RESULTS

SAMPLE INTERVAL (feet)	Q_p (psf)	S_u (psf)	DRY UNIT WEIGHT (pcf)	MOISTURE CONTENT (%)	TOTAL UNIT WEIGHT (pcf)
28 - 30	5,210	2,605	124.2	14.7	142.5
48 – 50	3,610	1,805	123.4	15.6	142.7
68 – 70	5,150	2,575	129.0	14.0	147.1
88 – 90	6,680	3,340	127.1	12.3	142.7

The soil profile described above and included on the appended boring logs are generalized descriptions of the conditions encountered. The stratification depths described above and shown on the boring logs indicate a zone of transition from one soil type to another and do not show exact depths of change from one soil type to another. We based the soil descriptions on visual classification of the soils encountered. Soil conditions may vary between or away from the boring locations. Please refer to the boring logs for the soil conditions at the specific boring locations.

Thickness measurements of surficial materials reported on the boring logs (e.g., the asphalt pavement/aggregate base) need to be considered approximate since mixing of these materials can occur in small diameter boreholes. Therefore, if accurate thickness measurements are required for inclusion in bid documents or purposes of design, perform additional evaluations such as shallow test pits or pavement cores.

It is sometimes difficult to distinguish between fill and natural soils based on samples and cuttings from small-diameter boreholes, especially when portions of the fill do not contain man-made materials, debris, topsoil or organic layers, and when the fill appears similar in composition to the local natural soils. Therefore, the delineation of fill described above and on the appended boring logs are to be considered approximate only. Make a more comprehensive evaluation of the extent and composition of the suspect fill by reviewing former site topography plans such as grading plans from the original construction, aerial photographs, and other historic site records and by observing test pit excavations.

3.2 GROUNDWATER CONDITIONS

During drilling at boring B1, we encountered groundwater at 6 feet below the existing ground surface. After pulling the augers from the borehole at the end of the boring, measurable groundwater was not present. Accurate groundwater measurements could not be obtained at boring B2 as the boring was advanced using wash rotary methods (i.e. by injecting a water-bentonite slurry into the borehole) beginning at a depth of 15 feet. The groundwater encountered at boring B1 appeared to be perched, or trapped, within a predominantly clayey profile.

We expect hydrostatic groundwater levels and the potential rate of infiltration into excavations to fluctuate throughout the year, based on variations in precipitation, evaporation, run-off, and other factors. The groundwater levels indicated by the borings represent conditions at the time we took the readings. The actual groundwater levels at the time of construction may vary. If more information regarding groundwater levels at this site is required, then we recommend additional subsurface assessment(s).

4. PRELIMINARY ANALYSIS AND RECOMMENDATIONS

4.1 SITE PREPARATION

4.1.1 EXISTING FILL CONSIDERATIONS

We encountered existing clay fill extending about 3.5 to 5 feet below the existing ground surface at the borings performed for this evaluation. Due to the proposed excavation depth for the mixed use building, we expect the existing fill will be completely removed from within the new building footprint.

For new exterior slabs/pavements, we anticipate that some existing fill may remain below those improvements, assuming that existing site grades remain relatively unchanged. As with any construction on existing fill, there is a risk for poor structural performance (e.g. settlement, cracking) of slabs/pavements/utilities, etc. supported on the existing fill. Based on the borings and assuming proper subgrade preparation during construction, we anticipate the risk for poor performance of new grade slabs/pavements would be relatively low. Proper subgrade preparation includes removing unsuitable fill, organic-laden fill, buried organic soils, and other unsuitable materials, uniformly compacting existing suitable fill with appropriate compaction equipment, performing proofroll tests, undercutting overly soft/loose subgrade, and replacing undercuts with suitable engineered fill. If even a low risk for significant subgrade movement is not acceptable, then the existing fill would need to be completely removed and replaced with an engineered fill. Refer to Section 4.1.2 in this report for subgrade preparation recommendations.

Based on our observations and test results, we anticipate most of the existing fill is suitable for reuse as engineered fill onsite, provided the fill is properly placed and compacted in controlled lifts and the recommendations for subgrade preparation expressed in Section 4 of this report are followed. However, we encountered some construction debris in the fill at boring B2 (concrete/slag pieces). If/where significant amounts of construction debris are encountered, it would need to be segregated from the fill below it could be reused as engineered fill. Refer to Section 4.1.4 for engineered fill requirements.

4.1.2 GENERAL SITE SUBGRADE PREPARATION

Overall, we anticipate the exposed subgrade will be adequate for support of the new improvements, provided the subgrade is properly prepared and protected from disturbance during construction.

We expect the exposed subgrade will be sensitive to disturbance during construction, especially where groundwater is near the surface, so it will be important to protect these soils. Construction traffic over the exposed subgrade could cause the subgrade to rut or pump, and the subgrade would be especially sensitive to disturbance during/after wet periods. Disturbed subgrade loses strength as a result, and the presence of groundwater in the disturbed subgrade makes it difficult to improve the strength of (e.g. dry out) the subgrade. This is of particular concern in the proposed basement excavation, where water from surface runoff and/or precipitation can easily accumulate.

We recommend limiting construction traffic over the subgrade, and protecting the subgrade with a layer of crushed stone. In addition, a layer of geotextile separator fabric is recommended between the clay subgrade and crushed stone layer. The crushed stone layer can also be used to control groundwater accumulations. We recommend a 6 to 9 inch layer of MDOT 6A crushed limestone below a 3-inch layer of MDOT 21AA crushed limestone. It may be beneficial to slope the clay subgrade towards water control areas (i.e. sump pits, perimeter drains, etc.) to limit water accumulations on the clay subgrade. Also, the crushed stone layer can be used as the leveling course for the basement level slab-on-grade (provided the crushed stone layer is protected from disturbance during construction).

We recommend scheduling earthwork activities during summer months when warmer and drier conditions are expected to reduce the amount of subgrade improvement required. Regardless, subgrade disturbance during construction is likely as the basement excavation will likely be open for multiple weeks or even months, and therefore additional subgrade improvements (e.g. in-place moisture conditioning, undercuts) would be required to achieve a stable subgrade for engineered fill placement. We recommend including a contingency in the construction budget for additional subgrade improvements.

In the proposed building pad area, remove existing below-grade structures, including but not limited to foundations, floor slabs, and underground utilities in their entirety to expose suitable soils. Prior to placement of crushed stone, we recommend performing a proofroll test over the subgrade. Typically, the proofroll test involves a large piece of construction equipment. Where areas are accessible for proofrolling, we recommend using a fully loaded tandem axle truck (50,000 lbs. minimum) to perform the proofroll test. For areas that are inaccessible with large construction equipment, we recommend an SME representative perform handheld tests to evaluate subgrade stability. We recommend an SME representative be on-site to observe and test the exposed subgrade. Based on the results of the field tests and observations (and lab tests, as applicable), the SME representative can provide recommendations in the field as to the suitability of the subgrade for structural support. Areas of unsuitably loose/wet subgrade will need to be either improved in-place (e.g., dried and recompacted) or be removed (undercut) and replaced with engineered fill.

4.1.3 SUBGRADE PREPARATION FOR FLOOR SLABS

Based on the planned excavation depth for the new structure, the subgrade for the basement level slab-on-grade is anticipate to consist of natural clays. We consider the natural clays to be suitable for support of new slabs, provided that the subgrade is properly prepared according to the recommendations presented in this report. For properly prepared clay subgrade, we recommend a subgrade modulus of reaction of 150 pci for slab design (based on a 30-inch diameter plate load test). Prior to concrete placement for floor slabs, we recommend observation and testing of the final subgrade for suitability of floor slab support, i.e. by performing a proofroll test over the subgrade (see recommendations in Section 4.1.2).

The crushed stone placed as a leveling course for the slab must be compacted per the "Engineered Fill Requirements" section of this report (Section 4.1.4). As stated in Section 4.1.2, consideration can be given to supporting the slab on the crushed stone layer placed for subgrade protection during site earthwork operations, provided that the crushed stone is protected from disturbance. Otherwise, we recommend placing the concrete soon after placement of the leveling course and protecting the underlying subgrade from disturbance.

Provide a vapor retarder below the floor slab if the slab is to receive an impermeable floor finish/seal or a floor covering which would act as a vapor retarder. Even if these floor coverings are not planned, the vapor retarder can reduce the transmission of moisture vapor from the ground into the structure due to thermal and humidity variations, and other conditions. This is especially important given that the subgrade for the slab-on-grade is anticipated to consist of relatively impermeable natural clays. However, the placement of a vapor retarder affects construction of the floor slab, concrete curing, and the rate of moisture loss as the concrete dries. The flatwork contractor must use the appropriate equipment, materials, and methods to prevent undesirable slab curling/warping.

We recommend floor slabs be separated by isolation joints from structural walls and columns bearing on their own foundations to permit relative movement. Provide a minimum of 6 inches of engineered fill between the bottom of the slab and the top of the spread foundations/pile caps below. Otherwise, we recommend the structural engineer account for potential relative settlements, such as grade beams, thickened slabs with appropriate reinforcing steel or other appropriate details.

Protect the slab-on-grade subgrade soils from frost action during winter construction. Any frozen soils have to be thawed and compacted, or removed and replaced prior to slab-on-grade construction.

4.1.4 ENGINEERED FILL REQUIREMENTS

Any fill placed within the construction area, including utility trench backfill, must be an approved material, free of frozen soil, organics, or other unsuitable materials. If the proposed fill contains more than 4 percent organics, do not use such materials for engineered fill. We recommend the fill be spread in level layers not exceeding 9 inches in loose thickness and be compacted to a minimum 95 percent of the maximum dry density as determined in accordance with the Modified Proctor Test. Thicker lifts of backfill may be acceptable, provided the compaction equipment can achieve the minimum compaction criterion throughout the entire thickness of the lift within the area of placement and with the type of backfill used. SME can provide recommendations in the field for adjusting lift thicknesses based on the specific type of compaction equipment/methods used during construction and verification the entire lift of fill is compacted to the project requirements.

Special handling and/or disposal of the onsite soils (and groundwater) may be required. Refer to the project environmental report(s), and due care plan, for this project when considering the handling and/or disposal of the site soils (and groundwater).

Due to site constraints associated with performing earthwork in a basement area, we expect that any engineered fill placed within the building footprint will consist of imported granular fill. Granular fill such as MDOT Class II sand, MDOT 21AA crushed aggregate, or MDOT 6A crushed stone (with a separator fabric) are considered suitable for use as a general engineered fill.

We believe that the natural soils, along with most of the existing fill, encountered at the site are suitable for reuse as engineered fill in other areas of the site (if required), provided they meet the requirements listed in the previous paragraph. However, we expect that some moisture conditioning of the existing clay fill and natural clays would be required before they could be reused as engineered fill. We do not recommend reusing topsoil and other soils containing (one or more of the following) more than 4 percent organics, significant (greater than 5 percent) debris/rubble, or any undesirable materials (e.g. trash, expansive aggregates, etc.) as engineered fill. We encountered some construction debris (concrete/slag pieces) within the existing fill at boring B2. Therefore, it will be important to further evaluate the existing fill soils in the field during construction, to verify that the fill being reused as engineered fill does not contain significant debris/rubble.

For backfill in confined areas, and where drainage is required, we recommend using imported granular backfill such as MDOT Class II granular material, MDOT 21AA crushed limestone, and/or MDOT 6A crushed limestone. The specific type of imported fill will depend on a variety of factors. For most instances, we anticipate MDOT Class II granular material will be adequate. Crushed aggregate/stone would be necessary where the existing subgrade is in a wet condition and/or where site drainage is critical. In addition to the use of crushed stone, it would likely be necessary to cap the stone with MDOT 21AA crushed limestone, or wrap the crushed stone with a heavy-duty non-woven geotextile fabric, to prevent the surrounding soils from infiltrating into the crushed stone.

For trenches and other excavations, we recommend the upper 18 inches of backfill consist of soils that are similar with the surrounding subgrade. The purpose for this is to limit mixing of different soil types near final subgrade levels.

4.2 FOUNDATIONS

Due to the relatively heavy structural loads anticipated for the new building, we recommend supporting the structure on a mat foundation or deep foundation system. Consideration could also be given to utilizing strip foundations (as a shallow foundation option) to support the column loads. Individual shallow spread-type foundations are considered feasible for column loads of roughly 900 kips or less.

The following sections provide foundation construction recommendations for this project.

4.2.1 MAT FOUNDATIONS

We consider a reinforced concrete mat foundation to be feasible for supporting the new building. As an alternate, strip foundations (along the column lines) could be viable in combination with spread-type foundations for the lighter column/wall loads. The mat, or strip, foundation would need to be adequately rigid to distribute the column loads and reduce the deflections of the mat/strip foundation. Refer to the shallow foundation section for additional recommendations regarding the strip foundation option.

Once the contractor completes the excavation operations, the subgrade preparation and construction of the mat foundations can commence. Once the subgrade at the bottom of foundation elevation is exposed, an SME field representative will need to test the bearing soils and verify the subgrade is suitable for the support of the mat.

The mat foundations should bear on a minimum of 9 inches of aggregate (e.g., 6 inches of MDOT 6A crushed stone below 3 inches of MDOT 21AA crushed aggregate), supported by suitable natural clays. The purpose of the crushed aggregate layer is to provide a proper working platform for foundation construction and also to limit disturbance to the underlying subgrade soils. We recommend a maximum allowable bearing pressure of 3,000 psf for the mat foundation to limit the total settlement, which is further described in this section.

The design of semi-rigid mats uses soil-subgrade theory to model the soil structure interaction and determine the deflections and bending moments in the mat. For soil-structure analysis using spring-constants, we recommend using a modulus of subgrade reaction of 100 kcf.

We estimate total settlement for the mat foundation using the recommended maximum net allowable bearing pressure or modulus of subgrade reaction, minimum mat foundation dimensions, and bearing on suitable soils as described above to be about 1 inch. Differential settlements primarily depend on the stiffness of the mat and the distribution of the loads on the mat. Typically, mat foundations can limit differential settlements to less than ¼ of total settlement, or less than 1/4 inch using the above total settlement estimate. For critical foundations, this estimate should be confirmed with aforementioned soil-structure analysis, typically using a finite element based computer program.

The settlement estimates provided are based on the available boring information, the anticipated estimated maximum gravity load of 1,600 kips, our experience with similar structures and soil conditions, and field verification of suitable bearing soils by SME

4.2.2 AUGER CAST-IN-PLACE PILES

Depending on the final building loads, deep foundations may also be considered for this site. We also anticipate that a driven type of deep foundation system (such as driven H-piles) would not be desirable due to potential noise and/or vibration concerns for the neighboring structures at the site. Therefore, we consider auger cast-in-place (ACIP) piles to be a deep foundation option for this project.

In general, we expect the ACIP piles would consist of a sand-cement grout mix (possibly with admixtures) pumped under pressure through the auger stem as the auger is slowly withdrawn from the hole. Add reinforcing steel to the column of grout once the augers are extracted to provide suitable reinforcement to resist uplift and/or lateral loads.

Preliminarily, we anticipate that the ACIP piles would need to extend into the dense very dense natural sands (encountered beginning at about 94 feet below the existing ground surface at boring B2) to develop sufficient capacity. Preliminarily, we recommend a pile tip elevation that is at least 100 feet below the existing ground surface. It would be beneficial to perform additional deep borings on the site once the existing building has been demolished to further explore the subsurface conditions and develop a design tip elevation for the piles. Based on findings at boring B2, and assuming the top of pile elevation is no lower than 25 feet below the existing ground surface, we present the following estimates for allowable ACIP pile capacities.

PRELIMINARY ACIP PILE CAPACITIES

PILE DIAMETER (inches)	PILE LENGTH* (feet)	ALLOWABLE DOWNWARD PILE CAPACITY (kips)	ALLOWABLE UPWARD PILE CAPACITY (kips)
18	75	250	150
24	75	350	250

*Assumes pile top begins at 25 feet below the existing ground surface.

We base the design pile capacities above on a factor of safety of 2.0 (assuming performing a pile load test to confirm these capacities). We would be pleased to review and comment on different pile capacities that the structural engineer may consider efficient for this specific project. We recommend the pile load test(s) be performed prior to installing production piles, and additional pile load tests if additional pile depth/diameter combinations are used. SME can assist the design team with developing the pile load test program, which could also include lateral or tensile tests (if applicable to the pile design). We recommend performing the load test(s) based on ASTM D-1143, and the total load applied during the load test(s) based on at least twice the allowable working capacity.

Steel reinforcement will depend on the final pile design, and will be needed to provide resistance to lateral and tensile loads in the pile, and (to a lesser degree) for axial loads. For tensile loads only, a single, large-diameter steel bar is often used for reinforcement extending through either part of, or the entire, pile length. For compression loads a set of smaller-diameter steel bars are recommended for either part of, or the entire, pile length. Reinforcing steel cages can also be installed in the upper portion of the piles to resist bending moments.

The auger cast pile equipment will need to be capable of readily advancing into the very dense/hard subgrade, and possibly past some cobbles, without overdrilling. Overdrilling can lead to reduced pile capacity and possible ground loss around the piles. Piles encountering ‘auger refusal’ above the design terminal depth (e.g. due to very dense sand/hard clay layers or cobbles/boulders) will need to be further evaluated on a case-by-case basis to assess the design pile capacity, and if a reduced pile capacity is required. We recommend auger refusal be defined as a rate of less than 1 foot of penetration per minute under full operating torque of at least 75,000 foot-pounds.

We estimate total settlement of less than 3/4-inch for ACIP piles bearing on the dense/very dense sands can be achieved on this site, under the design working capacity in compression and the recommended pile length (to be finalized after performing additional deep borings), and constructed according to the recommendations of this report. About half of the estimated settlement would be due to elastic compression of the pile.

We recommend the contractor consider the following comments to reduce the risk of oversized holes due to mining, decompression, or loss of soil. To achieve the design tip elevation without excessive auger rotation, we recommend the contractor use a drill rig with a minimum torque of 75,000 ft.-lbs. and the ability to use full torque at a slow rotational speed. Also, exercise care to not excessively rotate the augers when penetrating the sands, or in an attempt to get through obstructions. Excessive rotation of the augers can result in a condition where the adjacent soils pull into the augered hole. Care must also be taken when pumping grout into the pile (during extraction of the augers) so that a sufficient volume of grout is pumped (to prevent ‘necking’ of the pile), but not at too high of a pressure near existing structures (including utilities) to prevent damaging (or pumping grout into) those structures. In addition, where overly loose/soft subgrade exists near/below existing structures, special shoring, bracing, underpinning of the existing structures may be necessary to protect those structures from undesirable movement due to the aggravation of subgrade during pile installation. Maintain a minimum distance of 3 feet from the edges of existing structures/utilities to limit such disruptions.

Another consideration for the successful installation of ACIP piles is to coordinate the rate of auger withdrawal with the pumping rate of grout while providing an adequate grout head (pressure) to support the hole, resist hydrostatic pressures, and ensure completely filling all voids with grout. Based on our experience, expect additional grout volumes within the granular soils (especially where cobble/boulders are encountered), and to densify overly loose soils (e.g. loose fill). However, care must be taken during pumping grout near existing structures so that excess grout (and grout pressure) does not adversely affect surrounding/nearby structures. Also, during ACIP pile installation, the contractor needs to carefully sequence operations to avoid damage to previously installed piles during installation of adjacent piles. The 2012 MBC indicates piles shall not be installed within six pile diameters, measured center to center, to an adjacent pile with grout less than 12 hours old. We suggest this spacing be used as a guide, and if interconnection between recently grouted piles is observed during construction, it may be necessary to increase this spacing or to provide a longer delay between pile installations.

If encountering auger refusal above the design tip bearing elevation, and the obstruction cannot be removed, or if the pile is knocked out of vertical alignment, it will be necessary to grout the pile from the point of refusal. The obstructed pile may either be rejected, or evaluated and assigned a reduced capacity, depending on circumstances and installation records. SME will need to evaluate these situations on a case-by-case basis during construction. Also, the project structural engineer will need to be contacted to evaluate the design loads at such locations, and to recommend locations of additional piles (if needed) and any design modifications to the associated pile caps. We recommend prospective contractors include in their bids unit rates for obstruction removal, down-time, additional grout volumes, and installation of additional pile footage due to obstructions. We also recommend allocating a project budget contingency for obstructions during pile installation. SME can assist you in preparing the budget contingency.

The contractor will need to have grout on-site prior to beginning of auger withdrawal. Grout piles that are abandoned due to obstructions. We recommend the contractor maintain a minimum grout volume ratio of 1.2, which is the ratio of the actual grout volume to the theoretical pile volume, but higher grout volume ratios in the range of about 1.3 to 1.4 may occur in some cases. During auger withdrawal, we recommend maintaining a minimum pressure head equivalent to 10 feet of grout above the auger tip, but that pressure can be reduced to a pressure head equivalent to 5 feet of grout when pumping near existing, and sensitive, structures. We also recommend that the contractor use a pile installation recorder during the installation of load test and production piles.

4.2.3 DEEP FOUNDATION CONSIDERATIONS

To help control the minor amount of differential settlement between shallow foundations and neighboring deep foundations, we recommend a minimum 30-foot center-to-center distance between the two foundation types, assuming the shallow foundations bear on the natural clays. Additionally, provide sufficient control joints between the two foundation systems to manage differential movement.

The preliminary auger cast pile capacities do not include down-drag forces.

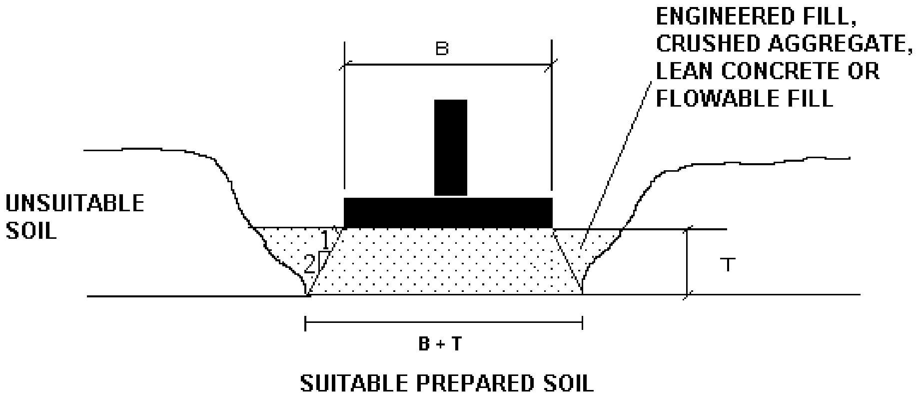
We recommend using a minimum design spacing of at least three pile/pier diameters between adjacent piles/piers (center-to-center) within a group. The use of closer pile/pier spacing would require additional evaluation of the group effect. The bottom of any exterior pile caps and grade beams must be situated a minimum of 42 inches below final site grades to mitigate the potential for frost action on the bottom of these elements.

The contractor may encounter obstructions and/or refusal to auger penetration above the target tip elevation during pile/pier installation due to naturally occurring very dense soil layers or cobbles and boulders. The type, size, and frequency of these obstructions will have varying effects on the installation. When possible, the contractor needs to penetrate the obstruction, maneuver around the obstruction (provided pile/pier plumbness/alignment requirements are not exceeded), or remove the obstruction by augering or excavation from the surface, and then backfill the resulting excavation and resume pile/pier installation. Excavations to remove obstructions must not undermine existing structures/improvements.

4.2.4 SHALLOW FOUNDATIONS

For areas with structural column loads of about 900 kips or less, or for strip-type foundations (e.g strip footings supporting the 1,600 kip column loads), shallow foundations may be considered for support in lieu of a deep foundation system. For such cases, we recommend a maximum net allowable bearing pressure of 4,000 pounds per square-foot (psf) for shallow spread or continuous foundations bearing directly on suitable natural clays. We do not recommend supporting the foundations on existing fill at this site. Once the subgrade at the bottom of foundation elevation is exposed, an SME field representative will need to test the bearing soils and verify the subgrade is suitable for the design soil bearing pressure.

Where undercutting is performed to improve foundation bearing areas, the zone of undercutting and backfill must extend laterally on a two vertical to one horizontal slope from the edge of the footing as illustrated on the Typical Foundation Undercutting Diagram below.



NOTES:

1. Foundations constructed on engineered fill placed in foundation undercuts will need to be formed with man-made forms.
2. Oversizing the excavation is not required along the edge of a perimeter foundation that is adjacent to a temporary earth retention wall.

Based on the depths of existing fill encountered at the site, we anticipate that some undercutting will be required to extend the foundations through the existing fill. Based on the borings, suitable natural soils are anticipated about 3.5 to 5 feet below the existing ground surface, i.e. just below the existing fill. However, the majority of the site is covered by the existing building and therefore, the depth and extent of existing fill (outside of the new building footprint) should be further explored once the building has been demolished. We recommend an SME field engineer be onsite during foundation construction to verify that the subgrade is suitable for the design soil bearing pressure.

For bearing capacity and settlement considerations, we recommend the dimensions for isolated spread foundations be at least 48 inches, and continuous strip foundations must be no less than 24 inches wide.

Foundations must be situated a minimum of 42 inches below final site grades along exterior walls or in any unheated areas for protection against frost action during normal winters. Interior foundations in heated areas of the building may be constructed at shallower levels if the foundations bear on suitable natural soils. However, the foundations and proposed bearing soils must be protected from freezing during construction if work occurs in the winter months. In addition, any caved soils must be removed from the foundation bearing surfaces before placing concrete.

We estimate total settlement for spread/continuous foundations using the recommended maximum net allowable bearing pressure and bearing on suitable soils as described above and as verified in the field at the time of construction by SME to be about 1 inch. Differential settlements are estimated to be about one-half the total settlement. The settlement estimates provided are based on the available boring information, our experience with similar structures and soil conditions, and field verification of suitable bearing soils by SME.

4.3 SEISMIC SITE CLASS

The site is located at approximately geographic location latitude N42.543934 degrees and longitude -W83.210573 degrees. From available topographical information available for purposes of identifying the depth to bedrock, the approximate ground surface at the site is about elevation 765 feet. Based on Plate 13 (Topography of the Bedrock Surface) in the Hydrogeologic Atlas of Michigan the top of rock elevation varies between about 550 and 600 feet in the vicinity of the site. Based on the above information, the glacial drift is roughly 165 to 215 feet thick.

Based on the shear strength and N-values for drift at the site (averaged over the upper 100 feet of the profile obtained at boring B2) seismic site Class D applies to this site in accordance with the 2015 Michigan Building Code (MBC).

Based on the location of the site at the indicated approximate latitude and longitude, the mapped short-period spectral response acceleration, S_S, and mapped spectral response acceleration at 1-second period, S_1, is 0.089g and 0.045g, respectively. Based on the mapped accelerations, the calculated short-period spectral response acceleration S_{DS}, and calculated spectral response acceleration at 1-second period, S_{D1}, is 0.095g (less than 0.167g) and 0.073g (greater than 0.067g), respectively. Based on the referenced design values, seismic Design Category B is applicable for this site.

4.4 BELOW-GRADE WALLS AND DRAINAGE

For the two levels of below-grade parking planned for this project, we anticipate that the basement walls could be up to 25 feet tall. We assume that the walls will be load-bearing and therefore need to be supported on a mat/deep foundation system as recommended in Section 4.2 of this report.

Below-grade walls need to be backfilled with MDOT Class II granular material. Establish positive surface drainage away from the building exterior below-grade (where practical). Below-grade wall backfill that will support floor slabs, pavements, sidewalks and other improvements will need to be compacted to a minimum of 95 percent of the maximum dry density determined by the Modified Proctor test. As a minimum, backfill not used for structural support of floor slabs, pavements or sidewalks must be compacted to the degree where it is stable under construction equipment. Exercise care during compaction of the wall backfill to avoid overstressing the walls and design the walls to accommodate the additional stresses associated with operating compaction equipment adjacent to the wall.

For a drained granular backfill and a level finish surface behind the wall, we recommend an active equivalent fluid pressure of 40 pounds per cubic foot (pcf) for design. This earth pressure is based on the wall being flexible enough to permit the active earth pressure condition to be reached. Typically, an outward movement away from the backfill equal to approximately 0.001 times the height of the wall is generally required to achieve the active earth pressure condition for granular backfill.

If the wall is restrained or is rigid enough so that it does not rotate sufficiently to reach the active earth condition, a higher lateral earth pressure (at-rest condition) should be used for design. For rigid walls backfilled with a free-draining granular material and a level finish surface behind the wall, we recommend an equivalent fluid pressure of 60 pcf for design. Also, any additional lateral pressures due to surcharge loading, such as adjacent floor or column loads, traffic loads, sloping ground, or parking loads, must be added to the above lateral earth pressures for design.

The earth pressures presented above are for a drained backfill. To reduce the potential for the build-up of hydrostatic pressure behind below-grade walls from wet weather events and temporary perched groundwater, we recommend permanent edge drains be installed along the exterior side of the perimeter of the below-grade walls. We recommend the perimeter edge drains consist of a minimum 6-inch-diameter perforated plastic drain pipe, surrounded by 6 inches of a filter material, such as pea gravel, which is completely wrapped with a filter fabric. Install the foundation drain at or just above the foundation bearing level (for the mat foundation option) or bottom of pile cap/grade beam (for the deep foundation option. This will maintain water infiltrations at a low elevation and reduce hydrostatic pressure on both the walls and the slab-on-grade. As indicated above, the walls must be backfilled with MDOT Class II granular material.

The drains should be discharged into a sump and pumping system, or to a gravity drainage outlet if feasible. We recommend the design include provisions for access to the drains for cleaning and maintenance. A continuous waterproofing membrane should be placed on the exterior of the below-grade walls. The membrane should be protected against damage from backfilling operations with a protective board placed against the completed system. As a layer of MDOT 21AA and MDOT 6A limestone is recommended for the floor slab leveling course (see Section 4.1.2), provided the crushed limestone remains relatively free of clay and other debris that may affect permeability, underslab drains are not required for the floor slabs. However, weep holes through the foundation walls below the basement slab should be provided to direct water to the perimeter drains. Provided our recommendations are properly implemented, cleanouts are installed, and drains and pumps are properly maintained, waterstops will not be required for most of the below grade areas. However, install water stops at all below-grade cold joints (and continuous waterproofing) in watertight structures or in structures extending below the basement floor level (such as elevator pits). Also, based on the estimated long-term groundwater level for the site, designing the basement slabs to resist hydrostatic uplift forces is not required.

The following parameters for evaluating the stability of the retaining walls assume the base of the wall bears directly on the very stiff natural clays and the wall is backfilled with a well-draining granular backfill. To evaluate the sliding of the wall, compute the sliding resistance at the base and the passive (resisting) and active (driving) earth forces. The sliding resistance may be determined by using a recommended ultimate sliding coefficient of 0.4 for the very stiff natural clays encountered at the site, limited to an ultimate unit value of 1,000 psf. Passive, active and at-rest earth pressure coefficients of 3.0, 0.33 and 0.50, respectively, may be used for design in combination with a unit weight of backfill of 120 pcf. This assumes a granular backfill will be in contact with the wall on the backside and on the front, at the toe of the wall. We recommend a safety factor between 1.5 and 2.0 for the lateral sliding resistance analysis, depending on the boundary conditions. Consider the movement required to achieve the full passive pressure when using passive pressure for resistance. In addition to checking sliding stability of the retaining walls, evaluate the safety factor from overturning, location of the resultant force at the base, mass stability, and contact pressure at the base. If desired, SME would be available to assist the project team in the design of the walls incorporating these considerations. However, such analyses go beyond the current scope of this evaluation.

4.5 STABILITY OF SLOPES

Although open-cut excavations will not be practical for the currently planned excavation limits and depth, we present the following recommendations for angles of repose of temporary slopes if open-cut excavations are to be performed on the site:

SOIL TYPE	ANGLE OF REPOSE [1,2]
Compacted Sand (no groundwater)	1.5H:1V (34°)
Stiff Clay - minimum of 2.5 tsf [3]	½H:1V (63°)
Stiff Clay with Sand Seams/Layers	1H:1V (45°)
Sand with Silt or Clay Seams/Partings	1.5H:1V (34°)

1. Conditions encountered during construction may require flatter slopes and/or a flat working space at the top of the slope, and each situation will need to be reviewed by the contractor on a case-by-case basis. Also, flatter slopes would be required in clay with sand seams or partings that could potentially develop slide planes. As with any temporary, slopes weather conditions and surface runoff can adversely affect the slope condition and we expect regular maintenance of temporary slopes will be required.

2. The allowable slopes in underlying layers limit the allowable slope angle of any individual layer (if the slopes are continued through said layers). For example, if an excavation was planned extending through stiff clay overlying sand with silt partings, the entire excavation would be limited to a slope of 34 degrees.
3. The cohesive soil strength values are unconfined compressive strength based on a hand penetrometer, and assume the subgrade consists of a homogeneous cohesive profile (e.g. no sand/silt partings, seams, layers, etc).

For permanent slopes, we recommend 1V:3H slopes. Steeper slopes (up to 1V:2H) may be possible, provided the backfill soils are inorganic lean clay or sand soils, properly compacted, do not entrap groundwater, and can be protected from surface erosion with an appropriate vegetative cover and/or erosion control mats. Shallower slopes may be required to address other constraints such to provide easier access across the slope, or due to the presence of trapped groundwater in the slope.

4.6 TEMPORARY EARTH RETENTION

For the current site planning (i.e. two levels of below-grade parking with the building footprint occupying the majority of the site) a temporary earth retention system (TERS) will be required to construct the below-grade structures for this project.

We recommend temporary (or permanent) earth retention systems consist of pre-drilled solider pile and lagging wall construction. The advantages of a pre-drilled solider pile and lagging wall include 1) limited vibrations as the piles are installed using pre-drilling techniques and 2) more installation options in areas of limited space. In general, the predominantly clayey site soils are conducive to soldier piles and timber lagging, and use of soldier piles and lagging will also allow for easier offset around existing and proposed utilities. Sheet piles can also be considered. However, unless the sheeting can be retrieved after the below-grade construction the sheeting will be more expensive than the soldier pile and lagging. Also, the vibrations induced from driving the sheet piles may cause ground movements (e.g., settlement) away from the piles, distress to nearby structures, and be a nuisance to nearby tenants/businesses.

Depending upon the final building footprint, there may be sufficient room around the perimeter of the building to allow for some pre-excavation. If pre-excavation cannot be performed, a braced ERS may be required (also depending on the final depth of the excavation).

The design of TERS depends upon a number of design-focused variables (e.g., minimum setback/space requirements, design load combinations, conflicts with existing or new construction, etc.) that need to be considered in selecting an appropriate system. The design must also consider construction sequencing to achieve a completed (built) product that is implemented in harmony with the overall progress of construction. In addition, the successful performance of these systems will be based on limiting the movements of the nearby structures. Strict settlement/movement criteria will need to be assigned for underpinning and TERS supporting structures (especially those sensitive to movements), whereas less-stringent criteria may be adequate for a TERS that is only supporting non-structural subgrade. The limits on settlement/movement, as well as the specific type of system and sequencing required, will need to be determined by the design engineer on a case-by-case basis. SME would be pleased to provide design services for the TERS if desired.

4.7 CONSTRUCTION CONSIDERATIONS

Based on the short-term groundwater levels observed during drilling and our experience with local groundwater conditions, we generally do not anticipate that groundwater will be a major factor during construction. However, the contractor will likely encounter some groundwater from perched sources and surface run-off/precipitation, and should be prepared to handle such cases.

Where into excavations occurs (from perched groundwater, surface run-off, precipitation, or other factors), we believe it can be controlled using standard sump pit and pumping procedures. In excavation areas where seepage accumulates, a working surface of either crushed aggregate or crushed concrete will likely be required to protect the exposed surface from disturbance.

The contractor will need to remove ponded or standing water from areas where water collects and prevent surface water runoff from reaching foundation excavations or the prepared subgrade for pavements/grade slabs. In addition, use designated haul roads for construction traffic and do not randomly traffic the site. Remove and replace disturbed subgrade soils with engineered fill. Under adverse weather conditions, protect areas of exposed subgrade at the site by placing crushed concrete or crushed aggregate on the exposed subgrade. In addition, place foundation concrete as soon as foundation excavations have been completed and approved to reduce the potential for disturbance of the foundation subgrade.

We recommend the bid documents require prospective contractors to include unit prices for removing unsuitable subgrade such as debris-laden fill, buried organics, overly fine-grained, disturbed soils, etc. and replacing it with suitable engineered fill. Also, we recommend establishing a contingency in the construction budget for this work. The actual quantity of unsuitable soils onsite will vary, and can be significantly impacted by the contractor's means-and-methods (e.g., equipment and/or effort), time of year, variable subsurface conditions, etc. Actual required undercut quantities must be determined during construction by additional subsurface evaluations in the field (e.g., test pits, proofrolls, hand auger probes, etc.). For project contracts and bid documents, we recommend units of cubic yards in-place. This allows for direct measurement of undercuts in the field that are not subject to arbitrary "fluff factors" when considering other units such as loose yards or weight.

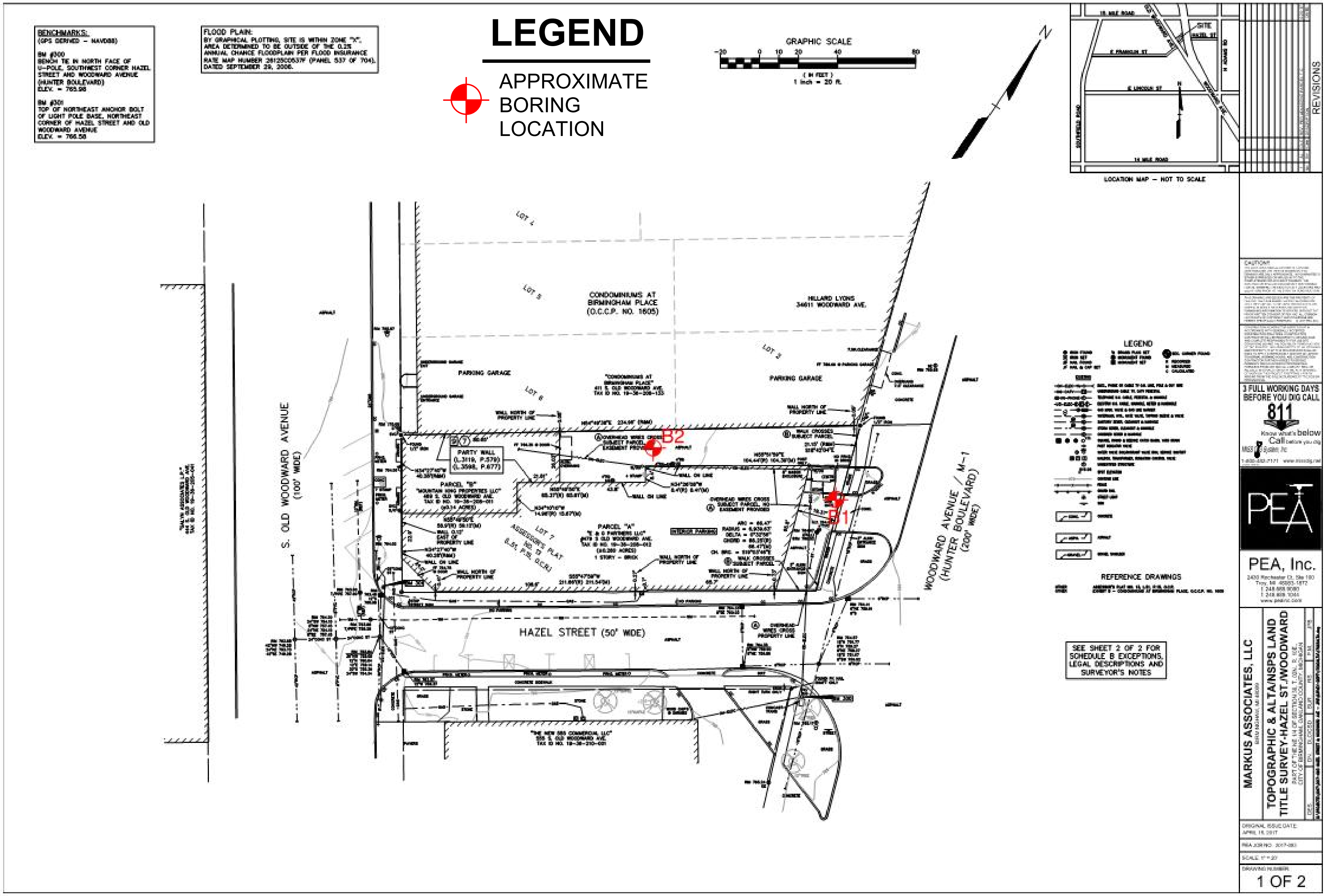
Coordinate with the project environmental engineer regarding the removal of any soils/groundwater from the site.

Take care during demolition and earthwork operations to protect adjoining and adjacent structures to remain. Do not undermine existing structures. Where necessary, install temporary shoring/bracing to properly shore/brace existing structures and protect them from distress. Any shoring/bracing will need to be designed by a professional engineer licensed in the State of Michigan.

The contractor must provide a safely sloped excavation or an adequately constructed and braced shoring system in accordance with federal, state and local safety regulations for individuals working in an excavation that may expose them to the danger of moving ground. Additionally, if storing material or operating equipment near an excavation, use appropriate shoring to resist the extra pressure due to the superimposed loads.

APPENDIX A

BORING LOCATION PLAN
BORING LOG TERMINOLOGY
BORING LOGS (B1 THROUGH B2)



BENCHMARKS:
(GPS DERIVED – NAVD88)

BM #300
BENCH TIE IN NORTH FACE OF U-POLE, SOUTHWEST CORNER HAZEL STREET AND WOODWARD AVENUE (HUNTER BOULEVARD)
ELEV. = 765.98

BM #301
TOP OF NORTHEAST ANCHOR BOLT OF LIGHT POLE BASE, NORTHEAST CORNER OF HAZEL STREET AND OLD WOODWARD AVENUE
ELEV. = 766.58

FLOOD PLAIN:
BY GRAPHICAL PLOTTING, SITE IS WITHIN ZONE "X". AREA DETERMINED TO BE OUTSIDE OF THE 0.2% ANNUAL CHANCE FLOODPLAIN PER FLOOD INSURANCE RATE MAP NUMBER 26125C0537F (PANEL 537 OF 704), DATED SEPTEMBER 29, 2006.

SME

Indiana
Michigan
Ohio

DATE:	02/06/18
DRAWN BY:	AK
WO #:	NA
JOB:	078171.00
SCALE:	AS SHOWN

BORING LOCATION PLAN
PROPOSED MIXED USE BUILDING
SOUTH OLD WOODWARD AVE
BIRMINGHAM, MICHIGAN

BORING LOG TERMINOLOGY

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

COARSE-GRAINED SOIL (more than 50% of material is larger than No. 200 sieve size.)			
	Clean Gravel (Less than 5% fines)		
GRAVEL More than 50% of coarse fraction larger than No. 4 sieve size	▨	GW	Well-graded gravel; gravel-sand mixtures, little or no fines
	▨	GP	Poorly-graded gravel; gravel-sand mixtures, little or no fines
	Gravel with fines (More than 12% fines)		
	▨	GM	Silty gravel; gravel-sand-silt mixtures
	▨	GC	Clayey gravel; gravel-sand-clay mixtures
	Clean Sand (Less than 5% fines)		
SAND 50% or more of coarse fraction smaller than No. 4 sieve size	▨	SW	Well-graded sand; sand-gravel mixtures, little or no fines
	▨	SP	Poorly graded sand; sand-gravel mixtures, little or no fines
	Sand with fines (More than 12% fines)		
	▨	SM	Silty sand; sand-silt-gravel mixtures
	▨	SC	Clayey sand; sand–clay-gravel mixtures
FINE-GRAINED SOIL (50% or more of material is smaller than No. 200 sieve size)			
SILT AND CLAY Liquid limit less than 50%	▨	ML	Inorganic silt; sandy silt or gravelly silt with slight plasticity
	▨	CL	Inorganic clay of low plasticity; lean clay, sandy clay, gravelly clay
	▨	OL	Organic silt and organic clay of low plasticity
SILT AND CLAY Liquid limit 50% or greater	▨	MH	Inorganic silt of high plasticity, elastic silt
	▨	CH	Inorganic clay of high plasticity, fat clay
	▨	OH	Organic silt and organic clay of high plasticity
HIGHLY ORGANIC SOIL	▨	PT	Peat and other highly organic soil

OTHER MATERIAL SYMBOLS

■	Topsoil
□	Void
▨	Sandstone
▨	Asphalt
▨	Glacial Till
▨	Siltstone
▨	Base
▨	Coal
▨	Limestone
▨	Concrete
▨	Shale
▨	Fill

LABORATORY CLASSIFICATION CRITERIA

GW	$C_U = \frac{D_{60}}{D_{10}}$ greater than 4; $C_C = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with PI greater than 7	
SW	$C_U = \frac{D_{60}}{D_{10}}$ greater than 6; $C_C = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for SW	
SM	Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
SC	Atterberg limits above "A" line with PI greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent……………………………..GW, GP, SW, SP
More than 12 percent…………………………..GM, GC, SM, SC
5 to 12 percent……………..……..Cases requiring dual symbols

- SP-SM or SW-SM (SAND with Silt or SAND with Silt and Gravel)
- SP-SC or SW-SC (SAND with Clay or SAND with Clay and Gravel)
- GP-GM or GW-GM (GRAVEL with Silt or GRAVEL with Silt and Sand)
- GP-GC or GW-GC (GRAVEL with Clay or GRAVEL with Clay and Sand)

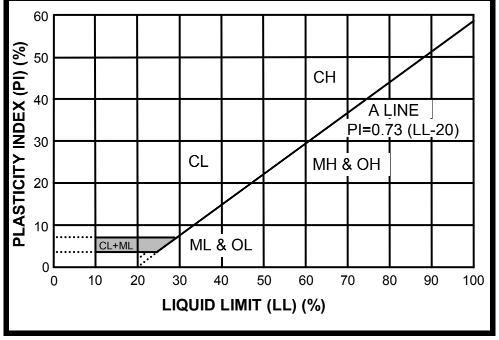
If the fines are CL-ML:

- SC-SM (SILTY CLAYEY SAND or SILTY CLAYEY SAND with Gravel)
- SM-SC (CLAYEY SILTY SAND or CLAYEY SILTY SAND with Gravel)
- GC-GM (SILTY CLAYEY GRAVEL or SILTY CLAYEY GRAVEL with Sand)
- GM-GC (CLAYEY SILTY GRAVEL or CLAYEY SILTY GRAVEL with Sand)

PARTICLE SIZES

Boulders	-	Greater than 12 inches
Cobbles	-	3 inches to 12 inches
Gravel- Coarse	-	3/4 inches to 3 inches
Fine	-	No. 4 to 3/4 inches
Sand- Coarse	-	No. 10 to No. 4
Medium	-	No. 40 to No. 10
Fine	-	No. 200 to No. 40
Silt and Clay	-	Less than (0.0074 mm)

PLASTICITY CHART



VISUAL MANUAL PROCEDURE

When laboratory tests are not performed to confirm the classification of soils exhibiting borderline classifications, the two possible classifications would be separated with a slash, as follows:

For soils where it is difficult to distinguish if it is a coarse or fine-grained soil:

- SC/CL (CLAYEY SAND to Sandy LEAN CLAY)
- SM/ML (SILTY SAND to SANDY SILT)
- GC/CL (CLAYEY GRAVEL to Gravelly LEAN CLAY)
- GM/ML (SILTY GRAVEL to Gravelly SILT)

For soils where it is difficult to distinguish if it is sand or gravel, poorly or well-graded sand or gravel; silt or clay; or plastic or non-plastic silt or clay:

- SP/GP or SW/GW (SAND with Gravel to GRAVEL with Sand)
- SC/GC (CLAYEY SAND with Gravel to CLAYEY GRAVEL with Sand)
- SM/GM (SILTY SAND with Gravel to SILTY GRAVEL with Sand)
- SW/SP (SAND or SAND with Gravel)
- GP/GW (GRAVEL or GRAVEL with Sand)
- SC/SM (CLAYEY to SILTY SAND)
- GM/GC (SILTY to CLAYEY GRAVEL)
- CL/ML (SILTY CLAY)
- ML/CL (CLAYEY SILT)
- CH/MH (FAT CLAY to ELASTIC SILT)
- CL/CH (LEAN to FAT CLAY)
- MH/ML (ELASTIC SILT to SILT)
- OL/OH (ORGANIC SILT or ORGANIC CLAY)

DRILLING AND SAMPLING ABBREVIATIONS

2ST	–	Shelby Tube – 2" O.D.
3ST	–	Shelby Tube – 3" O.D.
AS	–	Auger Sample
GS	–	Grab Sample
LS	–	Liner Sample
NR	–	No Recovery
PM	–	Pressure Meter
RC	–	Rock Core diamond bit. NX size, except where noted
SB	–	Split Barrel Sample 1-3/8" I.D., 2" O.D., except where noted
VS	–	Vane Shear
WS	–	Wash Sample

OTHER ABBREVIATIONS

WOH	–	Weight of Hammer
WOR	–	Weight of Rods
SP	–	Soil Probe
PID	–	Photo Ionization Device
FID	–	Flame Ionization Device

DEPOSITIONAL FEATURES

Parting	–	as much as 1/16 inch thick
Seam	–	1/16 inch to 1/2 inch thick
Layer	–	1/2 inch to 12 inches thick
Stratum	–	greater than 12 inches thick
Pocket	–	deposit of limited lateral extent
Lens	–	lenticular deposit
Hardpan/Till	–	an unstratified, consolidated or cemented mixture of clay, silt, sand and/or gravel, the size/shape of the constituents vary widely
Lacustrine	–	soil deposited by lake water
Mottled	–	soil irregularly marked with spots of different colors that vary in number and size
Varved	–	alternating partings or seams of silt and/or clay
Occasional	–	one or less per foot of thickness
Frequent	–	more than one per foot of thickness
Interbedded	–	strata of soil or beds of rock lying between or alternating with other strata of a different nature

CLASSIFICATION TERMINOLOGY AND CORRELATIONS

Cohesionless Soils

Relative Density	N-Value (Blows per foot)
Very Loose	0 to 4
Loose	4 to 10
Medium Dense	10 to 30
Dense	30 to 50
Very Dense	50 to 80
Extremely Dense	Over 80

Cohesive Soils

Consistency	N-Value (Blows per foot)	Undrained Shear Strength (kips/ft^2)
Very Soft	0 - 2	0.25 or less
Soft	2 - 4	0.25 to 0.50
Medium	4 - 8	0.50 to 1.0
Stiff	8 - 15	1.0 to 2.0
Very Stiff	15 - 30	2.0 to 4.0
Hard	> 30	4.0 or greater

Standard Penetration 'N-Value' = Blows per foot of a 140-pound hammer falling 30 inches on a 2-inch O.D. split barrel sampler, except where noted.

BORING B 1

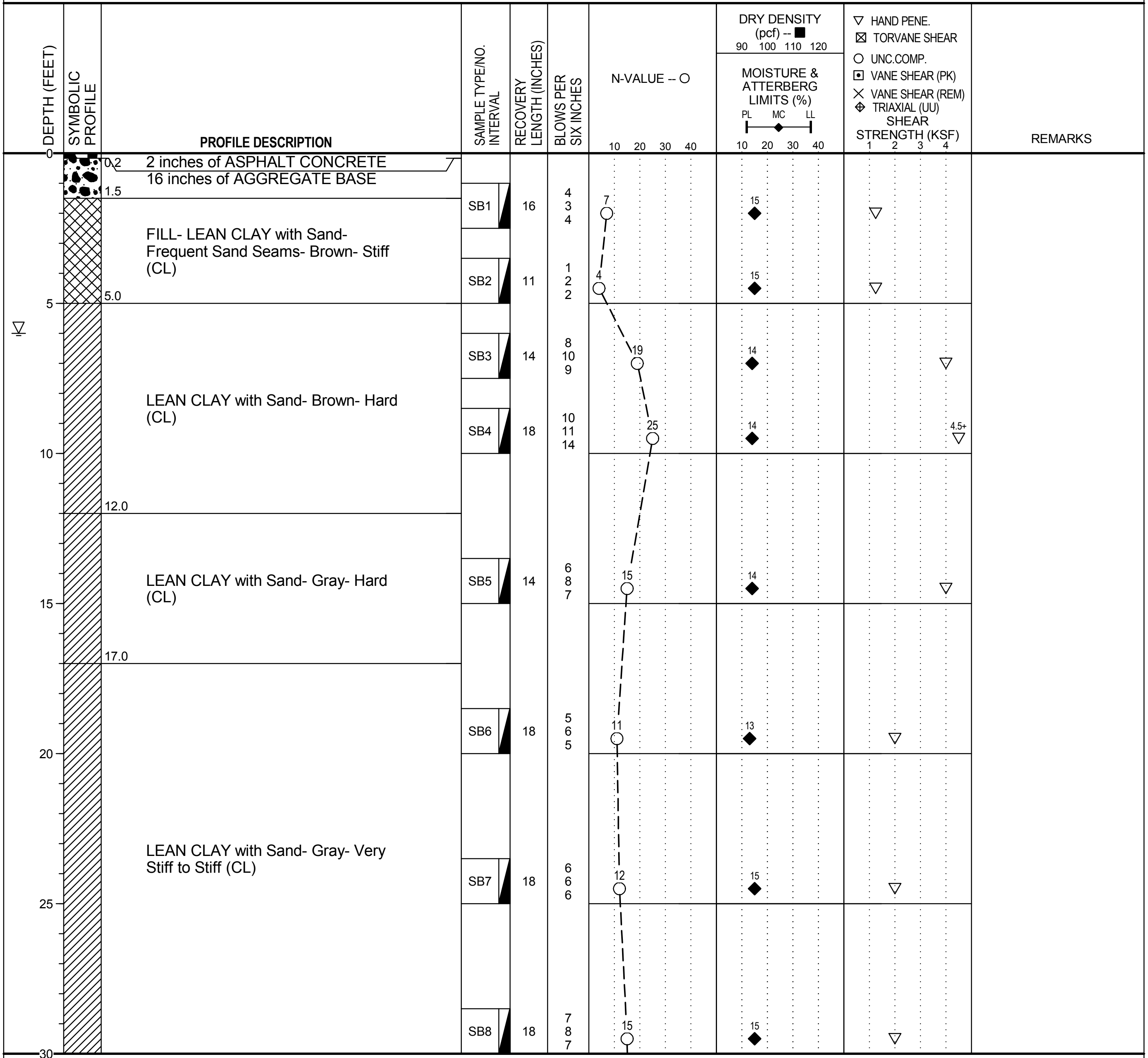
PAGE 1 OF 2

PROJECT NAME: Proposed Mix Use Building - South Old Woodward Ave **PROJECT NUMBER:** 078171.00

CLIENT: Birmingham Tower Partners, LLC **PROJECT LOCATION:** Birmingham, Michigan

DATE STARTED: 1/25/18 **COMPLETED:** 1/25/18 **BORING METHOD:** Solid-stem Augers

DRILLER: JR **RIG NO.:** 253 (CME 75) **LOGGED BY:** AK **CHECKED BY:** AK



DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	BLOWS PER SIX INCHES	N-VALUE	MOISTURE (%)	REMARKS
0.2	2 inches of ASPHALT CONCRETE						
1.5	16 inches of AGGREGATE BASE						
5.0	FILL- LEAN CLAY with Sand- Frequent Sand Seams- Brown- Stiff (CL)	SB1	16	4 3 4	7	15	
		SB2	11	1 2 2	4	15	
12.0	LEAN CLAY with Sand- Brown- Hard (CL)	SB3	14	8 10 9	19	14	
		SB4	18	10 11 14	25	14	
17.0	LEAN CLAY with Sand- Gray- Hard (CL)	SB5	14	6 8 7	15	14	
	LEAN CLAY with Sand- Gray- Very Stiff to Stiff (CL)	SB6	18	5 6 5	11	13	
		SB7	18	6 6 6	12	15	
		SB8	18	7 8 7	15	15	

GROUNDWATER & BACKFILL INFORMATION

	DEPTH (FT)
▽ **DURING BORING:**	6.0
▼ **AT END OF BORING:**	None

BACKFILL METHOD: Auger Cuttings capped with Asphalt Cold Patch

NOTES: 1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.

(Continued Next Page)

SME

BORING B 1

PAGE 2 OF 2

PROJECT NAME: Proposed Mix Use Building - South Old Woodward Ave **PROJECT NUMBER:** 078171.00

CLIENT: Birmingham Tower Partners, LLC **PROJECT LOCATION:** Birmingham, Michigan

DRY DENSITY (pcf) -- ■ 90 100 110 120

MOISTURE & ATTERBERG LIMITS (%) PL MC LL 10 20 30 40

▽ HAND PENE.
☒ TORVANE SHEAR
○ UNC.COMP.
⊡ VANE SHEAR (PK)
× VANE SHEAR (REM)
◈ TRIAXIAL (UU)

SHEAR STRENGTH (KSF) 1 2 3 4

DEPTH (FEET)	SYMBOLIC PROFILE	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	BLOWS PER SIX INCHES	N-VALUE -- ○ 10 20 30 40	MOISTURE & ATTERBERG LIMITS (%)	SHEAR STRENGTH (KSF)	REMARKS
30	▨	LEAN CLAY with Sand- Gray- Very Stiff to Stiff (CL) *(continued)*							
35	▨		SB9	18	7 8 8	16 ○	14 ◆	▽	
40	▨	40.0	SB10	18	8 8 8	16 ○	16 ◆	▽	
		END OF BORING AT 40.0 FEET.							
45									
50									
55									
60									
65									
70									

BORING B 2

PAGE 1 OF 4

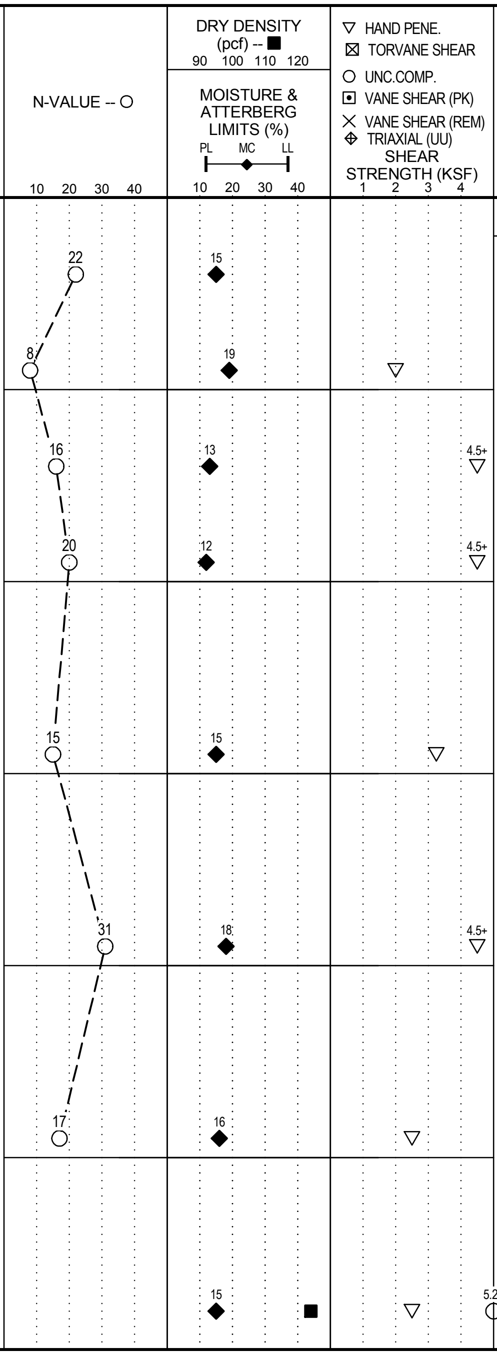
PROJECT NAME: Proposed Mix Use Building - South Old Woodward Ave **PROJECT NUMBER:** 078171.00

CLIENT: Birmingham Tower Partners, LLC **PROJECT LOCATION:** Birmingham, Michigan

DATE STARTED: 1/24/18 **COMPLETED:** 1/25/18 **BORING METHOD:** Hollow-stem Augers/Rotary Wash

DRILLER: JR **RIG NO.:** 253 (CME 75) **LOGGED BY:** AK **CHECKED BY:** AK

DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	BLOWS PER SIX INCHES	N-VALUE -- ○	MOISTURE & ATTERBERG LIMITS (%)	SHEAR STRENGTH (KSF)	REMARKS
0.3	3 inches of ASPHALT CONCRETE							
3.5	FILL- LEAN CLAY with Sand- Frequent Sand Seams & Construction Debris (Slag & Concrete)- Dark Brown & Black (CL)	SB1	14	13 14 8	22	15		Sample was too disturbed to perform a shear strength test
6.0	LEAN CLAY with Sand- Brown & Gray- Very Stiff (CL)	SB2	18	2 3 5	8	19	▽	
13.5	LEAN CLAY with Sand- Brown- Hard (CL)	SB3	18	5 7 9	16	13	4.5+ ▽	
		SB4	18	7 9 11	20	12	4.5+ ▽	
18.5	LEAN CLAY with Sand- Gray- Very Stiff (CL)	SB5	16	5 7 8	15	15	▽	
27.5	SILT with Sand- Gray- Hard to Very Stiff (ML)	SB6	18	8 15 16	31	18	4.5+ ▽	
		SB7	18	5 7 10	17	16	▽	
30	LEAN CLAY with Sand- Gray- Very Stiff to Stiff (CL)	2ST8	24			15 ■	▽ 5.21	



GROUNDWATER & BACKFILL INFORMATION

DEPTH (FT)

∇ **DURING BORING:** Note 2

BACKFILL METHOD: Bentonite & Cement 60 to 120 feet, Auger Cuttings above 60 feet capped with Asphalt Cold Patch

NOTES:
1. The indicated stratification lines are approximate. In situ, the transition between materials may be gradual.
2. Rotary wash methods were used to advance the boring starting at a depth of 15 feet, therefore, groundwater information could not be obtained.

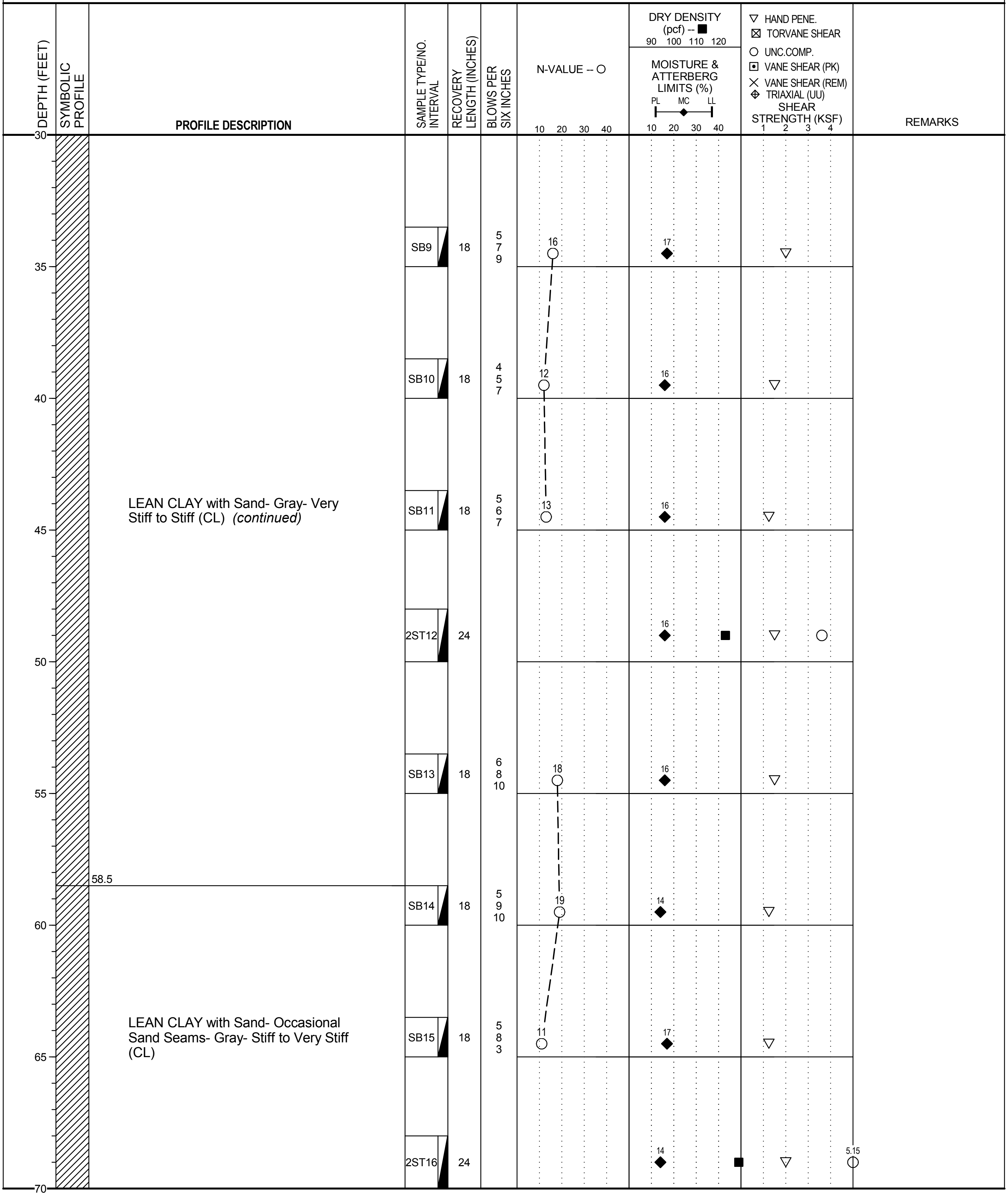
(Continued Next Page)

BORING B 2

PAGE 2 OF 4

PROJECT NAME: Proposed Mix Use Building - South Old Woodward Ave **PROJECT NUMBER:** 078171.00

CLIENT: Birmingham Tower Partners, LLC **PROJECT LOCATION:** Birmingham, Michigan



LEAN CLAY with Sand- Gray- Very Stiff to Stiff (CL) *(continued)*

58.5

LEAN CLAY with Sand- Occasional Sand Seams- Gray- Stiff to Very Stiff (CL)

SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	BLOWS PER SIX INCHES	N-VALUE	MOISTURE (MC)
SB9	18	5 7 9	16	17
SB10	18	4 5 7	12	16
SB11	18	5 6 7	13	16
2ST12	24			16
SB13	18	6 8 10	18	16
SB14	18	5 9 10	19	14
SB15	18	5 8 3	11	17
2ST16	24			14

(Continued Next Page)

SME

BORING B 2

PROJECT NAME: Proposed Mix Use Building - South Old Woodward Ave **PROJECT NUMBER:** 078171.00

CLIENT: Birmingham Tower Partners, LLC **PROJECT LOCATION:** Birmingham, Michigan

DRY DENSITY (pcf) -- ■ 90 100 110 120

MOISTURE & ATTERBERG LIMITS (%) PL MC LL 10 20 30 40

N-VALUE -- ○ 10 20 30 40

- ▽ HAND PENE.
- ☒ TORVANE SHEAR
- ○ UNC.COMP.
- ⊡ VANE SHEAR (PK)
- × VANE SHEAR (REM)
- ◈ TRIAXIAL (UU)

SHEAR STRENGTH (KSF) 1 2 3 4

DEPTH (FEET)	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	BLOWS PER SIX INCHES	N-VALUE	MOISTURE (%)	DRY DENSITY	SHEAR STRENGTH (KSF)	REMARKS
70 – 73.5	LEAN CLAY with Sand- Occasional Sand Seams- Gray- Stiff to Very Stiff (CL) *(continued)*								
73.5 – 94.0	LEAN CLAY with Sand- Gray- Very Stiff (CL)	SB17	18	13 16 17	33	10		▽	
		SB18	18	8 10 12	22	16		▽	
		SB19	4	5 8 10	18	18			Sample was too disturbed to perform a shear strength test
		2ST20	24			12	■	▽ ○ 6.68	
		SB21	18	15 26 30	56	13		▽	
94.0 – 98.5	Fine to Medium SAND- Dark Gray- Very Dense (SP)								
98.5 – 103.5	Fine to Coarse SAND with Silt- Gray- Dense (SP-SM)	SB22	18	27 24 19	43				
103.5 – 110.0	LEAN CLAY- Gray- Very Stiff (CL)	SB23	18	12 13 14	27	25		▽	
		SB24	10	14 17 21	38	27			Sample was too disturbed to perform a shear strength test

(Continued Next Page)

BORING B 2

PAGE 4 OF 4

PROJECT NAME: Proposed Mix Use Building - South Old Woodward Ave **PROJECT NUMBER:** 078171.00

CLIENT: Birmingham Tower Partners, LLC **PROJECT LOCATION:** Birmingham, Michigan

DEPTH (FEET)	SYMBOLIC PROFILE	PROFILE DESCRIPTION	SAMPLE TYPE/NO. INTERVAL	RECOVERY LENGTH (INCHES)	BLOWS PER SIX INCHES	N-VALUE -- ○ (10 20 30 40)	DRY DENSITY (pcf) -- ■ (90 100 110 120) / MOISTURE & ATTERBERG LIMITS (%) PL MC LL (10 20 30 40)	▽ HAND PENE. ⊠ TORVANE SHEAR ○ UNC.COMP. ⊡ VANE SHEAR (PK) × VANE SHEAR (REM) ⊕ TRIAXIAL (UU) SHEAR STRENGTH (KSF) (1 2 3 4)	REMARKS
110	▨	LEAN CLAY with Sand- Frequent Fine to Medium Sand Seams & Layers- Gray- Hard (CL)							Driller reported driving a rock during sampling for SB24
115	▨		SB25	18	35 30 34	64	17	4.5+	
120	▨	120.0	SB26	18	27 30 32	62	11	4.5+	
		END OF BORING AT 120.0 FEET.							

125

130

135

140

145

150

APPENDIX B

IMPORTANT INFORMATION ABOUT THIS GEOTECHNICAL ENGINEERING REPORT
GENERAL COMMENTS
LABORATORY TESTING PROCEDURES

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled.* No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be*, and, in general, *if you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely*. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.*

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration.*** Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL
BUSINESS
ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org   www.geoprofessional.org

GENERAL COMMENTS

BASIS OF GEOTECHNICAL REPORT

This report has been prepared in accordance with generally accepted geotechnical engineering practices to assist in the design and/or evaluation of this project. If the project plans, design criteria, and other project information referenced in this report and utilized by SME to prepare our recommendations are changed, the conclusions and recommendations contained in this report are not considered valid unless the changes are reviewed, and the conclusions and recommendations of this report are modified or approved in writing by our office.

The discussions and recommendations submitted in this report are based on the available project information, described in this report, and the geotechnical data obtained from the field exploration at the locations indicated in the report. Variations in the soil and groundwater conditions commonly occur between or away from sampling locations. The nature and extent of the variations may not become evident until the time of construction. If significant variations are observed during construction, SME should be contacted to reevaluate the recommendations of this report. SME should be retained to continue our services through construction to observe and evaluate the actual subsurface conditions relative to the recommendations made in this report.

In the process of obtaining and testing samples and preparing this report, procedures are followed that represent reasonable and accepted practice in the field of soil and foundation engineering. Specifically, field logs are prepared during the field exploration that describe field occurrences, sampling locations, and other information. Samples obtained in the field are frequently subjected to additional testing and reclassification in the laboratory and differences may exist between the field logs and the report logs. The engineer preparing the report reviews the field logs, laboratory classifications, and test data and then prepares the report logs. Our recommendations are based on the contents of the report logs and the information contained therein.

REVIEW OF DESIGN DETAILS, PLANS, AND SPECIFICATIONS

SME should be retained to review the design details, project plans, and specifications to verify those documents are consistent with the recommendations contained in this report.

REVIEW OF REPORT INFORMATION WITH PROJECT TEAM

Implementation of our recommendations may affect the design, construction, and performance of the proposed improvements, along with the potential inherent risks involved with the proposed construction. The client and key members of the design team, including SME, should discuss the issues covered in this report so that the issues are understood and applied in a manner consistent with the owner’s budget, tolerance of risk, and expectations for performance and maintenance.

FIELD VERIFICATION OF GEOTECHNICAL CONDITIONS

SME should be retained to verify the recommendations of this report are properly implemented during construction. This may avoid misinterpretation of our recommendations by other parties and will allow us to review and modify our recommendations if variations in the site subsurface conditions are encountered.

PROJECT INFORMATION FOR CONTRACTOR

This report and any future addenda or other reports regarding this site should be made available to prospective contractors prior to submitting their proposals for their information only and to supply them with facts relative to the subsurface evaluation and laboratory test results. If the selected contractor encounters subsurface conditions during construction, which differ from those presented in this report, the contractor should promptly describe the nature and extent of the differing conditions in writing and SME should be notified so that we can verify those conditions. The construction contract should include provisions for dealing with differing conditions and contingency funds should be reserved for potential problems during earthwork and foundation construction. We would be pleased to assist you in developing the contract provisions based on our experience.

The contractor should be prepared to handle environmental conditions encountered at this site, which may affect the excavation, removal, or disposal of soil; dewatering of excavations; and health and safety of workers. Any Environmental Assessment reports prepared for this site should be made available for review by bidders and the successful contractor.

THIRD PARTY RELIANCE/REUSE OF THIS REPORT

This report has been prepared solely for the use of our Client for the project specifically described in this report. This report cannot be relied upon by other parties not involved in the project, unless specifically allowed by SME in writing. SME also is not responsible for the interpretation by other parties of the geotechnical data and the recommendations provided herein.

LABORATORY TESTING PROCEDURES

VISUAL ENGINEERING CLASSIFICATION

Visual classification was performed on recovered samples. The appended General Notes and Unified Soil Classification System (USCS) sheets include a brief summary of the general method used visually classify the soil and assign an appropriate USCS group symbol. The estimated group symbol, according to the USCS, is shown in parentheses following the textural description of the various strata on the boring logs appended to this report. The soil descriptions developed from visual classifications are sometimes modified to reflect the results of laboratory testing.

MOISTURE CONTENT

Moisture content tests were performed by weighing samples from the field at their in-situ moisture condition. These samples were then dried at a constant temperature (approximately 110º C) overnight in an oven. After drying, the samples were weighed to determine the dry weight of the sample and the weight of the water that was expelled during drying. The moisture content of the specimen is expressed as a percent and is the weight of the water compared to the dry weight of the specimen.

HAND PENETROMETER TESTS

In the hand penetrometer test, the unconfined compressive strength of a cohesive soil sample is estimated by measuring the resistance of the sample to the penetration of a small calibrated, spring-loaded cylinder. The maximum capacity of the penetrometer is 4.5 tons per square-foot (tsf). Theoretically, the undrained shear strength of the cohesive sample is one-half the unconfined compressive strength. The undrained shear strength (based on the hand penetrometer test) presented on the boring logs is reported in units of kips per square-foot (ksf).

TORVANE SHEAR TESTS

In the Torvane test, the shear strength of a low strength, cohesive soil sample is estimated by measuring the resistance of the sample to a torque applied through vanes inserted into the sample. The undrained shear strength of the samples is measured from the maximum torque required to shear the sample and is reported in units of kips per square-foot (ksf).

LOSS-ON-IGNITION (ORGANIC CONTENT) TESTS

Loss-on-ignition (LOI) tests are conducted by first weighing the sample and then heating the sample to dry the moisture from the sample (in the same manner as determining the moisture content of the soil). The sample is then re-weighed to determine the dry weight and then heated for 4 hours in a muffle furnace at a high temperature (approximately 440º C). After cooling, the sample is re-weighed to calculate the amount of ash remaining, which in turn is used to determine the amount of organic matter burned from the original dry sample. The organic matter content of the specimen is expressed as a percent compared to the dry weight of the sample.

ATTERBERG LIMITS TESTS

Atterberg limits tests consist of two components. The plastic limit of a cohesive sample is determined by rolling the sample into a thread and the plastic limit is the moisture content where a 1/8-inch thread begins to crumble. The liquid limit is determined by placing a ½-inch thick soil pat into the liquid limits cup and using a grooving tool to divide the soil pat in half. The cup is then tapped on the base of the liquid limits device using a crank handle. The number of drops of the cup to close the gap formed by the grooving tool ½ inch is recorded along with the corresponding moisture content of the sample. This procedure is repeated several times at different moisture contents and a graph of moisture content and the corresponding number of blows is plotted. The liquid limit is defined as the moisture content at a nominal 25 drops of the cup. From this test, the plasticity index can be determined by subtracting the plastic limit from the liquid limit.

Passionate People Building
and Revitalizing our World

SME

4.11 Air Quality Report

2015 Annual Air Quality Report

Michigan

DEQ Department of Environmental Quality

For information or assistance regarding this publication, contact the Department Of Environmental Quality, Air Quality Division, P.O. Box 30260, Lansing, MI 48909-7760 or the DEQ Environmental Assistance Center toll-free number (800-662-9278)

Department of Environmental Quality
www.michigan.gov/deq

ACKNOWLEDGMENTS

This publication was prepared utilizing information provided by the Air Quality Evaluation Section (AQES) and other staff of the Michigan Department of Environmental Quality (MDEQ), Air Quality Division (AQD). Copies can be obtained on-line at: http://www.michigan.gov/deqair, under “Spotlight,” “Air Publications,” “Reports,” then “Annual Air Quality Reports,” or call 517-284-6747 to request a hard copy.

AQES, Air Monitoring Unit Staff:

Peter DeHart
Jason Duncan
Craig Fitzner
Marc Foreman
Eric Gafner
Tom Gauthier
Navnit Ghuman, co-editor
Eric Hansen
Cynthia Hodges, co-editor
Steve Irrer
Susan Kilmer
Dan Ling
Bryan Lomerson
Mark Lotoszinski
Matthew Nowak
Matt Riselay
Amy Robinson, co-editor
Debbie Sherrod

AQES, Biowatch Unit Staff: David Gregory

AQES, SIP Unit Staff: Kaitlyn Leffert, Mary Maupin

AQES, Strategy Develop Unit Staff: Jim Haywood

AQES, Toxics Unit Staff: Mike Depa, Doreen Lehner, Bob Sills, Keisha Williams

AQES, Section Secretary: Lorraine Hickman

The AQD also wishes to acknowledge the significant contributions that were provided by William Endres of the **City of Grand Rapids, Air Pollution Control Division**, which operates and maintains air monitoring equipment in West Michigan.

Cover Photos: Top – Barn near West Branch, and Lower Right – Au Sable River in Iosco County, Courtesy of Andrew Kent, Lower Left – Ostego Lake State Park, Courtesy of Becky Radulski

Printed: August 2016

TABLE OF CONTENTS

TABLE OF CONTENTS
Continued

Page No.

FIGURES

TABLE OF CONTENTS
Continued

Page No.

FIGURES, Continued

APPENDICES

2015 Air Quality Report

Introduction

The federal Clean Air Act (CAA) requires the U.S. Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS) for six criteria pollutants considered harmful to public health and the environment. Criteria pollutants are the pollutants for which the EPA must describe the characteristics and potential health and welfare effects.These standards define the maximum permissible concentration of criteria pollutants in the air (see **Table 1.1**).

The six criteria pollutants are monitored by the Michigan Department of Environmental Quality (DEQ), Air Quality Division (AQD). These criteria pollutants are:

- Carbon monoxide (CO),
- Lead (Pb),
- Nitrogen dioxide (NO_2),
- Ozone (O_3),
- Particulate matter smaller than 10 and 2.5 microns in diameter (PM_{10} and $PM_{2.5}$, respectively), and
- Sulfur dioxide (SO_2).

Chapters 2 through **7** provide information on each of the six criteria pollutants and include:

- Michigan's monitoring requirements for 2015,
- Attainment/nonattainment status,
- Monitoring site locations (tables show all the monitors active in 2015), and
- Air quality trends from 2010-2015 broken down by location.[1]

The 2015 data for each criteria pollutant is available in **Appendix A.**

The AQD also monitors air toxics. Air toxics are other hazardous air pollutants that can affect human health and the environment.[2] This data can be found in **Appendix B.**

The purpose of this report is to provide a snapshot of Michigan's 2015 air quality data, air quality trends, overview of the monitoring network (available in much greater detail in the 2016 Network Review)[3], air toxics monitoring program, and other AQD programs, such as MIair and Emissions Inventory[4].

---

[1] The air quality trends are based on actual statewide monitored readings, which are also listed in the EPA's Air Quality Subsystem Quick Look Report Data at https://www3.epa.gov/airtrends/

[2] A fact sheet and a Citizen's guide to participation is available on the DEQ's website at http://www.michigan.gov/documents/deq/deq-ess-caap-citizensguidetomiairpollutioncontrol_195548_7.pdf and at http://www.michigan.gov/documents/deq/deq-ead-guide-aqdguide_273529_7.pdf.

[3] Available on online at http://www.michigan.gov/documents/deq/deq-aqd-toxics-2016_Air_Mon_Network_Review_489490_7.pdf

[4] Online information about criteria pollutants and air toxics, along with this and previous annual air quality reports, are available via the AQD's website at http://www.michigan.gov/deq/0,4561,7-135-3310_4195---,00.html

Chapter 1: Background Information

This chapter provides a summary of the development of the NAAQS and how compliance with these standards is determined. Also included is an overview of Michigan's air sampling network, long term air quality trends, and the variety of monitoring techniques and requirements used to ensure quality data is obtained.

National Ambient Air Quality Standards (NAAQS)

Under Section 109 of the CAA, the EPA establishes a primary and secondary NAAQS for each pollutant for which air quality criteria have been issued. The primary standard is designed to protect the public health with an adequate margin of safety, including the health of the most susceptible individuals in a population, such as children, the elderly, and those with chronic respiratory ailments. Factors in selecting the margin of safety for the primary standard include the nature and severity of the health effects involved and the size of the sensitive population at risk. Secondary standards are chosen to protect public welfare (personal comfort and well-being) and the environment by limiting economic damage, impacts on visibility and climate, as well as the harmful effects on soil, water, crops, vegetation, wildlife, and buildings.

In addition, the NAAQS have various averaging times to address health impacts. Short averaging times reflect the potential for acute (immediate) effects, whereas long-term averaging times are designed to protect against chronic (long term) effects.

NAAQS have been established for CO, Pb, SO_2, NO_2, O_3, and PM. **Table 1.1** lists the primary and secondary NAAQS, averaging time, and concentration level for each criteria pollutant in effect in 2015. The concentrations are listed as parts per million (ppm), micrograms per cubic meter (µg/m^3), and/or milligrams per cubic meter (mg/m^3).

Table 1.1: NAAQS in Effect during 2015 for Criteria Pollutants

Pollutant	Primary (health-related)		Secondary (welfare-related)	
	Level	Averaging Time	Level	Averaging Time
Carbon Monoxide (CO)	9 ppm (10 mg/m^3)	8-hour average, not to be exceeded more than once per year *(1971)*	None*	
	35 ppm (40 mg/m^3)	1-hour average, not to be exceeded more than once per year *(1971)*		
Lead (Pb)	0.15 µg/m^3	Maximum rolling 3-month average *(2008)*	Same as Primary	
Nitrogen Dioxide (NO_2)	0.053 ppm (100 µg/m^3)	Annual mean *(1971)*	Same as Primary	
	0.100 ppm	98th percentile of 1-hr average, averaged over 3-years *(2010)*	None	
Particulate Matter (PM_{10})	150 µg/m^3	24-hour average, not to be exceeded more than once per year over 3 years *(1987)*	Same as Primary	
Particulate Matter ($PM_{2.5}$)	12.0 µg/m^3	Annual mean, averaged over 3 years *(2012)*	15.0 µg/m^3	Annual mean
	35 µg/m^3	98th percentile of 24-hour concentration, averaged over 3 years *(2006)*	Same as Primary	
Ozone (O_3)	0.075 ppm†	Annual 4th highest 8-hour daily max averaged over 3 years *(2008)*	Same as Primary	
Sulfur Dioxide (SO_2)	0.075 ppm	99th percentile of 1-hour daily max averaged over 3 years *(2010)*	0.5 ppm	3 hours

*In 1985, EPA revoked the secondary standard for CO (for public welfare) due to a lack of evidence of adverse effects on public welfare at or near ambient concentrations.

†EPA changed the standard to 0.070 after the 2015 ozone season, so 2015 ozone data is based on the 0.075 ppm standard.

To demonstrate compliance with the NAAQS, the EPA has defined specific criteria for each pollutant, which are summarized in **Table 1.2.**

Table 1.2: Criteria for the Determination of Compliance with the NAAQS

POLLUTANT	CRITERIA FOR COMPLIANCE
CO	Compliance with the CO standard is met when the second highest, non-overlapping 35 ppm 1-hour average standard and/or the 9 ppm 8-hour average standard is not exceeded more than once per year.
Pb	Compliance with the Pb standard is met when daily values collected for 3 consecutive months are averaged and do not exceed the 0.15 µg/m^3 standard.
NO_2	Compliance is met when the annual arithmetic mean concentration does not exceed the 0.053 ppm standard and the 98th percentile* averaged over 3-years of the 1 hour concentration does not exceed 100 ppb.
O_3	The 8-hour O_3 primary and secondary standards are met when the 3-year average of the 4th highest daily maximum 8-hr average concentration is less than or equal to 0.075 ppm.†
PM	PM_{10}**:** The 24-hour PM_{10} primary and secondary standards are met when 150 µg/m^3 is not exceeded more than once per year on average over 3 years.
	$PM_{2.5}$**:** The annual $PM_{2.5}$ primary and secondary standards are met when the annual arithmetic mean concentration is less than or equal to 12 µg/m^3 and 15 µg/m^3, respectively. The 24-hour $PM_{2.5}$ primary and secondary standards are met when the 3-year average of the 98th percentile ** 24-hour concentration is less than or equal to 35 µg/m^3.
SO_2	To determine compliance, the 99th percentile*** 1-hour concentration averaged over a three year period does not exceed 0.075 ppm, and the 3-hour average concentration shall not exceed 0.5 ppm more than once per calendar year.

*****_98th percentile daily maximum 1-hour value_ is the value below which nominally 98 percent of all daily maximum 1-hour concentration values fall, using the ranking and selection method specified in section 5.2 of appendix S of CFR Part 50.

****** _98th percentile_ is the daily value out of a year of $PM_{2.5}$ monitoring data below which 98 percent of all daily values fall using the ranking and selection method specified in section 4.5(a) of appendix N of CFR Part 50.

*******_99th percentile daily maximum 1-hour value_ is the value below which nominally 99 percent of all daily maximum 1-hour concentration values fall, using the ranking and selection method specified in section 5 of appendix T of CFR Part 50.

†EPA changed the standard to 0.070 after the 2015 ozone season, so 2015 ozone data is based on the 0.075 ppm standard.

As part of the EPA's grant to the DEQ, the AQD provides an annual Network Review document[5] of all monitoring data collected from the previous year and recommendations on any network changes. These recommendations are based on each monitor's exceedance history, changes in population distribution, and modifications to federal monitoring requirements under the CAA. Under the amended air monitoring regulations that began in 2007, states are required to solicit public comment (in May of each year) on their future air monitoring network design prior to submitting the annual review to the EPA in July.

Michigan Air Sampling Network

The Michigan Air Sampling Network (MASN) is operated by the DEQ's AQD, along with other governmental agencies. For instance, the O_3 and $PM_{2.5}$ monitors in Manistee County and Chippewa County are tribal monitors handled by the Little River Band of Ottawa Indians and the Inter-tribal Council of Michigan, respectively. **Figure 1.1** shows the 2015 MASN monitoring

---

[5] Most recent Network Reviews found online at: http://www.michigan.gov/documents/deq/deq-aqd-toxics-2016_Air_Mon_Network_Review_489490_7.pdf

sites. **Figures 1.2** and **1.3** are pictures of two monitoring stations; one at Port Huron and the other at Houghton Lake, respectively.

The MASN consists of federal reference method (FRM) monitors that enable continuous monitoring for the gaseous pollutants O_3, CO, NO_2, and SO_2, PM monitors that measure particulate concentrations over a 24-hour period, and high volume samplers for Pb. In addition, continuous $PM_{2.5}$ and PM_{10} monitors provide real-time hourly data, and $PM_{2.5}$ chemical speciation monitors determine the chemical composition of $PM_{2.5}$. The MASN data is also used to provide timely reporting to the DEQ's air quality reporting web page (discussed in **Chapter 9**). The types of monitoring conducted in 2015 and the MASN locations are shown in **Table 1.3.**

The **NCore network** began January 1, 2011, as part of EPA's 2006 amended air monitoring requirements. NCore is a multi-pollutant network that integrates several advance measurement systems for particles, pollutant gases and meteorology. This information will support scientific studies ranging across technological, health, and atmospheric process disciplines. Michigan has two NCore sites, Allen Park and Grand Rapids-Monroe Street. Further information on the effects of these criteria pollutants are discussed in **Chapters 2** through **7**.

The **Near Road-NO_2 Monitoring network** will focus on vehicle emissions and how they disperse near roadways. In 2011 Michigan took over EPA's pre-existing near-roadway site at Eliza Howell Park in Detroit. A second near road site was added in Livonia in January 2015. Data from these sites are discussed further in **Chapters 2** and **5.**

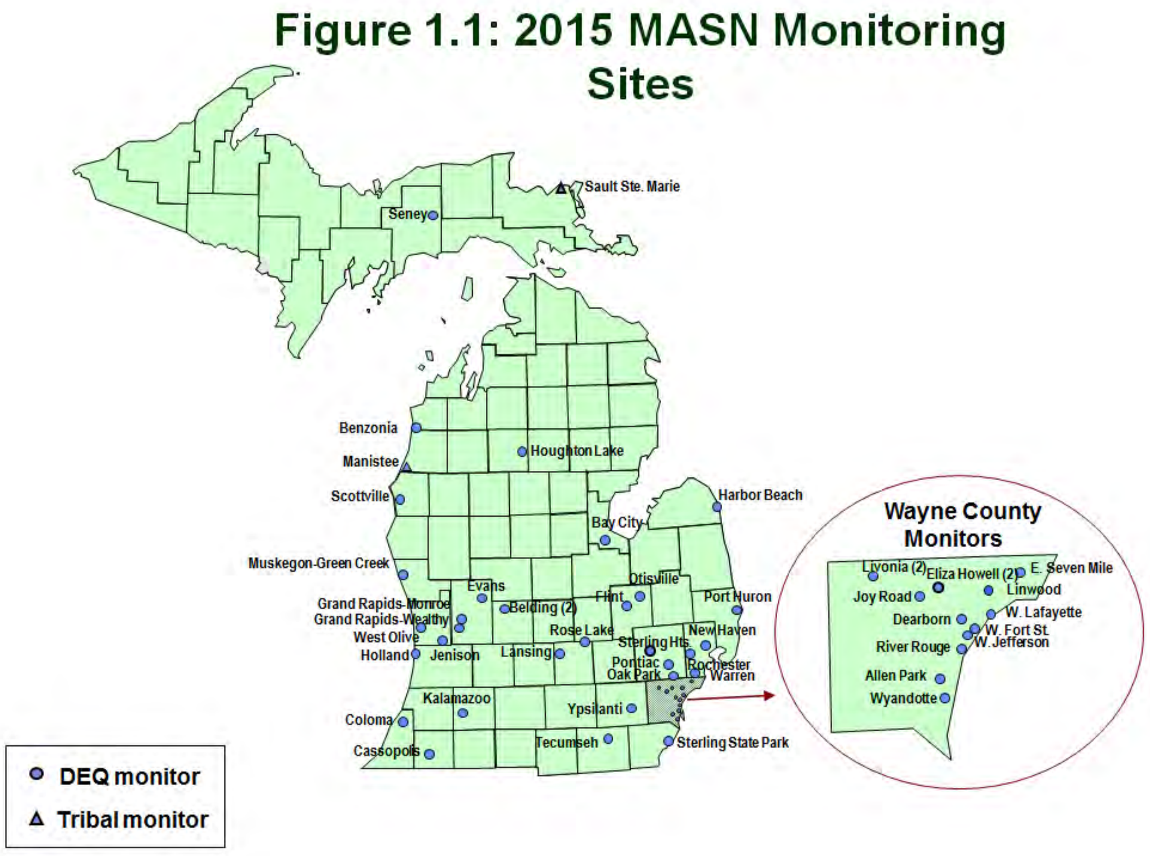


Figure 1.1: 2015 MASN Monitoring Sites

Figure 1.2: Port Huron Monitoring Site

Figure 1.3: Houghton Lake Monitoring Site

Table 1.3 Types of Monitoring Conducted in 2015 and MASN Location

Area	AIRS ID	Site Name	CO	NO_2	Trace NO_y	O_3	PM_{10}	$PM_{2.5}$	$PM_{2.5}$ TEOM	$PM_{2.5}$ Speciation	SO_2	Trace SO_2	VOC	Carbonyls	Trace Metals	Wind Speed & Direction, Temp.	Relative Humidity	Solar Radiation	Barometric Pressure
Detroit-Ann Arbor	260910007	Tecumseh				√		√	√	√+E						√			√
	260990009	New Haven				√		√								√	√	√	
	260991003	Warren				√													
	261250001	Oak Park				√		√								√			
	261470005	Port Huron				√		√	√		√					√			
	261470031	Port Huron-Rural St.													√@+Pb				
	261610008	Ypsilanti				√		√	√							√			√
	261630001	Allen Park	√*		√	√	√	√	√	√+A		√			√@+Pb	√	√		√
	261630005	River Rouge					√							√	√@	√			
	261630015	Detroit-W. Fort St.					√	√		√	√		√	√	√@	√	√		√
	261630016	Detroit-Linwood						√											
	261630019	Detroit-E. Seven Mile		√		√		√								√	√		√
	261630025	Livonia						√								√	√		√
	261630027	Detroit-W. Jefferson													√@				
	261630033	Dearborn					√	√	√	√+EA			√	√	√ + Pb	√	√		√
	261630036	Wyandotte						√											
	261630039	Detroit-W. Lafayette						√	√							√			
	261630093	Eliza Howell-Near Roadwa	√	√												√			
	261630094	Eliza Howell-Downwind	√	√												√	√		√
	261630095	Livonia-Near Roadway	√	√				√								√	√		√
Flint	260490021	Flint				√		√	√							√			√
	260492001	Otisville				√										√			
Grand Rapids	261390005	Jenison				√										√			
	261390011	West Olive									√					√			
	260810007	Grand Rapids-Wealthy						√											
	260810020	Grand Rapids-Monroe	√*		√	√	√	√	√	√		√			√@+Pb	√			√
	260810022	Evans				√										√			
Lansing/East Lansing	260650012	Lansing		√		√		√	√		√					√			√
	260370001	Rose Lake				√													
Monroe Co	261150006	Sterling State Park						√			√					√			
Huron Co	260630007	Harbor Beach				√										√			
Bay Co	260170014	Bay City						√	√							√			
MissaukeeCo	261130001	Houghton Lake		√		√		√	√							√			√
Allegan Co	260050003	Holland				√		√								√	√	√	√
Benzie Co	260190003	Benzonia				√													
Berrien Co	260210014	Coloma				√		√								√			
Cass Co	260270003	Cassopolis				√										√			
Kalamazoo Co	260770008	Kalamazoo				√		√	√							√			
Manistee Co	261010922	Manistee $				√		√								√		√	√
Mason Co	261050007	Scottville				√										√			
Muskegon Co	261210039	Muskegon-Green				√										√			
Schoolcraft Co	261530001	Seney Nat'l Wildlife				√			√							√	√	√	√
Chippewa Co	260330901	Sault Ste. Marie $				√		√	√							√			
Ionia Co	260670002	Belding-Reed St.													√@+Pb	√			
	260670003	Belding-Merrick St.													√@+Pb				

√ = Data Collected
= Mn only
@ = Mn, As, Cd, Ni
Pb = Lead
$ = Tribal monitor
* = Trace CO monitor
E = EC/OC monitor
A = Aethalometer monitor

Quality Assurance

The AQD's Air Monitoring Unit (AMU) ensures that all data collected and reported is of high quality and meets federal requirements. The AMU has a quality system in place that includes a Quality Assurance Project Plan (QAPP), standard operating procedures (SOPs), standardized forms and documentation policies, and a robust audit and assessment program.

The monitoring network adheres to the requirements in Title 40 of the Code of Federal Regulations (CFR), Parts 50, 53, and 58. This ensures that the monitors are correctly sited, operated in accordance to the federal reference methods, and adhere to the quality assurance requirements.

Quality assurance checks are conducted by site operators at the frequencies required in the regulations and unit procedures. Independent audits are conducted by the AMU's Quality Assurance (QA) Team, which has a separate reporting line of supervision. The quality assurance checks and audits are reported to the EPA each quarter.

External audits are conducted annually by the EPA. The EPA conducts Performance Evaluation Program (PEP) audits for $PM_{2.5}$ samplers and the National Performance Audit Program (NPAP) checks for the gaseous monitors. The EPA also conducts program-wide Technical Systems Audits (TSAs) every three to five years to evaluate overall program operations, and assess adequacy of documentation and records retention. External audits are also conducted on the laboratory operations for certain analytical techniques using performance evaluation samples.

Long-term Trends

Congress passed the Clean Air Act (CAA) in 1970; however, Michigan has had a long-standing history of environmental awareness well before the Act was established. In 1887, Detroit was the first city in Michigan to adopt an air quality ordinance, which declared that the dense smoke from burning coal was a public nuisance.

The EPA is required to review the criteria pollutant standards every five years. Over time, based upon toxicological data, the standards (NAAQS) have been tightened to better protect public health (see Appendix D). Areas that meet the NAAQS are considered to be in "attainment." Locations where air pollution levels persistently exceed the NAAQS may be designated as "nonattainment." That is why some areas in the state may be designated to nonattainment from attainment even though monitoring shows that air quality continues to improve.

Due to the vast availability of historical data, criteria pollutant data from Southeast Michigan are shown in **Figures 1.4** through **1.9.** These figures show how the ambient levels and the standards for these pollutants have changed over the last 35 plus years. Since this area is highly industrialized it is a good indicator of the Air Quality improvement for the rest of the state.

Figure 1.4 shows the ozone levels at the Detroit E. Seven Mile Road site. This graph shows how the standard changed from a 1-hour average of 0.120 ppm to an 8-hour average of 0.08 ppm in 1997. The standard was further lowered to 0.075 ppm in 2008 and to 0.070 at the end of 2015. Since the final rule of the 2015 NAAQS became effective after the 2015 ozone season, the 2015 data is evaluated based on the 2008 standard.

Figure 1.4: Historical Ozone at DEQ's Detroit E. Seven Mile Site

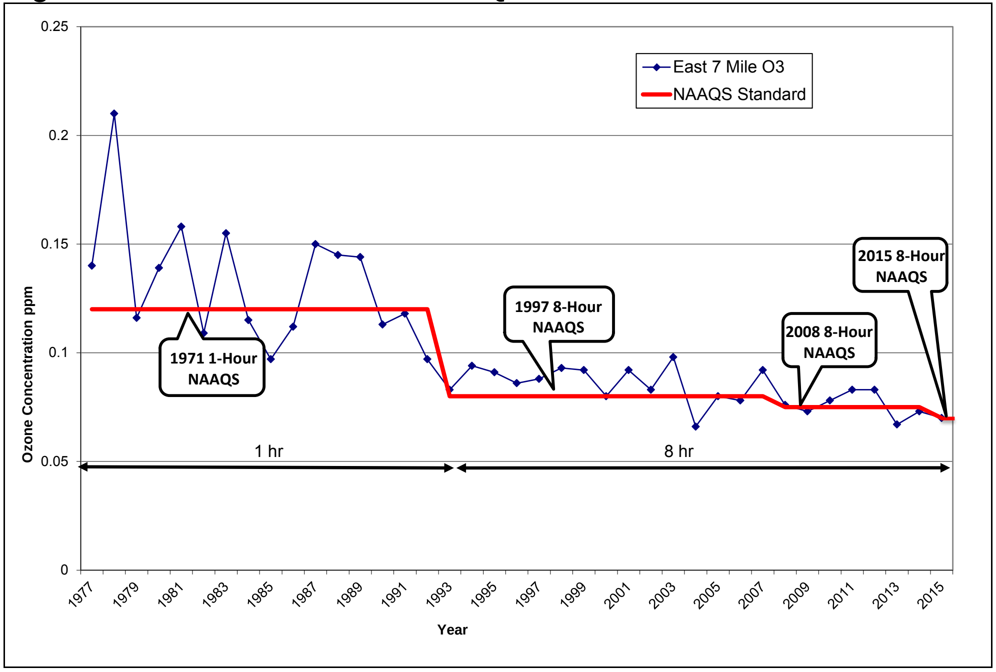


Figure 1.5 shows the SO_2 trend for the old annual standard and the new 1-hour standard for W. Fort Street (SWHS) in Detroit. In 2010, the EPA changed the standard from an annual average to 99th percentile of a 1-hour standard in which the SO_2 concentration cannot exceed 0.075 ppm averaged over 3 years. This resulted in nonattainment status for a portion of Wayne County (see **Chapter 4** for additional details). Even though the area is in nonattainment for 1-hour SO_2 standard, the levels of SO_2 have decreased significantly over the years.

Figure 1.5: Historical Annual and 1-hour SO_2 Averages at Detroit – W. Fort Street (SWHS)

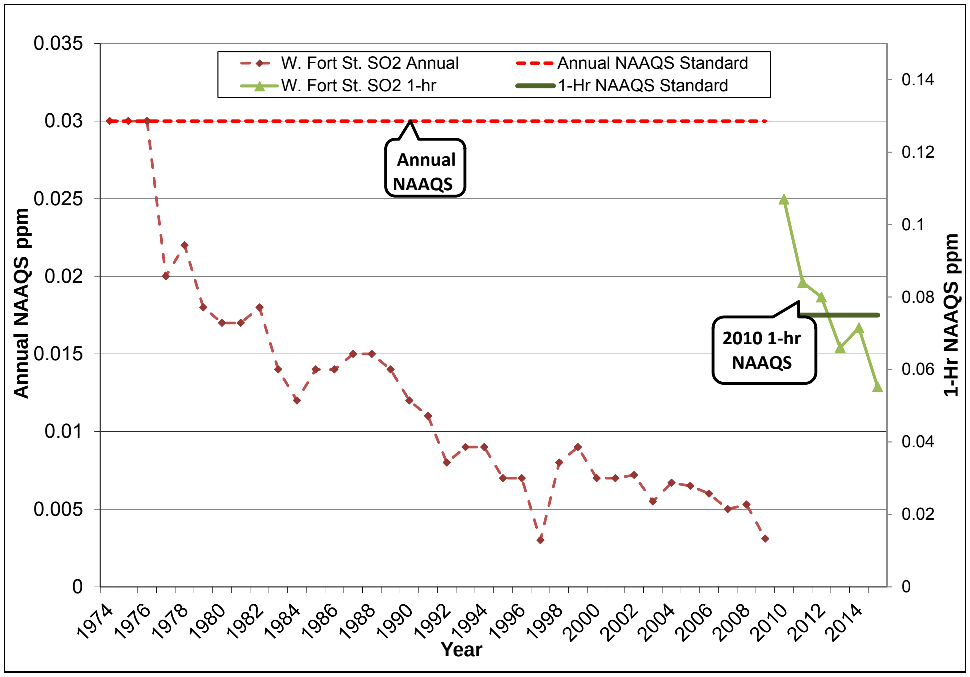


Figure 1.6 shows the CO trend at Allen Park to be well below the 1-hour standard of 35 ppm, which has remained unchanged since 1971.

Figure 1.6: Historical 1-hour CO Averages at Allen Park

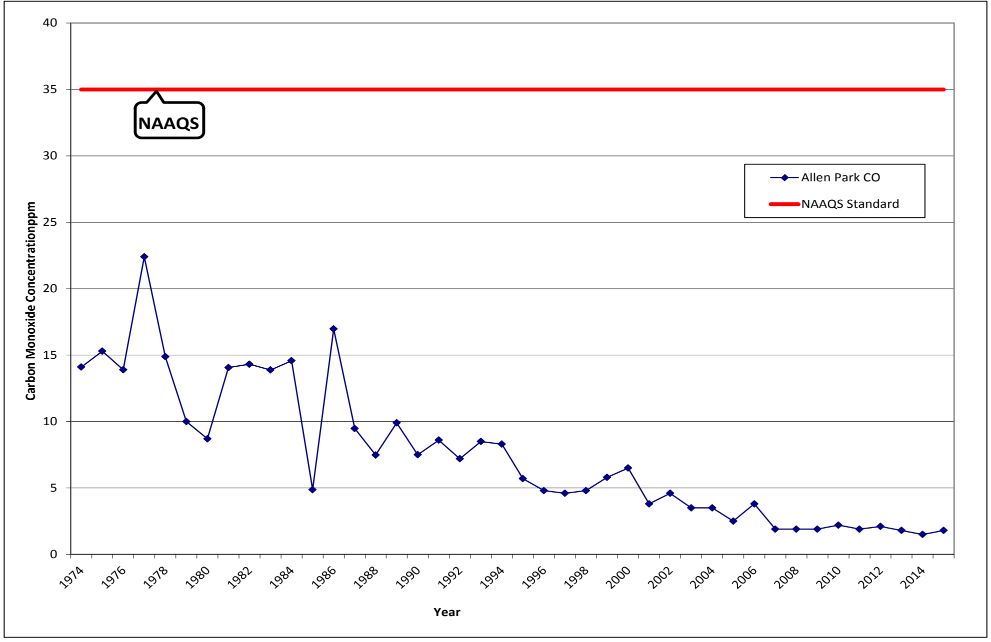


Figure 1.7 shows the trend for lead at Dearborn. Lead is of concern because lead is harmful to the neurological development of children. The largest decrease in lead in the air is due to the removal of lead in gasoline. By 1975, most newly manufactured vehicles no longer required leaded gasoline, and as a result, there was a dramatic decrease in ambient lead levels. In 1996, the EPA banned the sale of leaded fuel for use in on-road vehicles. The graph also shows the decrease in the lead standard that occurred in 2008.

Figure 1.7: Historical Quarterly / 3-month Averages for Lead at Dearborn

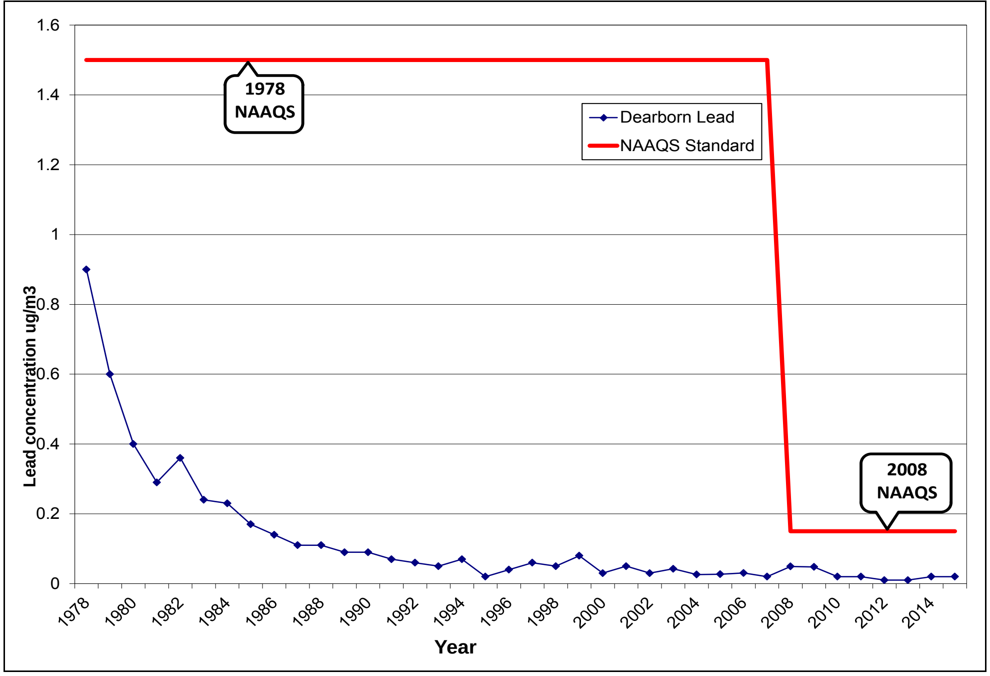


Figure 1.8 shows the trend for NO_2. NO_2 has been well below the annual standard of 53 ppb, and shows a downward trend. In 2010, EPA added a 1-hour standard of the 98th percentile not to exceed 100 ppb averaged over three years. One-hour NO_2 concentrations in Michigan have also maintained well below the standard.

Figure 1.8: Historical Annual NO_2 at E. Seven Mile Road.

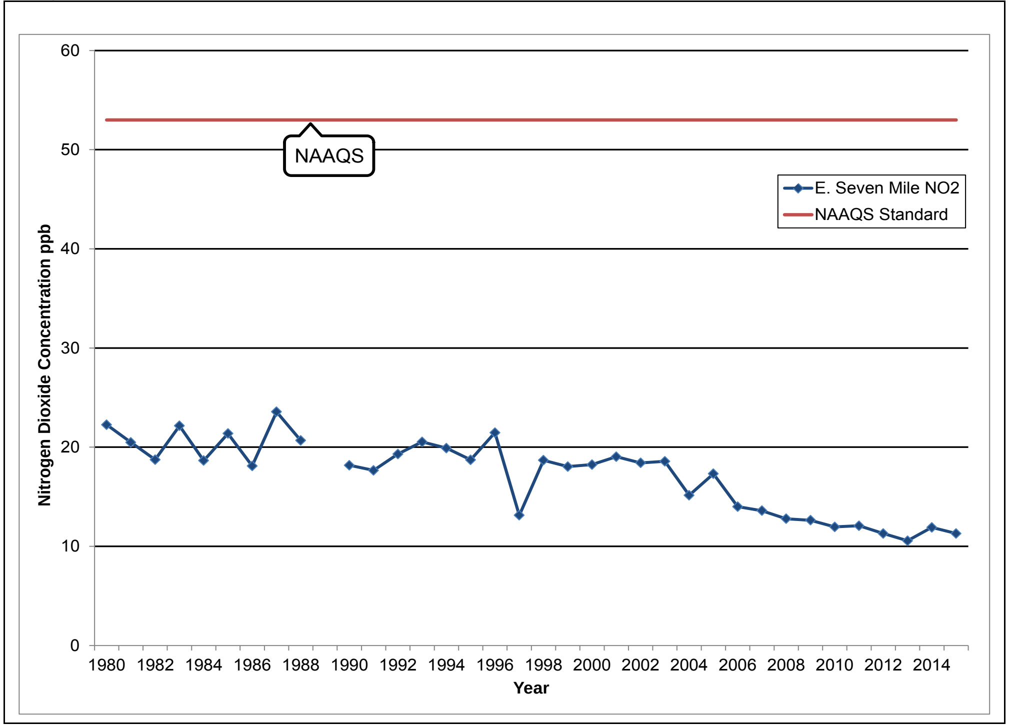
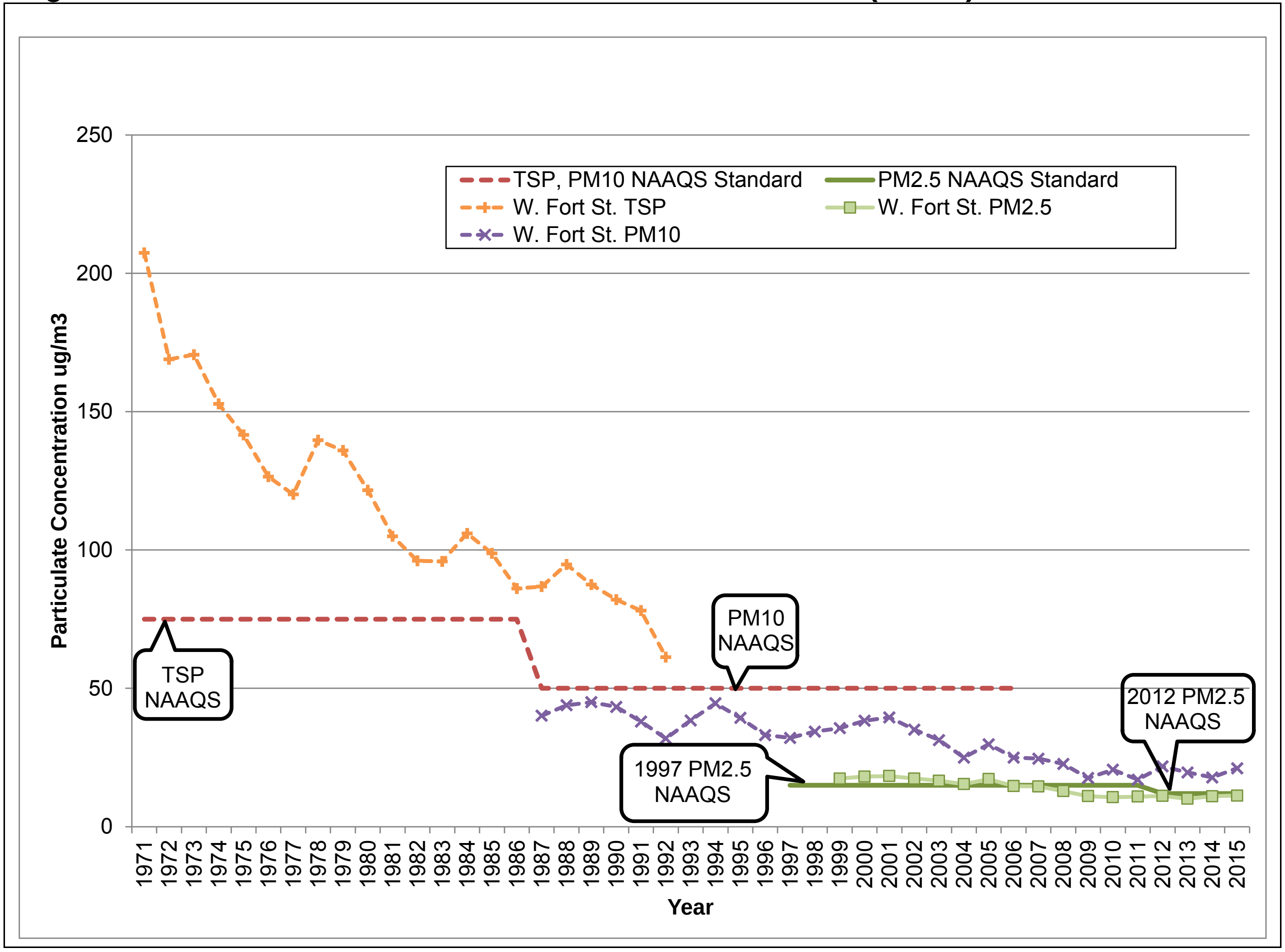


Figure 1.9 shows the trends for particulate matter. In 1971 EPA promulgated an annual and 24-hour particulate standard based on total suspended particulates (TSP). In 1987, EPA changed the standard to $PM_{10.}$ Health studies indicated that particles smaller than 10 microns affects respiration. In 1997 EPA added additional NAAQS for a smaller particle fraction size, $PM_{2.5}$, which can get deeper into the lungs and possibly into the blood stream. In 2006, EPA revoked the PM_{10} annual standard but kept the PM_{10} 24-hour standard. The $PM_{2.5}$ 24-hour standard was also reduced from 65 $\mu g/m^3$ to 35 $\mu g/m^3$. In 2012, EPA again reduced the annual standard from 15 $\mu g/m^3$ to 12 $\mu g/m^3$. Particulate trends show that particulate concentrations have decreased and the state is in compliance for all particulate NAAQS; however, Michigan has had non-attainment issues in Southeast Michigan for TSP, PM_{10} and $PM_{2.5}$.

Figure 1.9: Historical Annual Particulate Matter at W. Fort St. (SWHS).



Chapter 2: Carbon Monoxide (CO)

Carbon monoxide is a colorless, odorless, tasteless, and poisonous gas, formed during incomplete burning of fuel. Levels peak during colder months primarily due to cold temperatures that affect combustion efficiency of engines. It has a standard of 9 ppm for the second highest 8-hour average and 35 ppm for the second highest 1-hour average. Its sources and effects are as follows:

Sources: CO is given off whenever fuel or other carbon-based materials are burned. Outdoor exposure sources include automobile exhaust, industrial processes (metal processing and chemical production), and non-vehicle fuel combustion. Natural sources include volcanos, forest fires and photochemical reactions in the atmosphere. Indoor exposure sources include wood stoves and fire places, gas ranges with continuous pilot flame ignition, unvented gas or kerosene heaters, and cigarette smoke.

Effects: CO enters the bloodstream through the lungs, where it displaces oxygen delivered to the organs and tissues. Elevated levels can cause visual impairment, interfere with mental acuity by reducing learning ability and manual dexterity, and can decrease work performance in the completion of complex tasks. In extreme cases, unconsciousness and death can occur. CO also alters atmospheric photochemistry contributing to the formation of ground-level O_3, which can trigger serious respiratory problems.

Population most at risk: Those who suffer from cardiovascular (heart and respiratory) disease, unborn babies, infants and the elderly are most at risk for exposure to elevated levels of CO. People with angina and peripheral vascular disease are especially at risk, as their circulatory systems are already compromised and less efficient at carrying oxygen; however, elevated CO levels can also affect healthy people.

Figure 2.1 shows the location of each CO monitor that ran in 2015. The Eliza Howell Park and Livonia sites are required under the Near-Roadway Network. A second downwind site at Eliza Howell Park a comparison to the near-roadway sites The other two sites, Grand Rapids and Allen Park, are where trace CO (lower detection levels 1 ppm-50 ppb) are being monitored as part of the NCore Network.

Figure 2.1: Trace Carbon Monoxide (CO) Monitors in 2015

Figures 2.2 and **2.3** show CO emission sources and CO emissions by county (courtesy of the EPA's State and County Emission Summaries).

Figure 2.2: CO Emissions by Source Sector

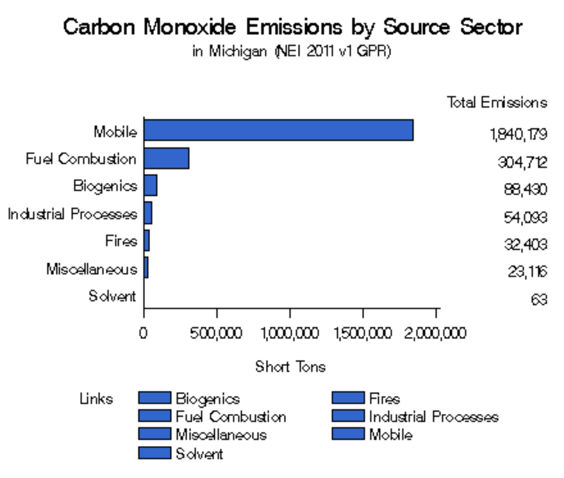
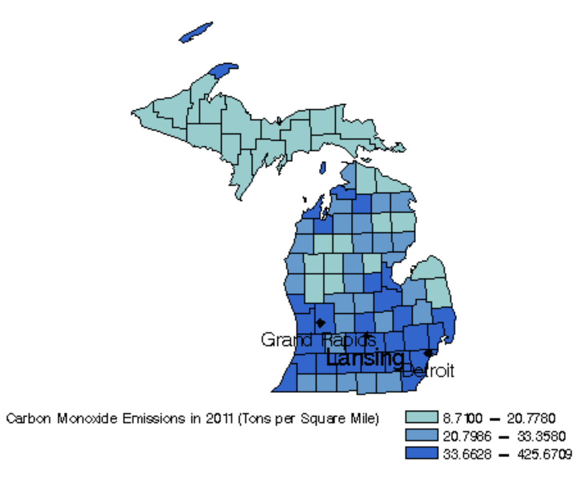


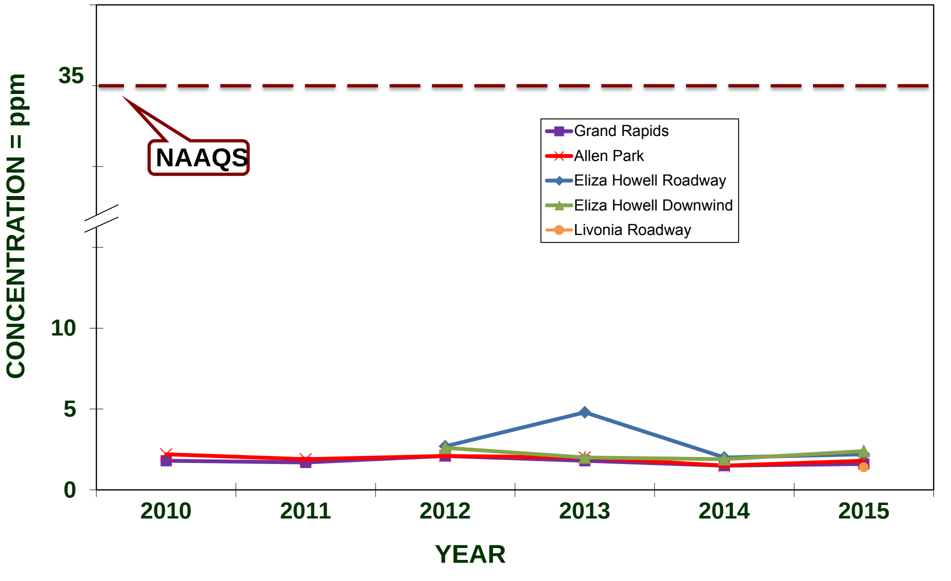
Figure 2.3: CO Emissions in 2011



Near-roadway Monitoring: On August 31, 2011, the EPA approved design changes to part of the CO ambient monitoring network. This network, now referred to as the near-roadway network, is focused on high traffic urban roads in Core-based Statistical Areas (CBSAs) with more than one million people. The DEQ took over two of the EPA's pre-existing, near-roadway sites at Eliza Howell Park, Detroit in June 2011. And in January 2015 the Livonia near road site also started sampling.

Figure 2.4 provides the maximum second highest 1-hour CO level trends for Michigan from 2010-2015, which demonstrates that there have not been any exceedances of the 1-hour CO NAAQS.

Figure 2.4: CO Levels in MI from 2010-2015
(2nd Highest 1-Hr Maximum Values)



Chapter 3: Lead (Pb)

Lead is a highly toxic metal found in coal, oil, and other fuels. It is also found in older paints, municipal solid waste and sewage sludge, and may be released to the atmosphere during combustion. On November 12, 2008, the EPA lowered the Pb NAAQS from a maximum quarterly average of 1.5 µg/m^3 to a 3-month rolling average of 0.15 µg/m^3. Its sources and effects are as follows:

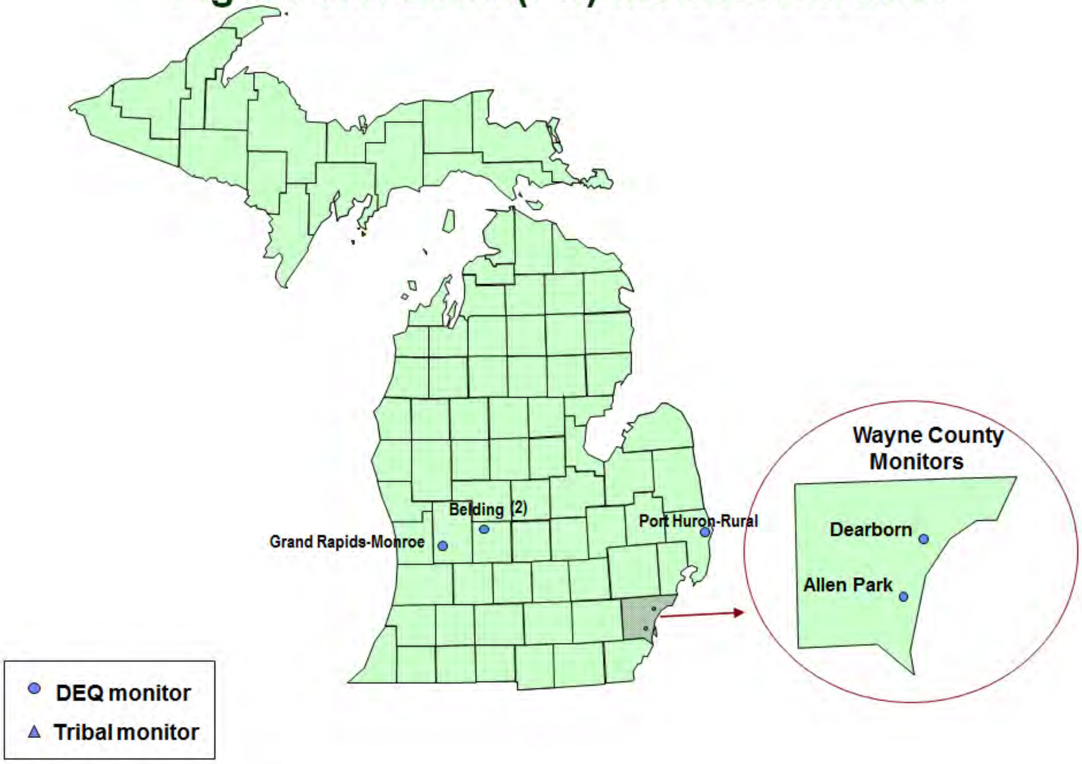
Sources: With the phase-out of leaded gas in the 1970s, the major sources of lead emissions have been due to ore and metals processing and piston-engine aircraft operating on leaded aviation fuel. Other industrial sources include lead acid battery manufacturers, waste incinerators and utilities. The highest air concentrations of lead are usually found near lead smelters.

Effects: Exposure occurs through the inhalation or ingestion of Pb in food, water, soil, or dust particles. Pb primarily accumulates in the body's blood, bones, and soft tissues, and adversely affects the kidneys, liver, nervous system, and other organs.

Population most at risk: Fetuses and children are most at risk since low levels of lead may cause central nervous system damage. Excessive lead exposure during the early years of life is associated with lower IQ scores and neurological impairment (seizures, mental development, and behavioral disorders). Even at low doses, lead exposure is associated with changes in fundamental enzymatic, metabolic, and homeostatic mechanisms in the body, and Pb may be a factor in high blood pressure and subsequent heart disease.

Figure 3.1 shows the location of the Lead monitors in the MASN in 2015.

Figure 3.1: Lead (Pb) Monitors in 2015



Figures 3.2 and **3.3** show Pb emission sources and Pb emissions by county (courtesy of the EPA's State and County Emission Summaries).

Figure 3.2: Lead Emissions by Source Sector

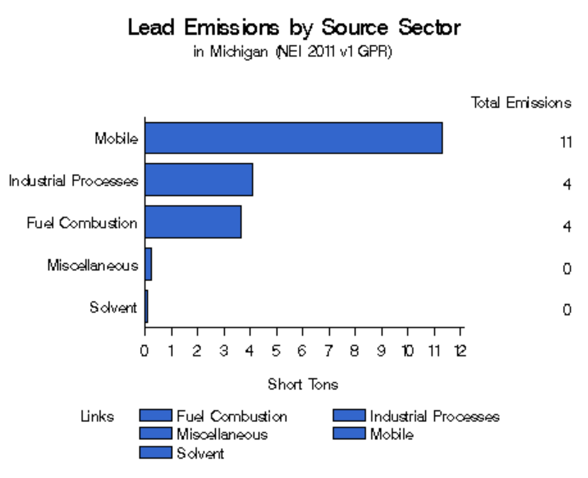
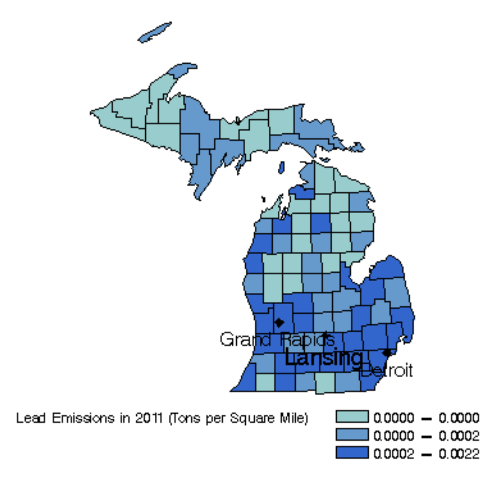


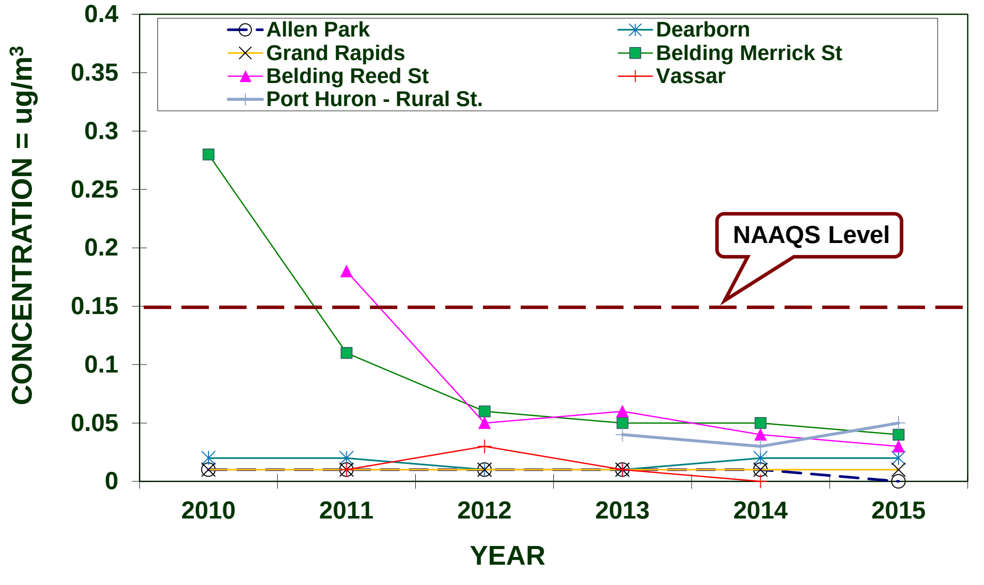
Figure 3.3: Lead Emissions in 2011



On November 12, 2008, the EPA modified the Pb NAAQS by reducing the level of the standard from a maximum quarterly average of 1.5 µg/m^3 to a 3-month rolling average of 0.15 µg/m^3. The monitoring network design was modified to consist of source-oriented monitors and population-oriented monitors.

Figure 3.4 shows the maximum 3-month rolling average values for Lead from 2010 to 2015.

Figure 3.4: Lead Levels in Michigan from 2010-2015 (Maximum 3-Month Average Values)



As part of the 2008 lead NAAQS standard, the DEQ is required to monitor near stationary lead sources emitting more than 1/2 ton per year. DEQ currently has three point-source lead monitoring sites Rural St. in Port Huron (started November 2012); Merrick St. in Belding (started January 2010) and Reed St. in Belding (started July 2011). The Merrick St. monitor located in Belding recorded a violation of the new health standard in 2010, as shown in **Figure 3.5.** Hence a second site, Reed St., was added in July 2011 at Belding which also recorded a violation in 2011. Values for both the sites have been below the NAAQS for the past four years.

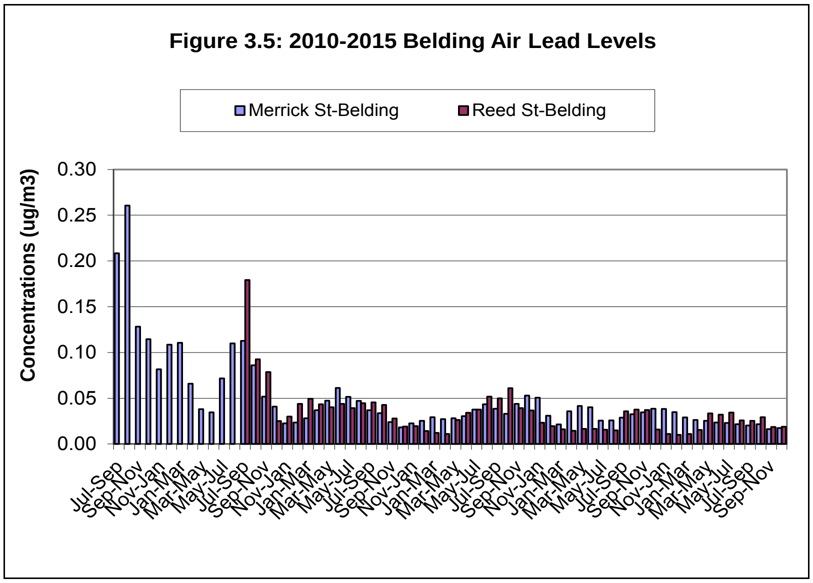


Figure 3.5: 2010-2015 Belding Air Lead Levels

All other lead sites in Michigan are well below the standard. The Dearborn site is part of the National Air Toxics Trend Sites (NATTS) and monitors lead and trace metals, both as total suspended particulate (TSP) and PM_{10}. Lead measurements as $PM_{2.5}$ are also made throughout the $PM_{2.5}$ speciation network.

Chapter 4: Sulfur Dioxide (SO_2)

Sulfur dioxide is a gas formed by the burning of sulfur-containing material. Odorless at typical ambient concentrations, SO_2 can react with other atmospheric chemicals to form sulfuric acid. At higher concentrations it has a pungent irritating odor similar to a struck match. When sulfur-bearing fuel is burned, the sulfur is oxidized to form SO_2, which then reacts with other pollutants to form aerosols. These aerosols can form particles in the air causing increases in $PM_{2.5}$ levels. In liquid form, it is found in clouds, fog, rain, aerosol particles, and in surface films on these particles. In June 2010, the EPA changed the primary SO_2 standard to a 99th percentile of 1-hour concentrations not to exceed 0.075 ppm, averaged over a 3-year period. The secondary standard has not changed and is a 3-hour average of 0.5 ppm. Its sources and effects are as follows:

Sources: Coal-burning power plants are the largest source of SO_2 emissions. Other sources include petroleum refineries, ore smelters, pulp and paper mills, steel mills and non-road transportation sources. SO_2 and particulate matter are often emitted together.

Effects: Exposure to elevated levels can affect breathing, cause respiratory illnesses, aggravate existing cardiovascular and pulmonary diseases, and alter the body's immune system. SO_2 and NO_X together are the major precursors to acid rain and are associated with the acidification of soils, lakes, and streams; as well as accelerated corrosion of buildings and monuments.

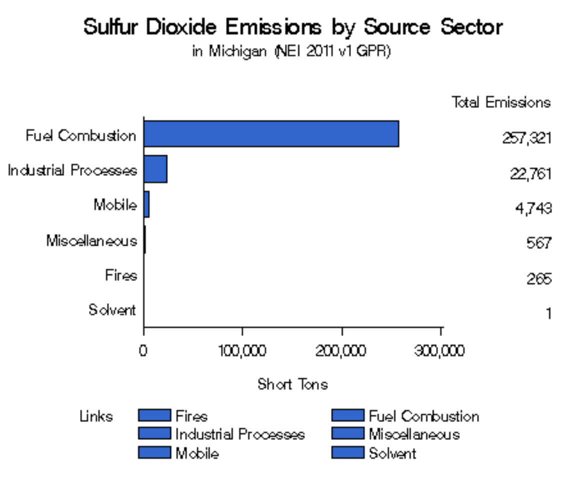
Population most at risk: Asthmatics, children, and the elderly are especially sensitive to SO_2 exposure. Asthmatics receiving short-term exposures during moderate exertion may experience reduced lung function and symptoms, such as wheezing, chest tightness, or shortness of breath. Depending upon the concentration, SO_2 may also cause symptoms in people who do not have asthma.

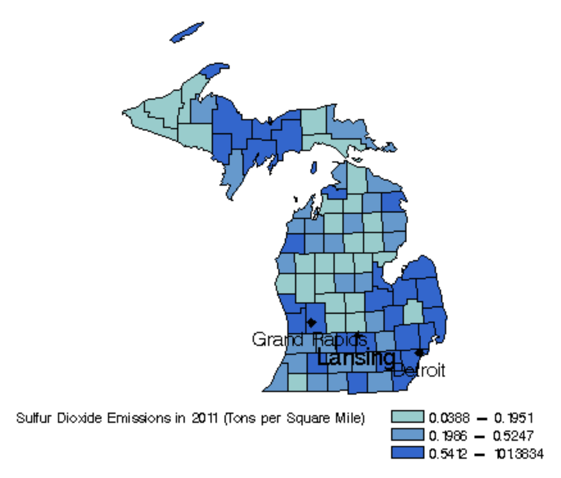
Figure 4.1 shows the location of each SO_2 monitor that ran in 2015. The two NCore Sites, Allen Park and Grand Rapids, have trace SO_2 monitors that have lower detection limits than traditional monitors.

Figure 4.1: Sulfur Dioxide (SO_2) Monitors in 2015

Figures 4.2 and **4.3** show SO_2 emission sources and SO_2 emissions by county (courtesy of the EPA's State and County Emission Summaries).

Figure 4.2: SO_2 Emissions by Source Sector **Figure 4.3: SO_2 Emissions in 2011**

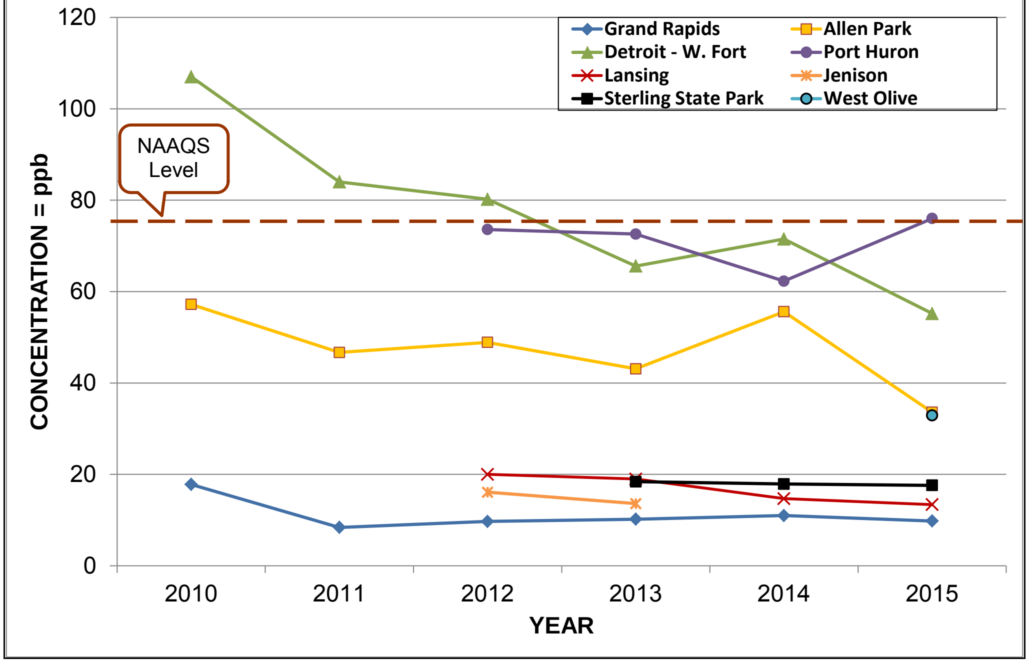




Historically, Michigan had been in attainment for SO_2 since 1982 with levels consistently well below the annual SO_2 NAAQS. However, in 2010 EPA changed the SO_2 NAAQS to a 1-hour standard which showed the SO_2 monitor at W. Fort Street (SWHS) in Detroit did not meet the new NAAQS. SO_2 concentrations have decrease at this site and are currently under the NAAQS.

The NCore sites, Grand Rapids and Allen Park, monitor for trace SO_2. For trend purposes, all SO_2 data are graphed together in **Figure 4.4**. Jenison and Port Huron were added to the SO_2 network in December 2011, and Sterling State Park in Monroe County was added to the SO_2 network in December 2012**.** The Jenison monitor was shut down January 1, 2014 and later moved to West Olive which started sampling January 2015.

Figure 4.4: SO_2 Levels in Michigan from 2010-2015 (1-hour 99th Percentile)



Chapter 5: Nitrogen Dioxide (NO_2)

Nitrogen Dioxide is a reddish-brown, highly reactive gas formed through oxidation of nitric oxide (NO). Upon dilution, it becomes yellow or invisible. High concentrations produce a pungent odor and lower levels have an odor similar to bleach. NO_x is term used to describe the sum of NO, NO_2, and other nitrogen oxides. NO_x can lead to the formation of O_3 and NO_2, and can react with other substances in the atmosphere to form acidic products that are deposited in rain (acid rain), fog, snow, or as particulate matter. Since 1971, the primary and secondary standard for NO_2 was an annual mean of 0.053 ppm. In January 2010, the EPA added a 1-hour NO_2 standard of 100 ppb, taking the form of the 98th percentile averaged over three years. The sources and effects of NO_2 are as follows:

Sources: NO_X compounds and their transformation products occur both naturally and as a result of human activities. Natural sources of NO_X are lightning, forest fires, bacterial processes in soil, and stratospheric intrusion. Stratospheric intrusion is when the stratospheric air descends towards the surface of the earth and mixes with the air at breathing level. Ammonia and other nitrogen compounds produced naturally are important in the cycling of nitrogen through the ecosystem. The major sources of man-made (anthropogenic) NO_x emissions come from high-temperature combustion processes such as those occurring in automobiles and power plants. Home heaters and gas stoves produce substantial amounts of NO_2 in indoor settings.

Effects: Exposure to NO_2 occurs through the respiratory system, irritating the lungs. Short-term NO_2 exposures (i.e., less than three hours) can produce coughing and changes in airway responsiveness and pulmonary function. Evidence suggests that long-term exposures to NO_2 may lead to increased susceptibility to respiratory infection and may cause structural alterations in the lungs. Exercise increases the ventilation rate and hence exposure to NO_2. Nitrate particles and NO_2 can block the transmission of light, resulting in visibility impairment (i.e., smog or haze). Deposition of nitrogen can lead to fertilization, eutrophication, or acidification of terrestrial, wetland, and aquatic systems.

Population most at risk: Individuals with pre-existing respiratory illnesses and asthmatics are more sensitive to the effects of NO_2 than the general population. Short-term NO_2 exposure can increase respiratory illnesses in children.

Figure 5.1 shows the location of all NO_2 monitors that operated in 2015. The E. Seven Mile monitor in Detroit is a downwind urban scale site that measures NO_2. The Detroit Eliza Howell (near roadway and downwind sites) and Livonia sites measure NO_2 in a near road environment. The NCore sites, Grand Rapids and Allen Park, monitor trace NO_Y, which includes NO_x, nitric acid and organic and inorganic nitrates (however, only NO_2 monitors can be used for attainment/nonattainment purposes). In addition, in 2010, the AQD added NO_2 monitors at Lansing and Houghton Lake to provide background information for modeling applications.

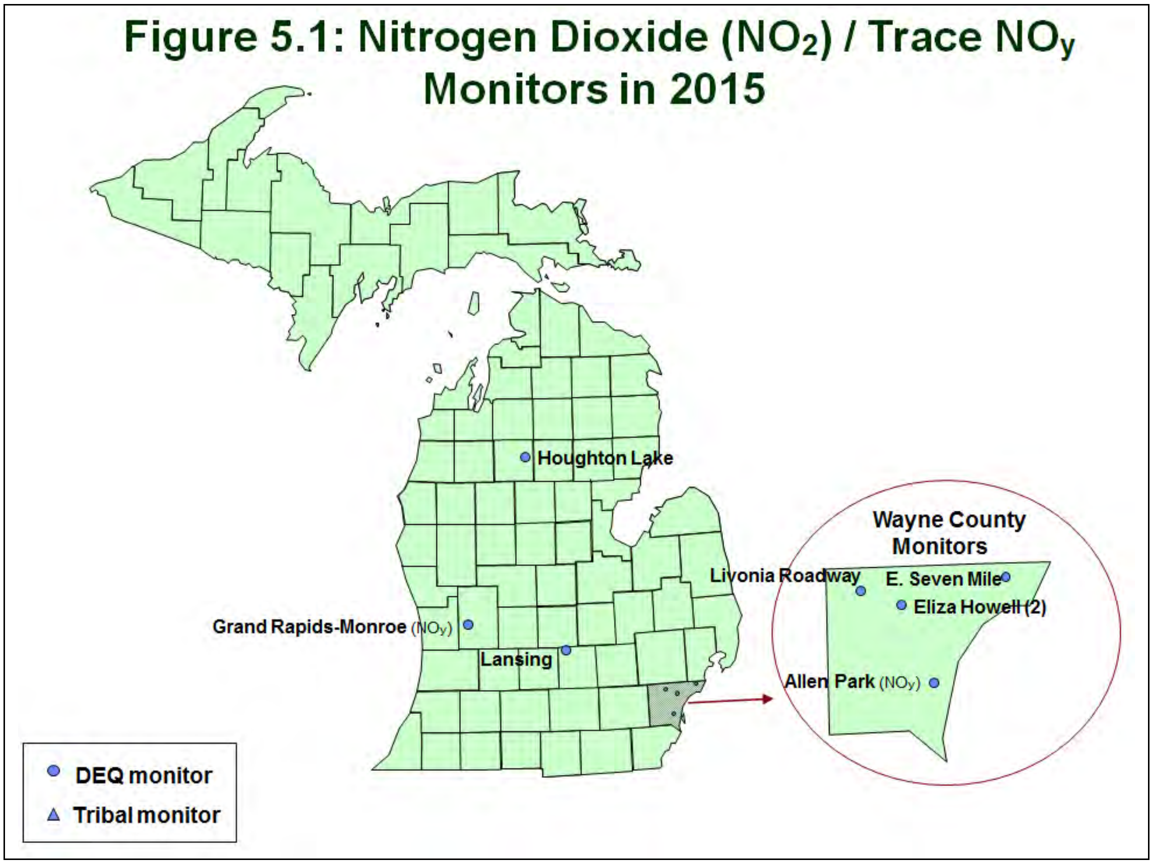


Figure 5.1: Nitrogen Dioxide (NO_2) / Trace NO_y Monitors in 2015

Figures 5.2 and **5.3** show NO_2 emission sources and NO_2 emissions by county (courtesy of the EPA's State and County Emission Summaries).

Figure 5.2: NO_2 Emissions by Source Sector

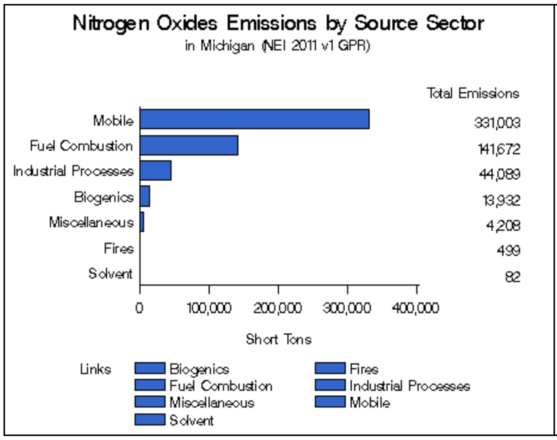
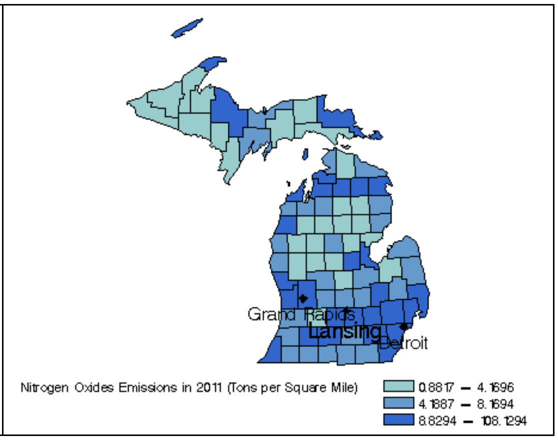
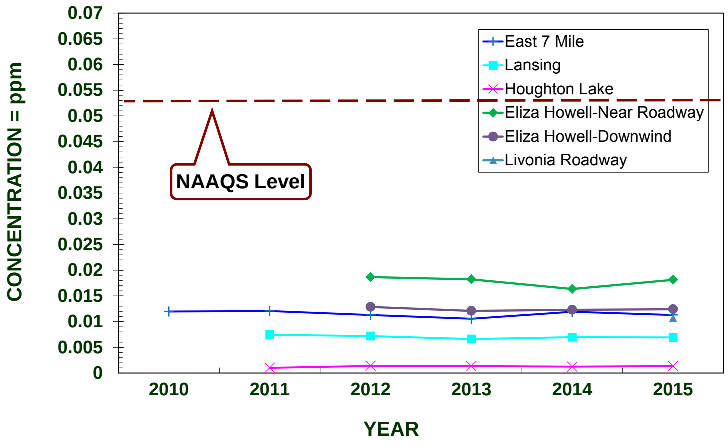


Figure 5.3: NO_2 Emissions in 2011



Michigan's ambient NO_2 levels have always been well below the NAAQS. Since March 3, 1978, all areas in Michigan have been in attainment for the annual NO_2 NAAQS. As shown in **Figure 5.4**, all monitoring sites have had an annual NO_2 concentration at less than half of the 0.053 ppm NAAQS. As such, when EPA lowered the NO_2 NAAQS in 2010, they designated Michigan as unclassifiable/attainment, since the existing NO_2 network did not provide adequate evidence that the NAAQS was met in all areas; however, there were no violations of the NO_2 standard. Thus, unclassifiable/attainment better reflects the current air quality conditions.

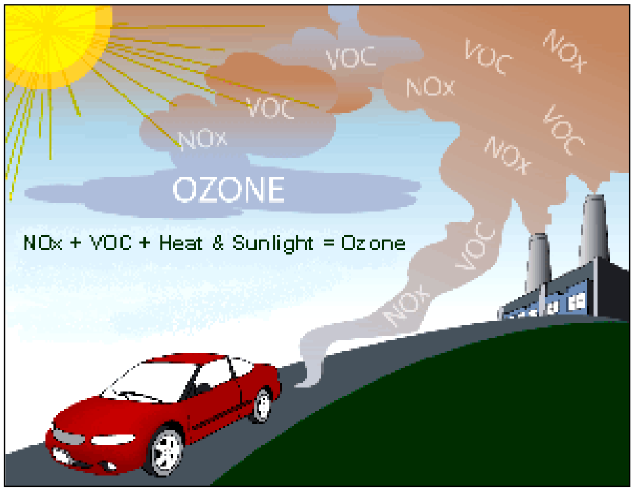
Figure 5.4: NO$_2$ Levels in MI from 2010-2015 (Annual Arithmetic Mean)*



*Since Allen Park and Grand Rapids are monitoring NO$_Y$, those sites are not included in graph.

Even though there are no nonattainment areas for NO$_2$ in Michigan and monitoring for attainment purposes is not required, monitors continue to operate to support photochemical model validation work.

Chapter 6: Ozone (O_3)



Ground-level O_3 is created by reactions involving nitrogen oxides (NO_X) and volatile organic compounds (VOCs), or hydrocarbons, in the presence of sunlight as the illustration to the right depicts (image courtesy of the EPA). These reactions usually occur during the hot summer months as ultraviolet radiation from the sun initiates a sequence of photochemical reactions. In Earth's upper atmosphere (the stratosphere) O_3 helps by absorbing much of the sun's ultraviolet radiation, but in the lower atmosphere (the troposphere), ozone is an air pollutant. O_3 is also a key ingredient of urban smog and can be transported hundreds of miles under certain meteorological conditions. Ozone levels are often higher in rural areas than in cities due to transport to regions downwind from the actual emissions of NO_X and VOCs. Shoreline monitors along Lake Michigan often measure high ozone concentrations due to transport from upwind states. The ozone NAAQS was revised by the EPA and became effective on May 27, 2008. It is a 3-year average of the 4th highest daily maximum 8-hour average concentration that must not exceed 0.075 ppm. After the end of the 2015 Ozone season, the standard was again revised and now must not exceed 0.070ppm. The sources and effects of ozone follow:

Sources: Major sources of NO_X and VOCs are engine exhaust, emissions from industrial facilities, combustion from power plants, gasoline vapors, chemical solvents, and biogenic emissions from natural sources. Ground-level O_3 can also be transported hundreds of miles under certain wind regimes. As a result, the long-range transport of air pollutants impacts the air quality of regions downwind from the actual area of formation.

Effects: Elevated O_3 exposure can irritate airways, reduce lung function, aggravate asthma and chronic lung diseases like emphysema and bronchitis, and inflame and damage the cells lining the lungs. Other effects include increased respiratory related hospital admissions with symptoms such as chest pain, shortness of breath, throat irritation, and cough. O_3 may also reduce the immune system's ability to fight off bacterial infections in the respiratory system, and long-term, repeated exposure may cause permanent lung damage. O_3 also impacts vegetation and forest ecosystems, including agricultural crop and forest yield reductions, diminished resistance to pests and pathogens, and reduced survivability of tree seedlings.

Population most at risk: Individuals most susceptible to the effects of O_3 exposure include those with a pre-existing or chronic respiratory disease, children who are active outdoors and adults who actively exercise or work outdoors.

Figure 6.1 shows the location of the DEQ's O_3 monitors in Michigan.

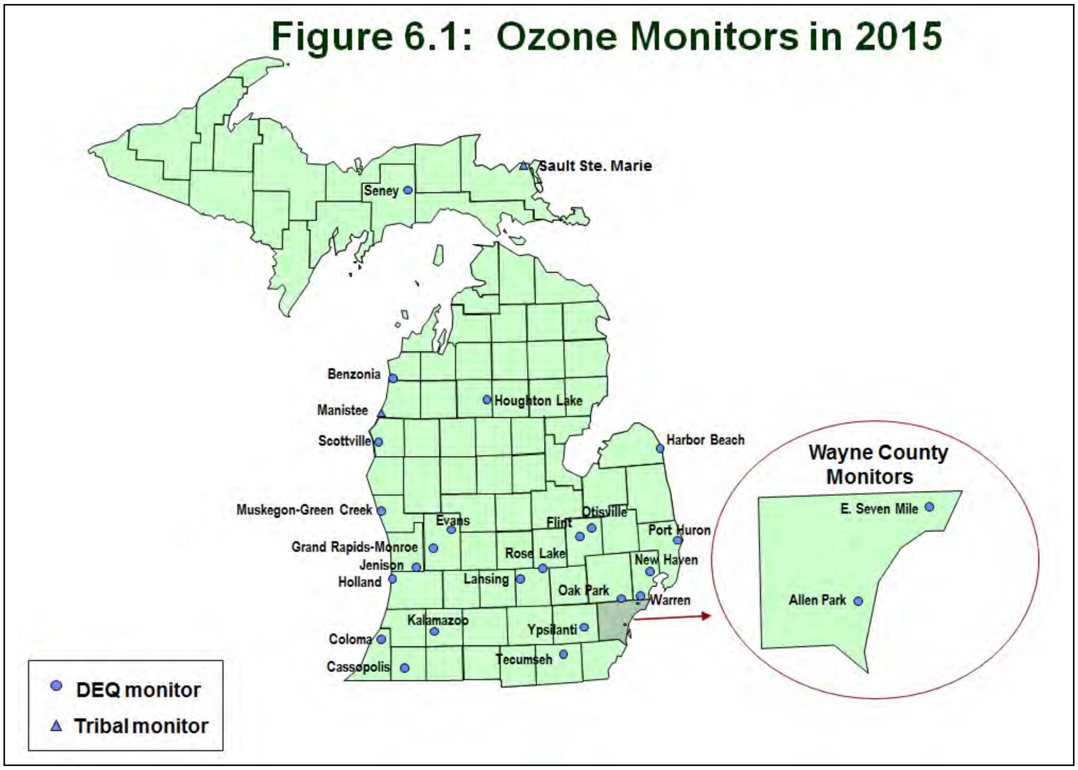


Figure 6.1: Ozone Monitors in 2015

Figures 6.2 and **6.3** show VOC emission sources and VOC emissions by county (courtesy of the EPA's State and County Emission Summaries).

Figure 6.2: VOC Emissions by Source Sector

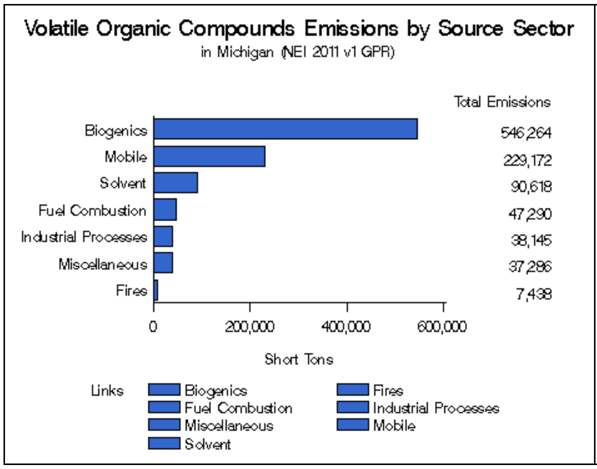
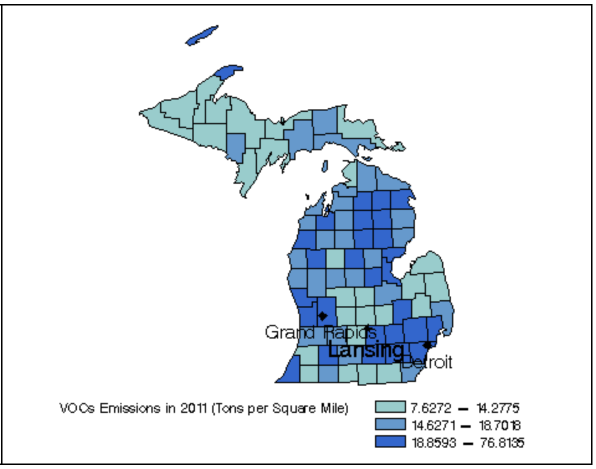


Figure 6.3: VOC Emissions in 2011



The EPA revised the primary 8-hour ozone NAAQS to 0.075 ppm in March 2008, which became effective May 2008. To attain the 2008 standard, the 3-year average of the 4th highest daily maximum 8-hour average concentration within an area must not exceed 0.075 ppm. The secondary 8-hour ozone was also revised, making it identical to the primary standard.

According to the EPA's April 30, 2012 letter, no areas in Michigan violated the 2008 standards or contributed to a violation of the ozone standards. Thus as a result, all of Michigan was designated as unclassifiable/attainment. In 2015 all ozone monitors in the state were below the

2008 NAAQS level of 0.075, but several monitors violated the new 2012 standard of 0.070. Designations for the new standard have not been made yet, but it is likely that Michigan will have some areas showing nonattainment for the 2012 standard (see **Table 6.1**).

The O_3 monitoring season in Michigan is currently from April 1 through September 30, the hottest portion of the year. Starting in 2017, the ozone season will be extended to March 1 through October 31, based on the 2015 NAAQS. During this time O_3 monitoring data is available for the public via the AQD's web site (discussed in **Chapter 9**). However year round O_3 monitoring is done at the following four sites: Allen Park, Grand Rapids, Houghton Lake and Lansing. This data helps in attainment designations and urban air quality and population exposure assessments.

Figure 6.1 shows all O_3 air quality monitors active in Michigan at the beginning of the 2015 ozone season.

Table 6.1: 3-year Average of the 4th Highest 8-hour Ozone Values from 2011-2013, 2012-2014, and 2013-2015 (concentrations in ppm). Numbers in Bold Indicate 3-year Averages Over the 2008 Ozone Standard of 0.075ppm.

Areas	County	Monitor Sites	2011-2013	2012-2014	2013-2015
Detroit-Ann Arbor	Lenawee	Tecumseh	0.075	0.073	0.065
	Macomb	New Haven	**0.077**	0.074	0.071
		Warren	**0.077**	0.072	0.066
	Oakland	Oak Park	**0.076**	0.071	0.066
	St. Clair	Port Huron	0.075	0.074	0.072
	Washtenaw	Ypsilanti	0.075	0.073	0.066
	Wayne	Allen Park	0.072	0.068	0.064
		Detroit-East 7 Mile	**0.077**	0.074	0.070
Flint	Genesee	Flint	0.074	0.072	0.066
		Otisville	0.074	0.072	0.067
Grand Rapids	Ottawa	Jenison	**0.077**	0.075	0.068
	Kent	Grand Rapids	0.074	0.071	0.067
		Evans	0.074	0.070	0.066
Muskegon Co	Muskegon	Muskegon	**0.081**	**0.079**	0.074
Allegan Co	Allegan	Holland	**0.086**	**0.083**	0.075
Huron	Huron	Harbor Beach	0.072	0.071	0.065
Kalamazoo-Battle Creek	Kalamazoo	Kalamazoo	0.075	0.073	0.067
Lansing-East Lansing	Ingham	Lansing	0.072	0.070	0.065
	Clinton	Rose Lake	0.071	0.069	0.064
Benton Harbor	Berrien	Coloma	**0.082**	**0.079**	0.073
Benzie Co	Benzie	Benzonia	0.074	0.073	0.068
Cass Co	Cass	Cassopolis	**0.078**	0.073	0.068
Chippewa Co	Chippewa	Sault Ste. Marie	0.067	0.065	0.059
Mason Co	Mason	Scottville	0.075	0.074	0.068
Missaukee Co	Missaukee	Houghton Lake	0.070	0.070	0.064
Manistee Co	Manistee	Manistee	0.074	0.072	0.067
Schoolcraft Co	Schoolcraft	Seney	0.072	0.073	0.068

Tables 6.2 and **6.3** highlight the number of days when two or more O_3 monitors exceeded 0.075 ppm. It also specifies in which month they occurred and the temperature range.

Table 6.2: 2015 West Michigan Ozone Season

Daily High Temperature Range			2015 WEST MICHIGAN OZONE SEASON											
			April		May		June		July		August		September	
			Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days
	>=	95	0	0	0	0	0	0	0	0	0	0	0	0
90	<=	94	0	0	0	0	0	0	1	0	1	0	0	0
85	<=	89	0	0	1	0	0	0	10	1	4	0	4	0
80	<=	84	0	0	6	0	9	0	10	0	10	0	9	0
75	<=	79	1	0	5	0	13	0	6	0	9	0	7	0
70	<=	74	1	0	7	0	6	0	3	0	3	0	6	0
65	<=	69	7	0	4	0	2	0	1	0	3	0	2	0
60	<=	64	8	0	3	0	0	0	0	0	1	0	2	0
55	<=	59	6	0	3	0	0	0	0	0	0	0	0	0
50	<=	54	3	0	2	0	0	0	0	0	0	0	0	0
49	<=		4	0	0	0	0	0	0	0	0	0	0	0
Totals			**30**	**0**	**31**	**0**	**30**	**0**	**31**	**1**	**31**	**0**	**30**	**0**

Days: Number of days during month when the daily high temperature falls within the specified temperature range.

O_3 Days: Number of days, during specified temperature range, when two or more area monitors exceeded 75 ppb.

For West Michigan there were no O_3 exceedance days except for one day in July when ozone exceeded 0.075 ppm at two or more ozone monitors. The temperatures for those days were between 85^0F and 89^0F.

Table 6.3: 2015 Southeast Michigan Ozone Season

Daily High Temperature Range			2015 SOUTHEAST MICHIGAN OZONE SEASON											
			April		May		June		July		August		September	
			Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days	Days	O_3 Days
	>=	95	0	0	0	0	0	0	0	0	0	0	0	0
90	<=	94	0	0	0	0	1	0	4	0	1	0	4	0
85	<=	89	0	0	3	0	1	0	10	1	9	0	3	0
80	<=	84	0	0	9	0	11	0	8	0	8	0	6	0
75	<=	79	3	0	9	0	8	0	7	0	10	0	9	0
70	<=	74	0	0	1	0	7	0	1	0	0	0	4	0
65	<=	69	7	0	4	0	2	0	1	0	3	0	3	0
60	<=	64	10	0	3	0	0	0	0	0	0	0	1	0
55	<=	59	2	0	1	0	0	0	0	0	0	0	0	0
50	<=	54	5	0	1	0	0	0	0	0	0	0	0	0
49	<=		3	0	0	0	0	0	0	0	0	0	0	0
Totals			**30**	**0**	**31**	**0**	**30**	**0**	**31**	**1**	**31**	**0**	**30**	**0**

Days: Number of days during month when the daily high temperature falls within the specified temperature range.

O_3 Days: Number of days, during specified temperature range, when two or more area monitors exceeded 75 ppb.

For Southeast Michigan there were no O_3 exceedance days except for one day in July when ozone exceeded 0.075 ppm at two or more ozone monitors. The temperature for that day was between 85^0F and 89^0F.

Table 6.4 gives a breakdown of the O_3 days and the specific monitors that went over the standard in the western, central/upper, and eastern Michigan.

Table 6.4: 8-hour Exceedance Days (>0.075 ppm) and Locations

Date	Monitors with Exceedances of the Ozone Standard			Total
	Western Michigan	Central/Upper Michigan	Eastern Michigan	
05/07/2015	Manistee	Seney		2
06/10/2015	Cassopolis			1
07/06/2015			Harbor Beach, New Haven, E. Seven Mile	3
07/12/2015			Harbor Beach	1
07/17/2015	Holland			1
07/24/2015	Holland, Grand Rapids, Muskegon, Jenison			4
08/17/2015	Muskegon			1
09/01/2015			New Haven	1
09/02/2015			Port Huron	1
09/03/2015	Coloma			1
09/16/2015		Seney		1
09/17/2015			Port Huron	1
			TOTAL	18

On June 6, 2015 there were three monitors and on June 24, 2015 there were four monitor readings that exceeded the level of the standard. Sites with the most exceedances in the western region of Michigan were Holland and Muskegon with two each. The central/upper Michigan site with the most exceedance was Seney with two. New Haven, Harbor Beach and Port Huron each had two exceedances in eastern Michigan.

Figure 6.4: O_3 Levels in Detroit-Warren-Flint CSA from 2010-2015 (4th Highest 8-Hour O_3 Values)

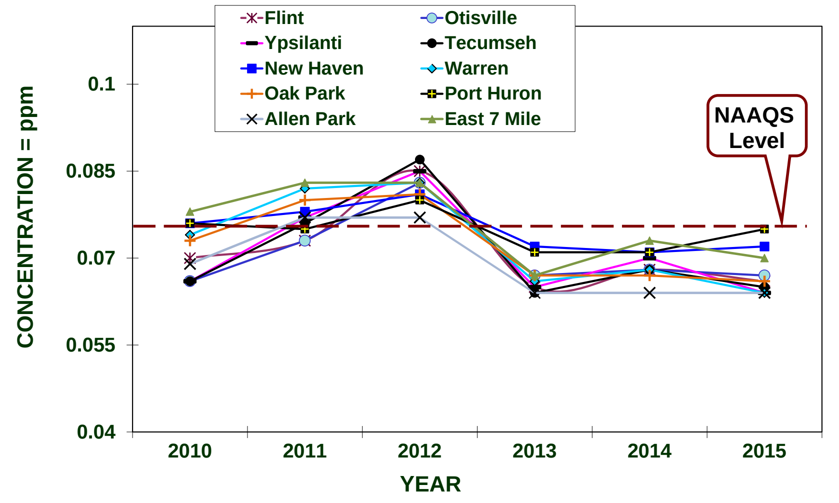


Figure 6.4 shows the 4th highest 8-hour O_3 values for Southeast Michigan monitoring sites from 2010-2015. No sites violated the 3-year standard.

Figure 6.5: O_3 Levels in the Grand Rapids-Muskegon-Holland CSA from 2010-2015 (4th Highest 8-Hour O_3 Values)

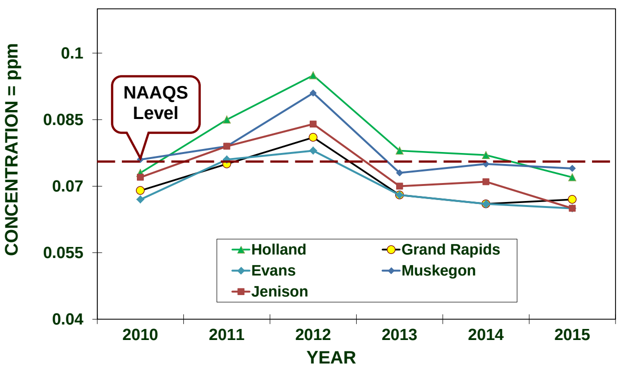


Figure 6.6: O_3 Levels in the Kalamazoo-Portage MSA, Lansing-E. Lansing-Owosso CSA, Niles-Benton Harbor MSA, & South Bend-Mishawaka (IN-MI) MSAs from 2010-2015 (4th Highest 8-Hour O_3 Values)

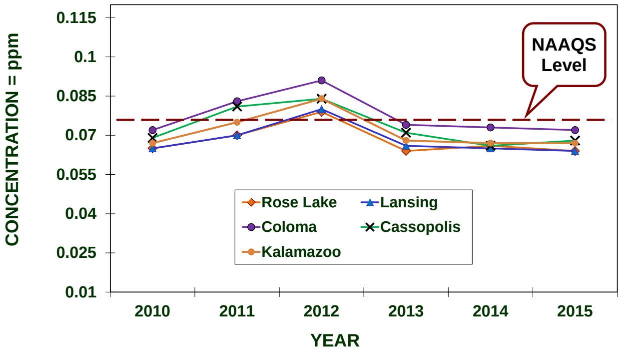


Figure 6.7: O_3 Levels in MI's Northern Lower and Upper Peninsula Areas from 2010-2015 (4th Highest 8-Hour O_3 Values)

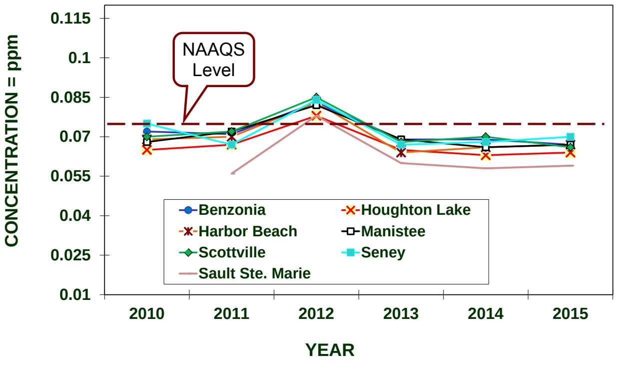


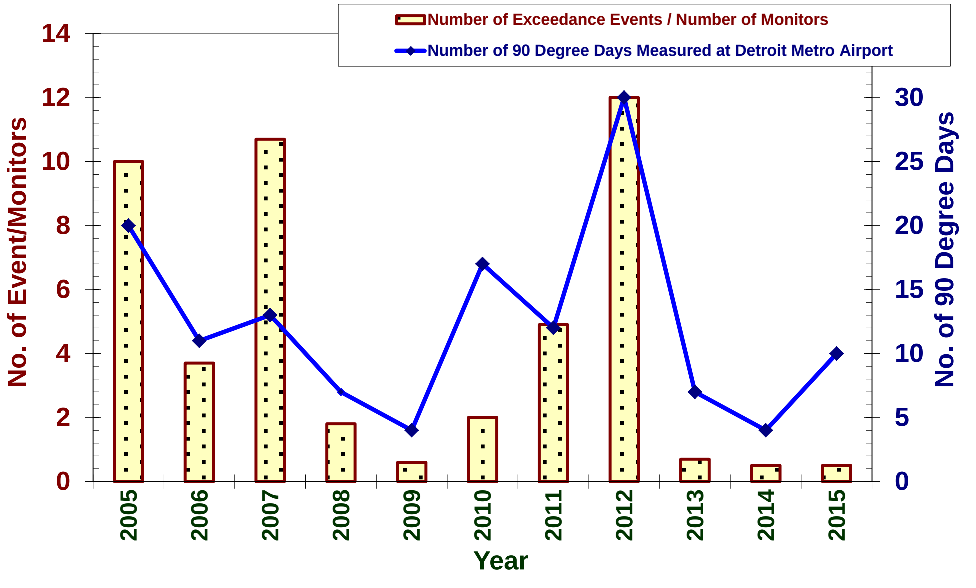
Figure 6.5 shows the 4th highest 8-hour O_3 values for Grand Rapids-Muskegon-Holland CSA. No sites violated the 3-year standard.

Figure 6.6 shows 4th highest 8-hour O_3 values for Mid-Michigan. No sites violated the 3-year standard.

Figure 6.7 shows 4th highest 8-hour O_3 values for Northern Lower and Upper Peninsula Michigan. No sites violated the 3-year standard.

Figure 6.8 shows 8-hour O_3 readings ≥ 0.075 ppm with the number of 90°F days (≥ 90°F) measured at the Detroit Metropolitan Airport. The total number of southeastern Michigan-area 8-hour readings above 0.075 ppm was divided by the number of monitors that were in operation each year to provide a relative indication of the frequency of elevated 8-hour O_3 values.

Figure 6.8: 8-Hour O_3 Level Events Exceeding the 0.075 ppm NAAQS from 2005-2015



This comparison shows the influence of temperature with respect to elevated O_3 levels. Over the past 10 years, a typical summer would have an average of 12.5 days with the maximum daily temperature exceeding 90°F. Over the time period from 2005 through 2015, the highest number of 90°F days occurred in 2012 (30 days), while the lowest number occurred in 2009 and 2014 (four days).

Chapter 7: Particulate Matter (PM_{10}, $PM_{2.5}$, $PM_{2.5}$ Chemical Speciation and TSP)

Particulate matter (PM) is a general term used for a mixture of solid particles and liquid droplets (aerosols) found in the air. These are further categorized according to size; larger particles with diameters of less than 50 micrometers (µm) are classified as total suspended particulates (TSP). PM_{10} consists of "coarse particles" less than 10 µm in diameter (about one-seventh the diameter of a human hair) and $PM_{2.5}$ are much smaller "fine particles" equal to or less than 2.5 µm in diameter. PM_{10} has a 24-hour average standard of 150 µg/m^3. $PM_{2.5}$ has an annual average standard of 12 µg/m^3, and a 98th percentile 24-hour average of 35 µg/m^3 over three years. The sources and effects of PM are as follows:

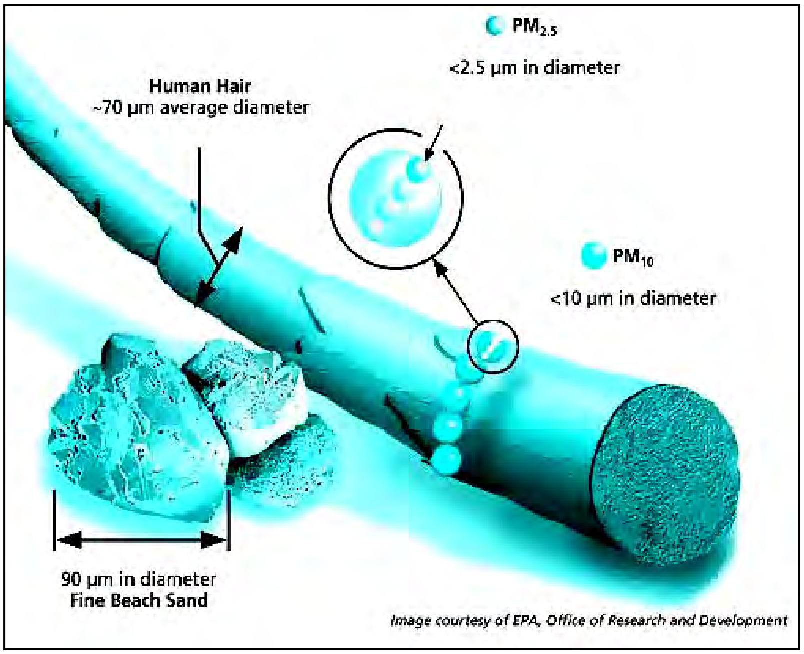


Image courtesy of EPA, Office of Research and Development

Sources: PM can be emitted directly (primary) or may form in the atmosphere (secondary). Most man-made particulate emissions are classified as TSP. PM_{10} consists of primary particles that can originate from power plants, various manufacturing processes, wood stoves and fireplaces, agriculture and forestry practices, fugitive dust sources (road dust and windblown soil), and forest fires. $PM_{2.5}$ can come directly from primary particle emissions or through secondary reactions that include VOCs, SO_2, and NO_X emissions originating from power plants, motor vehicles (especially diesel trucks and buses), industrial facilities, and other types of combustion sources.

Effects: Exposure to PM affects breathing and the cellular defenses of the lungs, aggravates existing respiratory and cardiovascular ailments, and has been linked with heart and lung disease. Smaller particles (PM_{10} or smaller) pose the greatest problems, because they can penetrate deep in the lungs and possibly into the bloodstream. PM is the major cause of reduced visibility in many parts of the U.S. $PM_{2.5}$ is considered a primary visibility-reducing component of urban and regional haze. Airborne particles impact vegetation ecosystems and damage paints, building materials and surfaces. Deposition of acid aerosols and salts increases corrosion of metals and impacts plant tissue.

Population most at risk: People with heart or lung disease, the elderly, and children are at highest risk from exposure to PM.

PM_{10}

Since October 1996, all areas in Michigan have been in attainment with the PM_{10} NAAQS. Due to the recent focus upon $PM_{2.5}$ and because of the relatively low concentrations of PM_{10} measured in recent years, Michigan's PM_{10} network has been reduced to a minimum level. **Table 1-3** identifies the locations of PM_{10} monitoring stations that were operating in Michigan during 2015. These monitors are located mostly in the state’s largest populated urban areas: four in the Detroit area and one in Grand Rapids. The PM_{10} monitor in Vassar was shut down at the end of 2014 due to the factory, the source of the emissions, being shut down. To better characterize the nature of particulate matter in Michigan, many of the existing PM_{10} monitors are co-located with $PM_{2.5}$ monitors in population-oriented areas.

Figure 7.1 shows the location of each PM_{10} monitor.

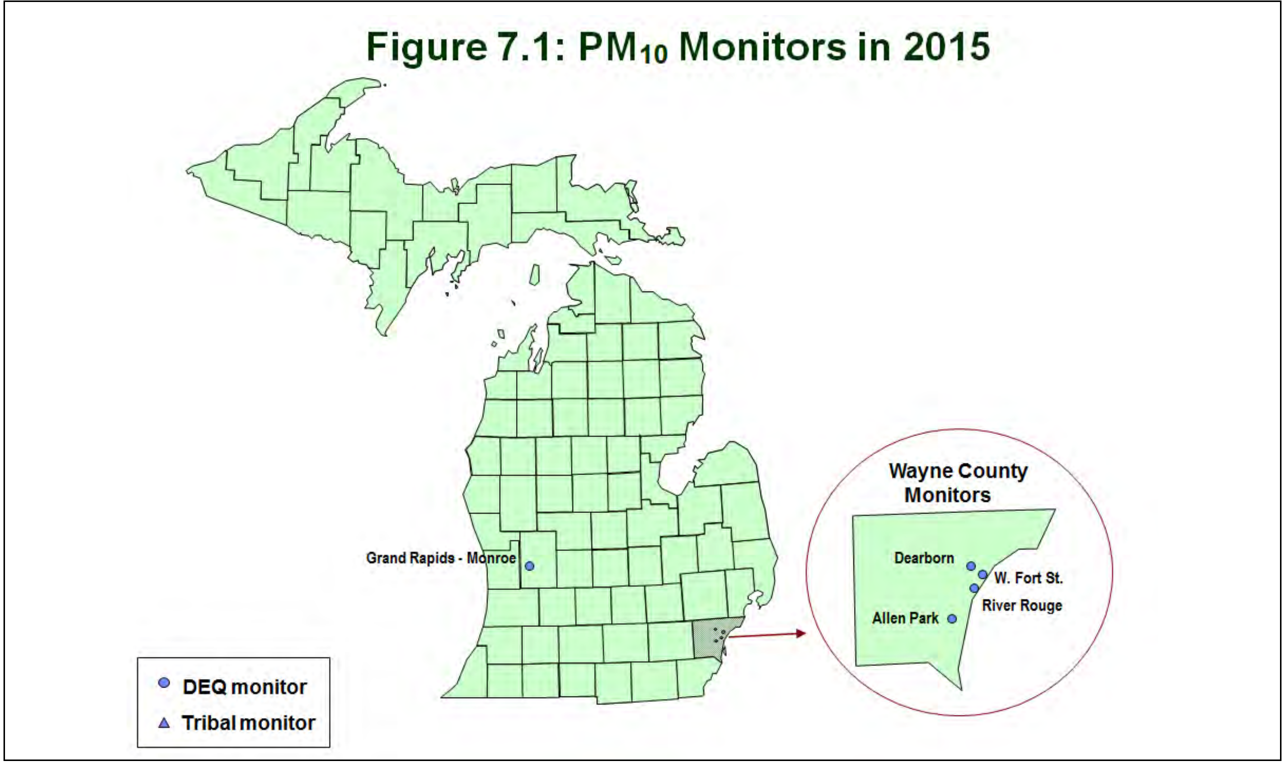


Figure 7.1: PM_{10} Monitors in 2015

Figures 7.2 and **7.3** show PM_{10} emission sources and PM_{10} emissions by county (courtesy of the EPA’s State and County Emission Summaries).

Figure 7.2: PM_{10} Emissions by Source Sector

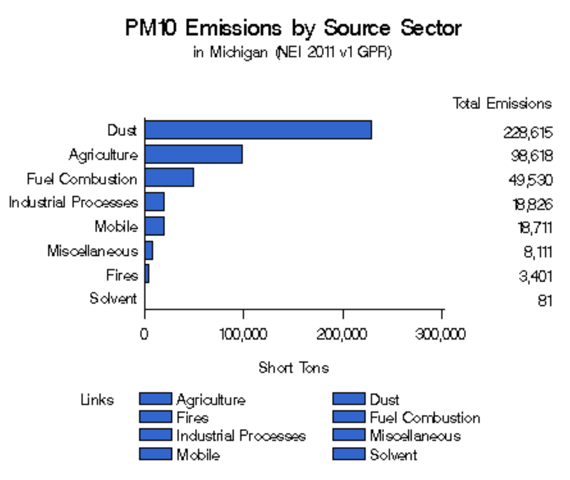


Figure 7.3: PM_{10} Emissions in 2011

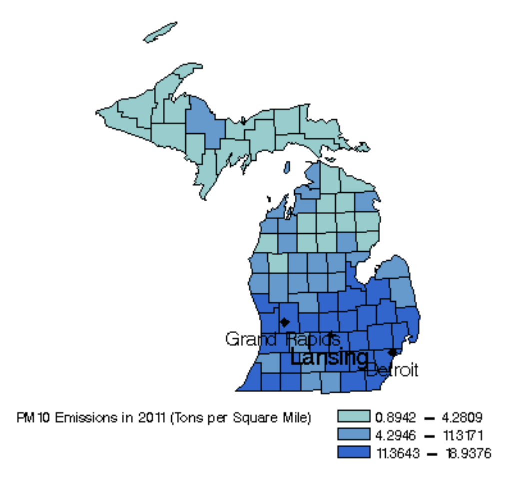
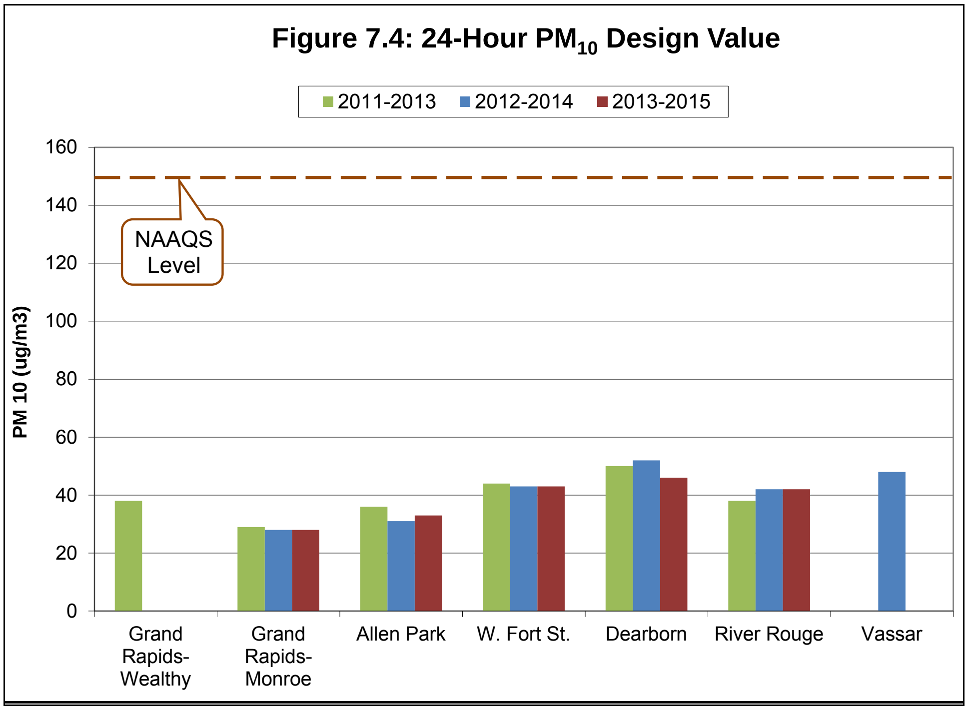


Figure 7.4 shows the PM_{10} levels in Michigan compared to the 24-hour average of 150 µg/m^3. This standard must not be exceeded on average more than once per year over a 3-year period. The design value is the 4th highest value over a 3-year period. The PM_{10} levels at all sites in Michigan are well below the national standard.



$PM_{2.5}$

All Michigan counties from 2010-2014 met the 1997 annual $PM_{2.5}$ standard of 15 µg/m^3 and the 2006 24-hour $PM_{2.5}$ standard of 35 µg/m^3. The EPA designated Michigan in attainment of these standards in August 2013. In December 2012, the EPA revised the annual primary standard to 12 µg/m^3 while the annual secondary standard remained at 15 µg/m^3. The primary and secondary 24-hour standard remained as 35 µg/m^3. In December 2014, EPA determined that no area in Michigan violated the 2012 standard and the state was classified and unclassifiable/attainment.

Fine particulate matter ($PM_{2.5}$) is measured using three techniques: Federal Reference Method (FRM), Continuous Methods, and Chemical Speciation Methods. These methods are described in more detail below.

$PM_{2.5}$ FRM monitoring: The concentrations of $PM_{2.5}$ measured over a 24-hour time period are determined using the filter based gravimetric FRM. Only data generated by the FRM monitors are used for comparisons to the NAAQS in Michigan. The sites are located in urban, commercial, and residential areas where people are exposed to $PM_{2.5}$.

Continuous $PM_{2.5}$ monitoring: Continuous monitoring is beneficial as it provides real-time hourly data that supplements the $PM_{2.5}$ data collected by FRM monitors. This data forms the basis of the information reported on AirNow and MIair.

Chemical Speciation monitoring: Speciated monitoring provides a better understanding of the chemical composition of $PM_{2.5}$ material and better characterizes background levels.

Figure 7.5 shows the location of each $PM_{2.5}$ monitor.

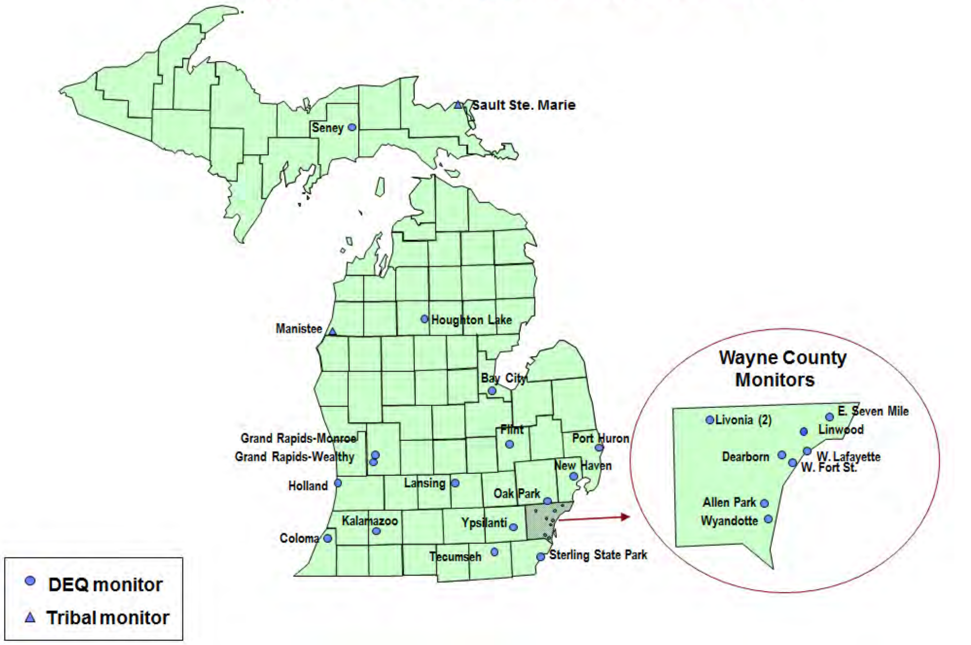


Figure 7.5: $PM_{2.5}$ Monitors in 2015

$PM_{2.5}$ FRM Monitoring Network: $PM_{2.5}$ FRM monitors are deployed to characterize background or regional $PM_{2.5}$ transport collectively from upwind sources. A $PM_{2.5}$ monitor was added to the new near-roadway site in Livonia the started in January 2015.

Four $PM_{2.5}$ FRM monitoring sites are co-located with PM_{10} monitors to allow for $PM_{2.5}$ and PM_{10} comparisons[6]. Co-located PM_{10} and $PM_{2.5}$ sites include Grand Rapids-Monroe, Dearborn, Allen Park, and Detroit's W. Fort Street (SWHS) station.

Continuous $PM_{2.5}$ Network: Short-term measurements of $PM_{2.5}$ or PM_{10} are updated on an hourly basis using Tapered Element Oscillating Microbalance (TEOM) instruments. At least one continuous TEOM is required at the NCore $PM_{2.5}$ monitoring site in a metropolitan area with a population greater than one million. Both Detroit (Allen Park) and Grand Rapids (Monroe) meet this requirement[7]. Under the revised 2006 air monitoring regulations, 50 percent of the FRM monitoring sites are now required to have a continuous $PM_{2.5}$ monitor. For Michigan, there are 26 FRM monitoring sites, 13 of which also have TEOMS. The DEQ initially operated all TEOM units with an inlet temperature of 50ºC, but this high inlet temperature was volatilizing nitrate levels during the winter months. Therefore, the DEQ began operating TEOMs with a 30°C inlet temperature October through March and a 50°C inlet temperature between April and September.

$PM_{2.5}$ Chemical Speciation Monitoring Network: Single event Met-One Speciation Air Sampling System (SASS) monitors are used throughout Michigan's speciation network and are placed in population-oriented stations in both urban and rural locations. $PM_{2.5}$ chemical speciation samples are collected over a 24-hour period and analyzed to determine various components of $PM_{2.5}$. There were eight SASS monitors operating in Michigan; see **Table 1.3.** Houghton Lake, Port Huron and Sterling State Park were shut down Jan 24th, 2015 due to lack

---

[6] Requirements for $PM_{2.5}$ FRM sites are obtained from the Revised Requirements for Designation of Reference and Equivalent Methods for $PM_{2.5}$ and Ambient Air Quality Surveillance for PM [62 FR 38763]; Guidance for Using Continuous Monitors in $PM_{2.5}$ Monitoring Networks [EPA-454/R-98-012, May 1998]; and Appendix N to Part 50 -Interpretation of the National Ambient Air Quality Standards for PM [40 CFR Part 50, July 1, 1998].

[7] Under the Guidance for Using Continuous Monitors in $PM_{2.5}$ Monitoring Networks [EPA-454/R-98-012, May 1998].

of funding. The primary objectives of the chemical speciation monitoring sites are to provide data that will be used to determine the sources of poor air quality and to support the development of attainment strategies. Historical speciation data for Michigan indicates that $PM_{2.5}$ is made up of 30 percent nitrate compounds, 30 percent sulfate compounds, 30 percent organic carbon[8], and 10 percent unidentified or trace elements.

Continuous $PM_{2.5}$ Speciation Monitoring (EC/OC and Aethalometer) Network: To determine diurnal changes in $PM_{2.5}$ composition, the DEQ operated two aethalometers and two elemental carbon/organic carbon (EC/OC) monitors in 2015.

- Aethalometers measure carbon black, a combustion by-product typical of transportation sources, by concentrating particulate on a filter tape and measuring changes in optical transmissivity and absorption. In 2015, the DEQ's aethalometers were located at Allen Park and Dearborn.
- The EC/OC instruments measure elemental carbon, using pyroloysis coupled with a nondispersive infrared detector to separate the elemental and organic carbon fractions. Instruments are located at Dearborn and Tecumseh.

$PM_{10\text{-}2.5}$

The 2006 amended air monitoring regulations specified that measurements of PM_{10}-$PM_{2.5}$ need to be added to the NCore sites[9]. The DEQ began PM_{10}-$PM_{2.5}$ monitoring in 2010 at Allen Park and Grand Rapids – Monroe Street.

Table 1.3 in chapter 1 shows all of Michigan's $PM_{2.5}$ FRM monitoring stations operating in 2015 and denotes which sites also have TEOM, SASS, Aethalometer or EC/OC monitors in operation.

Figures 7.6 and **7.7** show $PM_{2.5}$ emission sources and $PM_{2.5}$ emissions by county (from the EPA's State and County Emission Summaries).

Figure 7.6: $PM_{2.5}$ Emissions by Source Sector

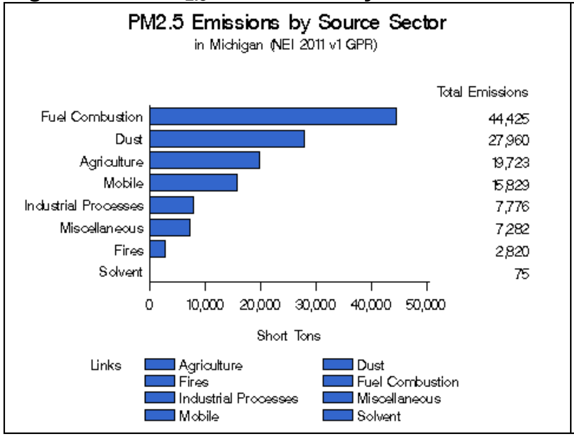
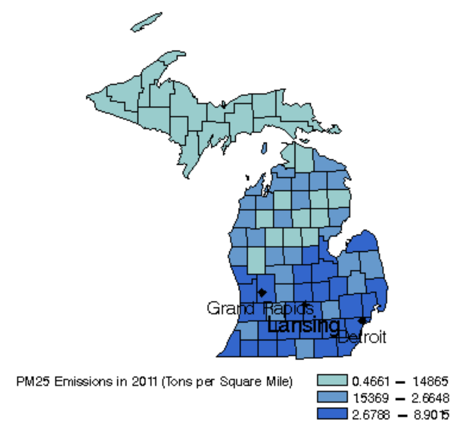


Figure 7.7: $PM_{2.5}$ Emissions in 2011



---

[8] To better understand the chemical composition of the organic carbon fraction, a number of studies have been conducted in southeast Michigan to further investigate organic carbon. Information can be found in the Michigan 2012 Ambient Air Monitoring Network Review, available at http://www.michigan.gov/documents/deq/deq-aqd-aqe-2012-Air-Mon-Network-Review_357137_7.pdf

[9] Current information can be found at https://www3.epa.gov/pm/actions.html.

Table 7.1 provides the 3-year average of the annual mean $PM_{2.5}$ concentrations for 2013-2015. Michigan's levels are below the 12 µg/m^3 primary standard[10]. Stations labeled #2 provide a precision estimate of the overall measurement and operate on a one in six sampling schedule. All other monitors are sampled on a one-in-three-day schedule, except for Allen Park #1 and Detroit – W. Lafayette, which sample daily.

Table 7.1: 3-year Average of the Annual Mean $PM_{2.5}$ Concentrations

Areas	County	Monitoring Sites	2013	2014	2015	2013-2015 Mean
Detroit-Ann Arbor	Lenawee	Tecumseh	7.93	8.78	8.58	8.4
	Livingston					
	Macomb	New Haven	7.95	9.10	9.73	8.9
	Oakland	Oak Park	8.38	9.33	9.37	9.0
	St. Clair	Port Huron	8.44	9.40	9.51	9.1
	Washtenaw	Ypsilanti #1	8.64	9.79	9.56	9.3
		Ypsilanti #2	9.18	9.37	9.08	9.2
	Wayne	Allen Park	9.49	10.13	9.66	9.8
		Detroit-Linwood	8.86	9.74	10.18	9.6
		Detroit-East 7 Mile	8.71	9.64	9.79	9.4
		Detroit-W. Fort	10.11	10.99	11.26	10.8
		Detroit-W. Lafayette	9.34	9.68	9.12	9.4
		Wyandotte	8.00	9.71	8.62	8.8
		Dearborn #1	11.01	11.77	11.50	11.4
		Dearborn #2	10.80	11.64	11.65	11.4
		Livonia	8.67	9.46	9.31	9.2
		Livonia-Roadway			9.53	
Flint	Genesee	Flint	7.44	8.92	8.16	8.2
	Lapeer					
Grand Rapids	Ottawa	Jenison	8.09			
	Kent	Grand Rapids-Wealthy	8.99	9.91	9.37	9.4
		Grand Rapids #1	8.38	9.49	9.30	9.1
		Grand Rapids #2	8.80	9.30	10.37	9.4
Muskegon Co	Muskegon	Muskegon	9.95*			
Allegan Co	Allegan	Holland	7.82	8.68	7.88	8.1
Monroe Co	Monroe	Luna Pier	9.71*			
		Sterling State Park	8.91*	9.03*	9.26	9.1
Kalamazoo-Battle Creek	Calhoun					
	Kalamazoo	Kalamazoo #1	8.27	9.64	8.90	8.9
		Kalamazoo #2	8.79	9.45	9.34	9.1
	Van Buren					
Lansing-East Lansing	Ingham	Lansing	7.58	9.38	8.56	8.5
	Clinton					
	Eaton					
Benton Harbor	Berrien	Coloma	7.97	8.49	8.15	8.2
Bay Co	Bay	Bay City	7.47	8.17	7.74	7.8
Missaukee Co	Missaukee	Houghton Lake	5.49	5.62	5.59	5.6
Manistee Co	Manistee	Manistee	6.45	6.16	6.37	6.3
Chippewa Co	Chippewa	Sault Ste. Marie #1	6.04	6.23	5.79*	6.1
		Sault Ste. Marie #2	6.21	5.67	6.18*	6.0

*Indicates mean does not meet completeness criteria.

---

[10] For comparison to the standard, the average annual means is rounded to the nearest 0.1 µg/m^3.

Table 7.2 is a detailed assessment of the 24-hour 98th percentile $PM_{2.5}$ concentrations for 2013-2015 showing Michigan's levels are below the 35 μg/m^3 standard (3-year average)[11].

Table 7.2: 98th Percentile $PM_{2.5}$ Values Averaged over 3 Years

Areas	County	Monitoring Sites	2013	2014	2015	2013-2015 Mean
Detroit-Ann Arbor	Lenawee	Tecumseh	16.8	22.8	25.2	22
	Livingston					
	Macomb	New Haven	18.3	27.0	31.6	26
	Oakland	Oak Park	18.9	23.3	29.6	24
	St. Clair	Port Huron	18.9	25.2	28.7	24
	Washtenaw	Ypsilanti #1	18.5	24.5	25.9	23
		Ypsilanti #2	18.9	23.7	20.6	21
	Wayne	Allen Park	22.8	26.4	23.1	24
		Detroit-Linwood	20.0	23.6	27.1	24
		Detroit-East 7 Mile	19.9	22.0	25.6	23
		Detroit-W. Fort St.	21.2	23.8	27.1	24
		Detroit-Newberry	10.2*			
		Detroit-W. Lafayette	22.0	25.5	22.4	23
		Wyandotte	17.7	25.6	21.1	22
		Dearborn #1	24.1	26.5	28.1	26
		Dearborn #2	20.8	26.7	24.7	24
		Livonia	19.6	25.7	26.8	24
		Livonia-Roadway			25.2	
Flint	Genesee	Flint	16.6	24.3	22.3	21
	Lapeer					
Grand Rapids	Ottawa	Jenison	18.2			
	Kent	Grand Rapids-Wealthy	19.0	24.3	25.5	23
		Grand Rapids #1	18.3	23.0	25.6	22
		Grand Rapids #2	18.7	26.9	24.3	23
Muskegon Co	Muskegon	Muskegon	18*			
Allegan Co	Allegan	Holland	17.7	23.4	21.2	21
Monroe Co	Monroe	Luna Pier	9.7*			
		Sterling State Park	19.5*	23.9*	25.7	23
Kalamazoo-Battle Creek	Calhoun					
	Kalamazoo	Kalamazoo #1	17.7	23.9	22.3	21
		Kalamazoo #2	17.9	30.6	21.3	23
	Van Buren					
Lansing-East Lansing	Ingham	Lansing	17.4	22.1	24.5	21
	Clinton					
	Eaton					
Benton Harbor	Berrien	Coloma	17.4	19.8	19.4	19
Bay Co	Bay	Bay City	16	21.1	23.3	20
Missaukee Co	Missaukee	Houghton Lake	17.1	16.3	17.9	17
Manistee Co	Manistee	Manistee	18.2	17.3	19.3	18
Chippewa Co	Chippewa	Sault Ste. Marie #1	14.4	15.3	15.8	15
		Sault Ste. Marie #2	15.5	12.7	16.4	15

*Indicates mean does not meet completeness criteria.

---

[11] The 98th percentile value was obtained from the EPA AQS. For the purpose of comparing calculated values, the 3-year 24-hour average is rounded to the nearest 1 μg/m^3.

Figures 7.8 through **7.11** illustrate the current annual mean $PM_{2.5}$ trend for each monitoring site in Michigan. For clarity, the monitoring sites within the Detroit-Warren-Flint CSA have been broken down into two graphs. **Figure 7.8** shows those sites in Wayne County, and **Figure 7.9** shows the remaining counties within the CSA.

Figure 7.8: Detroit-Warren-Flint CSA - (Wayne County Only) Annual Arithmetic Means for $PM_{2.5}$ from 2010-2015

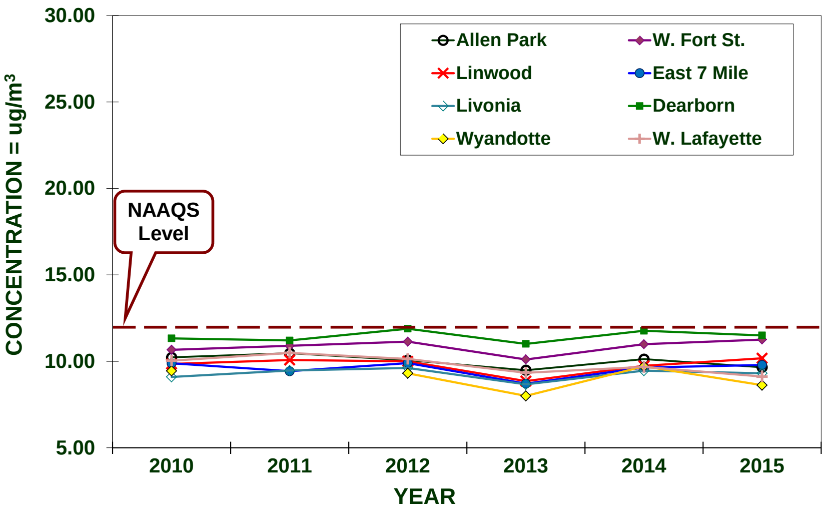


Figure 7.8 shows that 2015 levels in Wayne County remained below the $PM_{2.5}$ NAAQS standard. Historically, Dearborn has had the highest readings in the state.

Figure 7.9: Detroit-Warren-Flint CSA (without Wayne County) Annual Arithmetic Means for $PM_{2.5}$ from 2010-2015

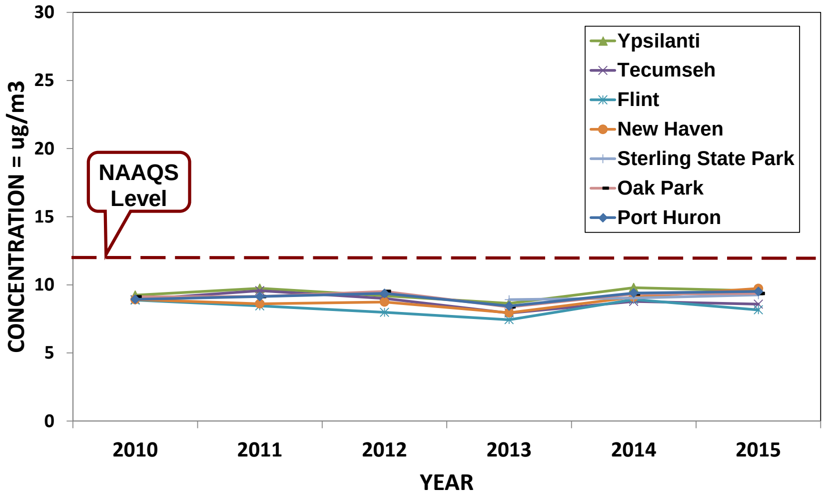


Figure 7.9 contains the remainder of those sites in the Detroit-Warren-Flint CSA that are outside of Wayne County. These sites also show readings in 2015 to be below the $PM_{2.5}$ NAAQS.

Figure 7.10: West MI - Grand Rapids-Muskegon-Holland CSA, Kalamazoo & Benton Harbor MSAs Annual Arithmetic Means for $PM_{2.5}$ from 2010-2015

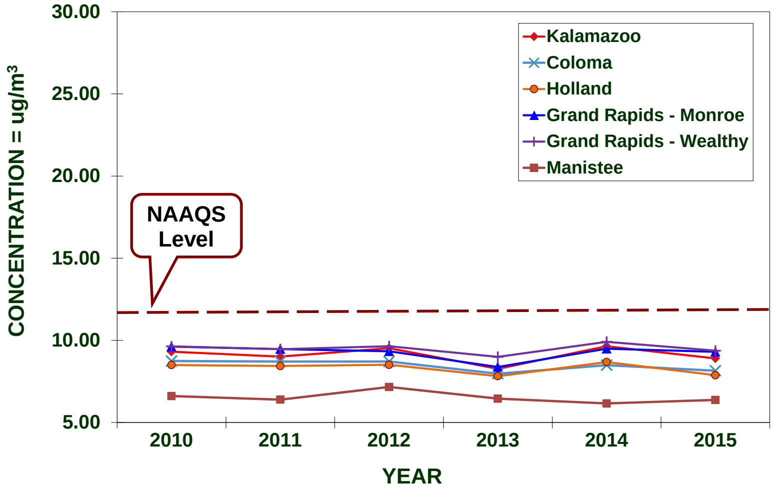


Figure 7.10 combines the $PM_{2.5}$ monitoring sites located in West Michigan-Grand Rapids-Muskegon-Holland CSA, Kalamazoo and Benton Harbor MSAs. All sites are below the annual $PM_{2.5}$ NAAQS.

Figure 7.11: Lansing-E. Lansing CSA, Saginaw-Bay City CSA, Cadillac MiSA & Upper Penninsula Annual Arithmetic Means for $PM_{2.5}$ from 2010-2015

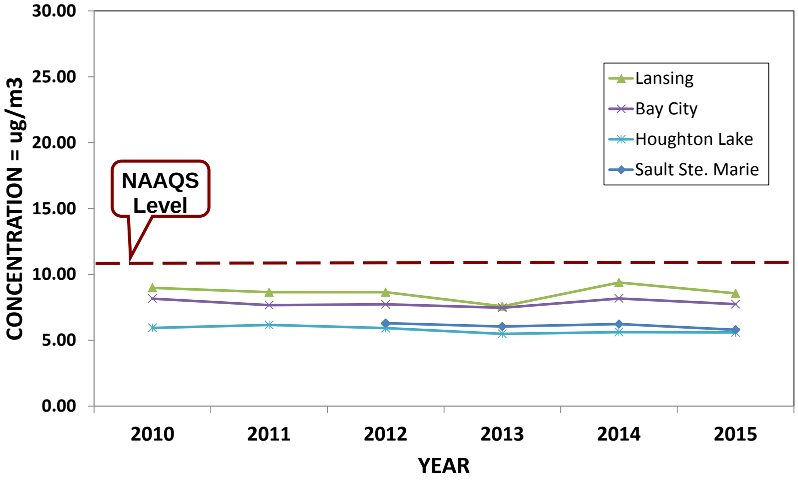


Figure 7.11 displays the remaining monitoring sites in the Northern Lower and Upper Peninsula. All of these sites are below the annual $PM_{2.5}$ NAAQS standard.

Chapter 8: Toxic Air Pollutants

In addition to the six criteria pollutants discussed in the previous chapters, the AQD monitors for a wide variety of substances classified as toxic air pollutants, and/or Hazardous Air Pollutants (HAPs). Under the Clean Air Act (CAA), the EPA specifically addresses a group of 187 HAPs. Under Michigan's air regulations, Toxic Air Contaminants (TACs) are defined as all non-criteria pollutants that may be *"…harmful to public health or the environment when present in the outdoor atmosphere in sufficient quantities and duration."* The definition of TACs lists 41 substances that are not TACs, indicating that all others are TACs. The sources and effects of toxics are as follows:

Sources: Air toxics come from a variety of mobile, stationary, and indoor man-made sources as well as outdoor natural sources. Mobile sources include motor vehicles, stationary sources include industrial factories and power plants, indoor sources include household cleaners, and natural sources include forest fires and eruptions from volcanoes.

Effects: Once air toxics enter the body, there is a wide range of potential health effects. They include the aggravation of asthma; irritation to the eyes, nose, and throat; carcinogenicity; developmental toxicity (birth defects); nervous system effects and various other effects on internal organs. Some effects appear after a shorter period of exposure, while others may appear after long-term exposure or after a long period of time has passed since the exposure ended. Most toxic effects are not unique to one substance, and some effects may be of concern only after the substance has deposited to the ground or to a water body (e.g., mercury, dioxin), followed by exposure through an oral pathway such as the eating of fish or produce. This further complicates the assessment of air toxics concerns due to the broad range of susceptibility that various people may have.

Population most at risk: People with asthma, children, and the elderly are at the highest risk from exposure to air toxics**.**

Air Toxics can be categorized as:

- *Metals:* Examples include aluminum, arsenic, beryllium, barium, cadmium, chromium, cobalt, copper, iron, mercury, manganese, molybdenum, nickel, lead, vanadium, and zinc.
- Organic Substances: Further divided into sub-categories that include -
  - VOCs, include benzene (found in gasoline), perchlorethylene (emitted from some dry cleaning facilities), and methylene chloride (a solvent and paint stripper used by industry);
  - carbonyl compounds (formaldehyde, acetone, and acetyladehyde);
  - semi-volatile compounds (SVOCs);
  - polycyclic aromatic hydrocarbons (PAHs)/polynuclear aromatic hydrocarbons (PNAs);
  - pesticides and;
  - polychlorinated biphenyls (PCBs).
- *Other substances*: Asbestos, dioxin, and radionuclides such as radon.

Because air toxics are such a large and diverse group of substances, regulatory agencies sometimes further refine these classifications to address specific concerns.

For example:

- Some initiatives have targeted those substances that are *persistent, bioaccumulative and toxic* (PBT), such as mercury, which accumulates in body tissues.
- The EPA has developed an Integrated *Urban Air Toxics Strategy* with a focus on 30 substances (the Urban HAPs List).[12]

The evaluation of air toxics levels is difficult due to several factors.

- There are no health-protective NAAQS. Instead, air quality assessments utilize various short- and long-term screening levels and health benchmark levels estimated to be safe considering the critical effects of concern for specific substances.
- There is incomplete toxicity information for many substances. For some air toxics, the analytical detection limits are too high to consistently measure the amount present, and in some cases, the risk assessment-based “safe” levels are below the detection limits.
- Data gaps are present regarding the potential for interactive toxic effects for co-exposure to multiple substances present in emissions and in ambient air. Air toxics also pose a challenge due to monitoring and analytical methods that are either unavailable for some compounds or cost-prohibitive for others (e.g., dioxins).

These factors make it difficult to accurately assess the potential health concerns of all air toxics. Nevertheless, it is feasible and important to characterize the potential health hazards and risks associated with many air toxics.

Table 8.1 shows the monitoring stations and what air toxic was monitored at each station in 2015. This table can also be found in **Appendix B** with the Air Toxics Monitoring Summary.

The PM2.5 speciation network was reduced due to EPA funding cuts. In January 2015, DEQ shutdown three monitors at Houghton Lake in Missaukee County, Sterling State Park in Monroe County and Port Huron in St. Clair County.

Table 8.1: 2015 Toxics Sampling Sites

SITE NAME	VOC	Carbonyl	PAHs	Metals TSP	Metals PM_{10}	Speciated $PM_{2.5}$
Allen Park				x	x	x
Dearborn	x	x	x	x	x	x
Detroit-W. Fort St.	x	x		x	Mn	x
Detroit-W. Jefferson				x		
Grand Rapids-Monroe				x		x
Belding-Merrick St.				x		
Belding-Reed St.				x		
Port Huron-Rural St.				x		
River Rouge		x		x	Mn	
Tecumseh						x

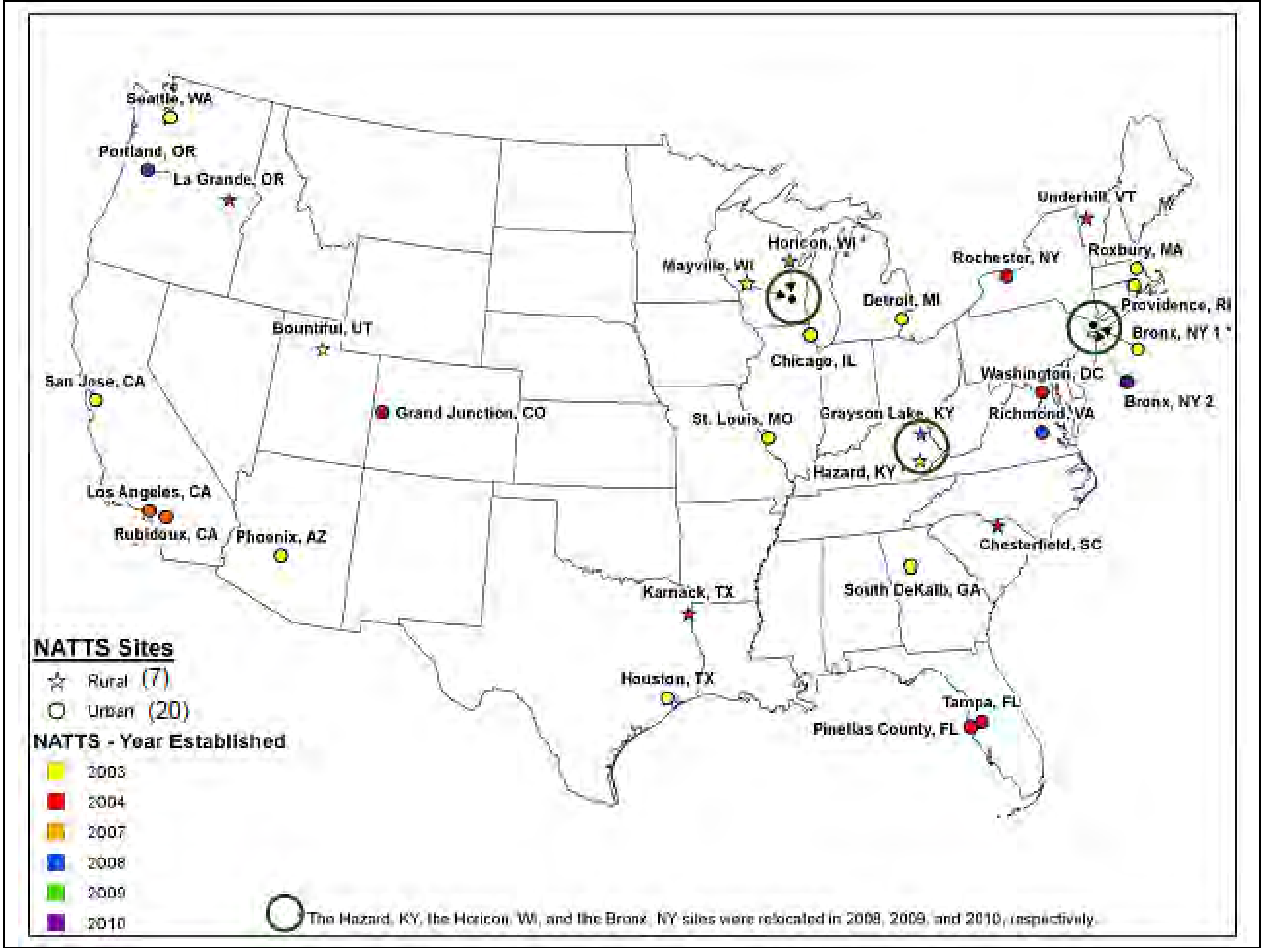
---

[12] EPA’s Air Toxics Website – Urban Strategy is located at https://www.epa.gov/urban-air-toxics/urban-air-toxic-pollutants.

National Monitoring Efforts and Data Analysis

The EPA administers national programs that identify air toxics levels, detect trends, and prioritize air toxics research. The DEQ participates in these programs. In addition, the AQD operates a site in Dearborn that is part of EPA's National Air Toxics Trend Stations (NATTS). The purpose of the NATTS network is to detect trends in high-risk air toxics such as benzene, formaldehyde, chromium, and 1,3-butadiene and to measure the progress of air toxics regulatory programs at the national level. Currently, the NATTS network contains 27 stations, 20 urban and seven rural (see **Figure 8.1**). The EPA requires that the NATTS sites measure VOCs, carbonyls, PAHs and trace metals on a once every six day sampling schedule. Hexavalent chromium is no longer required at NATTS sites and data collection was discontinued July 2013. The Dearborn NATTS site measures trace metals as TSP, $PM_{10,}$ and $PM_{2.5}$.

Figure 8.1: National Air Toxics Trends Sites.



Chapter 9: **MIair** – Air Quality Information in Real-Time

MIair is the internet tool that provides real-time air quality information via the DEQ's webpage. The www.deqmiair.org hotlink opens to the current Air Quality Index (AQI) map and displays air quality forecasts for "today" and "tomorrow." **MIair** also hosts EnviroFlash, the automated air quality notification system.

Air Quality Index

The Air Quality Index (AQI) is a simple tool developed to communicate current air quality information to the public. The current day's color-coded AQI values, ranging from Good to Hazardous (**Table 9.1**), are displayed in a forecast table and as dots on a Michigan map.

As can be seen from the annual summaries in **Appendix C**, air quality in Michigan is generally in the Good or Moderate range. An area will occasionally fall into the Unhealthy for Sensitive Groups range, but rarely reaches Unhealthy levels.

MIair includes an 'Actions to Protect Health' link: http://www.deqmiair.org/assets/AQIActionsToProtectHealth_2011.pdf which contains activity recommendations based on the AQI levels.

Air Quality Forecasts

Air Quality Division meteorologists provide air pollution forecasts to alert the public when air pollution levels may become elevated. *Action!* Days are declared when levels are expected to reach or exceed the Unhealthy for Sensitive Groups AQI health indicator. On *Action!* Days, businesses, industry, government and the public are encouraged to reduce air pollution levels by limiting vehicle use, refueling only after 6 PM, carpooling, walking, biking or taking public transit, deferring the use of gasoline-powered lawn and recreation equipment, limiting the use of volatile chemicals and curtailing all burning. More information on voluntary air pollution control measures can be found under the *Action!* Days tab on **MIair**.

Air Quality Notification

EnviroFlash is a free service that provides automated air quality (AQI) and ultraviolet (UV) forecasts to subscribers. Those enrolled receive e-mail or mobile phone text messages when the health level they select is predicted to occur. AIRNow iPhone and Android applications deliver ozone and fine particle air quality forecasts plus detailed real-time information that can be used to better protect health when planning daily activities. To learn more about this program, select the **MIair** button from Michigan's Air Quality page www.michigan.gov/air. To receive notices chose the 'Air Quality Notification' tab and click the 'Enroll in AQI EnviroFlash' link. Michigan's EnviroFlash network has the potential to reach up to 98% of the state's population.

AIRNow

The DEQ supplies Michigan air monitoring data to AIRNow, the EPA's nation-wide air quality mapping system. Information about AIRNow is available at www.epa.gov/airnow or you can select the AIRNow hot link at the bottom of each **MIair** webpage.

Table 9.1: AQI Colors and Health Statements

AQI Color, Category & Value	**PARTICULATE MATTER** (µg/m3) 24-hour	**OZONE** (ppm) 8-hour / 1-hour	**CARBON MONOXIDE** (ppm) 8-hour	**SULFUR DIOXIDE** (ppm) 24-hour	**NITROGEN DIOXIDE** (ppm) 1-hour
GREEN: Good 1- 50	**None**	**None**	**None**	**None**	**None**
YELLOW: Moderate 51- 100	**Unusually sensitive people should consider reducing prolonged or heavy exertion.**	**Unusually sensitive people should consider reducing prolonged or heavy exertion.**	**None**	**None**	**None**
ORANGE: Unhealthy For Sensitive Groups 101- 150	**People with heart or lung disease, Children, and Older adults should reduce prolonged or heavy exertion.**	**People with heart or lung disease, Children & older adults, and People who are active outdoors should reduce prolonged or heavy exertion.**	**People with heart disease, such as angina, should limit heavy exertion and avoid sources of CO, such as heavy traffic.**	**People with asthma should consider limiting outdoor exertion.**	**None**
RED: Unhealthy 151- 200	**People with heart or lung disease, Children, and Older adults should avoid prolonged or heavy exertion. Everyone should reduce prolonged or heavy exertion.**	**People with heart or lung disease, Children & older adults, and People who are active outdoors should avoid prolonged or heavy exertion. Everyone should reduce prolonged or heavy exertion.**	**People with heart disease, such as angina, should reduce moderate exertion and avoid sources of CO, such as heavy traffic.**	**Children, Asthmatics, and People with heart or lung disease should reduce outdoor exertion.**	**None**
PURPLE: Very Unhealthy 201- 300	**People with heart or lung disease, Children, and Older adults should avoid all physical exertion outdoors. Everyone else should limit outdoor exertion.**	**People with heart or lung disease, Children & older adults, and People who are active outdoors should avoid all physical exertion outdoors. Everyone else should limit outdoor exertion.**	**People with heart disease, such as angina, should avoid exertion and sources of CO, such as heavy traffic.**	**Children, Asthmatics, and People with heart or lung disease should avoid outdoor exertion; Everyone should reduce outdoor exertion.**	**Children and People with respiratory disease, such as asthma, should reduce outdoor exertion.**
MAROON: Hazardous 301- 500	**People with heart or lung disease, Children, and Older adults should remain indoors. Everyone should avoid prolonged or heavy exertion.**	**People with heart or lung disease, Children, and Older adults should remain indoors. Everyone should avoid all outdoor exertion.**	**People with heart disease, such as angina, should avoid exertion and sources of CO, such as heavy traffic. Everyone else should limit heavy exertion.**	**Children, Asthmatics, and People with heart or lung disease should remain indoors. Everyone should avoid outdoor exertion.**	**Children and People with respiratory disease, such as asthma, should avoid outdoor exertion.**

Chapter 10: Meteorological Information

Figures 10.1 through **10.3** shows average daily temperatures and **Figures 10.4** through **10.6** shows total monthly precipitation amounts compared to their climatic norms for sites in the Northern, Southern Lower and Upper Peninsula. These figures were constructed by averaging data from several National Weather Service stations and therefore are not meant to be representative of any one single location in Michigan. Instead, they are intended to depict the regional trends that occurred during the year 2015.

Figure 10.1: Southern Lower Peninsula
Observed Average Daily Temperatures vs.
Normal Average Daily Temperatures

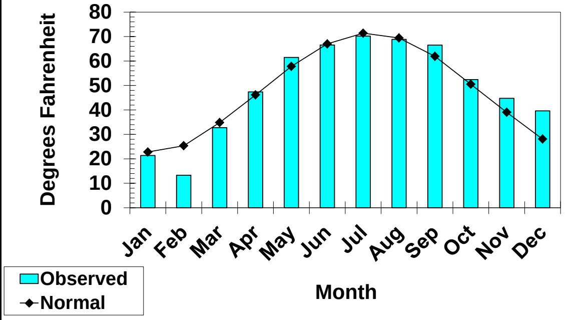


Figure 10.2: Northern Lower Peninsula
Observed Average Daily Temperatures vs.
Normal Average Daily Temperatures

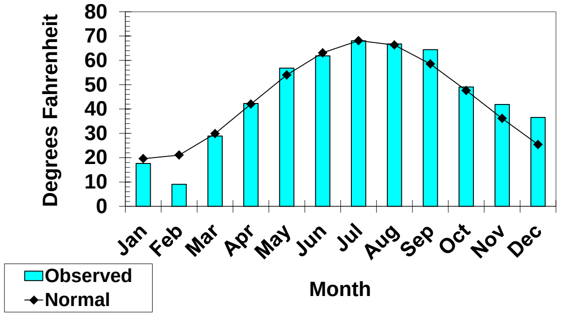


Figure 10.3: Upper Peninsula
Observed Average Daily Temperatures vs.
Normal Average Daily Temperatures

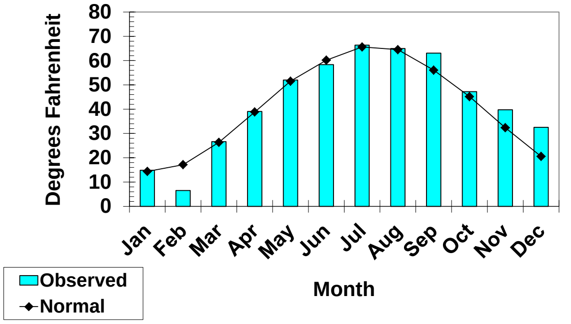


Figure 10.4: Southern Lower Peninsula
Observed Monthly Precipitation vs.
Normal Monthly Precipitation

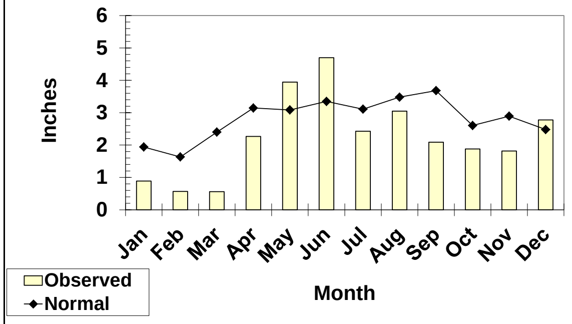


Figure 10.5: Northern Lower Peninsula
Observed Monthly Precipitation vs.
Normal Monthly Precipitation

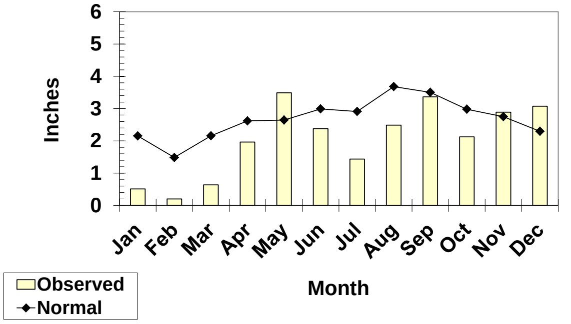
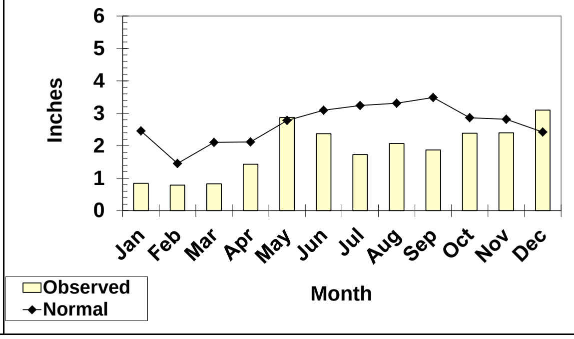


Figure 10.6: Upper Peninsula
Observed Monthly Precipitation vs.
Normal Monthly Precipitation



The weather plays a significant role in air quality, and can either help increase or decrease the amount of pollution in the air. High temperatures, sun and longer days (i.e., more daylight hours) is conducive to ozone formation, whereas rain tends to wash pollutants out of the air. *Action!* Days are declared when levels are expected to reach or exceed the Unhealthy for Sensitive Groups AQI health indicator; specifically, when meteorological conditions are conducive for the formation of elevated ground-level O_3 or $PM_{2.5}$ concentrations.

Table 10.1 Shows that there were only four *Action!* Days declared during the summer of 2015.

Table 10.1: *Action!* Days Declared During Summer 2015

Location	Year	Number	Dates
Benton Harbor	2015	1	7/18
Grand Rapids	2015	4	7/18, 8/16, 8/17, 9/6
Ludington	2015	4	7/18, 8/16, 8/17, 9/6

Appendix A: Criteria Pollutant Summary for 2015

Appendix A utilizes EPA's 2015 Air Quality System (AQS) Quick Look Report Data to present a summary of ambient air quality data collected for the criteria pollutants at monitoring locations throughout Michigan. Concentrations of non-gaseous pollutants are generally given in $\mu g/m^3$ and in ppm for gaseous pollutants. The following define some of the terms listed in the **Appendix A** reports.

Site I.D.: The AQS site ID is the EPA's code number for these sites.

POC: The Parameter Occurrence Code or POC is used to assist in distinguishing different uses of monitors, i.e., under Pb, NO_2, and SO_2, POC #1-5 are used to help differentiate between individual monitors. For PM, the POC numbers are used more for the type of monitoring, such as:

- 1 - federal reference method (FRM);
- 2 - co-located FRM;
- 3 - TEOM hourly PM_{10} and $PM_{2.5}$ measurements; and
- 5 - $PM_{2.5}$ speciation monitors (shown at right is a Met One SASS – speciation air sampling system).

 # OBS: For Pb, TSP, $PM_{2.5}$, and PM_{10}, the # OBS (number of observations) refers to the number of valid 24-hour values gathered.

For continuous monitors (CO, NO_2, O_3, $PM_{2.5}$ TEOM, and SO_2,), # OBS refers to the total valid hourly averages obtained from the analyzer.

Values: The value is listed for each criteria pollutant per its NAAQS (primary and secondary). The number of exceedances per site for the primary and secondary standards utilize running averages for continuous monitors (except for O_3) and does not include averages considered invalid due to limited sampling times. For example, a particulate-mean based only on six months could not be considered as violating the annual standard. As noted, each site is allowed one short-term standard exceedance before a violation is determined.

>: The "greater than" symbol (>) heads the column reporting values or observations above the corresponding primary or secondary standards.

CRITERIA POLLUTANT SUMMARY FOR 2015

CO Measured in ppm

Site ID	POC	City	County	Year	# OBS	1-hr Highest Value	1-hr 2nd Highest Value	1-hr OBS > 35	8-hr Highest Value	8-hr 2nd Highest Value	8-hr OBS > 9
260810020	1	Grand Rapids	Kent	2015	8244	1.6	1.6	0	1.2	1.2	0
261630001	1	Allen Park	Wayne	2015	8219	1.9	1.8	0	1.2	1.1	0
261630093	1	Eliza Howell - Roadway	Wayne	2015	8404	2.3	2.2	0	2.2	1.7	0
261630094	1	Eliza Howell - Downwind	Wayne	2015	8156	2.5	2.4	0	2.2	1.7	0
261630095	1	Livonia - Roadway	Wayne	2015	8295	1.4	1.4	0	1.3	1.2	0

Pb (24-Hour) Measured in $\mu g/m^3$

Site ID	POC	City	County	Year	# OBS	Highest rolling 3-month Arith Mean	Highest Value (24 hr)	2nd Highest Value (24hr)
260670002	1	Belding - Reed St.	Ionia	2015	60	0.03	0.292	0.167
260670003	1	Belding - Merrick St.	Ionia	2015	57	0.04	0.085	0.081
260810020	1	Grand Rapids	Kent	2015	59	0.01	0.017	0.015
261470031	1	Port Huron Rural St.	St. Clair	2015	60	0.05	0.180	0.161
261630001	1	Allen Park	Wayne	2015	58	0.00	0.011	0.007
261630033	1	Dearborn	Wayne	2015	59	0.02	0.084	0.046

NO_2 Measured in ppb

Site ID	POC	City	County	Year	# OBS	1-Hr Highest Value	1-Hr 2nd Highest Value	98th Percentile 1-hr	Annual Arith Mean
260650012	1	Lansing	Ingham	2015	6843	43.0	41.0	38.0	6.94
261130001	1	Houghton Lake	Missaukee	2015	8049	17.0	11.0	7.0	1.37
261630019	2	Detroit - E. Seven Mile	Wayne	2015	8431	57.0	53.0	45.0	11.29
261630093	1	Eliza Howell - Roadway	Wayne	2015	8564	59.0	65.0	50.0	18.13
261630094	1	Eliza Howell - Downwind	Wayne	2015	8684	54.0	50.0	47.0	12.42
261630095	1	Livonia – Roadway	Wayne	2015	8315	54.0	54.0	48.0	10.66

NO_Y Measured in ppb

Site ID	POC	City	County	Year	# OBS	1-Hr Highest Value	1-Hr 2nd Highest Value	Annual Arith Mean
260810020	1	Grand Rapids	Kent	2015	8194	229.8	186.5	14.50
261630001	1	Allen Park	Wayne	2015	7060	209.8	208.3	20.41

O_3 (1-Hour) Measured in ppm

Site ID	POC	City	County	Year	Num Meas	Num Req	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Day Max >/= 0.125 Measured	Values >/= 0.125 Estimated	Missed Days < 0.125 Standard
260050003	1	Holland	Allegan	2015	183	183	0.101	0.089	0.089	0.080	0	0	0
260190003	1	Benzonia	Benzie	2015	183	183	0.085	0.081	0.076	0.072	0	0	0
260210014	1	Coloma	Berrien	2015	182	183	0.093	0.086	0.085	0.080	0	0	1
260270003	2	Cassopolis	Cass	2015	180	183	0.085	0.079	0.075	0.075	0	0	1
260330901	1	Sault Ste. Marie	Chippewa	2015	168	183	0.075	0.073	0.070	0.064	0	0	0
260370001	2	Rose Lake	Clinton	2015	182	183	0.074	0.069	0.068	0.067	0	0	1
260490021	1	Flint	Genesee	2015	183	183	0.077	0.073	0.071	0.068	0	0	0
260492001	1	Otisville	Genesee	2015	181	183	0.078	0.078	0.072	0.071	0	0	0
260630007	1	Harbor Beach	Huron	2015	183	183	0.099	0.095	0.083	0.078	0	0	0
260650012	2	Lansing	Ingham	2015	182	183	0.069	0.069	0.068	0.068	0	0	1
260770008	1	Kalamazoo	Kalamazoo	2015	177	183	0.076	0.073	0.073	0.071	0	0	0
260810020	1	Grand Rapids	Kent	2015	183	183	0.081	0.080	0.078	0.072	0	0	0
260810022	1	Evans	Kent	2015	183	183	0.079	0.071	0.071	0.069	0	0	0
260910007	1	Tecumseh	Lenawee	2015	183	183	0.075	0.071	0.070	0.070	0	0	0
260990009	1	New Haven	Macomb	2015	183	183	0.104	0.094	0.090	0.081	0	0	0
260991003	1	Warren	Macomb	2015	183	183	0.081	0.076	0.073	0.072	0	0	0
261010922	1	Manistee	Manistee	2015	183	183	0.086	0.082	0.079	0.077	0	0	0
261050007	1	Scottville	Mason	2015	183	183	0.077	0.076	0.075	0.072	0	0	0
261130001	1	Houghton Lake	Missaukee	2015	182	183	0.085	0.070	0.068	0.068	0	0	1
261210039	1	Muskegon	Muskegon	2015	177	183	0.104	0.093	0.086	0.084	0	0	2
261250001	2	Oak Park	Oakland	2015	179	183	0.087	0.082	0.076	0.073	0	0	1
261390005	1	Jenison	Ottawa	2015	162	183	0.080	0.077	0.075	0.072	0	0	0
261470005	1	Port Huron	St .Clair	2015	181	183	0.094	0.092	0.090	0.089	0	0	2
261530001	1	Seney	Schoolcraft	2015	183	183	0.088	0.080	0.079	0.078	0	0	0
261610008	1	Ypsilanti	Washtenaw	2015	183	183	0.074	0.074	0.072	0.071	0	0	0
261630001	2	Allen Park	Wayne	2015	170	183	0.079	0.077	0.076	0.075	0	0	7
261630019	2	Detroit - E. Seven Mile	Wayne	2015	180	183	0.092	0.084	0.081	0.079	0	0	1

O_3 (8-Hour) Measured in ppm

Site ID	POC	City	County	Year	% OBS	Valid Days Measured	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Day Max > 0.075
260050003	1	Holland	Allegan	2015	100	183	0.084	0.079	0.075	0.072	2
260190003	1	Benzonia	Benzie	2015	100	183	0.073	0.072	0.069	0.067	0
260210014	1	Coloma	Berrien	2015	99	182	0.078	0.074	0.073	0.072	1
260270003	2	Cassopolis	Cass	2015	98	180	0.078	0.074	0.069	0.068	1
260330901	1	Sault Ste. Marie	Chippewa	2015	92	168	0.065	0.064	0.063	0.059	0
260370001	2	Rose Lake	Clinton	2015	99	182	0.070	0.066	0.065	0.064	0
260490021	1	Flint	Genesee	2015	100	183	0.074	0.070	0.068	0.066	0
260492001	1	Otisville	Genesee	2015	98	180	0.073	0.067	0.067	0.067	0
260630007	1	Harbor Beach	Huron	2015	99	182	0.079	0.078	0.068	0.067	2
260650012	2	Lansing	Ingham	2015	98	180	0.068	0.066	0.065	0.064	0

O_3 (8-Hour) Measured in ppm (continued)

Site ID	POC	City	County	Year	% OBS	Valid Days Measured	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Day Max > 0.075
260770008	1	Kalamazoo	Kalamazoo	2015	96	176	0.071	0.070	0.070	0.067	0
260810020	1	Grand Rapids	Kent	2015	99	182	0.076	0.072	0.068	0.067	1
260810022	1	Evans	Kent	2015	99	182	0.073	0.066	0.065	0.065	0
260910007	1	Tecumseh	Lenawee	2015	100	183	0.067	0.065	0.065	0.065	0
260990009	1	New Haven	Macomb	2015	100	183	0.079	0.076	0.072	0.072	2
260991003	1	Warren	Macomb	2015	96	176	0.066	0.065	0.065	0.064	0
261010922	1	Manistee	Manistee	2015	99	182	0.076	0.072	0.069	0.067	1
261050007	1	Scottville	Mason	2015	100	183	0.072	0.068	0.067	0.066	0
261130001	1	Houghton Lake	Missaukee	2015	98	180	0.071	0.069	0.066	0.064	0
261210039	1	Muskegon	Muskegon	2015	96	175	0.089	0.077	0.075	0.074	2
261250001	2	Oak Park	Oakland	2015	96	175	0.075	0.072	0.072	0.066	0
261390005	1	Jenison	Ottawa	2015	86	158	0.077	0.066	0.066	0.065	1
261470005	1	Port Huron	St .Clair	2015	98	179	0.078	0.076	0.075	0.075	2
261530001	1	Seney	Schoolcraft	2015	100	183	0.080	0.076	0.071	0.070	2
261610008	1	Ypsilanti	Washtenaw	2015	100	183	0.067	0.067	0.065	0.064	0
261630001	2	Allen Park	Wayne	2015	92	168	0.069	0.069	0.066	0.064	0
261630019	2	Detroit - E. Seven Mile	Wayne	2015	97	178	0.080	0.074	0.072	0.070	1

$PM_{2.5}$ (24-Hour) Measured in $\mu g/m^3$ at Local Conditions

Site ID	POC	Monitor	City	County	Year	# OBS	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	98%	Wtd. Arith. Mean
260050003	1	FRM	Holland	Allegan	2015	116	23.6	22.5	21.2	20.3	21.2	7.88
260170014	1	FRM	Bay City	Bay	2015	117	25.9	23.5	23.3	22.5	23.3	7.74
260210014	1	FRM	Coloma	Berrien	2015	117	28.2	23.0	19.4	19.1	19.4	8.15
260330901	1	FRM	Sault Ste. Marie	Chippewa	2015	68	18.7	15.8	12.4	11.5	15.8	5.79*
260330901	2	FRM	Sault Ste. Marie	Chippewa	2015	44	16.4	16.4	13.7	12.0	16.4	6.18*
260490021	1	FRM	Flint	Genesee	2015	118	24.9	23.2	22.3	20.9	22.3	8.16
260650012	1	FRM	Lansing	Ingham	2015	116	34.3	32.1	24.5	21.7	24.5	8.56
260770008	1	FRM	Kalamazoo	Kalamazoo	2015	112	30.5	26.5	22.3	20.7	22.3	8.90
260770008	2	FRM	Kalamazoo	Kalamazoo	2015	59	30.5	21.3	18.2	17.9	21.3	9.34
260810007	1	FRM	Grand Rapids - Wealthy	Kent	2015	113	58.5	26.6	25.5	25.0	25.5	9.37
260810020	1	FRM	Grand Rapids - Monroe	Kent	2015	116	50.5	26.3	25.6	24.0	25.6	9.30
260810020	2	FRM	Grand Rapids - Monroe	Kent	2015	57	51.0	24.3	22.2	20.7	24.3	10.37
260910007	1	FRM	Tecumseh	Lenawee	2015	120	31.1	30.4	25.2	20.3	25.2	8.58
260990009	1	FRM	New Haven	Macomb	2015	117	82.0	32.3	31.6	24.0	31.6	9.73

*Indicates the mean does not satisfy summary criteria

PM$_{2.5}$ (24-Hour) Measured in μg/m^3 at Local Conditions (continued)

Site ID	POC	Monitor	City	County	Year	# OBS	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	98%	Wtd. Arith. Mean
261010922	1	FRM	Manistee	Manistee	2015	119	20.5	20.4	19.3	19.0	19.3	6.37
261130001	1	FRM	Houghton Lake	Missaukee	2015	114	27.3	18.3	17.9	17.7	17.9	5.59
261150006	1	FRM	Sterling State Park	Monroe	2015	118	35.5	29.4	25.7	25.4	25.7	9.26
261250001	1	FRM	Oak Park	Oakland	2015	117	52.2	29.8	29.6	23.6	29.6	9.37
261470005	1	FRM	Port Huron	St. Clair	2015	118	34.3	33.4	28.7	27.3	28.7	9.51
261610008	1	FRM	Ypsilanti	Washtenaw	2015	117	31.1	30.6	25.9	25.7	25.9	9.56
261610008	2	FRM	Ypsilanti	Washtenaw	2015	60	25.3	20.6	20.2	19.0	20.6	9.08
261630001	1	FRM	Allen Park	Wayne	2015	334	35.1	34.2	31.9	29.3	23.1	9.66
261630015	1	FRM	Detroit - W. Fort	Wayne	2015	120	37.6	32.0	27.1	25.0	27.1	11.26
261630016	1	FRM	Detroit - Linwood	Wayne	2015	117	35.2	31.5	27.1	25.4	27.1	10.18
261630019	1	FRM	Detroit - E. Seven Mile	Wayne	2015	116	32.0	30.3	25.6	23.4	25.6	9.79
261630025	1	FRM	Livonia	Wayne	2015	119	31.3	30.2	26.8	24.6	26.8	9.31
261630033	1	FRM	Dearborn	Wayne	2015	119	36.3	36.2	28.1	27.4	28.1	11.50
261630033	2	FRM	Dearborn	Wayne	2015	58	26.0	24.7	24.7	22.5	24.7	11.65
261630036	1	FRM	Wyandotte	Wayne	2015	110	37.0	32.2	21.1	18.1	21.1	8.62
261630039	1	FRM	Detroit - W. Lafayette	Wayne	2015	341	37.3	30.5	27.5	26.2	22.4	9.12
261630095	1	FRM	Livonia-Roadway	Wayne	2015	112	31.5	31.1	25.2	22.0	25.2	9.53

PM$_{2.5}$ TEOM (1-Hour) Measured in μg/m^3

Site ID	POC	Monitor	City	County	Year	# OBS	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Wtd. Arith. Mean
260170014	3	TEOM	Bay City	Bay	2015	8495	157.0	57.0	54.0	53.0	8.56
260330901	3	BAM	Sault Ste. Marie	Chippewa	2015	8050	70.8	58.3	57.5	56.4	8.59
260490021	3	TEOM	Flint	Genesee	2015	8312	286.0	192.0	163.0	71.0	8.89
260650012	5	TEOM	Lansing	Ingham	2015	8521	154.0	137.0	126.0	120.0	8.93
260770008	3	TEOM	Kalamazoo	Kalamazoo	2015	8497	82.0	76.0	70.0	69.0	9.19
260810020	3	TEOM	Grand Rapids	Kent	2015	8310	330.0	227.0	198.0	153.0	9.38
260910007	3	TEOM	Tecumseh	Lenawee	2015	7958	123.0	107.0	92.0	88.0	8.94
261130001	3	TEOM	Houghton Lake	Missaukee	2015	8139	55.0	55.0	49.0	44.0	7.23
261470005	3	TEOM	Port Huron	St. Clair	2015	8673	76.0	72.0	68.0	66.0	9.23
261530001	3	TEOM	Seney	Schoolcraft	2015	8649	50.0	49.0	42.0	40.0	6.19
261610008	3	TEOM	Ypsilanti	Washtenaw	2015	8636	237.0	175.0	99.0	95.0	9.28
261630001	3	TEOM	Allen Park	Wayne	2015	8221	245.0	141.0	117.0	117.0	10.60
261630033	3	TEOM	Dearborn	Wayne	2015	8363	319.0	78.0	75.0	63.0	11.47
261630039	3	TEOM	Detroit – W. Lafayette	Wayne	2015	8581	64.0	57.0	56.0	56.0	10.01
261630039	3	BAM	Detroit – W. Lafayette	Wayne	2015	7579	73.6	65.1	63.6	62.7	11.84

PM_{10} (24-Hour) Measured in $\mu g/m^3$

Site ID	POC	Monitor	City	County	Year	# OBS	# Req.	Valid Days	% OBS	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Wtd Arith Mean
260810020	1	GRAV	Grand Rapids - Monroe	Kent	2015	54	60	54	90	92	29	28	28	16.8
261630001	1	GRAV	Allen Park	Wayne	2015	58	60	57	95	37	35	30	29	16.8
261630005	1	GRAV	River Rouge	Wayne	2015	57	60	57	95	46	40	38	35	20.5
261630015	1	GRAV	Detroit - W. Fort St.	Wayne	2015	58	60	58	97	58	49	37	36	21.1
261630033	1	GRAV	Dearborn	Wayne	2015	60	60	60	100	52	46	46	44	25.1
261630033	9	GRAV	Dearborn	Wayne	2015	30	30	28	93	50	48	44	37	26.0

PM_{10} TEOM (1-Hour) Measured in $\mu g/m^3$

Site ID	POC	Monitor	City	County	Year	# OBS	Highest Value	2nd Highest Value	3rd Highest Value	4th Highest Value	Wtd. Arith. Mean
261630033	3	TEOM	Dearborn	Wayne	2015	8593	258	224	197	190	22.8

SO_2 Measured in ppb

Site ID	POC	City	County	Year	# OBS	1-hr Highest Value	1-hr 2nd Highest Value	99th %ile 1-hr	24-hr Highest Value	24-hr 2nd Highest Value	OBS >0.5	Arith Mean
260650012	1	Lansing	Ingham	2015	8187	18.8	14.1	13.4	3.9	3.5	0	0.87
260810020	2	Grand Rapids	Kent	2015	8256	13.9	10.7	9.8	3.0	2.6	0	0.69
261150006	1	Sterling State Park	Monroe	2015	7083	18.7	18.2	17.6	12.1	3.8	0	0.98*
261390011	1	West Olive	Ottawa	2015	7968	53.6	53.1	32.9	12.1	10.6	0	0.77
261470005	1	Port Huron	St. Clair	2015	8383	100.5	97.8	76.0	22.1	21.2	0	2.29
261630001	1	Allen Park	Wayne	2015	7770	60.6	44.5	33.6	13.5	10.6	0	1.18*
261630015	1	Detroit - W. Fort St.	Wayne	2015	8358	73.0	64.3	55.2	44.8	18.5	0	2.28

*Indicates the mean does not satisfy summary criteria

Appendix B: 2015 Air Toxics Monitoring Summary for Metals, VOCs, Carbonyl Compounds, PAHs, Hexavalent Chromium & Speciated $PM_{2.5}$

Appendix B provides summary statistics of ambient air concentrations of various substances monitored in Michigan during 2015. At each monitoring site, air samples were taken over a 24-hour period (midnight to midnight). These air samples represent the average air concentration during that 24-hour period. The frequency of air samples collected is typically done once every 6 or 12 days. Sometimes the sampled air concentration is lower than the laboratory's analytical method detection level (MDL). When the concentration is lower than the MDL, two options are used to estimate the air concentration. The calculation of the minimum average ("Average (ND=0)") uses 0.0 μg/m³ for a value less than the MDL. In the calculation of the maximum average ("Average (ND=MDL/2)") the MDL divided by 2 (i.e., ½ the MDL) is substituted for air concentrations less than the MDL.

Table B shows the monitoring stations and what types of air toxics were monitored at each station in 2015. The following terms and acronyms are used in **Appendix B-1** and **B-2** data tables:

- Num Obs: Number of Observations (number of daily air samples taken during the year)
- Obs>MDL: Number of daily samples above the MDL
- Average (ND=0): average air concentration in 2015, assuming daily samples below MDL were equal to 0.0 μg/m³.
- Average (ND=MDL/2): average air concentration in 2015, assuming daily samples below MDL were equal to one half the MDL.
- MDL: Analytical MDL in units of μg/m³
- Max1: Highest daily air concentration during 2015
- Max2: Second highest daily air concentration during 2015
- Max3: Third highest daily air concentration during 2015
- μg/m³: Micrograms per cubic meter (1,000,000 μg = 1 g)

Table B: Monitoring Stations and Types of Air Samples Collected

	Appendix B-1					Appendix B-2
Site Name	**VOC**	**Carbonyl**	**PAHs**	**Metals TSP**	**Metals PM_{10}**	**Speciated PM2.5**
Allen Park				x	x	x
Dearborn	x	x	x	x	x	x
Detroit-W. Fort St.	x	x		x	Mn	x
Detroit-W. Jefferson				x		
Grand Rapids-Monroe				x		x
Belding-Merrick St.				x		
Belding-Reed St.				x		
Port Huron-Rural St.				x		
River Rouge		x		x	Mn	
Tecumseh						x

VOC = volatile organic compound; PAHs = polycyclic aromatic hydrocarbon; TSP = total suspended particulate; PM_{10} = particulate matter with aerodynamic diameter less than 10 μm; Mn = manganese;

APPENDIX B-1

Allen Park (261630001) Concentrations in micrograms per cubic meter (μg/m^3)

Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (Tsp) Stp	58	58	0.00185	0.00185	8.86E-06	0.00853	0.00722	0.00489
Arsenic Pm10 Stp	58	58	0.00161	0.00161	9.98E-06	0.00689	0.00624	0.00565
Cadmium (Tsp) Stp	58	58	0.000173	0.000173	9.72E-06	0.00036	0.00033	0.00032
Cadmium Pm10 Stp	58	58	0.000329	0.000329	1.17E-05	0.00106	0.001	0.0009
Lead (Tsp) Lc Frm/Fem	58	58	0.00419	0.00419	0	0.0118	0.00712	0.00668
Lead Pm10 Lc	58	58	0.003	0.003	0	0.0106	0.00543	0.00521
Manganese (Tsp) Stp	58	58	0.0211	0.0211	5.76E-05	0.0617	0.0482	0.042
Manganese Pm10 Stp	58	58	0.00875	0.00875	6.84E-05	0.0241	0.0201	0.0186
Nickel (Tsp) Stp	58	58	0.00115	0.00115	5.33E-05	0.00197	0.00194	0.00194
Nickel Pm10 Stp	58	58	0.000788	0.000788	6.47E-05	0.00187	0.00135	0.00131

Dearborn (261630033) Concentrations in micrograms per cubic meter (μg/m^3)

Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
1,1,2,2-Tetrachloroethane	60	0	0	0.0618	0.124	0	0	0
1,1,2-Trichloroethane	60	0	0	0.0464	0.0928	0	0	0
1,1-Dichloroethane	60	0	0	0.0304	0.0607	0	0	0
1,1-Dichloroethylene	60	0	0	0.0159	0.0317	0	0	0
1,2,4-Trichlorobenzene	12	0	0	0.186	0.371	0	0	0
1,2,4-Trimethylbenzene	60	60	0.627	0.627	0.103	3.94	1.94	1.89
1,2-Dichlorobenzene	60	0	0	0.0721	0.144	0	0	0
1,2-Dichloropropane	60	0	0	0.0393	0.0786	0	0	0
1,3,5-Trimethylbenzene	60	58	0.205	0.207	0.103	1.35	0.664	0.644
1,3-Butadiene	60	60	0.0925	0.0925	0.031	0.257	0.219	0.215
1,3-Dichlorobenzene	60	0	0	0.0752	0.15	0	0	0
1,4-Dichlorobenzene	60	19	0.0146	0.0681	0.156	0.0721	0.0661	0.0601
2,5-Dimethylbenzaldehyde	66	0	0	0.00548	0.011	0	0	0
Acenaphthene (Tsp) Stp	66	58	0.00909	0.0091	0.000275	0.0328	0.0291	0.0289
Acenaphthylene (Tsp) Stp	66	43	0.000413	0.000429	8.43E-05	0.00315	0.00128	0.00121
Acetaldehyde	66	66	1.77	1.77	0.0101	3.06	2.88	2.83
Acetone	66	66	3	3	0.0291	6.2	5.58	5.41
Acetonitrile	60	60	0.683	0.683	0.0521	2.55	1.9	1.58
Acetylene	60	60	1.09	1.09	0.0213	3.07	2.95	2.43
Acrylonitrile	60	3	0.00235	0.0198	0.0369	0.0847	0.0304	0.026
Anthracene (Tsp) Stp	66	66	0.000617	0.000617	9.10E-05	0.00271	0.00189	0.00146
Arsenic (Tsp) Stp	86	86	0.00217	0.00217	8.63E-06	0.00657	0.00655	0.00546
Arsenic Pm10 Stp	90	90	0.00187	0.00187	9.99E-06	0.00721	0.0065	0.00527

Dearborn (261630033) Concentrations in micrograms per cubic meter (µg/m^3)

Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Barium (Tsp) Stp	86	86	0.025	0.025	0.0004	0.163	0.155	0.0425
Barium Pm10 Stp	90	90	0.0158	0.0158	0.00052	0.193	0.164	0.028
Benzaldehyde	66	66	0.17	0.17	0.013	0.365	0.278	0.26
Benzene	60	60	0.797	0.797	0.125	1.95	1.48	1.45
Benzo[A]Anthracene (Tsp) Stp	66	66	0.000192	0.000192	0.000103	0.000534	0.000494	0.000481
Benzo[A]Pyrene (Tsp) Stp	66	65	0.000186	0.000196	0.000167	0.000585	0.000451	0.000438
Benzo[B]Fluoranthene (Tsp) Stp	66	66	0.000381	0.000381	0.000116	0.00106	0.000779	0.00076
Benzo[G,H,I]Perylene (Tsp) Stp	66	66	0.000236	0.000236	8.61E-05	0.000711	0.000599	0.000544
Benzo[K]Fluoranthene (Tsp) Stp	66	43	0.000103	0.000134	0.000124	0.000354	0.000314	0.000304
Beryllium (Tsp) Stp	86	84	8.37E-05	8.38E-05	5.69E-06	0.00027	0.00023	0.0002
Beryllium Pm10 Stp	90	84	2.15E-05	2.18E-05	7.04E-06	5.00E-05	5.00E-05	5.00E-05
Bromochloromethane	60	0	0	0.0397	0.0794	0	0	0
Bromodichloromethane	60	0	0	0.0603	0.121	0	0	0
Bromoform	60	1	0.000688	0.0871	0.176	0.0413	0	0
Bromomethane	60	57	0.0392	0.04	0.035	0.0738	0.0699	0.0583
Butyraldehyde	66	66	0.356	0.356	0.00885	1.28	1.04	0.785
Cadmium (Tsp) Stp	86	86	0.000364	0.000364	9.33E-06	0.00171	0.00098	0.00078
Cadmium Pm10 Stp	90	90	0.000281	0.000281	1.18E-05	0.00098	0.00073	0.00068
Carbon Disulfide	60	60	0.268	0.268	0.0374	7.63	0.511	0.43
Carbon Tetrachloride	60	60	0.666	0.666	0.0629	0.818	0.812	0.786
Chlorobenzene	60	12	0.0158	0.0489	0.0829	0.106	0.101	0.101
Chloroethane	60	58	0.124	0.125	0.0237	0.362	0.335	0.269
Chloroform	60	60	0.517	0.517	0.0781	1.19	1.15	1.01
Chloromethane	60	60	1.32	1.32	0.0227	1.67	1.63	1.62
Chloroprene	60	0	0	0.0217	0.0435	0	0	0
Chromium (Tsp) Stp	86	86	0.00718	0.00718	0.000132	0.0166	0.0158	0.0147
Chromium Pm10 Stp	90	90	0.00349	0.00349	0.000165	0.00902	0.00746	0.0062
Chrysene (Tsp) Stp	66	66	0.00048	0.00048	8.71E-05	0.00121	0.000983	0.000881
Cis-1,2-Dichloroethene	60	1	0.00622	0.0336	0.0555	0.373	0	0
Cis-1,3-Dichloropropene	60	0	0	0.0386	0.0772	0	0	0
Cobalt (Tsp) Stp	86	86	0.000267	0.000267	1.92E-05	0.00069	0.00061	0.00056
Cobalt Pm10 Stp	90	90	0.000133	0.000133	2.81E-05	0.00048	0.0003	0.0003
Copper (Tsp) Stp	86	86	0.0511	0.0511	0.000229	0.274	0.232	0.152
Copper Pm10 Stp	90	90	0.0418	0.0418	0.000286	0.143	0.124	0.111
Dibenzo[A,H]Anthracene (Tsp) Stp	66	65	3.94E-05	4.62E-05	0.000113	9.86E-05	8.99E-05	7.85E-05
Dibromochloromethane	60	1	0.000283	0.0548	0.111	0.017	0	0
Dichlorodifluoromethane	60	60	2.68	2.68	0.0396	3.35	3.26	3.11
Dichloromethane	60	60	1.81	1.81	0.066	15.4	4.48	3.96
Ethyl Acrylate	60	2	0.00205	0.0238	0.045	0.0819	0.041	0
Ethylbenzene	60	60	0.366	0.366	0.0825	2.16	1.43	0.864
Ethylene Dibromide	60	0	0	0.0692	0.138	0	0	0
Ethylene Dichloride	60	58	0.0683	0.0691	0.0526	0.109	0.0971	0.0971
Fluoranthene (Tsp) Stp	66	66	0.00455	0.00455	0.000233	0.0175	0.0173	0.0153
Fluorene (Tsp) Stp	66	63	0.0082	0.0082	0.000608	0.025	0.0245	0.0241
Formaldehyde	66	66	3.33	3.33	0.0139	6.91	6.25	5.8
Freon 114	60	60	0.117	0.117	0.0559	0.14	0.133	0.133

Dearborn (261630033) Concentrations in micrograms per cubic meter (µg/m^3)

Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Hexachlorobutadiene	12	0	0	0.181	0.363	0	0	0
Hexanaldehyde	66	66	0.135	0.135	0.00819	0.307	0.262	0.262
Indeno[1,2,3-Cd]Pyrene (Tsp) Stp	66	65	0.000214	0.00022	0.000106	0.000476	0.000438	0.000425
Iron (Tsp) Stp	86	86	1.6	1.6	0.00311	3.52	3.36	3.25
Iron Pm10 Stp	90	90	0.681	0.681	0.00388	2.34	1.52	1.45
Isovaleraldehyde	66	0	0	0.00705	0.0141	0	0	0
Lead (Tsp) Lc Frm/Fem	86	86	0.013	0.013	0	0.084	0.0465	0.0369
Lead Pm10 Lc	90	90	0.0105	0.0105	0	0.0969	0.0501	0.0482
M/P Xylene	60	60	1.07	1.07	0.122	7.34	4.52	2.8
Manganese (Tsp) Stp	86	86	0.11	0.11	5.60E-05	0.319	0.301	0.249
Manganese Pm10 Stp	90	90	0.0313	0.0313	6.88E-05	0.0708	0.0694	0.0679
Methyl Chloroform	60	38	0.0172	0.0302	0.0709	0.0382	0.0382	0.0327
Methyl Ethyl Ketone	66	66	0.468	0.468	0.00885	1	0.956	0.891
Methyl Isobutyl Ketone	60	60	0.228	0.228	0.0574	0.697	0.549	0.479
Methyl Methacrylate	60	2	0.00233	0.0577	0.115	0.119	0.0205	0
Methyl Tert-Butyl Ether	60	1	0.0003	0.0251	0.0505	0.018	0	0
Molybdenum (Tsp) Stp	86	86	0.00111	0.00111	1.21E-05	0.00916	0.00471	0.00292
Molybdenum Pm10 Stp	90	90	0.000919	0.000919	1.44E-05	0.00898	0.00436	0.00267
Naphthalene (Tsp) Stp	66	66	0.117	0.117	0.000382	0.312	0.306	0.267
Nickel (Tsp) Stp	86	86	0.00243	0.00243	5.23E-05	0.0184	0.00612	0.00576
Nickel Pm10 Stp	90	90	0.00162	0.00162	6.42E-05	0.0153	0.00676	0.00525
N-Octane	60	60	0.259	0.259	0.0794	0.706	0.5	0.486
O-Xylene	60	60	0.378	0.378	0.0695	1.39	1.04	1
Phenanthrene (Tsp) Stp	66	66	0.0186	0.0186	0.000329	0.0836	0.0551	0.0545
Propionaldehyde	66	66	0.326	0.326	0.00713	0.57	0.551	0.546
Propylene	60	60	0.695	0.695	0.0551	1.65	1.3	1.26
Pyrene (Tsp) Stp	66	66	0.00216	0.00216	0.000114	0.00741	0.00567	0.00565
Styrene	60	60	1.2	1.2	0.0682	8.9	3.1	2.64
Tert-Butyl Ethyl Ether	60	0	0	0.0167	0.0334	0	0	0
Tetrachloroethylene	60	59	0.179	0.179	0.0949	0.475	0.42	0.366
Tolualdehydes	64	64	0.154	0.154	0.0197	0.383	0.31	0.251
Toluene	60	60	1.39	1.39	0.0678	6.48	3.41	3.19
Trans-1,2-Dichloroethylene	60	0	0	0.0238	0.0476	0	0	0
Trans-1,3-Dichloropropene	60	0	0	0.0477	0.0953	0	0	0
Trichloroethylene	60	11	0.0108	0.0482	0.0913	0.107	0.086	0.0699
Trichlorofluoromethane	60	60	1.5	1.5	0.0449	2.19	1.83	1.8
Valeraldehyde	66	66	0.0927	0.0927	0.00705	0.211	0.169	0.155
Vanadium (Tsp) Stp	86	86	0.00406	0.00406	1.92E-05	0.0106	0.00974	0.00902
Vanadium Pm10 Stp	90	90	0.00159	0.00159	2.37E-05	0.00516	0.00497	0.00399
Vinyl Chloride	60	5	0.00111	0.0105	0.0204	0.0179	0.0153	0.0128
Zinc (Tsp) Stp	86	86	0.143	0.143	0.0011	0.478	0.466	0.43
Zinc Pm10 Stp	90	90	0.0824	0.0824	0.00136	0.364	0.36	0.285

Detroit, W. Fort St. (N. Delray-SWHS) (261630015) Concentrations in micrograms per cubic meter (µg/m^3)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
1,1,2,2-Tetrachloroethane	30	0	0	0.16	0.32	0	0	0
1,1,2-Trichloroethane	30	0	0	0.0482	0.0965	0	0	0
1,1-Dichloroethane	30	0	0	0.085	0.17	0	0	0
1,1-Dichloroethylene	30	0	0	0.0753	0.151	0	0	0
1,2,4-Trichlorobenzene	30	0	0	0.662	1.32	0	0	0
1,2,4-Trimethylbenzene	30	4	0.071	0.201	0.301	0.69	0.48	0.48
1,2-Dichlorobenzene	30	0	0	0.181	0.362	0	0	0
1,2-Dichloropropane	30	1	0.0467	0.577	1.1	1.4	0	0
1,3,5-Trimethylbenzene	30	0	0	0.119	0.238	0	0	0
1,3-Butadiene	30	0	0	0.06	0.12	0	0	0
1,3-Dichlorobenzene	30	0	0	0.14	0.28	0	0	0
1,4-Dichlorobenzene	30	0	0	0.19	0.38	0	0	0
2,2,4-Trimethylpentane	30	5	0.0927	0.152	0.142	0.64	0.61	0.57
Acetaldehyde	30	30	1.74	1.74	0	3.02	2.98	2.82
Acetone	30	30	2.3	2.3	0	4.72	4.48	4.28
Acetonitrile	30	13	0.266	0.406	0.492	0.78	0.75	0.67
Acrylonitrile	30	0	0	0.391	0.783	0	0	0
Arsenic (Tsp) Stp	58	58	0.00222	0.00222	8.74E-06	0.0131	0.006	0.00486
Benzaldehyde	30	30	0.117	0.117	0	0.305	0.226	0.198
Benzene	30	30	0.846	0.846	0.0937	2.7	1.6	1.6
Bromodichloromethane	30	0	0	0.0748	0.15	0	0	0
Bromoform	30	0	0	0.171	0.342	0	0	0
Bromomethane	30	0	0	0.11	0.22	0	0	0
Cadmium (Tsp) Stp	58	58	0.000349	0.000349	9.60E-06	0.00231	0.00092	0.00086
Carbon Tetrachloride	30	1	0.0143	0.122	0.222	0.43	0	0
Chlorobenzene	30	0	0	0.101	0.201	0	0	0
Chloroethane	30	0	0	0.06	0.12	0	0	0
Chloroform	30	28	0.642	0.646	0.12	1	0.99	0.87
Chloromethane	30	30	1.08	1.08	0.155	1.3	1.3	1.3
Chloroprene	30	0	0	0.055	0.11	0	0	0
Cis-1,2-Dichloroethene	30	0	0	0.0603	0.121	0	0	0
Cis-1,3-Dichloropropene	30	0	0	0.065	0.13	0	0	0
Dibromochloromethane	30	0	0	0.145	0.291	0	0	0
Dichlorodifluoromethane	30	30	2.26	2.26	0.249	2.8	2.8	2.8
Dichloromethane	30	29	0.593	0.598	0.344	0.92	0.91	0.8
Ethylbenzene	30	2	0.0377	0.173	0.29	0.6	0.53	0
Ethylene Dibromide	30	0	0	0.146	0.292	0	0	0
Ethylene Dichloride	30	0	0	0.095	0.19	0	0	0
Formaldehyde	30	30	3.27	3.27	0	10.5	7.18	6.47
Freon 113	30	0	0	0.11	0.22	0	0	0
Freon 114	30	0	0	0.17	0.34	0	0	0
Hexachlorobutadiene	30	0	0	0.443	0.886	0	0	0
Hexanaldehyde	30	25	0.122	0.122	0	0.877	0.26	0.23

Detroit, W. Fort St. (N. Delray-SWHS) (261630015) Concentrations in micrograms per cubic meter (µg/m^3)

Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
M/P Xylene	30	9	0.448	0.702	0.725	2.6	2.3	1.7
Manganese (Tsp) Stp	58	58	0.0608	0.0608	5.62E-05	0.597	0.122	0.119
Manganese Pm10 Stp	57	57	0.0172	0.0172	6.81E-05	0.0418	0.0418	0.0347
Methyl Chloroform	30	0	0	0.105	0.21	0	0	0
Methyl Ethyl Ketone	30	23	1.13	1.26	1.1	2.5	1.9	1.7
Methyl Isobutyl Ketone	30	4	0.363	0.732	0.851	5	2.7	2
Methyl Tert-Butyl Ether	30	0	0	0.0948	0.19	0	0	0
N-Hexane	30	19	0.878	0.893	0.0856	3.4	3	2.4
Nickel (Tsp) Stp	58	58	0.00278	0.00278	5.19E-05	0.036	0.00468	0.0045
O-Xylene	30	7	0.136	0.261	0.326	0.81	0.69	0.67
Propionaldehyde	30	30	0.329	0.329	0	0.564	0.564	0.555
Styrene	30	0	0	0.378	0.756	0	0	0
Tetrachloroethylene	30	0	0	0.115	0.23	0	0	0
Tolualdehydes	30	1	0.0016	0.0016	0	0.048	0	0
Toluene	30	29	1.25	1.25	0.436	3.1	2.6	2.4
Trans-1,2-Dichloroethylene	30	0	0	0.0738	0.148	0	0	0
Trans-1,3-Dichloropropene	30	0	0	0.0443	0.0886	0	0	0
Trichloroethylene	30	0	0	0.0808	0.162	0	0	0
Trichlorofluoromethane	30	30	1.2	1.2	0.23	1.5	1.5	1.5
Valeraldehyde	30	30	0.161	0.161	0	0.425	0.325	0.303
Vinyl Chloride	30	0	0	0.0648	0.13	0	0	0

Detroit, W. Jefferson, South Delray (261630027) Concentrations in micrograms per cubic meter (µg/m^3)

Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (Tsp) Stp	59	59	0.00243	0.00243	8.85E-06	0.00879	0.00737	0.00567
Cadmium (Tsp) Stp	59	59	0.0004	0.0004	9.69E-06	0.00115	0.001	0.00092
Manganese (Tsp) Stp	59	59	0.122	0.122	5.75E-05	0.511	0.473	0.412
Nickel (Tsp) Stp	59	59	0.00285	0.00285	5.37E-05	0.00934	0.00834	0.00622

River Rouge (261630005) Concentrations in micrograms per cubic meter (μg/m^3)

Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Acetaldehyde	30	30	1.99	1.99	0	3.66	3.08	3.06
Acetone	30	30	2.59	2.59	0	4.95	4.75	4.28
Arsenic (Tsp) Stp	59	59	0.00218	0.00218	8.73E-06	0.0153	0.00853	0.00553
Benzaldehyde	30	30	0.152	0.152	0	0.366	0.305	0.259
Cadmium (Tsp) Stp	59	59	0.000372	0.000372	9.58E-06	0.00113	0.00105	0.00089
Formaldehyde	30	30	4.93	4.93	0	8.72	7.28	7.04
Hexanaldehyde	30	30	0.628	0.628	0	2.1	1.98	1.72
Manganese (Tsp) Stp	59	59	0.0545	0.0545	5.61E-05	0.161	0.133	0.121
Manganese Pm10 Stp	58	58	0.0179	0.0179	7.00E-05	0.0505	0.0431	0.0407
Nickel (Tsp) Stp	59	59	0.00153	0.00153	5.25E-05	0.00443	0.00356	0.00315
Propionaldehyde	30	30	0.386	0.386	0	0.736	0.701	0.632
Tolualdehydes	30	2	0.00204	0.00204	0	0.0406	0.0206	0
Valeraldehyde	30	30	0.314	0.314	0	0.81	0.632	0.575

Grand Rapids-Monroe St. (260810020) Concentrations in micrograms per cubic meter (μg/m^3)

Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (Tsp) Stp	59	59	0.00141	0.00141	9.03E-06	0.00923	0.0046	0.00429
Cadmium (Tsp) Stp	59	59	0.000136	0.000136	9.88E-06	0.00094	0.00033	0.00031
Lead (Tsp) Lc Frm/Fem	59	59	0.00437	0.00437	0	0.0174	0.0159	0.0098
Manganese (Tsp) Stp	59	59	0.0126	0.0126	5.81E-05	0.0352	0.0254	0.0245
Nickel (Tsp) Stp	59	59	0.0011	0.0011	5.36E-05	0.00214	0.00207	0.00186

Belding-Merrick St. (260670003) Concentrations in micrograms per cubic meter (μg/m^3)

Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (Tsp) Stp	57	57	0.0012	0.0012	8.71E-06	0.00891	0.00602	0.00311
Cadmium (Tsp) Stp	57	57	0.000185	0.000185	9.55E-06	0.00084	0.00075	0.00054
Lead (Tsp) Lc Frm/Fem	57	57	0.0225	0.0225	0	0.0855	0.0812	0.0795
Manganese (Tsp) Stp	57	57	0.00915	0.00915	5.63E-05	0.0263	0.0207	0.0203
Nickel (Tsp) Stp	57	57	0.000805	0.000805	5.22E-05	0.002	0.00164	0.00123

Belding-Reed St. (260670002) Concentrations in micrograms per cubic meter (μg/m^3)

Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (Tsp) Stp	60	60	0.00117	0.00117	8.71E-06	0.00815	0.00427	0.00405
Cadmium (Tsp) Stp	60	60	0.000179	0.000179	9.55E-06	0.00088	0.00064	0.00049
Lead (Tsp) Lc Frm/Fem	60	60	0.0218	0.0218	0	0.292	0.167	0.154
Manganese (Tsp) Stp	60	60	0.00823	0.00823	5.63E-05	0.0203	0.0169	0.0162
Nickel (Tsp) Stp	60	60	0.000774	0.000774	5.22E-05	0.00139	0.00119	0.00118

Port Huron-Rural St. (261470031) Concentrations in micrograms per cubic meter (µg/m³)								
Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Arsenic (Tsp) Stp	60	60	0.00154	0.00154	0.00000875	0.0111	0.00598	0.00549
Cadmium (Tsp) Stp	60	60	0.000529	0.000529	0.00000958	0.00274	0.00231	0.00172
Lead (Tsp) Lc Frm/Fem	60	60	0.0327	0.0327	0	0.18	0.162	0.138
Manganese (Tsp) Stp	60	60	0.00996	0.00996	0.0000568	0.0222	0.0199	0.0197
Nickel (Tsp) Stp	60	60	0.00116	0.00116	0.000052	0.0044	0.00223	0.00204

APPENDIX B-2

Allen Park (261630001), Speciated $PM_{2.5}$ (µg/m^3)

Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	119	97	0.0245	0.0269	0.0215	0.183	0.14	0.133
Ammonium Ion Pm2.5 Lc	119	118	0.918	0.918	0.0115	5.99	5.16	3.71
Antimony Pm2.5 Lc	119	30	0.00424	0.0194	0.0402	0.0734	0.0421	0.0397
Arsenic Pm2.5 Lc	119	59	0.000943	0.0014	0.0018	0.00747	0.00695	0.00595
Barium Pm2.5 Lc	119	65	0.00826	0.0128	0.0194	0.243	0.0404	0.0345
Bromine Pm2.5 Lc	119	111	0.00399	0.0041	0.00186	0.016	0.0122	0.0112
Cadmium Pm2.5 Lc	119	27	0.00155	0.00842	0.0176	0.0256	0.021	0.0152
Calcium Pm2.5 Lc	119	119	0.0428	0.0428	0.00744	0.155	0.09	0.0899
Cerium Pm2.5 Lc	119	13	0.000982	0.00899	0.0191	0.0695	0.0318	0.00373
Cesium Pm2.5 Lc	119	47	0.0029	0.00822	0.0174	0.0227	0.019	0.0185
Chlorine Pm2.5 Lc	105	104	0.0601	0.0601	0.00703	0.466	0.421	0.358
Chromium Pm2.5 Lc	119	85	0.00199	0.00239	0.00259	0.0328	0.0215	0.0152
Cobalt Pm2.5 Lc	119	77	0.000509	0.000835	0.00157	0.00241	0.0022	0.00214
Copper Pm2.5 Lc	119	112	0.00922	0.00929	0.00303	0.123	0.0502	0.0389
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	106	105	0.413	0.413	0	1.12	0.844	0.785
Indium Pm2.5 Lc	119	57	0.00501	0.0104	0.0215	0.0396	0.0279	0.0268
Iron Pm2.5 Lc	119	119	0.109	0.109	0.00445	0.302	0.283	0.253
Lead Pm2.5 Lc	119	79	0.00253	0.00319	0.00471	0.0234	0.0175	0.0142
Magnesium Pm2.5 Lc	119	83	0.0159	0.0189	0.0174	0.444	0.0783	0.0681
Manganese Pm2.5 Lc	119	103	0.00208	0.0023	0.0025	0.0102	0.00849	0.00614
Nickel Pm2.5 Lc	119	98	0.00099	0.00114	0.00145	0.00963	0.00701	0.00448
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	106	106	2.55	2.55	0	9.13	6.35	5.89
Phosphorus Pm2.5 Lc	119	14	0.0000144	0.00554	0.0113	0.00122	0.00006	0.00005
Potassium Ion Pm2.5 Lc	119	116	0.11	0.11	0.0189	4.68	0.32	0.199
Potassium Pm2.5 Lc	119	119	0.0918	0.0918	0.00768	4.28	0.183	0.174
Rubidium Pm2.5 Lc	119	55	0.00048	0.00111	0.00247	0.00786	0.0042	0.00247
Selenium Pm2.5 Lc	119	77	0.00123	0.00166	0.00241	0.00684	0.00639	0.00602
Silicon Pm2.5 Lc	119	119	0.0607	0.0607	0.0127	0.479	0.255	0.187
Silver Pm2.5 Lc	119	14	0.000533	0.00876	0.0185	0.0117	0.0105	0.00816
Sodium Ion Pm2.5 Lc	119	119	0.11	0.11	0.00937	0.984	0.396	0.362
Sodium Pm2.5 Lc	119	93	0.0567	0.0621	0.0398	0.402	0.35	0.345
Strontium Pm2.5 Lc	119	51	0.00136	0.00219	0.00298	0.0948	0.00921	0.00379
Sulfate Pm2.5 Lc	119	118	1.75	1.75	0.00677	6.1	6.04	5.98
Sulfur Pm2.5 Lc	119	119	0.614	0.614	0.00848	2.13	2.12	2.04
Tin Pm2.5 Lc	119	20	0.00166	0.0123	0.0261	0.0256	0.0224	0.021
Titanium Pm2.5 Lc	119	83	0.00413	0.00488	0.00471	0.255	0.014	0.0092
Total Nitrate Pm2.5 Lc	119	119	1.93	1.93	0.0142	16	12.3	9.38
Vanadium Pm2.5 Lc	119	59	0.000535	0.00136	0.00322	0.0028	0.00278	0.00245
Zinc Pm2.5 Lc	119	119	0.0141	0.0141	0.00233	0.0541	0.046	0.0448
Zirconium Pm2.5 Lc	119	20	0.000848	0.00523	0.012	0.0191	0.0104	0.00933

Dearborn (261630033), Speciated $PM_{2.5}$ (µg/m^3)

Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	58	49	0.0319	0.0341	0.0219	0.203	0.0963	0.0859
Ammonium Ion Pm2.5 Lc	58	57	0.973	0.973	0.0108	3.86	3.47	3.37
Antimony Pm2.5 Lc	58	14	0.00423	0.0185	0.0378	0.0501	0.0374	0.0326
Arsenic Pm2.5 Lc	58	38	0.00123	0.00157	0.00175	0.00901	0.00373	0.00373
Barium Pm2.5 Lc	58	26	0.00931	0.014	0.0166	0.171	0.0342	0.0342
Bromine Pm2.5 Lc	58	57	0.00479	0.0048	0.0017	0.013	0.0127	0.00967
Cadmium Pm2.5 Lc	58	14	0.00108	0.00714	0.016	0.0105	0.00934	0.00883
Calcium Pm2.5 Lc	58	58	0.09	0.09	0.00737	0.315	0.22	0.213
Cerium Pm2.5 Lc	58	4	0.000421	0.00749	0.0161	0.0203	0.00222	0.00105
Cesium Pm2.5 Lc	58	26	0.00496	0.00985	0.0154	0.0304	0.0267	0.0237
Chlorine Pm2.5 Lc	53	52	0.0645	0.0645	0.00724	0.256	0.202	0.175
Chromium Pm2.5 Lc	58	36	0.00119	0.00166	0.00246	0.00951	0.00653	0.00416
Cobalt Pm2.5 Lc	58	56	0.00156	0.0016	0.00152	0.00416	0.00416	0.00355
Copper Pm2.5 Lc	58	57	0.0115	0.0116	0.00289	0.0841	0.0614	0.0452
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	54	54	0.575	0.575	0	1.89	1.52	1.41
Indium Pm2.5 Lc	58	23	0.00551	0.0116	0.02	0.0327	0.0292	0.0292
Iron Pm2.5 Lc	58	58	0.384	0.384	0.00384	1.96	1.14	0.859
Lead Pm2.5 Lc	58	50	0.00883	0.00918	0.00424	0.0824	0.0531	0.0448
Magnesium Pm2.5 Lc	58	49	0.0278	0.0294	0.0173	0.301	0.256	0.0634
Manganese Pm2.5 Lc	58	57	0.00858	0.0086	0.00226	0.0298	0.0293	0.0217
Nickel Pm2.5 Lc	58	41	0.00101	0.00124	0.0015	0.0189	0.00477	0.0025
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	54	54	2.95	2.95	0	6.83	5.82	5.49
Phosphorus Pm2.5 Lc	58	6	0.000107	0.00552	0.0111	0.00278	0.00231	0.00059
Potassium Ion Pm2.5 Lc	58	58	0.137	0.137	0.0165	3.29	0.234	0.192
Potassium Pm2.5 Lc	58	58	0.132	0.132	0.00832	3.34	0.242	0.234
Rubidium Pm2.5 Lc	58	23	0.000378	0.00106	0.00222	0.00484	0.00185	0.00164
Selenium Pm2.5 Lc	58	45	0.00162	0.00188	0.00244	0.00655	0.00548	0.00489
Silicon Pm2.5 Lc	58	58	0.0847	0.0847	0.0138	0.485	0.206	0.185
Silver Pm2.5 Lc	58	7	0.000629	0.00786	0.0166	0.0109	0.00933	0.00583
Sodium Ion Pm2.5 Lc	58	58	0.105	0.105	0.00967	0.285	0.242	0.237
Sodium Pm2.5 Lc	58	50	0.0882	0.0919	0.0426	0.283	0.261	0.25
Strontium Pm2.5 Lc	58	29	0.00177	0.00244	0.00269	0.0677	0.0041	0.00385
Sulfate Pm2.5 Lc	58	58	2.01	2.01	0.00595	5.22	4.44	4.29
Sulfur Pm2.5 Lc	58	58	0.689	0.689	0.0085	1.96	1.64	1.48
Tin Pm2.5 Lc	58	11	0.00262	0.0123	0.0249	0.0396	0.0385	0.0175
Titanium Pm2.5 Lc	58	30	0.00196	0.00312	0.00477	0.0149	0.0107	0.0084
Total Nitrate Pm2.5 Lc	58	58	2.1	2.1	0.0128	9.59	7.19	7.04
Vanadium Pm2.5 Lc	58	29	0.000623	0.00143	0.00321	0.00358	0.00272	0.0026
Zinc Pm2.5 Lc	58	58	0.0571	0.0571	0.00238	0.281	0.274	0.17
Zirconium Pm2.5 Lc	58	9	0.00695	0.0108	0.0101	0.364	0.00812	0.00793

Detroit, W Fort St. (N. Delray-SWHS) (261630015), Speciated $PM_{2.5}$ (µg/m^3)

Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	55	46	0.0717	0.0735	0.0223	2.47	0.0918	0.0873
Ammonium Ion Pm2.5 Lc	55	54	1.09	1.09	0.0105	3.98	3.58	3.52
Antimony Pm2.5 Lc	55	13	0.00362	0.0186	0.0385	0.0315	0.0269	0.0247
Arsenic Pm2.5 Lc	55	33	0.00122	0.00162	0.00179	0.00666	0.00548	0.00421
Barium Pm2.5 Lc	55	32	0.0117	0.0145	0.0186	0.148	0.0666	0.0446
Bromine Pm2.5 Lc	55	53	0.00469	0.00478	0.0018	0.0133	0.0118	0.0111
Cadmium Pm2.5 Lc	55	16	0.00213	0.00801	0.0166	0.0174	0.0117	0.0117
Calcium Pm2.5 Lc	55	55	0.16	0.16	0.00747	3.53	0.398	0.249
Cerium Pm2.5 Lc	55	2	0.00298	0.0103	0.0184	0.0949	0.0688	0
Cesium Pm2.5 Lc	55	25	0.0044	0.00989	0.0171	0.0568	0.0287	0.0205
Chlorine Pm2.5 Lc	49	48	0.0616	0.0616	0.00718	0.288	0.26	0.219
Chromium Pm2.5 Lc	55	37	0.000947	0.00137	0.00252	0.00907	0.00603	0.00333
Cobalt Pm2.5 Lc	55	44	0.00116	0.00133	0.00156	0.0123	0.00324	0.00262
Copper Pm2.5 Lc	55	52	0.00925	0.00932	0.00311	0.049	0.0229	0.0216
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	48	48	0.534	0.534	0	1.21	1.09	0.939
Indium Pm2.5 Lc	55	18	0.00369	0.0101	0.0207	0.0338	0.0222	0.0198
Iron Pm2.5 Lc	55	55	0.289	0.289	0.00429	2.51	1.11	1.05
Lead Pm2.5 Lc	55	49	0.00553	0.00592	0.00457	0.0333	0.0266	0.0223
Magnesium Pm2.5 Lc	55	51	0.0265	0.0274	0.018	0.34	0.19	0.0769
Manganese Pm2.5 Lc	55	55	0.00647	0.00647	0.0024	0.0703	0.0248	0.0197
Nickel Pm2.5 Lc	55	40	0.000738	0.000966	0.00151	0.00453	0.00374	0.00298
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	48	48	2.66	2.66	0	7.13	5.9	5.89
Phosphorus Pm2.5 Lc	55	7	0.0012	0.00638	0.0109	0.0644	0.00092	0.0002
Potassium Ion Pm2.5 Lc	55	55	0.115	0.115	0.0175	1.75	0.346	0.23
Potassium Pm2.5 Lc	55	55	0.124	0.124	0.00831	1.8	0.913	0.297
Rubidium Pm2.5 Lc	55	24	0.000582	0.0012	0.00237	0.00526	0.00486	0.00337
Selenium Pm2.5 Lc	55	44	0.00166	0.00187	0.00253	0.00837	0.00733	0.00586
Silicon Pm2.5 Lc	55	55	0.214	0.214	0.0136	6.86	0.241	0.224
Silver Pm2.5 Lc	55	10	0.000775	0.00753	0.0173	0.0128	0.0056	0.00466
Sodium Ion Pm2.5 Lc	55	55	0.096	0.096	0.00964	0.257	0.252	0.239
Sodium Pm2.5 Lc	55	48	0.0534	0.0569	0.0424	0.225	0.18	0.156
Strontium Pm2.5 Lc	55	26	0.00198	0.0026	0.00282	0.0378	0.0338	0.0065
Sulfate Pm2.5 Lc	55	55	2.32	2.32	0.00619	7.52	5.4	4.65
Sulfur Pm2.5 Lc	55	55	0.766	0.766	0.00845	2.46	1.79	1.52
Tin Pm2.5 Lc	55	13	0.00208	0.0117	0.0257	0.0245	0.021	0.0175
Titanium Pm2.5 Lc	55	33	0.0051	0.00609	0.00473	0.185	0.0197	0.00795
Total Nitrate Pm2.5 Lc	55	55	2.11	2.11	0.013	9.83	8.25	6.5
Vanadium Pm2.5 Lc	55	33	0.000918	0.00158	0.00317	0.00419	0.00385	0.00384
Zinc Pm2.5 Lc	55	55	0.0314	0.0314	0.00239	0.194	0.173	0.111
Zirconium Pm2.5 Lc	55	12	0.00151	0.00516	0.0112	0.0235	0.0231	0.00935

Tecumseh (260910007), Speciated $PM_{2.5}$ ($\mu g/m^3$)

Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	60	40	0.0172	0.0212	0.0223	0.175	0.121	0.0674
Ammonium Ion Pm2.5 Lc	60	57	0.852	0.852	0.0121	3.6	3.54	2.99
Antimony Pm2.5 Lc	60	20	0.00685	0.0201	0.0386	0.0595	0.0583	0.0478
Arsenic Pm2.5 Lc	60	32	0.000693	0.00114	0.0018	0.00653	0.00385	0.00265
Barium Pm2.5 Lc	60	16	0.005	0.0104	0.0178	0.0954	0.0642	0.0507
Bromine Pm2.5 Lc	60	58	0.00344	0.00351	0.00178	0.0146	0.012	0.00816
Cadmium Pm2.5 Lc	60	16	0.00172	0.00799	0.0165	0.0257	0.0175	0.014
Calcium Pm2.5 Lc	60	57	0.0297	0.0298	0.00736	0.175	0.145	0.069
Cerium Pm2.5 Lc	60	7	0.00381	0.00914	0.0175	0.165	0.0445	0.0133
Cesium Pm2.5 Lc	60	14	0.00156	0.00761	0.0165	0.0164	0.0163	0.0133
Chlorine Pm2.5 Lc	54	42	0.0188	0.0197	0.00712	0.0918	0.0848	0.08
Chromium Pm2.5 Lc	60	30	0.000822	0.00148	0.00249	0.00848	0.00546	0.00341
Cobalt Pm2.5 Lc	60	33	0.000355	0.000723	0.00155	0.00161	0.00148	0.00132
Copper Pm2.5 Lc	60	35	0.00135	0.00189	0.00303	0.0436	0.00412	0.00282
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	54	53	0.19	0.19	0	0.723	0.58	0.355
Indium Pm2.5 Lc	60	23	0.00389	0.0103	0.0208	0.035	0.0209	0.0163
Iron Pm2.5 Lc	60	60	0.0521	0.0521	0.00408	0.125	0.113	0.111
Lead Pm2.5 Lc	60	36	0.00158	0.00232	0.00447	0.0156	0.00705	0.00664
Magnesium Pm2.5 Lc	60	42	0.0104	0.013	0.0176	0.142	0.0477	0.0432
Manganese Pm2.5 Lc	60	49	0.00361	0.00386	0.00235	0.04	0.0245	0.0241
Nickel Pm2.5 Lc	60	36	0.000314	0.000642	0.0015	0.00134	0.00124	0.00118
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	54	54	2.14	2.14	0	8.33	4.68	4.39
Phosphorus Pm2.5 Lc	60	6	0.0000463	0.00538	0.0109	0.0019	0.00071	0.00005
Potassium Ion Pm2.5 Lc	60	59	0.11	0.111	0.0187	2.56	0.195	0.128
Potassium Pm2.5 Lc	60	59	0.0922	0.0923	0.00823	2.37	0.158	0.135
Rubidium Pm2.5 Lc	60	29	0.00044	0.000988	0.00234	0.00398	0.0032	0.00237
Selenium Pm2.5 Lc	60	42	0.000813	0.00121	0.00251	0.00343	0.00277	0.0027
Silicon Pm2.5 Lc	60	59	0.0596	0.0598	0.0136	0.364	0.296	0.248
Silver Pm2.5 Lc	60	6	0.000539	0.0082	0.0175	0.0175	0.00699	0.00422
Sodium Ion Pm2.5 Lc	60	59	0.0776	0.0777	0.00986	0.315	0.243	0.189
Sodium Pm2.5 Lc	60	38	0.0306	0.0396	0.042	0.166	0.158	0.115
Strontium Pm2.5 Lc	60	27	0.00089	0.00162	0.00279	0.0309	0.00338	0.00224
Sulfate Pm2.5 Lc	60	59	1.63	1.63	0.00608	4.16	4.15	4.13
Sulfur Pm2.5 Lc	60	59	0.571	0.571	0.00841	1.41	1.33	1.33
Tin Pm2.5 Lc	60	9	0.00136	0.012	0.0257	0.0245	0.0176	0.014
Titanium Pm2.5 Lc	60	33	0.0014	0.00246	0.00473	0.0106	0.00779	0.0077
Total Nitrate Pm2.5 Lc	60	59	1.81	1.81	0.0135	9.16	7.31	6.81
Vanadium Pm2.5 Lc	60	28	0.000399	0.00126	0.00318	0.00194	0.00186	0.00186
Zinc Pm2.5 Lc	60	59	0.0137	0.0137	0.00238	0.102	0.0638	0.0516
Zirconium Pm2.5 Lc	60	5	0.00044	0.00523	0.0112	0.0151	0.00594	0.0021

Grand Rapids-Monroe St. (260810020), Speciated $PM_{2.5}$ (µg/m^3)

Chemical Name	Num Obs	Obs > MDL	Average (ND=0)	Average (ND=MDL/2)	MDL	Max 1	Max 2	Max 3
Aluminum Pm2.5 Lc	103	84	0.0293	0.0313	0.0208	0.223	0.183	0.156
Ammonium Ion Pm2.5 Lc	104	103	0.855	0.855	0.013	5.08	4.79	3.7
Antimony Pm2.5 Lc	103	28	0.00628	0.0207	0.0384	0.0562	0.055	0.0549
Arsenic Pm2.5 Lc	103	57	0.000924	0.00125	0.00168	0.0093	0.00702	0.0049
Barium Pm2.5 Lc	103	42	0.00797	0.0108	0.00957	0.458	0.0515	0.0269
Bromine Pm2.5 Lc	103	102	0.00354	0.00356	0.00153	0.0131	0.0106	0.0101
Cadmium Pm2.5 Lc	103	18	0.00101	0.00759	0.0157	0.0128	0.0117	0.0105
Calcium Pm2.5 Lc	103	102	0.0657	0.0658	0.00644	0.91	0.485	0.399
Cerium Pm2.5 Lc	103	9	0.000185	0.00378	0.0078	0.00385	0.0035	0.0028
Cesium Pm2.5 Lc	103	29	0.00259	0.00595	0.00971	0.0506	0.0339	0.0243
Chlorine Pm2.5 Lc	103	90	0.0589	0.0594	0.00696	0.798	0.491	0.389
Chromium Pm2.5 Lc	103	66	0.00326	0.00368	0.00226	0.0397	0.0362	0.0211
Cobalt Pm2.5 Lc	103	69	0.00044	0.000669	0.00137	0.00235	0.00169	0.00168
Copper Pm2.5 Lc	103	87	0.00465	0.00482	0.00206	0.173	0.0109	0.0107
Ec Csn_Rev Unadjusted Pm2.5 Lc Tot	105	104	0.331	0.331	0	1.2	0.901	0.719
Indium Pm2.5 Lc	103	37	0.00343	0.0101	0.0205	0.0372	0.0315	0.0256
Iron Pm2.5 Lc	103	103	0.0854	0.0854	0.00189	0.327	0.242	0.206
Lead Pm2.5 Lc	103	56	0.00145	0.0022	0.00328	0.0195	0.00749	0.00721
Magnesium Pm2.5 Lc	103	70	0.0184	0.0206	0.0137	0.718	0.0766	0.0433
Manganese Pm2.5 Lc	103	85	0.00216	0.00231	0.00178	0.0106	0.0102	0.00925
Nickel Pm2.5 Lc	103	76	0.000966	0.00116	0.0014	0.00832	0.00558	0.00485
Oc Csn_Rev Unadjusted Pm2.5 Lc Tot	105	105	2.44	2.44	0	9.94	6.33	6.08
Phosphorus Pm2.5 Lc	103	0	0	0.0058	0.0116	0	0	0
Potassium Ion Pm2.5 Lc	104	101	0.148	0.148	0.0133	8.96	0.254	0.23
Potassium Pm2.5 Lc	103	103	0.125	0.125	0.00772	7.31	0.238	0.153
Rubidium Pm2.5 Lc	103	36	0.000275	0.000908	0.00194	0.00208	0.00191	0.00188
Selenium Pm2.5 Lc	103	58	0.000539	0.00102	0.0022	0.00277	0.00222	0.00217
Silicon Pm2.5 Lc	103	102	0.0826	0.0827	0.0138	0.554	0.37	0.334
Silver Pm2.5 Lc	103	15	0.000813	0.00875	0.0187	0.0117	0.0117	0.0105
Sodium Ion Pm2.5 Lc	104	104	0.0863	0.0863	0.0107	0.675	0.583	0.548
Sodium Pm2.5 Lc	103	70	0.0326	0.0399	0.0389	0.284	0.251	0.183
Strontium Pm2.5 Lc	103	33	0.00181	0.0026	0.00244	0.152	0.00328	0.00283
Sulfate Pm2.5 Lc	104	104	1.56	1.56	0.00494	11.2	6.86	5.57
Sulfur Pm2.5 Lc	103	103	0.542	0.542	0.00827	3.4	2.15	2.04
Tin Pm2.5 Lc	103	10	0.000884	0.0121	0.025	0.0199	0.0163	0.0128
Titanium Pm2.5 Lc	103	68	0.00264	0.00347	0.00483	0.0171	0.013	0.0125
Total Nitrate Pm2.5 Lc	104	104	1.71	1.71	0.0144	11.8	9.57	8.72
Vanadium Pm2.5 Lc	103	43	0.000385	0.00134	0.00331	0.00453	0.00326	0.00316
Zinc Pm2.5 Lc	103	102	0.00957	0.00958	0.00222	0.0502	0.0275	0.0255
Zirconium Pm2.5 Lc	103	13	0.000536	0.00475	0.00922	0.00935	0.00842	0.00594

Appendix C: 2015 AQI Pie Charts

Appendix C contains pie charts that were created to show the AQI values for each of Michigan's 2015 monitoring sites and includes the total number of days measurements were taken, along with the pollutant distribution of the AQI values for those measurements. It is important to note that not all pollutants are measured at each site. In fact, some sites only obtain AQI measurements for that portion of the year corresponding to the ozone season; therefore, the number of days for each site may not be equivalent to 365. **Figures C.1** through **C.4** are grouped by Consolidated Statistical Area (CSA). CSAs are geographic regions based on population and employment data that the US Census compiles. They are defined by the US Office of Management and Budget. More information on CSAs can be found on the US Census Website: www.census.gov **Figures C.5** and **C.6** show the remaining sites (not part of a CSA) located in Michigan's Upper and Lower Peninsulas.

Figure C.1: AQI Summaries for Detroit-Warren-Flint CSA

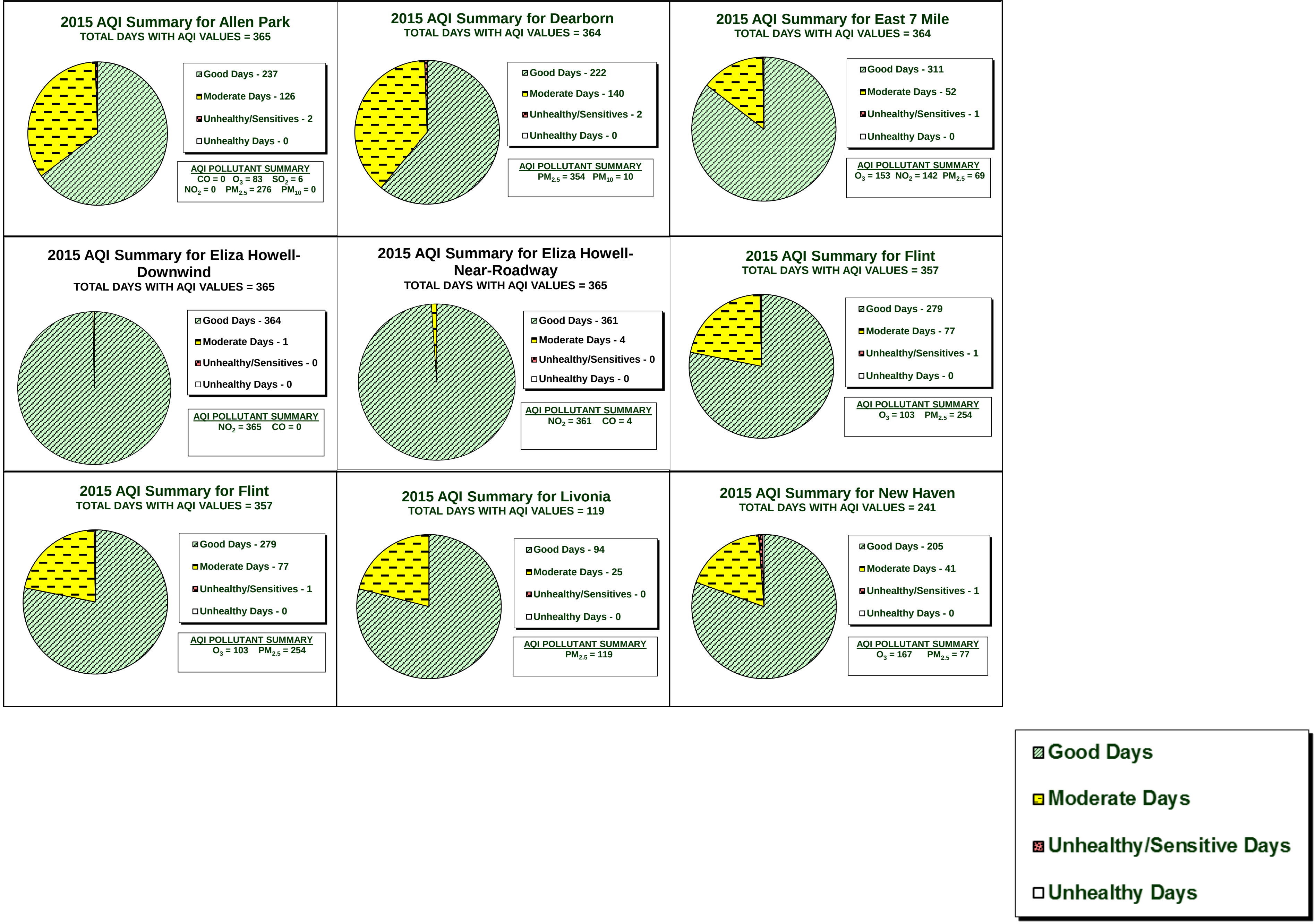
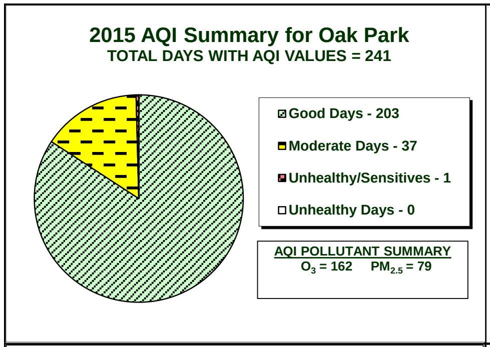
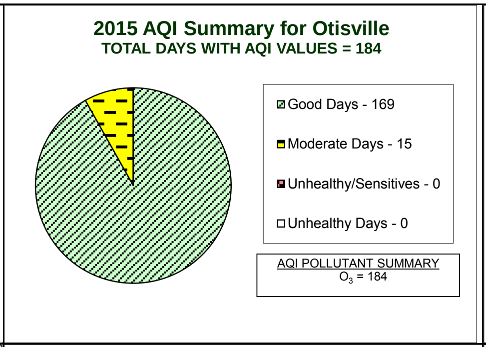
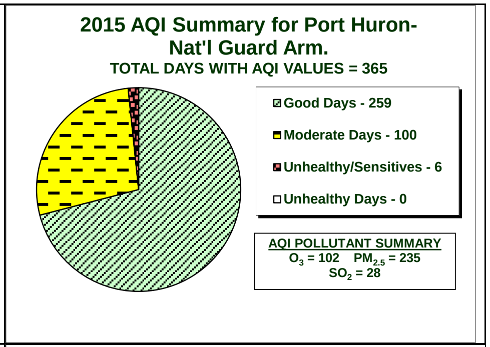
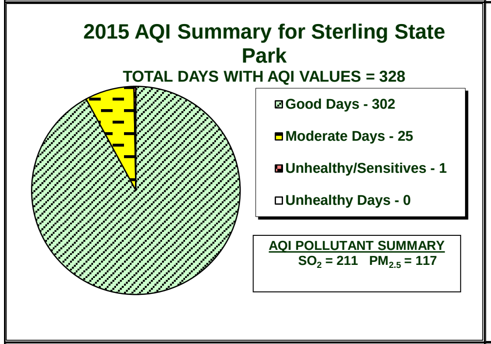


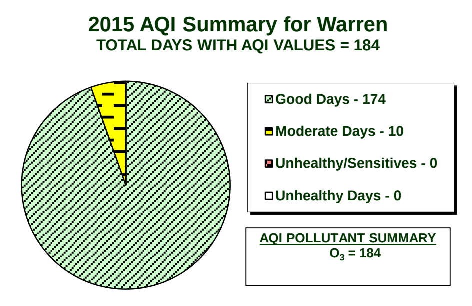
Figure C1, continued: AQI Summaries for Detroit-Warren-Flint-CSA

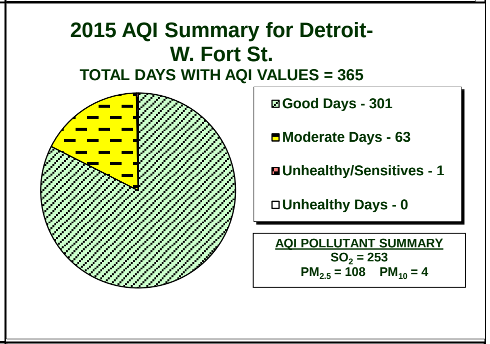


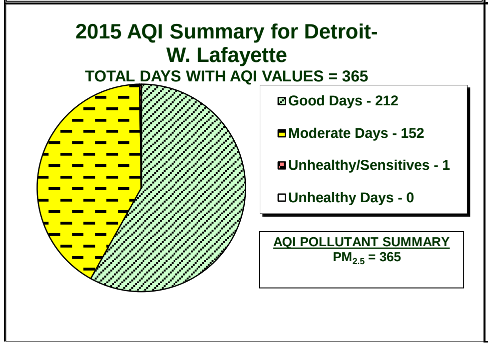


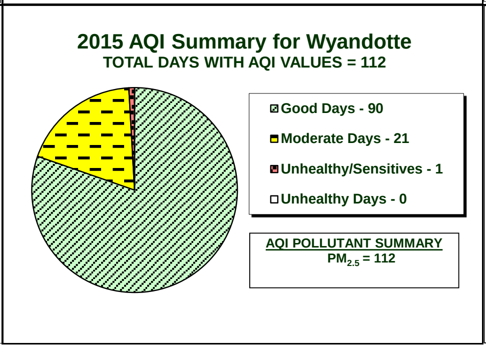


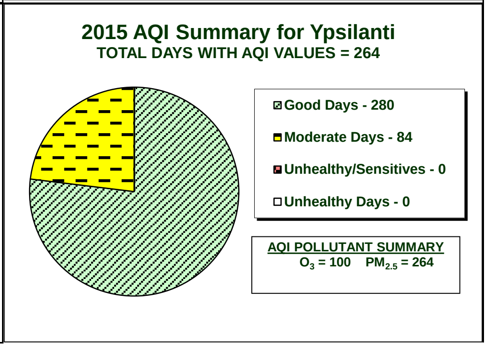












▨ Good Days
🟨 Moderate Days
🟥 Unhealthy/Sensitive Days
☐ Unhealthy Days

Figure C2: AQI Summaries for Lansing-East Lansing-Owosso CSA

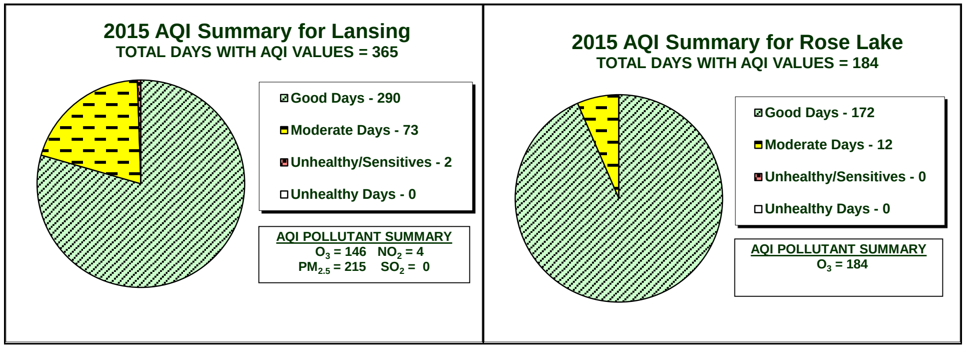


Figure C3: AQI Summary for Saginaw-Bay City-Saginaw Twp North CSA

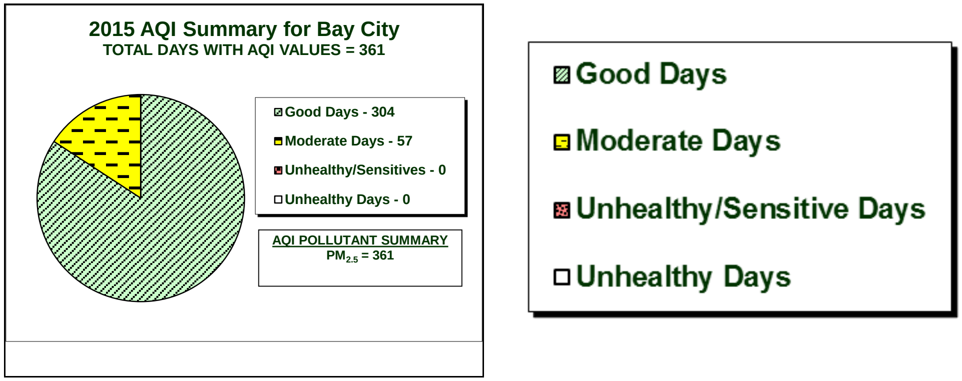
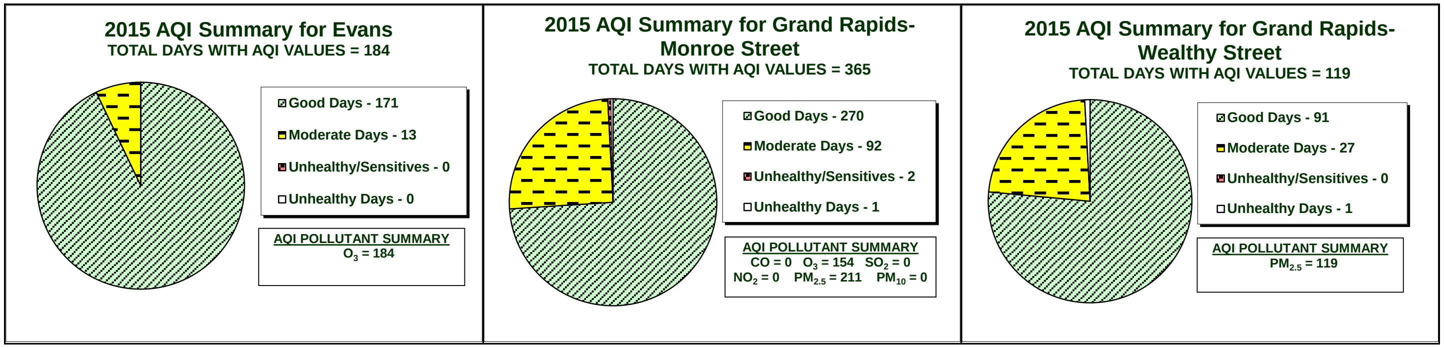
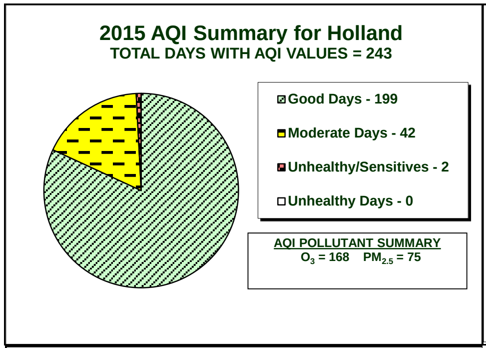
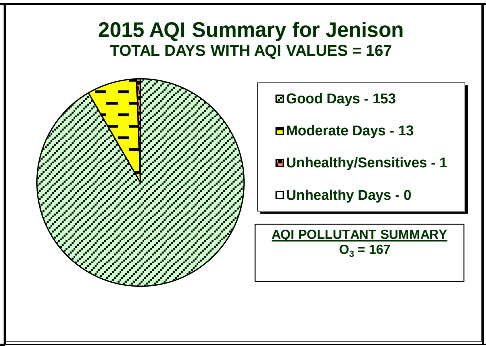
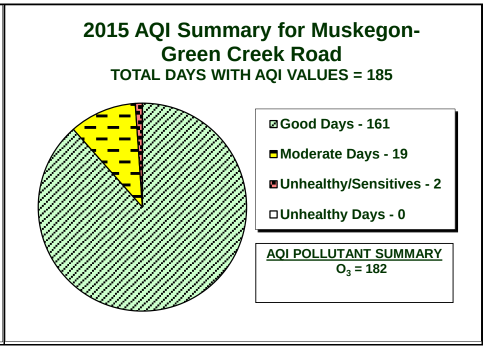


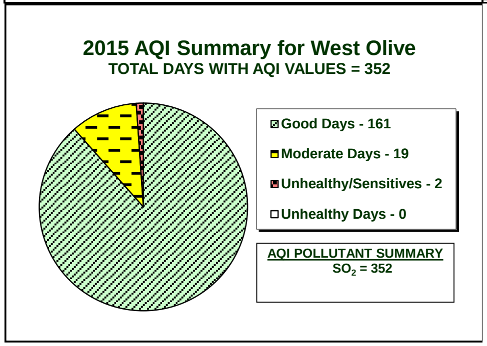
Figure C4: AQI Summaries for Grand Rapids-Muskegon-Holland CSA











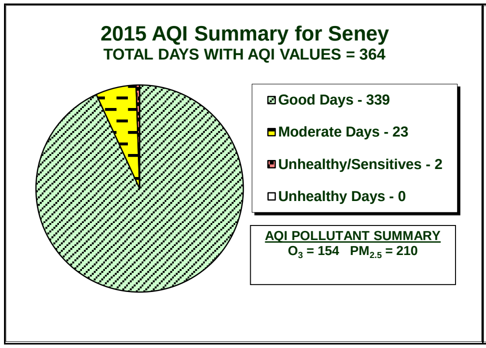
▨ Good Days

▨ Moderate Days

▨ Unhealthy/Sensitive Days

☐ Unhealthy Days

Figure C5: AQI Summary for Upper Peninsula



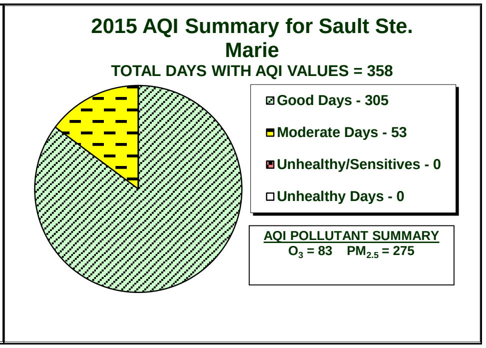
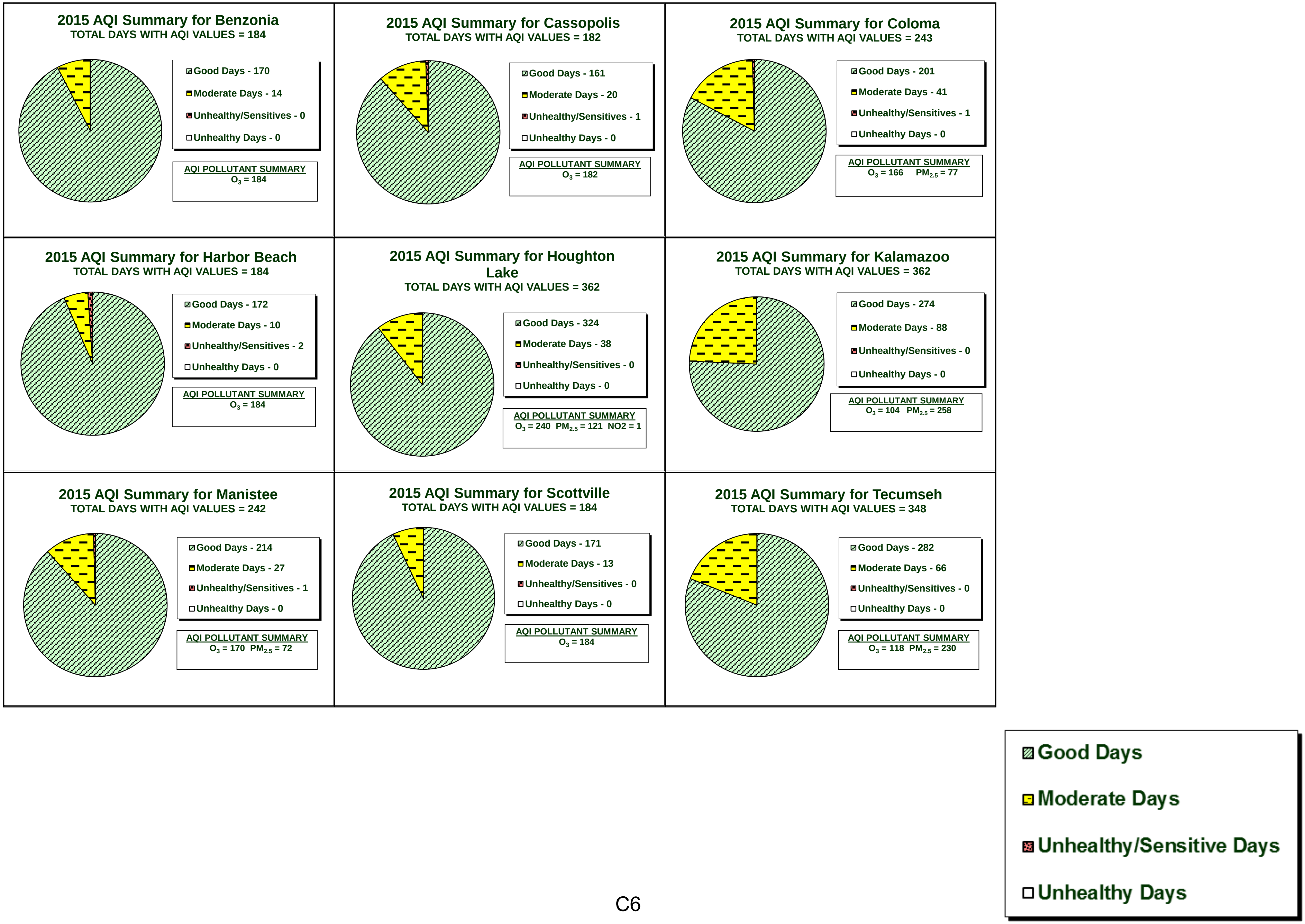


Figure C6: AQI Summaries for Michigan's Other Lower Peninsula Areas



Appendix D: NAAQS Changes

	1971	1978	1979	1987	1997	2006	2008	2010	2012	2015
CO	**1-hour** maximum not to exceed 35 ppm more than once in a year. **8-hour** maximum not to exceed 9 ppm more than once in a year.									
Lead		**Calendar quarter** average of 1.5 µg/m^3 not to be exceeded.					**3-month** average of 0.15 µg/m^3 not to be exceeded.			
NO2	**Annual** average of 53 ppb or less.							98th percentile of the **1-hour** concentration averaged over 3 years is 100 ppb or less.		
SO2	**24-Hour** concentration of 0.14 ppm not exceeded more than once per year. **Annual** average of 0.03 ppm or less.							**1-hour** average of 99th percentile is 75 ppb or less, averaged over 3 years. Previous revoked.		
Ozone	**Total photochemical oxidants**: **1-hour** max of 0.08 ppm not exceeded once per year		**1-hour** maximum concentration is 0.12 ppm one or less hour per year		4th highest daily maximum **8-hour** concentration averaged over 3 year is 0.08 ppm or less		4th highest daily maximum **8-hour** concentration averaged over 3 year is 0.075 ppm or less			4th highest daily maximum **8-hour** concentration averaged over 3 year is 0.070 ppm or less
TSP & PM10	**TSP**: **24-hour** average not to exceed 260 µg/m^3 more than once per year. **Annual** geometric mean of 75 µg/m^3.			**PM10**: **24-hour** average not to exceed 150 µg/m^3 more than once per year on average over a 3-year period. **Annual** mean of 50 µg/m^3 or less average over 3 years.		**Annual** average revoked. **24-hour** average retained.				
PM2.5					**Annual** mean of 15.0 µg/m^3 or less average over 3 years. 98th percentile of **24-hour** average of 65 µg/m^3 or less averaged over 3 years	**Annual** mean retained. 98th percentile of **24-hour** average of 35 µg/m^3 or less averaged over 3 years.			**Annual** mean of 12.0 µg/m^3 or less average over 3 years. 98th percentile of **24-hour** average retained.	

Appendix E: Acronyms and Their Definitions

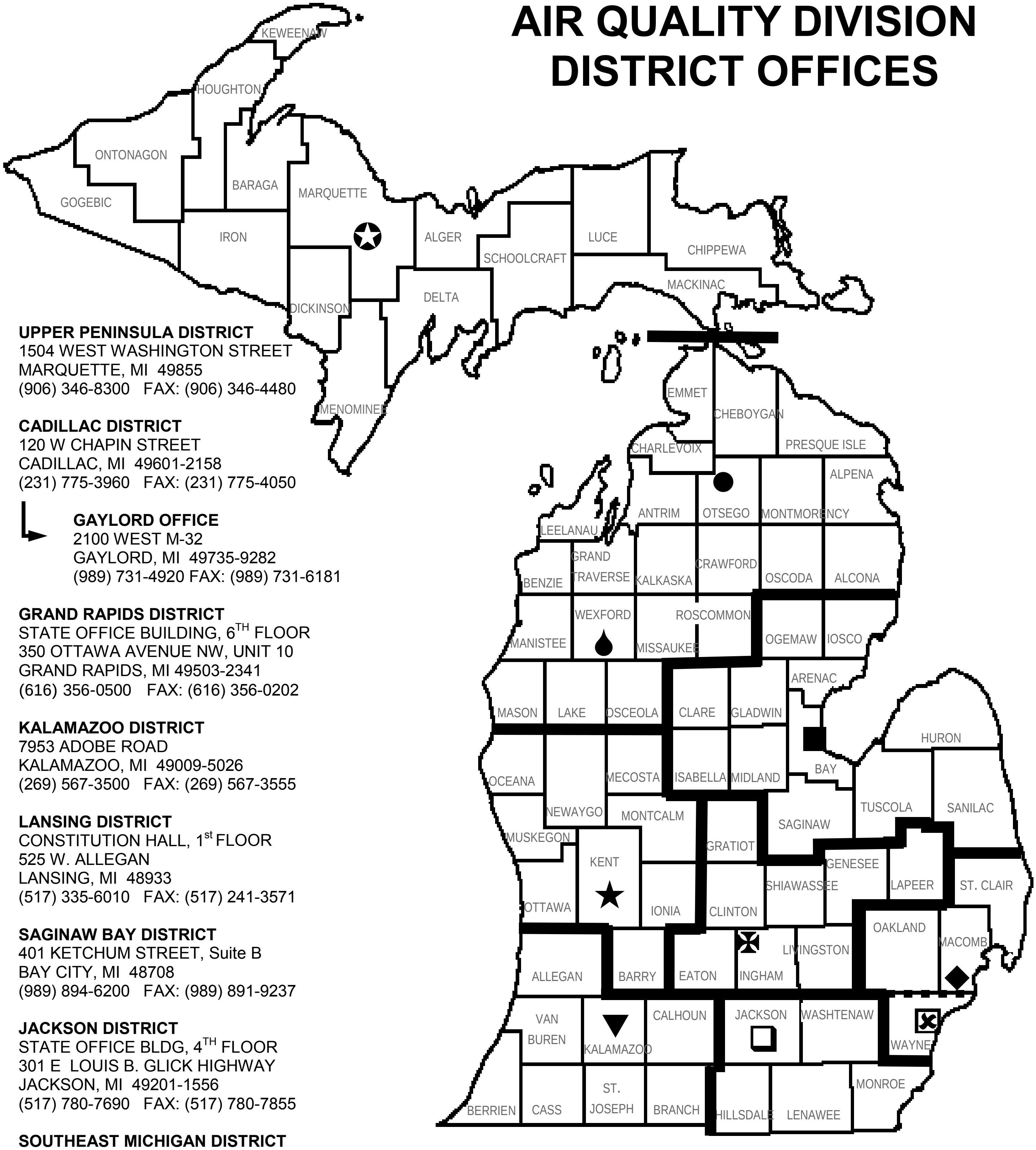
>	Greater than
<	Less than
≥	Greater than or equal to
≤	Less than or equal to
%	Percent
μg/m^3	Micrograms per cubic meter
μm	micrometer
AIRS ID	Aerometric Information Retrieval System Identification Number
AMU	Air Monitoring Unit
AQD	Air Quality Division
AQES	Air Quality Evaluation Section
AQI	Air Quality Index
AQS	Air Quality System (EPA air monitoring data archive)
As	Arsenic
BAM	Beta Attenuation Monitor (hourly PM$_{2.5}$ measurement monitor)
CAA	Clean Air Act
CBSA	Core-Based Statistical Area
Cd	Cadmium
CFR	Code of Federal Regulations
CO	Carbon monoxide
CSA	Consolidated Statistical Area
DEQ	Michigan Department of Environmental Quality
EC/OC	Elemental carbon/Organic carbon
EPA	U.S. Environmental Protection Agency
FDMS	Filter Dynamic Measurement System
FEM	Federal Equivalent Method
FIA	Family Independence Agency
FR	Federal Register
FRM	Federal Reference Method
HAP	Hazardous Air Pollutant
hr	Hour
Lc	Local Conditions
MASN	Michigan Air Sampling Network
MDL	Method Detection Limit
mg/m^3	Milligrams per meter cubed
MI	Michigan
MiSA	Micropolitan Statistical Area
Mn	Manganese
MSA	Metropolitan Statistical Area
NAAQS	National Ambient Air Quality Standard
NAMS	National Air Monitoring Station
NATTS	National Air Toxics Trend Sites
NCore	National Core Monitoring Sites
ND	Non-detect
NEI	National Emission Inventory
Ni	Nickel

Appendix E: Acronyms and Their Definitions, Continued

NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_X	Oxides of Nitrogen
NO_Y	Oxides of nitrogen + nitric acid + organic and inorganic nitrates
NPAP	National Performance Audit Program
O_3	Ozone
Obs or OBS	Observations
PAH	Polynuclear Aromatic Hydrocarbon
Pb	Lead
PBT	Persistent, Bioaccumulative and Toxic
PCB	Polychorinated biphenyls
PEP	Performance Evaluation Program
PM	Particulate matter
$PM_{2.5}$	Particulate matter with an aerodynamic diameter less than or equal to 2.5 microns
PM_{10}	Particulate matter with a diameter of 10 microns or less
$PM_{10-2.5}$	Coarse PM equal to the concentration difference between PM_{10} and $PM_{2.5}$
PNA	Polynuclear aromatic hydrocarbons
POC	Parameter Occurrence Code
ppb	parts per billion
ppm	parts per million = mg/kg, mg/L, µg/g (1 ppm = 1,000 ppb)
QA	Quality assurance
QAPP	Quality Assurance Project Plan
SASS	Speciation Air Sampling System ($PM_{2.5}$ Speciation Sampler)
SO_2	Sulfur dioxide
SOP	Standard Operating Procedures
STN	Speciation Trend Network ($PM_{2.5}$)
Stp	Standard Temperature and Pressure
SVOC	Semi-Volatile Compound
SWHS	Southwestern High School
TAC	Toxic Air Contaminant
TEOM	Tapered element oscillating microbalance (hourly $PM_{2.5}$ measurement monitor)
tpy	ton per year
TRI	Toxic Release Inventory
TSP	Technical Systems Audit
TSP	Total Suspended Particulate
U.S.	United States
UV	Ultra-violet
VOC	Volatile organic compounds
Vs	Versus

MICHIGAN DEPARTMENT ENVIRONMENTAL QUALITY
AIR QUALITY DIVISION

AIR QUALITY DIVISION DISTRICT OFFICES



✪ **UPPER PENINSULA DISTRICT**
1504 WEST WASHINGTON STREET
MARQUETTE, MI 49855
(906) 346-8300 FAX: (906) 346-4480

💧 **CADILLAC DISTRICT**
120 W CHAPIN STREET
CADILLAC, MI 49601-2158
(231) 775-3960 FAX: (231) 775-4050

● ↳ **GAYLORD OFFICE**
2100 WEST M-32
GAYLORD, MI 49735-9282
(989) 731-4920 FAX: (989) 731-6181

★ **GRAND RAPIDS DISTRICT**
STATE OFFICE BUILDING, 6TH FLOOR
350 OTTAWA AVENUE NW, UNIT 10
GRAND RAPIDS, MI 49503-2341
(616) 356-0500 FAX: (616) 356-0202

▼ **KALAMAZOO DISTRICT**
7953 ADOBE ROAD
KALAMAZOO, MI 49009-5026
(269) 567-3500 FAX: (269) 567-3555

✠ **LANSING DISTRICT**
CONSTITUTION HALL, 1st FLOOR
525 W. ALLEGAN
LANSING, MI 48933
(517) 335-6010 FAX: (517) 241-3571

■ **SAGINAW BAY DISTRICT**
401 KETCHUM STREET, Suite B
BAY CITY, MI 48708
(989) 894-6200 FAX: (989) 891-9237

❑ **JACKSON DISTRICT**
STATE OFFICE BLDG, 4TH FLOOR
301 E LOUIS B. GLICK HIGHWAY
JACKSON, MI 49201-1556
(517) 780-7690 FAX: (517) 780-7855

◆ **SOUTHEAST MICHIGAN DISTRICT**
27700 DONALD COURT
WARREN, MI 48092-2793
(586) 753-3700 FAX: (586) 753-3731

☒ **DETROIT DISTRICT OFFICE**
CADILLAC PLACE, SUITE 2-300
3058 WEST GRAND BLVD
DETROIT, MI 48202-6058
(313) 456-4700 FAX: (313) 456-4692
[Wayne County sources]

AIR QUALITY INTERNET ADDRESS:

www.michigan.gov/air

7/2014

4.12 Proposed Security System

Vigilante Security INC.
ALARM SYSTEMS
2681 Industrial Row Drive • Troy, Michigan 48084-7038
(248) 559-7100 • (800)589-7100 • (Fax)(248) 559-1322
www.vigilantesecurity.com

April 9th, 2018

Mr. Michael Testrake
Christopher J. Longe Architecture & Interiors
124 Peabody Street
Birmingham, Michigan 48009
248-258-6940 / mtestrake@cjlongeaia.com

Re: Access control system at:
South Old Woodward
Markus Management Group, LLC
251 East Merrill, Suite 204
Birmingham, Michigan 48009

Dear Michael,

Enclosed is preliminary scope of possible security for this project. Please note that is for informational purposes only and a more specific scope can be defined/described later. This preliminary scope contains thoughts of keyless access control.

At **Vigilante Security**, we are committed to bringing our customers a growing variety of products and services designed to meet an ever increasing public demand for family and property protection. In doing so, we lead a fast-paced industry with innovative ideas that will provide peace of mind for our customers. Installing equipment is only the first aspect or our program as we strive to provide the *best possible customer service of any company* and to *complete all tasks in a superior manner*. We will always be there to help educate you and answer any questions you may have regarding your equipment, our services, or any problems as well as new and improved products as they are introduced.

It is our intent, in each installation to offer top quality in materials used, up to the minute service, and lower pricing.

Some of the areas which we continue to excel are:

a) Our commitment to provide the best possible service and support after the sale.

b) All of our circuitry includes the highest quality stranded-copper jacketed wire with all connections hot- soldered for longer life and system reliability.

c) We conceal all wiring and sensors wherever possible and, most importantly, the entire alarm's circuitry is fully "supervised" which prevents circumvention and makes the system fail safe.

d) We carry $ 3,000,000.00 per occurrence of special liability insurance for your protection.

e) We do not subcontract our installations. All our personnel are highly competent alarm technicians and receive full in-house training in microprocessor-based electronics plus installation techniques that emphasize concealment as well as meticulous craftsmanship. In addition, all our employees are required to undergo police background investigations and are also fully insured and bonded.

f) Our service after the sale includes 24-hour service personnel for your assistance, should you require it.

g) We own and operate a fully computerized central station.

h) We are Underwriters Laboratories approved for residential and commercial installation.

i) We are an Underwriters Laboratories listed <u>and</u> Factory Mutual approved Central Station.

Please go over these materials at your leisure. If you have any questions, or if you wish, we can set up a time to get together to go over everything in detail.

Very truly yours,

Steve Vansteel

Steve Vansteel, Fire/Security Consultant
VIGILANTE SECURITY, INC.

PROPOSAL

ACCESS CONTROL SYSTEM

Overview-	Furnish and install new equipment to provide controlled access through desired interior and exteriors doors by use of a valid access card or key-fob credential and or by automatically locking & unlocking any controlled door by schedule or on command by the on staff security officer. This equipment will be administrated on site with software installed on a computer supplied in the surveillance system proposal that will serve as both the access control and surveillance system workstation computer. Should the surveillance system proposal be rejected, additional fees for access control computer will be necessary.
Software-	(1) Access control software package installed on client provided access control system server computer. This computer be located at the concierge security station and used by the officer to lock, unlock or momentarily grant elevator access to desired floor. This software will also indicate to the officer if any protected doors are open or propped open.
Data Converter-	(1) Lan to serial converter communication module
Door Controller Panels-	(8) Eight door controller package for 58 readers
Controller Enclosures-	(5) Door controller enclosures with lock & key set for above
Controller Power Supply-	(5) Controller power supply modules for above
Lock Power Supply-	(8) Lock power supply modules for below
Standby Power-	(8) 12 VDC 7 A/H batteries to supply standby power to supply power during a primary power loss
Fire Alarm Door Release-	(1) Door lock override circuit provided to fire alarm control panel (provided by others) for termination by your fire alarm contractor.
Concierge Security Station-	See software heading listed above

Credential Readers- 32- HID, Single gang style proximity readers for the following doors

1- HID, Long range style proximity readers for the following gate

Note:

<> Indicates device to be furnished but installed by others at no expense to Vigilante Security

* Indicates device to be furnished & installed by others at no expense to Vigilante Security

** Indicates assistance required by elevator contractor at no expense to Vigilante Security

*** Indicates assistance required by vehicle gate contractor at no expense to Vigilante Security

Door 1

Location: Parking level - P3
Elevator car #1

Credential reader: Single gang proximity style inside car
Electric locking device: Designated floor control
Installation support: **Elevator contractor assistance required
Special application: Fire alarm activation will disable elevator floor restriction until fire alarm system is reset

Door 2

Location: Parking level - P3
Elevator car #2

Credential reader: Single gang proximity style inside car
Electric locking device: Designated floor control
Installation support: **Elevator contractor assistance required
Special application: Fire alarm activation will disable elevator floor restriction until fire alarm system is reset

Door 3

Location: Parking level - P3
Elevator car #3

Credential reader: Single gang proximity style inside car
Electric locking device: Designated floor control
Installation support: **Elevator contractor assistance required

Special application: Fire alarm activation will disable elevator floor restriction until fire alarm system is reset

Door 4

Location:	Parking level - P3 Freight Elevator car #4
Credential reader:	Single gang proximity style inside car
Electric locking device:	Designated floor control
Installation support:	**Elevator contractor assistance required
Special application:	Fire alarm activation will disable elevator floor restriction until fire alarm system is reset

Door 4

Location:	Parking level - P3 West entry into residential lobby
Credential reader:	Slim mullion proximity style
Electric locking device:	*Electric latch retraction, strike or handle door lock
Power transfer device:	*Electric hinge or door cord loop (if required)
Egress hardware:	*Egress push paddle or crash bar (if required)
Installation support:	*Electric locking device above installed by others
Door status switch:	Contact on door(s) to provide door status indication
Special application:	Fire alarm activation may activate this door’s locked or unlocked condition until fire alarm system is reset
Door prop notification:	Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 5

Location:	Parking level - P3 East entry into staircase
Credential reader:	Slim mullion proximity style
Electric locking device:	*Electric latch retraction, strike or handle door lock
Power transfer device:	*Electric hinge or door cord loop (if required)
Egress hardware:	*Egress push paddle or crash bar (if required)
Installation support:	*Electric locking device above installed by others
Door status switch:	Contact on door(s) to provide door status indication
Special application:	Fire alarm activation may activate this door’s locked or unlocked condition until fire alarm system is reset
Door prop notification:	Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 6

Location: Parking level - P2
West entry into residential lobby

Credential reader: Single gang proximity style
Electric locking device: *Electric latch retraction, strike or handle door lock
Power transfer device: *Electric hinge or door cord loop (if required)
Egress hardware: *Egress push paddle or crash bar (if required)
Installation support: *Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door's locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 7

Location: Parking level - P2
East entry into staircase

Credential reader: Single gang proximity style
Electric locking device: *Electric latch retraction, strike or handle door lock
Power transfer device: *Electric hinge or door cord loop (if required)
Egress hardware: *Egress push paddle or crash bar (if required)
Installation support: *Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door's locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 8

Location: Parking level - P1
West entry into residential lobby

Credential reader: Single gang proximity style
Electric locking device: *Electric latch retraction, strike or handle door lock
Power transfer device: *Electric hinge or door cord loop (if required)
Egress hardware: *Egress push paddle or crash bar (if required)
Installation support: *Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door's locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 9

Location: Parking level - P1
East entry into staircase

Credential reader: Single gang proximity style
Electric locking device: *Electric latch retraction, strike or handle door lock
Power transfer device: *Electric hinge or door cord loop (if required)
Egress hardware: *Egress push paddle or crash bar (if required)
Installation support: *Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door's locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 10

Location: Main level
Outside into residential lobby

Credential reader: Slim mullion proximity style
Electric locking device: *Electric latch retraction, strike or handle door lock
Power transfer device: *Electric hinge or door cord loop (if required)
Egress hardware: *Egress push paddle or crash bar (if required)
Installation support: *Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door's locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 11

Location: Main level
East entry into staircase

Credential reader: Slim mullion proximity style
Electric locking device: *Electric latch retraction, strike or handle door lock
Power transfer device: *Electric hinge or door cord loop (if required)
Egress hardware: *Egress push paddle or crash bar (if required)
Installation support: *Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door's locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 12

Location: Main level - Vehicle Gate
Exterior vehicle gate into parking level

Credential reader: Long range proximity style for vehicle access
Electric locking device: ***Interface into gate opener button
Power transfer device: N/A
Egress hardware: N/A
Installation support: ***Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door’s locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 13

Location: Mezzanine level
West entry into staircase

Credential reader: Slim mullion proximity style
Electric locking device: *Electric latch retraction, strike or handle door lock
Power transfer device: *Electric hinge or door cord loop (if required)
Egress hardware: *Egress push paddle or crash bar (if required)
Installation support: *Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door’s locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 14

Location: Mezzanine level
East entry into staircase

Credential reader: Slim mullion proximity style
Electric locking device: *Electric latch retraction, strike or handle door lock
Power transfer device: *Electric hinge or door cord loop (if required)
Egress hardware: *Egress push paddle or crash bar (if required)
Installation support: *Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door’s locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 15

Location:	Second level West entry into staircase
Credential reader:	Slim mullion proximity style
Electric locking device:	*Electric latch retraction, strike or handle door lock
Power transfer device:	*Electric hinge or door cord loop (if required)
Egress hardware:	*Egress push paddle or crash bar (if required)
Installation support:	*Electric locking device above installed by others
Door status switch:	Contact on door(s) to provide door status indication
Special application:	Fire alarm activation may activate this door’s locked or unlocked condition until fire alarm system is reset
Door prop notification:	Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 16

Location:	Second level East entry into staircase
Credential reader:	Slim mullion proximity style
Electric locking device:	*Electric latch retraction, strike or handle door lock
Power transfer device:	*Electric hinge or door cord loop (if required)
Egress hardware:	*Egress push paddle or crash bar (if required)
Installation support:	*Electric locking device above installed by others
Door status switch:	Contact on door(s) to provide door status indication
Special application:	Fire alarm activation may activate this door’s locked or unlocked condition until fire alarm system is reset
Door prop notification:	Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 17

Location:	Third level West entry into staircase
Credential reader:	Single gang proximity style
Electric locking device:	*Electric latch retraction, strike or handle door lock
Power transfer device:	*Electric hinge or door cord loop (if required)
Egress hardware:	*Egress push paddle or crash bar (if required)
Installation support:	*Electric locking device above installed by others
Door status switch:	Contact on door(s) to provide door status indication
Special application:	Fire alarm activation may activate this door’s locked or unlocked condition until fire alarm system is reset
Door prop notification:	Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 18

Location: Third level
East entry into staircase

Credential reader: Single gang proximity style
Electric locking device: *Electric latch retraction, strike or handle door lock
Power transfer device: *Electric hinge or door cord loop (if required)
Egress hardware: *Egress push paddle or crash bar (if required)
Installation support: *Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door’s locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 19

Location: Third level
Fitness Center

Credential reader: Single gang proximity style
Electric locking device: *Electric latch retraction, strike or handle door lock
Power transfer device: *Electric hinge or door cord loop (if required)
Egress hardware: *Egress push paddle or crash bar (if required)
Installation support: *Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door’s locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 20

Location: Fourth level
West entry into staircase

Credential reader: Single gang proximity style
Electric locking device: *Electric latch retraction, strike or handle door lock
Power transfer device: *Electric hinge or door cord loop (if required)
Egress hardware: *Egress push paddle or crash bar (if required)
Installation support: *Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door’s locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 21

Location:	Fourth level East entry into staircase
Credential reader:	Single gang proximity style
Electric locking device:	*Electric latch retraction, strike or handle door lock
Power transfer device:	*Electric hinge or door cord loop (if required)
Egress hardware:	*Egress push paddle or crash bar (if required)
Installation support:	*Electric locking device above installed by others
Door status switch:	Contact on door(s) to provide door status indication
Special application:	Fire alarm activation may activate this door's locked or unlocked condition until fire alarm system is reset
Door prop notification:	Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 22

Location:	Fifth level West entry into staircase
Credential reader:	Single gang proximity style
Electric locking device:	*Electric latch retraction, strike or handle door lock
Power transfer device:	*Electric hinge or door cord loop (if required)
Egress hardware:	*Egress push paddle or crash bar (if required)
Installation support:	*Electric locking device above installed by others
Door status switch:	Contact on door(s) to provide door status indication
Special application:	Fire alarm activation may activate this door's locked or unlocked condition until fire alarm system is reset
Door prop notification:	Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 23

Location:	Fifth level East entry into staircase
Credential reader:	Single gang proximity style
Electric locking device:	*Electric latch retraction, strike or handle door lock
Power transfer device:	*Electric hinge or door cord loop (if required)
Egress hardware:	*Egress push paddle or crash bar (if required)
Installation support:	*Electric locking device above installed by others
Door status switch:	Contact on door(s) to provide door status indication
Special application:	Fire alarm activation may activate this door's locked or unlocked condition until fire alarm system is reset
Door prop notification:	Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 24

Location: Sixth level
West entry into staircase

Credential reader: Single gang proximity style
Electric locking device: *Electric latch retraction, strike or handle door lock
Power transfer device: *Electric hinge or door cord loop (if required)
Egress hardware: *Egress push paddle or crash bar (if required)
Installation support: *Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door’s locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 25

Location: Sixth level
East entry into staircase

Credential reader: Single gang proximity style
Electric locking device: *Electric latch retraction, strike or handle door lock
Power transfer device: *Electric hinge or door cord loop (if required)
Egress hardware: *Egress push paddle or crash bar (if required)
Installation support: *Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door’s locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 26

Location: Seventh level
West entry into staircase

Credential reader: Single gang proximity style
Electric locking device: *Electric latch retraction, strike or handle door lock
Power transfer device: *Electric hinge or door cord loop (if required)
Egress hardware: *Egress push paddle or crash bar (if required)
Installation support: *Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door’s locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 27

Location: Seventh level
East entry into staircase

Credential reader: Single gang proximity style
Electric locking device: *Electric latch retraction, strike or handle door lock
Power transfer device: *Electric hinge or door cord loop (if required)
Egress hardware: *Egress push paddle or crash bar (if required)
Installation support: *Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door’s locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 28

Location: Eight level
West entry into staircase

Credential reader: Single gang proximity style
Electric locking device: *Electric latch retraction, strike or handle door lock
Power transfer device: *Electric hinge or door cord loop (if required)
Egress hardware: *Egress push paddle or crash bar (if required)
Installation support: *Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door’s locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 29

Location: Eight level
East entry into staircase

Credential reader: Single gang proximity style
Electric locking device: *Electric latch retraction, strike or handle door lock
Power transfer device: *Electric hinge or door cord loop (if required)
Egress hardware: *Egress push paddle or crash bar (if required)
Installation support: *Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door’s locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 30

Location: Ninth level
West entry into staircase

Credential reader: Single gang proximity style
Electric locking device: *Electric latch retraction, strike or handle door lock
Power transfer device: *Electric hinge or door cord loop (if required)
Egress hardware: *Egress push paddle or crash bar (if required)
Installation support: *Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door’s locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 31

Location: Ninth level
East entry into staircase

Credential reader: Single gang proximity style
Electric locking device: *Electric latch retraction, strike or handle door lock
Power transfer device: *Electric hinge or door cord loop (if required)
Egress hardware: *Egress push paddle or crash bar (if required)
Installation support: *Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door’s locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 32

Location: Ninth level
Pool

Credential reader: Single gang proximity style
Electric locking device: *Electric latch retraction, strike or handle door lock
Power transfer device: *Electric hinge or door cord loop (if required)
Egress hardware: *Egress push paddle or crash bar (if required)
Installation support: *Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door’s locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Door 33

Location: Ninth level
Work out room

Credential reader: Single gang proximity style
Electric locking device: *Electric latch retraction, strike or handle door lock
Power transfer device: *Electric hinge or door cord loop (if required)
Egress hardware: *Egress push paddle or crash bar (if required)
Installation support: *Electric locking device above installed by others
Door status switch: Contact on door(s) to provide door status indication
Special application: Fire alarm activation may activate this door's locked or unlocked condition until fire alarm system is reset
Door prop notification: Audible sounder in door vicinity after door prop delay expires. Sounder automatically resets upon closing of door (this feature is optional and not included at this time)

Wiring & Installation Materials- 1- Lot, Wiring and installation materials

Program & Testing- 1- System programming and testing checkout

Seminar of Operation- 1- Provide seminar of system operation

Vigilante Security INC.
ALARM SYSTEMS
2681 Industrial Row Drive • Troy, Michigan 48084-7038
(248) 559-7100 • (800)589-7100 • (Fax)(248) 559-1322
www.vigilantesecurity.com

April 9th, 2018

Mr. Michael Testrake
Christopher J. Longe Architecture & Interiors
124 Peabody Street
Birmingham, Michigan 48009
248-258-6940 / mtestrake@cjlongeaia.com

Re: Camera Surveillance system at:
South Old Woodward
Markus Management Group, LLC
251 East Merrill, Suite 204
Birmingham, Michigan 48009

Dear Michael,

Enclosed is preliminary scope of possible security for this project. Please note that is for informational purposes only and a more specific scope can be defined/described later. This preliminary scope contains thoughts of camera surveillance.

Thank you for allowing **Vigilante Security, Inc.,** the opportunity to provide you with our proposal for the IP surveillance system for the new property at South Old Woodward and Hazel.

At **Vigilante Security, Inc.,** we are committed to bringing our customers a growing variety of products and services designed to meet an ever increasing public demand for personal and property protection. In doing so, we are leaders in a fast-paced industry with innovative ideas that will provide peace of mind to our customers.

Installing equipment is only the first aspect of our program as we strive to provide the *best possible customer service of any company* and *complete all tasks in a superior manner*. We will always be there to help educate you and answer any questions regarding your equipment, our services or any concerns you have. We will always make available any new and improved products as they are introduced.

Please go over this proposal at your leisure. If additional information is needed, or if you wish to discuss this in detail, please feel free to contact me at (248) 559-7100 Ext.271

American Society for Industrial Security
National Burglar and Fire Alarm Association • Burglar and Fire Alarm Association of Michigan
Central Station Alarm Association • National Fire Protection Association
Associated General Contractors • Ohio Burglar and Fire Alarm Association
Building Industry Association of Southeastern Michigan • Michigan Automatic Fire Alarm Association
Underwriters Laboratories, Inc. Protective Signaling Services Central Station
FM APPROVED

Very truly yours,

Steve Vansteel

Steve Vansteel - Fire/Security Consultant
VIGILANTE SECURITY, INC.

PROPOSAL

IP DIGITAL VIDEO SURVEILLANCE SYSTEM

Head End Equipment

Overview- This proposal includes the installation of new equipment and circuit wiring to provide a camera surveillance system to the most current technology of IP digital video. This proposed work will include a network digital video server recorder, camera power supply and cameras using IP mega-pixel technology for all locations. The IP digital video server recorder will be attached to your client provided network ethernet port and broadband internet service for off premise viewing of live and recorded video of the cameras plus allow viewing at the concierge security desk.

Video Server- (1) Network video server with the following configuration:

Windows Operating System
12TB Black / purple HDD for video storage partitioned as follows: "C" drive 150GB for OS, remaining space for storage
8 GB Ram memory
Keyboard & mouse
Video monitors (Included)

Features:

1080P Screen Recording Audio Input/ Output
Central Management Software
DW Spectrum Codecs & Streams: H.264
MJPEG, MPEG4 Cross Platform
Linux, Windows, and MAC clients
Digital Zoom
Live and Playback Dual Stream Recording
Firmware Upgrade
Manual Fully Customizable Layouts
Help Menu on Major Functions
Import/ Export Configurations Between Multiple DVRs
Mobile Application: Apple iOS devices: iPad, iPad mini, iPhone, iPod Touch Android devices: all smartphones and tablets
Multiple Recording Schedules

Separate Recording Schedules per camera

OnVIF Conformant

S.M.A.R.T Health Check with E-mail Notifications

Simple Enterprise Scalability Special Search Options which includes: Go To, Multi-Date & Time, Panoramic, Smart Search, Smart Motion Search, Thumbnail Search, Preview Search, Single Channel Playback during Live, Frame-by-Frame

Watermark Verification [Digital Signature Authentication]

Web- Based Client with Multi- User Access: Live, Playback Advanced Motion Detection Recording Mode: Continuous, Motion Recording, Motion Recording + Low Resolution always E-mail and Text Event Notifications

Server License- (1) Video management server license

Power Supply- (5) Sixteen port (PoE) power over ethernet switch for camera power & network connectivity for the cameras proposed below

Concierge Video Station- (1) Dell, Desktop computer, mouse & keypad with three output video cards to display camera images onto two display monitors and the DSX access control software on another as listed below.

Video Monitors- (2) Dell, 27" flat panel color monitors to display any desired layout of camera images

Elevator Cameras

Elevator Cameras- (3) HIK, High resolution indoor rated covert mini turret dome style camera with the following features and suggested for the locations listed below:

Features:

- Indoor rated
- 2.0 megapixel (1080P, 30fps)
- 2.8mm auto focus lens
- True auto day/night
- Wide dynamic range for day or night
- 120db Noise reduction at night

Includes:

- Camera license

Suggested Elevator Locations:

Camera #1

Camera Environment:	Interior, Inside
Mounting Location:	In corner at ceiling of elevator car #1
Camera View:	Elevator car interior

Camera #2

Camera Environment:	Interior, Inside
Mounting Location:	In corner at ceiling of elevator car #2
Camera View:	Elevator car interior

Camera #3

Camera Environment:	Interior, Inside
Mounting Location:	In corner at ceiling of elevator car #3
Camera View:	Elevator car interior

Camera #4

Camera Environment:	Interior, Inside
Mounting Location:	In corner at ceiling of freight elevator car #4
Camera View:	Elevator car interior

Interior Cameras

Interior Cameras- (75) HIK, High resolution indoor rated mini dome style camera with the following features and suggested for the locations listed below:

Features:

- Indoor rated
- 3.0 megapixel (1080P, 30fps)
- 2.8~12mm auto focus lens
- 30m Infra-red illumination
- Electronic auto day/night
- Wide dynamic range for day or night
- 3D DNR Noise reduction at night

Includes:

- Camera license

Suggested Inside Locations:

Camera #5

Camera Environment: Interior, Inside
Mounting Location: Parking P3 level, On wall or ceiling
Camera View: Viewing elevator lobby

Camera #6

Camera Environment: Interior, Inside
Mounting Location: Parking P3 level, On wall or ceiling
Camera View: Viewing freight elevator lobby

Camera #7

Camera Environment: Interior, Inside
Mounting Location: Parking P3 level, In west stairwell on wall or ceiling
Camera View: Viewing stairwell

Camera #8

Camera Environment: Interior, Inside
Mounting Location: Parking P3 level, In east stairwell on wall or ceiling
Camera View: Viewing stairwell

Camera #9 - 15

Camera Environment: Interior, Inside
Mounting Location: Parking P3 level, On wall or ceiling
Camera View: Viewing parking areas

Camera #16

Camera Environment: Interior, Inside
Mounting Location: Parking P2 level, On wall or ceiling
Camera View: Viewing elevator lobby

Camera #17

Camera Environment: Interior, Inside
Mounting Location: Parking P2 level, On wall or ceiling
Camera View: Viewing freight elevator lobby

Camera #18

Camera Environment: Interior, Inside
Mounting Location: Parking P2 level, In west stairwell on wall or ceiling
Camera View: Viewing stairwell

Camera #19

Camera Environment: Interior, Inside
Mounting Location: Parking P2 level, In east stairwell on wall or ceiling
Camera View: Viewing stairwell

Camera #20 - 27

Camera Environment: Interior, Inside
Mounting Location: Parking P2 level, On wall or ceiling
Camera View: Viewing parking areas

Camera #28

Camera Environment: Interior, Inside
Mounting Location: Parking P1 level, On wall or ceiling
Camera View: Viewing elevator lobby

Camera #29

Camera Environment: Interior, Inside
Mounting Location: Parking P1 level, On wall or ceiling
Camera View: Viewing freight elevator lobby

Camera #30

Camera Environment: Interior, Inside
Mounting Location: Parking P1 level, In west stairwell on wall or ceiling
Camera View: Viewing stairwell

Camera #31

Camera Environment: Interior, Inside
Mounting Location: Parking P1 level, In east stairwell on wall or ceiling
Camera View: Viewing stairwell

Camera #32 - 39

Camera Environment: Interior, Inside

Mounting Location: Parking P1 level, On wall or ceiling

Camera View: Viewing parking areas

Camera #33

Camera Environment: Interior, Inside

Mounting Location: Main level, On wall or ceiling

Camera View: Viewing residential entry lobby

Camera #34

Camera Environment: Interior, Inside

Mounting Location: Main level, On wall or ceiling

Camera View: Viewing concierge area

Camera #35

Camera Environment: Interior, Inside

Mounting Location: Main level, On wall or ceiling

Camera View: Viewing elevator lobby

Camera #36

Camera Environment: Interior, Inside

Mounting Location: Main level, On wall or ceiling

Camera View: Viewing freight elevator lobby

Camera #37

Camera Environment: Interior, Inside

Mounting Location: Main level, In west stairwell on wall or ceiling

Camera View: Viewing stairwell

Camera #38

Camera Environment: Interior, Inside

Mounting Location: Main level, In east stairwell on wall or ceiling

Camera View: Viewing stairwell

Camera #39 - 41

Camera Environment: Interior, Inside

Mounting Location: Main level, parking area on wall or ceiling

Camera View: Viewing parking

Camera #42

Camera Environment: Interior, Inside

Mounting Location: Second level, On wall or ceiling

Camera View: Viewing elevator lobby

Camera #43

Camera Environment: Interior, Inside

Mounting Location: Second level, On wall or ceiling

Camera View: Viewing freight elevator lobby

Camera #44

Camera Environment: Interior, Inside

Mounting Location: Second level, In west stairwell on wall or ceiling

Camera View: Viewing stairwell

Camera #45

Camera Environment: Interior, Inside

Mounting Location: Second level, In east stairwell on wall or ceiling

Camera View: Viewing stairwell

Camera #46

Camera Environment: Interior, Inside

Mounting Location: Third level, On wall or ceiling

Camera View: Viewing elevator lobby

Camera #47

Camera Environment: Interior, Inside

Mounting Location: Third level, On wall or ceiling

Camera View: Viewing freight elevator lobby

Camera #48

Camera Environment: Interior, Inside

Mounting Location: Third level, In west stairwell on wall or ceiling

Camera View: Viewing stairwell

Camera #49

Camera Environment: Interior, Inside

Mounting Location: Third level, In east stairwell on wall or ceiling

Camera View: Viewing stairwell

Camera #50

Camera Environment: Interior, Inside

Mounting Location: Third level, In fitness center

Camera View: Viewing fitness center

Camera #51

Camera Environment: Interior, Inside

Mounting Location: Fourth level, On wall or ceiling

Camera View: Viewing elevator lobby

Camera #52

Camera Environment: Interior, Inside

Mounting Location: Main level, On wall or ceiling

Camera View: Viewing freight elevator lobby

Camera #53

Camera Environment: Interior, Inside

Mounting Location: Fourth level, In west stairwell on wall or ceiling

Camera View: Viewing stairwell

Camera #54

Camera Environment: Interior, Inside

Mounting Location: Fourth level, In east stairwell on wall or ceiling

Camera View: Viewing stairwell

Camera #55

Camera Environment: Interior, Inside
Mounting Location: Fifth level, On wall or ceiling
Camera View: Viewing elevator lobby

Camera #56

Camera Environment: Interior, Inside
Mounting Location: Fifth level, On wall or ceiling
Camera View: Viewing freight elevator lobby

Camera #57

Camera Environment: Interior, Inside
Mounting Location: Fifth level, In west stairwell on wall or ceiling
Camera View: Viewing stairwell

Camera #58

Camera Environment: Interior, Inside
Mounting Location: Fifth level, In east stairwell on wall or ceiling
Camera View: Viewing stairwell

Camera #59

Camera Environment: Interior, Inside
Mounting Location: Sixth level, On wall or ceiling
Camera View: Viewing elevator lobby

Camera #60

Camera Environment: Interior, Inside
Mounting Location: Sixth level, On wall or ceiling
Camera View: Viewing freight elevator lobby

Camera #61

Camera Environment: Interior, Inside
Mounting Location: Sixth level, In west stairwell on wall or ceiling
Camera View: Viewing stairwell

Camera #62

Camera Environment: Interior, Inside
Mounting Location: Sixth level, In east stairwell on wall or ceiling
Camera View: Viewing stairwell

Camera #63

Camera Environment: Interior, Inside
Mounting Location: Seventh level, On wall or ceiling
Camera View: Viewing elevator lobby

Camera #64

Camera Environment: Interior, Inside
Mounting Location: Seventh level, On wall or ceiling
Camera View: Viewing freight elevator lobby

Camera #65

Camera Environment: Interior, Inside
Mounting Location: Seventh level, In west stairwell on wall or ceiling
Camera View: Viewing stairwell

Camera #66

Camera Environment: Interior, Inside
Mounting Location: Seventh level, In east stairwell on wall or ceiling
Camera View: Viewing stairwell

Camera #67

Camera Environment: Interior, Inside
Mounting Location: Sixth level, In west stairwell on wall or ceiling
Camera View: Viewing stairwell

Camera #68

Camera Environment: Interior, Inside
Mounting Location: Sixth level, In east stairwell on wall or ceiling
Camera View: Viewing stairwell

Camera #69

Camera Environment: Interior, Inside
Mounting Location: Eight level, On wall or ceiling
Camera View: Viewing elevator lobby

Camera #64

Camera Environment: Interior, Inside
Mounting Location: Eight level, On wall or ceiling
Camera View: Viewing freight elevator lobby

Camera #70

Camera Environment: Interior, Inside
Mounting Location: Eight level, In west stairwell on wall or ceiling
Camera View: Viewing stairwell

Camera #71

Camera Environment: Interior, Inside
Mounting Location: Eight level, In east stairwell on wall or ceiling
Camera View: Viewing stairwell

Camera #72

Camera Environment: Interior, Inside
Mounting Location: Ninth level, In west stairwell on wall or ceiling
Camera View: Viewing stairwell

Camera #73

Camera Environment: Interior, Inside
Mounting Location: Ninth level, In east stairwell on wall or ceiling
Camera View: Viewing stairwell

Camera #74

Camera Environment: Interior, Inside
Mounting Location: Ninth level, On wall or ceiling
Camera View: Viewing elevator lobby

Camera #75

Camera Environment: Interior, Inside
Mounting Location: Ninth level, On wall or ceiling
Camera View: Viewing freight elevator lobby

Camera #76

Camera Environment: Interior, Inside
Mounting Location: Ninth level, In west stairwell on wall or ceiling
Camera View: Viewing stairwell

Camera #77

Camera Environment: Interior, Inside
Mounting Location: Ninth level, In east stairwell on wall or ceiling
Camera View: Viewing stairwell

Camera #78

Camera Environment: Interior, Inside
Mounting Location: Ninth level, In pool area on wall or ceiling
Camera View: Viewing pool area

Camera #79

Camera Environment: Interior, Inside
Mounting Location: Ninth level, In workout room on wall or ceiling
Camera View: Viewing workout room

Miscellaneous- Verify camera views with client
System programming and testing checkout
Client workstation setup
DW smart-phone setup (Apple/Android)
Provide seminar of system operation

4.13 Site Photographs

124 Peabody
Birmingham
Michigan
48009

Site Photographs

CHRISTOPHER J LONGE AIA
ARCHITECTURE

124 Peabody
Birmingham
Michigan
48009

Site Photographs