APPENDIX A – Prince George Mobile Monitoring Protocols

(Adapted from Gail Millar's Protocol for Mobile Monitoring in the Bulkley Valley)

1.   List of Equipement.
-GPS with Datalogger and screwdriver
-Folder with Nephelometer Sampling Sheets and pen
-Power inverter
-Nephelometer with power cord and 9pin cord to attach to laptop
-Laptop with power cord
-Book of routes and maps

2.   Pre and Post Departure Preparation
1.   E-mail Peter Jackson with the names of the research assistants who will be monitoring and the area(s) being monitored (Jennifer).
2.   Call the RCMP 250-561-3300 with a description of the vehicle, liscence plate number, and the areas of town which will being monitored.
3.

Prius	2007 Toyota	664 AWS
Escape	2008 Ford Hybrid	712 AWS (Ben's)
Sierra	2007 GMC	6429KR (Brenda's)
Sierra	2007 GMC	1723KT (Kristen's)

4.   Set the nephelometer clocks to UTC (adapted from Larson et al., 2005)
The nephelometer clocks must be set to UTC so that the two nephelometers and GPS unit are synchronized.
a. On nephelometer menu:
i. Press 'Enter' button
ii. Scroll down to 'Adjust clock'.
iii. Press 'Select' button
b. Set the date to match UTC date shown on the laptop (pre-set to UTC time)
c. Set the time to match the upcoming UTC minute on the laptop.
d. Once appropriate date and time have been selected, scroll down to '**Save Time ->'**
e. Press the 'Enter' button the instant that UTC time (on the NIST
website) reaches the appropriate minute. The screen will display: "Setting
Clock".
f. Verify that the nephelometer clocks have been synchronized to UTC
time by comparing the time on the main display screen of the
nephelometers and the laptop.
5. a. Set up the nephelometer so that the inlet tube is outside the window and the funnel faces towards the back of the vehilcle.
b. Set up the GPS with the receiver (magnet) outside the vehicle. Plug the GPS into the cigarette lighter.
c. Set up the power inverter and attach the nephelometer power cord between the nephelometer and the power
inverter.
d. Set up the laptop. Plug one end of the laptop power cord into the laptop.
e. Turn on the laptop. Open the HyperTerminal program (Start   Accessories
Communications). f. The "Connection Description" screen in will appear. Type in
today's date abd press ok.
g. One the next screen (Figure A 6), you will be prompted for the information on the serial

port location. Select Com 1 for the black laptop or Com 4 for the silver laptop. The other information on the screen does not apply. Click OK.
h. The 'COM Properties' screen will then appear. Select: Bits per second: 9600, Data bits: 8, Parity: None, Stop bits:
1 and Flow Control: Hardware. Click Ok.
i. A blank screen will appear. Select 'Transfer' (from the HyperTerminal menu) then 'Capture Text to File'. The program will ask you the name and location of the text file that will be created (this is the data file that the nephelometer measurements will be saved to). Select Browse and save the file as:
C:/Today'sDate_MonitoringLocation.txt
Click Start.

j. Start the vehicle
k. Turn the power inverter on.
l. Once the power inverter's light is green, flip the switch for the gps and turn the nephelometer on at the same time.
m. Plug the laptop into the power inverter once the light on the power inverter is green again.
n. Drive the predetermined route using the navigation instructions and maps.
Residential streets should be driven at 30km/h. Non residential areas (with no houses) can be driven at the normal
speeds for the area. Areas where houses are particularly sparse (i.e. some parts of the Hart, North Nechako area etc.. can be driven at normal vehicle speeds.)
While driving, have the navigator make observations of conditions that may affect data (e.g. if area has heavy wood smoke, if a train passed by etc.) by: a) pressing the event button on the GPS datalogger and b) making a note of the condition associated with each event on the *Mobile Monitoring Sampling Sheet*
o. At least one residential block needs to be repeated at both the beginning and end of the route. p. At the end of the trip, turn the power off on the nephelometer and GPS at the same time.
q. Turn the power off on the nephelometer and undo the setup

APPENDIX B – Mobile Monitoring Sampling Sheet

Start Date and Time:	End Point and Time:	Research Assistant 1:
Route/Division:	Starting Point:	Research Assistant 2:
Datalogger: sticker/no sticker	Power Inverter: black/pink	Nephelometer: Mobile/Fixed
Liscence Plate of Vehicle:	Computer: silver/black	

Notetaker	Event Place	Event Time	Event Description

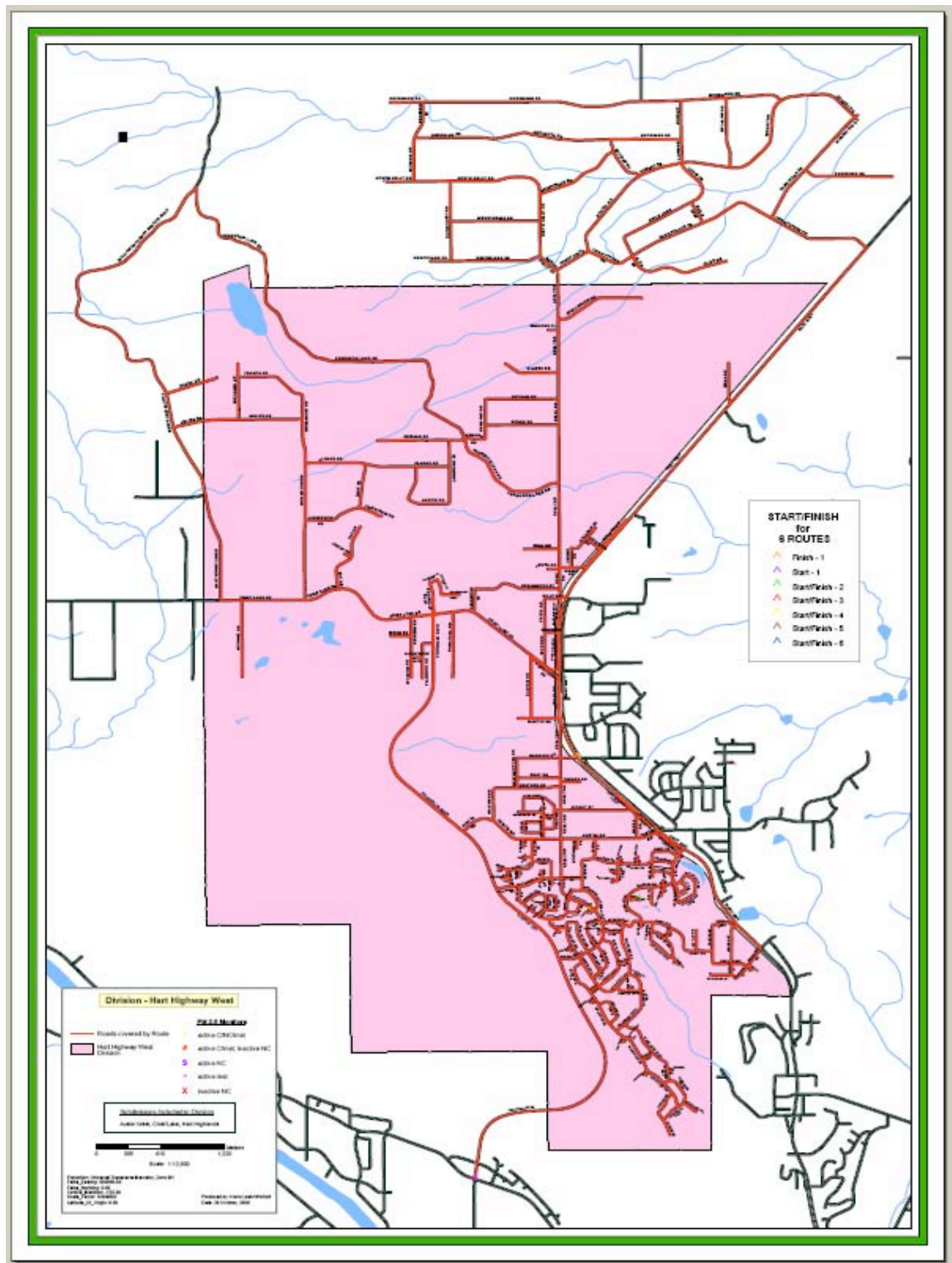# APPENDIX C – Maps of the Divisions in Prince George

Figure C-1: Map of Prince George's Division of Hart Highway West
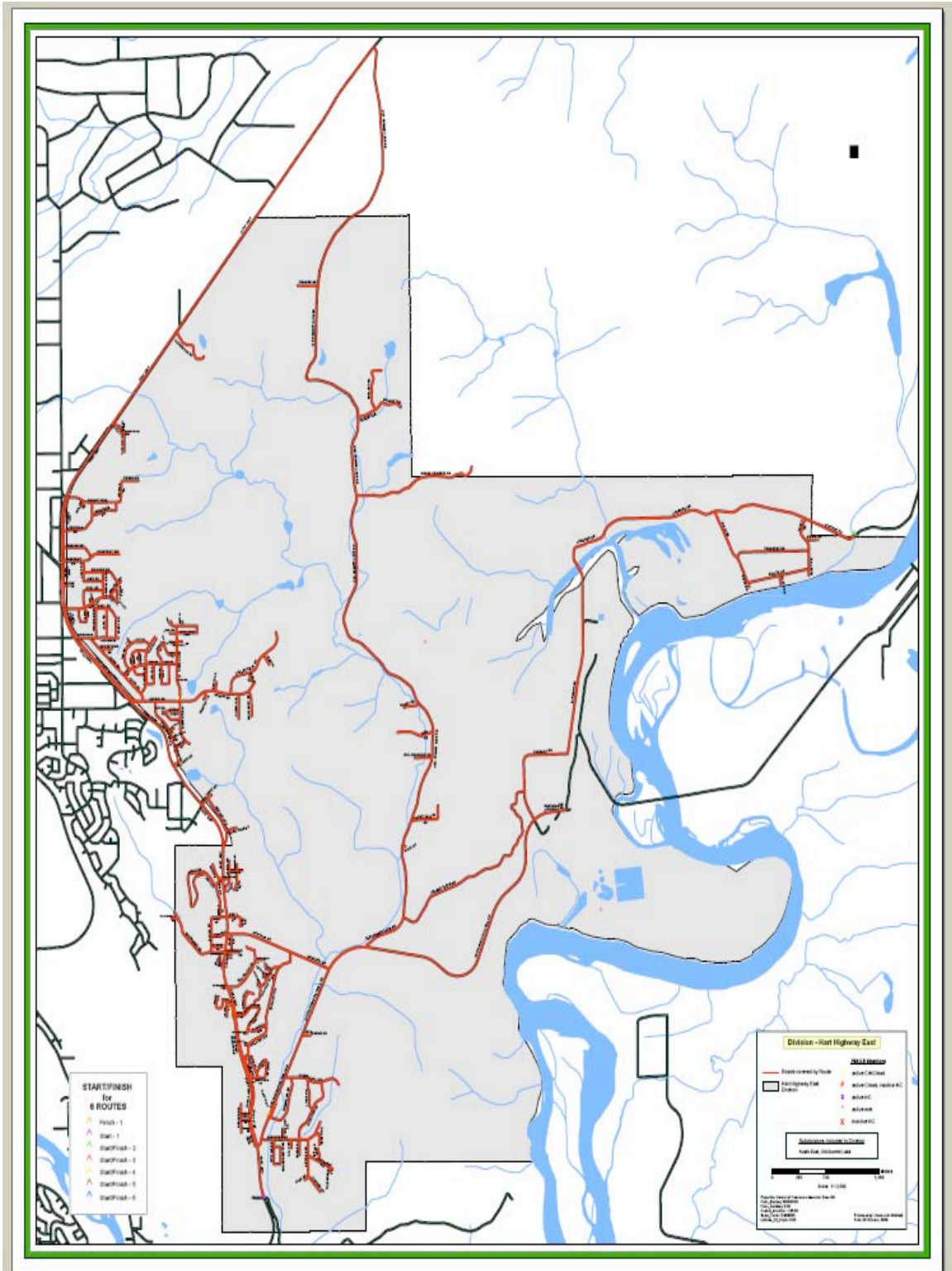
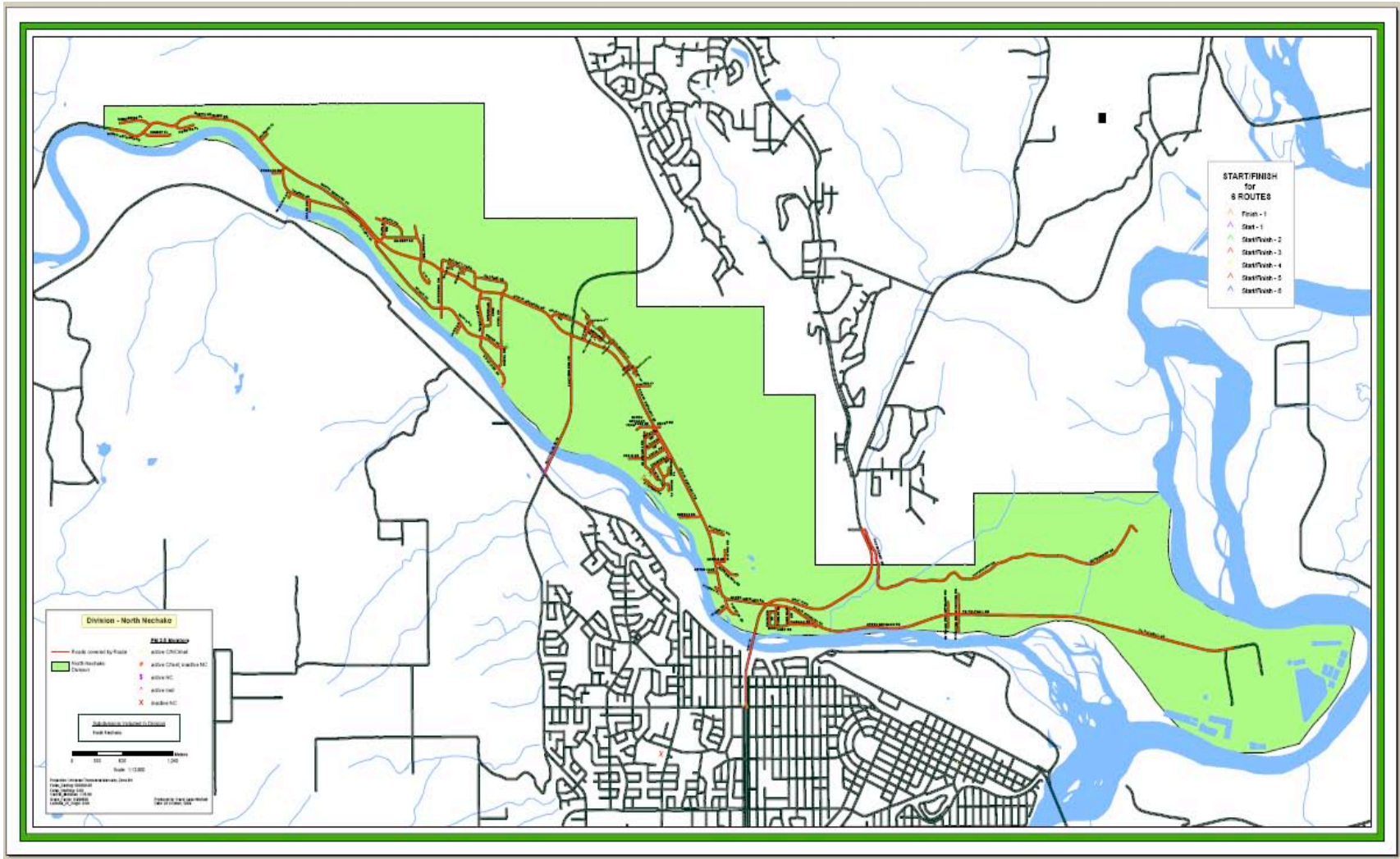**Figure C-2: Map of Prince George's Division of North Nechako**

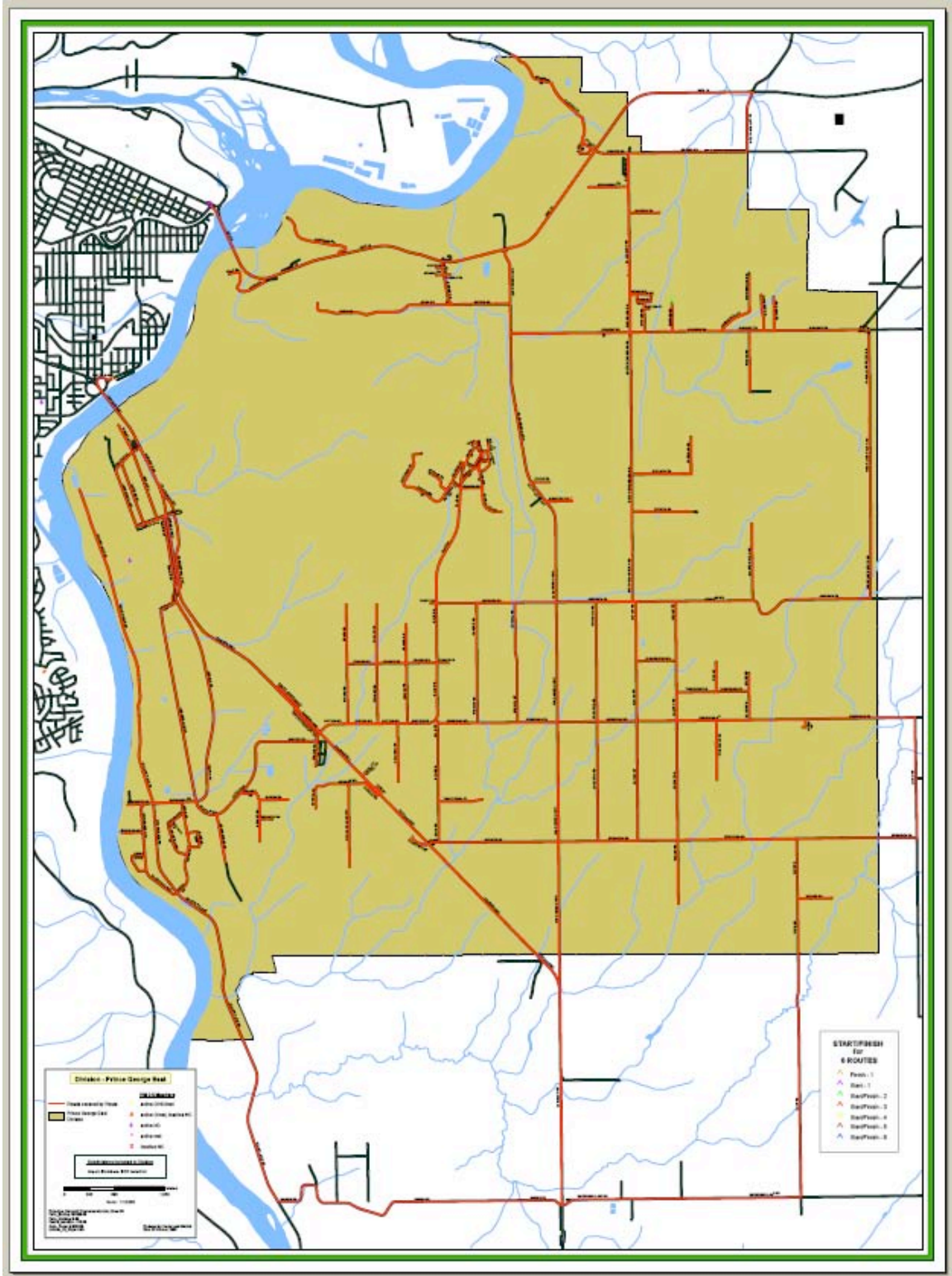**Figure C-3:** Map of Prince George's Division of North Nechako

Figure C-4: Map of Prince George's Division of Prince George East

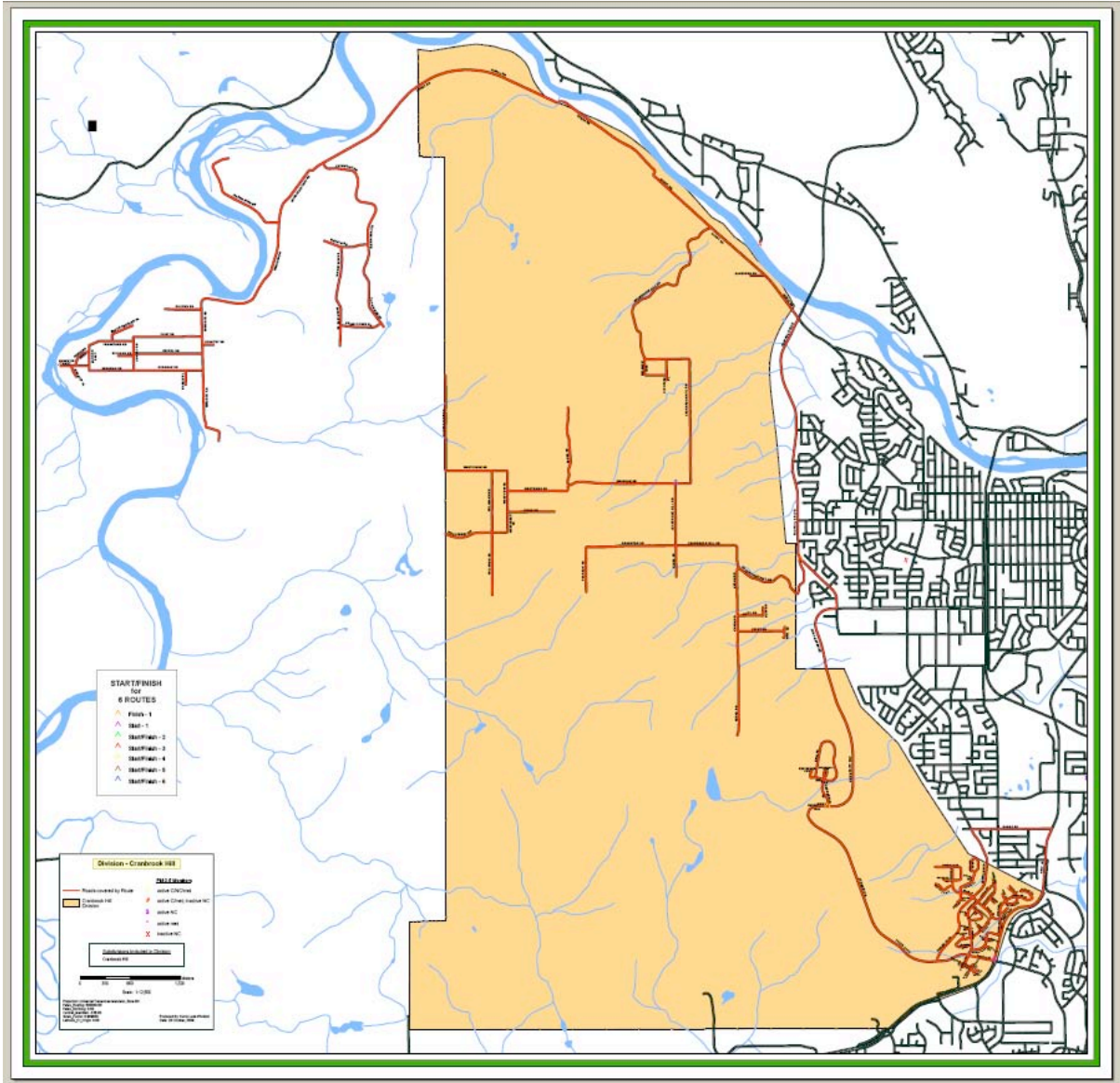**Figure C-5: Map of Prince George's Division of College Heights**

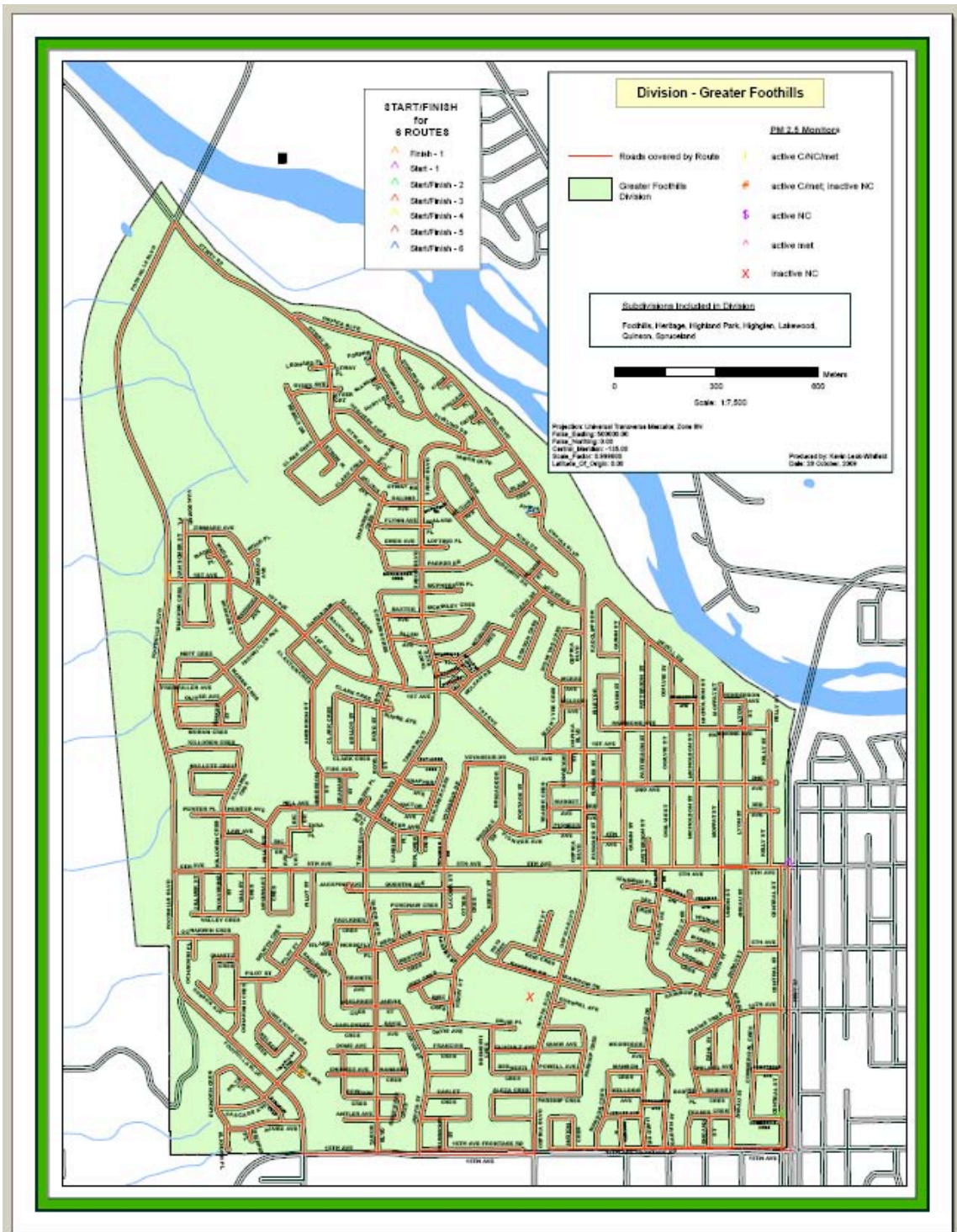**Figure C-6:** Map of Prince George's Division of Cranbrook Hill

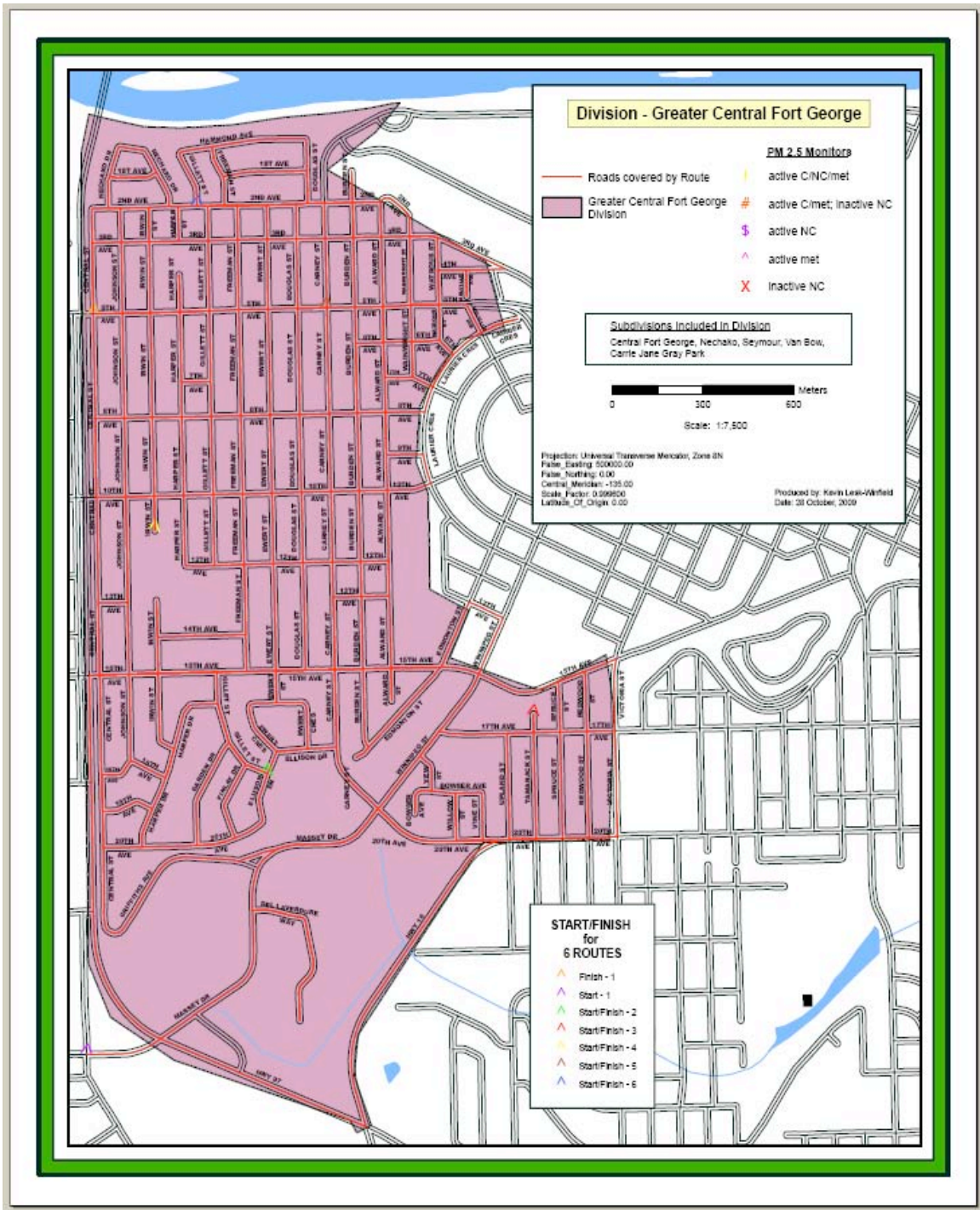**Figure C-7: Map of Prince George's Division of Greater Foothill**

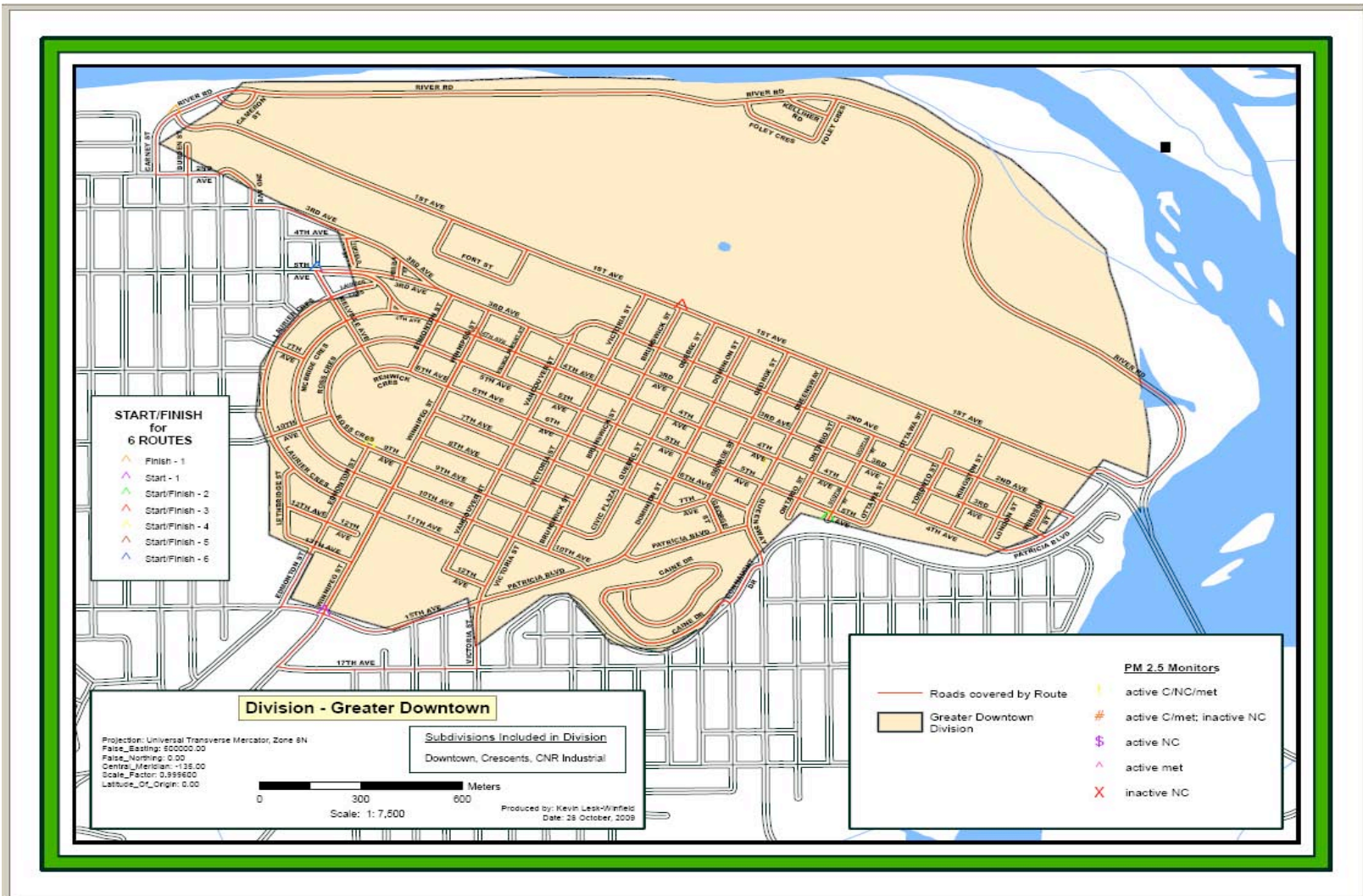**Figure C-8: Prince George's Division of Greater Central Fort George**

Figure C-9: Prince George's Division of Downtown
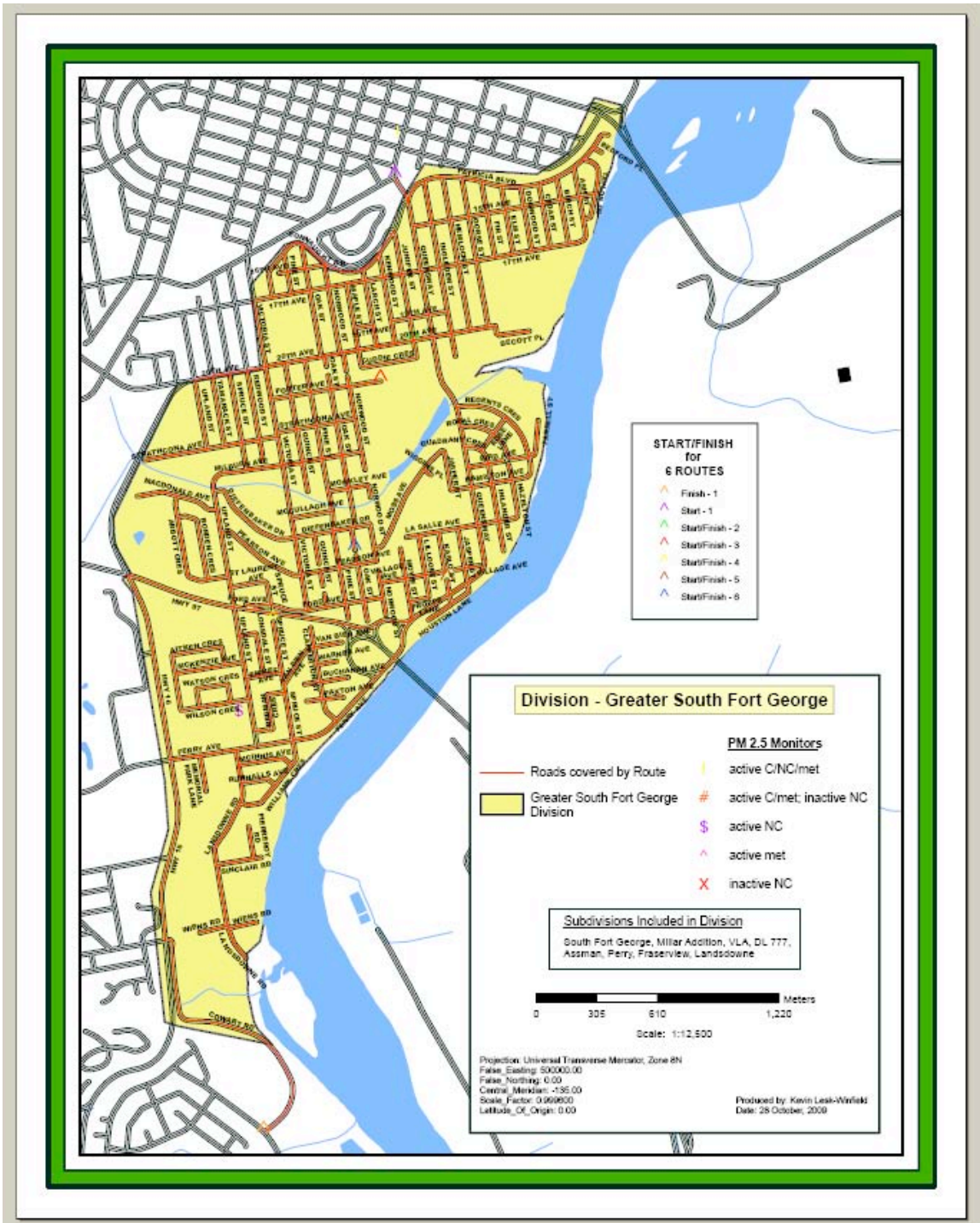
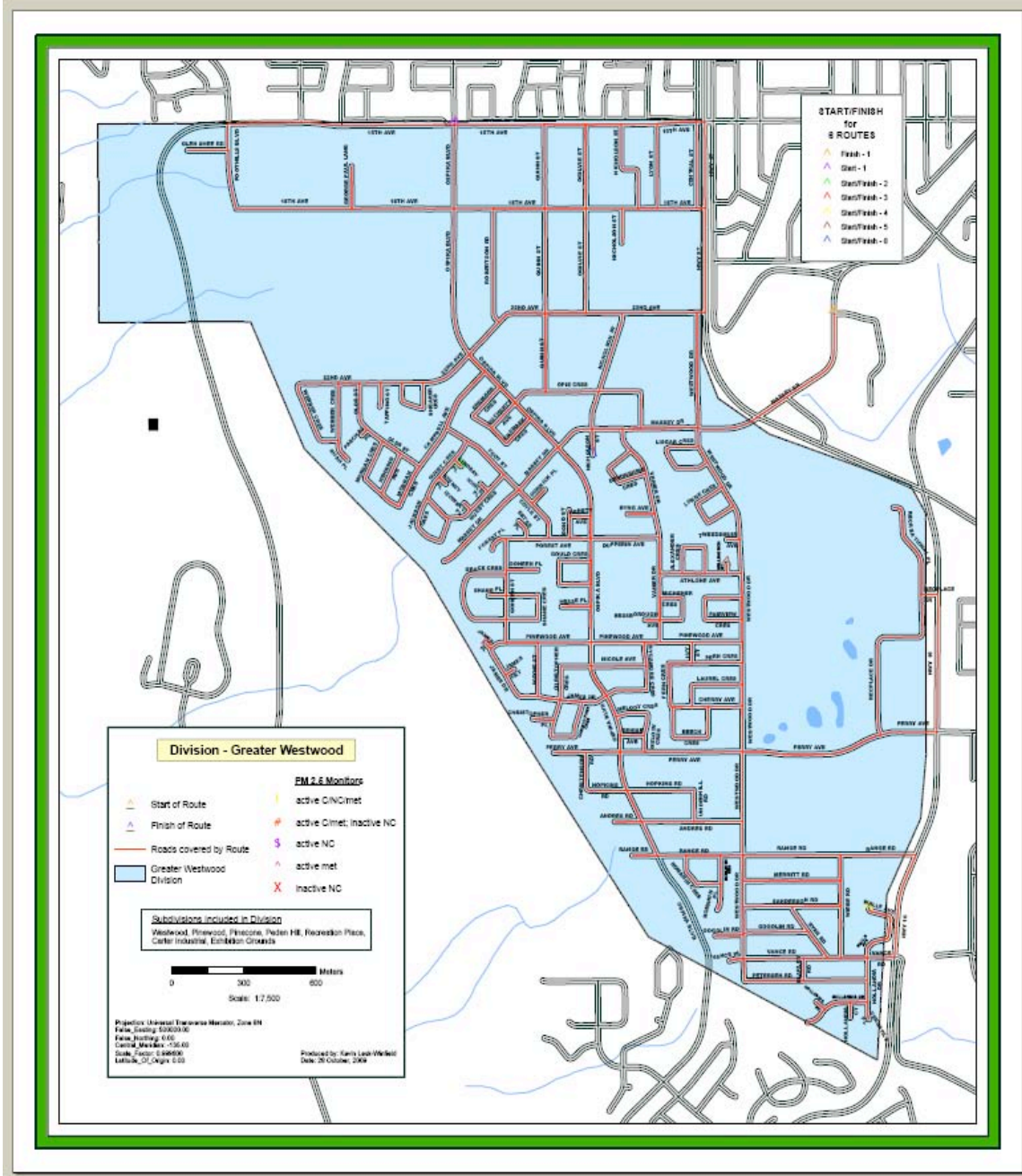**Figure C-10: Prince George's Division of Greater South Fort George**

Figure C-11: Map of Prince George's Division of Westwood

APPENDIX D – Time Matching Data Processing for Mapping Smoke (GPS and Nephelometer Data)

Standard Operating Procedure Version 1.1

Authors: J. Su, AM Baribeau

1. Data Clean-Up Prior to Processing
Open each of the raw nephelometer and GPS logger data files, and delete any data outside of the time period for which data logging took place. **Remember that all records are based on Greenwich Mean Time (GMT), so if you sampled on 1/2/2005 starting at 8:30 p.m., your nephelometer and GPS records would show that you sampled actually at 1/3/2005 and 4:30 a.m.**

10 GPS coordinate system conversion

Latitude: As the first two digits in the downloaded GPS data are the true latitude degrees, these two digits should be extracted first. The remaining two integer digits (unit and ten) and all decimal digits are minutes, not degrees. They should be converted to degrees for locating spatial points. Label this latitude column 'LATTMP'.

For example, if our GPS records a point with latitude of 4916.2478, 49 is the degree of the point and 16.2478 is the minutes (not degrees). 49 can be separated by INT(4916.2478/100), and the remaining part is 4916.2478/100- INT(4916.2478/100) in minutes. The minutes should be converted to decimal degrees and added up with the integer degrees. The overall calculation can be expressed by:

$$LAT = INT(LATTMP/100)+(LATTMP/100-INT(LATTMP/100))*100/60 \qquad \textbf{eq.(1)}$$

Longitude: As the first three digits are the true longitude degrees, these three digits should be extracted first. The remaining two integer digits (unit and ten) and all decimal digits are minutes, not degrees. They should also be converted to degrees. Another thing is that we are in western hemisphere and longitude degrees should be negative values. Label this longitude column 'LONGTMP'.

$$LONG = -(INT(LONGTMP/100)+(LONGTMP/100-INT(LONGTMP/100))*100/60) \qquad \textbf{eq.(2)}$$

You now have added a formatted date, time field to your original GPS logger data file (we shall later refer to this file as GPS1 – save it as a .xls file).

2. Creating comparable time fields
In dealing with time-matching, we need to create a field in each of the GPS and Nephelometer downloaded data, and these two fields should have common expression of time and date.

Raw GPS data have two fields. One is time and another one is date. We can just add one field and combine them together. Be sure to put date in front of time, otherwise we might mix the sequence if a measurement crosses midnight. For example, if we have a GPS time of 44159 (hour 4, min 41 and sec 59) and date 60105 (Jan. 6, 2005), I created a value of 60105.044159 by:

$$GPSTIME = Date+Time/1000000 \qquad \textbf{eq.(3)}$$

The reason to use decimal is for avoiding possible integer overflow. Name the column of values resulting from the calculation of equation (3) above 'GPSTIME'.

The raw Nephelometer data have in sequence YR, MON, DAY, HR, MIN and SEC in separate fields (label

them as such). To be comparable with GPS date/time, a new field can be created in a way similar to:

$$\text{NEPHTIME} = yr + mon*100 + day*10000 + hr/100 + min/10000 + sec/1000000 \qquad \textbf{eq. (4)}$$

You now have added a formatted date, time field to your original Nephelometer data file (we shall later refer to this file as NEPH1 – save it as a .xls file) . Name the column of values resulting from the calculation of equation (4) above 'NEPHTIME'.

3. **Time-matching Macros & Preparation of Resulting Output Files for ArcMAP Plotting**
   The macros for time-matching of the two data sets can be run in the macro environment of Excel. Some files need to be created **in Excel** before running the script, as described below:

   A. Create a file named GPSTIMEmthday#.txt. Copy data from the GPSTIME field created above and paste them into the GPSTIMEmthday#.txt. Make sure do not use 1000 separators (,), otherwise one data point will be treated as two (if using 16,023.52, then it will be treated as 16 and 23.52). RECORD THE NUMBER OF ROWS OF GPSTIME DATA (~2800).
   B. Create another file named NEPHTIMEmthday#.txt. Copy data from the NEPHTIME field created above and paste them into the NEPHTIMEmthday#.txt. Also make sure do not use 1000 separators. RECORD THE NUMBER OF ROWS OF NEPHTIME DATA (~900).
   C. Copy the text from the timematching.txt file into a Visual Basic (VB) environment: in Excel, go to "Tools > Macro > Visual Basic Editor. Once you are in the VB Editor, go to Insert > Module. This will bring up an empty programming space into which you can copy the text from the timematching.txt.
      a. Make the following revisions to the timematching.txt source code:
         - Specify the correct # of rows of NEPHTIME data from B. above in the following line of the source code:

            *Dim Neph(***#rows NEPHTIME***, 2) As Double*

         - Specify the correct # of rows of GPSTIME data from A. above in the following line of the source code:

            *Dim GPS(***#rows GPSTIME***) As Double*

         - Change the # rows also for the NEPHTIME and GPSTIME in the following source code lines:

            lngNephRecording = **#rows NEPHTIME**

            lngGPSRecording = **#rowsGPSTIME**

         - Specify where the NEPHTIME and GPSTIME text files are stored, in the following lines of the source code (**bolded text below indicates example file path, where the user should provide a filename&path**):

            *Open "***C:\temp\Tim\NEPHTIME.txt***" For Input As #1*

            *Open "***C:\temp\Tim\GPSTIME.txt***" For Input As #2*

         - Specify the location where you wish to save the output file that will be created from running the VB script, in the following lines of the source code (**bolded text below indicates example file path where the user should provide a filename&path**):

            *If (FileObject.FileExists("***C:\Temp\Tim\Matches.txt***")) Then*

            *Kill ("***C:\Temp\Tim\Matches.txt***")*

            End If

            'output results

Open **"C:\Temp\Tim\Matches.txt"** *For Output As #3*

D. Open or import the specified output file into Excel, and format data to 6 decimal places. The first column of the output file is the NEPHTIME and the second the GPSTIME. Add two more columns to the **NEPH1** (Excel) file created in the section of "**Creating comparable time fields**". Copy and paste the data derived from the output file into the two new columns just added.

      a. Verify that the first new column (from the output file) is exactly the same as your NEPHTIME field, and that the second new column is the GPSTIME closest to the NEPHTIME we are hoping to get.

      b. Check the first and last section of the data to see if there are any time discrepancies beyond 5 seconds. Remove any rows of data whose GPSTIME and NEPHTIME values are > 5seconds apart. [2]

      c. If you can make sure that the two NEPHTIME columns matches 100%, you can remove one of them, but be sure to keep one NEPHTIME and one GPSTIME fields in the NEPH1 data file for subsequent attribute joining in ArcMAP.

E. Save the revised GPS1 and NEPH1 data as dbf files, respectively. Prior to saving these data, however, certain formatting requirements must be verified:

      a. ENSURE THAT all of the GPS and NEPH date+time data columns, as well as Nephelometer scattering data (SCAT) are **formatted to show 6 decimal places**, and that the columns containing these data are wide enough to display the number of requested decimal places. (**the .dbf files will truncate numerical values if they 'appear' as such in the parent Excel file**, which will cause problems in subsequent attempts to join and process data in ArcMAP).The .dbf file will accept only one row of 'column header titles'. In addition, these titles may only be up to 8 characters long, and some symbols are not permitted. Name the column titles for each of the parameters listed below as suggested, as you will have to refer to them in ArcMAP**:**

        GPS .dbf file   **NEPH .dbf file**

        GPS time date = GPSTIME   NEPH time date = NEPHTIME

        Adjusted longitude value = LONG   Bscat value = SCAT

        Adjusted latitude value = LAT

      b. HIGHLIGHT the DATA that you wish to save into the .dbf file**. Failing to do so will result in a .dbf file containing 65000 rows of data (the max. number of rows permitted in any given Excel file). This will dump a large set of zeros into your ArcMAP plot and you will ultimately have to remove these.**

5. Plotting Nephelometer & GPS Logger Data in ArcMAP:

F. Use Tools > Add XY data to create a spatial presentation of the GPS data in ArcMap. Once you've opened the 'Add XY data' dialog box:

      a. Open the GPS1.dbf file that you created in section 4E above by using the file search option under the heading 'Choose a table from the map or browse for another table".

G. In the dialog box, you will also be asked to enter the X and Y coordinates of your data set, which will be your LONG and LAT column headings, respectively. Click on 'OK'. A set of GPS data should appear on the screen, representing the route that was driven during the corresponding smokemobile data logging session.

H. **Create a shape file from this layer**: right-click on the layer, choose Data > Export Data, and in the ensuing dialog box:

      a. Specify: Export 'all features';

      b. Choose: 'Use the same coordinate system as this layer's source data'

---

[2] More than 5 seconds discrepancy is created when a Nephelometer is turned on (starting

measurements) or off (ending measurements) **earlier** than the GPS unit.

      c.   Specify a destination file path and file name under the 'Output shape file or feature class' line.

      d.   Click on 'YES' when prompted the following: 'Do you want to add the exported map to the current view?'

      e.   Right-click on the OLD layer, click on 'Remove', and you will be left only with this new layer.

I.   Then use attribute joining in ArcMap to join the Nephelometer data from the NEPH1.dbf file to the current layer. To do this, right-click on the current layer, go to 'Joins and Relates' > 'Join'.

      a.   In the 'Join Data' dialog box, select the 'Join attributes from a table' option.

      b.   Under 'Choose the field in this layer that the join will be based on', select 'GPSTIME'.

      c.   Under 'Choose the table to join to this layer, or choose it from disk', find & select your NEPH1.dbf file created in section 4E above.

      d.   Under 'Choose the field in the table to join the base on', specify 'NEPHTIME'.

      e.   Click on 'Advanced', select "Keep only matching records". The GPS projection is in GCS_North_American_1983 and Datum: D_North_American_1983.

      f.   Right-click on the new layer containing the nephelometer data, and select

      g.   **Create a shape file from this layer**: Repeat step H. above.

            FORMAT Scattering Data:

      h.   Double-click on the NEPH layer, and go to the 'Symbology' tab. Under the 'Show' heading in this dialog box, click on '**Quantities**> Graduated Colors'.

      i.   Under the 'Fields > Value' heading, enter (select from a drop-down list) the column header that you have specified for the SCAT (nephelometer) data. Leave 'Normalization' at 'None' if you do not wish to normalize data.

      j.   Under 'Classification', enter a value of 3 into the 'Classes' box, and then click on 'Classify'.

      k.   Under 'Method', click on 'Quantiles' from the drop-down menu.

      l.   Click on 'Apply'.

      m.   Your map will now show up with different shades of a parent colour indicating 'low, medium, high' SCAT values.

      n.   Do a final adjustment of your marker colours by right-clicking on the symbol in the left-hand 'Layers' section of the screen. The custom is green=low, yellow=medium, and red=high.

6.   Adding a Legend and Scale to the Layout View of the Created Map

If you wish to display map graphical output in presentation software, or report-writing software, you will have to save your current view to a .jpg file so that it can be easily imported.

    i. To Create a Legend:

      a.   Go to: 'View > Layout View'

      b.   Go to: 'Insert > Legend'

      c.   In the subsequent dialog box, you must specify for which layer you wish to include a legend, and which attributes of this layer you wish to have displayed in the legend.

      d.   Once, you are finished specifying information pertaining to your legend (borders, background colour, etc.), click on "Apply' and/or 'OK'. At this point, your legend will have been inserted into your Layout View.

      e.   You can change the size and location of your legend by clicking on it and dragging it/resizing it using the cursor.

    ii. To Insert a Scale:

While still in Layout View,

      f.   Go to: 'Insert > Scale Bar'

      g.   Select one of the scale bars displayed on the left-hand side of the dialog box

      h.   Click on 'Properties', and then under 'Division Units', specify 'Kilometres'.

      i.   Click on 'Apply', and then 'OK', and then the scale will appear on the Layout view.

    j. You can change the size and location of your scale bar by clicking on it and dragging it/resizing it using the cursor.

10.1.1.1.1 iii. Saving the Layout View of your Map as a JPEG File

    a. Go to 'File > Export Map'. You will be automatically prompted in a dialog box to save the file in .jpg format, with a filename that you specify.

    b. The file is ready to be imported easily into word processing or presentation software. NOTE THAT ONCE YOU HAVE IMPORTED this JPEG file, you will no longer be able to EDIT and MAKE CHANGES to it in its new application environment.

APPENDIX E – Time Macro

```
SUB MATCHGPS_NEPH()

    DIM NEPH(15089, 2) AS DOUBLE
    DIM GPS(15089) AS DOUBLE

    DIM LNGNEPHRECORDING AS LONG
    DIM LNGGPSRECORDING AS LONG
    LNGNEPHRECORDING = 15089
    LNGGPSRECORDING = 15089

    DIM I, J AS LONG

    OPEN "E:\MOBILE MONITORING C DRIVE\GPS &
NEPHTIME\NEPHTIMEDEC10.TXT" FOR INPUT AS #1
    OPEN "E:\MOBILE MONITORING C DRIVE\GPS & NEPHTIME\GPSTIMEDEC10.TXT"
FOR INPUT AS #2

    FOR I = 0 TO LNGNEPHRECORDING - 1
        INPUT #1, NEPH(I, 0)
    NEXT I
    CLOSE #1

    FOR J = 1 TO LNGGPSRECORDING - 1
        INPUT #2, GPS(J)
    NEXT J
    CLOSE #2

    FOR I = 0 TO LNGNEPHRECORDING - 1
        FOR J = 0 TO LNGNEPHRECORDING - 1
            IF NEPH(I, 0) = GPS(J) THEN
                NEPH(I, 1) = GPS(J)
            ELSEIF NEPH(I, 0) < GPS(J) THEN
                IF J > 0 THEN
                    IF NEPH(I, 0) > GPS(J - 1) THEN
                        IF (ABS(NEPH(I, 0) - GPS(J)) < ABS(NEPH(I, 0) - GPS(J - 1))) THEN
                            NEPH(I, 1) = GPS(J)
                        ELSE
                            NEPH(I, 1) = GPS(J - 1)
                        END IF
                    END IF
                ELSEIF J = 0 THEN
                    NEPH(I, 1) = GPS(J)
                END IF
            ELSE
                IF J < LNGGPSRECORDING - 1 THEN
                    IF NEPH(I, 0) < GPS(J + 1) THEN
                        IF NEPH(I, 0) < GPS(J + 1) THEN
                            IF (ABS(NEPH(I, 0) - GPS(J)) < ABS(NEPH(I, 0) - GPS(J + 1))) THEN
                                NEPH(I, 1) = GPS(J)
                            ELSE
                            NEPH(I, 1) = GPS(J + 1)
                        NEPH(I, 1) = GPS(J + 1)
```

```
            END IF
          END IF
        ELSEIF J = LNGGPSRECORDING - 1 THEN


            NEPH(I, 1) = GPS(J)
        END IF
      END IF
      END IF
      NEXT  J
      NEXT I

      DIM FILEOBJECT
      SET FILEOBJECT = CREATEOBJECT("SCRIPTING.FILESYSTEMOBJECT")

      IF (FILEOBJECT.FILEEXISTS("E:\MOBILE MONITORING C
DRIVE\MATCHESDEC10.TXT")) THEN
        KILL ("E:\MOBILE MONITORING C DRIVE\MATCHESDEC10.TXT")
      END IF

      'OUTPUT RESULTS
      OPEN "E:\MOBILE MONITORING C DRIVE\MATCHES.TXT" FOR OUTPUT AS #3

      FOR I = 0 TO LNGNEPHRECORDING - 1
        FOR J = 0 TO 1
          WRITE #3, FORMAT(NEPH(I, J), "#####.######");
        NEXT J
        WRITE #3,
      NEXT I
      CLOSE #3
END SUB
```

APPENDIX F – ACCESS CODE FOR ADJUSTING TEOM DATA

```
Option Compare Database

Option Explicit

Public Function GetIndex(IndexFile As String, key As String)

'Open the index file and for a given key (Date Hour Minute) return the corresponding row of data

'Return a blank row if we can't find anything

Dim nf As Integer

Dim data As String

Dim key1 As String

Dim found As Boolean

    nf = FreeFile

    Open IndexFile For Input As #nf

    found = False

    While Not EOF(nf) And Not found

        Line Input #nf, data

        key1 = Left(data, InStr(data, ",") - 1)

        If key1 = key Then found = True

    Wend

    Close (nf)

    If found Then

        GetIndex = data

    Else

        GetIndex = ","

    End If
```

```
End Function

Public Sub MakeFile(IndexFile As String, DataFile As String, iOutFile As String)

'Takes an index file of 1 minute increments and adds it to a data file of 10s increments to create

'a new 3rd file that merges the two.

Dim Index As String

Dim df As Integer

Dim of As Integer

Dim key As String

Dim data As String

Dim dd As String

Dim dt As String

Dim Fields() As String

    df = 1

    of = 2

    Open iOutFile For Output As #of

    Open DataFile For Input As #df

    While Not EOF(df)

        Line Input #df, data

        key = Left(data, InStr(data, ",") - 1) '2/2/2010 18:02:00 assuming mm/dd/yyyy

        dd = Left(key, InStr(key, " ") - 1) '2/2/2010

        dt = Mid(key, InStr(key, " ") + 1, 5) '18:02

        Fields = Split(dd, "/")

        key = Fields(2) & "-" & Right("0" & Fields(0), 2) & "-" & Right("0" & Fields(1), 2) & " " & dt 'Take the
date/time from data file and convert to index file format: yyyy-mm-dd HH:MM

        Index = GetIndex(IndexFile, key)

        Print #of, Index & "," & data
```

```
    Wend

    Close (df)

    Close (of)

End Sub
```