Step by step protocol for reproducing results of study titled *Remote sensing and air monitoring tools for waste fire surveillance*

**Identify fire reports**

1. Search Google News for reports of waste fires. Use the following key-word searches: *waste fire, landfill fire, recycling plant fire*.
2. Review news reports to determine date of burn and location of facility.
3. Develop partnerships with communities impacted by waste fires. Work with community partners to identify sites and dates of burn events. Use Google Forms to create community surveys so community members can report locations of waste sites and burn events.
4. Compile database of fires with location, date of burn, and site characteristics.

**Site characteristics and meteorology**

1. Download meteorological data during the day of reported fire event from ASOS station closest to each site from the Iowa State University Iowa Environmental Mesonet.
2. Download meteorological data during the day of reported fire events from Weather Underground.
3. Calculate daily prevailing wind direction at each site.
4. Download Landscan nighttime population measure in GeoTIFF format.
5. Download USGS CONUS NLCD in raster format.
6. Download RUCA codes for census tracts from USDA. Join RUCA data to census tract polygon shapefile in ArcGIS pro.
7. Create 3km buffers around each site.
8. Use the *Summarize Categorical Raster* on the NLCD raster with the 3km site buffer as selecting feature to get counts of the number of pixels of each land cover class.
9. Use the *Zonal Statistics* tool on the Landscan layer to sum population within each 3km site buffer.
10. Create new polygon feature delineating boundaries of waste sites (Boundary AOI).
11. Create square polygon feature containing the general area around each site. Make sure area is large enough to capture potential smoke plumes. (Environmental AOI).

**FIRMS fire detection assessment**

1. Download FIRMS data from all available platforms as a point shapefile using the FIRMS archived data downloader.
2. In ArcGIS Pro, select FIRMS point detections using the *select by location* tool, with the Boundary AOI polygons as the selecting features. Use the *within a distance* parameter to select FIRMS points based on a buffer distance to site polygon borders. Use the following distances based on instrument type: 30m for Landsat, 375m for VIIRS, and 1km for MODIS.
3. Export FIRMS shapefiles as separate csv for each instrument.
4. Read in FIRMS data csv as data frames in R.
5. Format date-time column as date format.
6. Format data frames so data for each instrument has the same columns in the same order.
7. Use *rbind* function to combine data from separate instruments into single data frame.
8. Export formatted and combined FIRMS data as csv.
9. Read in combined FIRMS data as point shapefile in ArcGIS Pro using *create points from xy data.*
10. Cross-reference FIRMS detections with basemap imagery to filter-out ‘false-alarms’, such as clustered detections from non-fire related activities. Look for gas flaring equipment, power generation stations, other industrial equipment, that spatially align with large clusters of continuous FIRMS detections.
11. Consider detections +- 2 days from reported fire events as corresponding to a specific fire report.
12. Use ArcGIS Pro and R to analyze data and create plots.
    1. Calculate cumulative days of detection per-instrument each year, before and after filtering.
    2. Calculate cumulative days of detection per-instrument each month.
    3. Analyze distributions of reported FRP and Brightness per instrument.

**Planetscope visualization and spectral analysis**

1. Use Planet Explorer to parse, examine, and download PlanetScope scenes. Upload AOI shapefile for each site to use as AOI in Planet Explorer.
2. Examine scenes for visual evidence of fire, up to a week after a fire was reported at each site. Visual evidence includes flames, smoke plumes, and burn scars.
3. Download scenes with visual evidence of fire in GeoTiff format.
   1. Use 4 or 8-band (when available) rectified to surface reflectance
   2. Harmonize to Sentine-2 to normalize radiometry
   3. Composite scenes into a single GeoTIFF
4. Load GeoTIFFs as raster features in ArcGIS pro.
5. Extract reflectance values at each band using delineations of observed flames, smoke plumes, and burn scars using the *Spectral Profile* charting tool in ArcGIS.
6. Plot reflectance values of fire features at each site using Excel.

**PurpleAir data analysis**

1. Use PurpleAir real time air quality map to find downwind PM sensors within 50km of each site.
2. Use PurpleAir API to download recorded data from sensors, +- 1 day of reported burn event. Use PM2.5\_atm variable (outdoor PM2.5 averaged between spectrometers).
3. Use Python to analyze and plot data.
4. Look for spikes in recorded PM2.5 that are sustained for over an hour and outside of a day/night or other observed cycle.