Project One: Environmental Analysis

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Contents

```
# Read me!
## Install these packages before running the report

install.packages(c("devtools", "hrbrthemes",
                  "tidyverse", "DT"))

remotes::install_github("MPCA-data/mpcadb")
remotes::install_github("MPCA-data/mncolors")
remotes::install_github("MPCA-data/mpcaej")
```

Summary

THE GOAL of this project is to identify the four Pokemon[1] that are polluting the local stream and causing it to glow a beautiful translucent purple on several occasions.

This document was written and created with R Markdown, a flexible text format that provides easy export to a variety of formats such as PDFs, Word docs, PowerPoint, and Web sites.

Here are some Markdown basics to get started writing R Markdown documents:

Add a link

To add a link in your text use the syntax:

---

[1] Pokemon are a new invasive species in MN. See Pokemen explosion in MN.

```
[Click here for MPCA](www.pca.state.mn.us)
```

The reader will see the following:
[Click here for MPCA](www.pca.state.mn.us)

Add an image

To insert an image use the syntax:

```
![Text about my image](link_to_the_image.png)
```

A large library of MPCA created images and visuals are available on MPCA's flickr site.

Here's an example showing an image of a turtle image that is saved locally in the same folder as the `.Rmd` file:

```
![Runaway Turtle](turtle.png)
```


Figure 1: Runaway Turtle

To change the image's size

To size images in PDF documents, you can add `{out.width="25%"}` to an R chunk options. You then use the `knitr::include_graphics()` function to insert an image with the designated width.

Here's how to show 3 tiny turtles by setting the image width to only extend 25% across the available space:

```
{r, out.width="25%"}

library(knitr)

include_graphics(c("turtle.png", "turtle.png", "turtle.png"))
```

Add a list

You can add bulleted lists with dashes as below:

```
- July 12, 2020
- July 18, 2020
- July 23, 2020
```

- July 12, 2020
- July 18, 2020
- July 23, 2020

Or create numbered lists by adding `1.` in front of each item.

```
1. July 12, 2020
1. July 18, 2020
1. July 23, 2020
```

1. July 12, 2020
2. July 18, 2020
3. July 23, 2020

Add a call-out box

You can create grey call-out boxes for special notes or quotes by adding the right carrot (>) —also known as the greater than sign— in front of text.
Like so:

```
> **Project details**
>
> Where:
> Who:
> What:
```

Project details

Where:
Who:
What:

More great Markdown features —like adding sortable tables and maps— appear below.

Data overview

The table below shows a glimpse of the results. You can add a caption to your table by adding `caption="My caption"` to the `kable()` function as below.

```
knitr::kable(head(mtcars), caption = '**TABLE 1.** A subset of mtcars.')
```

Table 1: **TABLE 1.** A subset of mtcars.

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
Mazda RX4	21.0	6	160	110	3.90	2.620	16.46	0	1	4	4
Mazda RX4 Wag	21.0	6	160	110	3.90	2.875	17.02	0	1	4	4
Datsun 710	22.8	4	108	93	3.85	2.320	18.61	1	1	4	1
Hornet 4 Drive	21.4	6	258	110	3.08	3.215	19.44	1	0	3	1
Hornet Sportabout	18.7	8	360	175	3.15	3.440	17.02	0	0	3	2
Valiant	18.1	6	225	105	2.76	3.460	20.22	1	0	3	1

Data sources

The data were downloaded from the following online resources:

1. US EPA
2. MN GEO Commons
3. TEMPO

```
library(tidyverse)

# Download data
data <- read_csv("")
```

DELTA is where data lives

Explore all the data available in MPCA's DELTA database with the RAINIER documentation pages.

Data dictionary

A raw Markdown table

Column	Description	Example value
geoid	Unique ID assigned to each Pokemon.	2430262
lat	Latitude coordinate of object's center.	-94.021
lon	Longitude coordinate of object's center.	44.521

Data glimpse

For this project, facilities were pulled from MPCA's TEMPO database.
You can use the `mpcadb` package to access TEMPO from R.

```r
library(mpcadb) #remotes::install_github("MPCA-data/mpcadb")

## TEMPO AI's
# Get a subset of AI names with get_ai()
ai_names <- get_ai(ai = c(420, 564, 878), keep_alt_names = F)
```

We use the `DT` package to create scrollable, searchable, interactive web
tables. The default for `DT` tables is to extend the full width of the page.

```r
library(DT)
library(dplyr)

# Keep the alternative name columns
ai_names <- get_ai(ai = c(420, 564, 878),
                   keep_alt_names = T)

# Drop underscores from column names
names(ai_names) <- names(ai_names) %>%
                   gsub("_", " ", .)

# Scrolly pretty table
DT::datatable(ai_names,
              caption = 'TABLE 2. Selected facilities.',
              rownames = F,
              options = list(pageLength = 4,
                             scrollX   = T,
                             dom = 'ftip'))
```

Search: _____

TABLE 2. Selected facilities.

MASTER AI ID	INT DOC ID	MASTER AI NAME	AI TYPE CODE	START DATE	END DATE	ALTERNATE RECORD SEQUENCE	USER GROUP ID	ALTERNATE AI ID	ALTER AI N.
420	0	Chippewa Valley Ethanol Co LLLP	CON	1995-05-01T05:00:00Z		15	TR+	760150036	Chippewa Ethanol C
420	0	Chippewa Valley Ethanol Co LLLP	CON	1995-05-01T05:00:00Z		21	AT+	TS0055034	Chippewa Ethanol C - AST
420	0	Chippewa Valley Ethanol Co LLLP	CON	1995-05-01T05:00:00Z		12	HW+	MNS000109488	Chippewa Ethanol C
420	0	Chippewa Valley Ethanol Co LLLP	CON	1995-05-01T05:00:00Z		14	AT+	TS0055034	Chippewa Ethanol C

Showing 1 to 4 of 12 entries   Previous   1   2   3   Next

(help) Access spatial data from MN's GIS Rest API

(help) Read data from: PDF's, Excel, Access

Charts

To place figures in the margin you can use the **knitr** chunk option `fig.margin=TRUE`.

Here's an example using a fuel efficiency chart:

```
{r fig-margin, fig.margin=TRUE, fig.cap="MPG vs Horsepower,
colored by transmission."}
```

```r
library(ggplot2)
library(mncolors) #remotes::install_github("MPCA-data/mncolors")

mtcars <- mtcars

mtcars$Transmission <- factor(mtcars$am,
                              labels = c('automatic',
                                         'manual'))

ggplot(mtcars, aes(hp, mpg, color = Transmission)) +
  geom_point() +
  geom_smooth() +
  scale_color_mn(palette = "accent", reverse = T) +
  theme(legend.position = 'top')
```
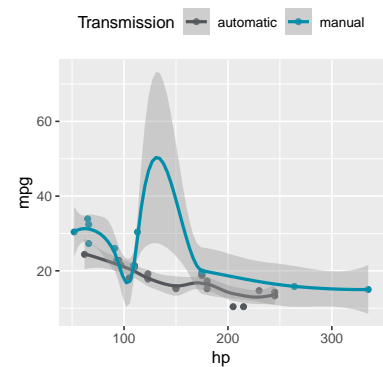

Figure 2: **FIG 1.** MPG vs horsepower, colored by transmission.

MN Colors

Here's one way to set the colors for your plots to align with the MN state brand.

```
library(mncolors) #remotes::install_github("MPCA-data/mncolors")
library(ggplot2)
#library(hrbrthemes)

ggplot(diamonds, aes(carat, price)) +
  geom_smooth(aes(color = cut), size = 1.5, show.legend = F) +
  scale_color_mn(palette = "green") +
  facet_wrap(vars(cut), nrow = 1) +
  labs(title    = "Increasing cost of cleanups",
       subtitle = "Brownfield site classifications",
       caption  = "Source: EPA Data Mart 2018",
       x        = "Site score") +
# scale_y_comma() +
# theme_ipsum_rc() +
  theme(plot.title   = element_text(color = mncolors(5, "blue")[5]),
        plot.caption = element_text(color = mncolors(5, "blue")[2],
                                    face  = 'bold'))
```

Increasing cost of cleanups
Brownfield site classifications

Source: EPA Data Mart 2018
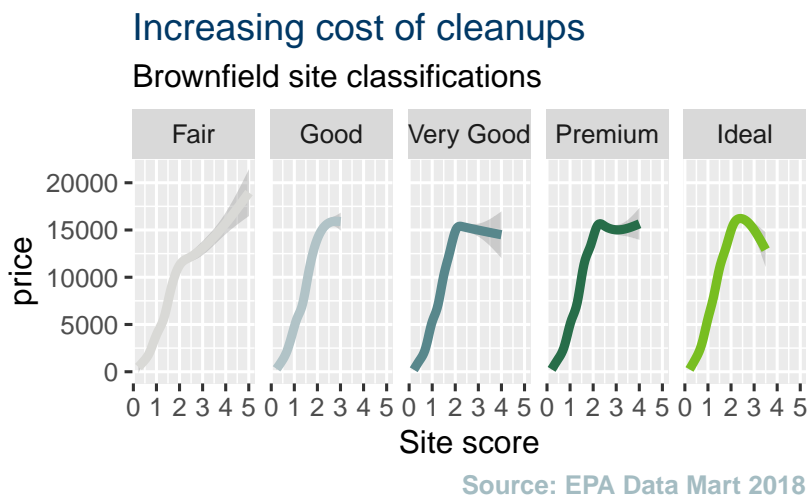
Analysis

We used the equation below to scale the Pokemon contribution to its relative size and spatial distribution in the watershed.

To set figures to span the entire page use the {r} chunk option `fig.fullwidth = TRUE`.

for x in $[a, b]$:

$$\frac{d}{dx}\left(\int_a^x f(u)\, du\right) = f(x)$$

```r
ggplot(diamonds, aes(carat, price)) +
  geom_smooth() +
  facet_grid(~ cut)
```
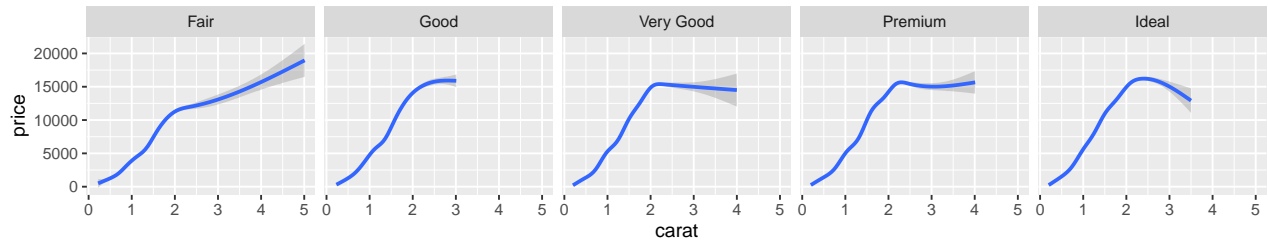

Figure 3: **FIG 2.** A full width figure.

(help) Non-detect and Censored data summaries

(help) Multivariate predictions

Maps

Leaflet maps are an easy way to add interactive maps to your report. Here's an example displaying the polygon shapefile of tribal nations located across MN.

Find shapefiles and spatial data in the MN GEOCOMMONS.

```r
library(mpcaej) #remotes::install_github("MPCA-data/mpcaej")
library(leaflet)
library(sf)
library(tidyverse)


ej_shapes    <- ej_shapes


tribal_areas <- tribe_shapes


#------ Map the polygons ---------#
leaflet(st_transform(tribal_areas, 4326)) %>%
  addProviderTiles(providers$Stamen.TonerLines,
                   options = providerTileOptions) %>%
  addProviderTiles(providers$CartoDB.Voyager,
                   options = providerTileOptions(opacity = 0.8)) %>%
  addPolygons(color       = "purple",
              weight      = 1,
              smoothFactor = 1.4,
              opacity     = 0.9,
              fillOpacity = 0.2)
```
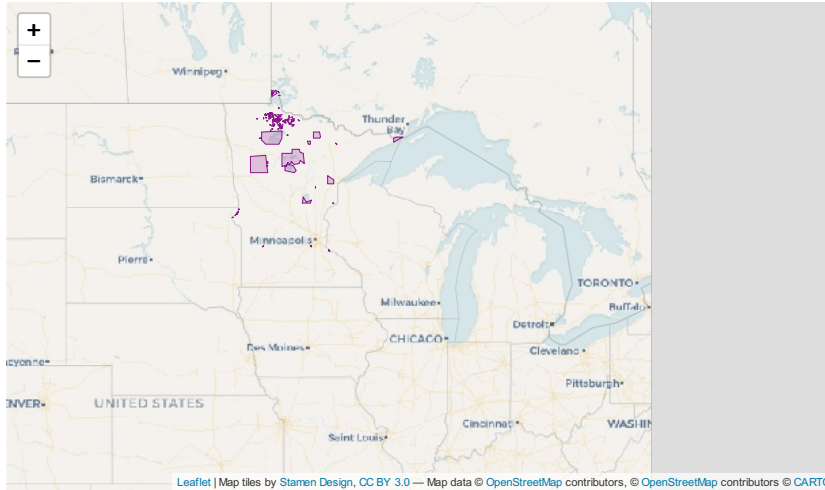
\begin{figure}
\caption[_Ref]{Ref. MPCA Geocommons 2020-10-10} \end{figure}

Site maps

Map markers

This is a map of the project monitoring sites dispersed around St. Paul.

```
sites <- read_csv('https://raw.githubusercontent.com/MPCA-air/aqi-watch/master/data-raw/locations.csv')

sites <- filter(sites, str_detect('Site Name', "Paul"))

# Add Markers and popup info
leaflet(sites) %>%
  addProviderTiles(providers$CartoDB) %>%
  addMarkers(popup = ~'Site Name')
```
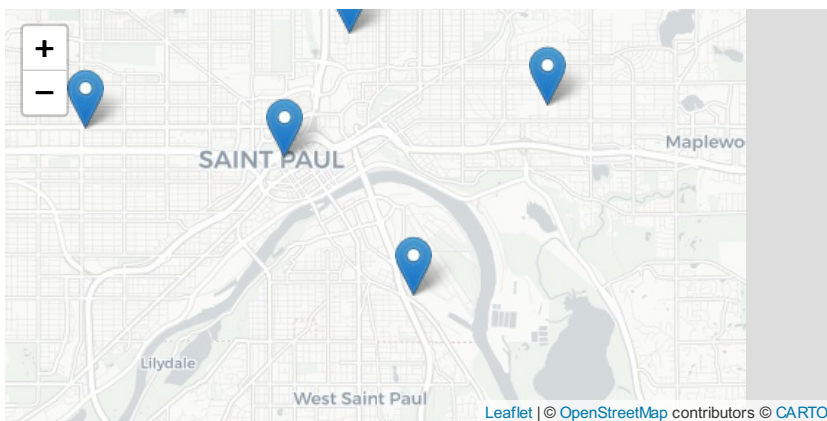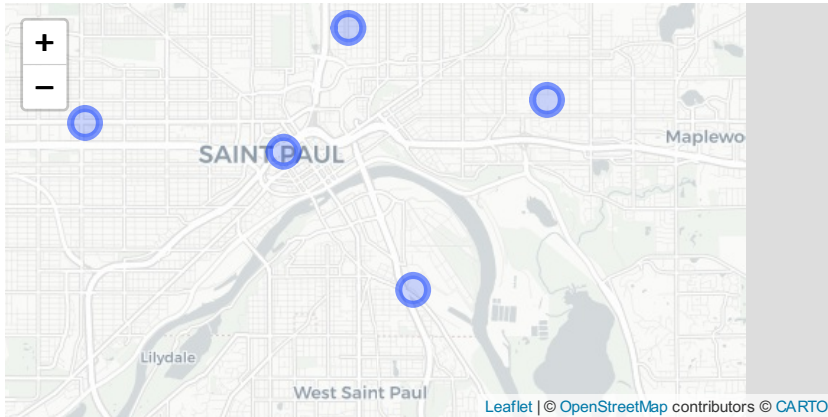

Circle markers

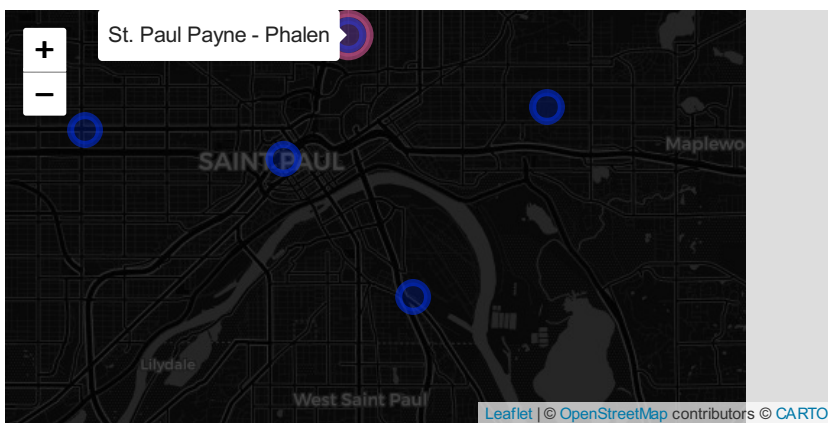The circles show the monitoring range of the monitors.

```r
# Add Darkness
leaflet(sites) %>%
  addProviderTiles(providers$CartoDB) %>%
  addCircleMarkers(label = ~`Site Name`)
```


Leaflet | © OpenStreetMap contributors © CARTO

Labeling a single site

As you can see, the site highlighted below has elevated levels of Pokemon.

```r
# Add Darkness
leaflet(sites) %>%
  addProviderTiles(providers$CartoDB.DarkMatter) %>%
  addCircleMarkers(label = ~`Site Name`) %>%
  addCircleMarkers(data   = sites[3, ],
                   color  = "hotpink",
                   radius = 15,
                   label  = ~`Site Name`,
                   labelOptions = labelOptions(noHide   = T,
                                               textsize = "15px"))
```


St. Paul Payne - Phalen

Leaflet | © OpenStreetMap contributors © CARTO

Conclusion

You can add quotes or highlight some text with the `tint::quote_footer()` function.

> *I can win an argument on any topic, against any opponent. People know this, and steer clear of me at parties. Often, as a sign of their great respect, they don't even invite me.*
>
> — Dave Barry

References

- 2012, A
- 2015, B
- 2018, C