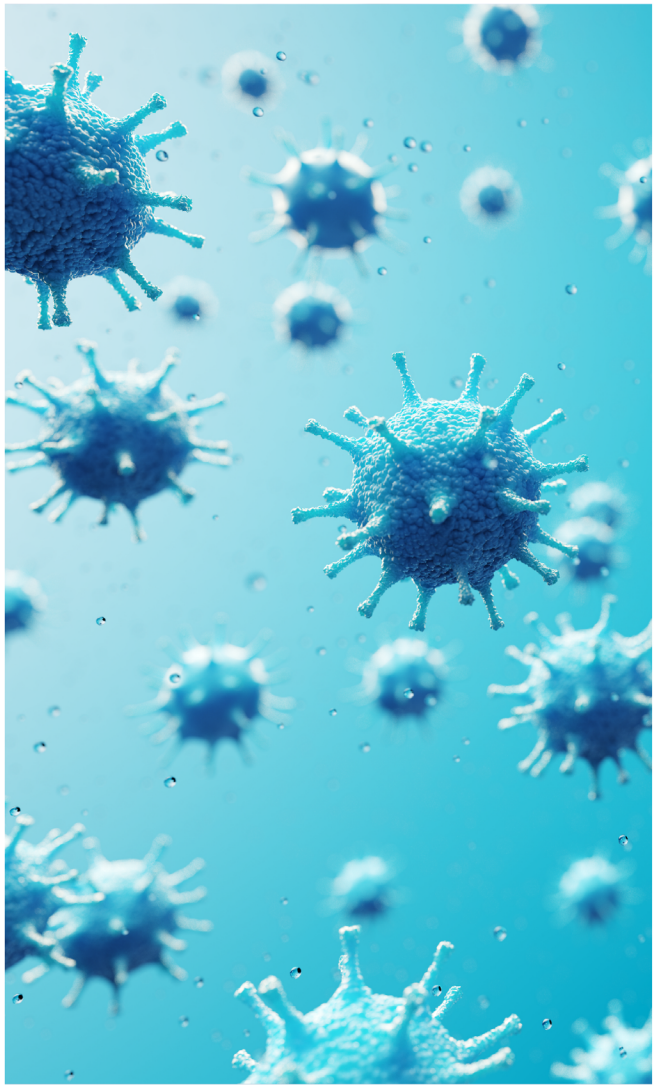


Jornada webinar: estudio de las aguas residuales con fines epidemiológicos

/28 de enero de 2021

Advertencia temprana de COVID-19 en Detroit mediante la detección de SARS-COV-2 en la depuradora de Detroit

Xavier Fonoll. Great Lakes Water Authority
Brijen Miyani, Irene Xagoraraki, Anna Mehrotra, Andrea Busch y John Norton

WATER UJI

UNIVERSITAT JAUME I
Cátedra FACSA de Innovación en el Ciclo Integral del Agua

facsa ciclo integral del agua

@xavi_fonoll

1. Objetivo del estudio
2. Presentación de GLWA
3. Muestreo (filtros cargados electropositivamente)
4. Extracción de ARN
5. Relación entre la concentración de SARS-COV-2 y el número de casos
6. Construcción de un modelo epidemiológico
7. Nuestro punto de vista

Objetivo: Detectar SARS-COV-2 en el agua residual y crear un modelo epidemiológico

FUNDING

La metodologia de trabajo se ha aplicado en previous estudios con otros virus.

Water Res. 2020 Oct 1; 184: 116160.
Published online 2020 Jul 7. doi: 10.1016/j.watres.2020.116160

PMCID: PMC7342010
PMID: 32738707

Identification of multiple potential viral diseases in a large urban center using wastewater surveillance

Camille McCall, Huiyun Wu, Brijen Miyani, and Irene Xagoraraki*

Journal of Applied Microbiology

Journal of Applied Microbiology ISSN 1364-5072

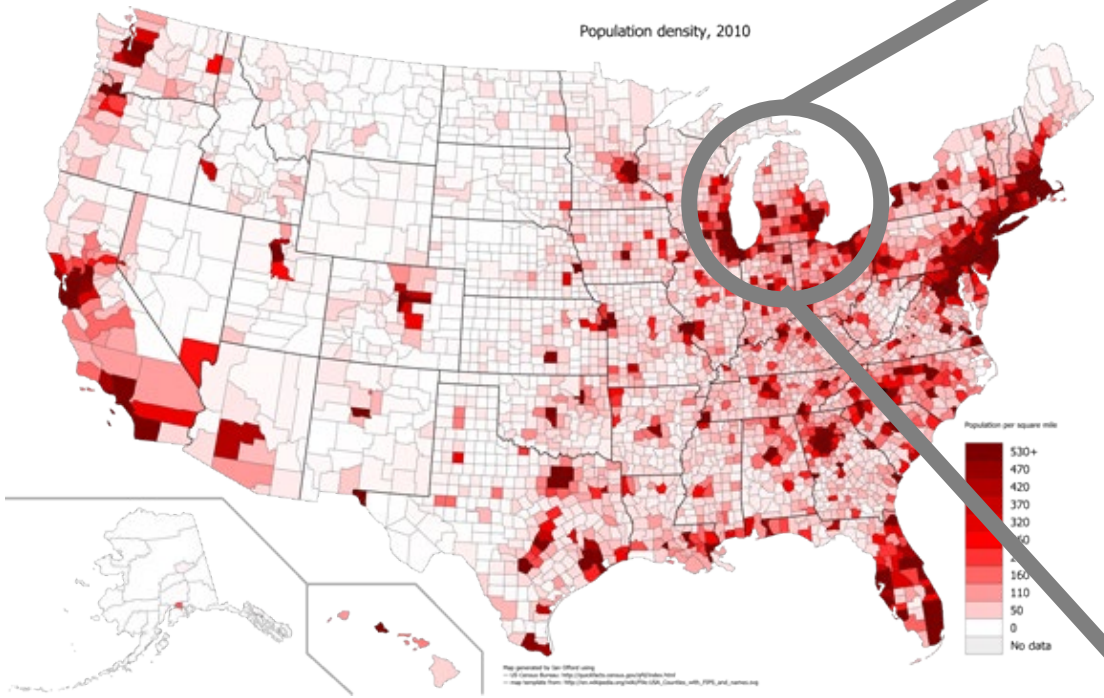
ORIGINAL ARTICLE

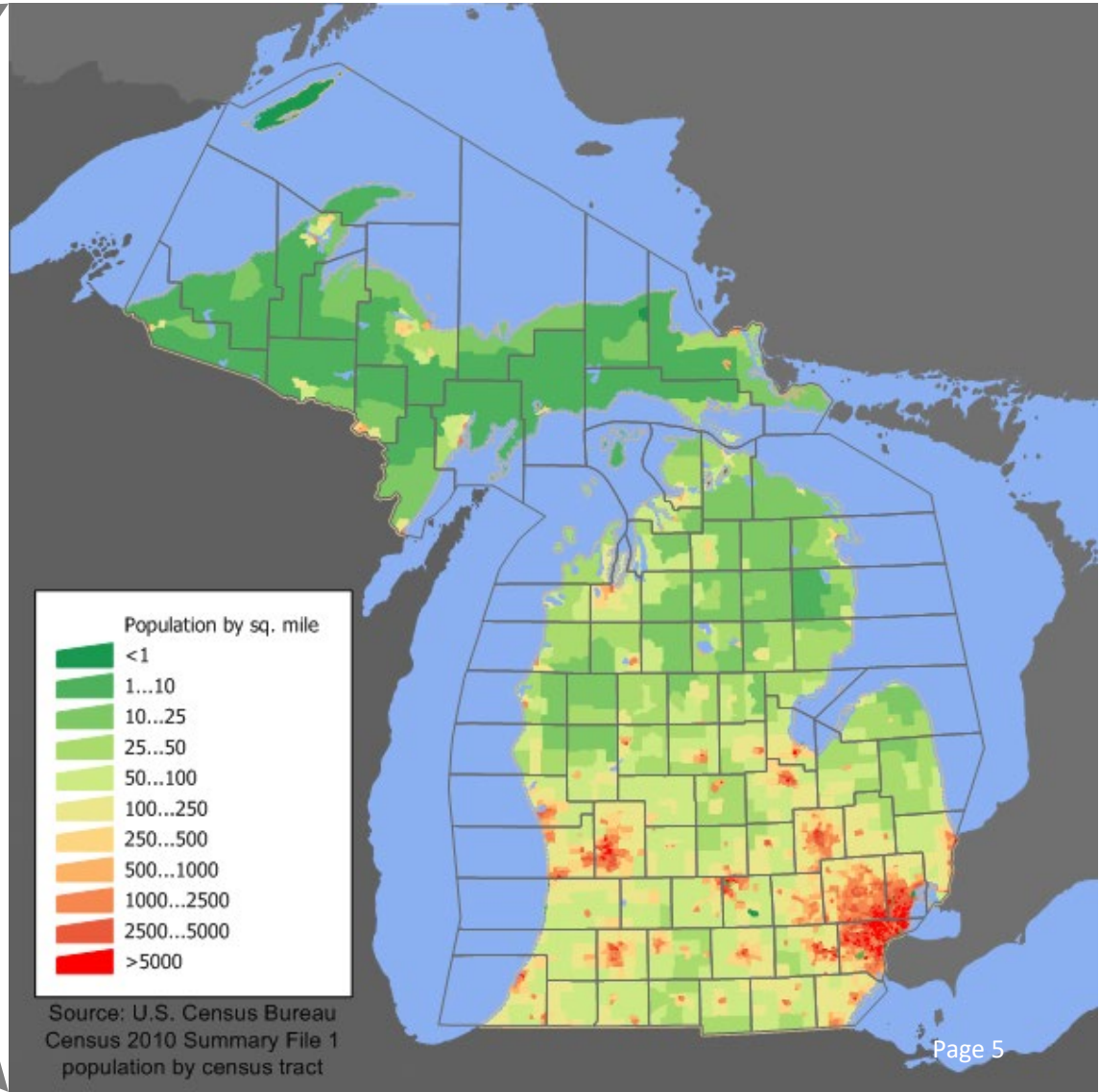
High abundance of human herpesvirus 8 in wastewater from a large urban area

B. Miyani, C. McCall and I. Xagoraraki

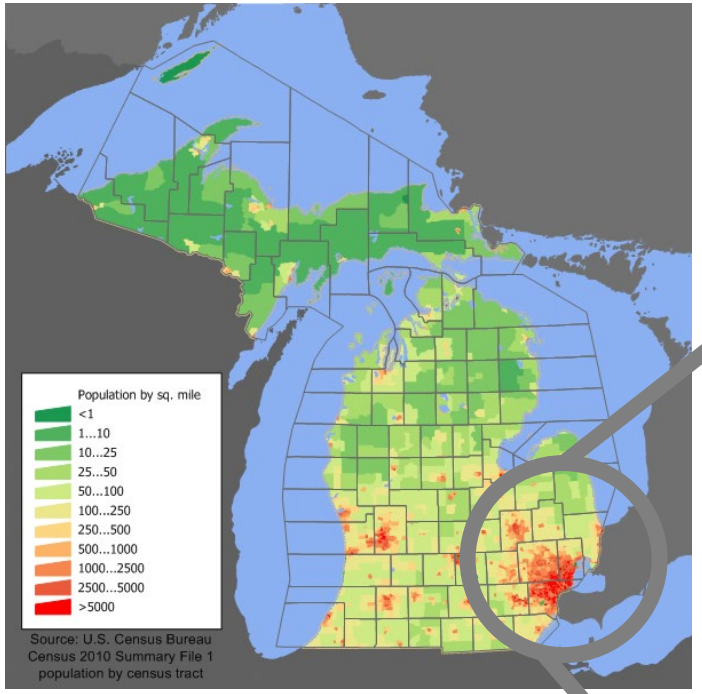
Department of Civil and Environmental Engineering, Michigan State University, East Lansing, MI, USA

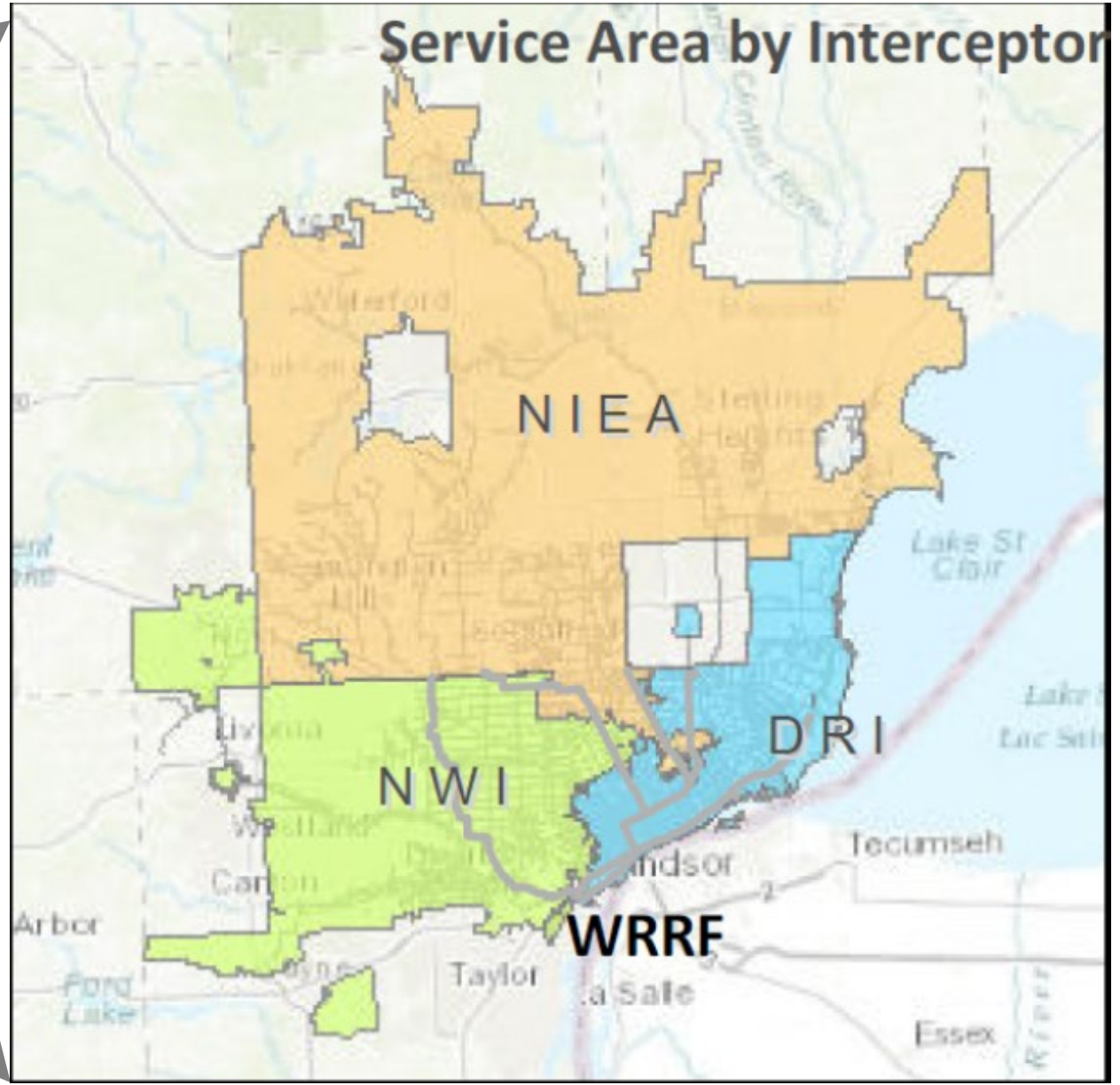
La depuradora tiene una capacidad máxima de 6400 ML/d y trata el agua residual de 2,8 millones de personas. Tratamos agua residencial, industrial y comercial.



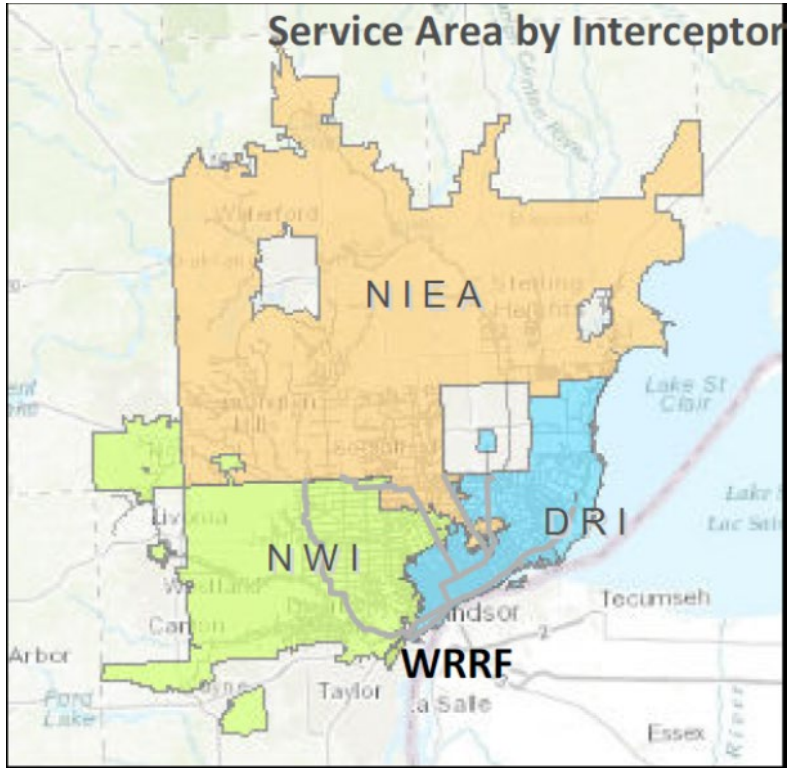


El agua residual llega mediante tres interceptores (NIEA, NWI y DRI)





Sabemos a qué códigos postales están conectados los interceptores.



OAKLAND COUNTY				
Zip Code	City/Township	NI-EA	DRI	O-NWI
48009	Birmingham	100%	0%	0%
48017	Clawson	100%	0%	0%
48025	Franklin	100%	0%	0%
48030	Hazel Park	100%	0%	0%
48033	Southfield	100%	0%	0%
48034	Southfield	100%	0%	0%
48067	Royal Oak	100%	0%	0%
48069	Pleasant Ridge	100%	0%	0%
48070	Huntington W.	100%	0%	0%
48071	Madison Heights	100%	0%	0%
48072	Berkley	100%	0%	0%
48073	Royal Oak	100%	0%	0%
48075	Southfield	100%	0%	0%
48076	Southfield	100%	0%	0%
48083	Troy	100%	0%	0%
48084	Troy	100%	0%	0%
48085	Troy	100%	0%	0%
48167	Northville	16%	0%	84%
48220	Ferndale	100%	0%	0%
48301	Bloomfield Hills	100%	0%	0%
48302	Bloomfield Hills	100%	0%	0%
48304	Bloomfield Hills	100%	0%	0%
48306	Rochester	100%	0%	0%
48307	Rochester	100%	0%	0%
48309	Rochester	100%	0%	0%
48320	Keego Harbor	100%	0%	0%
48322	West Bloomfield	100%	0%	0%
48323	West Bloomfield	100%	0%	0%
48324	West Bloomfield	100%	0%	0%
48326	Auburn Hills	100%	0%	0%
48327	Waterford	100%	0%	0%
48328	Waterford	100%	0%	0%
48329	Waterford	100%	0%	0%
48331	Farmington	100%	0%	0%
48334	Farmington	100%	0%	0%
48335	Farmington	91%	0%	9%
48336	Farmington	84%	0%	16%
48346	Clarkston	100%	0%	0%
48348	Clarkston	100%	0%	0%
48359	Lake Orion	100%	0%	0%
48360	Lake Orion	100%	0%	0%
48362	Lake Orion	100%	0%	0%
48363	Oakland	100%	0%	0%
48371	Oxford	100%	0%	0%
48098	Troy	100%	0%	0%
48237	Oak Park	100%	0%	0%
48374	Novi	0%	0%	100%
48375	Novi	0%	0%	100%
48377	Novi	0%	0%	100%

MACOMB COUNTY				
Zip Code	City/Township	NI-EA	DRI	O-NWI
48015	Center Line	0%	100%	0%
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48035	Clinton Township	100%	0%	0%
48036	Clinton Township	100%	0%	0%
48038	Clinton Township	100%	0%	0%
48042	Macomb	100%	0%	0%
48044	Macomb	100%	0%	0%
48045	Harrison Township	100%	0%	0%
48047	New Baltimore	100%	0%	0%
48048	New Haven	100%	0%	0%
48050	New Haven	100%	0%	0%
48051	New Baltimore	100%	0%	0%
48062	Richmond	100%	0%	0%
48066	Roseville	0%	100%	0%
48080	Saint Clair Shores	0%	100%	0%
48081	Saint Clair Shores	0%	100%	0%
48082	Saint Clair Shores	0%	100%	0%
48091	Warren	0%	100%	0%
48094	Washington	100%	0%	0%
48095	Washington	100%	0%	0%
48310	Sterling Heights	100%	0%	0%
48312	Sterling Heights	100%	0%	0%
48313	Sterling Heights	100%	0%	0%
48314	Sterling Heights	100%	0%	0%
48315	Utica	100%	0%	0%
48316	Utica	100%	0%	0%
48317	Utica	100%	0%	0%

WAYNE COUNTY				
Zip Code	City/Township	NI-EA	DRI	O-NWI
48101	Allen Park	0%	0%	100%
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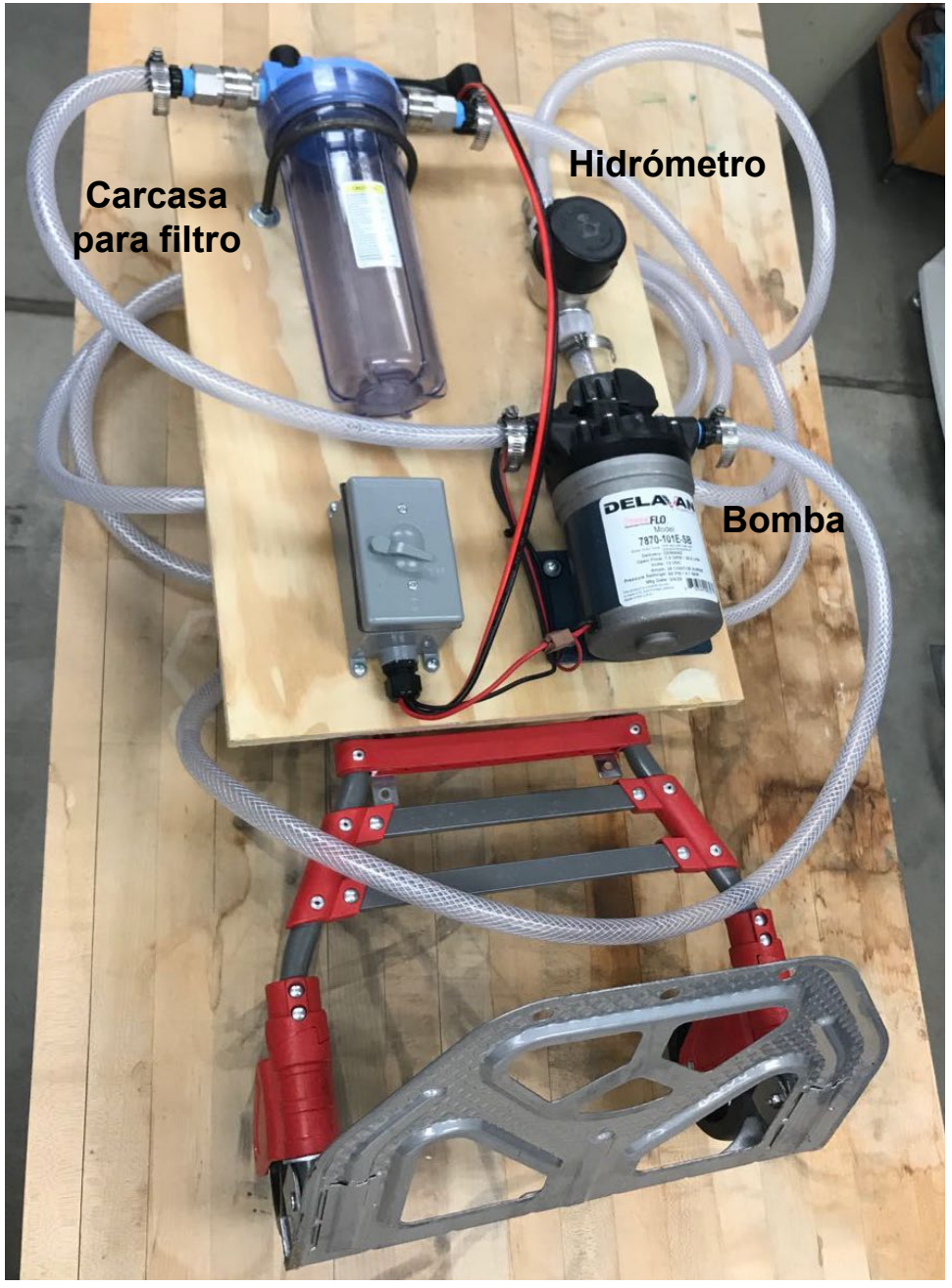
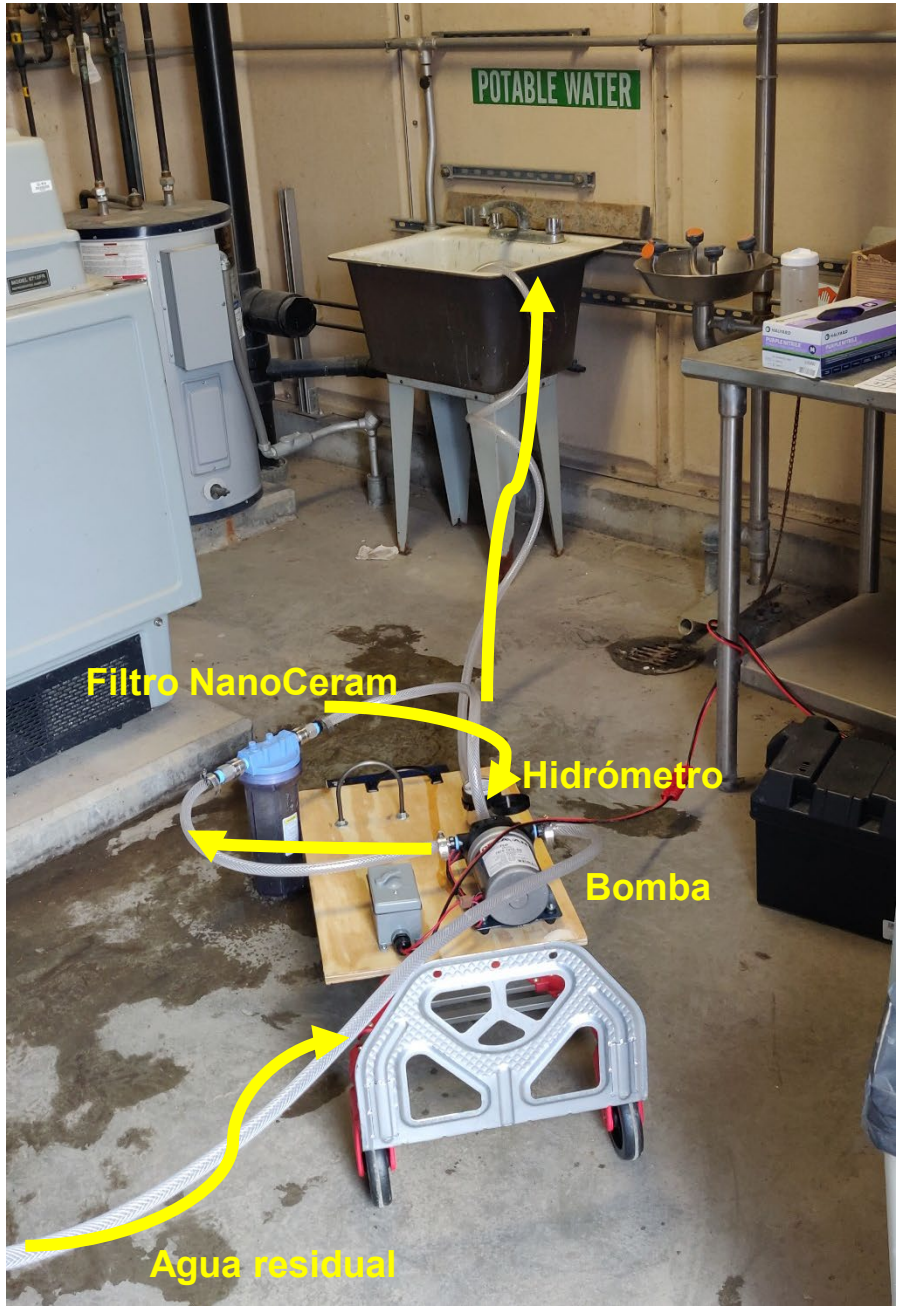
48120	Dearborn	0%	0%	100%
48122	Melvindale	0%	0%	100%
48124	Dearborn	0%	0%	100%
48125	Dearborn Heights	0%	0%	100%
48126	Dearborn	0%	0%	100%
48127	Dearborn Heights	0%	0%	100%
48128	Dearborn	0%	0%	100%
48135	Garden City	0%	0%	100%
48141	Inkster	0%	0%	100%
48150	Livonia	0%	0%	100%
48152	Livonia	0%	0%	100%
48154	Livonia	0%	0%	100%
48168	Northville	0%	0%	100%
48170	Plymouth	0%	0%	100%
48184	Wayne	0%	0%	100%
48185	Westland	0%	0%	100%
48186	Westland	0%	0%	100%
48187	Canton	0%	0%	100%
48201	Detroit	0%	100%	0%
48202	Detroit	0%	73%	27%
48203	Highland Park	73%	0%	27%
48204	Detroit	0%	20%	80%
48205	Detroit	0%	100%	0%
48206	Detroit	0%	48%	52%
48207	Detroit	0%	100%	0%
48208	Detroit	0%	100%	0%
48209	Detroit	0%	79%	21%
48210	Detroit	0%	49%	51%
48211	Detroit	49%	51%	0%
48212	Hamtramck	43%	57%	0%
48213	Detroit	19%	81%	0%
48214	Detroit	0%	100%	0%
48215	Detroit	0%	100%	0%
48216	Detroit	0%	100%	0%
48217	Detroit	0%	0%	100%
48219	Detroit	0%	0%	100%
48221	Detroit	79%	0%	21%
48223	Detroit	0%	0%	100%
48224	Detroit	0%	100%	0%
48225	Harper Woods	0%	100%	0%
48226	Detroit	0%	100%	0%
48227	Detroit	0%	0%	100%
48228	Detroit	0%	0%	100%
48230	Grosse Pointe	0%	100%	0%
48234	Detroit	20%	80%	0%
48235	Detroit	0%	0%	100%
48236	Grosse Pointe	0%	100%	0%
48238	Detroit	0%	0%	100%
48239	Redford	0%	0%	100%
48240	Redford	0%	0%	100%

Operarios de la planta y estudiantes colaboraron para recolectar muestras en cada interceptor (NIEA, NWI y DRI): 193 muestras entre el 8 de abril al 11 de Noviembre

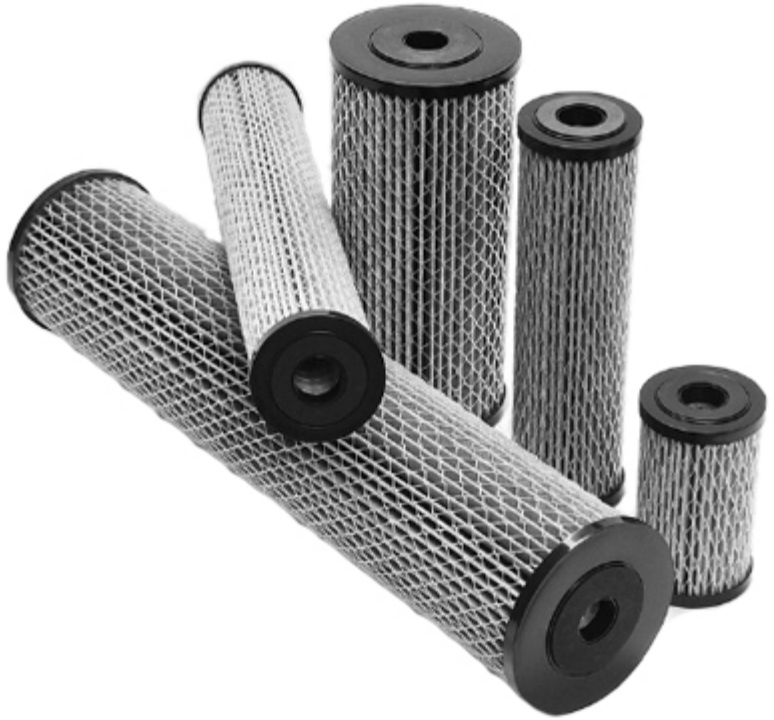
Se recolectaron 20-70 L por muestra de agua residual y se concentró SARS-COV-2 en un filtro.

EPA method 63321: Concentration and processing of waterborne viruses by positive charge 1mds cartridge filters and organic flocculation

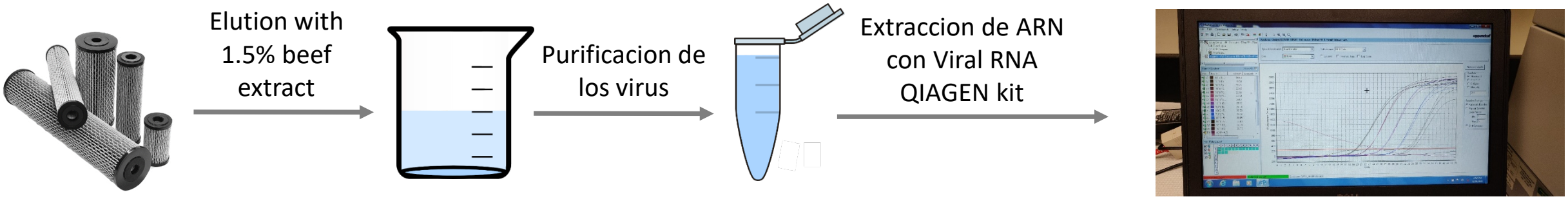




Los filtros NanoCeram® utilizan un medio filtrante (2-3 µm) altamente electropositivo que adsorbe rápidamente las partículas (>0.2 µm).



Los virus se eluyeron del filtro para extraer ARN y medir su concentración mediante el uso de PCR cuantitativa.



B. Miyani, X. Fonoll; J. Norton Jr., A. Mehrotra. I. Xagoraraki (2020). SARS-CoV-2 in Detroit Wastewater. Journal of Environmental Engineering 146, 11. https://doi.org/10.1061/(ASCE)EE.1943-7870.0001830

Gracias a los filtros pudimos detectar SARS-COV-2 en todas las muestras recolectadas.

Numero de muestras:
DRI: 68
NIEA: 65
ONWI: 60

Se colectaron 45% de las muestras en triplicado.

Concentración:
10^4 - 10^7 copias/L

Sampling Date	DRI Interceptor		NIEA Interceptor		ONWI Interceptor	
	Average	STDEV	Average	STDEV	Average	STDEV
4/8/2020	1.63E+05	8.59E+04	1.07E+05	4.93E+04	1.23E+05	7.13E+04
4/15/2020	1.96E+05	5.76E+04	2.00E+05	1.66E+04	1.04E+05	1.87E+04
4/16/2020	5.63E+04	NA	1.13E+05	3.16E+04	1.24E+05	7.81E+04
4/22/2020	1.90E+05	5.57E+04	1.49E+05	7.42E+04	1.87E+05	9.70E+04
4/23/2020	9.78E+04	1.79E+04	6.01E+04	NA	6.85E+04	NA
4/28/2020	1.50E+05	9.70E+04	2.25E+05	1.15E+05	1.12E+05	4.60E+04
4/30/2020	1.54E+05	4.61E+04	9.33E+04	NA	7.03E+04	1.86E+04
5/5/2020	1.26E+05	NA	1.45E+05	1.01E+05	6.33E+04	NA
5/7/2020	3.56E+05	NA	1.23E+05	3.80E+04	1.65E+05	9.91E+04
5/12/2020	1.08E+05	6.09E+04	2.07E+05	NA	1.92E+05	7.97E+04
5/14/2020	6.65E+04	NA	1.05E+05	2.94E+04	1.53E+05	7.84E+04
5/21/2020	8.07E+04	2.98E+04	1.17E+05	3.36E+04	1.16E+05	1.19E+05
5/26/2020	7.47E+04	2.54E+04	1.93E+05	9.04E+04	2.23E+05	1.44E+05
6/3/2020	7.17E+04	2.22E+04	2.82E+05	1.98E+05	3.78E+05	2.82E+05
6/10/2002	1.06E+06	8.07E+04	8.07E+05	8.14E+05	3.74E+05	4.60E+05
6/17/2020	1.83E+06	1.32E+04	1.62E+06	1.53E+05	1.49E+06	5.73E+05
6/24/2020	9.00E+05	5.49E+05	3.26E+06	2.84E+06	1.71E+06	1.21E+06
8/6/2020	9.20E+04	5.36E+04	1.64E+05	5.69E+04	9.90E+04	2.66E+04
8/11/2020	8.71E+04	1.65E+03	5.75E+05	3.52E+05	5.66E+05	4.68E+05
8/18/2020	8.36E+04	3.33E+04	NA	NA	1.18E+06	1.45E+05
8/26/2020	1.39E+05	NA	9.88E+04	2.02E+04	8.37E+04	3.05E+04
9/1/2020	1.04E+05	7.80E+04	NA	NA	NA	NA
9/8/2020	3.94E+05	5.13E+03	1.23E+06	1.42E+06	4.34E+05	3.37E+05
9/15/2020	9.42E+04	3.23E+04	7.14E+05	7.57E+05	8.48E+05	8.37E+05
9/29/2020	NA	NA	1.28E+06	1.04E+06	1.49E+06	2.11E+06
10/7/2020	2.80E+06	1.29E+06	1.99E+06	1.74E+05	3.53E+06	1.76E+06
10/14/2020	4.94E+05	7.11E+05	1.31E+06	1.14E+06	9.88E+05	5.93E+05
10/21/2020	1.13E+06	1.34E+06	1.24E+06	1.81E+06	NA	NA
10/28/2020	1.80E+05	3.26E+04	7.71E+05	1.11E+06	NA	NA
11/5/2020	1.33E+05	7.45E+04	2.25E+05	8.38E+04	2.69E+05	1.12E+04
11/11/2020	2.50E+05	1.33E+05	1.86E+05	4.28E+03	1.43E+05	4.49E+03

Sabemos a qué códigos postales están conectados los interceptores y el número de casos.

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48324	West Bloomfield	100%	0%	0%
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48327	Waterford	100%	0%	0%
48328	Waterford	100%	0%	0%
48329	Waterford	100%	0%	0%
48331	Farmington	100%	0%	0%
48334	Farmington	100%	0%	0%
48335	Farmington	91%	0%	9%
48336	Farmington	84%	0%	16%
48346	Clarkston	100%	0%	0%
48348	Clarkston	100%	0%	0%
48359	Lake Orion	100%	0%	0%
48360	Lake Orion	100%	0%	0%
48362	Lake Orion	100%	0%	0%
48363	Oakland	100%	0%	0%
48371	Oxford	100%	0%	0%
48098	Troy	100%	0%	0%
48237	Oak Park	100%	0%	0%
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48038	Clinton Township	100%	0%	0%
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48044	Macomb	100%	0%	0%
48045	Harrison Township	100%	0%	0%
48047	New Baltimore	100%	0%	0%
48048	New Haven	100%	0%	0%
48050	New Haven	100%	0%	0%
48051	New Baltimore	100%	0%	0%
48062	Richmond	100%	0%	0%
48066	Roseville	0%	100%	0%
48080	Saint Clair Shores	0%	100%	0%
48081	Saint Clair Shores	0%	100%	0%
48082	Saint Clair Shores	0%	100%	0%
48091	Warren	0%	100%	0%
48094	Washington	100%	0%	0%
48095	Washington	100%	0%	0%
48310	Sterling Heights	100%	0%	0%
48312	Sterling Heights	100%	0%	0%
48313	Sterling Heights	100%	0%	0%
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48315	Utica	100%	0%	0%
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48150	Livonia	0%	0%	100%
48152	Livonia	0%	0%	100%
48154	Livonia	0%	0%	100%
48168	Northville	0%	0%	100%
48170	Plymouth	0%	0%	100%
48184	Wayne	0%	0%	100%
48185	Westland	0%	0%	100%
48186	Westland	0%	0%	100%
48187	Canton	0%	0%	100%
48201	Detroit	0%	100%	0%
48202	Detroit	0%	73%	27%
48203	Highland Park	73%	0%	27%
48204	Detroit	0%	20%	80%
48205	Detroit	0%	100%	0%
48206	Detroit	0%	48%	52%
48207	Detroit	0%	100%	0%
48208	Detroit	0%	100%	0%
48209	Detroit	0%	79%	21%
48210	Detroit	0%	49%	51%
48211	Detroit	49%	51%	0%
48212	Hamtramck	43%	57%	0%
48213	Detroit	19%	81%	0%
48214	Detroit	0%	100%	0%
48215	Detroit	0%	100%	0%
48216	Detroit	0%	100%	0%
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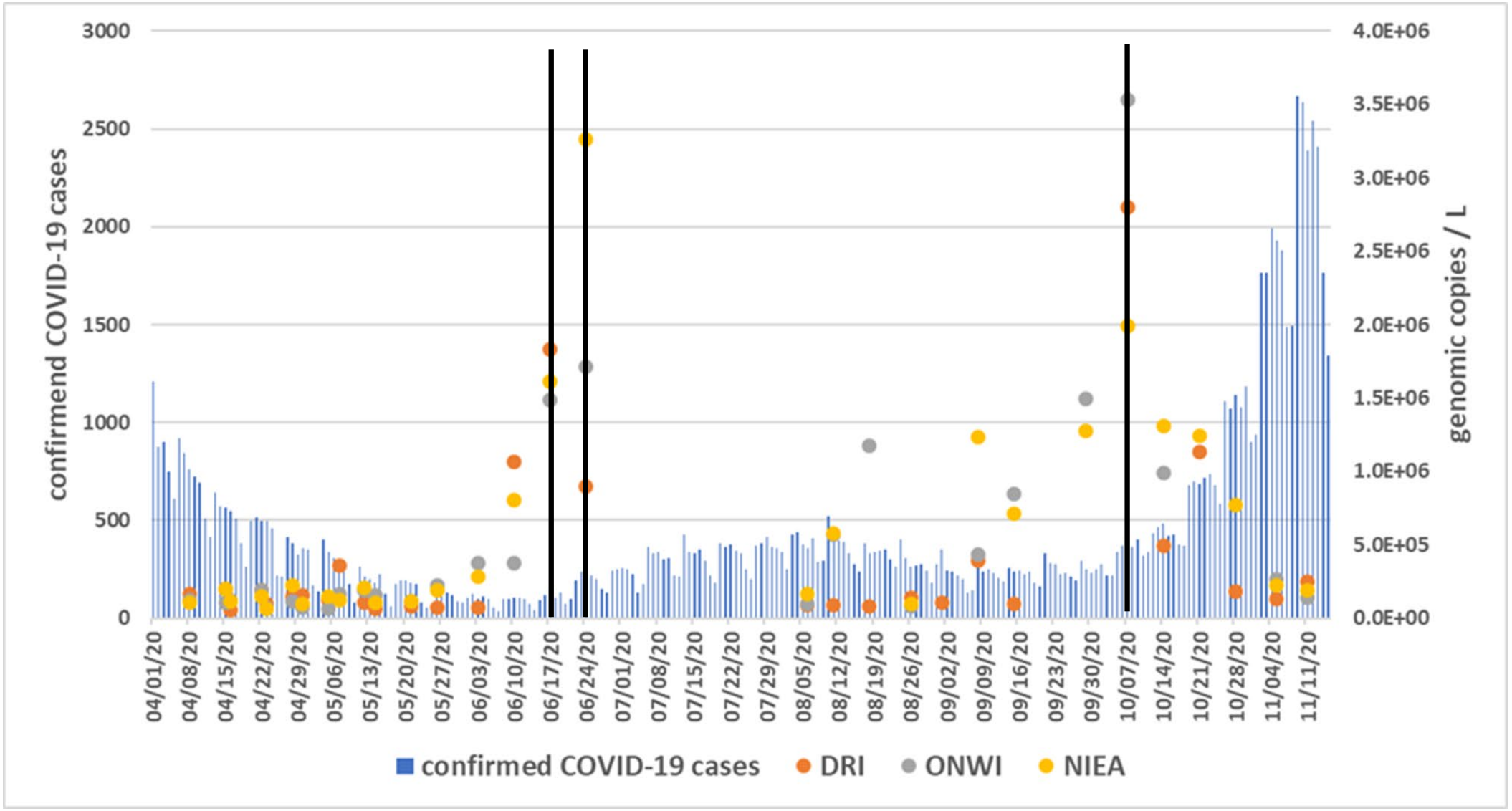
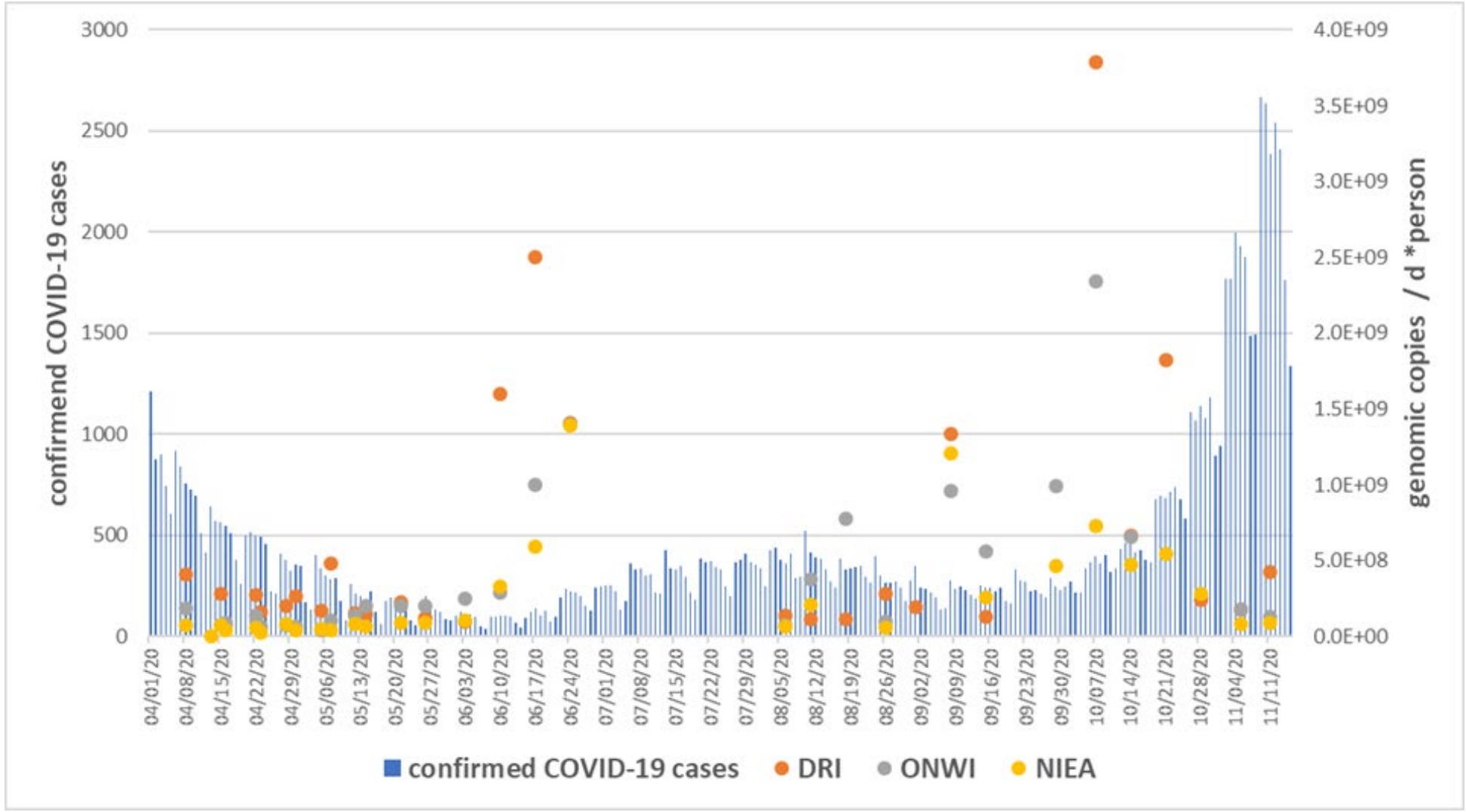
48230	Grosse Pointe	0%	100%	0%
48234	Detroit	20%	80%	0%
48235	Detroit	0%	0%	100%
48236	Grosse Pointe	0%	100%	0%
48238	Detroit	0%	0%	100%
48239	Redford	0%	0%	100%
48240	Redford	0%	0%	100%

Las olas de casos se podrian predecir con 28 días de antelación (Spearman's rank correlation, r=0.4).

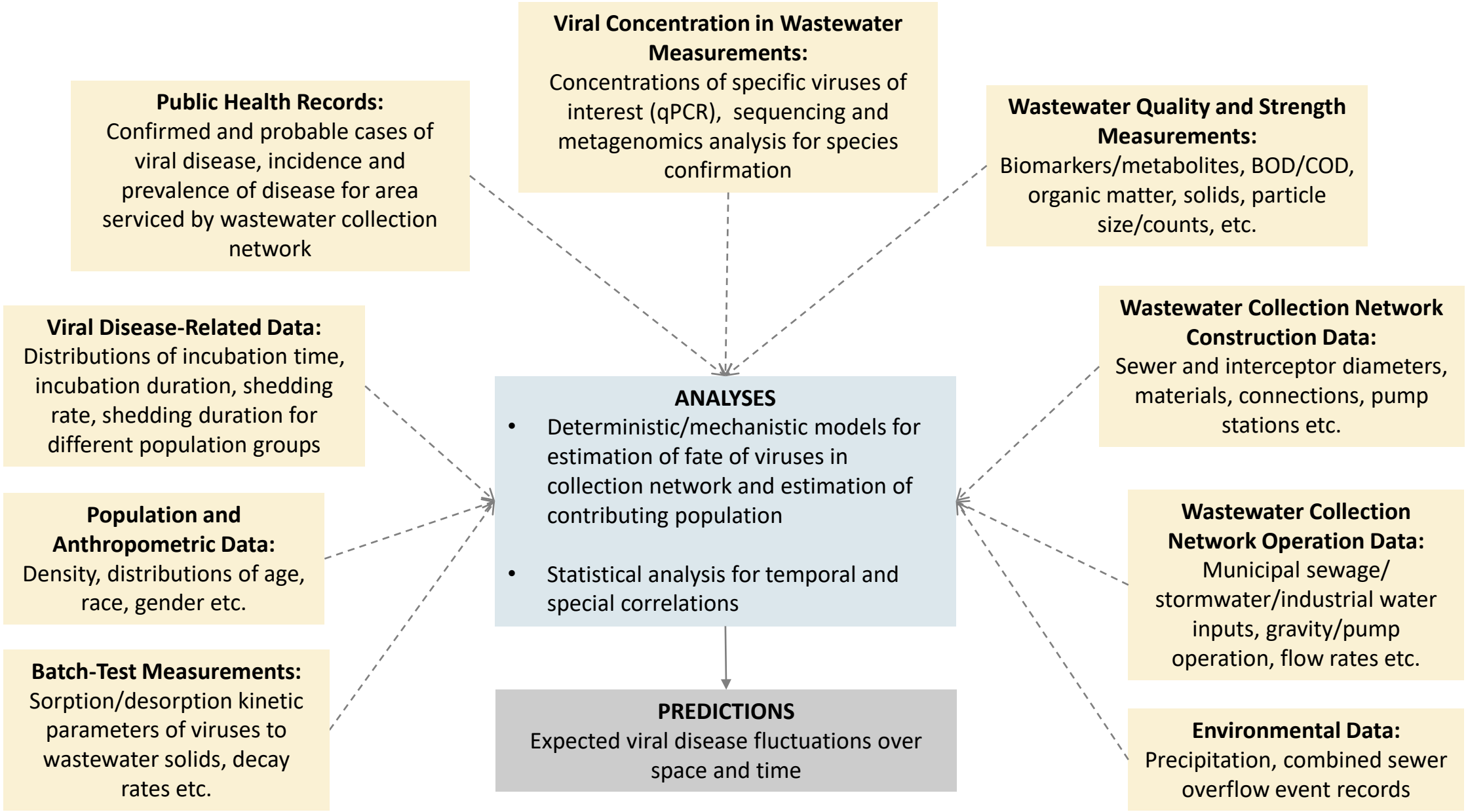


Las olas de casos se podrian predecir con 28 días de antelación (Spearman's rank correlation, r=0.3).



Para la normalización se tuvo en cuenta el caudal del interceptor y la población del área de servicio

Actualmente se está trabajando en el desarrollo de un modelo epidemiológico.



El punto de vista de GLWA: ¿Usaremos los métodos a largo plazo?

- Research & Innovation fue el promotor del estudio en la planta.
- El personal de la depuradora está contento con el estudio, pero, se usaran estos métodos largo plazo?
- Mas proyectos van a necesitar el conocimiento y los instrumentos usados en este estudio (Ya témenos un congelador de -80^{o}C).

Muchas gracias por su atención

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CDM Smith

Michigan State University Founded 1855