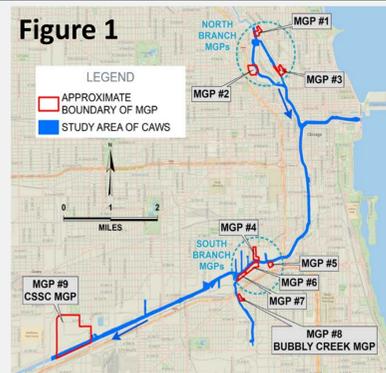


# Spatial Variations in Ambient PAH Concentrations in Sediment in a Complex Urban River System

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## INTRODUCTION

This is a case study on the use of ambient sediment data from four areas along the Chicago Area Waterway System (CAWS) to support the sediment investigation of multiple former manufactured gas plants (MGPs) located along CAWS. The areas studied are located along 11 miles of CAWS and reveal local differences within the urban environment. The sites for which this work is being done are enrolled in the Superfund Alternative Sites Program.



## BACKGROUND

With a long history of industrialization and combined sewer outfall (CSO) discharges, CAWS has received pollutant loading for centuries. Identifying the input of polycyclic aromatic hydrocarbons (PAH) to CAWS potentially due to the former MGPs is complicated by PAH contributions from myriad sources.

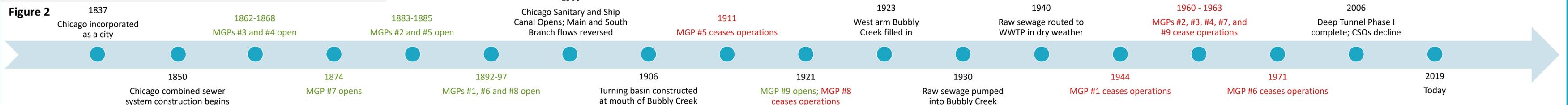
Determining the incremental input from these MGPs is further complicated by the engineering and permanent flow reversal of two branches of CAWS during the period of MGP operation (Figure 2).

Multiple tools have been used to establish ambient conditions adjacent to the former MGPs. Ambient areas are not affected by the former MGPs, but represent impacts related to the industrial, urban background setting of CAWS. By comparing to ambient sediment conditions, the potential effect of the former MGPs on sediment can be determined.

For reference, a sediment screening level often used for less industrial areas is the probable effect concentration (PEC) of 22.8 mg/kg total PAHs (MacDonald et al, 2000). PEC is the level at which toxicity to benthic organisms is probable.



Figure 2



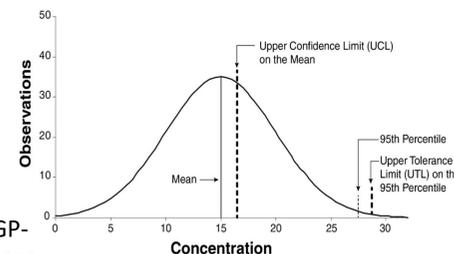
## METHODOLOGY

Four areas have been established to represent ambient sediment conditions, one for each MGP grouping; North Branch MGPs, South Branch MGPs, Bubbly Creek MGP, and Chicago Sanitary and Ship Canal (CSSC) MGP (Figure 1). Different characterization methods were used (Table 1).

Ambient Area	Method	Sample Placement	Length of Area (Ft)	Number of Samples
North Branch MGPs	Standalone study		8,500	59
South Branch MGPs	Extension of study area	Stratified random within regular grid	1,400	65
Bubbly Creek MGP	Extension of study area		1,400	45
CSSC MGP	Standalone study and extension of study area		TBD	TBD

At each area, stratified random sampling was conducted within a regular grid. However, for the North Branch and CSSC MGPs, a stand-alone ambient study was conducted; while for the South Branch and Bubbly Creek MGPs, the MGP study areas were expanded during the same mobilization to include that area representing ambient. Samples were collected from sediment surface down to the top of the native clay layer.

Total PAH (tPAH-13) 95/95 upper tolerance limits (UTLs) were calculated for each ambient area using ProUCL.



To further distinguish potentially MGP-impacted sediment samples from those representing ambient conditions, forensic evaluation was conducted on samples that exceeded the 95/95 UTL for that area.



Sampling for toxicity testing (*Hyalella azteca*, 28-day chronic) was completed at the North Branch MGPs ambient area to evaluate toxicity as a tool for characterizing ambient conditions. (photo: pubs.usgs.gov)

## RESULTS

### VARIATIONS IN PAH CONCENTRATIONS IN AMBIENT AREAS

The range of tPAH-13 concentration and 95/95 UTL values differs between the four ambient CAWS areas.

Area	Min tPAH (mg/kg)	Max tPAH (mg/kg)	95/95 UTL surface/sub-surface (mg/kg)	Notes
North Branch MGPs	0.775	803	342/409	Surface = 0-1.5 ft btos; approved by USEPA
South Branch MGPs	1.53	560	159/524	Surface = 0-1.5 ft btos; draft values
Bubbly Creek MGP	0.196	669	214/301	Surface = 0-0.5 ft btos; approved by USEPA
CSSC MGP	TBD	TBD	TBD	Work in progress to characterize ambient in CSSC

Some similarities and differences can be found between these ambient areas:

- The Bubbly Creek ambient area is near the head of Bubbly Creek with only a pumping station for the wastewater treatment plant upstream of it.
- The North and South Branch ambient areas have multiple potential non-MGP sources nearby in addition to CSOs.
- CSSC has potentially significant non-MGP PAH sources adjacent to the MGP that are influencing local ambient conditions.

## CONCLUSIONS and LESSONS LEARNED

Ambient tPAH concentrations ranged from 0.196 to 803 mg/kg over 11 miles of the CAWS study area; these are among the highest of recent urban studies.

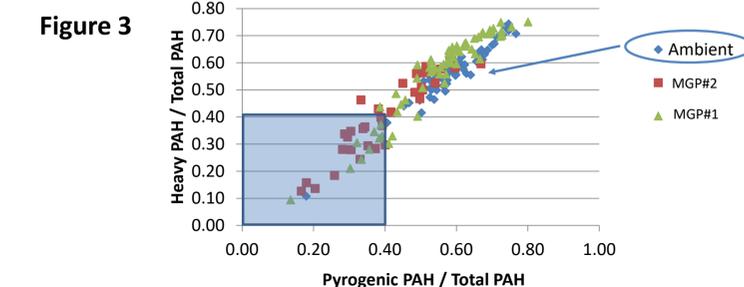
Reach-specific ambient studies were necessary due to variable local conditions and tPAH concentrations up to an order of magnitude greater than PEC.

Toxicity testing was not an effective tool for identifying toxic effects from the MGPs as ambient sediments themselves were toxic.

Data suggests the North Branch MGPs may not be influencing the downriver MGPs where ambient 95/95 UTLs are lower and forensic evidence indicates no departure from ambient conditions.

### OTHER TOOLS FOR CONFIRMING AMBIENT CONDITIONS

In combination with establishing the 95/95 UTL for an ambient area, forensic methods were used to identify samples affected by MGP source material and not simply ambient conditions. The double ratio plot in Figure 3 shows ambient samples clustered in the upper right, along with a majority of investigative samples from MGPs #1 and #2. However, a portion of the MGP samples (within the blue box) depart from ambient conditions. These investigative samples are potentially effected by the MGPs.



In addition, toxicity testing indicated that ambient samples themselves were toxic. Under these conditions, toxicity testing is not a useful indicator of the effect of the MGPs.

Despite a potential difficulty in identifying ambient conditions in some areas of CAWS due to reversal in river flow in 1900, use of the selected tools (tPAH concentrations, forensics, and geographic locations) allowed for identification of ambient conditions.

- The role of ambient conditions in remedial design:
- Ambient conditions represent what is achievable for the local area
  - Local sediment will backfill or cover remediated areas over time and remediated areas will return to ambient conditions
  - Cleanup goals of constituent concentrations less than ambient conditions represent goals that are unattainable over time