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June 21, 2022

Project #: EART-01

Earthjustice
21 Ocean Avenue
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Attn: Lisa Evans
Senior Counsel

Dear Ms. Evans:

Subject: Michigan City – CCR Management Area – Review of Sheet Pile Wall Assessments

Privileged and Confidential

INTRODUCTION

Background

Northern Indiana Public Service Company (NIPSCO) operates the Michigan City Generating Station (MCGS) in Michigan City, Indiana. This power generating station is located on 123 acres of land along the south shore of Lake Michigan at the west edge of Michigan City (Site, see Figures 1 and 2). NIPSCO historically used coal combustion residuals (CCR) and general fill to reclaim land (create made lands) along the shore of Lake Michigan.

A unique aspect of the Michigan City CCR Management Area is that it includes numerous sheet pile retention structures that were constructed partly to assist in reclaiming land and partly to contain CCR wastes in the CCR Management Area. This included the installation of sheet pile barriers along waterside property boundaries to the east (Trail Creek) and north (Lake Michigan). The earliest barriers were reportedly constructed in the 1930s and additional sheet pile walls were added by NIPSCO to accommodate expansion of the generating station and creation and reconfiguration of waste management units. These additional barrier structures were installed along both the Lake Michigan shoreline and at various locations within the Site, particularly in the central and northwestern portions (see Figure 2).

The sheet pile barriers facilitated the creation of 'made land' (alternatively referred to as 'reclaimed land') by filling behind the sheet pile barriers using soil fill and/or wastes and CCR generated by the MCGS. Historical records (e.g., aerial photographs) and Site data indicate that made land expanded sequentially away from the generating station main buildings and toward the lake, creating areas that were used to expand Site operations, ponds, and waste management units. NIPSCO has recently commissioned various consulting groups to assess the stability and integrity of the sheet pile structures. Earthjustice engaged Burgess Environmental Ltd. (Burgess) to review these assessments, which is the subject of this letter.

Figure 1: Site Location (Source: Wood, 2018)

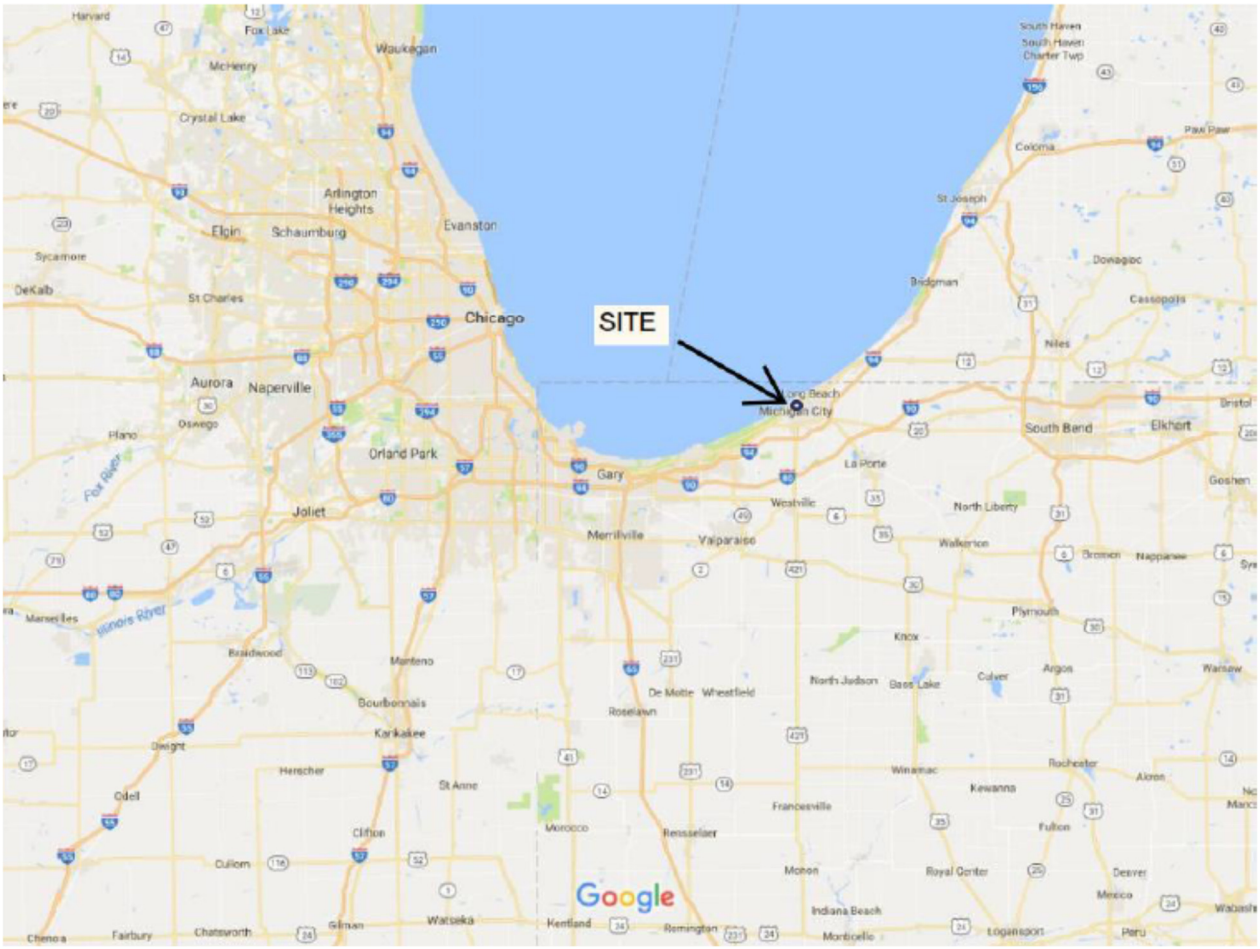
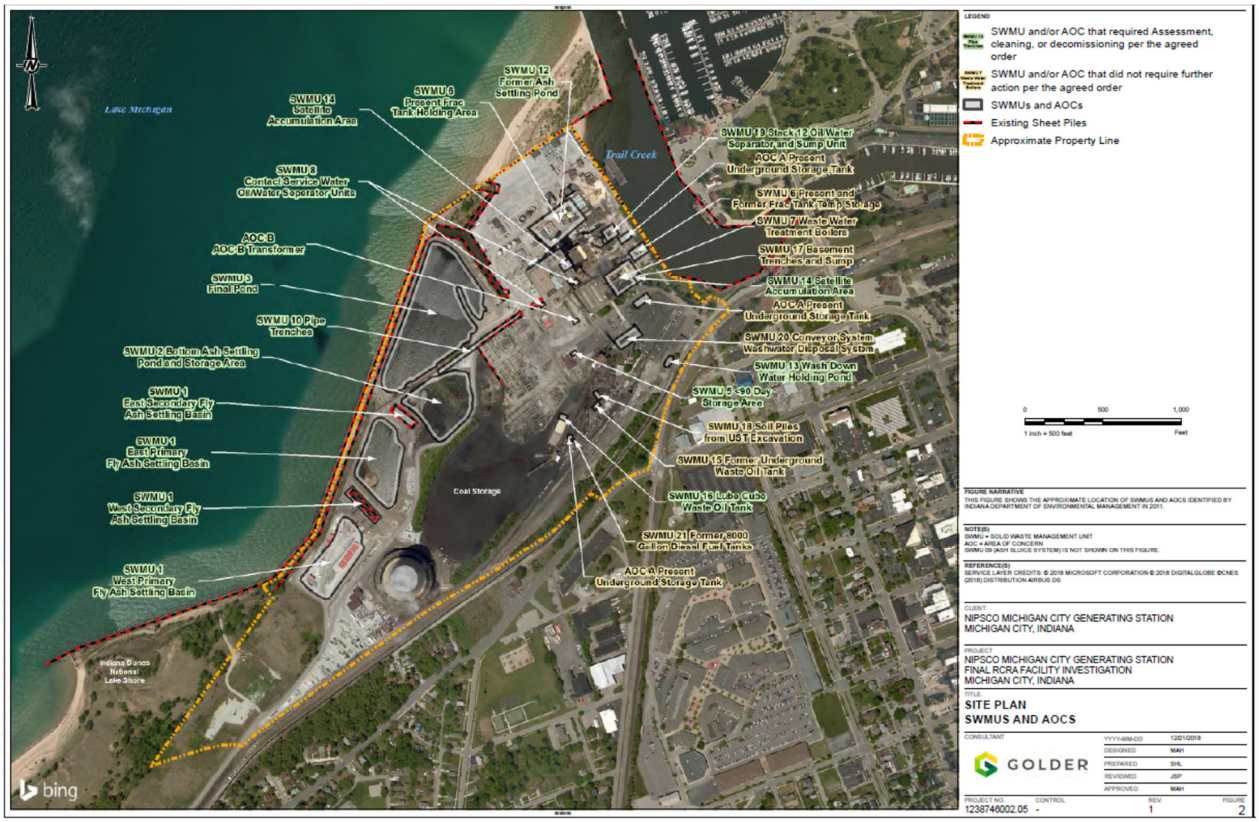


Figure 2: Plan View of Site (Source: Golder, 2018)



Basis of Review

The following documents form the basis of this review:

Sheet Pile Assessments

- Waterfront Facilities Inspections and Assessments, Northern Indiana Public Service Company. July 12, 2018 (Marine Solutions, 2018).
- Steel Pile Bulkhead Investigation Report, Northern Indiana Public Service Company, Michigan City, Indiana. December 15, 2020 (Marine Solutions, 2020).
- Request for Additional Information Michigan City Generating Station LaPorte County SW Program ID 46-010 U.S. EPA ID No. IND000715375. Letter dated November 3, 2021 (IDEM, 2021).
- Trail Creek Bulkhead Investigations and Assessments Summary, Waterfront Facilities Inspections and Assessments, and Risk-Based Evaluation of the Michigan City Generating Station. NIPSCO Responses to IDEM Request for Additional Information. March 3, 2022.
- Technical Review of Waterfront Facilities Inspections and Assessments Northern Indiana Public Service Company (NIPSCO) Michigan City Generating Station. Letter dated April 22, 2022 (Mabbett, 2022).

General Reports

- RCRA Facility Investigation Report, Northern Indiana Public Service Company, Michigan City Generating Station, Michigan City, Indiana, EPA ID NO.: IND000715375 (Golder, 2018).
- Surface Impoundment Closures (CCR Final Rule and RCRA Regulated) Closure Application, Michigan City Generating Station, Northern Indiana Public Service Company, Merrillville, Indiana (Wood, 2018).
- Supplemental Addendum Closure Application for Surface Impoundments, Michigan City Generating Station, Michigan City, Indiana (Wood, 2019).

Previous Comments Regarding Sheet Pile Wall

On behalf of Earthjustice, Burgess completed an initial review of the closure plan for the Michigan City CCR Management Area in December 2019. Concerns were raised regarding the following aspects of the sheet pile wall in the context of the containment of CCR waste and the associated closure plan (Burgess, 2019, Page 16):

1. the permeability of the sheet pile barrier and whether theses barriers could be relied upon to contain contaminated groundwater
2. steel sheets corrosion and its effect on integrity of the sheet pile barrier over time
3. the effect the sheet pile corrosion will have on the strength and stability of the sheet pile barrier

The permeability of an unsealed sheet pile wall is difficult to predict as it is dependent on soil conditions, pile type, water pressures, and the quality of the installation. The concept of “joint resistance” to leakage was developed by GeoDelft (ArcelorMittal, 2016), which correlates joint resistance to water flow and

pressure drop across the sheet pile. Implied in the GeoDelft method is that the equivalent permeability of a normal sheet pile wall is on the order of 10^{-7} m/s, which is approximately 2 orders of magnitude higher than the equivalent permeability of a compacted clay soil liner and more than 3 orders of magnitude higher than the equivalent permeability of an intact geomembrane liner.

Steel sheet pile walls are susceptible to corrosion, and increased corrosion rates should be anticipated when the sheet pile is in contact with fills due to oxygen replenishment (U.S. Army Corps, 1994). The pore spaces of fills typically contain higher concentrations of oxygen than native soil, which increases corrosion rates. Accelerated corrosion can occur in the presence of inorganic contaminants, such as CCR, because of increased electrical conductivity (salinity) of the pore water. The resulting loss of thickness at the joints of the sheet pile wall increases the overall permeability of the structure, and corrosion at the face of the steel sheet reduces the strength and bending resistance of the barrier.

The underlying corrosion estimates over 75 and 125 years were obtained from Table NA1, EC 3: Design of Steel Structures, Part 5: Piling of the UK National Annex (see Table 1). These estimates for corrosion are significant when considering the thickness of the steel sheet at the NIPSCO Michigan City facility, which is reported to be 0.375 inches (9.5 mm).

Table 1: Loss of Thickness of Sheet Pile due to Corrosion

Description of Contact Material	Loss of thickness (mm) per face, 75 years	Loss of thickness (mm) per face, 125 years
Undisturbed Nature Soils	0.9	1.5
Polluted natural soils and industrial sites	2.25	3.75
Non-compacted and non-aggressive fills	1.7	2.7
Non-compacted and aggressive fills (CCR waste)	4.5	7
Common fresh water (at water line)	1.15	1.65

Corrosion will result in increased seepage and CCR leakage through the sheet pile joints and will ultimately lead to buckling failure of the sheet pile barriers, which would likely, in turn, result in the release of CCR waste to the adjacent water bodies. This could be exacerbated by any flooding and associated erosion that may occur as the integrity of the sheet pile diminishes with corrosion.

DOCUMENT REVIEW COMMENTS

2018 Assessment

The issue of steel sheet pile degradation and potential for loss of integrity has been a concern that dates back to at least 2013 (Mabbett, 2022, Page 2). Each of the performance concerns outlined in the Burgess (2019) letter have been reinforced by the recent assessments that have been completed by NIPSCO's consultants. For example, the three primary issues of concern were validated by the 2018 assessment of

the steel sheet pile wall, as is evidenced by the following quotes extracted from the Marine Solutions (2018) report.

1. **Permeability of the Steel Sheet Pile**. "*Water seepage is evident through the interlocks*" (Section 3.1, 1st paragraph). "*Remove vegetation growing through the weep holes*" (Section 2, Table 2-1). The visible seepage between interlocks and the seepage through weep-holes in some steel sheets is evidence that the sheet pile wall is much more permeable than the equivalent permeability of a normal sheet pile wall of 10^{-7} m/s developed by GeoDelft (ArcelorMittal, 2016) and referenced in the Burgess (2019) letter. NIPSCO stated in its responses to IDEM that this cannot be fixed (NIPSCO, 2022, Response to Comment 3, Bulkhead Assessment).
2. **Corrosion**. "*the surfaces below water typically exhibit minor to moderate corrosion over 100% of the surface area . . . pitting up to 1/16-inch deep. . . . Additionally, isolated areas of Microbial Induced Corrosion (MIC) are present on the sheeting. . . . Greater than 25 percent loss of section was measured at the mudline*" (Section 3.1, 1st and 2nd paragraphs). This amount of corrosion is significant because it will weaken the steel sheets at key locations, such as at the waterline and mudline. The highest levels of corrosion were measured where the backfill of the sheet pile wall is washed out (Mooring Cell Inspection Report Form, page 2 of 5). The rate of measured corrosion is consistent with that predicted for non-aggressive soils backfill and freshwater application (UK National Annex), as outlined in Burgess (2019).
3. **Strength Loss and Movement**. "*The bulkhead is leaning outward and/or out of plumb. . . the backfill is washed out to varying degrees*" (Section 3.1, 3rd paragraph). This movement could be related to poor initial design, sheet pile corrosion and degradation as noted above, or both. For example, Marine Solutions (2018) was unable to verify the presence of tie-backs, which are an industry-standard method of enhancing the stability of steel sheets and do not appear to have been used at Michigan City (Mabbett, 2022, Page 2).

2020 Assessment

In response to these findings, "*NIPSCO undertook further investigation of the bulkhead misalignment condition, including geotechnical soil borings, topographic surveying, hydrographic surveying, excavating test pits, and additional above and below water inspection, plus a subsequent stability analysis of the bulkhead*" (IDEM, 2021). This assessment, which was also completed by Marine Solutions (2020), involved remeasuring the sheet pile wall deformations and hydrographic survey, drilling two geotechnical borings, and stability analysis of the sheet pile wall.

The movements of the sheet pile wall segments measured in 2020 (from 2015 to 2020) were concluded to be less than those measured between 2013 and 2015; however, recent movements of an additional 0.59 and 1.03 inches were measured for Targets A and B, respectively. While less than the previous measurements (1.72 and 1.63 inches at those targets, respectively), the recent movements remain significant. Marine Solutions (2020) identified a number of potential causes of the movement, including dredging to deepen the water depth along the sheet pile wall, high equipment loading adjacent to the wall, and possibly fluctuations in the level of Lake Michigan. The identifications of these root causes were speculative, and no detailed analyses were completed to verify or refute these potential causes. Marine Solutions concluded that, "*the documented movement in the vicinity of Targets A and B . . . raise concerns for either localized stability issues, history of extreme surface loading, or deformations due to previous construction evolutions"* (Section 3.1).

The stability analyses concluded that the steel sheet pile wall has sufficient remaining capacity. These analyses were completed assuming soil strength properties that, in my opinion, are quite aggressive. Sensitivity analyses should have been completed to determine the effect that adopting more conservative soil properties would have on the outcomes of the stability analyses. The stability analyses also assumed key parameters for the sheet pile wall, such as the depth of embedment of the steel sheets, because the design and construction of the sheet pile wall were not known. Accordingly, the results of these analyses are as reliable as the assumptions on which they are based, as was acknowledged on Page 9 of the summary, which states, "*the results presented are accurate only to the extent of the assumptions documented herein to develop the analysis models used".* More in-depth investigations were also recommended.

A letter issued by IDEM (2021), which appears to have issued in response to the Marine Solutions (2020) assessment, indicates that the regulator is concerned not only with the physical integrity of the sheet pile, but also with the contamination risks associated with the CCR waste at the Michigan City facility.

2022 Third Party Review

The third party review completed by Mabbett (2022) did not include any additional field studies or investigations; however, insight into the 2020 stability assessment completed by Marine Solutions can be inferred from Mabbett's report. A key focus of this assessment appears to have been on estimating the rate of deformation. Mabbett agreed with Marine Solutions' conclusion that, "*in general, there appears to have been more movement of the bulkhead between 2013 and 2015 than between 2015 and 2020*" (Page 2). This statement indicates that movement of the sheet pile wall continues to occur. The reduction in the rate of movement was attributed to reducing loads on the sheet pile wall, ("*This suggests that keeping the load away from the edge is helping to stabilize the bulkhead"* (Page 3)). The Mabbett Report also concludes that the are no tie-backs and that "*it should be assumed to be a cantilevered bulkhead*" (Page 2). This is a significant conclusion because cantilevered sheet pile walls are more susceptible to movement and failure than walls that include tie-backs.

Mabbett also reviewed the stability assessment for the wall and commented that aggressive soil strength parameters had been used to evaluate wall stability. They concluded that "*unusually heavy loads should be avoided within 30 feet of the wall*" (Page 3). NIPSCO and its consultants appear to be considering significant reparations for the wall, as is evidenced by the following: "*If further outward movement was observed during the monitoring program, it is likely that there is an issue with the stability of the wall and further corrective action would need to be taken. We agree with the recommendations from Marine Solutions that two suitable alternatives for corrective action would be to place riprap in front of the existing structure or to drive new sheet pile in front of the bulkhead*" (Page 3). This last statement indicates a lack of confidence in the current and future integrity of the steel sheet pile walls along the waterfront.

CONCLUSIONS AND RECOMMENDATIONS

The following concerns raised in the Burgess (2019) letter have been validated by the recent assessments completed by Marine Solutions (2018 and 2020):

- the steel sheets do not retard the seepage of contaminated pore water into Lake Michigan
- corrosion has and continues to undermine the integrity of the steel sheet pile walls
- documented movement of the sheet pile walls continues and is significant

Seepage of contaminated water into Lake Michigan and into groundwater was not a focus of the assessments completed by NIPSCO's contractors, who were concerned primarily with the structural integrity of the sheet pile wall. However, IDEM raised contamination concerns in their 2021 letter to NIPSCO regarding the CCR waste area and steel sheet pile walls at the Michigan City facility.

Corrosion of up to 25% of the steel sheet thickness has been measured. The pile modulus and moment of inertia, which are properties that represent the pile's ability to resist bending, are each dependent on wall thickness. In general, the sheet pile bending resistance will diminish at least in proportion to the reduction in wall thickness resulting from corrosion. Steel yield stress will also be affected negatively by corrosion, which will further reduce the sheet pile bending resistance over and above that associated with reduction in thickness. Ultimately, the steel sheet pile wall will corrode and fail if it is left in place.

The primary mitigation recommended to slow wall movement was to avoid stressing the wall any further. For example, it was recommended that large mobile equipment not be operated in close proximity to the wall. Bolstering the wall with riprap and/or replacing the steel sheet pile wall have also been suggested as more significant mitigations. Capping the CCR wastes adjacent to the steel pile sheet wall will increase the destabilizing loads on the wall and will require heavy equipment to operate next to the sheet pile wall.

Absent in any of the assessments and analyses was an evaluation and determination as to whether this is an appropriate application of steel sheet piles. To this point, the steel sheet piles are not permanent, and they are not reducing the flow of contamination into Lake Michigan. Accordingly, their application in this case, and the efforts being considered by NIPSCO's contractors to prolong their functionality, are misdirected. NIPSCO indicates that areas of CCR waste will be excavated and removed from five of the SWMUs (Response to Comment 2 on Risk-Based Evaluation), but appears to continue to rely on the steel sheet pile walls for containment for the SWMUs that will be closed in place.

If the CCR waste is to remain in place, then the steel sheet pile walls should be replaced by permanent retention structures. A permanent retention structure will not prevent the seepage of contaminated pore-water into Lake Michigan and/or Trail Creek, and the CCR waste will remain in direct contact with groundwater. Hence, the preferred solution is to remove the CCR waste and disposed of that waste in an appropriately engineered landfill.

LETTER CLOSURE

We trust that this letter provides the information that you require at this time. If you require further information or if you have any additional questions, please contact me. We appreciate having the opportunity to be of service to Earthjustice.

Yours sincerely,

Gordon J. Johnson, M.Sc., P.Eng. (AB)

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