Haute Géologie, LLC

Memorandum

To: Stephanie Heldt-Sheller, CHMM, Northwest Pipe Company

From: Ken Shump, R.G., Haute-Géologie

Copies: Claudia Powers, Buchalter
Mike Merchant, Black Helterline
Kris Ivarson, PMP, Jacobs

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Subject: Response to DEQ Question on Dioxins

Introduction and Purpose

DEQ noted in an email dated 13 August 2020 that a certain dioxin compound (1,2,3,7,8-pentachlorodibenzo-p-dioxin, or 1,2,3,7,8-PeCDD) was detected in sediment of the IT Slip near Outfall 18 at a concentration above the action level for sediment in the record of decision (ROD) for the Portland Harbor Superfund Site (EPA 2017), as amended by the Explanation of Significant Differences (EPA 2019) and two separate Errata (EPA 2018 and 2020). EPA and DEQ requested additional information regarding the ability of the Northwest Pipe site's Aquip storm water treatment system to treat for dioxins and furans. For the purposes of this memorandum, the related compounds dioxins and furans are referred to hereinafter collectively as dioxins.

This memorandum covers the following information:

- Potential sources for dioxins in the vicinity of the IT Slip
- An overview of the environmental transport of these compounds
- Treatment for hydrophobic organic contaminants in water
- How the Aquip stormwater treatment system reduces the concentration of highly hydrophobic compounds such as dioxins in storm water

Sources of Dioxins

The Agency for Toxic Substances and Disease Registry (ATSDR 1998) notes that dioxins (abbreviated CDDs) and furans (abbreviated CDFs), short for chlorinated dibenzo dioxins or furans are ubiquitous in the environment and originate from a wide variety of processes and activities, such as:

> "…the manufacture of chlorinated intermediates and pesticides, during smelting of metals, in the incineration of municipal, medical, and industrial wastes, and from the production of bleached wood pulp and paper. CDDs are also found in emissions from the combustion of various other sources, including coal-fired or oil- fired power plants, wood burning, and home heating systems. Generally, the more highly chlorinated CDDs are the most abundant congeners present in the emissions from these combustion sources. CDDs also occur in other combustion products (e.g., cigarette smoke), automobile exhaust from cars running on leaded gasoline with chlorine scavengers and to a lesser extent from cars running on unleaded gasoline, and diesel exhaust. CDDs/CDFs can form during the synthesis and

> combustion of chlorine-containing materials, such as polyvinylchloride (PVC), in the presence of naturally occurring phenols, vegetation treated with phenoxy acetic acid herbicides, paper and wood treated with chlorophenols, and pesticide-treated wastes."

When dioxins are formed by combustion or other high-temperature operations, the presence of chlorine or its ion chloride is a key factor in dioxin formation. For example, Menzel et al. (1998) noted that thermal oxygen cutting of scrap metal produced "sometimes very high" levels of dioxins, attributed to the presence of PVC and polychlorinated biphenyls (PCBs) associated with contaminated scrap metal and painted metal. The same processes involving virgin steel, such as used by Northwest Pipe for steel pipe fabrication, presented no such evidence.

Reviewing the history of operations at the site now owned by Northwest Pipe, a notable event related to the potential for dioxins to form was the major fire on June 17, 1961 that consumed grain stored in the bays of the former Oregon Shipbuilding Assembly Building, as well as the roof and a significant part of the structure itself. Other facilities within the IT Slip drainage basin also have been subject to uncontrolled fires, such as the large Schnitzer Steel Recycling Yard fire in August 2016 (Oregonian 2016), as well as historical fires at the shipyard in 1941 and 1944. In addition to these accidental fires, burning was a common method for removing the insulation (often composed of PVC plastic) from scrap copper wire for recycling purposes. This would almost certainly have been associated with Oregon Shipbuilding Corporation operations considering the large amount of electrical cable used in Liberty and Victory ships and the strategic importance of recycling scrap copper for the war effort. Uncontrolled combustion such as this has been linked to formation of dioxins when in the presence of chlorine-containing materials (ATSDR 1998 and EPA 2003). Chlorine that could have contributed to dioxin formation from the 1961 fire could have come from PVC electrical cable insulation or PCBs in electrical equipment that may have been destroyed in the fire. For fires at the Schnitzer Recycling Facility, such as the recent 2016 fire, chlorine could have originated in PCBs in coatings and electrical equipment consumed in the fire, PVC cable insulation, and PVC automobile vinyl.

Uncontrolled combustion, such as would occur in a structural or scrap metal fire, unavoidably leads to localized pyrolysis, which is a combustion-related condition that occurs in zones with elevated temperatures but an absence or near absence of oxygen. This would contrast with controlled combustion, such that occurring in an engineered and controlled incinerator, which leads to essentially complete combustion. Pyrolysis tends to favor production of heavier dioxins such as PeCDD over less chlorinated dioxins (EPA 2003).

The sediment samples containing PeCDD concentrations above the Portland Harbor ROD remedial action level were situated near Outfall 18 (WR123). This outfall has received stormwater discharge from a range of industrial facilities with close to a century of industrial activities. Northwest Pipe constitutes approximately one-quarter to one-third of the drainage basin of this outfall, with the proportion increasing more recently in response to other dischargers within the drainage basin routing their stormwater to other outfalls. In addition, historically several other outfalls were located near Outfall 18 in the IT Slip, conveying stormwater discharge from portions of a scrap metal recycling operation. As described in more detail later in this memorandum, Northwest Pipe's stormwater discharge is treated by a state-of-the-art treatment system that is effective at dioxin removal. The treatment system was installed in 2012 and has operated continuously since that time.

Environmental Transport of Dioxins

Dioxins have low dissolved-phase mobility in the environment and tend to move by particulate movement in either air or as suspended solids in water. The potential for migration for organic compounds such as dioxins in water can be described using the organic carbon (Koc) or octanol water (Kow) partition coefficient to assess the propensity for a particular compound to adsorb to organic carbon in the environment. Both coefficients are associated with the tendency for organic compounds to adsorb to organic matter in the environment, with Koc measuring the sorption behavior with organic carbon whereas Kow uses an alcohol with eight carbon atoms as a surrogate for organic carbon, such as in lipids. The two properties (Koc and Kow) vary directly: organic compounds that have high Kow values also have high Koc values, and organic compounds that have low Kow values also have low Koc values. EPA (1996) cites a 97 percent linear regression correlation between the two coefficients, indicating their close relationship.

Showing how effectively dioxins and other organic compounds adsorb to organic carbon can be calculated using equation (1) from EPA (1996):

$$Kd = Koc * foc$$

Where:

> *Kd* = The partition coefficient describing how a specific organic compound partitions between the dissolved phase and adsorbed phase (that is, sorption to organic carbon)
>
> *Koc* = The organic carbon partition coefficient, a property of each organic compound
>
> *foc* = fractional organic carbon content of soil or sediment in the area of interest

The reason dioxins have low mobility in the environment is because of their very large partitioning coefficient values, which lead to much greater partitioning to environmental organic carbon. While EPA has not reported a definitive Koc value for 1,2,3,7,8-PeCDD, the Kow for 1,2,3,7,8-PeCDD is reported in EPA (2003) as ranging from log 6.2 L/kg to log 7.4 L/kg, which is slightly higher, but similar to the log Kow range for TeCDD, which is reported to range from log 6.1 L/kg to log 7.1 L/kg.

The slightly lower log Kow values for TeCDD would lead to slightly lower log Koc values for that compound, compared to those of PeCDD. Since EPA (2003), has noted a definitive log Koc value for TeCDD, using that value an estimate of the log Koc value for PeCDD would be conservative.

EPA's estimate of the most definitive log Koc value for TeCDD is log 6.6 L/kg, or 3,981,072 L/kg. The highly hydrophobic behavior associated with such large Koc values is why dioxins generally do not exist in the dissolved phase at appreciable concentrations but are instead associated with fats or are adsorbed to particulate organic carbon in the environment.

The partitioning between the adsorbed phase and the dissolved phase for hydrophobic compounds such as PeCDD can be estimated by using the equation noted above: *Kd =Koc * foc*. The organic carbon content in site surface soil was measured in 12 samples collected in 2009. The results ranged from 4,300 mg/kg to 74,000 mg/kg, with a mean value of 30,825 mg/kg, or 3.1 percent foc.

Consequently, the partition coefficient between the adsorbed phase and the dissolved phase for PeCDD is calculated to be:

$$Kd = 3.1 * 3{,}981{,}072 = 12{,}341{,}323$$

Such a large result means that essentially all the PeCDD in a mixture of water and soil of the type found on the ground surface at Northwest Pipe would be in the solid phase, adsorbed to organic carbon in suspended soil particles. Therefore, a treatment approach that manages suspended solid particles, would be the most effective at managing dioxins in stormwater (Clark and Pitt 2012, Mohanty et al. 2018.

<u>Water Treatment for Dioxins</u>

Dioxins, as with furans and other similar compounds, are most effectively removed from water by removing the particulates to which these highly hydrophobic compounds are attached and by adsorbing the low concentration of these compounds that partition into the aqueous (dissolved) phase. Such treatment would involve two components: particulate removal via settling and filtration, coupled with adsorption onto carbon (Clark and Pitt 2012, Mohanty et al. 2018). Sources of carbon could include charcoal, biochar, or granular activated carbon (GAC).

The following section describes how NWP and its current Aquip stormwater treatment systems, are currently providing those two treatment systems effectively.

<u>Summary of Northwest Pipe Aquip System and other Source Control Measures</u>

Northwest Pipe Company has implemented a range of source control measures to control potential contaminants and prevent them from leaving the site via the stormwater pathway. These include routine housekeeping measures, each of which is targeted specifically at reducing the level of particulates suspended in stormwater, such as:

- Contracted regular pavement sweeping
- Installing and maintaining fabric filters in catch basins
- Regularly cleaning catch basins and stormwater conveyance lines
- NWP catch basins, by design, are intended to filter, separate, and therefore remove oil & grease and total suspended solids from stormwater as it enters the stormwater drainage system.

In addition to these routine practices, Northwest Pipe has implemented more extensive source control efforts such as:

- Installing and operating two state-of-the-art Aquip stormwater treatment systems, including one on each of the two site outfalls, which treat 100 percent of stormwater runoff before it is discharged to the IT Slip

- Removing contaminated soil hot spots and paving the remaining unpaved areas of the site under a DEQ-approved feasibility study and interim remedial measure (IRM) work plan. By implementing the IRM, essentially all unpaved soil at the site, which was exposed to stormwater in the past beginning when the site first was developed for industrial use, has been capped with pavement.

- Inspecting and repairing the pavement cap as needed

- Moving scrap metal bins under cover to prevent contact with precipitation

- Capturing and segregating stormwater in the cement mortar lining area and the fueling area, conveying some for re-use at the site (cement system) and sending the remaining through an oil-water separator and permitted discharge to the sanitary sewer system (fueling area)

- Modifying the stormwater conveyance system in response to site grading and paving

These efforts are described in more detail in the site's current Source Control Evaluation report (Jacobs 2020).

The Aquip system is a proprietary stormwater treatment system that provides several treatment methods. Aquip targets total suspended solids (TSS), metals, biological and chemical oxygen demand (BOD/COD) and nutrients in stormwater. It also removes oil that may be entrained in stormwater runoff, and dissolved organic compounds susceptible to carbon adsorption, such as dioxins. The pretreatment chamber allows suspended solids to begin settling out of suspension and removes free oil that may be present in stormwater runoff, such as from incidental oil drips from vehicles.

The main treatment chamber consists of layers of granular and adsorptive media, including sand and activated carbon, that removes stormwater contaminants such as metals, particulates, oil, organic compounds, and nutrients. Within the filtration chamber, contaminant removal occurs through a combination of straining, filtration, complexing, adsorption, absorption, micro-sedimentation, and biological degradation prior to discharge (StormwateRx 2019).

The Aquip system removal efficiency for suspended solids is reported by StormwateRx, for median values of 105 paired data sets (prior to and after treatment), to yield an 83 percent decrease in suspended solids concentration. This represents an underestimate of dioxin removal efficiency, however, because the presence of activated carbon in the Aquip filtration media provides a second treatment method – adsorption – to the filtration treatment provided by the system's filtration media, which would be in addition to the reduction associated with the removal of suspended solids. As noted earlier in this memorandum, dioxins, including 1,2,3,7,8 PeCDD identified in DEQ's email, are highly hydrophobic and strongly partition to organic carbon.

Northwest Pipe Company has implemented a broad range of source control measures to control potential contaminants and prevent them from leaving the site via the stormwater pathway. These include a treatment system that involves suspended solids reduction via filtration and settling, as well as a filter media that includes activated carbon. These two technologies – filtration and activated carbon – are particularly well-suited to dioxin removal from stormwater.

<u>**Summary**</u>

Considering the information collected and presented in this memorandum, the site has taken actions to have controlled potential sources of dioxins and furans.

The basis for this conclusion can be summarized as follows:

- <u>Northwest Pipe site's manufacturing processes are not linked to dioxin formation.</u> While certain metal cutting activities have been linked to production of dioxins, available data points to cutting of painted scrap metal that may contain PCBs or PVC in coatings as associated with dioxin production. Dioxin formation is not associated with cutting or welding of virgin (new, uncoated) steel, as is done at the Northwest Pipe facility for manufacturing steel pipe.

- <u>The Northwest Pipe site is paved and capped</u>. While uncontrolled fires potentially capable of generating dioxins have occurred in the past at the site now owned by Northwest Pipe, such as the 1961 conflagration that destroyed much of the Assembly Building (now reconstructed as the site's main production building), site soil has been capped as part of an interim remedial action and residual constituents attributable to that fire, if any, are capped and contained. The 2016 uncontrolled fire at Schnitzer's Steel Recycling Yard, not associated with the Northwest Pipe site, occurred partly in an area that drains to the IT Slip.

- State-of-the-art stormwater treatment systems & BMPs: The site has implemented a wide range of source control actions and best management practices to further limit potential contaminant loading to stormwater. Chief among these is the installation of two, state-of-the-art, Aquip stormwater treatment systems, each providing three treatment technologies – water retention and sediment settling; physical filtration through granular filtration media; and carbon adsorption within the Aquip treatment train. Individually and especially in combination, these technologies effectively target removal of highly hydrophobic, sediment-bound contaminants, such as dioxins and furans.

In conclusion, Northwest Pipe operations are not associated with the generation of dioxins, and paving has isolated any potential historically affected soil from stormwater. Northwest Pipe has implemented BMPs targeted at isolating hydrocarbons and particulates from stormwater. It has installed a state-of -the-art stormwater treatment system for treating all site stormwater. The system includes treatment processes that remove highly hydrophobic organic contaminants such as dioxins. Considering these facts, it is reasonable to conclude that the site is not a source of dioxins to storm water and already has implemented any reasonable measure that might be needed to address dioxins in stormwater.

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