



Oregon

John A. Kitzhaber, MD, Governor

Department of Environmental Quality

Northwest Region Portland Office

2020 SW 4th Avenue, Suite 400

Portland, OR 97201-4987

(503) 229-5263

FAX (503) 229-6945

TTY (503) 229-5471

April 3, 2013

Kenneth G. Chaput
SSG Environmental Remediation
The Boeing Company
P. O. Box 3707 MC 6Y-94
Seattle WA 98124-2207

John Cushing
Cascade Corporation
P. O. Box 20187
Portland OR 97294-0187

RE: *Boeing Portland, Cascade TGA Review and TSA
Remedy Mound Area Well Installations*
DEQ ECSI #635 and #1479

Dear Mr. Chaput and Mr. Cushing:

Thank you for the presentations and discussion at our meeting February 20, 2013. The Department of Environmental Quality (DEQ) has reviewed the June 4, 2012 Landau Associates *Boeing Portland, Cascade TGA Review*; the June 15, 2012 S.S. Papadopulos & Associates *TGA Closure, Comments from Landau Associates*; the November 6, 2012 Prowell Environmental *TSA Remedy Mound Area Well Installations*; the December 21, 2012 S.S. Papadopulos & Associates *Troutdale Sandstone Aquifer, TSA Remedy Mound Area Investigation*; the December 26, 2012 Landau Associates *Troutdale Sandstone Aquifer – TSA Remedy Mound Area Investigation*; and the November 2, 2012 Landau Associates *Cascade TGA Investigation*. DEQ believes that multiple transport mechanisms must be causing temporary increases in TCE concentration in isolated parts of the mound area. We request a limited investigation of groundwater near the eastern end of mulch bio-wall.

TCE Concentrations in the TSA Groundwater Mound Area

Groundwater remedy pumping started in 1997 and eventually lowered groundwater levels in the mound area by approximately 35 feet. As remedy pumping decreased water levels began to rise again in 2007 and apparently have largely regained their former level. TCE concentrations in some water table TSA wells, in particular MW-17ds and MW-18ds, have been increasing following resaturation while at most other wells concentrations are steady or declining. Several hypotheses have been presented to explain TCE increases in the mound area:

1. Slower flushing of the upper TSA due to relatively low permeability.
2. Continued migration of contamination from CU1 and the unsaturated upper TSA.

3. Retention of TCE in upper TSA when water levels fell followed by remobilization with recovering water levels.
4. Downward migration of contamination from the TGA over the CU1 truncation and into the TSA.

Slow Flushing of the Upper TSA

In 2011 Cascade performed recovery and slug tests on monitoring wells in the mound area to estimate aquifer properties. Testing indicated that horizontal hydraulic conductivity (K) of the lower TSA in the mound area is lower than previously estimated. As a result Cascade suggests that slow flushing is a plausible hypothesis for persistent TCE concentrations in the mound area. Boeing counters that slow flushing does not explain *increasing* concentrations and wells in lower-K areas do not consistently have higher concentrations.

Another variation not discussed by the parties is a possible residual TCE source in the vicinity of old TSA supply wells located near 205th Avenue and the old Shepard Farms irrigation well located several hundred feet north of the CU1 truncation. With all these wells now offline and TSA extraction wells also shut down east of 201st, we may now be drawing residual TCE back to the west through TSA extraction near the CU1 outcrop.

Continued migration from the CU1

To assess conditions in the TGA downgradient of the mulch bio-wall Cascade installed two monitoring well clusters, MW-47 and MW-48a, b, and c. The “a” and “b” wells are screened in the upper and lower TGA while the “c” level wells are screened in the top of the CU1 confining unit. Relatively low TCE concentrations were found in “a” and “b” wells and higher concentrations (up to 220 µg/l) were found in the upper CU1. It was anticipated early in the project that TCE from the TGA would move downward into the very low permeability CU1 and this has apparently occurred. The very low permeability of the siltstone confining unit is thought to be a barrier to continued vertical movement through the CU1 and this is demonstrated by observations that the highest TCE concentrations are still found in the upper part of the CU1. Vertical migration through CU1 appears to be a less likely hypothesis to explain increasing TCE concentrations.

Retention and Remobilization from the upper TSA

Boeing suggests this mechanism is unlikely because it assumes there was no significant flushing of the unsaturated zone during the past ten years in an area which should have seen significant recharge and the hypothesis does not explain the localized nature of TCE increases.

To better assess this hypothesis Cascade installed a cluster of three vapor monitoring wells immediately south of MW-17(ds) where significant increases in TCE concentration have been observed. The wells are known as VW-17d-42.5, -75.0, and -95.5 with their final depth included in the names. Data collected from the installations included:

- VOC analysis of core samples from the CU1 and TSA;
- VOC analysis of groundwater at the water table and two locations in the Lower TSA;
- VOC analysis of formation vapors from each well;
- Porosity, total organic carbon, and grain size analysis from many intervals and

- Detailed lithology.

Among the findings were that the upper part of the lower TSA appears to act as a confining layer which would isolate the upper TSA from the pumped lower TSA. The complex lithology near the water table and partial confining layer suggests the possibility of slow flushing of the TSA and persistent TCE concentrations. Core samples show the highest concentration of TCE at the top of the CU1 and decreasing concentrations with depth. Vapor samples were collected from each well and the highest concentration was from the deepest sample, in the lower part of the upper TSA. As seen in the generally low core sample results, none of the vapor samples suggest the magnitude of TCE concentrations that are observed in lower TSA groundwater. Depth discrete groundwater samples were collected in the lower TSA and compared to groundwater samples from the CU1. The highest groundwater TCE concentration was in the upper CU1 and within the lower TSA the highest concentration was at the water table.

The findings indicate that the highest TCE concentrations remain in the upper CU1 and suggest that there is not significant downward migration of TCE through the unsaturated zone to the water table however the results are not inconsistent with both the slow flushing and mobilization of some retained TCE as water levels rise in the TSA.

Downward migration from the TGA to the TSA

Boeing maintains that the most likely source is remnant contamination moving down from the TGA over the CU1 confining layer truncation. They suggest that the control trench, which was extended eastward and converted to a mulch bio-wall in 2006, never “eliminated the source of VOCs to the TSA mound area.” Boeing notes that there were significant TCE concentrations detected in Cascade TGA wells east of the trench along NE 201st Avenue and that buried utility lines in the 201st Avenue right-of-way could be a conduit for TCE-contaminated groundwater to move to the CU1 truncation and into the TSA. It appears there are several utility lines in 201st Avenue and some of these likely predate the East Multnomah County project so this conduit was likely present historically.

The conduit idea for the new stormwater line buried in backfill along 201st Avenue was first investigated in 2001. TCE was found at a maximum of 15 µg/l in the utility backfill east of the trench and at 7.3 µg/l about 160 feet downslope along 201st. Although recognized by DEQ as something of a conduit at the time it was not judged to be a significant contaminant pathway.

Boeing notes the roughly N-S series of wells, just west and parallel to 201st Avenue (MW-45, B-6, MW-35s, and MW-42), have had relatively high historic TCE concentrations and suggests that TCE has been skirting the east end of mulch bio-wall to move downslope toward the TGA truncation, possibly as a result of the 201st Avenue conduit. The more recent TCE concentrations in the remaining wells in this area are lower now however there is some uncertainty in concentration since the wells underwent a “bio-polishing” treatment from 2008-2010 to reduce local concentrations.

Boeing points out that there has been a small shift in TGA groundwater flow direction since the modification of the control trench. The recent Boeing reinterpretation of contours from August 2009 appears to over-emphasize this but it is generally understood that there is now an eastward component of groundwater flow in the primarily northern flow of the mound area. The eastern component was less evident historically and the reason for the change is not clear but it suggests a possible discharge boundary east of Shepard Spring. Boeing suggests that this could be the 201st Avenue conduit. TGA groundwater contouring from August 2012 shows a trough extending toward 201st which suggests an eastern discharge area however more recent contouring from February 2013 does not show the trough. Boeing suggests that another reason for the eastward component of flow is the relatively higher TGA hydraulic conductivity found in the eastern part of the mound area however this would have been the same historically, before more eastward flow. Another idea from Boeing that appears to be more likely is that the modification of the trench reduced its hydraulic influence and it now shunts more groundwater eastward where the conduit could have greater effect.

Boeing contends that the effectiveness of the mulch bio-wall is uncertain and untested. Cascade counters that monitoring wells MW-47a/b and MW-48a/b, immediately downgradient of the wall, demonstrate effectiveness.

Cascade presents several arguments against the hypothesis of downward migration of TCE contamination from the TGA. The TGA has been thoroughly investigated and monitored since 1986 and TCE concentrations at virtually all monitoring points are now below cleanup levels and below those in the TSA. With low TGA concentrations the flux of TCE from the TGA to the TSA must also be low. The flux is lower than the amount of TCE being removed from the TSA so it cannot be the primary source. There is no known source area for higher concentrations in the TGA.

Cascade notes that monitoring wells MW-42, B-6 and MW-45 are screened partially in the CU1 so reflect a mixture of CU1 and TGA groundwater. Concentrations are now higher in the CU1 than in any other unit so concentrations in these wells may have been higher in the past because of screen location.

MW-17(ds) is approximately 250 feet west of the 201st Avenue conduit and hydraulically upgradient of extraction well EW-14 to the south so unlikely to be effected by conduit flow. Lower TSA extraction well EW-18 is located much closer to the potential conduit but it is also located fairly close to MW-45 where TCE has been in compliance since 2009 so the conduit seems to have little effect in this area where it would be expected. EW-18 is no longer pumped because of low concentrations.

Boeing Proposal and DEQ Opinion

The phenomenon of increasing TCE concentrations in the mound area is not widespread and significant increases are only observed in two monitoring wells. DEQ expects that increasing concentrations will likely be short lived and concentrations will go back into decline with time and continued TSA remedy pumping. The investigation into the cause for TCE persistence and increase in the TSA has not identified a definitive single cause and there remains considerable

disagreement between Boeing and Cascade on the sources. DEQ believes that multiple contaminant transport mechanisms are likely. The installation of MW-47c and MW-48c clearly shows high TCE concentrations in the upper CU1 yet significant and widespread vertical transport through the CU1 confining unit is unlikely. We believe the work with the VW-17d wells presents a strong case for slow flushing as well as some retention and remobilization of TCE with recovering water levels. We note that the increasing concentrations at MW-17ds appear to be stabilizing now.

Increases in concentration at MW-18ds appear to be ongoing and it is not clear if the same transport mechanisms illustrated in the VW-17d wells are also underway here but we have no reason not to think so. MW-18ds is somewhat closer to 201st Avenue than MW-17ds so the concept of the conduit flow influence seems more likely here but the well is still some 300 feet south of the CU1 truncation. Pumping at EW-2 and south dipping beds (Figure 3 in Landau Associates, December 2012) could move TCE south in the TSA.

We agree with Cascade that investigation and monitoring of the TGA does not suggest a large, undiscovered source of TCE. However we recall during the installation of the original control trench that the aquifer exhibited great heterogeneity which was illustrated by strong seep flow into the trench during construction (*Cascade TGA Control Trench Construction Report*, EMCON 1996). This heterogeneity suggests that groundwater monitoring cannot always allow complete characterization. The current lack of monitoring wells along 201st Avenue which have not experienced bio-polishing treatment presents a possible data gap although we believe the bio-polished wells should be increasingly useful as monitoring points.

In their *Cascade TGA Investigation* memo Boeing proposes nine additional monitoring wells to investigate the concentration of TCE in groundwater flow around the mulch bio-wall and along the 201st Avenue conduit. Three permanent wells are proposed within the utility trench backfill to investigate conduit TCE concentrations. Boeing (November, 2012) presents a cross section (Figure 2) from Gresham design plans for the 201st storm line. From the figure it appears there could be conduit flow in several different lines within the right-of-way. As mentioned above, conduit flow was investigated in 2001, much closer to 1995 when relatively high concentrations existed widely in the TGA. The highest concentration then was 15 ppb which was not regarded as a high concentration at the time and concentrations in the TGA have been declining since then. For all the difficulty (installation and sampling) that permanent wells in the 201st Ave conduit backfill would now entail DEQ does not have enough evidence of a problem to endorse this proposal.

Boeing proposes a cluster of three TGA wells immediately up and down-gradient and at the end of the current mulch bio-wall. We currently have TGA wells MW-47a, -47b, -48a, and -48b all just downgradient of the bio-wall (and unimpacted by biopolishing) so this proposal is hard to justify at this time. See the DEQ proposal below.

Boeing proposes three new TGA wells NE of MW-42, B-6, and MW-45 to investigate conditions just downgradient of these wells which all received biopolishing treatment around 2008. Boeing mentions the highest TCE concentrations measured at these wells which all occurred at or near

their installation dates of 2001, 1995, and 2003 but concentrations then declined over the years to around 10-50 ppb before dropping to below 5 ppb after biopolishing treatment in '08. Based on the very detailed geologic logging of the recent TGA wells of the 47 and 48 series, Cascade points out that these older wells are all partially screened in CU1. In Boeing's *Cascade TGA Investigation* memo, Figure 3, the wells are shown partially screened in a unit Boeing calls "Siltstone." Cascade now interprets this unit as part of the CU1 and this interpretation seems reasonable to DEQ. As shown in MW-47c and -48c the Upper CU1 can contain higher concentrations of TCE. Cascade suggests that MW-42, B-6, and MW-45 likely had higher concentrations in the past due to their being screened partially in the CU1. See the DEQ proposal below for our recommendation.

The central question appears to be: are there high concentrations of TCE being shunted around the end of the mulch bio-wall which could then move into the 201st Avenue conduit and downgradient over the CU1 truncation and into the TSA. DEQ proposes a single well, between the end of the mulch bio-wall and 201st. This well would be in the heart of a group of five to six proposed Boeing wells and we believe would be best positioned to answer the central question. This location is just downgradient of MW-45, where the highest TCE concentration (500 ppb) was recorded in 201st Avenue "axis wells". It is near the end of the bio-wall and should be well positioned to intercept any flow moving around the wall and into the conduit.

DEQ requests the installation of a single TGA well in the vicinity of the east end of the mulch bio-wall at a location designed (and approved by all parties) to best assess TCE in groundwater possibly being shunting around the wall and moving into the conduit. We recommend that the well be sized large enough to accommodate a small pump so that in lieu of monitoring the well for several quarters in a typical investigation, the well can be pumped for a time. A pumped well will more quickly capture a larger radius of groundwater and provide answers in a shorter time. Temporary discharge pipe could likely be run above ground to intercept pipe going to the remaining active treatment compound. We believe this will allow a final determination of the presence of significant TCE contamination moving around the bio-wall and into the 201st conduit. If TCE contamination significantly greater than cleanup objectives is not encountered then DEQ is prepared to close this investigation and move the Cascade TGA project toward closure.

If you have any questions and comments, please contact me at (503) 229-6802 or by email at williams.robert.k@deq.state.or.us.

Sincerely,

Robert Williams
Project Manager

cc: Eric Weber, Chris Kimmel, Landau Associates
Charlie Andrews, Papadopulos & Associates
Cindy Bartlett, Geosyntec