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October 30, 2020

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Region 8, Montana Office
10 W. 15th Street, Suite 3200
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Jennifer Chergo
U.S. Environmental Protection Agency
1595 Wynkoop Street
Denver, Colorado, 80202

Re: Groundwater Conceptual Site Model Former Smurfit-Stone/Frenchtown Mill Site, Missoula County, Montana, Draft Version 3, Issued: June 26, 2020.

Dear Ms. Archer:

Thank you for the opportunity to submit comments on the Groundwater Conceptual Site Model for Smurfit-Stone. Due to length, our comments are submitted below in document form. We are happy to provide any referenced data, presentations, or reports. We look forward to continuing to participate in this process.

Sincerely,

Elena Evans

Hydrogeologist

Missoula Valley Water Quality District

301 W. Alder, Missoula, MT 59802

Missoula Valley Water Quality District Comments on Groundwater Conceptual Site Model Former Smurfit-Stone/Frenchtown Mill Site, Missoula County, Montana, Draft Version 3

The purpose of the CSM is to bring together data that describes groundwater contaminant transport on the site. This document should set a common understanding of site conditions and identify the uncertainties that exists, regardless of whether these uncertainties are acceptable. The District is very concerned that this document fundamentally is written in a defensive tone that downplays contamination, presenting hypotheses without sufficient data or rationale. The District believes the usefulness of this document is limited because of this. The CSM should be based upon site-specific data, rooted in the body of scientific study conducted in the area and highlight, rather than downplay, areas with insufficient data to draw conclusions.

Highlight Concerns:

A thorough discussion of the spatial and temporal aspects of contamination and transport is missing within the document. Did pumping and mounding alter potentiometric surfaces locally in such a way to affect transport of COPCs? How are these changes reflected (or not) in sample findings? Patterns involving the presence or absence of a COPC should go beyond the geo-chemical explanations and include a discussion of the physical processes involved, sources, and flow paths, again identifying the uncertainties.

Data collected as part of the remedial investigation is not synthesized in a way that adds to the hydrogeologic understanding of the area. The site was selected specifically for its proximity to the Clark Fork River. Grimestad (1977) identified highly variable hydraulic conductivity onsite due to alteration of native alluvium to create infiltrative disposal of kraft process pulp and paper mill liquid effluents. Despite clear identification of these processes within the Grimstad study and subsequent groundwater discharge studies and permits, the impact of highly variable hydraulic conductivity on COPC transport is not addressed within this CSM.

The CSM does not provide a clear understanding of where redox conditions occurred. Redox conditions are responsible for creating several COPCs that would not be present without the operational changes to pH from the site. A planform map through time of these conditions and an estimate of COPCs contributed to the aquifer through this process is needed to assess if there are ongoing impacts or if many of these COPCs are adsorbed to sediment. Volumetric assessments of COPCs from this process and probable locations is needed to begin to understand what remediation options are suitable and what would be expected in ongoing sampling.

Geologic characterization of the site is inadequate. Geologic units in individual well logs are generalized into regional aquifer units instead of looking at available data and creating meaningful geologic cross sections. Identification of preferential flowpaths, perched aquifer units, and a physically based understanding of COPC transport on the Site depends upon a thorough stratigraphic analysis. A comparison of NFMW1s and NFMW1d shows that the perched aquifer (NFMW1s) generally has higher concentrations of COPCs. There is considerable variability within well logs onsite within what has been characterized as Unit 1 but no discussion within the CSM is found.

1.0 Introduction

It is unclear why 2011 data has not been considered in this conceptual site model. We understand there was objection by PRPs to its inclusion, but a comprehensive review of its usability has not been produced. Its purpose as a “preliminary assessment” was to determine whether contamination exists to move forward with Superfund Listing. We are concerned that all points were not replicated in sampling and are further concerned that the general assessment methodology, particularly in the area of the landfills and sludge ponds is missing contaminants and is driving an unnecessarily sparce list of contaminants of potential concern and will produce an inaccurate risk assessment.

1.2 Objectives of the Conceptual Site Model Report

This document does not meet stated objectives. Stated objectives go beyond just groundwater to include interactions with the Clark Fork River, yet there is limited investigation into Clark Fork River dynamics and the impact these dynamics have on groundwater. Contaminant sampling is also focused upon groundwater, leaving interactions with surface ponds and meaningful sampling or analysis of impacts on the Clark Fork in need of further conceptual development.

2.0 Site Physical Setting

What is “seasonal meteoric water” and how does this differ from groundwater or surface water? Physical alteration of the site and its impact on the water cycle should be addressed in a groundwater conceptual site model.

2.3 Geology

Identification of quaternary-age deposition in ancestral Clark Fork and Bitterroot Rivers would aid in identification of preferential flow paths, given large lateral variation in stream channel migration and floodplain deposition. Closer inspection of well logs and more geologic cross-sections performed by a geologist would aid in this interpretation. Smith 1992 identified a number of laterally discontinuous confining units in the region. It does not appear that this potential pathway has been examined on this Site.

2.4 Hydrogeology

Assessment of impacts to Unit 3 should be very limited given number of samples and understanding of hydraulic connectivity provided by pumping tests. Any statements regarding Unit 3 should also convey context of applicability.

An understanding and discussion of variability within the semi-confining unit is needed to understand whether the three deep monitoring wells are representative and capture contaminated areas of Unit 3. Appendix B creates a model by identifying the predetermined regional groundwater units, however, there is considerable variability within the resolution of lithology captured in well logs and in the presence of water bearing units that may play an important role in connectivity and preferential flow. Cross sections that contain available detail beyond regional units within waste basins and sludge ponds is more appropriate (Ex. B-B' and Hoffman well where sand and water is present from 44 to 73 feet, more examples of variability and generalization provide in Appendix B comments).

3.0 Summary of Historical Mill Operations

3.1 Pulp and Paper Manufacturing Process

Highlighting that only 6% of the total output was bleached distracts from a meaningful understanding or discussion of presence and locations of COPCs. The purpose of the CSM is not to explain away sources.

This CSM describes permitting status of the landfills and sludge ponds as proof of no contamination present. The permitting described were closure permits because much of the landfills were not capable of being licensed due to the presence of groundwater and proximity to floodplain. There is no liner, leachate collection, etc. The purpose of the CSM is not to explain away risk. It is to take an objective look at contamination present and how it may be transported through water media. Permits have no place in the discussion (wastewater, landfill, air quality, or otherwise). Furthermore, securing the permits required in one particular regulatory environment does not absolve PRPs from current environmental regulations and standards.

3.3.1 Wastewater Treatment System Berms

Berms are described in a protective manner within the CSM. If non-native materials (landfill materials, sludge) were to be removed from the waste management areas, floodplain elevations would likely include more of the waste management areas than currently identified. Impacts from a confined floodplain may be seen in greater avulsion risk. The 100-year floodplain description of the waste management area is irrelevant since the waste and sludge piles artificially raise elevations above that of the 100-year floodplain. Impacts from a confined floodplain may be seen in greater avulsion risk. Further, the granular and pervious nature of the material makes it susceptible to winnowing and headcutting. Multiple berm structures also make it difficult to assess avulsion risk and what areas of the site would be at risk if different portions of the berm were breached. Assessments to date have not taken into account the considerable amount of ongoing maintenance and additional fill that has been added to shore up berms. Though the alluvial material piled up around the waste may offer some protection, quantification of this protection is impossible. This draft of the CSM appears to be attempting to make a case within a document of record for keeping these structures. It is not an appropriate use of the study.

3.3.2 Spoils Basins and Solid Waste Basins

This portion of the document misconstrues waste as well-characterized and waste disposal areas as constructed according to dump standards

4.0 Summary of Data used to Assemble the Groundwater Conceptual Site Model

A QAPP is to qualify data collected specifically within this process. Other data can be caveated or accepted with an understanding that there is a greater error bar. Data collected prior to the current QAPP should not necessarily be disqualified but rather caveated to identify uncertainty. Simply dismissing data decreases the overall site understanding and the reputability of a comprehensive CSM.

2011 data was collected to determine extent of potential contamination and identified sufficient pollution for a remedial investigation yet many locations where exceedances were identified have not been sampled again Ex (SSGW03) .

Much of this Groundwater Conceptual Site Model is based upon other studies and generalizations of the hydrology within the Missoula Valley. For example, well logs were grouped into five generalized stratigraphic units without identifying ways in which the site is different due to its location in the floodplain and more frequent reworking of stratigraphy. Lack of discussion regarding the incorporation of these documents/studies (Woessner 1988) as well as if the data collected as part of ongoing Site study concurs with studies is lacking. A review of the body of current scientific literature and data (Water Quality District, Department of Environmental Quality, Smith 2013, etc.) is needed – the most current document aside from those as a part of this study is from 2008.

Section 4.1.1

50 surface samples over five years is ten samples a year. Ten samples a year on average is too small of a sample size to assess a four mile river boundary over the course of a dynamic hydrograph and the variability of surface-groundwater interaction, upstream and downstream of the Site boundary on the CFR, tributary streams, and ponds. Importantly, if samples are not collected in areas where groundwater from the site is discharging to the river then samples are not representative of Site impacts but of upstream contributions. Larger scale river mixing and regional upwelling may mask site contributions (Forsland 2020). The intent of sampling locations should be identified within the context of sampling. Upstream contamination from other superfund sites does not diminish contamination from the Smurfit-Stone Container Site. The number of samples is insufficient for trend analysis. How does this effort compare to Sando and Vecchia 2016? Why were sites selected? How was groundwater inflow determined?

4.2 Groundwater

It would be helpful to also have a synthesis of available data from the 29 wells present during Mill operations. Without an understanding of how groundwater potentiometric surface, flow paths, and contaminant locations during operation of the site, it is difficult to assess where contaminants were distributed and what current presence/absence indicates. Within a large site, any changes in flow paths will need to be identified in order to understand what area wells represent and over what time scale. A Groundwater Conceptual Site Model should identify how the site altered hydrology during operation and continues to. Use of data from 2014 onward is not sufficiently descriptive enough to gain a conceptual understanding of the hydrology and potential contamination of the site.

Section 4.2.1 Groundwater Elevations

A figure showing monitored elevations, hydrogeologic units associated and x/y locations used for potentiometric surface development would be helpful (2 figures showing high and low groundwater).

5.0 Groundwater Flow and Quality

Section 5.1 - Groundwater Levels and Flow

Only using data collected after 2014 obfuscates the role that water mounding and extensive groundwater pumping had on local site dynamics and the transport and contribution of COPCs during the course of Mill operation. Without an understanding and discussion of these dynamics it is impossible to accurately identify if current sampling network can capture changes in COPCs. Did high water always occur in June or did it occur earlier in the spring as a function of mounding? Was there a greater fluctuation as a result in mounding? How did this impact hydraulic head and potentiometric gradient?

There is an obvious increasing trend in groundwater elevation at the nearby Water Quality District well (Fig. 1). Pumping seems to have impacted the well prior to 2010 so an increase in peak and minimum water elevations would be expected. After 2010, low water elevations appear to be consistent but peak water levels appear to increase. Are peak water elevations increasing across the site? Are they increasing in areas near waste basins and sludge ponds? This well is characterized as being in Unit 1 but the most recent swing in groundwater from peak flow in 2019 at 16.62 ft depth to water and low water in 2020 at 25.46 ft depth to water is difference of 8.83 ft. Is the characterization of Unit 1 fluctuation of two to seven feet only for wells onsite or should it be expanded to two to 8.8 feet?

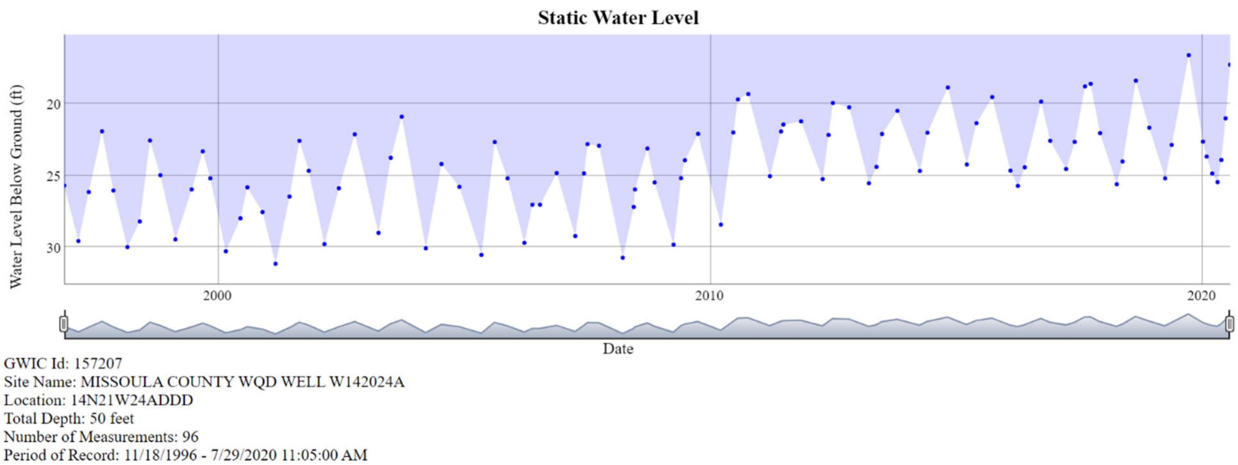


Fig. 1 GWIC hydrograph of County Well

Groundwater/Surfacewater Interactions

Citing one study from 1988 inaccurately portrays the current understanding of surface – groundwater interaction with the CFR in the Missoula Valley. See Forsland 2020 for review of current surface – groundwater studies on the Clark Fork River. In 2019, the University of Montana used collected water samples along the thalweg of the Clark For River to analyze radon decay and identify areas of groundwater discharge. Figure 11 from Forsland 2020 is revealing in demonstrating the variable nature of groundwater contributions to the Clark Fork River upstream, adjacent, and downstream of the Site. Review of this work, and other recent studies, should aid in determining whether surface water samples collected and discussed within the CSM are representative of the Site and improve selection of future surface water sampling locations.

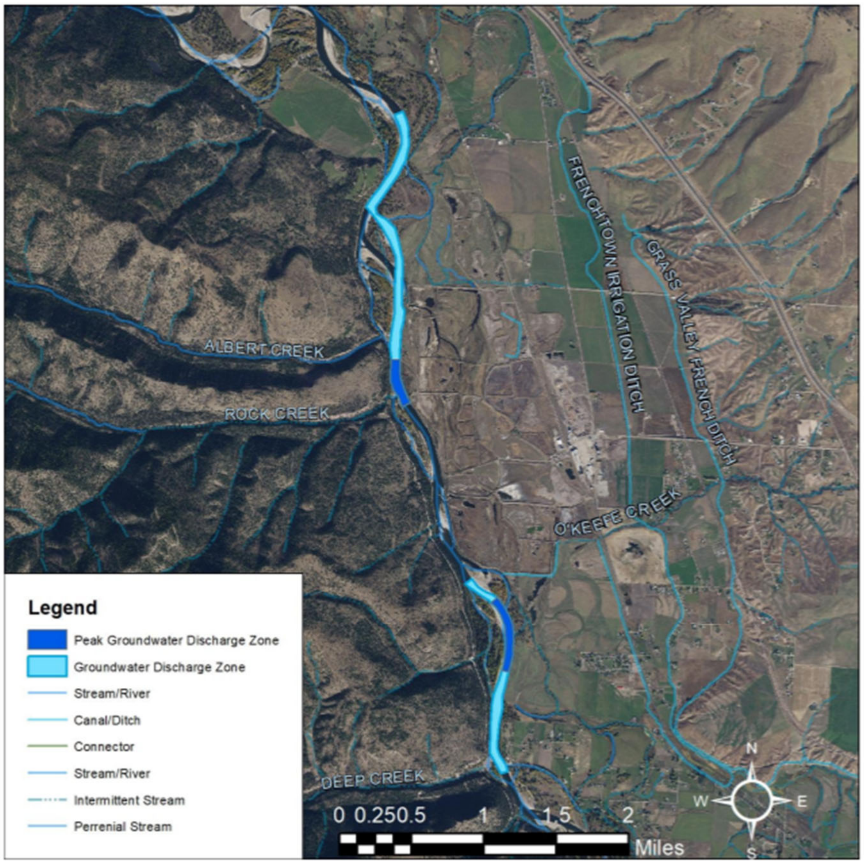
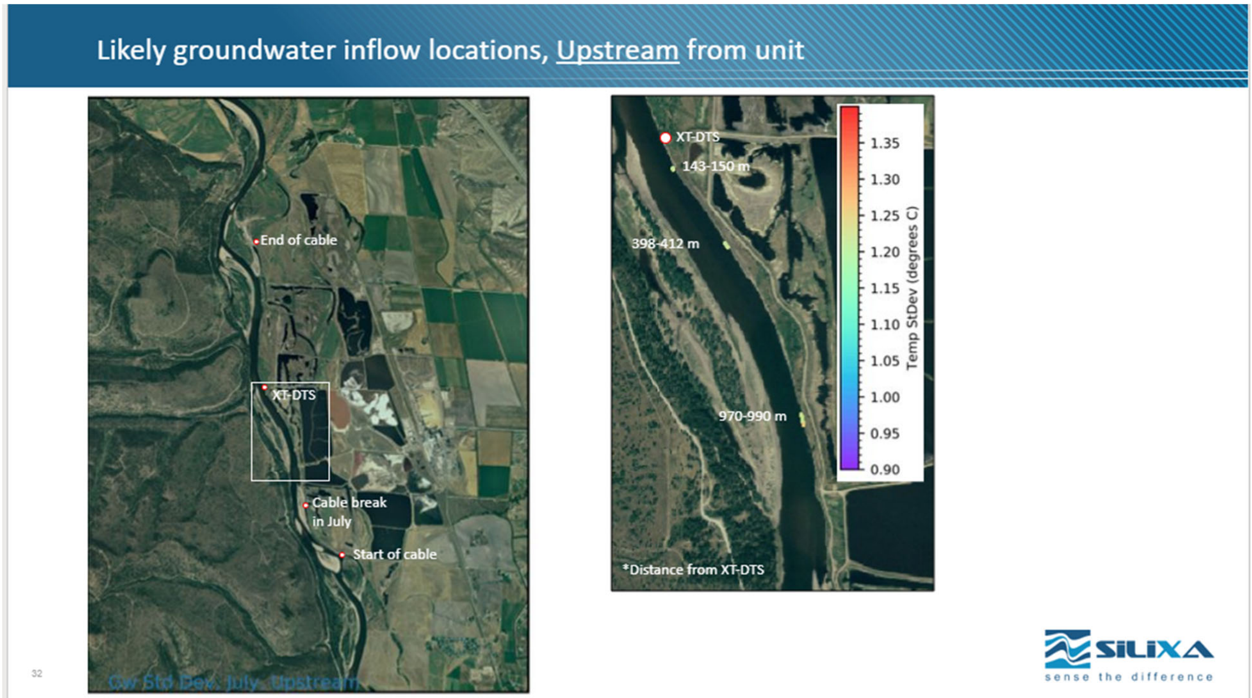


Figure 11. Aerial photograph showing distribution of groundwater discharge zones

Fig. 2 Forsland 2020 figure showing distribution of groundwater discharge zones on the Clark Fork River proximal to the Site.

In a complementary study to Forsland 2020, the Missoula Valley Water Quality District worked with Silixa, a distributed temperature sensing company, to instrument a majority of the boundary of the site with fiber optic cable in order to conduct distributed temperature sensing and evaluate areas of likely groundwater contribution from the site to the CFR. This technology relies upon the refraction of the laser signal to identify changes in temperature. Groundwater has a consistent temperature and so when compared to the diurnal variation in surface water can be used to identify localized groundwater inflow. Figure 3 shows maps presented at the publicly noticed January Water Quality Advisory Council meeting, demonstrating where groundwater inflow was found at approximately one foot below water in late summer 2019 adjacent to the fiber-optic cable. These areas are ideal locations to collect surface water samples to identify water quality impacts from the Site on surface water.



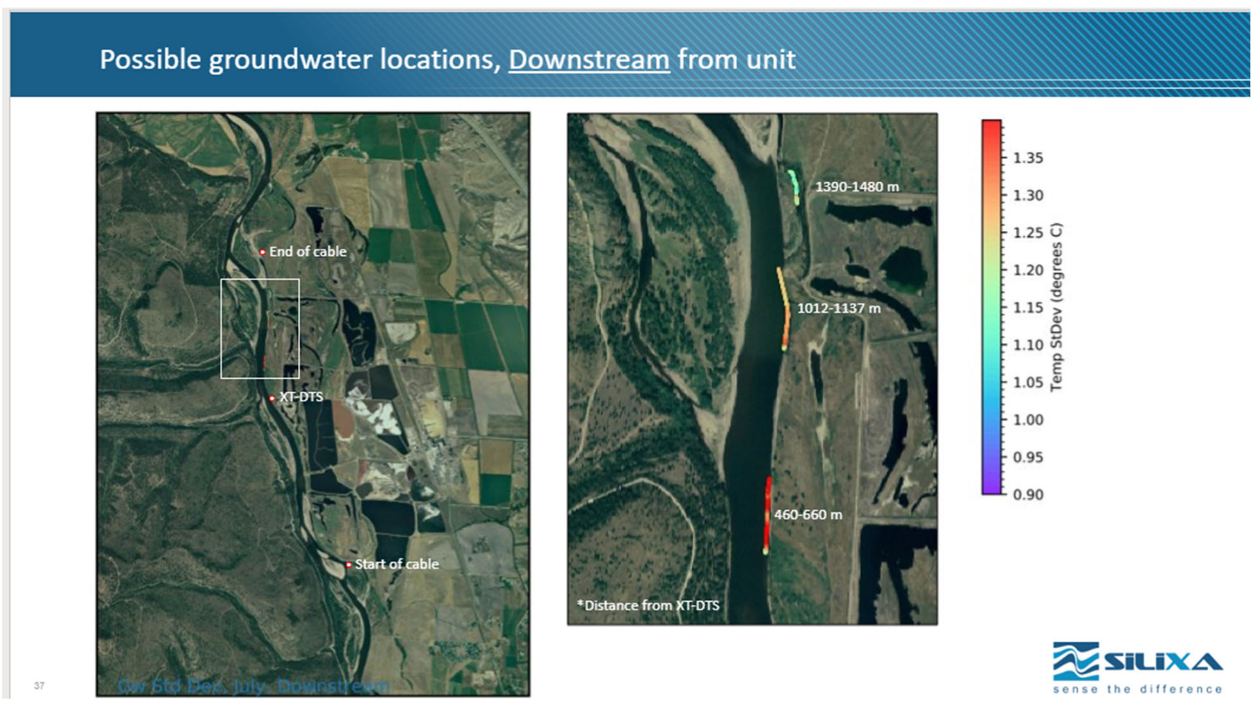


Fig. 3 Maps from Silixa presentation to WQAC January 2020 showing areas where groundwater signals were identified using distributed temperature sensing.

Another study conducted by the Missoula Valley Water Quality District was the 2006 Smurfit-Stone Channel Migration Zone Investigation Memorandum from Applied Geomorphology.

Major findings of this assessment are as follows:

• About 257 acres of the core CMZ area (Historic Migration Zone and Erosion Hazard Area) are now occupied by former Smurfit-Stone facilities, mainly treated wastewater storage ponds used to store and infiltrate wastewater until the mill closed in 2010.

• Another 13 acres of land between the ponds and the river have been armored and thereby isolated from the CMZ.

• When compared with upstream and downstream reaches, the Smurfit-Stone Mill site shows a marked loss of timbered area, sloughs, seasonal overflow channels, and floodplain area. Approximately 180 acres of open and closed timber area mapped in 1955 was displaced by mill site development, along with about 70 acres of high flow seasonal channel and almost 6 acres of historic abandoned channel sloughs.

• The active river corridor has been narrowed by over 40% through much of the site.

• General Land Office (GLO) maps from 1870 indicate that the main river channel was not demonstrably altered by the mill site development

• The site development has impacted habitat extent and quality as well as geomorphic process, although the influence of these activities on river behavior upstream and downstream of the sited is difficult to decipher with available data.

Additional data upstream and downstream of the site is being collected as part of an update to FEMA floodplain maps and the Missoula Valley Water Quality District will be working with Applied Geomorphology to update Channel Migration Zone mapping for the Clark Fork and Bitterroot Rivers.

5.1.1 Inter-Aquifer Communication and Vertical Gradients

How do hydraulic head changes compare to Smith 2013 and larger regional hydraulic head changes?

5.1.2 WWTS Operation Impacts to Groundwater Elevations

Regardless of whether aquifer water levels returned to pre-pumping levels, the change in pumping likely altered the flow paths of COPCs from sources. Sources and flow paths are not identified sufficiently within this document to show what impact this change may have had at the site.

What is the likely contribution to downward vertical hydraulic gradient the mounding played and how does this compare to what we see today?

Section 5.1.3

Limited exploration of waste basins mean there are a number of assumptions regarding the relative elevation of water and the bottom of the basins. As structures that were not surveyed or explicitly engineered, the bottom of these basins likely varies and this variation could play an important role in understanding how much waste within them becomes saturated Presumed bottom of basin elevations need to be identified on Figure 15 and should likely vary by at least a few feet. Similarly, the potentiometric surface may be different within waste basins as wells are predominately along the perimeter. Understanding the basin and water elevations and variation throughout basins is needed in order to determine the full extent of saturation. As mentioned above, an exploration of trends in groundwater elevation is also needed to determine if it is likely this degree of saturation can be expected to increase moving forward.

Section 5.1.4 Impacts to Groundwater Elevations Associated with Frenchtown Irrigation Ditch

Just as these impacts can be seen in groundwater so would previous operation of the ponds and site hydrology, further incorporation of previous operation is needed into this CSM.

5.2.2 Comparisons to Background

HHRA and BERA do not have to be completed to determine nature and extent of contamination.

5.2.3 Onsite Sources that May Impact Groundwater Quality

PCBs and VOC's from storage tanks and historic releases on OU2 should be included as potential sources.

5.2.4 General Water Chemistry

A table with a comparison of current water chemistry to that described in Tooke 2006 and other onsite studies would also be helpful in identifying how onsite water chemistry has changed through time. Averages are used throughout this section and a table with ranges, medians, maximums, minimums, number of samples would aid in the understanding of the range of results and whether an average is appropriate.

5.2.4.1 Sodium and Sulfate

What is the range in sodium and sulfate during Tooke 2006 compared to current values? How do these values, along with pH relate to anticipated loading of arsenic and manganese in these areas?

What is the degree of shift in concentration of sodium, sulfate and/or TDS at SMW4, NFMW7, SMW7, SMW10, NFMW16 and how does this compare to the range or change in SMW6, SMW5, SMW2, SMW1, and County MW? Why was SMW4 not considered a background well? What are the physical processes that have led to these wells showing improvement? NFMW16 is close to NFMW15, MW7, NFMW6 – how do these compare? Why are SMW7, SMW20 TWFR, NFMW23 not showing similar trends?

5.2.4.2 Common Ions

What dataset was used to create stiff diagrams? Is there much variation through time? Is there seasonal variation? Should there be caveats given the spatial resolution of sampling in Unit 3? This data is not included in the appendices.

5.2.4.3 Total Dissolved Solids

TDS was used early on in site operation to assess meeting permit requirements. How do these compare to historic concentrations while Site was in operation?

5.2.4.5 Redox Potential and Dissolved Oxygen

What is the goal of establishing something as a relationship if there is no functional correlation?

5.2.4.7 Temperature and pH

NFMW1s is identified as a perched aquifer. Further discussion of how a perched aquifer interacts with the other units and further exploration of available well data in the area is needed. If this well has the highest pH and that is a driver in COPCs, it is also important within this model to discuss how the perched aquifer could be a preferential flow path to the CFR at different times during the hydrograph.

5.3.1 Arsenic, Cobalt, and Manganese Concentrations

Throughout this section, the most appropriate, local data should be used as background. The District regularly samples its suite of monitoring wells for water quality. Preliminary data for constituents of interest are provided as more appropriate background concentrations as all of these are from the Missoula Aquifer.

Arsenic

WQD (n=1293) Avg =1.148µg/L median =1 µg/L

Arsenic concentrations below five are not background. Within the Missoula Aquifer, background arsenic concentrations should be closer to 1 µg/L.

Cobalt

The District does not regularly sample for cobalt.

Any consideration of elevated cobalt tied to isolated alluvial aquifer deposits would need considerable study. Incorporation of nuanced geologic information available in well logs currently obscured in available cross sections would be needed. Discussion of low pH and anaerobic conditions reveal need for further discussion of onsite groundwater flow prior to data collected in 2014 and any data regarding Cobalt found in earlier studies. What mechanism is driving the lowest pH levels to occur at SMW15? This is a component and understanding that should be included in a CSM.

Citation of values of cobalt in CFR bed sediments from USGS 2003 is less revealing than Table 17 which has groundwater values and seems more appropriate for comparison. Or is there more data regarding cobalt soil samples that is missing from this discussion? Initially comparing groundwater data from USGS 2003 to site groundwater data may be helpful in identifying impacts and areas where further study of cobalt concentrations in sediment may be needed.

Manganese

WQD (n=407) Avg =0.1658 mg/L median = .00105 mg/L

More discussion of the range in values is needed. Where isn't manganese present above background (MVWQD background) levels in Unit 1? What is driving manganese presence at the water supply wells in addition to the water supply wells? Also, the use of groundwater units and operable units in this section is confusing.

5.3.2 Dioxins and Furans

The fact that NFMW1s has consistently had high concentrations of TEQ, while NFMW1d does not show similar concentrations despite being classed as Unit 1, demonstrates that the current conceptual model using only three groundwater units is overly simplified. Without this analysis, the ability to fully characterize, and therefore remediate, contamination onsite is missing from the CSM.

5.3.3 PCBs, VOCs, and SVOCs

Groundwater is complex on this site and there does not appear to be enough spatial and temporal resolution on PCBs, VOCs, and SVOCs to determine if low levels will persist. Table 14 demonstrates that there are areas where COPCs are increasing. Without a physical understanding of flowpaths and how these have changed over time and at different points in the hydrograph, statements regarding the absence of these COPCs cannot be made. It is also unclear what background levels are being used and if these samples are being compared to the background levels at the time they were sampled or a composite. Further exploration is needed.

6.0 Temporal and Seasonal Trends in Water Quality

There is a good description of what statistical analysis may have occurred, but it is unclear if any corrections were made (here and in Appendix F). 2011 data should be included as well. It should be made clear that statistical analysis is only for Stiff Diagrams. Other trend analysis consists of time-plots and many still show considerable variability that should be discussed in the context of physical processes.

7.0 Fate and Transport of COPCs

Variability in Manganese as a surrogate – SMW4 (and possibly others) show variations that demonstrate the potential for preferential and changing flow paths.

The Groundwater Conceptual Site Model does not need to necessarily focus on risk as defined in the HHRA and doing so may result in oversimplification of groundwater and surface water cycling and interaction on the site.

7.1.1 COPC Loading from WWTS Solids to Unit 1 Groundwater

The many factors and the interplay between these factors should be conveyed in a planform map (in addition to 29a and 29b) to identify the spatial extent. Current descriptions of these factors is not sufficient to understand COPC loading which makes discussion of attenuation mute.

Dioxins are present onsite despite high organic carbon. Comparison of NFMW1s and NFMW1d demonstrate that where dilution is limited, dioxins are present in groundwater. Further, it highlights the role that preferential flow paths may play in conveying COPCs to the CFR.

7.1.2 Aquifer Matrix Metals Loading to Unit 1 Groundwater

Discussion of MVWQD data for arsenic and manganese is above.

Iron (n=681) average = 0.0368 mg/L median=0.009 mg/L

There are many glacial aquifers within the United States. The Missoula Valley Water Quality District has conducted water quality sampling since the early 1990s and Missoula Water and public water supplies are required to do water quality testing. All of these would be more localized data that take into account the lithology and hydrology of the Missoula Aquifer.

Further, the high caliber of water quality within the Missoula Aquifer is documented in its designation as a sole-source aquifer by the EPA. The lithology of the aquifer is unique with the combination of Glacial Lake Missoula deposition and Belt Group stratigraphy. Additionally, many of the other glacial aquifers in the United States have higher urban populations or intensive cropland that can alter trace elements found in groundwater.

The appropriate background concentrations should be used for comparison, particularly with ample available data in a well-studied basin.

7.1.3 Unit 1 Aquifer Matrix to Unit 3 Groundwater

It is unclear what background values for COPCs are being used – are upgradient values or state/nationwide references being used?

7.1.4 Unit 1 Groundwater to Former WWTS Ponds

This discussion is confusing because of the obvious interaction between Clark Fork River stage, groundwater elevation, and elevation of ponds. The site was selected due to this interaction and ponds were constructed to take advantage of groundwater filtration of mill water. Rising elevations of groundwater will fill depressions in the ground and some of the groundwater elevation increase will be due to increases in stage on the Clark Fork River.

Not only is redox potential higher in surface water samples, the likelihood of dilution of contaminants in surface water is higher. This is an important distinction because it does not mean the contributions from the site are lower, only that it is harder to identify within the Clark Fork River due to the size of the river or harder to identify in ponds as they are also influenced by upstream Clark Fork River water.

Appendix A

1955 Photo -Old swales and oxbows are evident within this photograph and should be incorporated as preferential flow paths. Lavalle and O'Keefe Creek also likely took different paths. Further clarification of why the 100-year flood plain is included on the map is needed. Mapping of the 100 year floodplain took into account the berms and increase in elevation that resulted from landfill and sludge pond contributions. The 100 – year floodplain would have been much different in extent at the time of this 1955 photo. Identification of month would be helpful.

1980 Photo – It would be helpful to understand the timeline under which berms were developed and how much maintenance has occurred to identify the amount of ongoing maintenance that would be required to continue to maintain current elevations.

Appendix B

Relying upon a computer program to create cross sections and identifying pre-determined hydrologic units obscures available information and does not add to the current understanding of the site. These same cross sections should be done by a geologist with all available data. This is overly simplified to the detriment of understanding available site data. All well logs within the CSM are not included here and should be. All well logs should also be provided to the GWIC well log system.

Water Quality District Well Log

Section 9: Well Log

Geologic Source

111ALVM - ALLUVIUM (HOLOCENE)

From	To	Description
0	2	BLACK LOAM
2	30	SANDY GRAVEL STRINGERS OF CLAY
30	35	SAND SOME SMALL GRAVEL WATER
35	50	GRAVELLY SAND. SOME TAN CLAY

CountyMW	0	35	1
CountyMW	35	50	2

Section 9: Well Log

Geologic Source

112ALVM - ALLUVIUM (PLEISTOCENE)

From	To	Description
0	0.5	BLACK DIRT
0.5	17	FINE SAND AND LARGE GRAVEL MIXED
17	28	FINE SILTY GRAY SAND
28	31	GRAY SAND AND COARSE
31	49	FINE TO GRAY BROWN SILTY SAND FEW SCATTERED GRAVEL
49	57	BROWN SITY SAND FINE FEW SCATTERED GRAVELS
57	78	VERY SILTY BROWN SAND WITH CLAY LENSES
78	84	CLEANER SLIGHTLY COARSER BROWN SAND W/SOME GRAVEL
84	90	BROWN CLAY
90	94	GRAVEL IMBEDDED IN BLUE GRAY CLAY
94	108	FINE BROWN SILTY SAND
108	115	COARSER CLEANER BROWN SAND FEW SCATTERED GRAVELS SOME FINE MICA MIXED IN
115	131	COARSE GRAVEL MIXED WITH VERY FINE BROWN TO GRAY SAND SOME FINE MICA MIXED IN
131	134.5	BOULDERS AND COBBLESTONES SOME VERY FINE BROWN SAND
134.5	144	FINE TAN TO BROWN SAND MIXED COARSE GRAVEL

3/14/2013 Deep Well #11

Site Name: WALDORF HOERNER PAPER PRODUCTS COMPANY GWIC Id: 71266 Additional Lithology Records		
From	To	Description
144	148	VERY FINE BLUE GRAY SAND MIXED WITH GRAVEL AND COBBLESTONES
148	162	FRACTURED GREEN ARGILLITE

Deep Well #11	0	31	1
Deep Well #11	31	115	2
Deep Well #11	115	148	3
Deep Well #11	148	162	5

Hoffman Well

Section 9: Well Log

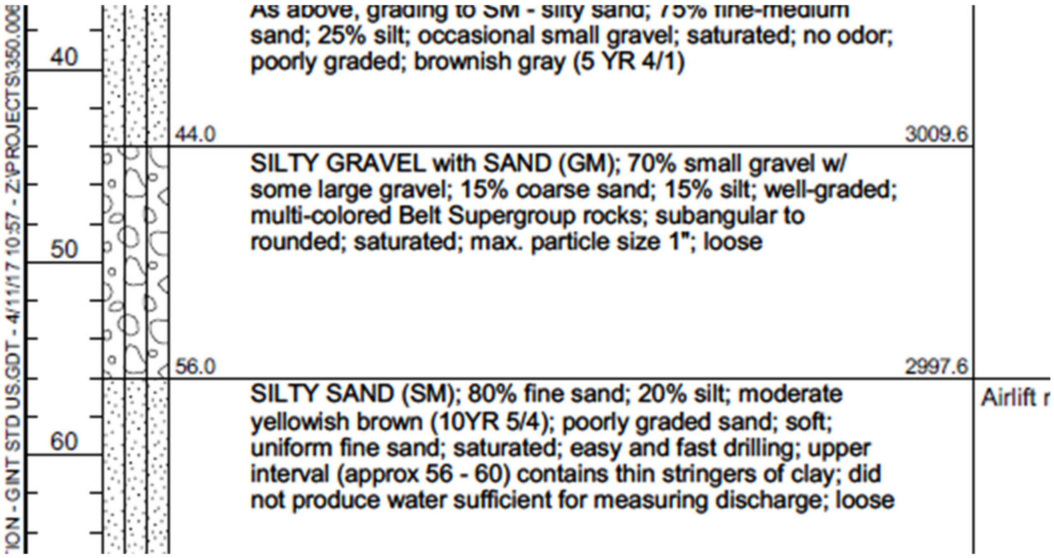
Geologic Source

112ALVM - ALLUVIUM (PLEISTOCENE)

From	To	Description
0	2	SAND AND GRAVEL
2	12	CLAY SAND AND GRAVEL
12	22	CLAY SAND GRAVEL AND WATER
22	36	SAND AND WATER
36	44	TAN CLAY
44	73	SAND AND WATER
73	96	TAN CLAY
96	139	SAND AND WATER
139	147	CLAY SMALL GRAVEL SAND AND WATER
147	158	SAND GRAVEL AND WATER

Hoffman Construction Well	0	36	1
Hoffman Construction Well	36	139	2
Hoffman Construction Well	139	158	3

17-D



References

Boyd, K. and Thatcher T. 2016 Smurfit-Stone Channel Migration Zone Investigation Memorandum.

Forsland, D. Detecting Groundwater Discharge in the Clark Fork River near Stone Container Using Spectral Alpha Decay Detection for Dissolved Radon in Surface Water Samples. https://scholarworks.umt.edu/utpp/306

Grimestad, Garry Ronald, "A GEO-HYDROLOGIC EVALUATION OF AN INFILTRATIVE DISPOSAL SYSTEM FOR KRAFTPROCESS PULP AND PAPER MILL LIQUID EFFLUENTS" (1977).Graduate Student Theses, Dissertations, & Professional Papers.10001.https://scholarworks.umt.edu/etd/10001

Sando, S.K., and Vecchia, A.V., 2016, Water-quality trends and constituent-transport analysis for selected sampling sites in the Milltown Reservoir/Clark Fork River Superfund Site in the upper Clark Fork Basin, Montana, water years 1996–2015: U.S. Geological Survey Scientific Investigations Report 2016–5100, 82 p., http://dx.doi.org/10.3133/ sir20165100.

Smith, L.N., LaFave, J.I., and Patton, T.W., 2013, Groundwater resources of the Lolo-Bitterroot area: Mineral, Missoula, and Ravalli counties, Montana Part A* - Descriptive Overview and Water-Quality Data: Montana Bureau of Mines and Geology Montana Ground-Water Assessment Atlas 4-A, 96 p.