STONE ENVIRONMENTAL
535 Stone Cutters Way / Montpelier / VT / 05602 / USA
802.229.4541 / info@stone-env.com / www.stone-env.com

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Sue Fillion
Planning Director
Town of Brattleboro
230 Main Street, Suite 202
Brattleboro, VT 05301

Stone Project No. 19-015
Subject: File Review Summary – Long Falls Paperboard No. 6 Fuel Oil Release (SMS #1990-0482)

Dear Sue,

Stone Environmental, Inc. (Stone) has prepared this file review summary of Vermont Department of Environmental Conservation (VT DEC) Sites Management Section (SMS) files associated with a No. 6 fuel oil release at the Long Falls Paperboard (LFP) facility located at 161 Wellington Road, Brattleboro, Vermont (the Site). VT DEC provided Stone with access to Site electronic files associated with discovery and assessment of the No. 6 fuel oil release formerly managed under Site file SMS #1990-0482. VT DEC was not able to locate archived paper files associated with SMS #1990-0482 which they believe were lost during the 2011 flooding of the Waterbury State Office Complex as a result of Tropical Storm Irene. Available SMS files reviewed include:

- Griffin International, Inc. (Griffin) Report on the Investigation of Subsurface Petroleum Contamination, Specialty Paperboard, Brattleboro, Vermont dated July 1990 (previously reviewed as part of Stone's Phase II Environmental Site Assessment, October 14, 2019 (2019 Phase II ESA)),
- Letter to Griffin from Barr Engineering Company Re: Qualifications and Experience in Petroleum Remediation Services for Specialty Paperboard, Inc., Brattleboro, Vermont dated October 24, 1990,
- Barr Engineering Company Feasibility Study, Remediation of No. 6 Fuel Oil Release, Specialty Paperboard, Inc. Brattleboro Mill, Brattleboro, Vermont dated January 1991,
- ESE Biosciences Group Biofeasibility Evaluation and Biotreatment Design, included as an attachment to the Barr Engineering Company Feasibility Study.
- Letter from Environmental Assessment and Remediation, Inc. to Mr. Charles Schwer of the VT DEC dated February 20, 1991,
- Griffin letter to Mr. Richard Spiese of the VT DEC RE: No. 6 Fuel Oil Contamination, Specialty Paperboard, Brattleboro, VT (VT DEC Site #90-0482) dated October 18, 1994 (previously reviewed as part of the 2019 Phase II ESA),
- Maps (two files),
- Correspondence related to SMS #1990-0482 (sixty-four files), and
- Site scoring criteria (seven files).

A summary of environmental assessment of the fuel release conducted by Stone during the 2019 Phase II Environmental Site Assessment (ESA) was also reviewed.

The objective of the file review was to identify data gaps to help determine whether additional assessment is required to support remedial planning associated with No. 6 fuel oil contamination at the Site.

1. Site Background

1.1 Site Description

The Site is situated on a 39.52-acre parcel and includes an approximately 200,000-square foot paper manufacturing plant, an associated wastewater treatment plant and lagoons, and a sand filter house. The manufacturing facility is a concrete and metal structure with a partial basement and partial second floor. The facility was constructed in 1960, with several additions being constructed between the late 1960s and late 1990s was formerly used to heat the paper manufacturing plant. The paper manufacturing plant was formerly heated using No. 6 fuel oil. Two 25,000-gallon underground storage tanks (USTs) containing No.6 fuel oil were removed from immediately south of the building in 1990 and two new No. 6 fuel oil were installed south of the former UST locations – these USTs are still present in the subsurface and are in operation for backup fuel storage. The paper manufacturing plant's current natural gas heating system is serviced by an above ground gas island and associated underground piping located immediately southeast of the plant and existing USTs.

The Site is generally flat and is situated on an alluvial terrace of the Connecticut River and is zoned for industrial use. Process water for the plant is pumped primarily from the Connecticut River; the plant is also served by two on-site backup process water supply wells ("Shallow Well" and "Deep Well") installed in the overburden (i.e., not drilled into bedrock) in the southwestern corner of the site. The facility is also serviced by the municipal public water system. The bathrooms and laboratory are served by an on-site septic system located to the northwest of the wastewater treatment plant lagoons.

The Site is bound to the east and south by the Connecticut River, to the northeast by an undeveloped woodland, to the southwest by an electrical substation and Wellington Road, and to the north and northwest by several commercial properties, including: the BDCC Business Park, Suburban Propane, C&S Wholesale Grocers, and now closed Windham Solid Waste Management District (SWMD) Landfill.

1.2 Site History

According to a Phase I Environmental Site Assessment (ESA) completed by Ramboll US Environ Corporation (2015 Ramboll), the Site has been in continuous use as a paper mill since it was

originally developed in 1960 by Case Brothers which operated at the Site until 1967 at which time it was acquired by Boise Cascade. The facility was operated by Boise Cascade until 1989 when the name was changed to Specialty Paper Board, Inc, which ultimately was renamed as FiberMark, Inc. in 1998. FiberMark Inc. filed for bankruptcy in 2004 and reemerged under new ownership of Silver Point Capital in 2006 before subsequently being acquired by America Securities in 2008. The FiberMark Inc. business was sold to Neenah in 2015 and operated as Neenah until purchase by BDCC in December 2018. Upon purchase by BDCC, Long Falls Paperboard took over facility operations.

In February 1990, two, 25,000-gallon USTs containing No. 6 fuel oil were excavated and removed from the property. A hole was observed in one of the USTs and it was determined that No. 6 fuel oil had been leaking from the hole. Griffin International, Inc. (Griffin) performed an initial site investigation in 1990 and follow-up monitoring through 1994, recommending that the Site be considered for a Site Management Activities Complete (SMAC) designation, which was granted by VT DEC in 1994.

2. File Review Summary

2.1 Griffin Report on the Investigation of Subsurface Petroleum Contamination, Specialty Paperboard, Brattleboro, Vermont, July 1990

In response to the discovery of a leaking UST in 1990, Soils Engineering, Inc. completed three soil borings, MW-1, SB-1, and MW-2, to evaluate the extent of soil contamination. No. 6 fuel oil was observed in soil boring MW-1 from 8 feet below ground surface (bgs) to 47 feet bgs. No petroleum was encountered in SB-1 at a maximum exploratory depth of 50 feet bgs or within MW-2. MW-1 and MW-2 were constructed as monitoring wells and SB-1 was backfilled.

Griffin completed four additional soil borings and monitoring wells in May 1990, including MW-3, MW-4, SB-2, and SB-3. Thick black petroleum contamination was observed in soil boring MW-3 from 21.5 to 67 feet bgs and in SB-2 from 15 to 72 feet bgs and was observed to be in contact with groundwater. No petroleum contamination was observed within SB-3 or MW-4. Groundwater monitoring wells were installed in borings MW-3 and MW-4 and were constructed of 20 (MW-3) and 25 (MW-4) feet of 2-inch diameter 0.010-inch PVC well screen with enough riser pipe to extend to the ground surface.

Hydraulic measurements made in MW-1 through MW-4 in May and June 1990 indicated that the direction of groundwater flow was to the north-northwest. Based on the configuration of monitoring wells and exclusion of data from MW-3, it is Stone's opinion that there was insufficient data in the 1990 Griffin investigation to accurately determine groundwater flow direction. However, groundwater elevation and flow direction at the Site is likely influenced by seasonal fluctuations and fluctuations in Connecticut River surface water elevations. The Connecticut River

may fluctuate between gaining (e.g. groundwater discharges to the river) and loosing (e.g. the river discharges to groundwater) in response to these fluctuations.

Groundwater samples were collected from each of the four groundwater monitoring wells on May 18 and June 25, 1990 and were analyzed by EPA Methods 601 (halocarbons), 602 (purgeable aromatics), and 418.1 (hydrocarbons). During the June 25, 1990 groundwater sampling event, three wells associated with the adjoining landfill (MW-5, -6, and -7) and one of the two on-Site water supply wells were sampled and analyzed by the methods listed above. MW-3 was not sampled on June 25, 1990 due to the presence of free product within the well. Based on analytical results:

- MTBE and benzene were detected in MW-3 at concentrations above their respective Vermont Groundwater Enforcement Standard (VGES). The presence of methyl tert-butyl ether (MTBE) in groundwater samples collected near historic USTs indicate that No. 6 fuel oil is likely co-mingled with gasoline that was likely released from a former gasoline UST. The gasoline UST was formerly located approximately 60 feet southwest of the No. 6 fuel oil USTs.

- Several chlorinated volatile organic compounds (CVOCs) were detected in groundwater samples collected near former USTs. CVOCs detected at concentrations above their respective VGES included tetrachloroethylene (PCE; MW-1, MW-2, and MW-4) and vinyl chloride (MW-2, MW-3 and MW-4). Griffin indicated that the likely source of CVOCs is from upgradient industrial properties, the nearby landfill, or wastes disposed of along the bank of the Connecticut River.

- PCE and trichloroethene (TCE) was detected in MW-6 at concentrations exceeding VGES. Note: MW-6 is located over a quarter of a mile northeast and likely cross-gradient of the No. 6 fuel oil release area. The CVOCs PCE and TCE in this well are likely associated with the adjoining and upgradient Windham SWMD Landfill. CVOCs detected in groundwater samples collected from No. 6 fuel oil area monitoring wells are likely from a separate on-Site or upgradient source.

2.2 Barr Engineering Company Letter to Griffin, October 24, 1990

This letter provided Griffin with Barr Engineering Company's (Barr) qualifications and experience conducting petroleum remediations and does not provide any Site-specific information.

2.3 Barr Engineering Company Feasibility Study, Remediation of No. 6 Fuel Oil Release, Specialty Paperboard, Inc. Brattleboro Mill, Brattleboro, Vermont, January 1991

Barr prepared a feasibility study (FS), as a subcontractor to Griffin, to evaluate remedial options for the release of No. 6 fuel oil from former Site USTs.

Barr estimated a maximum of 68,100 gallons of No. 6 fuel oil is present within 3,530 cubic yards (yd^3) of soil extending from 10 to 70 feet below ground surface based on the following assumptions:

- The highest TPH concentration previously measured (50,000 milligrams per kilogram {mg/kg}) represents the average TPH concentration in the contaminated soil.
- Soil bulk density is 1,850 kilograms per cubic meter (kg/m^3).
- No. 6 fuel oil has a specific gravity of 970 kg/m^3.

Based on slug tests reportedly conducted on a Site water supply well by The Johnson Company (JCO) in 1990, Barr estimated geometric mean and maximum hydraulic conductivity of the Site aquifer of 0.02 and 0.08 centimeters per second (cm/sec), respectively. At the time the FS was prepared, TPH was not detected in groundwater located forty feet in the direction presumed to be downgradient of fuel oil contaminated soil in contact with groundwater. Considering the low water solubility and high viscosity of No. 6 fuel oil and Site hydrogeologic conditions, Barr indicated that No. 6 fuel oil would have become immobile in the subsurface due to both capillary action and increased viscosity as it cooled and was unlikely to migrate 300 feet to the Connecticut River. Barr's risk evaluation identified soil, groundwater, and surface water as potentially impacted media but indicated that there is little risk to nearby sensitive receptors based on the physical properties of No. 6 fuel oil, unlikelihood that contaminated groundwater would migrate off-Site, and lack of groundwater use for potable water.

Remedial Alternatives evaluated based on technical effectiveness, technical feasibility/implementability, secondary environmental factors, and cost included:

<u>Soil Alternatives</u>:

A. Capping contaminated soil by maintaining the asphalt parking lot surrounding the facility to limit infiltration of water. This alternative assumed that biannual groundwater monitoring would be conducted to monitor the dissolved phase groundwater plume in order to determine whether additional remedial actions would be required in the future.
B. In-situ volatilization (e.g. soil venting) involves applying a vacuum to vapor extraction wells to remove VOCs from soil vapor and treating the effluent. This alternative assumed groundwater monitoring would be conducted as described above for the soil cap alternative.
C. Excavation and off-Site disposal would involve excavating the contaminated soil and transporting to a landfill for disposal. Based on the depth of coal tar contamination (72 feet bgs) and proximity to the Site building, excavation would be difficult to implement and poses risk to the building's structural integrity.
D. Excavation and on-Site disposal is the same as alternative C except a lined containment system would be constructed on-Site for disposal of contaminated soil.

E. Excavation and thermal desorption in an asphalt plant is the same as alternative C except soil would be transported to an asphalt plant where it would be used as aggregate following thermal desorption of fuel oil. This practice is no longer acceptable by the VT DEC.
F. Excavation and land treatment are the same as alternative C except soil would be spread approximately in a six-inch layer nutrients and pH buffers would be applied and tilled and irrigated. No. 6 fuel oil mass would be reduced by biodegradation and photo-oxidation. This practice is no longer acceptable by the VT DEC.
G. In-situ biological treatment involves introducing nutrients and oxygen while maintaining pH and soil moisture conditions to enhance naturally occurring bacteria to degrade the No. 6 fuel oil into benign byproducts.

Groundwater Alternatives:

H. Groundwater recovery (e.g. pump and treat) involves extracting groundwater from the aquifer, treating, and re-injecting.
I. Free product recovery would involve installing a large diameter well, pumping water to create a cone of depression in the water table and removing the No. 6 fuel oil that accumulates on top of the water drawn into the well.

Barr indicated that the likely immobile nature of No. 6 fuel oil, limited ability for water infiltration due to the presence of asphalt, low concentrations and limited extent of dissolved phase VOCs, and dilution that would likely occur if the dissolved phase VOC plume reached the Connecticut River, the release of No. 6 fuel oil at the Site poses little risk to human health and the environment. To manage long-term liability related to the release of No. 6 fuel oil, Barr recommended implementing soil remedial alternative G, in-situ bioremediation, possibly augmented by first removing free product as described in groundwater alternative I, free product recovery.

Costs associated with each remedial alternative, as presented by Barr, are summarized in Table 1. To estimate present worth, Stone applied an annual cost increase of 2% and rounded to the nearest $1,000.

Table 1. Remedial Alternative Cost Summary

Alternative	Barr Cost Estimate, 1990	Estimated Present Worth
A: Capping/Groundwater Monitoring (10 years)	$139,000	$252,000
B: In-Situ Volatilization (2 years)	$151,000	$274,000
C: Excavation/Off-Site Disposal	$1, 049,000	$1,900,000
D: Excavation/On-Site Disposal	$1,368,000	$2,448,000
E: Excavation/Thermal Desorption at Asphalt Plant	$1, 014,000	$1,837,000
F: Excavation/Biological Land Treatment	$807,000	$1,462,000
G: In-Situ Biological Treatment (2 years)	$331,000	$600,000
H: Groundwater Recovery and Treatment (10 years)	$670,000	$1,214,000
I: Free Product Recovery (10 years)	$910,000	$1,648,000

2.3.1 ESE Biosciences Group (EBIO) Biofeasibility Evaluation and Biotreatment Design

A bench-scale biofeasibility study for in-situ bioremediation technologies was conducted by EBIO on behalf of Griffin. A composite soil sample, collected from 40 and 65 feet bgs from SB-A, and a groundwater sample (MW-16) were enriched with trace metals and nutrients and compared to control samples that did not undergo enrichment. Soil and groundwater samples submitted for the biofeasibility study were contaminated with No. 6 fuel oil. The purpose of the control sample was to mimic how No. 6 fuel oil would degrade under natural Site conditions.

The study found that indigenous microorganisms are adapted to Site contaminants and toxicity effects would not likely inhibit bioremediation. After seven days, microorganism growth increased by an order of magnitude in enriched soil compared to no increase in microorganism growth in the control soil. In the enriched soil sample, a 74% reduction of petroleum hydrocarbons was measured at day 14 of the experiment and a 91% reduction of petroleum hydrocarbons was observed at the end of the experiment on day 21. No significant change in petroleum hydrocarbon concentrations were observed in the control sample at the end of the experiment.

EBIO concluded that Site petroleum hydrocarbons are biodegradable and indigenous microorganisms can degrade the petroleum hydrocarbons under the right conditions and recommended in-situ bioremediation for the Site. EBIO indicated that a conceptual design for in-situ bioremediation was provided to Griffin in proposal #90.0178 dated July 20, 1990 and is described in detail within this report along with conceptual drawings and description of the groundwater modeling methodology used to support the design. The groundwater model assumed that the aquifer is isotropic, vertically homogenous, and disregarded hydraulic influence of the Connecticut River.

2.4 Report on August 1994 Groundwater Sampling and Analysis for Specialty Paperboard, Brattleboro, Vermont performed by Griffin International, Inc., October 1994.

The 1994 Griffin report summarizes results of groundwater monitoring conducted in August 1994. Liquid levels were gauged in ten Site monitoring wells (MW-1, -2, - 3, -4, -9, -11, -12, -14, -15, and -

16) and groundwater samples collected from seven monitoring wells (MW-1, -2, -4, -9, -11, -12, and -14) using bailers. No. 6 fuel oil was present in monitoring wells MW-3 (68.18 feet bgs), -15 (68.85 feet bgs), and -16 (68.00 feet bgs) and was too viscous for the interface probe to pass and allow for thickness measurement. Free product had not been previously observed in MW-16. Griffin inferred the direction of groundwater flow to be to the south – southeast towards the Connecticut River.

Groundwater samples were analyzed for VOCs by EPA Method 8240 and for total petroleum hydrocarbons (TPH) by EPA Method 418.1. MTBE and CVOCs were detected at concentrations below current VGES except for in MW-11, where MTBE was detected at a concentration of 14.2 micrograms per liter (µg/L), which exceeds the current VGES of 11 µg/L. Based on these results, Griffin recommended that the Site be considered for a Sites Management Activity Completed (SMAC) designation.

2.5 Letter from Environmental Assessment and Remediation, Inc. to Mr. Charles Schwer of the VT DEC February 20, 1991

This letter provides qualifications and experience to the VT DEC and requests that Environmental Assessment and Remediation, Inc. be added to VT DEC's list of qualified consultants to perform petroleum site investigation and remedial work. No Site-specific information is provided.

2.6 Maps

A map dated May 11, 1992 shows private and public water supply wells, surface water, and topography in the vicinity of the Site on a scale of 1:25,000. The quality of the map is poor and may not include all current water supply wells in the vicinity of the Site.

A vicinity map created by the ANR Vermont Geographical information System (GIS) dated September 24, 1993 depicts roads, sensitive ecological areas, public lands, surface water, town boundaries, well head protection areas, hazardous waste sites, mineral resources, public water supply wells, and USTs. Stone's Phase II ESA Vicinity Map provides a contemporary depiction of these features in compliance with the VT DEC's Investigation and Remediation of contaminated Properties Rule (IRule).

2.7 Correspondence

Stone reviewed sixty-four correspondence files provided within SMS file #1990-0482. Many of these files included cost estimates, proposals, and work plans for environmental assessments described above that do not provide additional information about the No.6 fuel oil release, work completed, or subsurface conditions. Information salient to this file review and data gap analysis that was gleaned from the correspondence include:

1. Hand-written notes assumed to be VT DEC review questions and comments regarding Barr's 1990 FS included:

a. TPH concentrations in groundwater collected from MW-16 in September 1990 varied widely depending on the analytical method.
b. On page 9 of the FS, Barr calculated a cooling rate of No.6 fuel oil.
    i. Fuel oil saturated soil extends from approximately 8 feet bgs to the water table, not from ground surface.
    ii. Soil and groundwater will act as the primary heat sinks for cooling fuel oil not the atmosphere.
c. VT DEC expressed concern that high concentrations of No. 6 fuel oil would indeed be toxic to microorganism growth.

2. The UST tank pull form from removal on February 1 and 2, 1990 confirmed two 25,000-gallon No. 6 fuel oil USTs were removed. The form listed the condition for both USTs as leaking. A subsequent memorandum internal to the ANR's Petroleum Sites Management Section indicated that there were 2 to 3-inch holes on the second UST and that a test pit extended to 15.5-feet bgs contained all No. 6 fuel oil saturated soil. These soils were returned to the excavation.
3. Letter between Barr and Griffin Re: Borings and Monitoring Wells at Specialty Paperboard, Inc. dated August 28, 1990 making several recommendations on investigation locations and testing parameters to support the FS. Barr recommended:
    a. Submitting four soil samples for the following analyses to evaluate treatability:
        i. Oil content
        ii. TPH by modified EPA Method 8015
        iii. Chlorinated VOCs and benzene, toluene, ethylbenzene, and xylenes (BTEX) by EPA Methods 601/602
        iv. pH
        v. Nutrient levels (nitrogen, phosphorous, and iron)
        vi. Moisture content and field capacity
        vii. Grain size distribution
    b. Conduct a seepage test, slug tests, collect a free product sample, and conduct continuous hydraulic monitoring of select Site wells and water level of the Connecticut River.
4. Griffin Work Plan -Specialty Paperboard, Inc. dated August 28, 1990 indicates that the following scope would be completed:
    a. Installation of six additional monitoring wells and subsequent groundwater sample collection and analysis
    b. Installation of a river gauge
    c. 24-hour water level monitoring of the river gauge and two monitoring wells followed by a pump test of one of the Site water supply wells and slug tests on two of the Site wells.

5. Letter from Griffin to Specialty Paperboard, Inc. dated October 4, 1990 summarizing work completed at the Site and work to be completed at that time. Work completed to that date included:
    a. Installation of eight groundwater monitoring wells (MW-9, -10, -11, -12, -13, -14, -15, and -16) and one soil boring (SB-3).
    b. Falling head tests (locations not identified).
    c. Collected soil samples for analysis.
    d. Collected water samples from fourteen wells. Eight inches of No. 6 fuel oil was observed in MW-3 and droplets were observed in MW-16.
    e. Installed a river gauge and collected river stage and potentiometric surface data logger measurements with JCO.
    f. Site wells were surveyed.
    g. Analysis of soil and water samples for FS had begun.
6. C.T. Male Associates, P.C. results of survey measurements made on October 2, 1990. This letter includes monitoring well elevations referenced to the National Geodetic Vertical Datum of 1929 (NAVD 29) and calculated water level elevations in monitoring wells, the river gauge and other unknown "10-inch and 6-inch wells." A graph showing water level elevations in the river gauge and MW-10 is included. It is difficult to discern which series represents the river gauge and which represents MW-10. However, water elevations in the two series generally mimic each other, suggesting that groundwater elevations are likely influenced by the surface water elevation of the Connecticut River. A map with notations and dated October 5, 1990 indicates that a falling head tests were conducted at MW-16 and SB-A, over 5-feet of product is present in MW-3, and product was "shoved up at various intervals" at MW-15.
7. Fax from Griffin to VT DEC dated October 23, 1990 regarding the detection of No. 2 fuel oil in a water sample (MW-16) at 959 micrograms per liter. No other extractable petroleum compounds were detected in the sample, including No.6 fuel oil. The fax indicates that the chemist indicated this may be the result of degradation of No. 6 fuel oil.
8. Letter from Griffin to Specialty Paperboard, Inc. on October 26, 1990 provides a status report, which indicates:
    a. Groundwater monitoring wells MW-1, -2, -3-, 4, - 10, -13, -14, -15, and -16 were sampled on October 24, 1990 and analyzed for organic compounds by EPA Method 624 and petroleum hydrocarbons by New York State Method 310-13. Results were not available
    b. Water level in the Connecticut river was high as a result of recent rainfall and was observed approximately 1.5-inches below the top of the staff gauge.
    c. Water temperatures in wells located closest to the No. 6 fuel oil release ranged from 3 to 5 degrees (scale not indicated) higher than wells further from the release.

    d. JCO had completed pump tests, which indicate water levels between Site wells and the Connecticut River water levels are correlated and that the supply well does not noticeably affect the contaminated area of the Site.
9. Letter from Griffin to VT DEC Re: Groundwater sampling and analysis, Specialty Paperboard, Brattleboro dated March 12, 1991. This letter indicates that quarterly groundwater monitoring would commence on March 1991 and include collection of groundwater samples from MW-1, -4, and -13 for total recoverable petroleum hydrocarbons by EPA Method 418.1.
10. Letter from Griffin to Specialty paperboard, Inc. dated April 4, 1991 includes analytical results from the March 22, 1991 groundwater monitoring event. 3.69 feet of No. 6 fuel oil was measured in MW-3 and 0.23 feet of product was measured in MW-15. Liquid level data was included in a follow-up letter dated April 12, 1991.
11. Several letters discuss and include specifications for a product recovery system. In a letter from VT DEC to Specialty Paper, Inc. dated April 30, 1991, the VT DEC approved the later to seek bids to install the product recovery system. A draft request for proposal (RFP) and qualifications was submitted by Specialty Paperboard, Inc. to VT DEC on May 28, 1991 and RFPs distributed to several environmental remediation contractors on June 10, 1991.
12. Letter from Griffin to Specialty paperboard, Inc. dated August 15, 1991 includes analytical results from the July 12, 1991 groundwater monitoring event. This letter indicated:
    a. MW-17 is a duplicate if MW-4. Note: a monitoring well with the identification MW-17 was subsequently installed in 1992.
    b. No detectable concentrations of for total recoverable petroleum hydrocarbons (EPA Method 418.1) were detected in MW-2 and MW-4, located downgradient of the fuel oil release area.
    c. 2.5 feet of No. 6 fuel oil was measured in MW-3 and 1.5 feet in MW-15.
    d. Water level elevations were generally 1.25 feet lower than the March 1991 monitoring event. The river gauge was no longer in place.
13. Letter from Griffin to Specialty paperboard, Inc. dated November 25, 1991 includes analytical results from the October 14, 1991 groundwater monitoring event. This letter indicated:
    a. MW-17 is a duplicate of MW-2.
    b. No detectable concentrations of for total recoverable petroleum hydrocarbons (EPA Method 418.1) were detected in MW-2 and MW-4, located downgradient of the fuel oil release area.
    c. 1.0 foot of No. 6 fuel oil was measured in MW-3 and 1.5 feet in MW-15.
    d. Water level elevations were generally 1.0 foot higher than measurements made in July 1991. These changes were attributed to seasonal fluctuations in the water table.

14. Letter from Griffin to Specialty paperboard, Inc. dated February 11, 1992 includes analytical results from the January 17, 1992 groundwater monitoring event. This letter indicated:
    a. MW-17 is a duplicate of MW-2.
    b. No detectable concentrations of for total recoverable petroleum hydrocarbons (EPA Method 418.1) were detected in MW-2 and MW-4, located downgradient of the fuel oil release area.
    c. 3.48 feet of No. 6 fuel oil was measured in MW-3 and 2.78 feet in MW-15.
    d. Water level elevations were generally 0.25 feet lower than October 1991. These changes were attributed to seasonal fluctuations in the water table.
    e. Griffin proposed to reduce groundwater monitoring frequency to semi-annual.
15. Letter from Specialty Paperboard to VT DEC dated May 1, 1992 indicated 20-gallons of No. 6 fuel oil was spilled on April 24, 1992 while transferring fuel from one UST to the other. A concrete dike was poured around the oil delivery area to contain future spills.
16. Letter from Griffin to Specialty Paperboard Re: proposal to install groundwater monitoring well dated June 26, 1992. Griffin's proposal includes installing one monitoring well within the center of the No. 6 fuel oil release area to evaluate whether No. 6 fuel oil will enter the well. Griffin suggests that this information could be used to determine whether the fuel oil is still mobile. Installation of the well was approved by VT DEC on July 23, 1992. In a letter from Griffin to Specialty Paperboard, Inc. dated October 15, 1992, the monitoring well (MW-17) was installed fifteen feet from MW-3 adjacent to the heated underground fuel conduits.
    a. Soils at MW-17 were saturated with No. 6 fuel from approximately 20 to 73 feet bgs. The highest PID reading of 50 ppm was measured at the water table interface and decreased to 24 ppm at the terminal boring depth of 75 feet bgs.
    b. Soil temperatures of vadose zone soils ranged from 25° C to 28° C and decreased to 21° C below the water table. Griffin indicated that groundwater temperatures away from the No. 6 fuel oil range between 11° C to 17° C.
    c. Several days after well installation, No.6 fuel oil was present at 70 feet below top of casing and was too viscous to penetrate with the meter.
    d. Griffin recommended collecting an additional round of groundwater monitoring data in July 1993.
17. Letter from Griffin to Specialty paperboard, Inc. dated July 27, 1992 includes analytical results from the July 1, 1992 groundwater monitoring event. This letter indicated:
    a. MW-17 is a duplicate of MW-2.
    b. No detectable concentrations of for total recoverable petroleum hydrocarbons (EPA Method 418.1) were detected in MW-2 and MW-4, located downgradient of the fuel oil release area, or MW-13 and MW-14.
    c. Low levels of CVOCs were detected in MW-1 and MW-14.

d. Low levels MTBE was detected in MW-4 and MW-13.

18. Letter from Griffin to VT DEC Re: disposal of petroleum contaminated soils at Specialty Paperboard, Inc. dated October 2, 1992. Griffin requested VT DEC approve off-Site disposal of approximately 27 cubic yards of soil contaminated with No. 6 fuel oil generated from previous environmental investigations. This request was approved by VT DEC on October 13, 1992.
19. VT DEC letter to Specialty Paperboard, Inc. dated November 14, 1994 Re: Sites Management Activities Completed, Specialty Paperboard, Brattleboro (site #90-0482).
    a. The VT DEC issued a SMAC designation for the Site based on:
        i. Two USTs removed from the Site on February 1 and 2, 1990 had a release of No. 6 fuel oil.
        ii. Investigations at the Site to date have indicated that the No. 6 fuel oil is extremely viscous and will not migrate.
        iii. Groundwater sampling and analysis at the Site indicate that groundwater contaminant concentrations are either non-detect or below VGES.

2.8 Site Scoring Criteria

Vermont Sites Priority System (VSPS) scoresheets completed in May 1992 by Dubois & King, Inc. consist of checklists that evaluate contaminant migration pathways and risk to sensitive receptors from the fuel oil release and are based on a review of prior Griffin and Barr reports. No additional information related to the fuel oil release is included in the scoresheets. Contaminant migration pathways including air, groundwater, surface water, on-Site exposure, and Site assessment, were scored on a scale of 0 – 100. The groundwater migration pathway had the highest score (37), indicating this was the most likely contaminant migration pathway.

2.9 Stone 2019 Phase II ESA

Stone located four historic wells within the fuel release area, including MW-1, -3, -4, and -16. MW-1 and MW-3 were dry to depths of 72.1 feet bgs and 72.0 feet bgs, respectively. Depth to water in MW-4 was 80 feet bgs and the total depth was 83 feet bgs. Approximately one-foot of heavy petroleum non-aqueous phase liquid (NAPL) was encountered at 68 feet bgs in MW-16.

One soil boring (IP-03/3a) was advanced immediately south of the former UST area and approximately 25-feet northeast of MW-4. One soil sample was collected from 70.5 feet bgs and analyzed for VOCs (8260C), SVOCs (8270D and 8270D-SIM), and 23 target analyte metals (6010D, 7471B, and 4500CN-CE). No VOCs or SVOCs were detected in the soil sample collected from IP-03 at concentrations exceeding Vermont Soil Standards (VSS) for residential properties.

A groundwater monitoring well was constructed at IP-03 to a depth of 75 feet bgs, developed, and a groundwater sample collected and analyzed for VOCs (8260C), SVOCs (8270D), TAL Metals and cyanide (6010D, 6020B, 7470A, and 9010C/9012B), and per- and polyfluoroalkyl substances

(PFAS; 537-modified). No VOCs or SVOCs were detected in the groundwater sample collected from IP-03.

Two additional soil borings and groundwater monitoring wells (IP-02 and IP-07) were installed in locations presumed to be downgradient of the suspected former locations of diesel and gasoline USTs. No VOCs or SVOCs were detected in groundwater samples collected from these locations.

Stone collected water samples from the two on-Site water supply wells ('Deep' and 'Shallow'), which contained naphthalene and lead at concentrations above the VGES and MTBE at concentrations below the VGES. The presence of naphthalene and MTBE in the on-Site supply wells indicate that petroleum products may have migrated southwest, possibly due to hydraulic influence of the supply wells or there is another unidentified on or off-Site source that is impacting these wells.

Stone concluded that No. 6 fuel oil from the pre-1990 release is still present in the subsurface, but not at concentrations high enough to impact sensitive receptors, e.g. downgradient groundwater or soil.

3. Conceptual Site Model

The Conceptual Site Model (CSM) presented herein is based on results from the Phase II ESA and historical investigations and assessments of the Site as described in the File Review Summary, above. The CSM includes a discussion of the known physical, geologic, and hydraulic attributes of the Site and surrounding area, how No. 6 fuel oil was released at the Site, transport pathways, fate mechanisms, and potential routes of exposure to ecological and human receptors. The CSM provides the context from which site investigation activities are developed and a framework to make sound Site management decisions.

3.1 Topography

Ground surface at the Site is generally flat, except along the Connecticut River where the land slopes steeply downward approximately 70 feet. Ground surface in the surrounding area north and northwest of the Site generally slopes to the south and east.

Groundwater at the northeastern portion of the site, northeast of the wastewater treatment system lagoons, has been reclassified as Class IV groundwater due to contaminants from the Windham SWMD landfill located immediately to the northwest of the site.

3.2 Geology

According to the Agency of Natural Resource (ANR) Atlas, the Site is underlain by schist (primary) and metawacke (secondary) bedrock. Bedrock was reported at depths of 137 and 142 feet below ground surface in two bedrock wells drilled to the west and southwest of the Site where ground surface elevations are similar to the Site. Overburden groundwater production wells at the Site

were drilled to approximately 100 ft bgs. Therefore, it is anticipated that bedrock would be encountered between 100 and 150 ft bgs at the Site.

Overburden soils at the Site are mapped as fluvial sands. Griffin's 1990 Investigation of Subsurface Petroleum Contamination report described subsurface soils as "nearly horizontal stratigraphic sequences, each measuring approximately one-foot thick and that they begin as coarse, well rounded, well sorted sand at the top and grade into fine, silty sand at the bottom" of each sequence. Griffin further concluded that the stratigraphic sequence planes dip slightly to the south. During this Phase II ESA, strata observed during the installation of groundwater monitoring wells did not concur with this prior assessment; while lower-energy (e.g., fine sands and silt) stratigraphic units were observed in select borings, such as IP-05 and IP-03, high-energy deposits (medium to coarse sands through gravel and cobbles) were common. We interpret this variability within Site strata to be indicative of a meandering river system bisecting through previously deposited lacustrine deltaic sediments. Coarser sediments with angular to sub-angular grains, like those that are prominent between 0 and 20 ft bgs Site-wide, suggest that these sediments are close to their source and that the paleo-Connecticut River flowed at high velocities along the Site.

3.3 Hydrogeology

Depth to water in the No. 6 fuel oil release has been measured between 66 and 69 feet bgs during several monitoring events conducted between 1990 and 1994 and again in 2019. Based on surrounding area topography, groundwater flow would be presumed to be east or southeast toward the Connecticut, however, due to the impoundment of the Connecticut River by the Vernon Dam at Vernon, Vermont approximately 10 miles downstream of the Site, at least periodically, the Connecticut River may be a losing stream in the vicinity of the Site. Concurrent hydraulic monitoring data collected in 1990 from a staff gauge in the Connecticut River and Site groundwater monitoring wells was not available within available SMS #1990-0482 files.

Groundwater contour maps created during prior environmental assessment of the Site indicate groundwater surface gradient toward the river (Griffin, 1994) and groundwater elevation data collected as part of this Phase II ESA showed slight horizontal gradients to the east and southeast. Based on this information, and in the absence of multiple rounds of groundwater and surface water level data, we would expect the Connecticut to be both a losing and gaining stream near the LFP property, depending on groundwater and river levels and recharge.

Operation of the two Site water supply wells likely influences groundwater flow direction as evidenced by the presence of naphthalene, MTBE, and lead in water samples collected in 2019. A possible source of these contaminants is the former gasoline and No. 6 fuel oil USTs located approximately 900 feet to the northeast of the wells. Based on slug tests conducted on a Site water supply well by JCO in 1990, geometric mean and maximum hydraulic conductivity of the Site aquifer was estimated a of 0.02 cm/sec and 0.08 cm/sec. According to Griffin, pumping tests

completed by JCO in 1990 indicated that there is a strong hydraulic connection between potentiometric surfaces in Site monitoring wells and the Connecticut River but no noticeable connection between water supply and monitoring wells. Griffin also indicated that the water level in the Connecticut River was very high from recent rain fall. If these conditions persisted during JCO's pumping tests, potential hydraulic effects on the No. 6 fuel release area from the water supply wells may not have been noticeable due to more broad and pronounced hydraulic effects of the Connecticut River, which was likely a losing stream at that time.

The vertical component of the hydraulic head distribution is unknown. In the southeast portion of the Site, we expect that pumping of the Long Falls Paperboard production wells will induce a downward gradient.

The connection between the unconsolidated, overburden aquifer and the bedrock aquifer is unknown.

3.4 Release Mechanisms

The only known documented contaminant releases at the Site are from various petroleum surface spills and releases from No. 6 fuel oil USTs. Reported petroleum spills were generally contained (except for a reported release that impacted the on-site clarifier) and the No. 6 fuel oil leaking UST release received a VT DEC SMAC letter in 1994. However, at that time soil and groundwater were not sampled for the primary constituents of No. 6 fuel oil: polycyclic aromatic hydrocarbons (PAHs). No SVOCs, including PAHs, were detected in groundwater samples collected in 2019 at locations presumed to be downgradient of the No. 6 fuel release (e.g. IP-03, 02, and 07).

3.5 Contaminant Distribution, Fate and Transport

Petroleum products, containing VOCs and SVOCs, will tend to migrate downward through soil to the groundwater table with some of the product adsorbing to soil particles. Petroleum VOCs and most SVOCs have a specific gravity less than water and will tend to stay high in the groundwater column.

Investigation point IP-03 was advanced as close as practicable to the former leaking No. 6 fuel oil USTs. Less than 1 part per million by volume (ppmv) photoionization detector (PID) response was measured in screened soils to the water table. In the soil sample collected at 70.5 feet depth, no VOCs or SVOCs were detected above screening values. Of note, an extremely low detection of tetrachloroethene in this soil sample was estimated at 0.00029 mg/Kg, many orders of magnitude below the VSS Resident standard of 2.4 mg/Kg. In groundwater, no VOCs of concern or SVOCs were detected in IP-03.

Free-phase petroleum product was detected in monitoring well MW-16 at an elevation > 10 feet above the observed water table; it is unknown if this is representative of current in-situ conditions

as it could be the same No. 6 fuel oil present as it was left when last monitored in 1994, which was measured at the same depth of 68 feet bgs.

Monitoring wells IP-02 and IP-07 were installed at locations that were presumed to be hydraulically downgradient of the suspected former locations of the five diesel and gasoline USTs to evaluate current groundwater conditions. PID response of soils screened were at 1.0 ppmv or lower at each well location. No VOCs of concern or SVOCs were detected in the groundwater. Note that due to above ground natural gas tanks and underground utilities, IP-07 could not be installed directly in the suspected area of the former USTs.

Naphthalene was detected in samples collected from both the 'Deep' and 'Shallow' production well (EPA Method 8260C analysis) at estimated concentrations of 1.1 µg/L and 1.8 µg/L, above the VGES of 0.5 µg/L for this compound. Additional SVOCs were detected in each of these samples but well below the respective VGES standards. MTBE was also detected in each of these samples at concentrations of 2 µg/L and 9.9 µg/L, below the VGES standard of 11 µg/L. MTBE was detected in a 1994 sample collected from nearby former monitoring well MW-11 at a concentration of 14.2 µg/L. These data indicate that petroleum products may have migrated and/or were hydraulically influenced due to pumping to the production well area and in the absence of a continuing source, are and/or would be expected to decline over time.

3.6 Sensitive Receptor Evaluation

Contamination from the No. 6 fuel oil release has been evaluated for its potential to adversely affect sensitive receptors. Table 2 presents the potentially affected media, potential pathways, and potential receptors.

Table 2. Sensitive Receptors Evaluation – No. 6 Fuel Oil Release

Affected Media	Potential Pathways	Sensitive Receptors/Potential Risk
Surface Water	Overland flow of stormwater runoff and groundwater discharge	Connecticut River / Low – No petroleum VOCs or SVOCs associated with the No. 6 fuel release have been detected in groundwater at concentrations above VGES at locations immediately downgradient of the release.
Surface Soil	Direct contact to contaminated materials	Site users & trespassers / Low – Soil contaminated by the release of No. 6 fuel oil is at least eight feet bgs and located below an asphalt parking lot.
Subsurface Soil	Direct contact with No. 6 fuel oil contaminated soil	Groundwater / Low – The presence of No. 6 fuel oil in the subsurface does not appear to be resulting in migration of dissolved phase groundwater contamination beyond the release area. Construction workers / Medium – Future excavations within the No. 6 fuel oil release area may encounter contaminated soil.
Groundwater	Infiltration of surface water through impacted soil may leach contaminants to groundwater.	Potential discharge to Connecticut River / Low – See surface water Potential uptake into facility process water / Medium – naphthalene and lead were detected in the sample collected from the 'Deep' production well at concentrations above VGES.
Sediment	Discharge of contaminated soils to the Connecticut River from stormwater.	Potential discharge to the Connecticut River / Low
Air	Vapor intrusion of petroleum VOCs.	Potential Vapor Intrusion from subsurface VOCs / Low Potential volatilization of VOCs in soil (current or future) / Low

Abbreviations: VOCs – volatile organic compounds; SVOCs- semi-volatile organic compounds

4. Data Gaps

Based on our review of available SMS #1990-0482 files and the 2019 Phase II ESA, Stone has identified the following data gaps:

1. The effects on groundwater flow direction by surface water elevation changes in the Connecticut River and operation of two on-Site water supply wells is poorly understood.
    a. The absence of VOCs or SVOCs in groundwater samples collected from IP-02 and IP-07 would indicate that petroleum contaminants are not migrating to the southwest from the No. 6 fuel release area. However, the presence of naphthalene and MTBE in a 2019 water supply sample indicate that water supply wells may influence groundwater flow from the No. 6 fuel release area to the southwest or there is another unidentified on or off-Site source for these contaminants. Dissolved phase petroleum contaminants from the former gasoline (MTBE and naphthalene) and No. 6 fuel oil (naphthalene) USTs may follow downward vertical hydraulic gradients along flow lines that are not intercepted by monitoring wells IP-02 and IP-07. Based on the coarse channel deposits observed at the Site, the main transport mechanism for dissolved phase contaminants is expected to be advection of groundwater, not diffusion.

b. Pump test data collected by JCO in 1990 reportedly indicated no hydraulic connection between on-Site water supply wells and groundwater monitoring wells in the No. 6 fuel release area. However, this data, which was not available for review, may have been collected during a time of high surface water elevations in the Connecticut River. This data may be representative of Site hydraulic conditions when the Connecticut river is a losing stream, but not when it is a gaining stream relative to groundwater.
c. Dissolved phase contamination associated with the No. 6 fuel oil release does not appear to be migrating towards the Connecticut River. However, the vertical hydraulic gradient has not been assessed and dissolved phase contaminants may follow downward vertical hydraulic gradients along flow lines that are not intercepted by monitoring wells located downgradient of the former UST area (e.g. IP-03 and MW-4).
d. Hydraulic data collected in 1991 from a staff gauge in the Connecticut River and two Site monitoring wells during a water supply pump test and monitoring well slug tests were not included in SMS #1990-0482 files.

2. PAH groundwater data (as SVOCs) has only been collected one time in 2019. This is insufficient to conclude that there are no adverse effects to groundwater from the No. 6 fuel oil release.
3. The potential impact to sensitive receptors from uptake of naphthalene and lead into Site water supply wells at concentrations above VGES is poorly understood. Water supply wells provide non-contact process water. It is likely that on-Site water treatment practices volatize naphthalene prior to discharge to the Connecticut River. However, this assumption should be verified.
4. Griffin attributed the detection of No. 2 fuel oil in a groundwater sample collected from MW-16 in 1990 to degradation of No. 6 fuel oil. This assumption is false as No. 6 fuel oil is relatively stable and does not break down into other refined petroleum products. Stone assumes that the analytical results for this sample was an error.
5. Bioremediation technologies have advanced significantly since 1991. Stone identified the following data gaps in the 1991 feasibility study:
    a. The volume and physical properties of No. 6 fuel oil is poorly understood. Barr calculated the volume of fuel oil based on assumed TPH concentrations, soil bulk density, and fuel oil specific gravity. TPH concentrations varied widely based on analytical method. Calculations of No. 6 fuel oil volume and analysis of mobility should be based on measured physical properties and contaminant concentrations following contemporary analytical methods.
    b. The groundwater modeling methodology used to support the 1991 bioremediation design assumed that the aquifer is isotropic, vertically homogenous, and disregarded hydraulic influence of the Connecticut River. Should bioremediation be

considered as a remediation technology for No. 6 fuel oil at the Site, design needs to account for anisotropy and heterogeneities in the aquifer and hydraulic influence of both the Connecticut River and on-Site water supply wells.

c. A No. 6 fuel oil NAPL sample should have been included in the 1991 biofeasibility evaluation and biotreatment design.

6. The current extent of No. 6 fuel oil is unknown. However, it is unlikely, based on the physical properties, that No. 6 fuel oil would have migrated significantly since the 1990s environmental investigations.

5. Recommendations

Stone makes the following recommendations based on this file review, updated CSM, and data gap analysis:

1. Additional groundwater monitoring wells should be installed near existing wells IP-03, IP-07, and IP-02 to evaluate the vertical component of the Site hydraulic gradient.
2. Groundwater monitoring should be conducted in existing and newly installed wells to evaluate whether dissolved phase contaminants are migrating via advection of groundwater at depths below the water table.
    a. MW-4 should be redeveloped and incorporated into future groundwater monitoring.
    b. Groundwater samples should be analyzed for VOCs and PAHs.
3. A staff gauge should be installed within the Connecticut River. The staff gauge and select groundwater monitoring wells should be instrumented with pressure transducers to collect hydraulic data, which can be used to evaluate Site hydraulic conditions both with and without active pumping of the deep and shallow water supply wells.
4. Site wastewater should be sampled and at multiple points along the treatment train and analyzed for VOCs and lead to evaluate whether these contaminants persist in wastewater discharge.
5. A sample of No. 6 fuel oil should be collected for physical properties analysis to support estimation of contaminant mass and mobility. This should be collected from a new boring since the No. 6 fuel oil present in MW-16 has been exposed to the atmosphere for almost 30 years and may not be representative of in-situ conditions.
6. In-situ No. 6 fuel oil contaminated soil samples should be collected for bench scale treatability tests to support the evaluation of current bioremediation technologies for Site remediation.

Please do not hesitate to contact me with any questions regarding this file review and data gap analysis.

Sincerely,

Lee Rosberg
Project Geologist
Direct Phone / 802.229.5378
Mobile / 802.229.5378
E-Mail / lrosberg@stone-env.com

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