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ATTENTION:
Environmental/Technical Leader

Northern Pulp Abercrombie Pulp Mill and Associated Works
Hydrogeological and Hydrological Evaluation (Mill Site) - Final

In August 2011, Dillon Consulting Limited (Dillon) was retained by Northern Pulp Nova Scotia Corporation (Northern Pulp) to assist with various sections of Industrial Approval No. 2011-076657 issued by Nova Scotia Environment on May 10, 2011 for the Pulp Mill located on Abercrombie Point in Pictou County, Nova Scotia, and Associated Works. The work involved and associated deadlines were documented within our June 17, 2011 work plan letter. Since each section has its own deadline, the information presented herein relates to Section 9 (Groundwater and Surface Water) and Section 10 (Registered Public Drinking Water Supply) only. Other work relating to the industrial landfills and asbestos waste disposal area will be reported separately at a later date.

The following paragraphs provide a description of the site in general, including a brief site history. The hydrogeological and hydrological assessment section presents information gathered from previous assessments (focused on the landfill portion of the Mill site), and outlines potential sources of concern communicated by Northern Pulp personnel and/or identified during a site visit on August 18, 2011. The recommendations section provides justification for the proposed additional monitoring locations. Finally, a timeline to complete the proposed well drilling program and subsequent surface and groundwater sampling program is presented.

SITE DESCRIPTION

The Mill is situated on a peninsula, bounded to the north, east and west by Pictou Harbour, the Middle River of Pictou and the East River of Pictou, respectively (**Attachment 1 - Figure 1**). The Mill has undergone significant management and operational changes since opening in the late 1960s.

To date, monitoring at the Mill has been focused on the landfill portion of the site (Attachment 1 – **Figure 2**). Since 1978, industrial waste generated from the Mill has been disposed of at a site referred to as Landfill 3. Prior to this, materials were disposed of at two locations referred to as Landfills 1 and 2.

Landfill 1, likely utilized from Mill start-up in September 1967 until its abandonment in 1972, contains wood waste and, to a lesser degree, construction debris, mill garbage, old barrels and, prior to the opening of the Mt. William regional landfill, municipal solid waste. Landfill 2, operational from 1972 to 1988, contains wood waste. Landfills 1 and 2 were closed in 1996.

SITE HISTORY

In 1989, Dillon prepared a 20-year solid waste management strategy in relation to Landfill 3 for the owner at the time, Scott Maritimes Limited. This strategy involved a design to extend the existing landfill facility (including a landfill operations manual), as well as the installation of a surface and groundwater monitoring system and establishment of existing water quality. To this end, a total of 25 monitoring wells were constructed at 10 sites located around the landfills and a surface water network of seven sampling locations was established. The hydrogeological information gathered was presented in Dillon's "*Solid Waste Landfill, Surface/Groundwater Monitoring System and Baseline Water Quality Report – Final*" (August 1990).

In 1996, additional wells were installed by Jacques Whitford during closure of Landfills 1 and 2. In particular, 8 monitoring wells at three locations and a surface water network of six sampling locations were established. The information gathered was presented in Jacques Whitford's "*Kimberly-Clark Nova Scotia Inc., Industrial Waste Landfill Closures, Abercrombie Point, Nova Scotia, Project No. 11392*" (Draft Report dated July 1996).

Since 1989, Dillon has conducted a surface and groundwater monitoring program in relation to the landfill sites. The monitoring well network has continuously been inspected with minor repairs completed throughout the monitoring program. Over the years, wells have been decommissioned (due to damage) and surface water stations have been removed. In 2009, extensive reparations, including well decommissioning and drilling of replacement wells, were supervised by Dillon following standard industry protocols. This work was documented in Dillon's "*2009 Annual Monitoring Report*" (March 2010).

HYDROGEOLOGICAL AND HYDROLOGICAL EVALUATION (MILL SITE)

It should be noted that this evaluation was not meant to be a Phase I environmental site assessment, in that a historical review of the site was not undertaken; however, some historical information (e.g., location of former tanks) was communicated by Northern Pulp during the evaluation of the Mill site.

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A) Hydrogeological Evaluation

Based on the information provided by Northern Pulp and Dillon's historical involvement with the landfill sites, a review of existing hydrogeological information for the Mill was undertaken. According to Northern Pulp personnel, other than the monitoring locations noted above, no other sampling locations have been established by others in relation to Mill operations.

The following discussion is based on the initial baseline water quality report prepared by Dillon (1990), as well as a site visit to tour the entire Mill site in August 2011. As noted above, the 1996 Jacques Whitford report was prepared in draft; however, the report was also reviewed during this assessment.

i) Hydrogeology

Geologically, the Mill site is blanketed by red brown silty, sandy, clay till. Thickness varies from a thin veneer of less than one metre (m) to a covering of greater than 7 m. The underlying bedrock is the Pictou Formation, consisting of a sedimentary sequence of interbedded mudstone, siltstone, sandstone, conglomeritic sandstone and minor coal seams.

Groundwater occurs near surface, generally within 1 to 3 m. The shallow flow system mirrors surface topography, with recharge occurring in localized highs and discharge in low-lying areas. A watershed divide intersects the far eastern portion of the site (near the eastern side of Landfill 3) in a general north-south direction. Groundwater flow east of the divide is in a southeasterly direction towards the East River, while flow west of the divide is in a west-southwest direction towards the Middle River. Both of these rivers discharge to Pictou Harbour.

In situ hydraulic conductivity testing on the 1989 wells produced a wide range of hydraulic conductivity values. Ranges were determined for each well type (i.e., surficial, shallow bedrock and deep bedrock) as follows:

Aquifer	Hydraulic Conductivity	
	(cm/sec)	(m/day)
Base of Surficial Till	10^{-5} to 10^{-4}	10^{-3} to 10^{-1}
Shallow Bedrock	10^{-5}	10^{-3} to 10^{-2}
Deep Bedrock	10^{-5} to 10^{-4}	10^{-2}
Note: Summarized from Baseline Water Quality Report (Dillon, 1990)		

Groundwater flow velocities were also calculated for each well type as follows:

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Aquifer	Hydraulic Conductivity (m/day)	Determined Velocity (m/day)	Estimated Movement (m)		
			1 Yr	20 Yr	100 Yr
Surficial					
Min	10^{-3}	10^{-4}	0.3	6.3	31.4
Max	10^{-1}	10^{-2}	7.7	153.3	766.0
Shallow Bedrock					
Min	10^{-3}	10^{-4}	0.3	5.0	25.1
Max	10^{-2}	10^{-3}	1.8	35.0	175.2
Bedrock					
Min	10^{-2}	10^{-3}	0.4	8.8	43.8
Max	10^{-2}	10^{-3}	2.5	50.2	251.1

Note:
Summarized from Baseline Water Quality Report (Dillon, 1990).

The hydraulic gradient was found to range from 1 to 3 percent throughout; and, to calculate velocity, the porosity was assumed to be 0.20 within the till material and 0.25 in the bedrock.

It is assumed that similar hydrogeological conditions would be present in the northeastern portion of the property; however, no intrusive work has been undertaken in this area of the site.

It is noted that the site is located within a potable area; however, the closest residential well is approximately 900 m away from the site entrance and it has been assumed that the adjacent Canso Chemicals facility does not contain a viable water source. Therefore, there are no known groundwater receptors within 500 m of the site.

ii) Current Groundwater Monitoring Program

Monitoring is currently focused on the landfill portion of the Mill site. Since May 2011, monitoring of the landfills has been conducted in association with the new Industrial Approval No. 2011-076657. The Approval stipulates the frequency of groundwater sampling at the site (as well as leachate and the registered drinking water supplies) and lists parameters to be analyzed during each event in Table 4 (appended in **Attachment 2**). In addition, select locations will be analyzed for mercury, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and/or petroleum hydrocarbons (TPH/BTEX) on an annual basis; and the registered drinking water supplies will be analyzed for bacteria on a quarterly basis.

The current groundwater monitoring network includes 27 wells at 12 locations. Locations of all monitoring wells (both former and existing) are shown on Figure 2 (Attachment 1) and described in the table below.

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Groundwater samples are collected on a semi-annual basis from 11 monitoring wells and annually from all of the monitoring wells. Sampling of the Scale House and Construction Gate production wells are also part of the ongoing monitoring program (although not used for potable purposes, the production wells are sampled for bacteria along with the registered drinking water supplies); for the two production wells, samples are collected quarterly.

Well ID*	Aquifer	Location Description
1A 1B 1C	Surficial Shallow bedrock Deep bedrock	west side of the site, near the Scale House across from, or down gradient of, Landfill 1 & possibly down gradient of Landfill 3
2A **2B**	Surficial Shallow bedrock	adjacent & west of Landfill 2; down gradient of Landfill 2 & Landfill 3
3A 3B 3C	Surficial Shallow bedrock Deep bedrock	adjacent & south of Landfill 2; down gradient of Landfill 2 & Landfill 3
4A **4B** 4C	Shallow bedrock Shallow bedrock Deep bedrock	west & down gradient of Landfill 3
5A 5B	Surficial Shallow bedrock	down gradient of Landfill 3
6A 6B	Surficial Shallow bedrock	down gradient of Landfill 3
7A 7B 7C	Surficial Shallow bedrock Deep bedrock	north of Landfill 3 & up gradient of all landfills
8B	Shallow bedrock	up gradient of all landfills *Originally 2 wells at this location; however, 8A (surficial) decommissioned in 2009*
9A 9C	Surficial Deep bedrock	up gradient of all landfills *Originally 3 wells at this location; however, 9B (shallow bedrock) decommissioned in 2009*
10	*No wells remain at this location*	formally 2 wells up gradient of all landfills: *10A (surficial) and 10B (shallow bedrock) decommissioned in 2002 and 2009, respectively*
09-1A **96-1B**	Surficial Shallow bedrock	up gradient of Landfill 1 & down gradient of Mill stockpile area *96-1A (surficial) replaced with 09-1A in 2009*
96-2B **09-2C**	Surficial Shallow bedrock	down gradient edge of Landfill 1 *Originally 3 wells (2 surficial & 1 shallow bedrock) at this location; however, 96-2A decommissioned in 1998 and 96-2C (shallow bedrock) replaced with 09-2C in 2009*

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Well ID*	Aquifer	Location Description
09-3B **96-3C**	Surficial Shallow bedrock	down gradient edge of Landfill 1 *Originally 3 wells (2 surficial & 1 shallow bedrock) at this location; however, 96-3A decommissioned in 1998 and 96-3B (surficial) replaced with 09-3B in 2009*
Construction Gate	Bedrock	down gradient of Landfills 2 & 3 Production well provides non-potable water to the contractor gatehouse at the back entrance
Scale House	Bedrock	down gradient of the Mill stockpile area & cross gradient of Landfills 1 & 2 Production well provides a non-potable water supply for the Scale House
Notes: Replaced infers that the original well was decommissioned * **BOLD** indicates semi-annual sample collection		

iii) Groundwater Quality

According to the 1990 report, groundwater at the site tends to be calcium sulphate and calcium bicarbonate rich and classed as moderately hard to hard. The pH range was greatest within the surficial aquifer and lowest in the deep bedrock aquifer.

In the past, groundwater samples have been collected for general inorganic chemistry, metals (including mercury), total suspended solids (TSS), chemical oxygen demand (COD), biological oxygen demand (BOD), as well as organics, such as, VOCs, PAHs and Acid Base Neutral Extractables (ABNEs). The Scale House and Construction Gate wells have also been sampled for bacteria.

According to the most recent monitoring report (Dillon's *2010 Annual Monitoring Report*, March 2011), common groundwater exceedances (based on a comparison to the Canadian Drinking Water Quality Guidelines) at the site included: iron, manganese, turbidity, colour and TDS, as well as low pH. Less common exceedances observed in 2010 included: arsenic, barium, cadmium and chloride in one or more samples. Organic analysis (VOCs and PAHs), performed annually on select wells, indicated an absence of VOCs in 2010 and presence of low concentrations of PAH compounds in three samples submitted. Bacteria were not detected in the Scale House or Construction Gate production wells.

Indicator parameters, such as chloride, hardness and conductivity, are generally higher in the closed Landfill 1 area wells (surficial and shallow bedrock), compared to the closed Landfill 2 or the operational Landfill 3.

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B) Hydrological Evaluation

i) Hydrology

There is a major surface watershed divide, running north-south, in the eastern portion of the property. To the east of the divide, surface waters drain easterly towards the East River and Pictou Harbour; and to the west of the divide, surface waters drain westerly towards the Middle River and Pictou Harbour.

On-site surface water (at the established stations) flows either into Begg Brook, which eventually discharges into the Middle River of Pictou Harbour, or directly into Pictou Harbour.

It is assumed that surface water in the northeastern portion of the property would flow in an easterly direction towards Pictou Harbour.

Surface water receptors at the site include small brooks, streams and/or wetlands, all of which eventually discharge into Pictou Harbour.

ii) Current Surface Water Monitoring Program

Similar to groundwater, monitoring is currently focused on the landfill portion of the Mill site. Since May 2011, monitoring has been conducted in association with the new Industrial Approval No. 2011-076657. The Approval stipulates the frequency of surface water sampling at the site (as well as the registered Mill Lab water supply) and lists parameters to be analyzed in Tables 3 and 4 (appended in Attachment 2), as well as TSS, COD and BOD during each event. In addition, for all surface water locations, mercury will be analyzed on an annual basis.

The current surface water monitoring network includes nine stations. Station locations are shown on Figure 2 (Attachment 1) and described in the table below. Sampling of the Middle River (i.e., Untreated Water - Dept. 8 and treated Mill Lab water supply) are also part of the ongoing monitoring program. Four surface water stations, as well as the two Middle River locations, are sampled on a quarterly basis; the remaining is sampled semi-annually.

Station ID*	Status	Location Description	Notes
SW2	Up gradient	Begg Brook south of the Mill	
SW4	Down gradient of Landfill 3	On-site surface water drainage Tributary of Begg Brook	

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Station ID*	Status	Location Description	Notes
SW5	Down gradient of Landfill 3, also receives some flow from Landfill 2	Surface water drainage from Landfills 2 & 3, downstream of SW4 Tributary of Begg Brook	
SW6	Down gradient of Landfill 3, also receives some flow from Landfill 2	Begg Brook prior to discharge into the Middle River of Pictou Harbour; downstream of SW5	Site moved further upstream in 1994 due to observed tidal influences. Sampling site is immediately down gradient of a beaver pond.
SW9	Down gradient of Landfill 1	Drainage ditch northeast edge of Landfill 1	
SW10	Down gradient of Landfill 1	Highway 106 drainage ditch, between the pond & Pictou Harbour Likely receives highway storm water runoff	Original location typically dry; SW10 was relocated within the same ditch in 1998.
SW11	Down gradient of Landfill 1	Highway 106 drainage ditch prior to discharge into Pictou Harbour Receives drainage from north section of Landfill 1 & Highway 106.	
SW12	Down gradient of Landfill 2	Drainage ditch which receives surface water from on site road ditches along edges of Landfill 2 & near Mill stockpile area Discharge into pond east side of Highway 106	
SW13	Down gradient of Landfill 2	Discharge of pond located between Landfill 2 & Highway 106; down gradient of SW12	Sample location may be affected by tidal action (i.e., waves).
Raw Water Dept. 8	intake water (untreated)	Middle River intake water, prior to treatment	

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Station ID*	Status	Location Description	Notes
Mill Lab	intake water (treated)	Middle River intake water, post-treatment – sample collected from the Mill Lab water supply	Registered water supply
Note: * **BOLD** indicates quarterly sample collection			

In relation to the surface water discharge limits table (Table 3); we have proceeded to sample based on our interpretation of the Approval text which states: "any water discharged from the site to a water course or wetland at the site". Therefore, chromium speciation is being conducted on surface waters SWs 5, 6, 9 and 12 on a quarterly basis and on SWs 4, 11 and 13 on an annual basis. Stations, such as SW2 (which represents background) and SW10 (which is in between other stations) will continue to be sampled for total chromium only. In addition, with regard to "clear flows" and "high flows" in the assessment of TSS, we assume that

- *no additional sampling events are required (i.e., will continue to sample on a quarterly basis)*
- *background levels refers to static conditions (non-precipitation or discharging events).*

NSE Action Request: Please notify if any changes are required based on this interpretation of Approval Section IV (m).

iii) Surface Water Quality

Surface water samples have been collected for general inorganic chemistry, metals (including mercury), TSS, COD and BOD. The Untreated Water - Dept. 8 (sourced from the Middle River) and Mill Lab (treated) locations have also been sampled for bacteria.

According to the most recent monitoring report (Dillon's *2010 Annual Monitoring Report*, March 2011), surface water exceedances (based on a comparison to the Canadian Environmental Quality Guidelines for Freshwater Aquatic Life) at the site included: arsenic, cadmium, chromium, copper, lead, manganese, mercury, selenium and zinc in one or more samples. Bacteria were detected in the untreated Middle River water; however, were not detected in the treated surface water collected from the Mill Lab.

Conductivity (a useful indicator of potential influence of waste-contaminated waters) values in uncontaminated, non-saline waters should be in the range of 0 to 1,500 uhmo/cm (Dillon, 1990). The background station (SW2) is within this range. Conductivity values for some of the onsite stations have been above this range; and, in fact, one station (SW6) was moved due to tidal influence, while another (SW13) on the west side of Highway 106 is known to be tidally influenced. In recent years, three onsite

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stations (SW5, SW9, SW12) have been impacted on the short-term due to malfunctions with the leachate collection system and/or presence of leachate seeps. During these events, a spike in conductivity levels (as well as other indicator parameters) was noted.

iv) Leachate

Leachate samples have been collected since 1993 and analyzed for general inorganic chemistry, metals (including mercury), TSS, COD and BOD. Currently, samples are collected on a quarterly basis. Since May 2011, analysis has also included TPH/BTEX as per Approval Table 4 (appended in Attachment 2). As anticipated, leachate exhibits elevated concentrations of anions and cations and several metals (Dillon, March 2011).

v) On-site Drainage

Based on site drawings and the August 18, 2011 site visit, drainage ditches in the operational area of the Mill Site are directed toward the Mill sewer system (and, ultimately, the Boat Harbour Treatment Plant).

In the chemical unloading and storage areas (Attachment 1 – Figure 2), the sewer system is separated based on chemical type, with acids directed to the acid sewer and bases to the alkali sewer. Of note, for the chemical storage area and lime kiln building south of the Main Building, a concrete U-ditch has been installed to capture any surface water discharge from this area (see **Attachment 3 - Photo 1**), which is then directed toward the Mill sewer.

The only water that eventually enters Pictou Harbour from the Mill site is non-contact water, which is described below and ultimately directed towards one of two locations (i.e., small brooks in the eastern portion of the site):

- **Area 1** (noted on Figure 2) - a catch basin along the site entrance road and underground piping from the southern perimeter of the site meet (underground) south of the large Bunker C tanks and daylight in the woods near a small, unnamed brook. For ease of reference, this brook has been shown as **east brook** on Figure 2. In addition, an area of standing water behind the southern Bunker C Tank is also directed towards this brook via drainage ditches; however, is tested (pH, conductivity) by Northern Pulp personnel prior to releasing. It is noted that the southern perimeter also receives runoff from the adjacent Canso Chemicals site via a spring present along the boundary of the two sites.

- **Area 2** (noted on Figure 2) - a concrete culvert daylights on the northwest side of the Ash Pond access road, which contains water from the car wash (outside the Mill, along the site entrance road). The water from the culvert then flows northerly overland to Pictou Harbour via a small, unnamed brook (shown as **north brook** on Figure 2).

C) Potential Sources of Contamination
Potential sources of contamination at the Mill site, which were identified by Northern Pulp personnel prior to the August 18, 2011 site visit, include:

- industrial landfills;
- leachate;
- chemical storage areas;
- petroleum storage tanks (existing aboveground storage tanks (ASTs) and former underground storage tanks (USTs);
- oil-water separators;
- cardlock facility;
- septic systems; and
- ash pond.

With the exception of former tanks and septic systems, most of the areas described below are identified on Figure 2 (Attachment 1).

i) Industrial Landfills
As noted above, **Landfill 1** contains wood waste and, to a lesser degree, construction debris, mill garbage, old barrels and potentially municipal solid waste. It was likely used from Mill start-up in September 1967 until 1972. **Landfill 2** contains wood waste and was utilized from 1972 to 1988. Both of these landfills were closed in 1996. **Landfill 3** contains industrial waste generated at the site since 1978 and is still in use, although a portion of the landfill has been capped. *An assessment of all three industrial landfills will be conducted by Dillon under Approval Section 13 work.*

There is also an asbestos waste disposal area near the east corner of Landfill 3. The disposal area is no longer used and has been capped. *An assessment of the cover material will be conducted by Dillon under Approval Section 14 work.*

ii) Leachate
There is no leachate collection system for Landfill 1. Information provided by Northern Pulp indicates that a culvert underlies the central portion of Landfill 1 (trending southeast-northwest), which drains the ditch on the northside of the road between the Mill and the Scale House. The inlet of the culvert is visible; however, the outlet has never been located. Leachate generated by Landfill 2 is directed towards a sedimentation pond, northwest of Landfill 2, for which overflow is directed under the Scale House Road towards the pond along Highway 106.

Leachate generated by Landfill 3 is collected via a network of collection pipes and manholes and directed towards the Boat Harbour Treatment Plant. A leachate lift station is located on the east side of the Stockpile Area, north of Landfill 3.

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There is also a leachate collection system around the hog pile and the north side of the south chip pile, which is directed towards the Boat Harbour Treatment Plant.

iii) Chemical Storage Areas

Many chemicals are used in the processing of wood pulp at the site. Chemicals are delivered to the site via train and/or pipeline from the adjacent facility (Canso Chemicals). The chemical unloading area is located on the back or west side of the Main Building, see Attachment 3 – **Photo 2** and Figure 2. Chemical tanks are also present on the front or east side of the Main Building (see Attachment 3 – **Photo 3** and Attachment 1 – Figure 2), as well as south of the Main Building.

Chemicals present in each area include:

- West side of Main Building – sulphuric acid (H_2SO_4), caustic, chlorate, chlorine dioxide (ClO_2), peroxide, sulphur dioxide (SO_2), methanol (CH_3OH), and liquid oxygen;
- East side of Main Building – various stages of cooking liquor and brown stock; and
- South of Main Building – green liquor and limestone storage, white liquid clarifier.

iv) Petroleum Storage Tanks

Based on information provided by Northern Pulp, the following table summarizes the various underground storage tanks that were removed from the site by area, the date, size and type of tank (where known). This information is based on site drawings provided by Northern Pulp. At present, to their knowledge, there are no underground storage tanks remaining at the site.

Area/Location	Underground Storage Tank Removal Information		
	Number and Size	Product	Date Removed
Scale House (southwest of)	1-5,000 gallon	Gasoline	1991
	1-5,000 gallon	Diesel	
	1-10,000 gallon	Diesel	
	1-5,000 gallon	Diesel	
East of existing Bunker C Day Tanks	2-35,000 gallon	Bunker C	1991
South of Garage	1-1,000 gallon	Waste Oil	1991
	1-2,000 gallon		
Southwest of Garage	1-2,000 gallon	Waste Oil	Unknown
Bunker C (day tank) Building (south of Lime Kiln Building)	1-15,000 gallon	Bunker C	1993
East side of Main Building/Warehouse	1-1,000 gallon	Diesel	1996
	1-2,000 gallon	Diesel	
	1-1,000 gallon	Gasoline	

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Area/Location	Underground Storage Tank Removal Information		
	Number and Size	Product	Date Removed
Cardlock Facility (on Scale House Rd)	3 (unknown volume)	Unknown	2002
Notes: The underground tanks noted above have been removed from the site. Information based on InteGreyted International site drawings (2004), as well as information provided by Northern Pulp personnel.			

The following table outlines the (exterior) aboveground petroleum storage tanks that remain at the site (see Attachment 3 – **Photos 4** through 7).

Area/Location	Aboveground Storage Tanks		
	Number and Size	Product	Comments
East of Main Building, near site entrance	2-5.04 million gallon (or 2-120,000 bbls)	Bunker C	The northernmost tank is currently used for storage [1], rather than Bunker C.
Fire Pump House (south of Main Building)	1-291 gallon (or 1-1,100 L)	diesel	
Day tanks (south of Main Building)	2-23,300 gallon (or 2-88,200 L)	Bunker C	These day tanks are supplied by the southern 5.04 million gallon Bunker C tank (noted above).
West of Wood Room (chip handling area)	2-1,202 gallon (or 2-4,550 L)	diesel	No photo available.
Cardlock Facility	2 (capacity unknown)	1 diesel, 1 gasoline	
Note: [1] The "inactive" 5.04 million gallon AST has been used by Atlantic Industrial Cleaners to store ship bilge water awaiting processing at their Debert facility; at other times, it has been used by the Mill to store effluent.			

In addition, a petroleum storage area is present outside the garage (see Attachment 3 – **Photo 8**), which is curbed and drains to an oil-water separator, OWS-3 outlined below.

*v) **Oil-Water Separators***

There are three below grade oil-water separator tanks at the site (see Attachment 3 – **Photos 9** through **11**) as follows:

- East of Main Building – OWS-1;
- South of Maintenance Building (located beside the Garage) – OWS-3; and
- Cardlock Facility (on Scale House Road, southwest of Scale House) – OWS-2A, which replaced OWS-2 in 2000.

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vi) Cardlock Facility

The Bluewave Energy Cardlock Facility is located on the Scale House Road, southwest of the Scale House. The facility contains the two ASTs (one gasoline and one diesel) and one oil -water separator (OWS-2A) noted above, as well as three pump islands (see Attachment 3 – **Photo 12** and Figure 2).

Three monitoring wells were observed at the facility. According to Bluewave Energy (Bluewave), the wells (MW99-1, MW99-2 and MW99-3) were installed by MGI in 1999.

These wells are not sampled; however, water levels have been taken and visual observations made by Bluewave personnel. Bluewave has given Dillon permission to access these wells and collect samples (on Northern Pulp's behalf).

vii) Septic Systems

Active septic systems at the Mill (i.e., present in 2004) include:

- Southwest of the Scale House;
- East of Wood Room; and
- North of Maintenance Services Building.

These septic systems drain into the Mill sewer system, which ultimately enters the Boat Harbour Treatment Plant.

Historical septic systems include:

- North of Garage – removed after 1997; and
- Overflow from Warehouse septic system (north of Main Building) – no flow observed in 2004 or August 2011.

viii) Ash Pond

An ash settling pond is located near the site entrance, north of the large Bunker C Tanks (see Attachment 3 – **Photo 13** and Figure 2). The ash pond receives sluce water from the Power Boiler, which is a mixture of raw water and fly ash. The ash settles out in the pond and remains under water. Some of this water is drained off and sent to the Boat Harbour Treatment Plant via the Mill sewer system. Periodically, the ash pond is dredged to remove the built up ash.

D) Pathways & Receptors

As noted above, drainage ditches within the operational area of the Mill Site are directed toward the Mill sewer system and the Boat Harbour Treatment Plant. For the potential sources of contamination presented above, most of these areas would be captured by the Mill sewer and treated at Boat Harbour. Exceptions include: (a) the southeast side of the Mill (**Areas 1 and 2** noted above), (b) leachate from Landfills 1 and 2, and (c) the cardlock facility on the Scale House Road.

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Pathways and receptors for exceptions (a), (b) and (c) noted above are outlined in the following table:

Area	Pathway	Receptor	
		SW	GW
Southeast side of the Mill	Discharge to surface and groundwater from the catch basin along the site entrance road, southern perimeter drainage, and controlled releases of standing water behind the southern Bunker C tank	Unnamed brooks (noted as east and north brooks on Figure 2) and eventually Pictou Harbour	Except for south side adjacent properties, the Mill site is surrounded by Pictou Harbour; and there are no known potable wells within 500 m of the site. The site is an industrial site and the production wells at the site are for non-potable water use only. Groundwater eventually discharges to Pictou Harbour [see Section A) i) above for velocity estimates].
Landfills 1 and 2	Discharge to surface and groundwater from the sedimentation pond, (Landfill 2) drainage ditches and/or culverts	Drainage ditch and pond along Highway 106, and eventually Pictou Harbour	
Cardlock Facility	If petroleum hydrocarbons were released, the LNAPL would accumulate on the water table and travel in the direction of groundwater flow	Pond along Highway 106, and eventually Pictou Harbour	

Note:
LNAPL – light non-aqueous phase liquid

RECOMMENDATIONS

For the industrial landfill portion of the Mill site, the current monitoring network of surface and groundwater sampling locations was put in place to assess any impacts in this area and, at this time, we do not believe that any additional sampling locations in relation to the industrial landfills are warranted and/or that any additional analytical analysis are required.

In addition, the cardlock facility will be assessed using the monitoring well network of three wells put in place by MGI in 1999 on behalf of Bluewave. Bluewave has granted

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permission for Dillon to access these wells for monitoring purposes. Once the recommendations outlined herein have been approved, sample collection will be attempted and samples analyzed for the parameters stipulated within the Approval (Tables 3 and 4, appended in Attachment 2).

In relation to the location of storage tanks (both historical and current), rather than place a monitoring well in relation to each tank, it is recommended that additional monitoring wells be placed in general down gradient areas. It is also not preferable to place a monitoring well in active areas of the Mill site, where underground utilities may present an issue or where site activities may disturb the well or make sampling a safety hazard. For each down gradient area, the additional well will be sampled and data assessed to determine whether or not any contamination is present and to evaluate whether further delineation is warranted.

Therefore, we recommend that six additional monitoring wells be incorporated into the existing groundwater monitoring network at the site. The proposed locations are shown on **Figure 3** (Attachment 1) and described below. Considering that the potential source releases would most likely be from accidental spills and due to the nature of potential contaminants (such as, petroleum hydrocarbons), each well will be screened within the surficial material (water table well) and, depending on field conditions, approximately 6 m in depth. A filter pack of silica sand will be placed in the annulus surrounding the screen and a bentonite seal placed above the screen, as well as near ground surface, to prevent surface water infiltration. Each wellhead will be completed with either an aboveground well protector or a flush mount cover, depending on the surroundings.

Monitoring Wells (MW)

- One MW down gradient of the chemical storage area (south of the Main Building) and up gradient of the large Bunker C tanks, alongside the site entrance road;
- One MW down gradient of the large Bunker C tanks and up gradient of the drainage ditch;
- One MW down gradient of the chemical storage area (front of Main Building), east of the Guard House; and
- One MW down gradient of the Mill Warehouse and oil water separator OWS-1, within the Mill parking lot. *Note: Beyond the parking lot (to the east), there is a steep drop off to a lower lying (potentially wet) area of the site;*
- One MW down gradient of the historical USTs on the east of the Mill Warehouse, also within the Mill parking lot; and
- One MW down gradient of the Maintenance Building and Garage, in the northern portion of the site.

It is noted that, depending on the ability to access monitoring information (if available) for the cardlock facility, an additional well may be required in this area of the site.

All of the new monitoring wells will be developed by removing at least five well volumes of water, and allowed to stabilize prior to sampling. During this process, field readings of pH and conductivity will be recorded. In addition to the parameters stipulated within the Approval (Table 4, appended in Attachment 2), analysis should also include mercury, volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs) to establish a baseline. In addition, select wells, such as, the three monitoring wells closest to the chemical storage areas should also be tested for chlorate/chlorite analysis in relation to the chemical storage tanks.

In addition, the new monitoring wells will be surveyed to establish relative groundwater elevations and flow directions. Attempts will be made to tie-in to the existing monitoring well network at the site, noting that this may not be possible as the existing wells are at a great distance.

Since historical information on hydraulic conductivity and groundwater velocity estimates is available, no additional investigation with respect to physical groundwater conditions (i.e., bail down tests) have been included at this time. However, this work can be added upon request.

We also recommend that three additional surface water stations be incorporated into the existing surface water monitoring network at the site. The proposed surface water sampling locations are also shown on **Figure 3** (Attachment 1) and described below.

Surface Waters (SW)

- Two SW locations along the east brook (one up gradient of site discharge and one down gradient); and
- One SW location along the north brook (one down gradient of the concrete culvert discharge).

The new surface water locations will be sampled as unfiltered grabs. Field readings of pH, temperature, conductivity, dissolved oxygen and flow rate will be recorded. In addition to the parameters stipulated within the Approval (Tables 3 and 4, appended in Attachment 2), TSS, COD and BOD, analysis should also include mercury, VOCs and PAHs to establish a baseline. The sampling locations will be photographed, flagged and GPS coordinates recorded for future reference.

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ESTIMATED TIMELINE

Our estimated timeline to perform the work is outlined below:

- ***Drilling*** within 2 – 3 weeks of finalizing the proposed well locations with NSE and obtaining the required approval from Northern Pulp;
- ***Sampling*** will take place immediately following the drilling program *(or, if timing is suitable, the sampling program could take place during one of the quarterly monitoring events scheduled for the facility – typically, March, June, September and December)* and will involve the parameters noted above. Similar to the ongoing monitoring program, all samples will be submitted to Maxxam Analytics laboratory in Bedford, Nova Scotia and invoiced directly to Northern Pulp;
- ***Data Compilation/Assessment*** within 2 weeks of receipt of the analytical results; and
- ***Reporting*** – a draft report (including well logs) will be prepared for Northern Pulp's review approximately 2 months after the sampling program has been completed; a final report will be prepared within two weeks' receipt of comments.

CLOSING

We trust this meets your requirements at this time. If, however, you have any questions or comments, please contact the undersigned.

Yours truly,

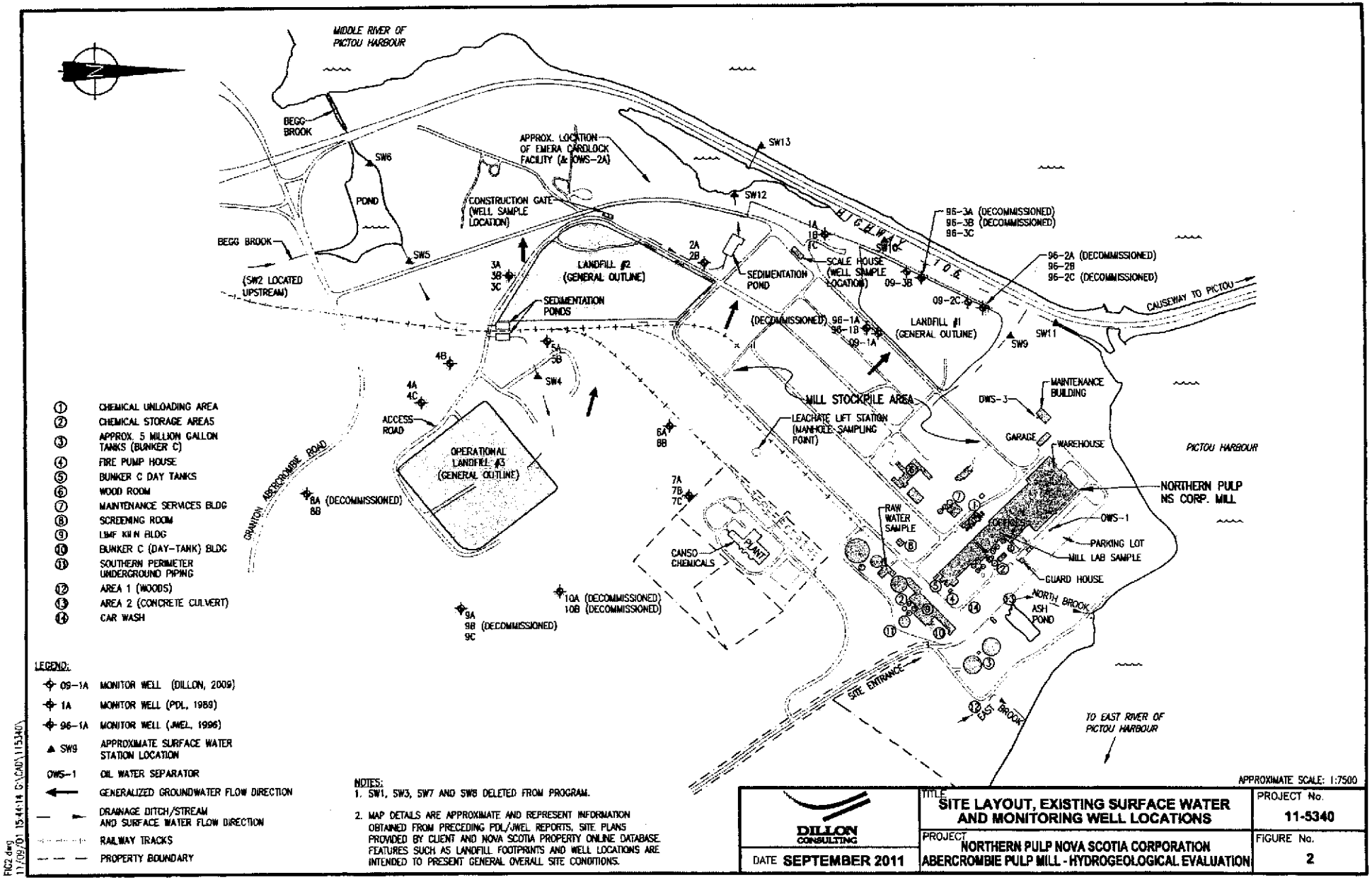
DILLON CONSULTING LIMITED

Beverley Smith

Beverley Smith, B.Sc., P.Geo.
Project Manager

BHS:jep
Attachments
Our File: 11-5340-1000

Attachment 1
Site Figures


MIDDLE RIVER OF PICTOU HARBOUR
BEGG BROOK
SW6
POND
BEGG BROOK
SW5
(SW2 LOCATED UPSTREAM)
APPROX. LOCATION OF EMERA CARDLOCK FACILITY (& OWS-2A)
CONSTRUCTION GATE (WELL SAMPLE LOCATION)
SW13
SW12
HIGHWAY 106
96-3A (DECOMMISSIONED)
96-3B (DECOMMISSIONED)
96-3C
1A
1B
1C
SW10
SCALE HOUSE (WELL SAMPLE LOCATION)
09-3B
96-2A (DECOMMISSIONED)
96-2B
96-2C (DECOMMISSIONED)
09-2C
CAUSEWAY TO PICTOU
2A
2B
3A
3B
3C
LANDFILL #2 (GENERAL OUTLINE)
SEDIMENTATION POND
SEDIMENTATION PONDS
(DECOMMISSIONED) 96-1A
96-1B
09-1A
LANDFILL #1 (GENERAL OUTLINE)
SW9
SW11
4B
5A
5B
SW4
4A
4C
ACCESS ROAD
MILL STOCKPILE AREA
MAINTENANCE BUILDING
OWS-3
LEACHATE LIFT STATION (MANHOLE SAMPLING POINT)
6A
6B
GARAGE
WAREHOUSE
PICTOU HARBOUR
OPERATIONAL LANDFILL #3 (GENERAL OUTLINE)
GRANTON ABERCROMBIE ROAD
8A (DECOMMISSIONED)
8B
7A
7B
7C
NORTHERN PULP NS CORP. MILL
RAW WATER SAMPLE
OFFICES
OWS-1
PARKING LOT
MILL LAB SAMPLE
CANSO CHEMICALS
PLANT
GUARD HOUSE
NORTH BROOK
ASH POND
10A (DECOMMISSIONED)
10B (DECOMMISSIONED)
9A
9B (DECOMMISSIONED)
9C
SITE ENTRANCE
EAST BROOK
TO EAST RIVER OF PICTOU HARBOUR
1 CHEMICAL UNLOADING AREA
2 CHEMICAL STORAGE AREAS
3 APPROX. 5 MILLION GALLON TANKS (BUNKER C)
4 FIRE PUMP HOUSE
5 BUNKER C DAY TANKS
6 WOOD ROOM
7 MAINTENANCE SERVICES BLDG
8 SCREENING ROOM
9 LIME KILN BLDG
10 BUNKER C (DAY-TANK) BLDG
11 SOUTHERN PERIMETER UNDERGROUND PIPING
12 AREA 1 (WOODS)
13 AREA 2 (CONCRETE CULVERT)
14 CAR WASH
LEGEND:
09-1A MONITOR WELL (DILLON, 2009)
1A MONITOR WELL (PDL, 1989)
96-1A MONITOR WELL (JWEL, 1996)
SW9 APPROXIMATE SURFACE WATER STATION LOCATION
OWS-1 OIL WATER SEPARATOR
GENERALIZED GROUNDWATER FLOW DIRECTION
DRAINAGE DITCH/STREAM AND SURFACE WATER FLOW DIRECTION
RAILWAY TRACKS
PROPERTY BOUNDARY
NOTES:
1. SW1, SW3, SW7 AND SW8 DELETED FROM PROGRAM.
2. MAP DETAILS ARE APPROXIMATE AND REPRESENT INFORMATION OBTAINED FROM PRECEDING PDL/JWEL REPORTS, SITE PLANS PROVIDED BY CLIENT AND NOVA SCOTIA PROPERTY ONLINE DATABASE. FEATURES SUCH AS LANDFILL FOOTPRINTS AND WELL LOCATIONS ARE INTENDED TO PRESENT GENERAL OVERALL SITE CONDITIONS.
APPROXIMATE SCALE: 1:7500
DILLON CONSULTING
DATE SEPTEMBER 2011
TITLE SITE LAYOUT, EXISTING SURFACE WATER AND MONITORING WELL LOCATIONS
PROJECT No. 11-5340
PROJECT NORTHERN PULP NOVA SCOTIA CORPORATION ABERCROMBIE PULP MILL - HYDROGEOLOGICAL EVALUATION
FIGURE No. 2
FIG2.dwg 11/09/01 15:44:18 G:\CAD\115340\