MALCOLM
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ENGINEERING FEASIBILITY STUDY
BB&S TREATED LUMBER SITE (#152123)
SPEONK, LONG ISLAND, NEW YORK

Prepared for:

**NEW YORK STATE DEPARTMENT OF
ENVIRONMENTAL CONSERVATION
DIVISION OF HAZARDOUS WASTE REMEDIATION**

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BB&S TREATED LUMBER SITE
FEASIBILITY STUDY

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1.0 INTRODUCTION

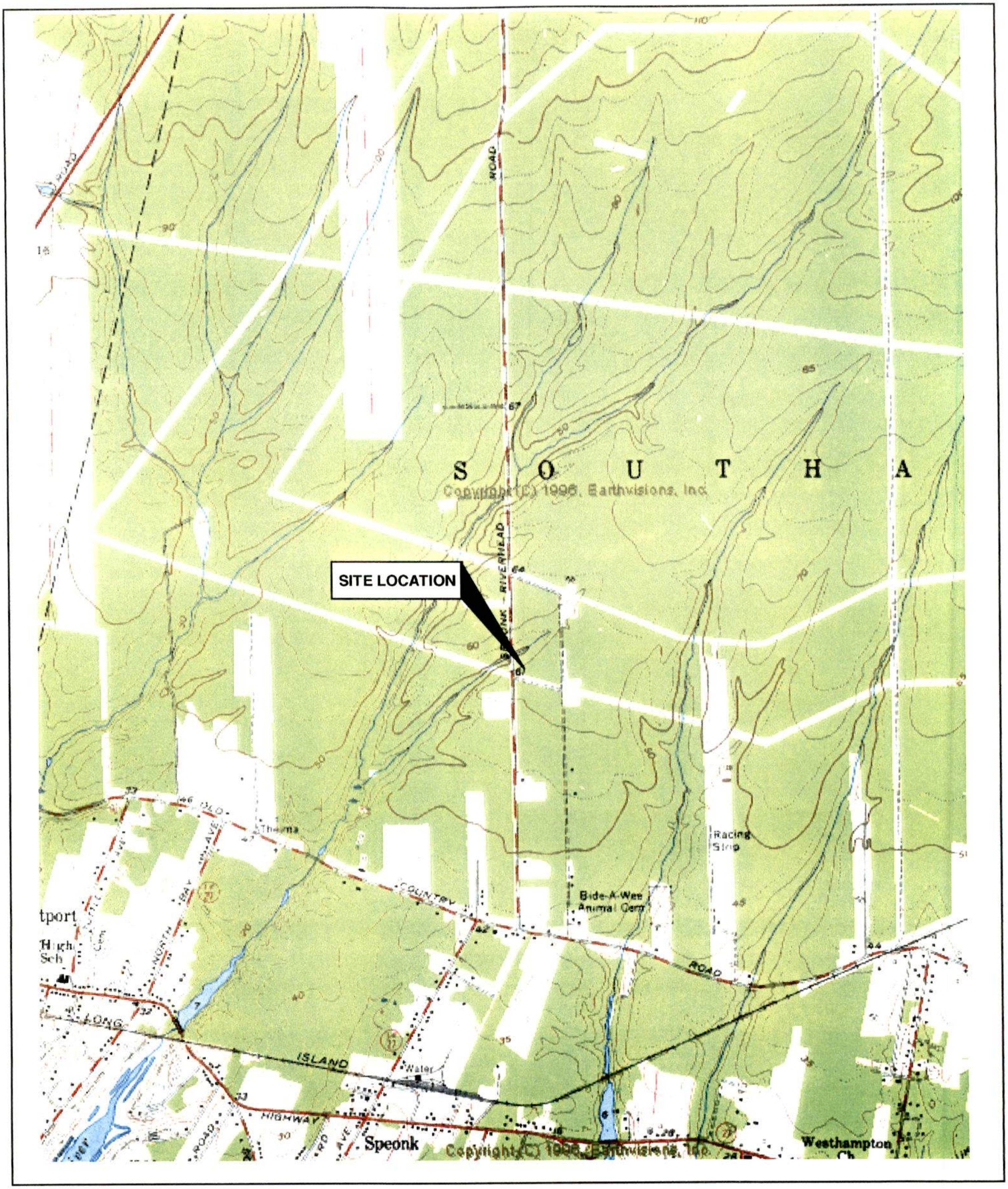
1.1 PURPOSE AND ORGANIZATION OF THE REPORT

The BB&S Treated Lumber Corporation is a former lumber preserving facility occupying an approximately 5-acre parcel of land. The wood treatment procedure used chromate, copper, and arsenate (CCA) as a wood preservative. The Site is located in a rural area on Speonk-Riverhead Road in the Hamlet of Speonk in the Town of Southampton, New York (Figure 1-1) and is registered as a "Class 2" site on the New York State Registry of Inactive Hazardous Waste Disposal Sites. Under the authority of Environmental Conservation Law Section 27, the New York State Department of Environmental Conservation (NYSDEC) assigned Malcolm Pirnie, Inc. to perform a Remedial Investigation/Feasibility Study (RI/FS) (Work Assignment #D002852-15) to determine the nature and extent of contamination, develop a conceptual model of the distribution and migration of contaminants to support selection of feasible alternatives for site remediation, and assess the applicability of updating/augmenting the existing reverse osmosis (RO) treatment system for remediation of groundwater.

Between February and August 1987, Groundwater Technology, Inc. (GTI) constructed and started-up an on-site RO groundwater treatment system. Through November 1990, the system had problems with bacterial buildup on the membranes and chronically exceeded hexavalent chromium SPDES discharge limitations.

During the period of March 1996 through November 1997, Malcolm Pirnie performed remedial investigation field activities in accordance with the NYSDEC-approved RI/FS Work Plan. Phase I field activities were conducted from March through August 1996 to define the nature and extent of contamination, delineate the groundwater contamination, assess the risks associated with the Site. During the course of the field investigative activities, a number of modifications/additions to the scope of work and/or investigative procedures were recommended on the basis of new information discovered and/or mitigating circumstances encountered in the field. These modifications are discussed in Section 3.0 of

FIGURE 1-1



Source: Eastport, NY USGS Quadrangle dated 1956

BB&S TREATED LUMBER
SPEONK, NEW YORK
SITE LOCATION MAP

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the Final Remedial Investigation (RI) Report submitted to NYSDEC on June 4, 1998. Based on the results of the Phase I RI, a Phase II RI was conducted from February through November 1997. The Phase II field activities were conducted to better define the extent of contamination in both on-site and off-site soil and groundwater. The results of these investigations are discussed in the Final RI Report.

The purpose of this Feasibility Study (FS) is to identify and evaluate feasible alternatives for remediation of groundwater and surface soils identified during the RI; and to develop a remedial approach which will provide reliable, long-term protection of human health and the environment in a cost-effective manner. A brief overview of the five sections contained in this FS is provided below.

- Section 1.0 presents a summary of the BB&S Treated Lumber site (the Site), including site history, and the nature and extent of contamination.

- Section 2.0 presents the remedial action objectives (RAOs) for the Site, identifies potential general response actions available to address the contaminants of concern in groundwater and soil, identifies potentially applicable, or relevant and appropriate Standards, Criteria, and Guidelines (SCGs) for the Site, and identifies and screens treatment technologies based on their applicability.

- Section 3.0 combines the screened technologies and general response actions into site-specific alternatives for remediation of the contaminated groundwater and soil. These remedial alternatives are then screened based on their effectiveness in achieving the RAOs for the site and their implementability.

- Section 4.0 provides a detailed analysis of the potentially feasible remedial alternatives (those alternatives that pass the preliminary screening in Section 3.0) based upon NYSDEC criteria for selection of a remedy, in accordance with its technical assistance and guidance memo (TAGM HWR 90-4030) entitled "Selection of Remedial Actions at Inactive Hazardous Waste Sites".

- Section 5.0 describes the recommended remedial alternatives for groundwater and soil, summarizes the rationale for remedy selection, and presents preliminary cost estimates.

1.2 BACKGROUND INFORMATION

1.2.1 Site Location and Description

The BB&S Treated Lumber site is located in the Pine Barren region of Suffolk County, Long Island, New York. The Pine Barren region covers approximately 50 square miles in southeastern Suffolk County. Land in the Pine Barrens is used for several purposes; principally housing, parks and recreation, and agriculture. Commerce and industry, transportation, and utilities comprise a smaller component of land use in the Pine Barrens.

The Site is surrounded by open pitch pine-red oak forests. The western boundary of the Site is Speonk-Riverhead Road. The properties located across Speonk-Riverhead Road are occupied by the Speonk Sand and Gravel Company to the west, and by an automobile restoration and dump operation to the east. The Site is enclosed by a fence, however, the unguarded entrance does not restrict unauthorized access.

No residences border the Site. The closest residence is approximately 300 feet southeast of the Site on 5th Avenue. The nearest business and residential development are located approximately 0.25 and 0.5 miles south (downgradient) of the Site. These residences use private groundwater wells as a sole source of drinking water. With the exception of a small paved parking lot located along Speonk-Riverhead Road and the concrete drip pad area, the Site is composed of unpaved sand and gravel. A framed building used for office space also houses the wood treatment process and the RO treatment system. The remainder of the site is used for storage of both treated and untreated lumber.

The Site is located within an area of gently sloping plains. Two small areas (less than one half acre each) of standing water are located in the northeast and southeast corners of the property. A catch basin collects runoff from the concrete drip pad area and outfalls on the west side of Speonk-Riverhead Road to an intermittent tributary to the East Branch River. Since the majority of the Site is unpaved, drainage of precipitation occurs primarily through infiltration into the ground. The Site is immediately underlain by Pleistocene outwash deposits consisting of fine- to coarse-grained sand and gravel to at least 120 feet below ground surface (bgs). The stratigraphy beneath the Site is fairly homogeneous. There are no significant or abrupt grain size changes that might be indicative of different geologic zones. The Gardiners Clay, underlying the outwash deposits beneath the Site, was not encountered in the deepest boring (i.e., 40 feet bgs) or while hydropunching at a maximum depth of 125 feet bgs.

1.2.2 Site History

Aerial photographs from 1959, 1969, 1976, and 1985 were reviewed and compared to existing Site features to trace the history of the Site and surrounding area. In 1959, the Site and most of the surrounding area consisted of scrub brush and farmland. An automobile dump was located to the northwest across Speonk-Riverhead Road, and cleared tracts of land were visible to the east and southeast of the Site. In 1969, what appeared to be another automobile dump occupied a tract of land east of the Site. In 1976, a portion of land (approximately 500 feet by 250 feet), in the southwest corner of the Site, had been developed and a small building had been constructed. The automobile dump to the east had expanded, although much of the surrounding area remained as scrub brush. In 1985, the Site had become a developed lumberyard and stacks of lumber throughout the property were clearly visible. With the exception of a quarry located west, across Speonk-Riverhead Road, further development was not evident.

Presently, the Site is an active lumberyard operated by Best Building and Supply Corporation. Although lumber is no longer treated on-site, treatment operations may resume in the future. The current operations consist of wholesale/retail distribution of treated and untreated lumber and assorted construction products. Much of the surrounding area appears the same as in 1985, with the exception of another sand and gravel quarry situated northeast of the Site.

1.2.3 Nature and Extent of Contamination

1.2.3.1 Characterization Methodologies

Characterization of the nature and extent of contamination associated with the BB&S Treated Lumber site was accomplished by the collection and analysis of 58 groundwater samples from on-site and off-site recovery, production, drinking, and monitoring wells, 12 on-site and 37 off-site surface soil samples, and 48 on-site and 2 off-site subsurface soil samples.

A detailed description of the groundwater and soil sampling programs and analytical results is presented in the RI report. In general, the majority of on-site contamination is confined to surface soils which have been impacted by site operations. Discharges of chromate, copper, and arsenate (CCA) are believed to have entered the soil and groundwater from concrete sumps located within the wood treatment building. Zinc is a minor component (less than 10 percent) of the CCA solution. Off-site soils in the tributary and along Speonk-Riverhead Road have been impacted by on-site contamination via surface water runoff. A brief summary of groundwater and surface soil contamination at the Site is presented below.

1.2.3.2 Groundwater

The average depth of all on-site groundwater monitoring wells is approximately 70 feet below grade. Groundwater is present within the homogeneous outwash deposits, beginning between 38 and 42 feet bgs, and flows towards the south. The upper glacial aquifer beneath the Site is highly transmissive and capable of producing large quantities of water.

Three rounds of groundwater samples were collected and analyzed for TAL (target analyte list) metals, including hexavalent chromium, for unfiltered samples. As part of the groundwater sampling program, the first sampling round was analyzed for both filtered (dissolved) and unfiltered (total) TAL metals. Since total and dissolved metals results correlated well, the subsequent two rounds of groundwater samples were analyzed for unfiltered (total) TAL metals only. The following discussion focuses on sample results for total metals.

Arsenic, total chromium, hexavalent chromium, and copper were detected in groundwater at concentrations exceeding NYSDEC Class GA water quality standards at all sampling locations except at wells DW-1, RW-3, MW-12, MW-13, and MW-16. The results from both total and dissolved metal analyses indicate a plume emanating from the wood treatment process building with minimum lateral dimensions of 1,200 feet in length and 250 feet in width. Total and hexavalent chromium, and copper concentrations exceeded NYSDEC Class GA standards in the deepest well sampled (i.e., RW-2 at 106 feet bgs). Zinc concentrations exceeded NYSDEC Class GA standards in RW-1, RW-2, and MW-8 during one round of sampling; concentrations in all other samples were well below NYSDEC Class GA standards.

The southern and western edges of the plume reach off-site as indicated by elevated levels of arsenic, chromium, hexavalent chromium, and copper in wells MW-14 and MW-15. The extent to which the plume extends to the south has not been determined. Chromium and hexavalent chromium were detected at concentrations exceeding NYSDEC Class GA standards at the wells located the farthest east and south of the treatment building (MW-1 and MW-14, respectively). The groundwater collected from the farthest downgradient well (MW-14) located to the south of the treatment building contained elevated chromium and hexavalent chromium concentrations in all three sampling rounds. Samples collected from wells MW-12 and MW-13, located upgradient and side gradient of MW-14, did not contain contaminant concentrations exceeding NYSDEC Class GA standards in either the first or third rounds of sampling. These results indicate that the groundwater plume is either discontinuous or narrow, escaping detection at MW-12 and MW-13. Possible reasons for a discontinuous groundwater contaminant plume are discussed in the RI Report.

Concentrations of iron, manganese, and sodium exceeded NYSDEC Class GA standards at a number of sampling locations. In general, samples collected from the upper glacial aquifer throughout Suffolk County contain high concentrations of iron, manganese, and sodium.

On-site Hydropunch® samples were analyzed for total (unfiltered) and dissolved (filtered) metals. Chromium, hexavalent chromium, copper, iron, lead, manganese, and zinc were detected in unfiltered samples, collected from all sampling intervals, at concentrations exceeding NYSDEC Class GA standards. Chromium (total and hexavalent) and copper were detected in filtered samples at concentrations exceeding NYSDEC Class GA standards in the two shallowest sampling intervals (i.e., 42 to 45, and 62 to 65 feet bgs) at two Hydropunch® sampling locations (i.e., HP-01 and HP-02). Based on these results, it is likely that contaminant concentrations detected in the deeper sampling intervals are attributed to sorption of these compounds to the suspended soil particles present in the unfiltered groundwater. Since these contaminants were not detected in the 82- to 85-foot sampling interval, groundwater contamination in the vicinity of HP-01 and HP-02 does not appear to extend deeper than 82 feet bgs.

Off-site Hydropunch® samples were analyzed for dissolved arsenic, chromium, hexavalent chromium, copper, lead, and zinc. Only lead was detected at concentrations slightly exceeding NYSDEC Class GA standards in the deepest sampling interval (i.e., 80 to 83 feet bgs) at Hydropunch® sampling location HP-10. Based on these results, the surface contamination has not impacted groundwater quality west of the Site.

1.2.3.3 Surface Soil

Surface soils (i.e., 0 to 3 inches below grade) along the perimeter of the concrete drip pad and near the center of the lumberyard contain concentrations of arsenic, chromium, and copper above NYSDEC cleanup objectives and site background levels. Zinc concentrations also exceed NYSDEC criteria in soils surrounding the concrete drip pad. Levels of arsenic and copper are slightly greater than NYSDEC cleanup objectives in catch basin and outfall soils. Chromium levels are above NYSDEC criteria at the catch basin but slightly below NYSDEC cleanup objectives at the outfall. Surface soil samples collected 200 feet downstream of the outfall in the intermittent tributary to the East Branch River contain arsenic, chromium, copper, lead, and zinc at concentrations above NYSDEC cleanup objectives. These results indicate that the contaminants from the Site have migrated off-site via the catch basin as a result of surface water runoff from the concrete drip pad area.

Iron was also detected at concentrations exceeding NYSDEC cleanup objective; however, elevated levels of iron were also detected in the Site background sample. Therefore, elevated concentrations of iron appear to be naturally occurring in the area and not related to site activities.

On September 30, 1998, NYSDEC collected additional surface and subsurface soil samples, not to supplement RI sampling efforts but to assist in defining the impacted areas for FS cost-estimating purposes. These sampling results will be discussed in Section 2.5, Volume and Extent of Impacted Media, and are tabulated in Appendix A.

1.2.3.4 Subsurface Soil

Arsenic, chromium, and copper were detected at concentrations exceeding NYSDEC cleanup objectives only in shallow soil along the perimeter of the office/treatment building (i.e., 0 to 2 feet bgs), and in the tributary to the East Branch River (i.e., 0 to 3 feet bgs). Iron was also detected at concentrations exceeding NYSDEC cleanup objective; however, elevated levels of iron were also detected in the Site background sample. Therefore, elevated concentrations of iron appear to be naturally occurring in the area and not related to site activities.

1.2.4 Contaminant Fate and Transport

Following review of the data obtained through remedial investigations, the potential contaminant migration pathways identified include:

- Migration of solubilized contaminants in soil into the groundwater due to infiltration of precipitation and/or contact of the groundwater with contaminated soils.
- Lateral movement in the groundwater via hydraulic gradients and vertical movement through the permeable overburden.
- Fugitive dust, generated from unvegetated loose sands, transported to off-site properties.
- Surface runoff from the soils surrounding the concrete drip pad, off-site via the intermittent tributary of the East Branch River.

Groundwater contamination was delineated during the RI and consists of a plume with minimum lateral dimensions of 1,200 feet in length and 250 feet (on-site) in width. The vertical extent of the groundwater plume varies with location. Groundwater contamination extends between 65 and 82 feet bgs at the southwestern corner of the treatment building (in the vicinity of HP-01) and to 106 feet bgs south of the treatment building in the vicinity of recovery well RW-2. The southern edge of the plume has not been defined but the plume has migrated at least to monitoring well MW-14, approximately 700 feet south of the BB&S property line. Off-site monitoring wells downgradient of the plume did not contain chemicals of concern above NYSDEC Class GA standards during the May 1996 sampling event. The closest residence is approximately 300 feet southeast (cross-gradient) of the Site and the closest downgradient receptor, an Autobody Shop, is located approximately 0.25 miles (1,320 feet) south of the Site. The potential exists for future contamination of off-site residential and commercial wells if measures to prevent further migration of the groundwater plume are not employed.

The transport of trace elements in soil may occur via the dissolution of metals into pore water and leaching to the groundwater. The sandy soils located at the Site do not readily bind inorganic compounds, thus they can mobilize to deeper soil layers and eventually to the groundwater.

To determine approximate travel times to potential downgradient receptors, a series of one-dimensional (ID) solute transport calculations were performed. Using reasonable assumptions with the best available data for the Site, total chromium concentrations exceeding 50 ug/L (Class GA Groundwater Quality Standard) would appear 0.25 miles downgradient in less than 14 years from the onset of contamination. Assuming the onset of contamination coincided with start-up of the collection system in 1987, the chromium concentration could reach 50 ug/L in 2001. A detailed presentation of the assumptions and results of the ID solute transport estimates has been included as Appendix B . In November 1998 through January 1999, the Suffolk County Department of Health Services (SCDHS) sampled six private wells located south of the Site for metals analyses. None of the samples exceeded the Class GA standards for chromium, and arsenic was not detected. The analytical data reports have been included as Appendix C.

The Site is composed of unvegetated, loose sands that have the potential, once airborne, to be deposited on off-site properties. Therefore, contaminated surface soils around the concrete drip pad and near the treated lumber storage area may be mobilized by site activities and wind.

Since the Site is devoid of vegetation, free movement of soil particles from surface run-off is possible. However, due to the permeability of the sandy soils, most surface water would probably quickly infiltrate into the soil. Arsenic, chromium, copper, lead, and zinc were detected at concentrations exceeding NYSDEC cleanup objectives in soils in the intermittent tributary to the East Branch River, extending approximately 200 feet downstream of the outfall, and in the ditches on either side of Speonk-Riverhead Road. The catch basin outfall and, ultimately, the tributary acts as a route for off-site migration of contaminants.

1.2.5 Public Health and Environmental Risk

1.2.5.1 Public Health Risk

A Human Health Risk Assessment was performed during the RI to evaluate the potential for adverse human health effects resulting from current or future exposure to contaminants at and migrating from the BB&S Treated Lumber site, without any action to control or mitigate such contamination. The analysis consisted of a discussion of potential human exposure pathways to site contaminants and an identification of potential receptors. Site workers, trespassers, future utility workers, and off-site residents were considered to be the potentially exposed population. This qualitative risk assessment was comprised of identification of hazards, assessment of exposure, assessment of toxicity, and characterization of risk.

Selection of chemicals of potential concern in groundwater was based on the exceedance of NYSDEC Class GA standards. Antimony, arsenic, total chromium, hexavalent chromium, copper, manganese, and zinc are considered chemicals of potential concern in groundwater at the Site. Selection of chemicals of potential concern in soils was based on exceedance of both NYSDEC cleanup objective and twice the average background concentration, at a frequency of detection greater than five percent. Arsenic, total chromium, copper, and zinc are considered chemicals of potential concern in on-site soils at the Site. Arsenic, total chromium, copper, lead, and zinc are considered chemicals of potential concern in off-site soils at the Site.

The USEPA ranks chemical carcinogens according to weight of evidence. Arsenic and hexavalent chromium are regarded as human carcinogens, and beryllium and lead are classified as probable human carcinogens. The chemical carcinogen classification for trivalent chromium was pending until USEPA, in September 1998, classified it as Class D (not carcinogenic). Antimony, trivalent chromium, copper, manganese, mercury, and zinc are not classifiable as to human carcinogenicity based on inadequate human and animal evidence of carcinogenicity or the absence of data.

The groundwater at the Site is classified by NYSDEC as Class GA, a drinking water source. In addition, the Site is located in an area classified as a sole-source aquifer. The groundwater from this aquifer is used by residents as a drinking water source and although no residential wells were impacted by the contaminants in the groundwater in 1996, the potential exists for future exposure from residential use. The groundwater plume serves as a continuing source of degradation of off-site groundwater. The significantly high concentrations of inorganic contaminants in groundwater, in excess of NYSDEC Class GA standards, warrant remedial action. Soil contamination also serves as a contributor to groundwater contamination. Remedial investigative activities indicated that most of the contamination was confined to the upper two feet. The surface soil currently poses a hazard to site workers and trespassers, as well as to future utility workers who may contact chemical contamination during daily operations or inhale fugitive dust generated by these activities. Contaminated soils have migrated off-site via the braided, intermittent tributary. Arsenic, chromium, copper, and lead were detected 200 feet downstream of the outfall pipe located on the west side of Speonk-Riverhead Road along the tributary to the East Branch River. In addition, low levels of arsenic, chromium, and copper were detected near the fence line in the predominant northeast windrow. Remedial action is warranted to prevent site workers, residents, and trespassers from potential exposure to site-related contaminants currently and in the future.

1.2.5.2 Environmental Risk

A fish and wildlife impact analysis was performed during the RI to identify actual or potential threats to fish and wildlife at the Site posed by site-related chemicals detected in soil and groundwater. The impact analysis included a characterization of the vegetation present and the value of these resources to humans, an evaluation of the potential exposure pathways to fish and wildlife, and a comparison of contaminant concentrations to regulatory criteria for the protection of fish and wildlife.

Contaminants from the Site have migrated off-site via surface runoff, as indicated by concentrations of antimony, arsenic, chromium, and copper in the soil samples collected from the catch basin and outfall, and downstream of the outfall in the intermittent tributary to the East Branch River, which exceeded background and toxicological benchmarks. To quantitatively determine the magnitude of risk associated with these four inorganic compounds detected in the soil, dose estimates in indicator species would need to be calculated. The potential risk is likely moderate for arsenic, chromium and copper due to these compounds being present at concentrations an order of magnitude greater than the toxicological benchmarks. Also, these compounds have migrated off-site via surface runoff from the concrete drip pad to the tributary where potential exposure to wildlife can occur.

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

2.1 INTRODUCTION

Based upon the contaminant characterization results, exposure pathways, and risk evaluation data presented in the RI, the following media contain site-related compounds exceeding cleanup criteria:

- An arsenic, total and hexavalent chromium-, and copper-contaminated groundwater plume with minimum lateral dimensions of approximately 1,200 feet long and 250 feet wide (on-site).
- Arsenic-, chromium-, and copper-contaminated shallow soils: on-site around the concrete drip pad, the office/treatment building, and in the center of the lumberyard; and off-site near the catch basin, catch basin outfall, and beyond the northeast fenceline in the predominant northeast windrow.
- Arsenic-, chromium-, copper-, and zinc-contaminated shallow soil off-site in the intermittent tributary to the East Branch River, extending approximately 200 feet downstream of the catch basin outfall, and in the ditches on the east and west sides of Speonk-Riverhead Road.

2.2 REMEDIAL ACTION OBJECTIVES

The identification of remedial action objectives (RAOs) for the media of concern components identified above, are based primarily on the human health and environmental risks posed by the site as identified in the health and ecological risk assessment of the RI report.

Based upon the findings presented above, the following RAOs have been developed for the BB&S Treated Lumber site:

- To prevent further off-site migration of metals-contaminated groundwater and soils to the environment which could result in adverse human health or environmental impacts.
- To prevent direct contact/ingestion of metals-contaminated on-site and off-site soils to eliminate human health and environmental risk.

2.3 GENERAL RESPONSE ACTIONS

Based on the RAOs presented above, the following subsections discuss the general response actions available for contaminated groundwater and shallow soil. Section 2.4 develops and screens the applicable treatment technologies associated with these general response actions.

2.3.1 Groundwater

As discussed in Section 2.2, the high concentrations of inorganics in the groundwater serve as a continuing source of degradation to off-site groundwater. The groundwater plume delineated during the RI is at least 1,200 feet long by 250 feet wide. Chromium is the primary contaminant of concern in groundwater and is prevalent in groundwater beneath and south of the Site. Arsenic and copper appear more sporadically in groundwater beneath the Site and do not appear in monitoring wells south of the Site. The vertical extent of the groundwater plume varies with location. Groundwater contamination extends between 65 and 82 feet bgs at the southwestern corner of the treatment building (in the vicinity of HP-01) and to approximately 106 feet bgs south of the treatment building in the vicinity of recovery well RW-2. The southern edge of the plume has not been determined but the plume has migrated at least the distance to monitoring well MW-14, approximately 700 feet south of the BB&S property line. Groundwater plume dimensions must be confirmed during the pre-design investigation.

The direction of groundwater flow is to the south with a hydraulic gradient of approximately 0.001. According to the information supplied by NYSDEC, the hydraulic conductivity of the surface stratum near the infiltration gallery is 3.6×10^{-3} cm/s. The upper glacial aquifer beneath the Site is highly transmissive and capable of producing large quantities of water. Estimated transmissivities range from 217,800 gpd/ft to 290,886 gpd/ft with an average of 267,612 gpd/ft.

General response actions for the groundwater are presented in Table 2-1, and include the following: containment; in situ treatment; ex situ on-site treatment followed by on-site or off-site disposal; and off-site treatment and disposal.

TABLE 2-1

BB&S TREATED LUMBER SITE
FEASIBILITY STUDY

GENERAL RESPONSE ACTIONS

Environmental Medium	General Response Actions
Groundwater	Containment
	In Situ Treatment
	Ex Situ Treatment and On-Site Disposal
	Ex Situ Treatment and Off-Site Disposal
	Off-Site Treatment and Disposal
Soil	Institutional Controls
	Containment
	In Situ Treatment
	Excavation and Off-Site Disposal
	Ex Situ Treatment and On-Site Disposal
	Ex Situ Treatment and Off-Site Disposal
	Off-Site Treatment and Disposal

2.3.2 Soil

As discussed in Section 2.2, on-site shallow soils contaminated with arsenic, chromium, and copper pose a hazard to trespassers as well as to current site workers and future utility workers who may inhale, or come in contact with, fugitive dust while performing their daily operations. The on-site shallow soils of concern are located around the concrete drip pad, office/treatment building, and in the lumberyard. In addition, a potential risk from exposure to arsenic, chromium, copper, and zinc exists for off-site wildlife. These compounds have migrated off-site as evidenced by contaminants detected in soil collected near the catch basin, catch basin outfall, within the tributary to the East Branch River, and in the predominant northeast windrow. Subsurface soil samples (up to 3 feet bgs) collected from the tributary contained concentrations of arsenic, total chromium, and copper that exceed NYSDEC cleanup criteria.

General response actions for the shallow contaminated soil are presented in Table 2-1. Alternatives for remediation include: institutional controls; containment; in situ treatment; excavation and off-site disposal; ex situ on-site treatment followed by either on-site or off-site disposal; and off-site ex situ treatment followed by off-site disposal. The general response actions for shallow soils will also eliminate the possible contributing inorganic load to the groundwater.

2.4 IDENTIFICATION OF SCGs

Section 121 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) establishes cleanup criteria for remedial actions performed under Sections 104 and 106. Remedial actions must achieve and maintain threshold criteria that: assure protection of human health and the environment; and comply with applicable, relevant and appropriate requirements (ARARs) of Federal environmental statutes, and New York State Standards, Criteria, and Guidelines (SCGs). For any material remaining on-site, unless an appropriate CERCLA waiver is invoked, the level or standard of control that must be met for the hazardous substance, or contaminant, is at least that of any "Standard and Criteria" and "Guidance" under New York State's environmental statue, or any more stringent applicable or relevant and appropriate standard, requirement, criteria, or limitation under any Federal environmental law.

A site's program must be designed so as to conform to standards and criteria that are generally applicable, consistently applied, and officially promulgated, that are either directly applicable, or that are not directly applicable but are relevant and appropriate, unless good cause exists why conformity should be dispensed with [(6NYCRR 375-1.10(c)(1)(i))]. Typically, the SCGs for a site are classified into three categories:

(1) Ambient- or chemical-specific SCGs are usually health- or risk-based numerical values (standards or criteria) that are applied to environmental media (i.e., air, water, soil) and must be achieved by a remedy for an affected medium or in discharges from the site to the ambient environment. In the absence of such values, chemical-specific SCGs may be derived using methodologies which, when applied to site-specific conditions, result in the establishment of numerical criteria. Examples of chemical-specific SCGs include New York State groundwater quality standards, and TAGM 4046 soil cleanup objectives.

(2) Action-specific SCGs are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous or toxic wastes. These action-specific requirements are not used to determine the remedial alternative; rather, they govern the design and performance of the alternative. Action-specific criteria may include discharge criteria for reinjection of treated groundwater.

(3) Location-specific SCGs are restrictions placed on the concentrations of hazardous substances or the conduct of activities solely because they are in specific locations.

SCGs will define the cleanup goals when they set an acceptable level with respect to site-specific factors. However, cleanup goals for some substances may be based on non-promulgated criteria and advisories rather than on SCGs if SCGs do not exist for those substances or an SCG alone would not be sufficiently protective in the given circumstances. To address these situations, "to be considered" (TBC) criteria, advisories, and guidance are identified if they exist.

Table 2-2 lists potential chemical-specific SCGs. Table 2-3 is a matrix that identifies potential remedial alternatives and whether the SCGS are applicable, or relevant and appropriate. Table 2-4 lists potential location-specific SCGs for the BB&S Treated Lumber site.

The procedure followed in the development of the SCGs is defined by NYSDEC in 6NYCRR Part 375-1.10. New York State groundwater quality standards and soil clean-up objectives were developed by NYSDEC as outlined in Water Quality Standards and Guidance Values (NYSDEC, 1990), and the Division Technical and Administrative Guidance Memorandum (TAGM) (NYSDEC, 1992), respectively.

2.5 VOLUME AND EXTENT OF IMPACTED MEDIA

2.5.1 Groundwater

The extent of the contaminated groundwater plume that exists on-site has been estimated at approximately 82 feet deep and 250 feet wide based on the results of sampling conducted during the RI. The dimensions of the groundwater plume south of the Site boundary have not been defined. The leading edge of the plume extends to monitoring well MW-14 and, therefore, at a minimum, the plume reaches 730 feet south of the Site. The width of the off-site plume is approximately 260 feet since contaminants of concern were not detected in monitoring wells MW-12 and MW-13 from May 1996 to February 1997 (at well depths of approximately 77 and 71 feet, respectively). The off-site groundwater plume is estimated to be at least 77 feet deep since high levels of chromium were detected in monitoring well MW-11 during the first round of sampling in May 1996. The groundwater plume may be less than 100 feet deep since no contaminants of concern were detected in recovery well RW-3. The depth of the off-site groundwater plume appears to vary greatly as no contaminants of concern were detected in the dissolved groundwater samples collected from nearby hydropunch location, HP-05, at depths between 42 to 103 feet. Groundwater plume dimensions must be confirmed during the pre-design investigation.

TABLE 2-2

BB&S TREATED LUMBER SITE
FEASIBILITY STUDY

POTENTIAL CHEMICAL-SPECIFIC STANDARDS, CRITERIA, AND GUIDELINES

Metal	Groundwater (mg/L)	Soil (mg/kg)			
	Class "GA" Groundwater Quality Standards (6NYCRR 703.5)	Soil Clean-up Objectives NYSDEC TAGM 4046			
		BG	CRDL	RSCG	TCLP (mg/L)
Arsenic	0.025	3-12	0.10	**7.5 or SB**	5.0
Chromium	0.050	1.5-40	0.10	**50[1] or SB**	5.0
Copper	0.200	1-50	0.25	**25 or SB**	NV
Zinc	0.300	9-50	0.20	**20 or SB**	NV

Notes:
BG = Eastern USA Background
CRDL = Contract Required Detection Limit
RSCG = Recommended Soil Cleanup Goal
SB = Site Background
TCLP = Toxicity Characteristic Leaching Procedure
NV = No value
(1) NYSDEC proposed new RSCG to replace 10 ppm in TAGM 4046.
Applicable soil clean-up objectives are in bold type.

TABLE 2-3

BB&S TREATED LUMBER SITE FEASIBLITY STUDY

REMEDIAL ALTERNATIVES AND THEIR POTENTIAL ACTION-SPECIFIC STANDARDS, CRITERIA AND GUIDELINES (SCGs)

SCGs	**Description/ Requirements**	**GROUNDWATER**				**SOIL**					
		Collection with Recovery Wells	**Ex Situ Treatment**		**Reinjection to Aquifer**	**Containment**	**In Situ Treatment**		**Ex Situ Treatment/ On-Site Disposal**		**Off-SiteTreatment and Disposal**
			Precipitation	**Electro-chemical**		**Asphalt Cover On-Site/Disposal of Off-Site Soils**	**S/S**	**Electrokinetic**	**S/S**	**Soil Washing**	
OSHA 29 CFR 1910.120	Hazardous waste operations and emergency response actions	A	A	A	N/A	A	A	A	A	A	A
6NYCRR 750-757	Regulations regarding the SPDES permit program	N/A	N/A	N/A	A	N/A	N/A	N/A	N/A	N/A	N/A
OGS 1.3.2	Procedures for effluent toxicity testing in the SPDES permit program	RA	RA	RA	A	N/A	N/A	N/A	N/A	N/A	N/A
OGS 1.3.7	Selection of analytical detection and quantitation limits in SPDES permit program	N/A	N/A	N/A	A	N/A	N/A	N/A	N/A	N/A	N/A
6NYCRR 370, 371	Identification and listing of haz. wastes; defines terms and stds. applicable to 370-374, 376	N/A	A	A	N/A	A	A	A	A	A	A
NYCRR 372	Regulates the hazardous waste (i.e., treatment process residuals) manifest system and record keeping requirements	N/A	N/A	A	N/A	A	N/A	A	N/A	A	A
NYCRR 373-2	Acceptable management of hazardous waste (i.e., treatment process residuals); tank/container management	N/A	RA	A	N/A	A	N/A	RA	N/A	RA	A
NYCRR 373-2.5	Generator Re quirement for Manifesting Waste for Off-Site Disposal	N/A	N/A	RA	N/A	A	N/A	N/A	N/A	A	A
6NYCRR 373-2.10	Tank Storage Design Requirements	A	A	A	A	N/A	A	A	A	A	N/A
6NYCRR 373-3	Chemical Physical & Biological Treatment Requirements	N/A	A	A	N/A	N/A	A	A	A	A	N/A
NYCRR 376	Identifies hazardous waste restricted from land disposal (e.g., treatment process residuals)	N/A	N/A	A	N/A	A	N/A	N/A	N/A	N/A	A
TAGM HWR-89-4031	Dust suppression during remedial action	N/A	N/A	N/A	N/A	A	N/A	N/A	A	A	A

TABLE 2-3

BB&S TREATED LUMBER SITE FEASIBLITY STUDY

REMEDIAL ALTERNATIVES AND THEIR POTENTIAL ACTION-SPECIFIC STANDARDS, CRITERIA AND GUIDELINES (SCGs)

SCGs	Description/ Requirements	GROUNDWATER				SOIL					
		Collection with Recovery Wells	Ex Situ Treatment		Reinjection to Aquifer	Containment	In Situ Treatment		Ex Situ Treatment/ On-Site Disposal		Off-SiteTreatment and Disposal
			Precipitation	Electro-chemical		Asphalt Cover On-Site/Disposal of Off-Site Soils	S/S	Electrokinetic	S/S	Soil Washing	
0 CFR 124, 144-148	Underground Injection Control (UIC) Program	A	N/A	N/A	A	N/A	N/A	N/A	N/A	N/A	N/A
0 CFR 264.2	Placement of a cap over wastes	N/A	N/A	N/A	N/A	RA	N/A	N/A	N/A	N/A	RA
49 CFR 107-171	DOT Rules for Hazardous Materials Transport	N/A	N/A	N/A	N/A	A	N/A	N/A	N/A	N/A	A

otes:
N/A = Not applicalbe or relevant and appropriate
A = Applicable
A = Relevant and appropriate

TABLE 2-4

BB&S TREATED LUMBER SITE
FEASIBILITY STUDY

POTENTIAL LOCATION-SPECIFIC STANDARDS, CRITERIA AND GUIDELINES (SCGs)

Federal ARARs	Description/Requirements	Applicability
NYSDEC TOGS 2.1.3	Primary Water Supply Aquifer (Principal Aquifer)	A
10 NYCRR 170	Protecct public water supplies	A
16 USC 703	Migratory Bird Treaty Act	A
6 NYCRR 182	State-Listed Endangered and Threatened Species of Fish and Wildlife	N/A
6 NYCRR 608	Protect certain classified streams	N/A
6 NYCRR 661	Limit/preclude excavation, filling, regrading in vegetated title wetlands or portions of adjacent areas	N/A
Title 23, Article 24 and 71 Environmental Conservation Law, Freshwater Wetlands Act	Preserve, protect and conserve freshwater wetlands	N/A
6 NYCRR 666	Procedural requirement for administration and management of the wild, scenic, and recreational rivers of NYS.	N/A
16 USC 470	Action to Recover/Preserve Artifacts of Historic Property	N/A

Notes:
TOGS = Technical and Operations Guidance Series
A = Applicable
N/A = Not applicable or relevant and appropriate

2.5.2 Soil

The presence of inorganic compounds of concern influence the volume and extent of soil potentially requiring remedial action. Two alternative clean-up scenarios were considered after evaluation of the data. Inorganic data from the RI (March 1996 through November 1997) and the supplemental FS sampling event conducted September 30, 1998 (see Appendix A) were compared to NYSDEC TAGM 4046 recommended soil clean-up goals listed in Table 2-2. Clean-Up Scenario A addresses on-site soil contaminated with arsenic in excess of 7.5 ppm, coincidentally reducing chromium concentrations to well below the proposed TAGM level. (A recommended soil clean-up goal for chromium of 50 ppm has been proposed by NYSDEC to replace the existing TAGM 4046 goal of 10 ppm, and is pending approval from the Commissioner.) Clean-Up Scenario B addresses on-site soil contaminated with chromium in excess of 50 ppm, coincidentally reducing arsenic concentrations to less than approximately 30 ppm. Both scenarios address off-site soil contaminated with arsenic in excess of 7.5 ppm and chromium in excess of 50 ppm. Figures 2-1 and 2-2 illustrate the areal extent of these impacted areas under Clean-Up Scenarios A and B. The volume of each impacted area using the two different exposure scenarios, along with the assumptions used to define the lateral extent of these areas, is summarized on Tables 2-5 and 2-6, respectively. The volume of impacted soil is estimated, based on the sampling conducted to-date, and will need to be better defined during the pre-design investigation.

Under Clean-Up Scenario A, all on-site soil sample results were compared to the NYSDEC TAGM 4046 recommended soil clean-up goal for arsenic of 7.5 ppm. Based on an analysis of existing soil data performed by SCDHS, addressing on-site soils contaminated with arsenic in excess of the TAGM clean-up goal (7.5 ppm) would likely result in on-site chromium residuals well below the 50 ppm TAGM clean-up goal for chromium (less than approximately 11 ppm). Table 2-5 presents the on-site and off-site impacted areas, with corresponding volumes, to be addressed under this clean-up scenario. Volumes have been established for cost estimating purposes assuming all off-site impacted areas will be addressed to an average depth of 2 feet. In some areas, the actual impacted depth, which will be confirmed during the pre-design investigation phase, may exceed three feet. With the

TABLE 2-5

BB&S TREATED LUMBER SITE
FEASIBILITY STUDY

VOLUME OF IMPACTED SOIL BASED ON CLEAN-UP SCENARIO A [1]

Location	Assumptions [2]	Surface Area sq.ft.	Depth ft.	Volume	
				cu.ft.	cu.yd.
On-Site:					
Lumber Yard	*Northern Area* - see Table 2-6	85,956	2.0	171,912	6,367
	Eastern Area - see Table 2-6	21,393	2.0	42,786	1,585
	Main Lumberyard Area - Limits are northern and eastern areas, storage building, drip pad, and office building.	134,375	0.5	67,188	2,488
	Area north of shed, approximately 125 ft (N-S) and 97 ft (E-W). Limits are 75 ft north of SP33-98, south to the shed, and west to the fence.	12,125	2.0	24,250	898
	Area surrounding SP25-98, approximately 60 ft (N S) by 84 ft (E-W). Limits are 30 ft north and south, and 42 ft west of SP25-98, and east to the fence.	5,040	2.0	10,080	373
Concrete Drip Pad	Extending 10 ft from the pad following the perimeter.	5,750	2.0	11,500	426
Office/Treatment Building	West side of building to fence, approximately 108 ft (N-S) by 50 ft (E-W). Limits are 10 ft south of concrete drip pad, 31 ft south of SB-02, and 50 ft west of building.	5,400	2.0	10,800	400
	South and west end of building to fence. Limits are 10 ft south of SB-04 and east edge of building.	3,471	2.0	6,942	257
	Subtotal On-Site:	**273,510**		**345,458**	**12,795**
Off-Site:					
Windrow	East of fence, approximately 56 ft (N-S) by 26 ft (E-W). Limits are 28 ft north and south of SP3-97, and 14 ft east of SP3-97.	1,456	2.0	2,912	108
Catch Basin	West of fence, approximately 65 ft (N-S) by 30 ft (E-W). Limits are 10 ft north of SP38-98, 10 ft south of the catch basin, east to the fence and west to the road.	1,950	2.0	3,900	144
Along Road	*East Side* - from road to grassed incline, approximately 302 ft (N-S) by 5 ft (E-W). Limits are 30 ft north of SRR-3 and 30 ft south of SRR-7.	1,510	2.0	3,020	112
	West Side - from road to treeline, approximately 302 ft (N-S) by 10 ft (E-W). Limits are 30 ft north of SRR-3 and 30 ft south of SRR-7.	3,020	2.0	6,040	224
Tributary/Outfall	Area angled in a SW-NE direction, approximately 60 ft wide from 10 ft off road to 36 ft southwest of SS-1F. Limits are 10 ft northwest of SP13-97 and 10 southeast of SP21-97, assuming additional 20-ft samples would have concentrations less than TAGM.	12,060	2.0	24,120	893
	Subtotal Off-Site:	**19,996**		**39,992**	**1,481**
			TOTAL VOLUME:	**385,450**	**14,276**

Notes:

[1] Clean-Up Scenario A addresses on-site soils contaminated with arsenic in excess of the TAGM 4046 recommended soil clean-up goal (7.5 ppm), coincidentally reducing chromium concentrations to well below the proposed TAGM level of 50 ppm.

[2] Limits for impacted areas are halfway to sample with arsenic concentrations below TAGM 4046 recommended soil clean-up goal. A reasonable distance was chosen when the nearest sample is at an unreasonable distance, or site features suggest isolated contamination.

TABLE 2-6

BB&S TREATED LUMBER SITE
FEASIBILITY STUDY

VOLUME OF IMPACTED SOIL BASED ON CLEAN-UP SCENARIO B (1)

Location	Assumptions (2)	Surface Area	Depth	Volume	
		sq.ft.	ft.	cu.ft.	cu.yd.
On-Site:					
Lumber Yard	*Northern Area* - from fence to shed, approximately 247 ft (N-S) by 348 ft (E-W). Limits are 30 ft north of SP-10, 50 ft south of SP23-98, and 42 ft west of SP20-98.	85,956	0.5	42,978	1,592
	Eastern Area - from fence to storage building, approximately 297 ft (N-S) by 73 ft (E-W). Limits are 46 ft north of SP13-98 and 46 ft south of SP6-98.	21,393	2.0	42,786	1,585
Concrete Drip Pad	Extending 10 ft from the pad following the perimeter.	5,750	2.0	11,500	426
Office/Treatment Building	West side of building to fence, approximately 108 ft (N-S) by 50 ft (E-W). Limits are 10 ft south of concrete drip pad, 31 ft south of SB-02, and 50 ft west of building.	5,400	2.0	10,800	400
	Subtotal On-Site:	**118,499**		**108,064**	**4,002**
Off-Site:					
Windrow	East of fence, approximately 56 ft (N-S) by 26 ft (E W). Limits are 28 ft north and south of SP3-97, and 14 ft east of SP3-97.	1,456	2.0	2,912	108
Catch Basin	West of fence, approximately 65 ft (N-S) by 30 ft (E-W). Limits are 10 ft north of SP38-98, 10 ft south of the catch basin, east to the fence and west to the road.	1,950	2.0	3,900	144
Along Road	*East Side* - from road to grassed incline, approximately 302 ft (N-S) by 5 ft (E-W). Limits are 30 ft north of SRR-3 and 30 ft south of SRR-7.	1,510	2.0	3,020	112
	West Side - from road to treeline, approximately 302 ft (N-S) by 10 ft (E-W). Limits are 30 ft north of SRR-3 and 30 ft south of SRR-7.	3,020	2.0	6,040	224
Tributary/Outfall	Area angled in a SW-NE direction, approximately 60 ft wide from 10 ft off road to 36 ft southwest of SS-1F. Limits are 10 ft northwest of SP13-97 and 10 southeast of SP21-97, assuming additional 20-ft samples would have concentrations less than TAGM.	12,060	2.0	24,120	893
	Subtotal Off-Site:	**19,996**		**39,992**	**1,481**
			TOTAL VOLUME:	**148,056**	**5,484**

Notes:

(1) Clean-Up Scenario B addresses on-site soil contaminated with chromium in excess of the proposed TAGM 4046 recommended soil clean-up goal (50 ppm), coincidentally reducing arsenic concentrations to less than approximately 30 ppm..

(2) Limits for impacted areas are halfway to sample with arsenic and/or chromium concentrations below TAGM 4046 recommended soil clean-up goals. A reasonable distance was chosen when the nearest sample is at an unreasonable distance, or site features suggest isolated contamination.

exception of the main lumberyard area, all on-site impacted areas are assumed to be addressed to a depth of 2 feet since several samples collected from shallow subsurface soils exceed the TAGM clean-up goals. The main lumberyard area is assumed to be addressed to a depth of 6 inches since this particular area is minimally impacted in the subsurface. Therefore, the resulting in-place volume of impacted soil under Clean-Up Scenario A is estimated at 12,800 cubic yards on-site and 1,500 cubic yards off-site. It has been assumed that the quantity of soil requiring remedial action will increase in volume by 25 percent during excavation and handling. Table 2-7 summarizes the quantities of soil to be addressed under this clean-up scenario.

Under Clean-Up Scenario B, all on-site soil sample results were compared to the NYSDEC TAGM 4046 recommended soil clean-up goal for chromium of 50 ppm. Based on an analysis of existing soil data performed by SCDHS, addressing on-site soils contaminated with chromium in excess of the TAGM clean-up goal (50 ppm) would likely result in on-site arsenic residuals of less than approximately 30 ppm. Table 2-6 presents the on-site and off-site impacted areas, with correspondence volumes, to be addressed under this clean-up scenario. Volumes have been established for cost estimating purposes assuming all off-site impacted areas will be addressed to an average depth of 2 feet. In some areas, the actual impacted depth, which will be confirmed during the pre-design investigation phase, may exceed three feet. With the exception of the northern area of the lumberyard, all on-site impacted areas are assumed to be addressed to an average depth of 2 feet for the purpose of volume estimation since:

- Subsurface soil concentrations exceed the TAGM clean-up goal for chromium.
- Surface soil concentrations far exceed the TAGM clean-up goal for chromium.

Only the northern area of the lumberyard is assumed to be addressed to a depth of 6 inches since this particular area is minimally impacted in the subsurface. Therefore, the resulting in-place volume of impacted soil under Clean-Up Scenario B is estimated at 4,000 cubic yards on-site and 1,500 cubic yards off-site. It has been assumed that the quantity of soil will

TABLE 2-7

BB&S TREATED LUMBER SITE
FEASIBILITY STUDY

SUMMARY OF SOIL QUANTITIES FOR TWO CLEAN-UP SCENARIOS

Soil Volume/Weight	Clean-Up Scenario A(1)	Clean-Up Scenario B(2)
In-Place Volume (cy):		
On-site	12,800	4,000
Off-site	1,500	1,500
Total	**14,300**	**5,500**
Excavated Volume (cy): (3)		
On-site	16,000	5,000
Off-site	1,875	1,875
Total	**17,875**	**6,875**
Weight (ton): (4)		
On-site	17,920	5,600
Off-site	2,100	2,100
Total	**20,020**	**7,700**

Notes:

(1) Clean-Up Scenario A addresses on-site soils contaminated with arsenic in excess of the TAGM 4046 recommended soil clean-up goal (7.5 ppm), coincidentally reducing chromium concentrations to well below the proposed TAGM level of 50 ppm.

(2) Clean-up Scenario B addresses on-site soil contaminated with chromium in excess of the proposed TAGM 4046 recommended soil clean-up goal (50 ppm), coincidentally reducing arsenic concentrations to less than approximately 30 ppm.

(3) Excavated volume = 1.25 x in-place volume.

(4) 1 cubic yard = 1.4 tons

increase in volume by 25 percent during excavation and handling. Table 2-7 summarizes the quantities of soil to be addressed under this clean-up scenario.

2.6 IDENTIFICATION AND SCREENING OF APPLICABLE TECHNOLOGIES

This section develops general response actions into technology alternatives for the remediation of groundwater and shallow soils at the BB&S Treated Lumber site. Table 2-8 lists the technologies considered for both the contaminated groundwater and shallow soils. The following subsections describe each of the technologies and discuss briefly their applicability to the conditions at the Site based on: physical and chemical characteristics of contaminants that determine the applicability of the technologies; and the performance and operating reliability of the technologies.

2.6.1 Groundwater

2.6.1.1 Containment

Containment of groundwater consists of constructing subsurface barriers to restrict the movement of groundwater, or removing the groundwater (via pumping) at a rate greater than or equal to the aquifer production rate. Typical subsurface barriers include slurry walls, sheet piling, and grouting. These technologies are "keyed-in" to a confining unit (a unit of very low vertical permeability), thereby preventing the downward migration of contamination. Since the confining layer (Gardiners Clay) beneath the BB&S site is deep, approximately 150 feet below grade, and the aquifer is highly transmissive and capable of producing large quantities of water, subsurface barriers will not be evaluated for groundwater control at the Site.

2.6.1.1.1 Collection

Groundwater collection through pumping is frequently used to control the migration of contaminant plumes through the hydraulic influence of groundwater withdrawal. Pumping wells and groundwater collection trenches are the common pumping methods.

TABLE 2-8

BB&S TREATED LUMBER SITE
FEASIBILITY STUDY

IDENTIFIED REMEDIAL TECHNOLOGIES

Environmental Medium	General Response Actions	Remedial Technologies
Groundwater	Containment	Subsurface Barriers, Collection
	In Situ Treatment	Absorption, Permeable Barrier Wall, Electrokinetic Remediation, Biological Processes
	Ex Situ Treatment and On-Site Disposal	Physical (reverse osmosis, electrochemical), Chemical (precipitation)
	Ex Situ Treatment and Off-Site Disposal	Physical (reverse osmosis, electrochemical treatment), Chemical (precipitation)/Trucking Off-Site or Discharging to Sewer System
	Off-Site Treatment and Disposal	Direct pumping to the Riverhead Sewer District or permitted trucking to disposal facility.
Soil	Institutional Control	Signs, Fencing, Deed Restriction.
	Containment	Various Cap/Cover Alternatives (topsoil, synthetic membrane, asphalt, RCRA Part 373)
	In Situ Treatment	Soil Flushing, Sorption, Ion Exchange, Chemical Treatment, Attenuation, Reduction, Electrokinetic Remediation, Solidification/Stabilization (S/S), Phytoremediation
	Excavation and Off-Site Disposal	Removal and transportation to permitted hazardous waste landfill
	Ex Situ Treatment and On-Site Disposal	Physical (S/S), Physical/ Chemical (soil washing, acid extraction), Thermal Treatment
	Ex Situ Treatment and Off-Site Disposal	Physical (S/S), Physical/ Chemical (soil washing, acid extraction), Thermal Treatment
	Off-Site Treatment and Disposal	Physical (S/S)

As described in the RI report, a three-dimensional groundwater model was used to evaluate the potential effectiveness of the existing recovery system. The recovery system was simulated using MODFLOW at a pumping rate of 85 gpm from recovery wells RW-1, RW-2, and RW-3 for a combined rate of 255 gpm. The resulting capture zone encompassed the contaminant plume to RW-3 but not the portion of the plume near MW-14.

Additional MODFLOW simulations were performed in December 1998 to assist in developing cost estimates for groundwater remedial alternatives that encompassed the off-site portion of the groundwater plume. Two groundwater remedial scenarios were evaluated with MODFLOW to provide a range of expected pumping rates and, hence, groundwater volumes that would require treatment. Further sampling of off-site downgradient wells will be necessary during the pre-design investigation to determine the most realistic scenario. Neither scenario took into account possible groundwater withdrawal from adjacent commercial or residential off-site wells. The effluent from the groundwater treatment system would be re-injected to the aquifer near the northern property boundary. The method of injection (e.g., infiltration gallery, surface application, deep well injection) will be determined during the pre-design investigation.

An *On-Site Groundwater Remedial Scenario* involving operating recovery wells RW-1, RW-2, and RW-3 at pumping rates of 50 gpm, 25 gpm, and 30 gpm, respectively, was evaluated for a combined pumping rate of 105 gpm. This scenario may be appropriate if a significant portion of the contaminant plume has not extended south of monitoring well MW-14. If the majority of the plume upgradient of RW-3 is captured, natural attenuation processes may be able to reduce groundwater concentrations downgradient of RW-3 to acceptable levels. An *On-Site and Off-Site Groundwater Remedial Scenario* involving operating recovery wells RW-1, RW-2, RW-3, and RW-4 at pumping rates of 50 gpm, 25 gpm, 30 gpm, and 30 gpm, respectively, was evaluated for a combined pumping rate of 135 gpm. Proposed recovery well RW-4 would be located downgradient of monitoring well MW-14 at the leading edge of the plume. This scenario may be necessary if groundwater sampling downgradient of MW-14 reveals that contaminant levels are approaching NYSDEC Class GA standards. Recovery well RW-4 would capture that portion of the plume that escapes capture with the three-well scenario. Since the leading edge of the plume has not been defined, RW-4 was assumed for cost-estimating purposes to be located approximately 550 feet downgradient of recovery well RW-3. This estimated location was based on time of travel calculations.

The results from the MODFLOW predictive calculations are highly uncertain because the volumes of groundwater to be pumped are sensitive to several parameters that have not been adequately characterized during field investigations performed to-date, viz., solute fate and transport characteristics, hydraulic properties of the aquifer, spatial distribution of the plume, and well locations. Also, the plume downgradient of monitoring well MW-14 must be defined before the additional recovery well can be appropriately located. As a result of the limitations of the data and uncertainties of the dimensions of the plume, the flow rates of all groundwater remedial alternatives have been conservatively multiplied by 1.5 times the predicted pumping rates. Thus, groundwater treatment system cost estimates will be developed using pumping rates for the On-Site Groundwater Remedial Scenario and the On-Site and Off-Site Groundwater Remedial Scenario of 158 gpm and 203 gpm, respectively. The full report describing the assumptions and results of the MODFLOW simulations has been included as Appendix D.

2.6.1.2 Treatment

Treatment of contaminated groundwater may be performed either in situ (i.e., in-place below ground) or ex situ (i.e., above ground) when combined with recovery wells as discussed in the previous section.

2.6.1.2.1 In Situ Treatment

In situ treatment utilizes physical, chemical and/or biological methods to remove or degrade contaminants in-place. Absorption, permeable barrier wall, electrokinetic decontamination, and bioremediation are potentially applicable in situ technologies used to treat the heavy metal-contaminated groundwater at the Site.

Absorption

Absorption is a technology used to remove dissolved hazardous substances such as toxic metals. An example is the Forager™ sponge which is a porous open-celled sponge that contains a water-soluble polyamide chelating polymer. This polymer has a selective affinity for certain species of metals dissolved in aqueous solutions. A large number of these one cubic centimeter sponges are confined within a tubular fish net enclosure and may be lowered vertically into circular shafts drilled into the ground, or stacked horizontally in a trench within the contaminated groundwater plume. Groundwater flows by natural gravity through the absorption units. Saturated units must be removed and disposed, or subjected to a regeneration treatment.

A SITE demonstration conducted in 1994 resulted in removal efficiencies for chromium of less than 50 percent. As of January 1997, no full-scale cleanup had been completed with this in situ technology. Therefore, this technology will not be evaluated for implementation at the BB&S Treated Lumber site.

Permeable Barrier Wall

A permeable barrier wall (PBW) removes ions from groundwater via adsorption onto ion exchange media placed in the subsurface perpendicular to groundwater flow. This adsorption technology relies on the natural hydraulic gradient which causes groundwater to migrate to the PBW and to flush contaminated soil. The PBW would contain appropriate media (e.g., zeolite) to adsorb heavy metals and would be installed downgradient of the groundwater plume. A secondary wall may be installed downgradient of the primary wall should the concentration of the contaminants of concern be higher than anticipated, due to lower than anticipated adsorptive capacity or groundwater channeling through the primary PBW. Adsorption through a PBW may be considered as an applicable technology to treat contaminated groundwater at the Site.

Electrokinetic Decontamination

Electrokinetic decontamination was developed to treat contaminated groundwater containing toxic cations (e.g., heavy metals including chromium, copper, and zinc) and toxic anions (e.g., arsenic). An electrokinetic ring fence uses a chain of electrode pairs deployed in the ground to recover ionic contamination from groundwater as it flows past the electrodes. Ion-permeable electrolyte casings are placed in the zone of contaminated groundwater and connected to a centralized electrolyte management system. Each casing has an electrode inside and together these casings form alternating rows of anodes and cathodes. Electrolyte is circulated in a closed loop between the electrode casings and an electrochemical ion exchange (EIX) based electrolyte management system. Once the electrodes are energized, electrolysis of water in the electrolyte forms hydrogen ions at the anodes and hydroxide ions at the cathodes. These ions migrate through the casing into the groundwater to generate a temporary and localized pH shift that desorbs contaminating ions. Acids are not pumped directly into the groundwater.

Once desorbed, the contaminating ions migrate under the influence of the applied potential (electromigration) to their respective electrodes (anodes for anions, cathodes for cations), where they pass through the electrode casing walls and are taken up by the circulating electrolytes. Careful management of the pH and other electrolyte conditions within the electrode casings is the critical element in controlling system performance. Contaminants are selectively recovered from the circulating electrolytes as they pass through the EIX. Soluble but benign elements are returned to the soil to maintain soil properties. Periodically, the EIX units are regenerated offline and contaminants are recovered in a concentrated, pure, and reusable form. Electrokinetic decontamination may be considered applicable for in situ remediation of the groundwater at the Site.

Biological Processes

Bioremediation is a treatment process that uses naturally occurring microorganisms to break down, or degrade, hazardous substances into less toxic or nontoxic substances. Microorganisms eat and digest organic substances such as fuels and solvents that are hazardous to humans. Contaminants targeted for bioremediation treatment are non-halogenated volatile and semi-volatile organics and fuels. The effectiveness of bioremediation is limited at sites with high concentrations of metals, highly chlorinated organics, or inorganic salts because these compounds are toxic to microorganisms. In contrast to organic contaminants, most inorganic contaminants cannot be degraded, but must be remediated by altering their transport properties. Immobilization, mobilization, or transformation of inorganic contaminants via bioaccumulation, biosorption, oxidation, reduction, methylation, demethylation, metal-organic complexation, ligand degradation, and phytoremediation are the various processes applied in the bioremediation of inorganic compounds. Phytoremediation processes will be retained for further analysis.

2.6.1.2.2 Ex Situ Treatment and On-Site Disposal

Collection of groundwater followed by on-site treatment/disposal would involve treatment using physical or chemical technologies to reduce contaminant concentrations to levels that would be acceptable for on-site reinjection to the groundwater aquifer. The various treatment processes specific to each technology are presented below.

Physical Treatment

Physical treatment of groundwater involves the removal of contamination through enhancement of naturally-occurring phenomena such as settling, volatilization, adsorption, etc. Given the nature of the groundwater contamination at the Site (i.e., heavy metals), the most common and applicable physical treatment technologies include reverse osmosis and electrochemical treatment.

Reverse Osmosis

Reverse osmosis (RO) is the reversal of natural osmosis by applying pressure greater than the osmotic pressure on the more concentrated side of the two solutions which are separated by a semipermeable membrane. This pressure forces the solvent through the membrane from the more concentrated side to the less concentrated side. The retained solution is called the concentrate and the solution passing through the membrane is called the permeate. Concentrate could be recycled to the wood preserving treatment process.

The performance of membranes can be quantified by determining the percent of salt passage and salt rejection. Reverse osmosis membranes reject most of the dissolved inorganic materials. The salt rejection characteristics of the membrane determine which salts are being retained in the concentrate stream and their concentration.

A reverse osmosis treatment system currently exists on-site. Although the system has not been effective in removing the metal contaminants from the collected groundwater, an engineering review revealed that the system was improperly designed (Malcolm Pirnie, 1998). A properly designed RO treatment system can effectively reduce arsenic, chromium, and copper levels below NYSDEC groundwater quality standards and should be able to achieve 90 percent water recovery. This technology will be retained for further analysis.

Electrochemical Treatment

Electrochemical treatment is designed to remove a mixture of heavy metals from contaminated groundwater. Contaminated groundwater is pumped through an electrochemical cell. The cell contains several cold-rolled steel plates separated by a small gap through which the process water flows. A direct current (DC) power supply is connected between the cell's two end electrodes. As current flows from one side to the other through the process water, an electrochemical reaction occurs during which the positively charged electrodes (anodes) emit ferrous ions. The free ferrous ions released from the electrodes attract contaminants into the insoluble matrix formed as the ions come out of solution. The process water then exits the cell to a reactor tank where hydrogen peroxide is added to oxidize the ferrous hydroxide to its ferric form. A small amount of polymer flocculent is added to the reactor tank effluent before the process water flows to a clarifier. The solids settle to the bottom of the clarifier and the overflow moves through a polishing filter before exiting the system. The settled solids are sent to a plate-and-frame filter press for dewatering and off-site disposal. The contaminant removal mechanisms include new compound formation, surface complexation and electrostatic attractions. Multiple metals can be removed simultaneously at a single pH with no chemical addition. An electrochemical treatment system may be considered applicable for remediation of the groundwater at the BB&S Treated Lumber site.

Chemical Treatment

The most common form of chemical treatment of heavy metal-contaminated groundwater is precipitation. The addition of sulfides, carbonates, and hydroxides to metal-contaminated groundwater can immobilize metals by precipitation of a highly insoluble compound. The following are considerations in the precipitation of heavy metals:

- Choice of reactant.
- Temperature of groundwater.
- Valence state of the metal in the groundwater.
- Potential colloidal state of the precipitated material.
- Possible formation of complex ions.

Chemical precipitation may be considered applicable as a groundwater treatment technology at the Site.

2.6.1.2.3 Ex Situ Treatment and Off-Site Disposal

On-site treatment of recovered groundwater followed by off-site disposal would involve the same treatment options discussed in Section 2.4.1.2.2; however, treated water would be sent to an off-site receptor (e.g., local POTW or to the outfall that drains to an intermittent tributary to East Branch River). Since on-site reinjection to the aquifer would be feasible, and the distance to the nearest sewer main is at least 3 miles from the Site, the off-site disposal option will not be retained for further evaluation.

2.6.1.2.4 Off-Site Treatment and Disposal

Off-site treatment/disposal of groundwater at the BB&S site would involve direct pumping to the Riverhead Sewer District, or permitted trucking off-site to a treatment/disposal facility. Discharge of untreated groundwater would likely have metal concentrations in excess of local sewer use ordinance limits. In addition, the large volume of water generated and the distance to the nearest sewer main (at least 3 miles) would make off-site disposal of untreated groundwater to the local POTW impractical.

Transporting groundwater to a permitted off-site treatment and disposal facility is advantageous at certain sites where there is limited space for treatment or when the treatment duration is anticipated to be short, thereby causing off-site treatment to be more cost effective than the purchase and operation of on-site treatment equipment. Aside from increased cost, the disadvantages of off-site treatment include the added risk of transporting the contaminated water and the limited availability of such off-site treatment facilities. Therefore, the off-site treatment and disposal scenario will not be retained for further analysis.

2.6.2 Soil

2.6.2.1 Institutional Controls

Although a fence surrounds the boundary of the Site, the unguarded entrance does not restrict unauthorized access. The institutional controls alternative may include measures such as implementing deed restrictions to prevent future inappropriate uses of the Site, securing the fence around the perimeter of the Site, posting warning signs (e.g., "warning" and "no trespassing" signs), adding fences to restrict access to the more heavily contaminated areas of the Site, and potentially hiring a security service to patrol the site perimeter. Institutional controls alone would not protect on-site workers from exposure to contaminated soil; however, certain control measures may reduce the risk posed to trespassers and on-site personnel until and during implementation of remedial actions.

2.6.2.2 Containment

Containment may involve various capping/covering technologies. Monitoring may be required after implementation of this remedy since contaminants would remain in-place. The cap/cover may require regular maintenance, or replacement if it should fail to meet the applicable standards, criteria, or guidelines. Covering typically constitutes placing one or more layers of clean material over the contaminated soils to reduce infiltration of precipitation and/or prevent direct contact, erosion, and migration of contaminated soil. The cover technologies that will be considered for the BB&S Treated Lumber site soils, with the exception of those soils off-site in the tributary to the East Branch River, are identified below.

Topsoil Cover

A topsoil cover is typically used only for the purpose of preventing erosion and mitigating contact with contaminated materials. It is only partially effective in reducing infiltration of precipitation or surface water through the soil by promoting evapotranspiration and runoff by improved vegetation cover. An approximate 6-inch thick layer of topsoil would be place over the contaminated soils and seeded to promote vegetative growth for erosion control and evapotranspiration. Since a topsoil cover is not practical for Site activities (i.e., heavy truck traffic) and cannot limit surface water infiltration, this technology is not considered to be an appropriate containment alternative for the contaminated soils at the Site.

Synthetic Membrane/Soil Cover System

The synthetic membrane/soil cover system would be effective in mitigating erosion and contact with contaminated soils, and limiting infiltration of surface water while minimizing the total cover thickness. A synthetic membrane/soil cover system consists of a synthetic fabric and geogrid synthetic drainage material. The synthetic fabric functions to protect the plastic sheeting from perforation due to rocks or sharp objects. The top layer of synthetic fabric is covered with a 12-inch layer of topsoil and seeded to promote vegetative growth for erosion control purposes. Truck traffic may jeopardize the integrity of the vegetative cap, resulting in possible erosion, damage to the membrane, and infiltration. Therefore, a synthetic membrane/soil cover system will not be further evaluated.

Asphalt Cover

An asphalt cover would be effective in mitigating erosion and contact with contaminated materials at a hazardous waste site, and would limit infiltration of surface water to various degrees depending upon its thickness and composition. An asphalt cover may be applicable and will therefore be retained for further evaluation.

6NYCRR Part 373 (RCRA) Cap

The RCRA cap is implemented at hazardous waste sites. This type of cap is especially useful when the potential for groundwater contamination from the hazardous constituents exits. The initial layer (placed following site grading to facilitate surface water run-off) consists of 24 inches of low permeability, recompacted soil followed by a synthetic membrane liner, a 12-inch sand drainage layer, a layer of synthetic filter fabric, and a 24-inch barrier protection layer. The final layer consist of 6 inches of topsoil seeded to promote vegetative growth for erosion control purposes. Placement of this cap would result in a minimum elevation in grade of approximately six feet. Since this increased soil elevation would interfere with operations at the Site, this containment technology for on-site soils will not be evaluated further.

2.6.2.3 In Situ Treatment

In situ treatment involves the immobilization, transfer, or destruction of hazardous materials in-place (i.e., without excavation). The technologies discussed may be cost-effective in situations where contamination from hazardous materials has not yet reached groundwater, but might if no action is taken. The in situ technologies applicable to shallow contaminated soils are described below. In situ vitrification is not an applicable technology for Site soils since it is typically used to treat contaminated soils at a minimum depth of 8 to 10 feet bgs. In addition, bioremediation will not be considered due to the limited effectiveness of degrading heavy metals such as those encountered at the Site.

Soil Flushing

Soil flushing involves extraction of contaminants from the soil with a suitable solvent such as water or other aqueous or non-aqueous solutions. A system for applying the contaminated area with solvent and for capturing the elutriate needs to be evaluated. This might involve flooding the site and collecting the elutriate in a series of shallow well points or subsurface drains, or appropriate placement of recharge and discharge wells. After treatment, the elutriate might be discharged to a receiving water body or sewer, or it might be recycled through the contaminated area. Soil flushing is potentially effective for inorganics, however, formulation of a single flushing fluid for multiple inorganics is complicated. With soil flushing, contaminated toxicity is not reduced, treatment times are lengthy, and great care must be exercised to ensure that all contaminated groundwater is recaptured to avoid off-site migration prior to treatment. Implementation difficulties would be encountered since the areas potentially requiring remedial action are scattered on-site and off-site. As a result of these potential problems, in situ soil flushing will not be retained for further evaluation.

Sorption

Heavy metal contaminants in soil may be immobilized by mixing the contaminated soil with a suitable adsorbent, or mixture of adsorbents, or with a metal complexing agent that binds the metal into a complex that strongly adsorbs to soil. The adsorbent, or complexing agent, may be mixed into the soil with conventional power implements or tillers. Suitable adsorbents for heavy metals include various agricultural products and by-products, such as straw, sawdust, peanut hulls, bark, and activated carbon. For maximum efficiency, the pH of the soil generally needs to be above 6.5. To maintain a high pH, lime can be mixed into the soil with the adsorbent. The amount of adsorbent added must be sufficient to tie up the releasable heavy metals, and periodic re-liming may be necessary to maintain the treated system at the required pH. Due to the need for continual monitoring of soil pH (possibly lime addition) and the potential for re-release of the metal contaminants, this in situ treatment technology will not be retained for further analysis.

Ion Exchange

Ion exchange is a process by which species, such as zeolites, have the capacity to release ions of one type and preferentially adsorb ions of another type at the vacated lattice position (i.e., exchange one type of ion for another). Cation exchangers have replaceable cations and anion exchangers have replaceable anions. Zeolites are a family of crystalline-hydrated alumino silicates with high selectivity and capacity for adsorption of heavy metal cations. Zeolites are stable over the pH range of 6 to 12, but begin to degrade around pH 4-5 and below. Therefore, zeolites should be used only in alkaline or limed soils where the pH is maintained above 6. The concentration of sodium exceeded NYSDEC Class GA standards in some groundwater samples collected on-site. This technology will not be evaluated further, since ion exchange polymers generally lack specificity for particular ions and, therefore, usually saturate quickly with species such as sodium.

Chemical Treatment

Chemical treatment involves the use of a buffering agent with phosphate compounds to render soils contaminated with heavy metals (e.g., arsenic, cadmium, chromium, copper, lead, and zinc) nonhazardous. The metals combine with the buffering agent to form nonleachable compounds that are less hazardous and extremely stable in nature. Typical doses of treatment chemicals are in the 5 to 10 percent range, resulting in considerably less bulking as compared to conventional treatment methods. In situ applications can be implemented using simple tilling equipment to blend the chemicals into the soil to a depth of 12 inches. If soil needs to be treated deeper than 12 inches, the first treated layer is scraped into piles and the procedure is repeated. The treated soil may possibly remain in-place, as long as it is capped to prevent erosion and direct contact, otherwise it must be landfilled as a nonhazardous waste. Since containment involving various capping/covering technologies has already been discussed as a separate alternative, chemical treatment of the soil in addition to capping is not feasible and, therefore, will not be retained for further evaluation.

Reduction

Reduction reactions may be carried out in-place to transform soil contaminants into less toxic or less mobile products. Heavy metals are reduced to their lowest valence state and rendered insoluble as stable organometallic complexes. Chemicals, such as sodium polythiocarbonate which have remarkable reducing and precipitating capabilities, can be percolated into the soil and the resultant precipitate is essentially insoluble and tends to increase its insolubility with time. Initial pilot tests are required in order to determine the specific formulation. Reduction may be considered as an applicable in situ treatment technology for soil.

Electrokinetic Remediation

Electrokinetic remediation uses a series of electrodes placed in the ground to recover ionic contaminants from the soil. Ion-permeable electrolyte casings are place in the contaminated soil and connected to a centralized electrolyte management system. Each casing has an electrode inside and together these casings form alternating rows of anodes and cathodes. Electrolyte is circulated in a closed loop between the electrode casings and an electrochemical ion exchange based electrolyte management system (EIX). Once the electrodes are energized, electrolysis of water in the electrolyte forms hydrogen ions at the anodes and hydroxide ions at the cathodes. These ions migrate through the casing into soil to generate a temporary and localized pH shift that desorbs contaminating ions, without pumping acids directly into the soil.

Once desorbed, the contaminating ions migrate under the influence of the applied potential (electromigration) to their respective electrodes (anodes for anions, cathodes for cations), where they pass through the electrode casing walls, and are taken up by the circulating electrolytes. Careful management of the pH and other electrolyte conditions within the electrode casings is the critical element in controlling system performance. Contaminants are selectively recovered from the circulating electrolytes as they pass through the EIX. Soluble but benign elements are returned to the soil to maintain soil properties. Periodically the EIX units are regenerated offline. This recovers the contaminants in a concentrated, pure, and reusable form. This in situ treatment technology will be retained for further analysis.

Solidification/Stabilization

In situ solidification/stabilization (S/S) involves the fixation of contaminated soils in-place. The technology is typically augmented by augering or cutting into a portion of the soils followed by pumping polymer or concrete-based solidification agents into the opening. These solidification agents are blended with the contaminated soil to form a solid matrix. The process is repeated, as necessary, across the site until all contaminated soils are immobilized. This process relies on moderate to high soil permeability to allow for dispersion of the solidification agents. This in situ immobilization technology may be considered applicable for the soils at the Site.

Phytoremediation

Phytoremediation is the use of plants to remove, contain, or render harmless environmental contaminants. Phytoremediation technologies can be developed for different applications in soil/sediment cleanup and are classified as either phytoextraction or phytostabilization. Phytoextraction technologies use hyperaccumulating plants to transport metals from the soil and concentrate them into the root system and into aboveground shoots. After the plants have been allowed to grow for some time, they are harvested and either incinerated or composted to recycle the metals. Phytostabilization uses plants to limit the mobility and bioavailability of metals in soils. Ideally, phytostabilizing plants should be able to tolerate high levels of metals and to immobilize them in the soil by sorption, precipitation, complexation, or the reduction of metal valences. Phytostabilizing plants also should exhibit low levels of accumulation of metals in shoots. Therefore, phytoremediation will be retained for further evaluation.

2.6.2.4 Excavation and Off-Site Disposal

Excavation followed by off-site disposal involves the removal of contaminated soil followed by transport and placement of the soil in a permitted hazardous waste landfill without treatment. Clean fill from an off-site source would replace the excavated material in all cases. Land Disposal Regulations (see Section 1.3) promulgated by USEPA place restrictions on the disposal of characteristic hazardous wastes (i.e., wastes which do not meet criteria for corrosivity, reactivity, ignitability, and toxicity per 40 CFR 261). Based on the nature and concentration of the contaminants in the soil, it is likely that these criteria would not be met due to the potential for the heavy metal-contaminated soils to fail the toxicity characteristic (i.e., as tested per the Toxicity Characteristic Leaching Procedure [TCLP] defined in 40 CFR 261). Therefore, off-site disposal of untreated soil will not be further evaluated.

2.6.2.5 Ex Situ Treatment and On-Site Disposal

Ex situ treatment technologies to be considered for excavated soils at the BB&S site include physical/chemical, and thermal processes. On-site disposal of the treated soil would involve backfilling the excavation or consolidating it elsewhere on-site. The specific treatment technologies associated with these disposal scenarios are discussed below.

2.6.2.5.1 Physical Treatment

Physical treatment of excavated soils typically refers to solidification and stabilization (S/S) of the soil by mixing it with a solidification agent, such as a polymer-based additive or Portland cement, on a batch basis. Solidification reduces the toxicity and mobility of the hazardous constituents of the matrix. The bound matrix can be formed in a cubic mold or monolithically poured in slurry form into the excavation from which it was removed, where it cures to form a stable, solid matrix. Ex situ S/S may be considered as an applicable technology for soils at the BB&S Treated Lumber site.

2.6.2.5.2 Physical/Chemical Treatment

Both soil washing and acid extraction technologies involve a physical separation step followed by a chemical process.

Soil Washing

Soil washing is a physical/chemical process to remove contaminants that reside in specific grain-size domains. Prior to treatment, oversize materials are separated from the contaminated soil with a series of vibrating screens. Wet screening is then applied to form a slurry which is pumped to hydrocyclones. The hydrocyclones mechanically separate the slurry into two streams, the underflow and the overflow. The underflow, which contains the coarse-grained material, is directed to the froth flotation cells where it is washed with surfactant and mechanically aerated. The effects of aeration and surfactant washing generate a heavy froth that floats to the top of the cells. The overflow (the fines and water) requires further treatment similar to that of an industrial effluent. The waste stream is directed to a sludge basin where solids are allowed to settle. The resulting sludge is dewatered using a belt filter press, if necessary, and disposed. Ex situ soil washing will be retained for further evaluation.

Acid Extraction

Acid extraction is a process that consists of soil slurrying, chemical extraction, and liquid processing. Water is added to the soil in a batch-reactor type vessel to create a soil slurry that is easy to handle. The chemical extraction step uses an acidic solvent to preferentially remove metal contaminants while leaving non-regulated, naturally-occurring metal in the soil. The optimal solvent/additives formulation, the required number of stages and the key operating parameters are site-specific and are determined by performing bench-scale treatability studies. In the liquid processing step, the metal laden solvent is treated with neutralization and precipitation to selectively recover the metal contaminants in a concentrated form suitable for recycling. The acid extract can be recovered and recycled back to the chemical extraction portion of the process, if economically feasible. Ex situ acid extraction may be considered applicable and, therefore, will be further evaluated.

2.6.2.5.3 Thermal Treatment

Thermal treatment involves heating the metal-contaminated soil in a reactor to a process temperature between 1,400 and 1,850°C. In the high-temperature reducing atmosphere, metals such as arsenic, cadmium, lead, and zinc are vaporized from the waste. Less volatile metals such as cobalt, copper, and nickel, if present in sufficient quantities, coalesce as a molten alloy. The remaining components of the soil, including some metal oxides such as those of iron, melt into a molten slag. The slag is continuously tapped and solidified on a non-contact, water-cooled vibrating conveyor. The process gases are drawn from the slag separator through the off-gas system where the vapors are post-combusted with ambient air and condensed as metal oxides, and all remaining H_2 and CO is combusted to water vapor and carbon dioxide. The gases are subsequently cooled, and the mixed metal oxide particulate is collected in a pulse-jet baghouse. The clean off-gas is discharged to the atmosphere. The volume of soil to be remediated is too small to justify a vendor's mobilization time and expense. Therefore, thermal treatment will not be further evaluated.

2.6.2.6 Ex Situ Treatment and Off-Site Disposal

Excavation followed by on-site treatment and off-site disposal is identical to on-site treatment/disposal, with the exception of the final deposition of the treated soil. Off-site disposal poses some additional risk in that the treated soil must be transported to an off-site location, which may be located a considerable distance from the site. However, this disposal alternative will be considered for further evaluation.

2.6.2.7 Off-Site Treatment and Disposal

Excavation followed by off-site treatment and disposal is essentially identical to excavation followed by on-site treatment, with the exception of the treatment location and final deposition of the treated soil. This alternative involves transporting the hazardous waste to an off-site facility for treatment (likely S/S) prior to disposal. This disposal alternative will be retained for further analysis.

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

Technologies that were deemed applicable for consideration given the conditions at the BB&S Treated Lumber site will be developed in this section into remedial alternatives to satisfy the general response actions for groundwater and shallow soil contamination. Each remedial alternative will be screened with respect to its overall effectiveness in achieving the RAOs for the Site, as well as it implementability. The objective of this preliminary screening is to narrow the list of potential alternatives (identified and described in Section 2.6) prior to conducting a detailed evaluation of the remedial alternatives selected. In accordance with NYSDEC TAGM No. 4030, cost is not used as a preliminary screening criterion.

Based on the applicability of groundwater remediation technologies presented in Section 2.6.1, the following options will be considered for development into remedial alternatives: containment (with the On-Site Groundwater Remedial Scenario and the On-Site and Off-Site Groundwater Remedial Scenario); in situ treatment; and ex situ treatment with reinjection to the aquifer through an on-site infiltration gallery. The specific technologies applicable for treatment of the groundwater include: in situ treatment (i.e., permeable barrier wall, electrokinetic decontamination, biological processes); physical treatment (i.e., reverse osmosis, electrochemical treatment); and chemical treatment (i.e., precipitation). A summary of the applicable groundwater remediation technologies to be screened in this section is presented in Table 3-1.

Based on the applicability of soil remediation technologies presented in Section 2.6.2, the following treatment technologies will be considered for development into remedial alternatives (see Table 3-1): containment (i.e., asphalt cover on-site/disposal of off-site soils); in situ treatment (i.e., reduction, electrokinetic remediation, solidification/stabilization, phytoremediation); ex situ treatment (i.e., solidification/stabilization, soil washing, acid extraction) with on-site or off-site disposal of the treated soil; and off-site treatment and disposal.

TABLE 3-1

BB&S TREATED LUMBER
FEASIBILITY STUDY

SUMMARY OF POTENTIALLY APPLICABLE TECHNOLOGIES

Medium/General Response Action	Remedial Technologies
Groundwater:	
No Action	Groundwater Monitoring Program; Deed Restrictions
Containment	Hydraulic Collection
In Situ Treatment	Permeable Barrier Wall, Electrokinetic Remediation, Biological Processes
Ex Situ Treatment and On-Site Disposal	Reverse Osmosis, Electrochemical Treatment, Chemical Precipitation
Soil:	
No Action	Secure Fence; Post Warning Signs; Deed Restrictions
Containment	Asphalt Cover On-Site/Disposal of Off-Site Soils
In Situ Treatment	Reduction, Electrokinetic Remediation, Solidification/Stabilization (S/S), Phytoremediation
Ex Situ Treatment and On-Site Disposal	S/S, Soil Washing, Acid Extraction
Ex Situ Treatment and Off-Site Disposal	S/S, Soil Washing, Acid Extraction
Off-Site Treatment and Disposal	S/S

3.1 GROUNDWATER

The development and screening of groundwater remedial action alternatives is presented in this section. A summary of the results of this preliminary screening is presented in Table 3-2.

3.1.1 No Action

The no action alternative implies undertaking no action to alter the current condition of the groundwater, and no treatment of the contaminants other than the naturally-occurring biodegradation process, if present. However, deed restrictions to prevent further use of groundwater and a Groundwater Monitoring Program would be implemented.

Effectiveness - The no action alternative is ineffective for mitigating migration of groundwater contamination.

Implementability - The no action alternative requires minimal implementation associated with the additional wells required for the Groundwater Monitoring Program.

Conclusion - No action will be retained for detailed analysis since it provides a benchmark for comparison to other remedial action alternatives and justifies the need for any remedial action for groundwater.

3.1.2 In Situ Treatment

3.1.2.1 Permeable Barrier Wall

A permeable barrier wall (PBW) consists of ion exchange media placed in the subsurface, downgradient of the groundwater plume and perpendicular to groundwater flow, to adsorb metal ions from the groundwater. This adsorption technology relies on the natural hydraulic gradient which causes groundwater to migrate to the PBW where contaminants are adsorbed to the PBW media. Either perforated caissons or precast concrete vaults are feasible for PBW construction. A key advantage of the perforated caisson method as opposed to the precast concrete vault is the reduced volume of soil generated during installation.

TABLE 3-2

BB&S TREATED LUMBER
FEASIBILITY STUDY

SCREENING OF POTENTIALLY APPLICABLE REMEDIAL ALTERNATIVES

Remedial Alternative	Description	Effectiveness (E)	Implementability (I)	Alternative Eliminated Based On:	
				E	I
ENVIRONMENTAL MEDIUM: Groundwater					
No Action	Groundwater remains in place with no containment or treatment. Implement Deed Restrictions and Groundwater Monitoring Program.	Ineffective for mitigating migration of groundwater contamination.	Groundwater monitoring program and deed restrictions can be readily implemented.	Retained only for comparative purposes.	
In Situ Permeable Barrier Wall (PBW)	Adsorbs metals as groundwater flows through permeable wall.	May be effective in removing metals with proper selection of adsorptive media. Potential for reduced integrity of PBW.	Not yet been implemented as full-scale.	X	X
In Situ Electrokinetic Remediation	Recovers metals as groundwater flows past chain of electrode pairs deployed in ground.	Ineffective for migration of groundwater contamination due to the mobility of the aquifer.	Not yet been implemented as full-scale.	X	X
In Situ Biological Processes	Mechanisms to reduce toxicity of inorganic contaminants. Evaluate phytoremediation.	May be effective if plant roots could reach deep contamination. Mixed results for arsenic removal.	Not readily available commercially. Plant roots would not reach plume.	X	X
Ex Situ Reverse Osmosis and On-Site Disposal	Collect groundwater, pretreat feed water, remove metals with reverse osmosis; reinject to infiltration gallery.	Effective in removing metals with proper membrane selection and system design and thus mitigates migration of contamination.	Readily implementable. Concentrate reused on-site.		X
Ex Situ Electrochemical Treatment and On-Site Disposal	Collect groundwater, remove metals with an electrochemical process using free ferrous ions; reinject to infiltration gallery.	Effectively removes metal and thus mitigates migration of contamination. Bench-scale testing required to determine removal efficiencies.	Implementable. Single vendor identified Bench- and pilot-scale equipment available.		

TABLE 3-2

BB&S TREATED LUMBER
FEASIBILITY STUDY

SCREENING OF POTENTIALLY APPLICABLE REMEDIAL ALTERNATIVES

Remedial Alternative	Description	Effectiveness (E)	Implementability (I)	Alternative Eliminated Based On:	
				E	I
Collection/On-Site Precipitation/On-Site Disposal	Collect groundwater, remove metal contamination via precipitation; reinject to infiltration gallery.	Effectively removes metal and thus mitigates migration of contamination.	Readily implementable.		
ENVIRONMENTAL MEDIUM: Soil					
No Action	Soil remains in-place with no treatment; secure existing perimeter fence, post warning signs, and implement deed restrictions.	Ineffective for mitigating contact with or migration of contaminated soils.	Securing fence, posting warning signs, obtaining deed restrictions are readily implementable.	Retained only for comparative purposes.	
Asphalt Cover On-Site/Disposal of Off-Site Soil	Cover on-site contaminated soils with asphalt and install perimeter drainage system. Excavate off-site soils and dispose at off-site facility.	On-site: Effectively limits human contact with soils; limits migration of soils; reduces infiltration. Off-site: Effectively eliminates human contact with soils.	Readily implementable.		
In Situ Reduction	Treat contaminated soils in place using reduction reactions to render metals permanently stable.	Effectively eliminates human contact with soils. Eliminates migration of contaminated soils. Arsenic removal variable and uncertain.	Implementable.	X	
In Situ Electrokinetic Remediation	Treat contaminated soils by placing electrodes in the ground to recover ionic contamination.	Effectively eliminates human contact with soils. Eliminates migration of contaminated soils.	Implementable; however, involves a proprietary technology and, therefore, only one vendor will perform work.		
In Situ Solidification / Stabilization (S/S)	Treat contaminated soils with in situ S/S.	Effectively eliminates human contact with soils. Effective in immobilizing contaminated soils. Bench-scale tests required to assess effectiveness.	Implementable.		

[redacted]

TABLE 3-2

BB&S TREATED LUMBER
FEASIBILITY STUDY

SCREENING OF POTENTIALLY APPLICABLE REMEDIAL ALTERNATIVES

Remedial Alternative	Description	Effectiveness (E)	Implementability (I)	Alternative Eliminated Based On:	
				E	I
In Situ Phytoremediation	Plants remove or stabilize metals in soil.	Phytoextraction of arsenic has had mixed results.	Not readily available commercially.	X	X
Ex Situ Solidification / Stabilization and On-Site Disposal	Treat contaminated soils on-site with S/S, dispose of treated product on-site.	Effectively eliminates human contact with soils. Effective in immobilizing contaminated soils. Bench-scale tests required to assess effectiveness.	Readily implementable.		
Ex Situ Soil Washing and On-Site Disposal	Treat contaminated soils on-site via soil washing, dispose of washed soils on-site.	Effectively eliminates human contact with soils. Eliminates migration of contaminated soils. Pilot tests required to determine surfactant blend.	Implementable, but limited in full-scale applications.		
Ex Situ Acid Extraction and On-Site Disposal	Treat contaminated soils on-site with acid extraction, dispose of treated soils on-site.	Effectively eliminates human contact with soils. Eliminates migration of contaminated soils. Bench-scale treatability tests required.	No full-scale applications have been documented. Single vendor identified.		X
Ex Situ Solidification / Stabilization and Off-Site Disposal	Treat contaminated soils on-site and dispose treated product off-site. Involves S/S treatment process.	Effectively eliminates human contact with soils. Effective in immobilizing contaminated soils.	Readily implementable; however, a great deal of effort would be required to dispose product off-site for a marginal reduction in risk.		X
Off-Site Treatment and Disposal	Treat contaminated soils at an off-site facility and dispose treated product.	Effectively eliminates human contact with soils. Effective in immobilizing contaminated soils.	Implementable.		

Effectiveness- Bench-scale testing would be required to determine the appropriate PBW media to remove arsenic, chromium, hexavalent chromium, and copper from groundwater. A secondary wall installed downgradient of the primary wall may be necessary if the concentration of metals are higher than anticipated, due to lower than anticipated adsorptive capacity or groundwater channeling through the primary PBW. Although a substantial amount of information exists to predict groundwater movement, subsurface heterogeneity inherently exists, resulting in groundwater migration in directions that were not predicted, thus posing some risk of bypassing the PBW. Also, the permeability of the PBW may be reduced over time with the accumulation of particles transported by the groundwater, or with precipitation caused by chemical changes in the groundwater. Reduced PBW permeability caused by either of these processes could result in partial bypassing. Preferential flow paths through the PBW may also be established, which would expend media more quickly in the vicinity of the flow channels, and may result in only partial treatment of groundwater passing through such channels.

Implementability - All equipment required to construct a PBW is available from manufacturers. A computer model can be used to conservatively approximate the performance of the PBW to determine when spent sorptive media replacement would be required. However, since the PBW technology has not yet been implemented in the field on either the pilot-scale or full-scale, media life could be significantly shorter than predicted by laboratory and computer model studies. Excavation of soil to a minimum depth of 106 feet (estimated plume depth) and installation of a PBW would result in many design and implementation difficulties including dewatering, trench stability, worker safety, equipment capabilities, and water and soil disposal. Additionally, the concept of being able to retrieve spent media by lifting the filter fabric sock containing the media out of the caisson has not been demonstrated on the full-scale, thus leading to potential delays during media change out. Pilot-testing would be required to establish full-scale design parameters.

Conclusion - A permeable barrier wall will not be retained for detailed analysis based on the various uncertainties with effectiveness of migration control and full-scale implementation.

3.1.2.2 Electrokinetic Decontamination

Electrokinetic decontamination is an in situ process developed to treat contaminated groundwater containing toxic cations (e.g., chromium, copper, and zinc) and toxic anions (e.g., arsenic). Geokinetics International, Inc. (Geokinetics), located in Orinda, California, has implemented this technology with an electrokinetic ring fence installed downgradient of a groundwater contaminant plume. This process uses a chain of electrode pairs deployed in the ground to recover ionic contamination from groundwater as it flows past the electrodes. Contaminants are selectively recovered from the circulating electrolytes as they pass through the electrochemical ion exchange (EIX) units. Soluble but benign elements are returned to the soil to maintain soil properties. The EIX units can be regenerated offline to recover the contaminants in a concentrated, pure, and reusable form. Geokinetics integrates patented technologies to operate this fully automated treatment process.

Effectiveness - Careful management of the pH and other electrolyte conditions within the electrode casings is the critical element in controlling system performance. Geokinetics has completed several projects involving the removal of arsenic, chromium, and copper. However, for this technology to be effective, the rate of groundwater flow must be much less than 100 meters per year. The groundwater at the Site has been estimated to significantly exceed this flow rate.

Implementability - Geokinetics is the equipment manufacturer, subcontractor for cleanup services, prime contractor for full-service remediation, and the technology licensor. Groundwater applications have only been performed at the pilot-scale level. Future full-scale operations will only be suitable for groundwater contamination less than 50 feet bgs.

Conclusion - In situ electrochemical decontamination of groundwater is not a suitable alternative for groundwater remediation at this Site because of the high flow rate and the depth of contamination and, therefore, will not be retained for detailed analysis.

3.1.2.3 Biological Processes

Biological processes can play a role in the treatment or remediation of water-containing metals. Select microorganisms and plants have the ability to render inorganic contaminants present at high concentrations in their environment nontoxic, presumably as a defense mechanism. The mechanisms used to reduce the toxicity of inorganic contaminants include immobilization, mobilization, and transformation. Processes that utilize these mechanisms include: bioaccumulation and biosorption; oxidation and reduction; methylation and demethylation; metal-organic complexation; ligand degradation; and phytoremediation.

Effectiveness- In situ biological processes typically involve degradation of organic contaminants. Groundwater contaminated with metals from wood preserving operations typically is not treated by bioremediation, since bioremediation systems do not effectively remove most inorganics (USEPA, 1997). High concentrations of heavy metals can resist treatment by inhibiting microbial activity. The processes listed above for inorganic contaminants are generally ex situ technologies, with the exception of phytoremediation. Phytoremediation would not be effective for remediation of the groundwater plume at this Site since the root system of the plants must be able to reach the contaminated groundwater (groundwater begins between 38 and 42 feet bgs). In addition, phytoremediation of arsenic has had mixed results.

Implementability - Identification of in situ biological processes for inorganic contaminants was confined to phytoremediation, which appears to be a promising bioremediation technology for metals removal. Implementation of phytoremediation would be limited as this technology is not readily available commercially and a root system could not be established at this depth.

Conclusion - In situ biological processes (i.e., phytoremediation) will not be retained for detailed analysis.

3.1.3 Ex Situ Treatment and On-Site Disposal

As presented in Section 2.6.1.1.1, two groundwater remedial scenarios were evaluated with MODFLOW and will be carried through the evaluation of ex situ groundwater treatment alternatives. Recovery wells RW-1, RW-2, and RW-3 would operate at a combined flow rate of 158 gpm for the On-Site Groundwater Remedial Scenario, and recovery wells RW-1 through RW-4 would operate at a combined rate of 203 gpm for the On-Site and Off-Site Groundwater Remedial Scenario. Based on the estimated groundwater production rates, the average daily volumes of water produced for the On-Site Groundwater Remedial Scenario and the On-Site and Off-Site Groundwater Remedial Scenario would be approximately 227,520 and 292,320 gallons, respectively. Ex situ treatment technologies would be implemented to reduce contaminant concentrations in collected groundwater to levels that would be acceptable for reinjection to the groundwater aquifer.

Effectiveness - Modeling results indicate that the On-Site Groundwater Remedial Scenario would be effective in capturing the contaminant plume downgradient to RW-3, but not the contamination extending to MW-14. Provided that the majority of the plume would be captured, eliminating the migration of contaminants towards MW-14, together with natural flushing of the aquifer, may reduce contaminant concentrations in this area below NYSDEC Class GA standards. The On-Site and Off-Site Groundwater Remedial Scenario would capture that portion of the plume escaping collection with recovery wells RW-1, RW-2 and RW-3, if determined to be a significant threat to downgradient receptors.

Implementability - Recovery wells RW-1 and RW-2 for groundwater collection are already in place; however, the piping would have to be replaced. Since RW-3 was recently destroyed, a new recovery well would have to be installed. Recovery well RW-4 would be installed at the leading edge of the plume as a contingency under the On-Site Groundwater Remedial Scenario or operation under the On-Site and Off-Site Groundwater Remedial Scenario. Both RW-3 and RW-4 would be 120 feet deep, 8-inch diameter PVC fully penetrating wells. These wells can be easily installed barring any opposition from property owners. All groundwater remedial alternatives assume that the treated effluent would be reinjected to the aquifer on the northern portion of the property. The method and location of injection will be determined during the pre-design investigation.

Conclusion - Collection of groundwater, under both the On-Site Groundwater Remedial Scenario and the On-Site and Off-Site Groundwater Remedial Scenario, followed by ex situ treatment will be retained for detailed analysis.

3.1.3.1 Reverse Osmosis

Reverse osmosis (RO) is a process that separates water from dissolved salts in solution by filtering through a semipermeable membrane at a pressure greater than the osmotic pressure. The retained solution is called the concentrate and the solution passing through the membrane is called the permeate. The existing treatment system was designed to treat approximately 330 gpm of groundwater contaminated with arsenic, chromium, and copper, and produced approximately 250 gpm of permeate. Although the system was not effective in removing the metal contaminants from the collected groundwater, an engineering review conducted during the RI revealed that the system was improperly designed (Malcolm Pirnie, 1998). The major deficiencies of the existing RO system are materials of construction, hydraulic staging, design flux rates, and inadequate pre-treatment.

Effectiveness - A properly designed RO treatment system can effectively reduce arsenic, chromium, and copper levels to below NYSDEC Class GA standards and, based on preliminary computer modeling, should be able to achieve 90 percent water recovery. A very high-quality feed is required for efficient operation of an RO unit. Pretreatment would consist of caustic soda addition to protect the membrane from chromate oxidation. A media filter followed by addition of a scale inhibitor would reduce the fouling potential from iron.

Implementability - Construction of a new RO system is readily implementable; however, disposal of the concentrate system may be difficult. At this point, it appears unlikely that a wood treatment company will be operating at the Site in the future, or that some other wood treatment facility on Long Island would be willing to accept this treatment effluent since it originates from a Class 2 inactive hazardous waste site. Since the concentrate stream cannot be used as dilution water in a wood treatment process, it would need to be disposed as a hazardous material. The large volume of effluent requiring disposal makes this alternative impractical for implementation at this Site.

Conclusion - Reverse osmosis will not be retained for detailed analysis.

3.1.3.2 Electrochemical Treatment

Andco Environmental Processes, Inc. (Andco), located in Buffalo, New York, has designed an electrochemical treatment process to simultaneously remove heavy metals from contaminated groundwater in combination with conventional unit operations such as clarification and filtration. Removing dissolved ions from solution is commonly achieved by adding the counter ion needed to form an insoluble precipitate. For example, addition of electrochemically generated ferrous ions will convert highly toxic and soluble hexavalent chromium to the less toxic and virtually insoluble trivalent form. The pH of the groundwater is controlled to ensure optimal pH for precipitation. Additional mechanisms would be required to remove arsenic to the NYSDEC Class GA standard. Surface complexation and electrostatic attractions are two important adsorption processes that enable arsenic removal and can be accomplished with the addition of iron.

Effectiveness- Andco performed a pilot-plant test for a wood-preserving operation in the western United States. At this facility, groundwater was used as process water and returned to the aquifer via a trench downgradient of the contaminated plume. The main contaminants of concern were arsenic, chromium, and copper at concentrations several times higher than drinking-water standards. After treatment, the effluent concentrations were <0.010 mg/L for arsenic, 0.005 mg/L for hexavalent chromium, 0.010 mg/L for total chromium, and <0.010 mg/L for copper - all heavy metal concentrations were below their respective drinking-water standards of 0.05, 0.05, 0.10, and 1.0 mg/L. If necessary, a final polishing step, such as multi-media filtration, can remove residual suspended solids prior to reinjection of treated water. Two pilot studies conducted at Superfund sites resulted in simultaneous removal of several heavy metals, including arsenic, chromium, and copper.

Implementability- Andco Environmental Processes was the only vendor identified to perform electrochemical treatment. As a result of successful bench-scale and pilot-plant tests performed by Andco, approximately 20 full-scale groundwater treatment systems have been implemented, three of which have been completed. Pilot plant equipment is available to confirm bench-scale studies and develop accurate design- related data for a full-scale treatment system. Skid-mounted, shop-tested treatment systems can be designed to treat from 1 gpm to 2,000 gpm of contaminated groundwater. Precipitates from the clarifier would be pumped to a slurry tank and then to a filter press. The filter press would generate sludge with approximately 30 percent solids, depending on the volume of groundwater treated, may require dumping as frequently as once per day. Manual operation requires an operator to spend one hour per day. Alternatively, the system can also be operated automatically with programmable control systems.

Conclusion - Electrochemical treatment systems will be retained for detailed analysis; however, a competitive bid situation may not be possible.

3.1.3.3 Chemical Precipitation

Chemical precipitation, as it applies to the groundwater at this Site, would involve the addition of sulfides, carbonates, and hydroxides to metal-contaminated groundwater to immobilize metals by precipitating the highly insoluble compounds.

Effectiveness - The effectiveness of heavy metal precipitation depends on the choice of reactant, temperature of groundwater, valence state of the metal in the groundwater, potential colloidal state of the precipitated material, and possible formation of complex ions. Since precipitation reactions are specific to the water source, bench-scale testing would be required to determine optimum conditions. Treated supernatant may require post-treatment or filtration prior to reinjection to the aquifer.

Implementability - The addition of precipitation reagents would generate a relatively large volume of residual solids. The settled sludge would need to be processed, either pressed and dried or solidified, prior to disposal. The process equipment necessary for chemical precipitation is readily available.

Conclusion - Chemical precipitation will be retained for detailed analysis.

3.2 SOIL

The development and screening of remedial action alternatives for soil is presented in this section. A summary of this preliminary screening is presented in Table 3-2.

3.2.1 No Action

The no action alternative consists of undertaking no action to alter the current condition of the soil, and therefore no treatment of the contaminants other than the potential for naturally-occurring biodegradation processes. An unsecured perimeter fence is currently the only existing on-site control measure. The fence would be secured and warning signs would be posted. A deed restriction would be implemented to prevent future inappropriate uses of the Site.

Effectiveness- The no action alternative is ineffective for mitigating contact with or migration of shallow contaminated soils and, therefore, does not meet the remedial action objectives for the Site.

Implementability - The no action alternative requires minimal implementation associated with securing the fence and posting signs.

Conclusion - The no action alternative will be retained for detailed analysis as it provides a benchmark for comparison to other remedial action alternatives and justifies the need for any remedial action.

3.2.2 Asphalt Cover On-Site/Disposal Of Off-Site Soils

A standard asphalt cover for all on-site soil would include a layer of stone, followed by a base asphalt course and a final top course. The asphalt layers would be smoothed and compacted following placement. Structures present would remain in place. Off-site impacted soil would be transported to an off-site facility for treatment and disposal.

Effectiveness- An asphalt cover would be effective in mitigating erosion and contact with contaminated materials, and would limit infiltration of surface water to various degrees depending upon its thickness and composition. An asphalt cover around the concrete drip pad would provide a sound working surface for activities conducted in that area (although elevated with respect to present grade). The asphalt cover placed over soils in the lumberyard could be used to stack wet lumber with proper containment and collection of the run-off. The asphalt cover would need to extend beyond the areas potentially requiring remedial action to reduce precipitation from migrating laterally beneath the asphalt cover. Removing off-site soils would eliminate further contact with contaminants.

Implementability- Construction of an asphalt cover would not require demolition of the current site structures, and would be implemented using conventional construction techniques. The asphalt cover would be sloped for proper drainage and a perimeter drain would be required to collect run-off. The collected run-off would need to be testing to determine if it requires treatment. The asphalt cover would need to extend beyond the impacted soil to avoid excavating into these soils. It is not feasible or ecologically beneficial to place an asphalt cover over the contaminated soils in the off-site areas. These areas are currently forested and asphalt replacing a forested area is not aethestically pleasing or ecologically functional. The thickness of the asphalt cover would prohibit placement along Speonk-Riverhead Road. Therefore, the soil in these areas would be shipped off-site to one of several treatment and disposal facilities. Clean soil to backfill the excavation is readily obtainable.

Conclusion- An asphalt cover for on-site soils with off-site treatment and disposal of off-site soils will be retained for detailed analysis.

3.2.3 In Situ Treatment

In situ treatment involves the immobilization, transfer or destruction of hazardous materials in-place (i.e., without excavation). The in situ technologies discussed below are potentially applicable for treating shallow soils contaminated with heavy metals.

3.2.3.1 Reduction

Reduction reactions may be carried out in-place to transform soil contaminants into less toxic or less mobile products. Heavy metals are reduced to their lowest valence state and rendered insoluble as stable organometallic complexes. Etus, Inc., utilizes a process called TR-DETOX that involves percolation of sodium polythiocarbonate, which has remarkable reducing and precipitating capabilities, into the soil. The resultant precipitate is essentially insoluble and tends to increase its insolubility with time.

Effectiveness - The TR-DETOX technology converts the heavy metals into a permanently stable, non-toxic form, thus effectively eliminating human contact with and migration of contaminated soils. Initial pilot tests are required in order to determine the specific formulation required. Based on previous treatability testing conducted by Etus, Inc., the removal efficiency for arsenic is extremely variable and unpredictable.

Implementability - The TR-DETOX technology does not require equipment beyond the normal range expected for material handling and blending (i.e., commonly used earth moving and mixing equipment). Etus, Inc. is the equipment manufacturer, subcontractor for cleanup services, and the technology developer. To date, Etus, Inc. has initiated two full-scale ex situ soil cleanups using this technology.

Conclusion- In situ reduction will not be retained for further evaluation due to the uncertainties in arsenic removal capability.

3.2.3.2 Electrochemical Remediation

Electrokinetic remediation is an in situ process developed to treat contaminated soil containing toxic heavy metals (e.g., arsenic, chromium, copper, and zinc). Electrokinetic remediation involves the application of low density direct current between electrodes placed in the soil to mobilize contaminants in the form of charged species. Geokinetics International, Inc. (Geokinetics) currently holds a patent for electrokinetic remediation of soils using a process that locates a series of electrodes in the soil to recover metal contaminants. A temporary and localized pH shift is generated to desorb contaminating ions. Once desorbed, the contaminating ions migrate to the electrodes and are taken up by the circulating electrolytes. The concentrated metals would be reused, treated or disposed.

Effectiveness - Careful management of the pH and other electrolyte conditions within the electrode casings is the critical element in controlling system performance. Geokinetics has initiated 40 full-scale electrokinetic remediation projects, and are very familiar and have had success with the removal of arsenic, chromium, and copper from soils. Full-scale results were not available for review at this time.

Implementability - Geokinetics is the equipment manufacturer, subcontractor for cleanup services, prime contractor for full-service remediation, and the technology licensor. This process is a proprietary technology and, therefore, Geokinetics would be the vendor for this project. Their full-scale facilities are transportable. They are currently conducting electrokinetic remediation at a site to remove CCA from soils located in several separate areas throughout the property. Soils potentially requiring remedial action at the BB&S site also exist in separate areas both on-site and off-site. Therefore, implementation of this alternative would be accomplished using the information gained from this operational site. As an in situ technology, the off-site vegetation on the west side of Speonk-Riverhead Road and in the northeast windrow would not need to be removed.

Conclusion- In situ electrochemical remediation of soil will be retained for detailed analysis.

3.2.3.3 Solidification/Stabilization

In situ solidification/stabilization (S/S) involves the fixation of contaminated soils in-place. The technology is typically augmented by augering or cutting into a portion of the soils followed by pumping polymer or concrete-based solidification agents into the opening. These solidification agents blend with the contaminated soil to form a solid matrix. The process is repeated, as necessary, until all contaminated soils are immobilized. S/S functions to reduce the mobility of hazardous constituents in the soil by binding the constituents in a non-leachable matrix.

Effectiveness - According to the EPA (USEPA, 1997), in situ S/S is generally applicable to most metals, however, the applicability to arsenic should be tested on a case-by-case basis. The USEPA believes that although published data generally are limited to those developed in demonstration projects sponsored by EPA, in situ S/S is likely to be effective in reducing leachable concentrations of metals to within regulatory or risk-based limits. Bench-scale testing would likely be required to assess the effectiveness of in situ S/S for demobilizing all constituents of interest contained in the shallow on-site and off-site impacted soils.

Implementability - Although many vendors provide S/S technologies for ex situ applications, relatively few companies offer in situ S/S treatment processes (USEPA, 1997). This in situ process relies on moderate to high soil permeability to allow for dispersion of the solidification agents. Since the on-site and off-site soils consist primarily of sand with some silt and gravel, the permeability should allow for sufficient dispersion of the stabilizers. According to the vendors contacted, in situ S/S of soils to depths greater than that reached by conventional tilling equipment (approximately 18 inches) would require excavation of the top soil layer(s). Once the lower layer has been stabilized, the next layer of soil would be returned to the excavation and the S/S process would be repeated. The post-curing increase in matrix volume of the soil waste (up to double the original volume) may interfere with facility operations; however, a portion of the S/S product could be disposed elsewhere on-site.

The tributary area and the off-site portion of the windrow would need to be cleared of vegetation to allow access for blending equipment. The vegetation would have to be tested for heavy metals to determine if disposal as a hazardous waste would be required. In situ S/S of the soils in these off-site areas would limit future utility of this area. However, an area on the northern portion of the BB&S property could be excavated to receive the off-site impacted soils. In situ S/S of the off-site soils would be performed within this excavation. The soil from this excavation would be used as backfill for the off-site areas, assuming that these uncharacterized on-site soils have not been impacted by Site operations. This is a reasonable assumption since Site operations (e.g., lumber storage) did not extend to this portion of the property, and this northern portion of the property is separated from the lumberyard by a ditch. The off-site areas would be regraded and seeded with an appropriate ground cover for erosion control.

Conclusion- In situ solidification/stabilization will be retained for detailed analysis.

3.2.3.4 Phytoremediation

Phytoremediation is a passive in situ process that uses plants to remove or stabilize metals in the soil through two mechanisms: phytoextraction and phytostabilization.

Phytoextraction technologies use hyperaccumulating plants to transport metals from the soil and concentrate them into the roots and aboveground shoots that can then be harvested and treated to further concentrate the contaminants prior to final disposal. Phytostabilization uses plants to limit the mobility and bioavailablity of metals in soils and is considered as containment rather than a remedial technology.

Effectiveness - The type of soil, as well as the rooting structure of the plant relative to the location of the contaminants, has a strong influence on uptake of any metal substance by the plant. Treatability studies would be required to select soil amendments to change pH, nutrient compositions and microbial activities that govern the efficiency of phytoremediation. Phytoextraction has been shown to be effective for copper, chromium and zinc; however, this technology has had mixed results with extraction of arsenic from soils. Phytoremediation offers the advantages of: being a truly in situ technology; lower capital and labor costs; retaining the functionality of the soil ecosystem; and being aesthetically pleasing. The disadvantages of this technology include the slow rate of decontamination and the eventual disposal of concentrated metals in plant biomass. This technology is also a potential threat to the food chain through herbivore ingestion of metal-rich plants. The use of trees can result in extraction of significant amounts of metals because of their high biomass production. However, the use of trees in phytoremediation requires long-term treatment and may create additional environmental concerns because of the distribution of falling leaves. Phytostabilizing plants should exhibit low levels of accumulation of metals in shoots, eliminating the possibility that residues in harvested shoots would be classified as hazardous wastes. In addition to stabilizing the metal contaminants present in the soil, phytostabilizing plants also stabilize the soil matrix to minimize erosion and migration of sediment.

Implementability - Currently, phytoremediation is not readily available commercially, although three grasses are commercially available for the stabilization of lead, copper, and zinc wastes. Relatively few field tests of the technology have been conducted. More research would be required prior to implementation of this technology for off-site soils.

Conclusion - Phytoremediation will not be retained for detailed analysis based on the potential threat to the food chain, the lack of commercially available plants required for the site-specific contaminants in off-site soils, and the mixed results with extraction of arsenic from soils. In addition, the phytoremediation process can take years for contaminant concentrations to reach regulatory levels and, therefore, is not appropriate for the off-site soils due to the immediate risk to human health and the environment.

3.2.4 Ex Situ Treatment and On-Site Disposal

As discussed in Section 2.6.2.6, based on the contamination detected in the soil and the physical characteristics of the soil, the ex situ treatment technologies potentially applicable to treat shallow soils both on-site and off-site include physical treatment by solidification/stabilization, and physical/chemical treatment by soil washing or acid extraction. Under this alternative, the end products of the treatment process would then be disposed on-site. Ex situ treatment technologies have been developed below into remedial action alternatives.

3.2.4.1 Solidification/Stabilization

Ex situ solidification and stabilization (S/S) typically refers to batch mixing soil with a solidification agent, such as a polymer-based additive or Portland cement. The bound matrix is typically formed in a cubic mold or can be monolithically poured in slurry form into the excavation from which it was removed, where it cures to form a stable, solid matrix.

Effectiveness - According to the EPA (USEPA, 1997), S/S is the presumptive remedy for metals contamination of soils, sediments, and sludges at wood preserving site (USEPA, 1995b). The S/S process has been demonstrated to be effective in reducing the leachability of metals in these materials at bench-, pilot-, and full-scale, with success dependant on proper selection of binders and additives and the test method used. Bench-scale testing will likely be required to assess the effectiveness of S/S in treating on-site and off-site soils.

Implementability- One vendor contacted has implemented approximately 30 full-scale soil and sludge S/S projects. The equipment required for excavation (e.g., backhoes and front-end loaders) and mixing (e.g., pugmills, mixers, extruders, screw conveyors, and ribbon blenders) is readily available. The stabilized soil can be placed back into the excavation; however, care must be taken to limit delays in replacing the mixture since the matrix will undergo expansion as it cures. This post-curing increase in the volume of waste mixture may interfere with facility operations if used to backfill the excavation; however, excess material may be stored elsewhere on-site.

As with the in situ S/S alternative, the tributary area and the off-site portion of the windrow would need to be cleared of vegetation to allow access for excavation equipment. The vegetation would have to be tested for heavy metals to determine if disposal as a hazardous waste would be required. S/S of soils in these off-site areas would limit future utility of this area. However, an area on the northern portion of the BB&S property could be excavated to receive the solidified product resulting from treatment of the off-site impacted soils. The on-site soil from this excavation would be used as backfill for the off-site areas, assuming that the uncharacterized on-site soils have not been impacted by Site operations. This is a reasonable assumption since Site operations (e.g., lumber storage) did not extend to this portion of the property, and it is separated from the lumberyard by a ditch. The off-site areas would be regraded and seeded with an appropriate ground cover for erosion control.

Conclusion - Ex situ solidification/stabilization will be retained for detailed analysis.

3.2.4.2 Soil Washing

Several soil washing technologies are available, involving both physical and chemical processes to remove contaminants from soil. These processes include physical sizing, material separation, scrubbing, and soil washing with surfactants.

Effectiveness - Treated products of the soil washing process include clean soil for reuse, water suitable for discharge to surface water or reinjection to groundwater, and a sludge containing the concentrated metals.

Implementability - Soil washing is available as a full-scale technology. Initial treatability tests are required in order to determine the appropriate surfactant blend. This technology is suitable for the sandy soils at the Site, since the treatment of soils with high silt/clay content would not be cost effective and soils with the majority of contaminants tightly bound to larger fractions may not be good candidates (USEPA, 1997).

As with S/S, the tributary area and the off-site portion of the windrow would need to be cleared of vegetation to allow access for excavation equipment. The treated soils could be returned to the excavation. The off-site areas would be regraded and seeded with an appropriate ground cover for erosion control.

Conclusion - Soil washing will be retained for detailed analysis.

3.2.4.3 Acid Extraction

Acid extraction is a process that consists of soil slurrying, chemical extraction, and liquids processing. Technologies exist that: preferentially remove metal contaminants while leaving non-regulated, naturally occurring metals in the soil; discharge metal contaminants from the process as a 50% to 99% pure concentrate suitable for and consistent with regulatory requirements for recycling; and remediate soil on-site for use as backfill.

Effectiveness - The optimal solvent/additive formulation, the required number of stages, and the key operating parameters are site-specific and are determined by performing bench-scale treatability studies. To-date, this technology has successfully remediated soils contaminated with arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc during pilot-scale projects.

Implementability- Acid extraction has only been implemented by IT Corporation at the pilot-scale as a SITE demonstration project; thus, many full-scale implementability issues would need to be addressed. In addition, pilot-scale testing has been limited to less than 5,000 tons of soil requiring treatment. IT Corporation has not implemented any full-scale operations to-date and was not aware of any vendors who have conducted pilot-scale or full-scale acid extraction projects.

Conclusion - Acid extraction will not be retained for detailed analysis.

3.2.5 Ex Situ Treatment and Off-Site Disposal

Ex situ treatment followed by off-site disposal would involve the same treatment technologies described in Section 3.2.4, namely solidification/stabilization (S/S) and soil washing. Since soil washing results in soil clean enough for backfilling the excavation, off-site disposal is not necessary. Therefore, only ex situ S/S followed by off-site disposal is evaluated below. The S/S process is identical to that described in Section 3.2.4.1.

Effectiveness - Off-site disposal would provide marginal additional reduction of risk to human health and the environment in that treated material would be removed from the site, precluding the potential for on-site contact or migration of any residual contamination. However, off-site disposal poses some additional risk in that the treated soil must be transported to an off-site location, which may be located a considerable distance from the Site.

Implementability - Off-site disposal of the treated soils is readily implementable and requires proper manifesting and transporting to an approved off-site disposal facility.

Conclusion - Ex situ S/S followed by off-site disposal will not be retained for detailed analysis as there is only a marginal reduction in risk by disposing the treated soil off-site but would require a great deal of extra effort compared to on-site disposal.

3.2.6 Off-Site Treatment and Disposal

Excavation of soils followed by off-site treatment and disposal would involve transportation of the hazardous soil to an off-site facility for treatment (likely stabilization/solidification) prior to disposal.

Effectiveness - Following excavation, contaminated soils would be transported to an off-site facility for treatment and subsequent disposal. This would provide marginal additional reduction of risk to human health and the environment in that treated material would be removed from the Site, precluding the potential for on-site contact or migration of contaminants. Transport of untreated contaminated soils may increase the risks to human health and the environment in the short-term, due to the potential for release of the soils to the environment via accidental spillage.

Implementability - Off-site treatment and disposal of the soils is readily implementable since several facilities capable of handling hazardous soils were identified.

Conclusion- Excavation of soils followed by off-site treatment and disposal will be retained for detailed analysis.

Table 3-3 presents a summary of the remedial action alternatives for groundwater and soil that have been retained for detailed analysis in Section 4.0.

TABLE 3-3

BB&S TREATED LUMBER
FEASIBILITY STUDY

SUMMARY OF REMEDIAL ACTION ALTERNATIVES

Medium/General Response Action	Remedial Technologies
Groundwater:	
No Action	Groundwater Monitoring Program; deed restrictions
Ex Situ Treatment and On-Site Disposal	Electrochemical Treatment, Chemical Precipitation
Soil:	
No Action	Secure fence, post warning signs, deed restrictions.
Containment	Asphalt Cover On-Site/Disposal of Off-Site Soils
In Situ Treatment	Solidification/Stabilization (S/S), Electrokinetic Remediation
Ex Situ Treatment and On-Site Disposal	S/S, Soil Washing
Off-Site Treatment and Disposal	S/S

4.0 DETAILED ANALYSIS OF ALTERNATIVES

4.1 INTRODUCTION

This section presents the detailed analysis of the remedial alternatives remaining after the preliminary screening in Sections 2 and 3. Each alternative is herein reviewed with respect to the seven evaluation criteria presented in NYSDEC's TAGM for the "Selection of Remedial Actions at Inactive Hazardous Waste Sites" (NYSDEC, 1990). These criteria serve to provide a basis of comparison and allow for ranking of the alternative by preference:

- **Short-Term Impacts and Effectiveness** - The effectiveness of alternatives in protecting human health and the environment during construction and implementation of the remedial action is evaluated by this criterion. Short-term effectiveness is assessed by protection of the community, protection of workers, environmental impacts, and time until protection is achieved.
- **Long-Term Effectiveness and Permanence** - This criterion evaluates the long-term protection of human health and the environment at the completion of the remedial action. Effectiveness is assessed with respect to the magnitude of residual risks; adequacy of controls, if any, in managing treatment residuals or untreated wastes that remain at the site; reliability of controls against possible failure; and potential to provide continued protection.
- **Reduction of Toxicity, Mobility, and Volume** - This evaluation criterion addresses the statutory preference for selecting remedial actions that permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances. This preference is satisfied when the treatment is used to reduce the principal threats at a site through destruction of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of total volume of contaminated media.
- **Implementability** - This assessment evaluates the technical and administrative feasibility of alternatives and the availability of services and materials.

- **Compliance with SCGs** - This threshold assessment addresses whether a remedy will meet all New York State Standards, Criteria and Guidelines (SCGs) or if more stringent, the applicable or relevant and appropriate requirements (SCGs) of Federal environmental statutes, or provide grounds for invoking a CERCLA waiver.

- **Overall Protection of Human Health and the Environment** - This threshold assessment addresses whether a remedy provides adequate protection, and describes how risks posed through each pathway are eliminated, reduced, or controlled. This evaluation allows for consideration of whether an alternative poses any unacceptable short-term or cross-media impacts.

- **Cost** - The estimated capital and long-term operation, maintenance and monitoring costs are evaluated by this criterion.

Capital, annual operation and maintenance (O&M), groundwater monitoring, and present-worth costs for each groundwater remedial alternative that has passed the preliminary screening are included in Table 4-1. The present worth of each groundwater remedial alternative, for both the On-Site Groundwater Remedial Scenario and the On-Site and Off-Site Groundwater Remedial Scenario, has been estimated based on 30 years of O&M and groundwater monitoring, at an interest rate of 5 percent. The treatment costs for each remedial action alternative for soil are presented in Table 4-2 for both Clean-Up Scenario A and Clean-Up Scenario B. The total capital cost of each remedial alternative includes an estimate of engineering and contingency costs, and contractor mobilization/demobilization (see Appendix E).

4.2 ANALYSIS OF GROUNDWATER REMEDIAL ACTION ALTERNATIVES

Based on the preliminary screening presented in Section 3.1, the electrochemical and precipitation alternatives have been retained for detailed analysis. Both alternatives are ex situ processes and, thus, require collection of groundwater using recovery wells. As mentioned in Section 2.6.1.1.1, the two groundwater remedial scenarios are as follows:

TABLE 4-1
BB&S TREATED LUMBER SITE
FEASIBILITY STUDY

COST SUMMARY OF REMEDIAL ACTION ALTERNATIVES FOR GROUNDWATER

Remedial Technology	Description	Treatment Costs					
			Annual Costs		Present Worth Costs[1]		
		Capital Cost	Operation& Maintenance	Groundwater/ Effluent Monitoring	Operation& Maintenance	Groundwater/ Effluent Monitoring	Total Present Worth Cost
On-Site Groundwater Remedial Scenario							
No Action	Groundwater remains untreated; install 3 sentinel wells; implement deed restrictions and Groundwater Monitioring Program.	$ 17,600	$ -	$ 7,000	$ -	$ 108,100	$ 125,700
Ex Situ Electrochemical Treatment and Reinjection to Aquifer	Collect groundwater; treat electrochemically; reinject to aquifer; dispose sludge off-site.	$ 1,691,000	$ 127,500	$ 24,700	$ 1,959,500	$ 380,300	$ 4,030,800
Ex Situ Treatment by Chemical Precipitation and Reinjection to Aquifer	Collect groundwater; treat by chemical precipitation; reinject to aquifer; dispose sludge off-site.	$ 1,374,400	$ 127,700	$ 24,700	$ 1,963,500	$ 380,300	$ 3,718,200
On-Site and Off-Site Groundwater Remedial Scenario							
No Action	Groundwater remains untreated; install 3 sentinel wells; implement deed restrictions and Groundwater Monitoring Program.	$ 17,600	$ -	$ 7,000	$ -	$ 108,100	$ 125,700
Ex Situ Electrochemical Treatment and Reinjection to Aquifer	Collect groundwater; treat electrochemically; reinject to aquifer; dispose sludge off-site.	$ 1,773,400	$ 147,300	$ 17,700	$ 2,264,700	$ 272,200	$ 4,310,300
Ex Situ Treatment by Chemical Precipitation and Reinjection to Aquifer	Collect groundwater; treat by chemical precipitation; reinject to aquifer; dispose sludge off-site.	$ 1,450,000	$ 141,700	$ 17,700	$ 2,177,800	$ 272,200	$ 3,900,000

Notes:

[1] Present worth calculated for an interest rate of 5% and a period of 30 years.

TABLE 4-2
BB&S TREATED LUMBER SITE
FEASIBILITY STUDY

COST SUMMARY OF REMEDIAL ACTION ALTERNATIVES FOR SOIL

Remedial Technology	Description	Clean-Up Scenario A[(1)]	Clean-Up Scenario B[(2)]
No Action	Soil remains in-place and untreated; secure perimeter fence; post warning signs; implement deed restrictions.	$ 15,000	$ 15,000
Asphalt Cover On-Site / Disposal of Off-Site Soils	Cover on-site soils requiring remedial action with an asphalt cover; dispose off-site soils at off-site facility.	$ 2,153,400	$ 2,153,400
In Situ Treatment by S/S	Treat contaminated soils in situ using stabilization/solidification (S/S).	$ 1,133,100	$ 745,800
In Situ Electrokinetic Remediation	Treat contaminated soils in situ using electrokinetic remediation; dispose dry precipitate off-site.	$ 3,029,200	$ 2,287,100
Ex Situ Treatment by S/S and On-Site Disposal	Excavate contaminated soils; treat soils on-site using S/S; dispose S/S product on-site.	$ 1,289,800	$ 782,300
Ex Situ Treatment by Soil Washing and On-Site Disposal	Excavate contaminated soils; treat soils on-site with soil washing; dispose soil on-site.	$ 4,791,600	$ 2,013,100
Off-Site Treatment and Disposal	Excavate contaminated soils; treat at off-site facility with S/S; dispose S/S product off-site.	$ 5,278,900	$ 2,047,500

Notes:

(1) Clean-up Scenarion A addresses on-site soils contaminated with arsenic in excess of the TAGM 4046 recommended soil clean-up goal (7.5 ppm), coincidentally reducing chromium concentrations to well below the proposed TAGM level of 50 ppm.

(2) Clean-up Scenario B address on-site soil contaminated with chromium in excess of the proposed TAGM 4046 recommended soil clean-up goal (50 ppm), coincidentally reducing arsenic concentrations to less than approximately 30 ppm.

- *On-Site Groundwater Remedial Scenario:* Re-install recovery well RW-3 south of the Site property line near former location (exact location to be determined during pre-design investigation); operate recovery wells RW-1, RW-2, and RW-3 at pumping rates of 50 gpm, 25 gpm, and 30 gpm, respectively; install three (3) off-site sentinel wells at leading edge of plume for semi-annual monitoring for TAL metals; install recovery well RW-4 south of MW-14 at leading edge of plume as a contingency plan should concentrations in the sentinel wells approach NYSDEC Class GA standards.

- *On-Site and Off-Site Groundwater Remedial Scenario:* Re-install recovery well RW-3 south of the Site property line near former location and install recovery well RW-4 south of MW-14 at leading edge of plume (exact locations to be determined during pre-design investigation); pump from recovery wells RW-1, RW-2, RW-3, and RW-4 at pumping rates of 50 gpm, 25 gpm, 30 gpm, and respectively; and install three (3) off-site sentinel wells at leading edge of plume for annual monitoring for TAL metals.

It is assumed for all ex situ alternatives that the treatment effluent will be reinjected into the aquifer, at a location on the northern portion of the property to be determined during the pre-design investigation. The no-action alternative has been retained as a comparison to these remedial action alternatives. Detailed analysis of these alternatives is presented below.

The no-action alternative implies that no remedial actions would be implemented to contain or treat the contaminated groundwater, apart from potential natural biodegradation processes. However, deed restrictions to prevent future use of groundwater and a Groundwater Monitoring Program would be implemented. Three (3) off-site sentinel wells would be installed at the leading edge of the plume for annual monitoring for TAL metals. A discussion of each of the evaluation criteria for this alternative follows.

4.2.1 No-Action Alternative

Short-Term Impacts and Effectiveness - With the no-action alternative, the only construction that would take place involves installation of the sentinel wells for the Groundwater Monitoring Program. Under this scenario, there is a potential for dermal contact with and ingestion of contaminated soils; however, these risks can be readily managed through the use of personal protective equipment (PPE). Relying on potential natural biodegradation as the only means of contaminant reduction makes it unlikely that the no-action alternative would be effective in reducing the contaminant concentrations to meet chemical-specific groundwater SCGs in the foreseeable future. Meanwhile, the contaminated groundwater plume has already migrated off-site and will continue to migrate southward toward residential drinking water wells.

Long-Term Effectiveness and Permanence - The original sources of groundwater contamination have been removed (i.e., leaking sumps and stored lumber). However, the contaminated groundwater plume will continue to migrate off-site for an undefined period of time. The southern edge of the groundwater plume has migrated off-site by at least 250 feet; the closest potential receptors are approximately 300 feet southeast (cross-gradient) and 0.25 miles downgradient of the Site. Based on the results of the ID modeling, it is unlikely that the contaminants in the groundwater would be reduced to NYSDEC Class GA standards through either natural biodegradation or groundwater transport phenomena such as dispersion before reaching downgradient receptors. The Groundwater Monitoring Program would provide for detection of site contaminants in downgradient monitoring wells.

Reduction of Toxicity, Mobility, and Volume - The no-action alternative would not reduce the mobility or volume or contaminated groundwater. Toxicity may be reduced somewhat by natural biodegradation processes; however, the volume of contaminated groundwater will only increase with time as the plume continues to migrate southward unless the surficial contaminated soils are remediated or storm water infiltration is prevented.

Implementability - The no-action alternative requires minimal implementation associated with the additional wells required for the Groundwater Monitoring Program.

Compliance with SCGs - Action-specific SCGs do not apply to the no-action alternative. The no-action alternative would comply with the location-specific SCGs for groundwater presented in Table 2-5 but not with the chemical-specific SCGs presented in Table 2-3.

Overall Protection of Human Health and the Environment - Residents and businesses in the area use groundwater as a sole source of drinking water. The closest potential receptors are approximately 300 feet southeast (cross-gradient) and 0.25 miles downgradient of the Site. With the no-action alternative, the potential exists for future contamination of off-site wells. Therefore, the no-action alternative would not be protective of human health and the environment.

Cost – The capital costs associated with installation of the sentinel wells for groundwater monitoring and implementation of deed restrictions are estimated at $12,600 and $5,000, respectively. The present worth cost for 30 years of annual groundwater monitoring is approximately $108,100. The cost breakdowns for sentinel well installation and groundwater monitoring are presented as Appendices E.1 and E.2, respectively.

4.2.2 Electrochemical Treatment with Reinjection to Aquifer Alternative

This alternative involves groundwater collection and ex situ treatment using an electrochemical treatment process. This system includes the following treatment steps; oxidant addition and pH adjustment; clarification; sludge thickening and pressing; and multi-media filtration. Treated effluent would be reinjected to the aquifer. The filter cake would be disposed off-site as a hazardous waste. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness - Site workers would be subject to increased chemical exposure risks during any subsurface activities in contaminated soil (e.g., installation of wells and piping for the groundwater collection, treatment and reinjection systems, or foundations for the treatment building). Potential site worker exposure may take the form of dermal contact with and ingestion of contaminated soils. These risks may be properly managed through the use of PPE. Physical risks may exist during construction of the reinjection or treatment systems. Implementation of this alternative, with provision of appropriate worker health and community safety measures, is not expected to significantly impact public health or the environment on-site or immediately adjacent to the Site. This alternative would become effective immediately upon start-up of the collection and electrochemical treatment systems. The estimated time frame to achieve start-up of an electrochemical treatment system is 26 months; 1 month for a treatability study, 6 months for the bidding phase, 7 months for site preparation, and 12 months for design and construction.

Long-Term Effectiveness and Permanence - To assure long-term reliability, regularly scheduled maintenance would need to be performed on the components of both the groundwater collection system and electrochemical treatment unit. The groundwater recovery wells would require minimal maintenance. The collection piping would be back washed periodically to loosen scale which may accumulate on the pipe and hinder flow to the treatment system. The sludge generated with electrochemical treatment would require disposal as a hazardous waste. The filtrate from the filter press would be recirculated through the treatment process.

Provided that the surficial contaminated soils are remediated, electrochemical treatment would provide a permanent reduction in the concentration of heavy metals in the groundwater over time. Since electrochemical treatment is not a well-documented technology, its effectiveness in removing site-specific contaminants from groundwater would be determined during a treatability study. Groundwater collection and treatment would cease once groundwater contaminant concentrations were reduced below NYSDEC Class GA standards. Thus, this alternative provides long-term effectiveness in achieving the groundwater remedial action objectives.

Reduction of Toxicity, Mobility, and Volume - Collection of the groundwater would reduce the mobility of the contamination by altering the hydraulic gradient within the radius of influence, thereby eliminating the migration of the contaminant plume to off-site areas. The electrochemical process brings about the separation of contaminants from the groundwater matrix. Separation technologies are rated second out of four in the NYSDEC hierarchy of remedial technologies. Electrochemical treatment of groundwater would reduce both the toxicity of the groundwater and the volume of contaminated media since the inorganic contaminants would be separated from the groundwater and concentrated in a filter cake.

Implementability – A building would be placed on the northern portion of the property to house the electrochemical treatment equipment. The estimated footprint of the building is 80 feet long by 40 feet wide. The treatment system components are readily available from Andco Environmental; however, no other vendors able to treat groundwater with the electrochemical process were identified. A treatability study would be necessary to determine the effectiveness of electrochemical treatment for Site contaminants and to develop accurate design-related data for a full-scale treatment system. The treatability study could be completed within a 1-month time frame. Pilot plant equipment is available to confirm bench-scale studies. Andco personnel can provide start-up and training services for the electrochemical system. At continuous flow rates through the treatment system of 203 gpm and 158 gpm, hazardous sludge would be produced at rates of approximately 0.5 and 0.7 tons per day, respectively. Implementation of this alternative would require the equivalent of a SPDES permit from NYSDEC for reinjection of the treated effluent into the aquifer upgradient of the groundwater plume.

Compliance with SCGs - The electrochemical treatment alternative complies with the action- and location-specific SCGs for pump-and-treat systems outlined in Tables 2-4 and 2-5, respectively. The electrochemical treatment system would be designed to comply with the chemical-specific SCGs for groundwater identified in Table 2-3. However, prior to treatability tests, it is difficult to predict removal efficiencies with any certainty due to the complicated nature of treating groundwater containing several heavy metals.

Overall Protection of Human Health and the Environment - The operation of a groundwater pump-and-treat system with electrochemical treatment would reduce off-site migration of contaminated groundwater, reduce the toxicity of the groundwater, reduce the volume of contaminated media by concentrating the metals, and meet the remedial action objectives for groundwater. The time frame for implementation of an electrochemical treatment system is estimated at 26 months. Eliminating or reducing the off-site migration of groundwater would reduce the potential for human or environmental exposure to the groundwater contaminants and, thus, would be protective of human health and the environment. Filter cake generated during the treatment process would be disposed off-site to eliminate any potential exposure to the concentrated heavy metal waste. Reinjection of the treated effluent to the aquifer would be protective of the sole-source aquifer used as a drinking water source, as the groundwater would be treated to NYSDEC Class GA standards prior to reinjection. Effluent monitoring would be required under the SPDES permit program to confirm that metal concentrations in the treatment system effluent have been reduced below NYSDEC Class GA standards.

Cost - Estimated capital, O&M, and monitoring costs for the electrochemical treatment system are presented on Table 4-1. The total present worth for this alternative, assuming 30 years of operation, maintenance, and monitoring, is approximately $4,030,800 for the On-Site Groundwater Remedial Scenario and $4,310,300 for the On-Site and Off-Site Groundwater Remedial Scenario (see Appendix E.3). The cost breakdowns for groundwater and effluent monitoring are presented as Appendices E.2 and E.5, respectively.

4.2.3 Precipitation with Reinjection to Aquifer Alternative

This alternative involves groundwater collection and ex situ treatment using chemical precipitation. This system would include the following treatment steps: chromate reduction; pH adjustment; hydroxide precipitation; flocculation and sedimentation; filtration; and pH adjustment. Treated effluent would be reinjected to the aquifer through an on-site infiltration gallery. The sludge would be disposed as a hazardous waste. STC Remediation, Inc. has a sludge stabilization step as part of its process train, rendering the sludge non-hazardous. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness - Site workers would be subject to increased chemical exposure risks during any subsurface activities in contaminated soil (e.g., installation of wells and piping for the groundwater collection, treatment and reinjection systems or foundations for the treatment building). Potential site worker exposure may take the form of dermal contact with and ingestion of contaminated soils. These risks may be properly managed through the use of PPE. Physical risks may exist during construction of the reinjection or treatment systems. Implementation of this alternative, with provision of appropriate worker health and community safety measures, is not expected to significantly impact public health or the environment on-site or immediately adjacent to the Site. This alternative would become effective immediately upon start-up of the collection and chemical precipitation treatment systems. The estimated time frame to achieve start-up of a chemical precipitation system is estimated at 26 months; 1 month for a treatability study, 6 months for the bidding phase, 7 months for site preparation, and 12 months for design and construction.

Long-Term Effectiveness and Permanence - To assure long-term reliability, regularly scheduled maintenance would be performed on the components of both the groundwater collection system and chemical precipitation treatment unit. The groundwater recovery wells would require minimal maintenance. The collection piping would be backwashed periodically to loosen scale that may accumulate on the pipe and hinder flow to the treatment system. Sludge generated during sedimentation would either be stabilized as part of the process and disposed as non-hazardous waste, or disposed as a hazardous waste. The filtrate from sludge dewatering would be recirculated through the treatment process.

Provided that the surficial contaminated soils are remediated, chemical precipitation would provide a permanent reduction in the concentration of heavy metals in the groundwater once NYSDEC Class GA standards have been achieved. Groundwater collection and treatment would cease once groundwater contaminant concentrations were reduced below NYSDEC Class GA standards. Thus, this alternative provides long-term effectiveness in achieving the groundwater remedial action objectives.

Reduction of Toxicity, Mobility, and Volume - Collection of the groundwater would reduce the mobility of the contamination by altering the hydraulic gradient within the radius of influence, thereby eliminating the migration of the contaminant plume to off-site areas. Chemical precipitation brings about the separation of contaminants from the groundwater matrix with flocculation and sedimentation. Separation technologies are rated second out of four in the NYSDEC hierarchy of remedial technologies. Treatment of the groundwater with chemical precipitation would reduce both the toxicity of the groundwater and the volume of contaminated media since the inorganic contaminants would be separated and concentrated in a sludge.

Implementability - A building would be placed on the northern portion of the property to the chemical precipitation treatment equipment. The estimated footprint of the building is 80 feet long and 40 feet wide. All treatment system components for chemical precipitation are readily available from their respective manufacturers, as are all equipment required for site preparation. Bench-scale treatability tests would be required to optimize the heavy metal removal efficiency of the precipitation process, and could be completed within a 1-month time frame. At continuous flow rates through the treatment system of 203 gpm and 158 gpm, hazardous sludge would be produced at rates of approximately 0.5 and 0.7 tons per day, respectively. The particular chemical precipitation process offered by STC Remediation, Inc. includes an additional step to stabilize the sludge so that it may be disposed as non-hazardous waste. Implementation of this alternative would require the equivalent of a SPDES permit from NYSDEC for reinjection of the treated effluent into the aquifer upgradient of the groundwater plume.

Compliance with SCGs - The chemical precipitation alternative complies with the action- and location-specific SCGs for pump-and-treat systems outlined in Tables 2-4 and 2-5, respectively. The chemical precipitation treatment process would be designed to comply with the chemical-specific SCGs for groundwater identified in Table 2-3. However, prior to treatability tests, it is difficult to predict removal efficiencies with any certainty due to the complicated nature of treating groundwater containing several heavy metals that require varying pH levels for optimum settling.

Overall Protection of Human Health and the Environment - The operation of a groundwater pump-and-treat system followed by chemical precipitation would reduce the off-site migration of contaminated groundwater, reduce the toxicity of the groundwater, reduce the volume of contaminated media by concentrating the metals, and meet the remedial action objectives for groundwater. The time frame for implementation of a chemical precipitation system is estimated at 26 months. Eliminating or reducing the off-site migration of groundwater would reduce the potential for human or environmental exposure to the groundwater contaminants and, thus, would be protective of human health and the environment. Sludge generated during precipitation would be dewatered on-site with a filter press and disposed at an off-site hazardous waste facility. The filtrate from the sludge dewatering process would be recirculated through the treatment process. Reinjection of the treated effluent to the aquifer would be protective of the sole-source aquifer used as a drinking water source, as the groundwater would be treated to NYSDEC Class GA standards prior to reinjection. Effluent monitoring would be required under the SPDES permit program to confirm that metal concentrations in the treatment system effluent have been reduced below NYSDEC Class GA standards.

Cost - Estimated capital, O&M, and monitoring costs for a chemical precipitation system are presented on Table 4-1. The total present worth for this alternative, assuming 30 years of operation, maintenance, and monitoring, is approximately $3,718,200 for the On-Site Groundwater Remedial Scenario and $3,900,000 for the On-Site and Off-Site Groundwater Remedial Scenario (see Appendix E.4). The cost breakdowns for groundwater and effluent monitoring are presented as Appendices E.2 and E.5, respectively.

4.3 ANALYSIS OF SOIL REMEDIAL ACTION ALTERNATIVES

Based on the preliminary screening presented in Section 3.2, the following soil remedial action alternatives have been retained for detailed analysis: no action; in situ stabilization/solidification (S/S); in situ electrokinetic remediation; ex situ S/S and ex situ soil washing with on-site disposal; and off-site treatment and disposal. The no-action alternative has been retained as a comparison to these remedial action alternatives. Detailed analysis of these alternatives is presented below.

4.3.1 No-Action Alternative

The no-action alternative consists of undertaking no remedial action to alter the current condition of the soil, and no treatment of the contaminants, apart from the potential for naturally occurring biodegradation processes. However, the existing unsecured Site perimeter fence would be secured to limit access to on-site areas, warning signs would be posted around the Site and deed restrictions would be implemented to prevent future inappropriate uses of the Site. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness - Under the no-action alternative, no additional remedial construction would take place; therefore, there is no potential for increased short-term risks to public health or the environment. The current public health and environmental risks presented in Section 1.2.5 for the Site would remain.

Long-Term Effectiveness and Permanence - Site workers would continue to be exposed to contaminated surface soils and future utility workers may be exposed to shallow contaminated soils. The secured fence surrounding the Site would limit trespassers from gaining access to the Site and potentially being exposed to the contaminated soil. Exposure to contaminated soil off-site along the tributary of the East Branch River would be possible since access to this area is not restricted. Leaving contaminated soils in-place presents an ecological risk for plants (e.g., root uptake) and animals (e.g., burrowing, eating metal-rich plants). Therefore, the no-action alternative is not effective in preventing direct human contact and provides no environmental protection.

Reduction of Toxicity, Mobility, and Volume - The no-action alternative does not contribute to the reduction of toxicity, mobility, or volume of the contaminated soils, above what may be accomplished with natural biodegradation processes.

Implementability - The no-action alternative requires minimal implementation associated with securing the perimeter fence and posting warning signs.

Compliance with SCGs - Action-specific SCGs do not apply to the no-action alternative. The no-action alternative would comply with the location-specific SCGs for soil presented in Table 2-5, but not with the chemical-specific SCGs presented in Table 2-3.

Overall Protection of Human Health and the Environment - Contaminants from the soil surrounding the concrete drip pad have migrated off-site, via surface water runoff, approximately 200 feet downstream of the outfall to the intermittent tributary of the East Branch River (west of Speonk-Riverhead Road). The no-action alternative would not mitigate further transport of contaminants and, therefore, would not be provide adequate protection of human health or the environment.

Cost – The capital cost associated with the no-action alternative includes securing the perimeter fence and posting warning signs ($10,000), and implementing deed restriction ($5,000). No annual O&M costs are associated with the no-action alternative.

4.3.2 Asphalt Cover On-Site/Disposal of Off-Site Soils Alternative

This alternative involves placement of an asphalt cover over all on-site soils that exceed cleanup criteria for certain site-related compounds, and any additional adjacent areas in order to maintain the continuity of the cover. The asphalt cover would not be a feasible remedial action for the off-site areas and, therefore, all impacted off-site soils would be transported to an off-site facility for treatment and disposal. Other remedial technologies for off-site soils would not be feasible due to the small volume of impacted soil. Clean soil would be placed in the off-site excavations and the disturbed areas would be seeded with an appropriate ground cover for erosion control. The asphalt cover would be placed over all impacted areas under the Residential Future Use Scenario. The asphalt cover would be comprised of a 6-inch crushed stone base, a 4-inch asphalt binder course, and a 2-inch top course of asphalt. A single layer of woven geotextile would underlie the crushed stone base in the lumberyard area to distribute the loads imposed on the asphalt surface by the lumberyard truck traffic. The asphalt cover over the lumberyard would be sloped and a perimeter drainage would collect the run-off from the asphalt cover. The run-off would be directed to two drywells for recharge to the aquifer. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness - Implementation of the asphalt alternative would not impact the general public, provided access is restricted during the construction phase. Construction personnel could be exposed to contaminated dust during site preparation. However, these exposure risks can be properly managed through the use of PPE and other appropriate health and safety procedures. Implementation of this alternative is not expected to substantially impact public health but would impact the environment immediately adjacent to the Site as a result of off-site clearing activities. Off-site areas would have to be restricted during vegetation removal and excavation of the hazardous soils.

This alternative would become effective immediately upon curing of the entire asphalt cover (approximately 1-day following final placement), installation of the drainage system, and removal of the off-site soils. The estimated time frame to complete this alternative is 17 months; 6 months for the bidding phase, 3 months for site preparation, 2 months for design of the cap, and 6 months for cap construction and off-site soil disposal.

Long-Term Effectiveness and Permanence - An asphalt cover would prevent direct contact with contaminated soils and would reduce off-site migration of contaminated soils via erosion. The asphalt cover would reduce infiltration of precipitation with long-term maintenance, including repair of cracks or damage caused by weathering, to ensure the continued integrity of the cover. Maintenance would be required more frequently in the lumberyard if that area is subject to truck and heavy equipment traffic associated with the handling of lumber. The degree of effort required in maintaining the asphalt cover would depend on the volume and weight of traffic using the capped area; the need for maintenance would be readily apparent through visual inspections. With proper maintenance, the asphalt cover alternative would provide long-term effectiveness in achieving the remedial action objectives for the on-site soils. Off-site treatment and disposal of the off-site soils would also provide long-term effectiveness and permanence.

Reduction of Toxicity, Mobility, and Volume - Placement of an asphalt cover would effectively eliminate the mobility of contaminants due to the migration of soils with erosion or by other means. The presence of an asphalt cover would reduce infiltration and decrease the leaching of contaminants from the soil to the groundwater provided that the cap is well maintained. The toxicity and volume of contaminants in Site soils would not be altered by the placement of an asphalt cap. Control and isolation technologies are ranked last in the NYSDEC hierarchy of remedial technologies. Disposal of the off-site soils would eliminate the toxicity, mobility, and volume of contaminants.

Implementability- Materials and equipment for the installation of an asphalt cover are readily available. For practical reasons, the asphalt cover and drainage system would be installed over the entire impacted lumberyard area. Implementation of the cover may be more difficult around the concrete drip pad and office/treatment building than in the open lumberyard area. The asphalt cover over the lumberyard soils would be sloped for proper drainage and a perimeter drain would be installed to collect run-off. Drywells would collect the run-off for recharge to the aquifer. Additional soil would be required in the lumberyard area to attain an adequate slope for drainage. The asphalt cover would need to extend beyond the impacted soil to avoid excavating into these soils for installation of the perimeter drain. If treated wood is stored on the cover, the collected run-off would need to be tested to determine if it requires treatment. All vegetation must be removed from the off-site tributary and windrow areas. Disposal of the hazardous soil would be readily implemented since several off-site treatment and disposal facilities exist.

Compliance with SCGs - This alternative complies with the action- and location-specific SCGs for the containment of hazardous wastes identified in Tables 2-4 and 2-5. This alternative does not comply with the chemical-specific SCGs for soils outlined in Table 2-3.

Overall Protection of Human Health and the Environment - Placement of an asphalt cover would be protective of human health and the environment in that, if properly maintained, it would limit infiltration of precipitation and reduce the potential for both direct human contact with the contaminated soils and further transport of contaminated soils off-site via erosion or other means. The metals would remain in the soil and, therefore, the potential exists for the metals to contaminate the groundwater. With regular maintenance of the asphalt, infiltration of precipitation would be kept to a minimum, reducing the potential for the metals to be carried to the groundwater. The time frame for implementation of an asphalt pad and disposal of off-site soils is estimated at 17 months. Disposal of off-site soils would eliminate any future exposure to Site contaminants. Thus, the asphalt cover with disposal of off-site soils alternative satisfies the remedial action objectives for the Site.

Cost- Estimated capital and O&M costs for the asphalt cover and off-site disposal are presented in Table 4-2. The total present worth for this alternative, assuming 30 years of cover maintenance, is estimated at $2,153,400 (see Appendix E.6).

4.3.3 In Situ Stabilization/Solidification Alternative

Solidification/Stabilization (S/S) processes physically bind or enclose contaminants within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization). Solidification can be achieved through the use of conventional pozzolans such as Portland cement. Stabilization treatment processes convert contaminants to less mobile forms through chemical interactions. More effective chemical fixation/solidification technologies have been developed to effectively treat a wide array of inorganic hazardous contaminants. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness - Implementation of in situ S/S would not impact the general public. Construction personnel could be exposed to contaminated dust during excavation of off-site areas and mixing operations. However, these exposure risks can be properly managed through the use of PPE and other appropriate health and safety procedures. Implementation of this alternative is not expected to substantially impact public health but would impact the environment immediately adjacent to the Site as a result of off-site clearing activities. This alternative would become effective immediately upon matrix curing (the same day as treatment following S/S). The estimated time frame to complete this alternative is 16 months for Clean-Up Scenario A and 15.5 months for Clean-Up Scenario B. Table 4-3 provides an estimate of the time required for completion of the various phases of this remedial alternative.

Long-Term Effectiveness and Permanence - A treatability study would be required to develop and optimize a suitable reagent formulation that would meet the desired remedial action objectives for the Site. Performance of the reagent is highly dependent on the mixing efficiency. In situ S/S renders the contaminants in the soil nonleachable and immobile. A leaching extraction test would be required to determine whether the soil meets the applicable standards for land disposal. The reduction of precipitation infiltrating the soil reduces the potential for transport of contaminants to the groundwater and/or off-site via erosion or other means. The soil from off-site areas would be excavated and treated in an on-site treatment pit, as described in Section 3.2.3.3, and the clean soil from the on-site treatment pit would

TABLE 4-3

BB&S TREATED LUMBER SITE
FEASIBILITY STUDY

ESTIMATED TIME FRAME FOR COMPLETION OF REMEDIAL ALTERNATIVES FOR SOIL

Remedial Alternative	Duration (months)						Total Project Duration (months)	
	Treatability Study	Design/ Construct	Bid Phase	Site Preparation	Remediation/ Scenario A[(1)]	Remediation/ Scenario B[(2)]	Clean-Up Scenario A	Clean-Up Scenario B
No Action	0	0	1	1	0	0	2	2
Asphalt Cover/Disposal	0	2	6	3	6	6	17	17
In Situ S/S	2	3	6	3	2	1.5	16	15.5
Electrokinetic Remediation	2	3	0	1	24	18	30	24
Ex Situ S/S	2	4	6	5	3	2	20	19
Ex Situ Soil Washing	1	5	6	6	4	2	22	20
Off-Site Treatment/Disposal	0	2	6	2	2	1	12	11

Notes:

(1) Clean-Up Scenario A addresses on-site soils contaminated with arsenic in excess of the TAGM 4046 recommended soil clean-up goal (7.5 ppm), coincidentally reducing chromium concentrations to well below the proposed TAGM level of 50 ppm.

(2) Clean-up Scenario B addresses on-site soil contaminated with chromium in excess of the proposed TAGM 4046 recommended soil clean-up goal (50 ppm), coincidentally reducing arsenic concentrations to less than approximately 30 ppm.

be used as backfill for these off-site areas. Therefore, all potential contaminant risks to humans and wildlife would be eliminated. Provided the treated soil product meets the leachability criteria, in situ S/S would provide long-term effectiveness in achieving the remedial action objectives for soils.

Reduction of Toxicity, Mobility, and Volume - The objectives of the S/S treatment processes are to reduce the mobility or solubility of the contaminants to levels required by regulatory or other risk-based standards, and to limit the infiltration of precipitation by reducing the permeability of the treated soil, generally to less than 10^{-6} cm/sec. The toxicity of the soil would not be reduced with S/S, since the contaminants are immobilized not destroyed. Solidification technologies are ranked third out of four in the NYSDEC hierarchy of remedial technologies. The in situ S/S treatment process on-site would result in a volume increase due to the addition of reagents; however, the additional non-hazardous material would be disposed on-site in the treatment pit.

Implementability - Vendors involved with in situ S/S also have in-house laboratories to perform treatability studies. The approximate time frame for completion of a treatability study is 2 months. Mixing is typically accomplished with standard construction equipment. Based on discussions with various vendors, disc-type equipment would till or plow the reagents into the contaminated soil to a depth of approximately 1.5 feet bgs (limited by reach depth of conventional tilling equipment). For depths greater than 1.5 feet bgs, the upper layer of soil would be excavated and stockpiled until the lower soils have been treated and compacted, and have hardened in-place. Batch sizes vary with the size of equipment vendors proposed to use. For large quantities of soil (20,000 to 40,000 tons), approximately 1,000 tons of soil can be processed per day. Smaller quantities of soil (less than 7,000 tons) would be processed at approximately 500 tons per day.

All vegetation must be removed from the off-site tributary and windrow areas prior to treatment. As discussed in Section 3.2.3.3, the soil from these off-site areas would be excavated and treated in the on-site treatment pit. The clean soil excavated to make this treatment pit would be used to backfill these off-site areas. The off-site areas would be regraded and seeded with an appropriate ground cover to minimize erosion. All other areas are void of vegetation. Due to the increase in soil volume following the S/S process, the on-site treatment pit would be sized to hold both the off-site treated soils and the excess treated on-site soil. A compacted layer of topsoil would have to be placed over the solidified soil product to protect the surface from damage due to heavy truck traffic.

Compliance with SCGs - This alternative complies with the action-specific SCGs for the treatment of hazardous wastes identified in Table 2-4. In order to comply with the location-specific SCG for soil listed in Table 2-5, the clearing of vegetation from the off-site areas could not take place during the May to July bird nesting season, according to Migratory Bird Treaty Act. Although published data generally are limited to demonstration projects sponsored by USEPA, in situ S/S is likely to be effective in reducing leachable concentrations of metals to within regulatory or risk-based limits (USEPA, 1993). One vendor contacted has initiated 3 full-scale in situ S/S projects. Therefore, this alternative is anticipated to comply with the chemical-specific SCGs for soil outlined in Table 2-3 with respect to the leachability of the contaminants from the soil.

Overall Protection of Human Health and the Environment - The in situ S/S alternative would be protective of human health and the environment in that contaminants are rendered nonleachable and immobile. S/S would reduce the infiltration of precipitation and, hence, contact with contaminants in the soil, and would reduce the potential for transportation of contaminants to the groundwater and/or to off-site areas via erosion or other means. Potential exposure to contaminated dust during excavation and mixing operations can be properly managed through the use of PPE and other appropriate health and safety procedures. The time frame for implementation of in situ S/S under Clean-Up Scenarios A and B is estimated at 16 and 15.5 months, respectively.

Cost - Estimated capital and operating costs for in situ S/S are presented in Table 4-2. The detailed cost breakdown for the two clean-up scenarios, as defined in Section 2.5.2, has been included as Appendix E.7. The total cost for Clean-Up Scenarios A and B is estimated at $1,133,100 and $745,800, respectively.

4.3.4 In Situ Electrokinetic Remediation

Electrokinetic remediation is a removal process developed to treat contaminated soil containing toxic heavy metals in situ. Electrokinetic remediation involves the application of low density direct current between electrodes placed in the soil to mobilize contaminants in the form of charged species. Geokinetics International, Inc. (Geokinetics) has implemented their proprietary technology for electrokinetic remediation of soils by locating a series of electrodes in the soil to recover metal contaminants. A temporary and localized pH shift is generated to desorb contaminating ions. Once desorbed, the contaminating ions migrate to the electrodes and are taken up by the circulating electrolytes. The metals can be recovered as a dry precipitate or as a concentrated liquid. For the purposes of this evaluation, it is assumed that a dry precipitate would be formed and disposed as hazardous waste. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness - Implementation of in situ electrokinetic remediation would not impact the general public provided warning signs are placed in off-site areas during soil treatment. Implementation of this alternative is not expected to substantially impact public health or the environment immediately adjacent to the Site. This alternative would become effective once all areas have been treated and contaminant concentrations in the soil are below the recommended cleanup objectives. The estimated time frame to complete this alternative is 30 months for Clean-Up Scenario A and 24 months for Clean-Up Scenario B. Table 4-3 provides an estimate of the time required for completion of the various phases of this remedial alternative.

Long-Term Effectiveness and Permanence - A bench-scale study would be required to design and optimize the full-scale electrokinetic remediation process for the Site. The contaminants would be removed from the soil and, therefore, all potential contaminant risks to humans and wildlife would be eliminated. However, no full-scale results for a completed project have been provided to-date. The concentrated metal precipitate would be disposed at an off-site facility, eliminating future exposure to contaminants.

Reduction of Toxicity, Mobility, and Volume - The objectives of electrokinetic remediation are to extract contaminants from the soil, and dispose the concentrated metal waste. Therefore, the electrokinetic remediation process would reduce the mobility of the contaminants to levels required by regulatory or other risk-based standards. Electrokinetic remediation would not destroy the toxic contaminants but concentrates them for off-site disposal. This treatment process would result in a volume reduction as the contaminants are removed from the soil in a concentrated form. As a separation technology, electrokinetic remediation ranks second out of four in the NYSDEC hierarchy of remedial technologies.

Implementability - A bench-scale treatability study would determine the parameters necessary for successful operation of a full-scale system. The time frame for completion of a bench-scale test is estimated at 2 months. A modular 5,000 to 10,000 cubic yard system would be used to rotate between impacted areas. Those on-site areas to be addressed to 6 inches below grade would be excavated and consolidated on an impermeable surface (plastic sheeting) in a 2-foot lift for treatment. Clean soil from an off-site source would be used to backfill the excavation. The spacing of electrodes would be determined based on the intended use of the Site during remediation and the desired time frame for remediation to be completed. Since Site soils have a low moisture content, water would have to be applied to the treatment areas. Vegetation would not have to be removed from the off-site tributary and windrow areas prior to treatment. Geokinetics holds the patent to this technology and, thus, this work cannot be competitively bid.

Compliance with SCGs - This alternative complies with the action-specific SCGs for the treatment of hazardous wastes identified in Table 2-4. Since clearing of off-site vegetation would not be required, this alternative also complies with the location-specific SCGs. According to Geokinetics, successful full-scale remediation of CCA-contaminated soil has been completed and the necessary sampling to confirm that the clean-up criteria have been met for the soils would be performed. Therefore, this alternative is anticipated to comply with the chemical-specific SCGs for soil outlined in Table 2-3 with respect to reducing contaminant concentrations below the recommended cleanup objectives.

Overall Protection of Human Health and the Environment - The in situ electrokinetic remediation alternative would be protective of human health and the environment in that contaminants are removed from the soil in a concentrated form and disposed off-site as hazardous waste. Since the contaminants would be removed from the soil, the potential for transport of contaminants to the groundwater and/or to off-site areas via erosion or other means would be eliminated. The off-site areas would not be disturbed by excavation and the soil would remain useable at the completion of this alternative. The time frame for implementation of in situ electrokinetic remediation under the Clean-Up Scenarios A and B is estimated at 30 and 24 months, respectively. The results of the bench-scale tests would better define the remediation time frame.

Cost - Estimated capital and operating costs for in situ electrokinetic remediation are presented in Table 4-2. The detailed cost breakdown for the two clean-up scenarios, as defined in Section 2.5.2, has been included as Appendix E.8. The total cost for Clean-Up Scenarios A and B is estimated at $3,029,200 and $2,287,100, respectively.

4.3.5 Ex Situ Solidification/Stabilization and On-Site Disposal Alternative

Solidification/Stabilization (S/S) processes physically bind or enclose contaminants within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization). Solidification can be achieved through the use of conventional pozzolans such as Portland cement. Stabilization treatment processes convert contaminants to less mobile forms through chemical interactions. More effective chemical fixation/solidification technologies have been developed to effectively treat a wide array of inorganic hazardous contaminants. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness - Implementation of ex situ S/S would not impact the general public, provided access is restricted during the excavation, mixing, and curing phases. As an ex situ remedy, the excavation associated with the ex situ S/S process would pose a potential health and safety risk to site workers through skin contact and air emissions. However, these exposure risks can be properly managed through the use of PPE and other appropriate health and safety procedures. Implementation of this alternative is not expected to substantially impact public health but will impact the environment immediately adjacent to the Site as a result of off-site clearing operations. This alternative would become effective immediately upon matrix curing (the same day as treatment following S/S; 28 days for complete curing and compliance sampling). The estimated time frame to complete this alternative is 20 months for Clean-Up Scenario A and 19 months for Clean-Up Scenario B. Table 4-3 provides an estimate of the time required for completion of the various phases of this remedial alternative.

Long-Term Effectiveness and Permanence - A treatability study would be required to develop and optimize a suitable reagent formulation that would meet the desired remedial action objectives for the Site. Performance of the reagent is highly dependent on the mixing efficiency. Batch mixing better controls the reagent addition and mixing processes. Ex situ S/S renders the contaminants in the soil nonleachable and immobile. A leaching extraction test would be required to determine whether the soil meets the applicable standards for land disposal. The reduction of precipitation infiltrating the soil reduces the potential for transportation of contaminants to the groundwater and/or off-site via erosion or other means. Since the treated soil would be placed in a disposal pit on-site, all potential off-site contaminant risks to humans and wildlife would be eliminated. Provided the treated soil product meets the leachability criteria, ex situ S/S would provide long-term effectiveness in achieving the remedial action objectives for soils.

Reduction of Toxicity, Mobility, and Volume - The objectives of the S/S treatment processes are to reduce the mobility or solubility of the contaminants to levels required by regulatory or other risk-based standards, and limit the infiltration of precipitation by reducing the permeability of the treated soil, generally to less than 10^{-6} cm/sec. The toxicity of the soil would not be reduced with S/S, since the contaminants are only immobilized, not destroyed. Solidification technologies are ranked third out of four in the NYSDEC hierarchy of remedial technologies. The ex situ S/S treatment process would result in a volume increase with the addition of reagents; however, the on-site disposal pit would be sized to hold the additional treated soil.

Implementability - Vendors involved with ex situ S/S also have in-house laboratories to perform treatability studies, which typically can be completed within 2 months. Conventional equipment required for excavation of soil and batch mixing with reagents are readily available. Soil from the on-site and off-site areas requiring remedial action would be excavated and stockpiled on-site for treatment. All vegetation must be removed from the off-site tributary and windrow areas so that the impacted soils are accessible for excavation. The soil would be screened and mixed with reagent using a continuous-mix process. Approximately 500 to 1,000 tons of soil can be processed per day, depending on the quantity of soil to be treated. Although the treated soil could be used to fill the on-site excavations, the extended remediation time frame would prohibit this approach. Therefore, as discussed in Section 3.2.3.3, an area on the northern portion of the BB&S property could be excavated to receive the on-site and off-site processed soils. The on-site soil from this excavation would be used as backfill for all on-site and off-site areas. The off-site areas would be regraded and seeded with appropriate ground cover to minimize erosion. This disposal pit would be sized to account for the post-treatment increase in soil volume.

Compliance with SCGs - This alternative complies with the action-specific SCGs for the treatment of hazardous wastes identified in Table 2-4. In order to comply with the location-specific SCGs for soil listed in Table 2-5, the clearing of vegetation from the off-site areas could not take place during the May to July bird nesting season, according to the Migratory Bird Treaty Act. While the treatment of contaminants is preferred, S/S technologies generally face minimal difficulty in obtaining the necessary regulatory/permitting approvals (USEPA, 1993). This alternative is anticipated to comply with the chemical-specific SCGs outlined in Table 2-3 with respect to the leachability of the contaminants from the soil.

Overall Protection of Human Health and the Environment - The ex situ S/S alternative would be protective of human health and the environment in that contaminants are rendered nonleachable and immobile. S/S would reduce the infiltration of precipitation and, hence, contact with contaminants in the soil, and would reduce the potential for transportation of contaminants to the groundwater and/or to off-site areas via erosion or other means. Potential exposure to contaminated dust during soil excavation can be properly managed through the use of PPE and other appropriate health and safety procedures. The time frame for implementation of ex situ S/S under Clean-Up Scenarios A and B is estimated at 20 and 19 months, respectively.

Cost- Estimated capital and operating costs for ex situ S/S with on-site disposal are presented in Table 4-2. The detailed cost breakdown for the two clean-up scenarios, as defined in Section 2.5.2, has been included as Appendix E.9. The total cost for Clean-Up Scenarios A and B is estimated at $1,289,800 and $782,300, respectively.

4.3.6 Ex Situ Soil Washing and On-Site Disposal Alternative

Ex situ soil washing involves sorbing contaminants onto soil particles which are separated from soil in an aqueous-based system. The wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove heavy metals. The soil washing application is a physical/chemical process that separates soil into oversize, coarse- and fine-grained fraction, identifies the contaminated fractions, and focuses treatment on those fraction. Oversize and coarse-grain soil can usually be returned clean to the site, while contaminated soil fines require further treatment or off-site disposal. Concrete or asphalt pads would be constructed to hold soil excavated from the areas requiring remedial action, the soil washing equipment, and the sludge generated from the soil washing process. A discussion of each of the evaluation criteria for this alternative follows.

Short-Term Impacts and Effectiveness - Implementation of ex situ soil washing would not impact the general public, provided access is restricted during the excavation and treatment phases. As an ex situ remedy, the excavation associated with the ex situ soil washing process would pose a potential health and safety risk to site workers through dermal contact and air emissions. However, these exposure risks can be properly managed through the use of PPE and other appropriate health and safety procedures. Implementation of this alternative is not expected to substantially impact public health but will impact the environment immediately adjacent to the Site as a result of off-site clearing operations. This alternative would become effective once coarse-grain soils have been cleaned and contaminated fines have been disposed off-site. The estimated time frame to complete this alternative is 22 months for Clean-Up Scenario A and 20 months for Clean-Up Scenario B.

Table 4-3 provides an estimate of the time required for completion of the various phases of this remedial alternative.

Long-Term Effectiveness and Permanence - A treatability study would be required to understand the particle-size/contaminant relationship, to confirm a process for the treatment of the waste of concern, and to better define the costs. The first phase of the treatability study would represent a "go/no go" point regarding the feasibility of soil washing. Ex situ soil washing would provide long-term effectiveness since contaminated fines would be separated and disposed off-site, and coarse-grain soils would be cleaned and returned directly to the area of excavation, if appropriate. Water would be continuously circulated throughout the soil washing process and at the conclusion of the soil washing operation the water would be tested to determine its ultimate disposal. One vendor claimed that the water is typically disposed on-site without treatment; however, water classified as hazardous must be disposed at an off-site facility or treated with the on-site groundwater treatment system prior to reinjection to the aquifer. One vendor identified eight successful full-scale applications of soil washing for metals-contaminated soils. Therefore, soil washing would provide long-term effectiveness in achieving the remedial action objectives for soils.

Reduction of Toxicity, Mobility, and Volume - Soil washing would reduce the mobility and volume of the contaminated coarse-grain soils that remain on-site. The toxicity of the contaminated fines would remain the same; however, the volume of contaminated material would be reduced and disposed off-site. Separation technologies are ranked second out of four in the NYSDEC hierarchy of remedial technologies.

Implementability - Vendors involved with soil washing also have in-house laboratories to perform treatability studies, which can be completed within 1 month. Conventional equipment required for excavation of soil is readily available. Available soil washing plants are modular and, therefore, are easily transported and erected. Approximately 30 tons of soil can be processed per day; 19 percent (by weight) of the processed soil would be disposed off-site as hazardous fines. All vegetation must be removed from the off-site tributary and windrow areas so the soil is accessible for excavation. Although the treated soil could be used as backfill for the excavations, the extended remediation time frame would prohibit this approach. Therefore, the washed soil would be placed in an on-site disposal pit and the contaminated fines would be disposed off-site. The clean soil excavated to make the disposal pit would be used to backfill the on-site and off-site excavations. The off-site areas would be regraded and seeded with appropriate ground cover to minimize erosion.

Areal requirements for the soil washing operations would vary with vendor. ARCADIS Geraghty & Miller estimate a plant footprint of 50 feet by 90 feet, and a soil sludge staging area of 50 feet by 100 feet. ARCADIS believes that full-scale soil washing would be competitive with other remediation technologies on projects that require cleanup of more than 20,000 tons of soil. Smaller volumes of soil can be processed with ARCADIS' 5 to 10 ton per hour pilot plant. Another vendor estimates their plant footprint to be 150 feet by 200 feet and the asphalt pad for soil/sludge staging to be approximately 2 acres (300 feet by 300 feet). With the latter estimate, the equipment, soil/sludge staging, and disposal areas would not fit on the northern portion of the property (approximately 300 feet by 350 feet).

Compliance with SCGs - This alternative complies with the chemical- and action-specific SCGs for the treatment of hazardous wastes identified in Tables 2-3 and 2-4. To comply with the location-specific SCGs for soil listed in Table 2-5, the clearing of vegetation from the off-site areas could not take place during the May to July bird nesting season, according to the Migratory Bird Treaty Act.

Overall Protection of Human Health and the Environment – Ex situ soil washing would be protective of human health and the environment in that the coarse-grain soil would be cleaned and returned directly to the excavation, if appropriate, and the contaminated fines would be disposed off-site. Potential exposure to contaminated dust during soil excavation can be properly managed through the use of PPE and other appropriate health and safety procedures. The time frame for implementation of ex situ soil washing under Clean-Up Scenarios A and B is estimated at 22 and 20 months, respectively.

Cost - Estimated capital and operating costs for soil washing are presented in Table 4-2. The detailed cost breakdown for the two clean-up scenarios, as defined in

Section 2.5.2, has been included as Appendix E.10. The total cost for Clean-Up Scenarios A and B is estimated at $4,791,600 and $2,013,100, respectively.

4.3.7 Off-Site Treatment and Disposal Alternative

All on-site and off-site impacted soils would be transported to an off-site facility for treatment and disposal. A discussion of each of the evaluation criteria for off-site disposal follows.

Short-Term Impacts and Effectiveness - Implementation of off-site treatment and disposal is not expected to impact the general public provided access is restricted during excavation and loading of the hazardous soil, and proper hazardous waste storage and transportation measures are taken. However, significant truck traffic on local roads and through rural settings may impact the general public. Excavation poses a potential health and safety risk to workers through dermal contact and air emissions; however, these exposure risks can be properly managed through the use of PPE and other appropriate health and safety procedures. Implementation of this alternative is not expected to substantially impact public health but there is a risk of accidental spills on local roads during transport of the hazardous soils off-site. The environment immediately adjacent to the Site would be impacted during off-site clearing activities. This alternative would become effective once soils have been disposed at the off-site facility. The estimated time frame to complete this alternative is 12 months for Clean-Up Scenarios A and 11 months for Clean-Up Scenario B. Table 4-3 provides an estimate of the time required for completion of the various phases of this remedial alternative.

Long-Term Effectiveness and Permanence - Off-site treatment and disposal would provide additional reduction of risk to human health and the environment as a result of the impacted soil being removed from the Site, precluding the potential for on-site contact or migration of contaminants. Therefore, this alternative would provide long-term effectiveness in achieving the remedial action objectives for soils.

Reduction of Toxicity, Mobility, and Volume - Since all soils would be transported to an off-site facility for treatment with S/S and disposal, reduction of contaminant mobility, toxicity, and volume would be accomplished. Solidification technologies are ranked third out of four in the NYSDEC hierarchy of remedial technologies.

Implementability- Off-site treatment and disposal of the impacted soils would be readily implemented, but would require proper manifesting and transporting to an approved off-site treatment and disposal facility. Several facilities have been identified to accept hazardous soil, treat it with S/S, and dispose of it at the facility. Clean soil to backfill the excavated area is readily attainable. Off-site areas would be regraded and seeded with an appropriate ground cover to minimize erosion.

Compliance with SCGs - Off-site treatment and disposal would comply with the action-specific SCGs for the treatment of hazardous wastes identified in Table 2-4. In order to comply with the location-specific SCGs listed in Table 2-5, the clearing of vegetation from the off-site areas could not take place during the May to July bird nesting season, according to the Migratory Bird Treaty Act. This alternative is anticipated to comply with the chemical-specific SCGs for soil outlined in Table 2-3, with respect to the leachability of the contaminants from the soil following S/S at the off-site facility.

Overall Protection of Human Health and the Environment - The off-site treatment and disposal alternative would be protective of human health and the environment in that contaminants would be rendered nonleachable and immobile at an off-site facility and disposed. This alternative would provide additional reduction of risk to human health and the environment since the impacted soils would be removed from the Site, precluding the potential for on-site contact or migration of contaminants. However, off-site disposal poses some additional risk as the hazardous soil must be transported via public roads to an off-site facility. There is a potential for accidental spills of hazardous soils on local roads, and significant truck traffic would be present in rural areas. The time frame for implementation of off-site treatment and disposal under Clean-Up Scenarios A and B is estimated at 12 and 11 months, respectively.

Cost - Estimated capital and operating costs for off-site treatment and disposal are presented in Table 4-2. The detailed cost breakdown for the two clean-up scenarios, as defined in Section 2.5.2, has been included as Appendix E.11. The total cost for Clean-Up Scenarios A and B is estimated at $5,278,900 and $2,047,500, respectively.

4.4 COMPARISON OF REMEDIAL ACTION ALTERNATIVES

This section presents a comparison of the remedial action alternatives for groundwater and soil with respect to the evaluation criteria discussed in the previous sections.

4.4.1 Groundwater

Only collection and ex situ treatment remained as feasible groundwater remedial alternatives with electrochemical treatment or chemical precipitation as the feasible treatment technologies. Two collection scenarios were carried through the analysis for cost-comparison purposes; collection and remediation of on-site groundwater only or collection and treatment of on-site and off-site groundwater. The following discussion compares the two ex situ treatment technologies.

Short-Term Impacts and Effectiveness - The only construction activities associated with the no-action alternative are installation of the sentinel wells. The risks of dermal contact and ingestion of contaminated soils can be readily managed through the proper use of PPE. Both remedial action alternatives are ex situ treatment methods and, therefore, would have the same type of physical risks during construction that can be addressed through worker health and community safety measures. Neither of the alternatives are expected to significantly impact public health or the environment on-site or immediately adjacent to the Site. Both alternatives equally meet the remedial action objectives for the Site groundwater in the short-term and would become effective immediately upon startup of their respective collection and treatment systems. The time frame to start-up of either treatment system is estimated at 26 months.

Long-Term Effectiveness and Permanence - The no-action alternative would not be effective in mitigating off-site migration of the contaminated groundwater plume. For the remaining alternatives, regular scheduled maintenance would need to be performed on the components of both the groundwater collection, treatment, and reinjection systems to ensure long-term reliability.

The process flow for electrochemical treatment includes tanks, pumps, chemical injection points, filter media, a clarifier, and a filter press. Due to the numerous components of this system, it is possible that repairs and/or maintenance could cause frequent system shut-down. The sludge from the filter press would require temporary storage prior to its disposal as a hazardous waste. The filter press filtrate is recirculated through the treatment system. Since electrochemical treatment is not a well-documented technology, its effectiveness in removing the site-specific contaminants would need to be determined during a treatability study.

The effectiveness of chemical precipitation systems is well documented and, therefore, the purpose of a treatability study would be to optimize the heavy metal removal efficiency of the process rather than establishing whether or not it could be effective. Similar to the electrochemical treatment process, chemical precipitation requires many components for operation which may result in frequent system shutdown. The treatment system may include in-process stabilization of precipitation by-products so that no RCRA characteristic hazardous sludge is produced. However, this alternative assumes hazardous sludge disposal for conservatism. The filter press filtrate is also recirculated through the treatment system.

Both remedial action alternatives would be designed to treat the groundwater contaminant plume and, at the completion of each remedial action, would provide long-term protection of human health and the environment. Both alternatives produce sludge that would require off-site disposal as a hazardous waste. The sludge generated through either process could be stabilized on-site and disposed off-site as a non-hazardous waste.

Reduction of Toxicity, Mobility, and Volume - The no-action alternative does not reduce the toxicity, mobility or volume of contaminated groundwater. The remaining remedial action alternatives will equally reduce the mobility of contaminated groundwater by altering the hydraulic gradient within the radius of influence, thereby eliminating the migration of the contaminant plume to off-site areas. Both alternatives involve separation technologies and reduce both the toxicity of the groundwater and the volume of contaminated media. Electrochemical treatment and chemical precipitation both generate hazardous sludge that would require off-site disposal.

Implementability - The no-action alternative requires minimal implementation associated with well installation for the Groundwater Monitoring Program. A building would be placed on the northern portion of the property to house the treatment equipment for either of the groundwater remedial alternatives. The building would be approximately 80 feet long by 40 feet wide. Treatment system components for the chemical precipitation system are readily available from their respective manufacturers, as are all equipment required for site preparation. Only one vendor (located in Buffalo, NY) could be identified to perform electrochemical treatment. Treatability tests would be required for both electrochemical treatment and chemical precipitation, and could be completed within approximately one month for both alternatives. Implementation of both alternatives would require the equivalent of a SPDES permit from NYSDEC for reinjection of the treated effluent into the aquifer upgradient of the groundwater plume. Both alternatives would require off-site disposal of hazardous sludge.

Compliance with SCGs - The no-action alternative does not comply with the location-, action-, or chemical-specific SCGs for groundwater. The remaining alternatives comply with the action- and location-specific SCGs for pump-and-treat systems outlined in Tables 2-4 and 2-5, respectively. The electrochemical and chemical precipitation systems would be designed to comply with the chemical-specific SCGs for groundwater identified in Table 2-3. Prior to treatability tests for electrochemical and precipitation systems, it is difficult to predict removal efficiencies with any certainty.

Overall Protection of Human Health and the Environment - The no-action alternative does not provide protection of human health and the environment. The operation of a groundwater pump-and-treat system followed by either of the treatment technologies would reduce the off-site migration of contaminated groundwater, reduce the toxicity of the groundwater, reduce the volume of contaminated media requiring disposal, and meet the remedial action objectives for groundwater. The time frame for implementation of either system is estimated at 26 months. Eliminating or reducing the off-site migration of groundwater would reduce the potential for human or environmental exposure to the groundwater contaminants and, thus, would be protective of human health and the environment. The sludge generated with electrochemical treatment and chemical precipitation would be disposed as hazardous waste unless a stabilization step could be added to the process train to render the sludge non-hazardous. Both of these treatment processes recirculate the filtrate from the filter press. Reinjection of the treated effluent to the aquifer would be protective of the sole-source aquifer used as a drinking water source, as the groundwater would be treated to NYSDEC Class GA standards prior to reinjection. Effluent monitoring would be required under the SPDES permit program for both alternatives.

Cost - The costs associated with installation of the sentinel wells and implementation of deed restrictions are estimated at $12,600 and $5,000, respectively .. The present worth cost for 30 years of annual groundwater monitoring (including installation) is estimated at $108,100. The present worth costs for each remedial action alternative includes 30 years of operation, and groundwater and effluent monitoring. The estimated capital and O&M costs for each alternative are presented as Appendices E.3 and E.4. The cost breakdowns for groundwater and effluent monitoring are presented as Appendices E.2 and E.5, respectively. The present worth cost of groundwater collection, treatment with an electrochemical process reinjection to the aquifer, disposal of the sludge as a hazardous waste, and groundwater and effluent monitoring is estimated at $4,030,800 for the On-Site Groundwater Remedial Scenario and $4,310,300 for the On-Site and Off-Site Groundwater Remedial Scenario. The present worth cost of groundwater collection, treatment with chemical precipitation, reinjection to the aquifer, disposal of the sludge as a hazardous waste, and groundwater and effluent monitoring is estimated at $3,718,200 for the On-Site Groundwater Remedial Scenario and $3,900,000 for the On-Site and Off-Site Groundwater Remedial Scenario.

4.4.2 Soil

The following remedial action alternatives for soil were evaluated in Section 4.3 and are discussed below: asphalt cover/off-site disposal; in situ S/S; in situ electrokinetic remediation; ex situ S/S; ex situ soil washing; and off-site treatment and disposal.

Short-Term Impacts and Effectiveness - Since there are no construction activities associated with the no-action alternative, apart from securing the perimeter fence, there are no additional short-term risks to human health or the environment. Provided access to off-site area is also restricted during implementation, none of the alternatives, with the exception of off-site treatment and disposal, would impact the general public. Any potential risks during implementation can be properly managed through the use of PPE and other appropriate health and safety procedures. With the Off-Site Treatment and Disposal Alternative, significant truck traffic and the potential for road spills on local roads would be of concern to the public. An asphalt cover would only be used for on-site soils; therefore, its implementation would have no impact on public health or the environment immediately adjacent to the Site. However, under this alternative, as well as in situ S/S, ex situ S/S and soil washing, off-site vegetation would have to be removed to access soils. The habitat that currently occupy the off-site areas would be uprooted and all vegetation would be destroyed. Therefore, implementation of these alternatives will impact the environment immediately adjacent to the Site. However, off-site areas would be backfilled with clean soil, regraded, and seeded with an appropriate ground cover for erosion control and to reestablish the disturbed areas. In situ electrokinetic remediation could be implemented without clearing off-site areas, thus, the environment would not be impacted. The estimated time frame to complete the remedial alternatives for soil, for Clean-Up Scenarios A and B, is: 17 months for the asphalt cover with off-site disposal; 16 and 15.5 months for in situ S/S; 30 and 24 months for electrokinetic remediation; 20 and 19 months for ex situ S/S; 22 and 20 months for ex situ soil washing; and 12 and 11 months for off-site treatment and disposal. Table 4-3 provides a breakdown of the estimated time required to complete the various phases of the remedial alternatives.

Long-Term Effectiveness and Permanence - With the no-action alternative, Site workers would continue to be exposed and utility workers may be exposed to contaminated soils. Exposure to contaminated soil in the off-site areas is possible since these areas are not restricted. An asphalt cover would prevent direct contact with on-site contaminated soils and reduce further off-site migration. Continued maintenance of the cover would be essential to reduce infiltration of precipitation. The cover would have to extend past the anticipated edge of contamination to reduce lateral movement of precipitation beneath the cap. If the asphalt cover is removed at any future date, the site soils would have to be addressed. Under this alternative, off-site soils would be transported to an off-site facility for treatment and disposal, eliminating further contact with soil contaminants.

A treatability or bench-scale study would be required for in situ S/S, ex situ S/S, and in situ electrokinetic remediation to define and optimize the parameters necessary for full-scale operation and to better effectiveness. A treatability study would also determine the feasibility of implementing the soil washing process for site contaminants.

Successful S/S would render the contaminants in the soil nonleachable and immobile. The infiltration of precipitation into the S/S treated soils (from in situ and ex situ S/S with on-site disposal) would be substantially reduced; hence, the potential for transport of contaminants to the groundwater and/or to off-site areas through erosion would be minimal. With in situ S/S, the treated soil mass in the lumberyard area would have to be covered with a layer of soil to prevent damage on the surface of the solidified mass as a result of truck traffic. An advantage of ex situ S/S over in situ S/S is the ability to better control the blending of reagents and soil in mixing equipment versus in the ground. Thorough blending of the reagents and soil is critical to the effectiveness of S/S.

Through the soil washing process, cleaned soil would be returned to the excavation, if appropriate, and contaminated fines would be disposed off-site as hazardous waste. Process water is recirculated and would only require disposal at the completion of the remedial action. This water may be discharged to the on-site treatment system, or directly discharged back to the aquifer, depending on contaminant concentrations.

Electrokinetic remediation, if effective, would permanently remove the contaminants from the soil and the concentrated metal residual would be disposed off-site as hazardous waste.

Therefore, soil washing, electrokinetic remediation, and off-site treatment and disposal would provide long-term protection of human health and the environment at the completion of the remedial action since no untreated wastes or treatment residual would remain on-site. Provided the treated soil product meets the leachability criteria, in situ and ex situ S/S would also provide long-term effectiveness in achieving the remedial action objectives for soil.

Reduction of Toxicity, Mobility, and Volume - The no-action alternative does not reduce the toxicity, mobility or volume of contaminated soil, above what may be accomplished with naturally occurring biodegradation processes.

An asphalt cover, if properly maintained, would effectively reduce the mobility of contaminants in on-site soils through reduced infiltration and erosion. However, this alternative would not reduce the toxicity or volume of contaminated media. In addition, if treated lumber is stored on the asphalt pad, an increased volume of contaminated media may be generated through run-off. Disposing the off-site soils at an off-site facility would effectively reduce the toxicity, mobility and volume of contaminated soil at the Site, but the same volume of contaminants would still exist at another location.

Both in situ and ex situ S/S would reduce the mobility of contaminants by reducing infiltration of precipitation. The toxicity of the soil would not be reduced since the contaminants would be immobilized not destroyed. S/S would result in a substantial volume increase due to the addition of reagent; however, this mass would be rendered non-hazardous.

Soil washing would remove metal contaminants from the soil, thereby reducing contaminant mobility. The volume of contaminated media would also be reduced as the heavy metals would be concentrated into a sludge. The toxic contaminants would not be destroyed but would be contained in the sludge and disposed off-site.

Electrokinetic remediation removes the contaminants from the soil in a concentrated form, thereby reducing contaminant mobility. The toxic contaminants would not be destroyed but would be disposed off-site. The reduction in the volume of contaminated media would be more significant than with soil washing as no additional products would be introduced during the process. The metals would be extracted from the soil and concentrated without the added bulk of soil fines and water.

Off-site treatment and disposal would reduce the mobility, toxicity and volume of hazardous substances on-site.

In the NYSDEC hierarchy of remedial technologies, separation/treatment technologies (electrokinetic remediation, soil washing, and off-site treatment and disposal) rank second, solidification technologies (in situ and ex situ S/S) rank third, and control and isolation technologies (asphalt cover) rank fourth or least preferable.

Implementability - The no-action alternative requires minimal implementation associated with securing the perimeter fence, implementing deed restrictions, and posting warning signs. An asphalt cover would be implementable; however, design difficulties may arise. The asphalt cover would have to be designed to drain properly while maintaining the usability of the lumberyard. The asphalt cover would have to extend far enough so the perimeter drain would not be excavated in contaminated soil. Maintenance requirements may be extensive depending on the weight and frequency of truck traffic, lumber storage practices, and weather conditions.

Electrokinetic remediation would require a bench-scale study, estimated at 2 months, to determine the number and placement of electrodes. On-site areas to be addressed to 6-inches below grade would be excavated and placed in a 2-foot lift on a plastic impermeable pad for treatment. A continuous application of water over the treatment area may be necessary due to the low moisture content and high permeability of Site soil.

All remaining alternatives would require clearing of all vegetation from off-site areas to access the soil. The vegetation may have to be disposed as a hazardous waste. The off-site areas would be filled with clean soil, regraded, and seeded with an appropriate ground cover for erosion control. S/S and soil washing would also require bench-scale treatability studies that would be completed within 2 months.

For in situ S/S, the top soil layer may have to be excavated to treat the lower layer, depending on the reach depth of the tilling equipment. The process time varies with the quantity of soil. For large quantities of soil (20,000 to 40,000 tons), approximately 1,000 tons of soil can be processed per day. Smaller quantities of soil (less than 7,000 tons) would be processed at approximately 500 tons per day. Ex situ S/S operations would also process between 500 and 1,000 tons per day. The soil washing process would treat approximately 30 tons per day.

As discussed in Section 3.2.3.3, an area on the northern portion of the BB&S property would be excavated to receive the off-site processed soil as well as any excess on-site soils (e.g., from the S/S process). A compacted layer of topsoil would have to be placed over the S/S product to protect the surface from damage due to heavy truck traffic. In addition to this disposal area, soil washing would require a substantial area for process equipment and soil/sludge staging. As the areal requirements for soil washing are estimated, it is possible that the northern portion of the property may not be of sufficient size.

A sufficient number of experienced vendors were identified who would be able to perform in situ S/S, ex situ S/S, and soil washing to allow competitive bidding; however, only one vendor was identified to perform electrokinetic remediation. Geokinetics holds the patent for this technology and, hence, this work could not go out for competitive bid. Several facilities were identified for off-site treatment and disposal of the hazardous soil.

Compliance with SCGs - The no-action alternative does not comply with the location-, action-, or chemical-specific SCGs for soil. All remedial action alternatives are anticipated to comply with the action-specific SCGs identified for this Site. The in situ electrokinetic remediation alternative would comply with the location-specific SCGs. All remaining alternatives would only comply with the location-specific SCGs if off-site clearing operations were not conducted during the May to July bird nesting season (per the Migratory Bird Treaty Act). The asphalt cover alternative would not comply with the chemical-specific SCGs for soil as the contaminants would remain on-site. Although published data for in situ

S/S generally are limited to demonstration projects sponsored by USEPA, it is anticipated that in situ S/S would comply with the chemical-specific SCGs. Ex situ S/S and soil washing have been demonstrated to be successful in attaining cleanup goals and, therefore, are anticipated to comply with the chemical-specific SCGs for soil. Electrokinetic remediation is anticipated to comply with the chemical-specific SCGs for soil; however, no full-scale results were available for review. Off-site treatment and disposal would comply with the chemical-specific SCGs, as is required of a treatment and disposal facility.

Overall Protection of Human Health and the Environment - The no-action alternative does not provide any protection of human health and the environment. Placement of an asphalt cover over on-site soils would be protective of human health and the environment in that it would limit infiltration of precipitation and reduce the potential for both direct human contact with the contaminated soils and further transport contaminated soils off-site via erosion or other means. The metals would remain in the soil and, therefore, the potential exists for the metals to contaminate the groundwater. With proper maintenance of the asphalt cover, infiltration of precipitation would be kept to a minimum, reducing the potential for the metals to be carried to the groundwater. All off-site soils would be excavated and transported to an off-site facility for treatment and disposal, eliminating any future exposure to site contaminants. The time frame for implementation of an asphalt pad, and removal of the off-site soils for disposal is estimated at 17 months. Thus, the asphalt cover/off-site disposal alternative would satisfy the remedial action objectives for the Site.

The in situ and ex situ S/S alternatives would be protective of human health and the environment in that contaminants are rendered nonleachable and immobile. S/S reduces the infiltration of precipitation and, hence, contact with contaminants in the soil, and reduces the potential for transport of contaminants to the groundwater and/or to off-site areas via erosion or other means. Potential exposure to contaminated dust during soil excavation can be properly managed through the use of PPE and other appropriate health and safety procedures. The time frame for implementation, under Clean-Up Scenarios A and B, is estimated at 16 and 15.5 months for in situ S/S and 20 and 19 months for ex situ S/S, respectively.

Soil washing would be protective of human health and the environment in that coarse-grain soil would be cleaned and returned directly to the area of excavation, if appropriate, and contaminated fines would be disposed off-site. The time frame for implementation of this ex situ soil washing under Clean-Up Scenarios A and B is estimated at 22 and 20 months, respectively.

The in situ electrokinetic remediation alternative would be protective of human health and the environment in that contaminants would be removed from the soil in a concentrated form and disposed off-site. Since the contaminants would be removed from the soil, the potential for transportation of contaminants to the groundwater and/or to off-site areas via erosion or other means would be eliminated. The off-site areas would not be cleared of vegetation or disturbed by excavation, and the soil would remain useable at the completion of the remedial action. The time frame for the implementation of in situ electrokinetic remediation under Clean-Up Scenarios A and B is estimated at 30 and 24 months, respectively.

The off-site treatment and disposal alternative would be protective of human health and the environment as it would provide additional reduction of risk as a result of the impacted soil being removed from the Site, precluding the potential for on-site contact or migration of contaminants. However, off-site disposal poses additional risk as the hazardous soil must be transported to an off-site disposal facility.

Cost - The cost to secure the perimeter fence, post warning signs, and implement deed restrictions under the no-action alternative is estimated at $15,000. The treatment cost for each remedial action alternative is summarized on Table 4-2 and detailed in Appendices E.6 through E.11. The lowest cost remedial alternative for Clean-Up Scenarios A and B is in situ S/S and is estimated at $1,133,100 and $745,800, respectively.

5.0 RECOMMENDED REMEDIAL ALTERNATIVES

5.1 CONCLUSIONS

5.1.1 Groundwater

In reviewing the remedial action alternatives for groundwater, the recommended remedial approach is collection and treatment with chemical precipitation, and reinjection of the treated groundwater to the aquifer. Chemical precipitation is the preferred treatment alternative since the effectiveness of this technology is well documented and several vendors exist who are experienced in chemical precipitation.

Both the electrochemical treatment and chemical precipitation alternatives would be effective in protecting human health and the environment during construction and implementation with proper use of PPE and other appropriate health and safety measures. The alternatives would equally meet the remedial action objectives for the Site groundwater in the short-term and would become effective immediately upon startup of their respective treatment systems. The estimated time frame to achieve start-up of either treatment system is estimated at 26 months.

The process flow for the electrochemical treatment and chemical precipitation systems includes many components that would likely require repairs and/or maintenance to ensure long-term reliability. The sludge generated with electrochemical treatment and chemical precipitation would have to be disposed as hazardous waste, unless a separate stabilization step can be added to the process to render the sludge non-hazardous. Both of these processes recirculate the filtrate from the filter press.

Both the remedial technologies would equally reduce the mobility of contaminated groundwater by altering the hydraulic gradient within the radius of influence, thereby eliminating the migration of the contaminant plume to off-site areas. Both remedial alternatives would bring about the separation of contaminants from the groundwater matrix and would reduce both the toxicity of the groundwater and the volume of contaminated media. Electrochemical treatment and chemical precipitation generate hazardous sludge that would be disposed off-site.

A building would be placed on the northern portion of the Site to house the treatment equipment for either groundwater remedial alternatives. The building size would be approximately 80 feet by 40 feet for either alternative. Treatment system components for the chemical precipitation system are readily available from their respective manufacturers but only one vendor has been identified to perform electrochemical treatment. Treatability tests would be required for both electrochemical treatment and chemical precipitation to develop accurate design-related data to optimize the full-scale treatment system. The feasibility of electrochemical treatment would be determined during these tests. Prior to treatability testing, it is difficult to predict removal efficiencies of the electrochemical and precipitation processes with certainty. However, experience with similar waste streams resulted in sufficient removal efficiencies to reduce contaminant concentrations to below NYSDEC Class GA standards. Implementation of both alternatives would require the equivalent of a SPDES permit from NYSDEC for reinjection of the treated effluent into the aquifer upgradient of the groundwater plume, via an on-site infiltration gallery. Effluent monitoring would be required under the SPDES permit program.

The operation of a groundwater pump-and-treat system followed by either of the treatment technologies would reduce the off-site migration of contaminated groundwater, reduce the toxicity of the groundwater, reduce the volume of contaminated media requiring disposal, and meet the remedial action objectives for groundwater.

The total present worth cost of groundwater collection, treatment with chemical precipitation, reinjection of treated effluent to the aquifer, disposal of the sludge as a hazardous waste, and 30 years of groundwater and effluent monitoring is approximately $410,300 less than electrochemical treatment (for the On-Site and Off-Site Groundwater Remedial Scenario). In addition, the cost of the chemical precipitation system presented here includes the stabilization step and, therefore, the total cost of the system could be reduced without this step. The difference in cost over a 30 year period between the two alternative clean-up scenarios (viz., on-site groundwater only vs. on-site and off-site groundwater) is $181,800.

5.1.2 Soil

The recommended remedial approach for on-site and off-site soils is ex situ S/S for both clean-up scenarios. Provided access is restricted during implementation, ex situ S/S would not impact the general public. Any potential risks during implementation can be properly managed through the use of PPE and other appropriate health and safety procedures. Ex situ S/S would impact the environment since the vegetation would have to be removed from the off-site areas for excavation of the contaminated soils. The habitat that currently occupy these forested areas would be uprooted and all vegetation would be destroyed. However, clean soil would be used to backfill the off-site excavations and the areas would be seeded with an appropriate ground cover to minimize erosion and reestablish the disturbed areas.

S/S would provide long-term protection of human health and the environment provided that the permeability of the treated soil can be sufficiently reduced and the solidified mass is not damaged. As a precautionary measure, the treated soil mass should be covered with a layer of soil to prevent damage from potential future truck traffic. Successful implementation of S/S would render the contaminants in the soil nonleachable and immobile. The infiltration of precipitation into the S/S treated soils would be substantially reduced; hence, the potential for transportation of contaminants to the groundwater and/or to off-site areas via erosion or other means would be minimal.

Ex situ S/S would reduce the mobility of contaminants by reducing infiltration of precipitation. The toxicity of the soil would not be reduced since the contaminants would be immobilized not destroyed. S/S would result in a substantial volume increase due to the addition of reagent; however, this mass would be rendered non-hazardous and disposed on-site.

A sufficient number of experienced vendors were identified to competitively bid ex situ S/S. Soil from on-site and off-site areas requiring remedial action would be excavated and stockpiled for treatment. Ex situ S/S would be implemented on-site using conventional equipment required for soil excavation and mixing with reagents. The area on the northern portion of the Site could be excavated to receive the processed soils. The soil from this area would be used as backfill for all on-site and off-site areas.

Ex situ S/S would comply with the action-specific SCGs identified for this Site, and with the location-specific SCGs provided off-site clearing operations were not conducted during the May to July bird nesting season (per the Migratory Bird Treaty Act). While the treatment of contaminants is preferred, S/S technologies generally face minimal difficulty in obtaining the necessary regulatory/permitting approvals (USEPA, 1993). Ex situ S/S is anticipated to comply with the chemical-specific SCGs, with respect to the leachability of the contaminants from the soil.

S/S would be protective of human health and the environment in that contaminants in the soil would be rendered nonleachable and immobile. S/S would reduce the infiltration of precipitation and, hence, the potential for transportation of contaminants to the groundwater and/or to off-site areas via erosion or other means would be minimal. Based on the estimates of the total present worth cost, ex situ S/S would be the second least expensive alternative (next to in situ S/S) to implement for both clean-up scenarios. The difference in cost between Clean-Up Scenarios A and B for in situ S/S is $507,500.

Implementation of the asphalt cover alternative would address on-site soils (off-site soils would be disposed off-site). Covering contaminants in-place is ranked as the least preferable remedial technology NYSDEC's hierarchy as the toxicity and volume of contaminants would not be reduced. Continued maintenance of the asphalt cover would be essential to reduce the infiltration of precipitation and, hence, the mobility of contaminants. If the asphalt cover is to be removed at a later time, the soils would have to be addressed. In addition, the cost for placement of an on-site asphalt cover with disposal of off-site soils would be approximately twice the cost of ex situ S/S.

The off-site treatment and disposal alternative would provide additional reduction of risk to human health and the environment as a result of the hazardous soil being removed from the Site. However, off-site disposal would pose additional risk during transportation of the hazardous material via public roadways to the treatment and disposal facility. This reduction in risk would not justify an increase in cost between 2 and 4 times that of ex situ S/S.

Although soil washing would likely be a feasible alternative for the Site, there are many potential disadvantages over ex situ S/S. Soil washing requires a substantial area for process equipment and soil/sludge staging. The areal requirements provided by vendors are estimated; however, with the additional space required for the groundwater treatment building and reinjection system on the northern portion of the Site, there may not be enough room to implement the soil washing alternative. Soil washing would also generate two waste streams; contaminated fines that would require off-site disposal as a hazardous waste, and process water that would require treatment at the end of soil washing operations. Treatability studies would be required for both ex situ S/S and soil washing; however, the objectives of the study for soil washing would be to determine the feasibility of this technology for the site-specific soils, whereas the objectives for the S/S study would be to optimize this proven technology. The time frame for soil washing would be approximately 2 months longer and the cost would be almost 4 times greater than ex situ S/S for Clean-Up Scenario A.

In situ electrokinetic remediation would not impact the general public provided access is restricted during implementation. Electrokinetic remediation is the only alternative that would be implemented without clearing vegetation from off-site areas, thus, only minimally disturbing off-site land and habitat. Electrokinetic remediation would, if successful, effectively and permanently remove the contaminants from the soil, thereby eliminating contaminant mobility to the groundwater and/or to off-site areas via erosion or other means. The recovered metals would be concentrated in a dry precipitate for off-site disposal. Electrokinetic remediation would provide long-term protection of human health and the environment at the completion of the remedial action since no untreated wastes or treatment residual would remain on-site. Geokinetics holds the patent for the electrokinetic remediation process, and although successful full-scale remediation of similar soils have apparently been completed, no results were available for review. Implementation of electrokinetic remediation would have many advantages over ex situ S/S, such as generating a minimal quantity of hazardous waste, remediating without disturbing off-site areas, and permanently removing contaminants from the soil. However, the disadvantages of this alternative, such as lack of full-scale results, a time frame for completion of approximately 1.5 times that for ex situ S/S, and a cost over two times the cost for ex situ S/S, would greatly out-weigh the advantages.

The in situ S/S alternative would be very similar to the ex situ S/S alternative. Ex situ S/S has been used for more full-scale applications; however, its time frame for completion and total cost for implementation are slightly higher than in situ S/S. Both in situ and ex situ S/S alternatives would satisfy the remedial action objectives for the Site. With ex situ S/S, a larger area would be required for soil staging and disposal, and more equipment would likely be required for soil processing. However, with ex situ S/S, the treatment area would be located away from Site activities, allowing the Site to resume operations once the excavated areas have been backfilled with clean soil, and thorough blending of soil and reagents would be better controlled in mixing equipment than in the ground. In addition, difficulties may arise with in situ S/S around Site structures.

5.2 RECOMMENDED ALTERNATIVES

5.2.1 Groundwater

The recommended alternative for contaminated groundwater is collection and treatment with chemical precipitation, and reinjection of the treated groundwater to the aquifer. Pretreatment would consist of lime addition to adjust the pH to approximately 10.0, with the concurrent addition of iron salts that act as a primary coagulant. An electronic metering pump would introduce a polymer and sulfide solution to promote floc growth. The flocculated waste water would be pumped to a plate type clarifier where the solids would settle. The settled sludge would be automatically pumped to a sludge holding tank. A small percentage of the sludge would be pumped back to the initial pH adjustment tank to assist in precipitation formation. The effluent from the clarifier would flow to polishing mixed media sand filters for removal of any suspended solids. The filters would be backwashed automatically and the filter backwash would be returned to the initial pH adjustment tank for recycling. The filter discharge would flow to a final pH adjustment tank where acid would be added by an electronic metering pump to reduce the pH to the required discharge standard. Accumulated sludge would be dewatered with a plate type filter press. The filtrate would also be recycled to the initial pH adjustment tank. With STC's process, reagents would be added to the sludge holding tank to assure that the sludge is non-hazardous and not a RCRA waste.

The treatment system would be housed in a building that would be situated on the northern portion of the property, in close proximity to the aquifer reinjection system. The equivalent of a SPDES permit would be required to discharge the effluent from the treatment system to the aquifer. Effluent monitoring would be required as part of the SPDES permit. A Groundwater Monitoring Program would also be implemented. The frequency at which the monitoring events would occur depends on further plume delineation scheduled as part of the pre-design investigation.

5.2.2 Soil

The recommended remedial approach for both on-site and off-site soils is ex situ S/S for either clean-up scenarios. The institutional controls recommended for the Site include securing/repairing the perimeter fence and posting warning signs around the Site. An area on the northern portion of the property would be excavated to receive both on-site and off-site solidified soils. The excavated clean soil would be used to backfill the on-site and off-site areas and to cover the solidified mass on-site to protect the integrity of the surface from potential future truck traffic. The tributary would be graded and seeded with an appropriate ground cover to minimize erosion and reestablish the disturbed habitat.

The treatability study would determine the most effective reagent formulation for stabilization of the site-specific contaminants. Conventional equipment would be used for batch mixing of soil with reagents. Approximately one sample per 1,000 tons of treated product would be analyzed for TCLP metals to assure that the contaminants have been rendered nonleachable.

5.3 COSTS

The present worth cost for chemical precipitation, assuming 30 years of operation, maintenance, and groundwater and effluent monitoring, at an interest rate of 5 percent, is estimated at $3,718,200 for the On-Site Groundwater Remedial Scenario and $3,900,000 for the On-Site and Off-Site Groundwater Remedial Scenario. The total cost for treating on-site and off-site impacted soils with ex situ S/S under Clean-Up Scenarios A and B is estimated at $1,289,800 and $782,300, respectively.

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APPENDIX A

SUPPLEMENTAL SOIL SAMPLING EVENT - SEPTEMBER 30, 1998

BB+S TREATED LUMBER SITE
FEASIBILITY STUDY

SUMMARY OF SURFICIAL SOIL INORGANIC RESULTS
SUPPLEMENTAL SAMPLING ON SEPTEMBER 30, 1998

	Sample Interval	Concentration (mg/kg)				Sample
Sample No.	**(feet)**	**Arsenic**	**Q**	**Chromium**	**Q**	**Location**
SP1-98	0 - 0.5	6.6		16.3		Southern Property Line
SP2-98	0 - 0.5	5.4		11.0		Southern Property Line
SP3-98	0 - 0.5	13.7		20.4		East of Office Building
SP4-98	0 - 0.5	8.5		13.4		Main Lumberyard
SP5-98	0 - 0.5	9.2		15.6		Main Lumberyard
SP6-98	0 - 0.5	116		233		Eastern Lumberyard
SP7-98	0 - 0.5	9.7		16.2		Main Lumberyard
SP8-98	0 - 0.5	13.0		23.7		Main Lumberyard
SP8-98 I	1.0 - 1.5	1.7	B	8.2		Main Lumberyard
SP9-98	0 - 0.5	34.7		79.8		Eastern Lumberyard
SP11-98	0 - 0.5	6.7		10.8		Main Lumberyard
SP12-98	0 - 0.5	13.8		22.7		Main Lumberyard
SP13-98	0 - 0.5	169		284		Eastern Lumberyard$^{(1)}$
SP14-98	0 - 0.5	15.0		25.4		Main Lumberyard
SP15-98	0 - 0.5	12.4		23.0		Main Lumberyard
SP16-98	0 - 0.5	13.2		22.3		Main Lumberyard
SP17-98	0 - 0.5	25.2		32.1		Main Lumberyard
SP17-98 I	1.0 - 1.5	3.6		3.7		Main Lumberyard
SP17-98 D	2.5 - 3.0	2.3		3.0		Main Lumberyard
SP18-98	0 - 0.5	18.8		28.6		Main Lumberyard
SP19-98	0 - 0.5	19.2		35.3		Main Lumberyard
SP20-98	0 - 0.5	54.4		79.8		Northern Lumberyard
SP21-98	0 - 0.5	13.0		21.6		Northern Lumberyard
SP22-98 I	1.0 - 1.5	37.8		62.3		Northern Lumberyard
SP22-98 D	2.5 - 3.0	1.6	B	6.9		Northern Lumberyard
SP23-98	0 - 0.5	42.5		83.9		Northern Lumberyard
SP24-98	0 - 0.5	10.0		10.7		Windrow Fenceline
SP25-98 I	1.0 - 1.5	3.7		4.9		North of Lumberyard
SP25-98 D	2.5 - 3.0	21.6		37.6		North of Lumberyard
SP26-98	0 - 0.5	36.0		46.6		Northern Lumberyard
SP27-98	0 - 0.5	19.6		28.4		Duplicate of SP17-98
SP28-98	0 - 0.5	12.6		17.4		Northern Lumberyard
SP29-98	0 - 0.5	4.1		7.0		Northern Property Line
SP30-98	0 - 0.5	8.5		12.2		Northern Property Line
SP31-98	0 - 0.5	1.9	B	8.3		Northern Property Line
SP32-98	0 - 0.5	4.0		6.9		North of Shed
SP32-98 I	1.0 - 1.5	1.2	B	6.4		North of Shed
SP33-98	0 - 0.5	15.2		19.4		North of Shed
SP33-98 I	1.0 - 1.5	28.3		36.0		North of Shed
SP34-98 I	1.0 - 1.5	82.8		112		Catch Basin
SP34-98 D	2.5 - 3.0	21.9		16.5		Catch Basin

APPENDIX A

MALCOLM PIRNIE

BB+S TREATED LUMBER SITE
FEASIBILITY STUDY

SUMMARY OF SURFICIAL SOIL INORGANIC RESULTS
SUPPLEMENTAL SAMPLING ON SEPTEMBER 30, 1998

Sample No.	Sample Interval (feet)	Concentration (mg/kg)				Sample Location
		Arsenic	Q	Chromium	Q	
SP35-98 I	1.0-1.5	131		160		Tributary
SP36-98 I	1.0-1.5	138		148		Tributary
SP36-98 D	2.5 - 3.0	209		188		Tributary
SP37-98	0 - 0.5	350		508		Tributary(1)
SP37-98 I	1.0 - 1.5	302		499		Tributary
SP38-98	0 - 0.5	56.5		81.1		Tributary
SP39-98	0 - 0.5	9.9		11.7		Duplicate of SP30-98
SP40-98	0 - 0.5	40.6		88.9		Northern Lumberyard

Notes:

(1) MS/MSD sample.

B = Reported value is less than the Contract Required Detection Limit (CRDL) but greater than the Instrument Detection Limit (IDL).

New York State Department of Environmental Conservation
Division of Environmental Remediation
Bureau of Eastern Remedial Action, Room 242
50 Wolf Road, Albany, New York 12233-7010
Phone: (518) 457-7924 FAX: (518) 457-4198

John P. Cahill
Commissioner

REPORT

Supplemental Soil Sampling for the Feasibility Study
BB&S Treated Lumber, Site No. 152123
October 1998

Introduction

This report describes in-house sampling activities performed for the BB&S Treated Lumber inactive hazardous waste site in Speonk, New York. These sampling activities were conducted by the staff of the Division of Environmental Remediation (DER) to supplement data collected during the Remedial Investigation by Malcolm Pirnie, Inc., under DER Standby Contract Work Assignment No. D002852-15. The data obtained in this supplemental sampling program are intended to be used to support remedy evaluation in the Feasibility Study under this work assignment. A Work Plan for Supplemental Soil Sampling for the Feasibility Study (NYSDEC, September 1998) was developed for this sampling event. This report describes results and deviations from the work plan. Questions concerning this report should be directed to Kathleen McCue, P.E., at the above address and phone.

Sample Locations

Sampling was conducted in a one-day effort on September 30, 1998. Final sample locations are noted on the attached site plan. Intervals are as noted in the Work Plan: Surface(S) samples are zero-two inches; intermediate (I) samples are from 1-1.5 feet; deep (D) samples from 2.5-3 feet below ground surface. Due to the hard-packed condition of soils in the lumber yard, it was necessary to delete some intermediate and deep soil samples and substitute other locations. Proposed samples at the location of SP-7 (east side of drip pad) were taken instead at SP17-98 (see site plan). Final locations of samples, as shown, are approximate. Wendel Survey of Lockport, NY, has surveyed the exact locations for Malcolm Pirnie for use in the FS.

Sampling Method and Descriptions

Surface samples were collected using disposable scoops to obtain sufficient sample volume (four ounces) from a one- to two-foot square area. Surface samples consisted of dry, loose fine to coarse sand and/or gravel. Intermediate and deep samples were obtained using a hand auger, and if necessary, a shovel. In general the subsurface samples consisted of uniform, slightly moist sand. In one area (Sample SP25-98, taken in proximity to ponded water) the samples were wet. The hand auger and other reusable equipment were decontaminated between locations using Alconox detergent, tap water, 10 percent nitric acid solution, and distilled water.

Analysis and Quality Control Samples

Samples were cooled with ice and hand-delivered to H2M Labs, Inc., on the same day of sampling. Seven-day turnaround was requested for arsenic and total chromium analysis according to Analytical Services Protocols (ASP). H2M faxed NYSDEC the Forms I on October 9, 1998 (attached). The remainder of the Category B data package will be sent to NYSDEC (copy directly to Nancy Potak, data auditor) on or before October 22, 1998.

The following numbers and types of environmental and QC samples were performed:

Number of Samples*	Blind Duplicate	Matrix Spike/ MSD	Trip Blank	Equipment Rinse Blank (Field Blank) ***
47	2	2**	N/A	1

* Two 2-oz bottles were provided for each sample.
** Though not required by the NYSDEC QA Officer, MS/MSDs were performed at the lab's request to facilitate Category B reporting.
*** Bottle of analyte-free water supplied with sample jars. One per day or sampling event.

The attached table shows the relation of sample names and contract lab identifiers, and indicates which sample locations were selected for QC sampling.

Surveying

All sample locations were marked with flagging and with paint in trafficked areas. Some flags were moved by BB&S personnel in the eastern portion of the active lumber yard area; however, the surveyor (Wendel) arrived late in the day on September 30, to prepare for surveying points the following day, and NYSDEC staff were able to point out the location of disturbed sample points.

Recommendations

Most samples show an expected pattern of decrease in concentration between surface, intermediate, and deep samples. At one location, SP25-98, an anomaly of higher deep concentrations appears. This may reflect an misplacement of samples in the collection or analysis process, or it may reflect site conditions. SP25-98 was taken in the depressed, ponded area northeast of the buildings near the eastern fence. Considerable, possibly recent (and cleaner) silt had filled the depression and might account for the appearance of reduced contamination in the shallower sample. Samples SP33-98 and SP33-98 I were also taken in a wet, silted-in area and may show a similar effect. Pending final audit of the data, NYSDEC recommends the FS be completed using all results obtained from this September 30, 1998 event.

Attachments:

1. Sample Location Map
2. Sample Identifier Table
3. Forms I: Unaudited Sample Results

SAMPLES TAKEN AT BB&S LUMBER CORPORATION ON SEPTEMBER 30, 1998

Work Plan Sample No.	Contract Lab ID	Remarks
SP1-98	A843-01	surface
SP2-98	A843-02	surface
SP3-98	A843-03	surface
SP4-98	A843-04	surface
SP5-98	A843-05	surface
SP6-98	A843-06	surface
SP7-98	A843-07	surface
SP8-98	A843-08	surface
SP8-98 I	A843-49	1'-1.5'
SP9-98	A843-09	surface
SP11-98	A843-11	surface
SP12-98	A843-12	surface
SP13-98	A843-13	surface, MS/MSD
SP14-98	A843-14	surface
SP15-98	A843-15	surface
SP16-98	A843-16	surface
SP17-98	A843-17	surface
SP17 -98 I	A843-10	1'-1.5'
SP17-98 D	A843-37	2.5'-3.0'
SP18-98	A843-18	surface
SP19-98	A843-19	surface
SP20-98	A843-20	surface
SP21-98	A843-21	surface
SP22-98 I	A843-22	1'-1.5' @ old SP-1-97
SP22-98 D	A843-38	2.5'-3' @ old SP-1-97

Work Plan Sample No.	Contract Lab ID	Remarks
SP23-98	A843-23	surface
SP24-98	A843-24	surface
SP25-98 I	A843-25	1'-1.5' @ old SP-10
SP25-98 D	A843 -39	2.5'-3' @ old SP-10
SP26-98	A843-26	surface
SP27-98	A843-27	blind duplicate @SP17-98
SP28-98	A843-28	surface
SP29-98	A843-29	surface
SP30-98	A843-30	surface
SP31-98	A843-31	surface
SP32-98 S	A843-32	surface
SP32-98 I	A843-40	1'-1.5'
SP33-98 S	A843-33	surface
SP33-98 I	A843-41	1'-1.5'
SP34-98 I	A843-34	1'-1.5' @ old SRR-3
SP34-98 D	A843-42	2.5'-3' @ old SRR-3
SP35-98 I	A843-35	1'-1.5' @ old SP14-97
SP36-98 I	A843-36	1'-1.5' @ old SP16-97
SP36-98 D	A843-43	2.5'-3' @ old SP16-97
SP37-98 S	A843-44	surface, MS/MSD
SP37-98 I	A843-45	1'-1.5'
SP38-98	A843-46	surface
SP39-98	A843-47	blind duplicate @SP30-98
SP40-98	A843-48	surface

APPENDIX B

ESTIMATES OF ONE-DIMENSIONAL SOLUTE TRANSPORT

ESTIMATES OF ONE-DIMENSIONAL SOLUTE TRANSPORT

November 18, 1998

1.0 INTRODUCTION AND OBJECTIVES

The BB&S Treated Lumber site, located in Speonk, Long Island, NY, is a former lumber preserving facility. Lumber treatment operations at the site began in 1979 using solutions of chromate, copper, and arsenate (CCA) for wood preservation. Soil and groundwater contamination underlying the site have been documented (RI report, revised June 1998). Discharges of CCA are believed to have entered the soil and groundwater from concrete sumps located within the treatment building and/or from a drip area where lumber was stacked until dry after treatment. A Remedial Investigation (RI) was conducted to determine the current nature and extent of contamination underlying the site. Some fraction of the total mass of contaminants released to soils and groundwater has been documented to have escaped capture (RI report, revised June 1998) and is migrating toward potential receptors. The goal of the analysis presented here is to develop a preliminary assessment of the rate at which these contaminants may migrate in groundwater in the future toward potential downgradient receptors.

The objectives of this analysis are to:

1. develop a method for estimating one-dimensional solute transport in the subsurface at the BB&S site under variable geochemical conditions; and
2. analyze the results in order to evaluate the need for development of a more rigorous, site-specific, numerical model. Such a model would be designed specifically to support, if necessary, a quantitative evaluation of remedial alternatives at the site.

2.0 CONCEPT

An analytical solution to the one-dimensional solute transport equation was used to estimate total chromium transport in the subsurface at the BB&S site. The hydraulic gradient runs south in the vicinity of the site, parallel to Speonk-Riverhead Road. The contaminant plume is elongated and currently extends south from the concrete drip pad and treatment building, the presumed contaminant source locations, a distance of more than 1200 feet (RI Report, revised June 1998). Preliminary MODFLOW/MODPATH groundwater modeling indicates that two wells (RW-1 and RW-2) pumped to recover contaminated groundwater create a capture zone extending roughly 60 feet downgradient of RW-2. Although the actual source of contamination is believed to be the concrete drip pad and the treatment building, solute transport was estimated for the purposes of this analysis from the downgradient limit of the capture zone or so-called stagnation point. The stagnation point is the location from which contaminants continue to migrate from the site with the prevailing gradient even when the recovery system is actively pumping, viz., that portion of the plume that is not captured by the recovery system. The concentration at this stagnation point, then, is considered the "source" concentration for the purposes of this analysis and has been estimated to reflect groundwater concentrations measured in this location rather than the actual source.

Governing equation:

$$D_l \frac{\partial^2 C}{\partial x^2} - \bar{v}\frac{\partial C}{\partial x} = R\frac{\partial C}{\partial t}$$

where:

$D_l =$ dispersion coefficient (L^2/t);
$C =$ contaminant concentration (M/L^3);
$x =$ distance downgradient from source (L);
$\bar{v} =$ Darcian groundwater flow velocity (L/t);
$R =$ retardation factor (-); and
$t =$ time (t).

Note that:

$D_l = \alpha_l \bar{v}$;
$\alpha_l = 0.093x + 0.007$ (from Gelhar et al., 1992);
$\bar{v} = -\frac{K}{n}\frac{\partial h}{\partial x}$; and
$R = 1 + \left(\frac{\rho_b K_d}{n}\right)$

where:

α_l = longitudinal dispersivity (L);
K = hydraulic conductivity (L/t);
n = effective porosity (-);
$\frac{\partial h}{\partial x}$ = hydraulic gradient (-);
ρ_b = soil bulk density (M/L^3); and
K_d = distribution coefficient (L^3/M).

Initial and boundary conditions:

$$C(x,0) = C_i$$
$$C(0,t) = C_0; 0 < t \le t_0$$
$$C(0,t) = 0; t > t_0$$
$$\frac{\partial C}{\partial x}(x = \infty, t) = 0$$

Analytical solution (from Ogata and Banks, 1961):

$$C(x,t) = C_i + (C_0 - C_i) \cdot f(x,t) \text{ for } 0 < t \le t_0$$

or

$$C(x,t) = C_i + (C_0 - C_i) \cdot f(x,t) - C_0 \cdot f(x, t - t_0) \text{ for } t > t_0$$

where:

$$f(x,t) = \left\{ \frac{1}{2} erfc\left[\frac{Rx - \bar{v}t}{2\sqrt{DRt}} \right] + \frac{1}{2} \exp\left(\frac{\bar{v}x}{D_l} \right) erfc\left[\frac{Rx + \bar{v}t}{2\sqrt{DRt}} \right] \right\}$$

and the error function and complementary error function are defined as:

$$erfc(x) = 1 - erf(x)$$

$$erf(x) = \frac{2}{\pi} \int_0^x e^{-u^2} du$$

3.0 DETERMINATION OF VALUES FOR INPUT PARAMETERS

***Hydraulic conductivity* (K):**

The site, located in the Pine Barrens region of Long Island, NY, is immediately underlain by Pleistocene glacial outwash deposits consisting of relatively uniform medium sand with some silty sand in the upper five feet of the soil profile. The K used in these calculations (1.58×10^{-1} cm/sec) is taken as the average K observed during on-site aquifer testing, as reported in the RI report (pages 4-11 through 4-12, and page 8-3). The measured values are very consistent, varying less than 10 percent from the average. Given the consistent observed K, and the homogeneous nature of the aquifer material, the K was not varied in this analysis.

***Effective porosity* (n):**

Given the granular nature of the aquifer material and the relative uniformity of grain size, the effective porosity was assumed to be roughly equal to the porosity. In the absence of site-specific data, the porosity was assumed to be 0.32. Depending on the actual grain size distribution, porosity for such homogeneous material may actually vary locally from roughly 0.30 to 0.37. An effective porosity of 0.32 serves as a reasonable estimate and accordingly contributes to conservative estimates of groundwater velocity.

***Hydraulic gradient* $\left(\frac{\partial h}{\partial x}\right)$:**

The hydraulic gradient used here (0.0012) was taken as the average gradient measured across the site in May 1996, August 1996, and February 1997, as reported in the RI report (page 4-10). The range of gradients measured is quite small. For these three dates, the gradient across the site was measured as 0.0011, 0.0014, and 0.0011, respectively.

Distribution coefficient **(K_d):**

The K_d, the ratio of the sorbed concentration to the dissolved concentration, is a function of the specific solution chemistry (e.g., pH, ionic strength, chemical speciation of the sorbate, charge on the sorbate species, and Eh) and soil characteristics (e.g., clay content, Fe_2O_3 content, specific surface area, f_{oc}, and pH). As a result of the influence of these variables, no generally applicable K_d exists for any given metal ion. The K_d specific to any particular soil-solution combination may be estimated empirically in the laboratory by mixing batches of the specific soil and solution. In the absence of this information, an attempt was made to find results from soil samples collected in close spatial and temporal proximity to groundwater samples. In such a case, given the known rapid sorption kinetics for metals in most systems (Sperry, 1997), it may be possible for purposes of a first-order approximation to assume that the two samples represent soil and groundwater that were in contact and at equilibrium. SB-2, collected in June 1996 at the water table (35 to 37 feet below ground surface), is within 10 feet of MW-5, from which samples were collected in May 1996, August 1996, and February 1997. The K_d calculated for total chromium using the soil sample from SB-2 at the water table and the average of the three groundwater samples collected from MW-5 is 2.65 L/kg. This results in retardation factors in excess of 10 for total chromium at this location. In reality, attenuation of the total mass of chromium in this environment at BB&S is likely to be considerably lower because some of the chromium underlying BB&S exists as Cr(VI) which exhibits anionic behavior. Note that one of the most widely known cases of chromium contamination is a Superfund site in Nassau County, Long Island, NY, a similar hydrogeologic setting. In this case, an elongated plume of Cr(VI) over 4000 feet long was observed to be migrating downgradient at the same velocity as groundwater (Palmer and Wittbrodt, 1991). By comparison, retardation factors for Cr(VI) at that site would be 1.0, ***less*** than that used as the upper estimate for retardation here by more than a factor of 50.

Longitudinal dispersivity (α_l):

Since no site-specific measurements for α_l are available, α_l has been estimated. Dispersivity is known to be scale-dependent and was estimated as described above based on Gelhar et al. (1992).

Initial concentration in aquifer $(C_i = C(x,0))$:

The average total chromium concentration measured in the furthest downgradient monitoring well MW-14, located roughly 700 feet south of the stagnation point, was over 180 µg/L. The equation used in this analysis does not account for a contaminant concentration distribution from the stagnation point to the downgradient receptor. Therefore, for the purpose of this analysis, the initial total chromium concentration in the aquifer downgradient from the stagnation point is assumed to be 0 µg/L. Since chromium has already been detected beyond the capture zone in MW-11 and MW-14, this assumption will yield estimates of chromium concentration that are ***less than*** those actually expected to be observed because this analysis is intended to estimate groundwater transport under natural conditions and in reality these conditions have been accelerated by historical pumping of RW-3. For this reason, these results are intended to reflect estimated total chromium transport and travel times **from the time at which chromium was first present at the stagnation point** at concentrations approximating C_0 (assumed to be at the start up of the groundwater collection system, viz. 1987).

Concentration at the source, viz. stagnation point $(C_0 = C(0,t))$:

Breakthrough curves are generated in this analysis from the groundwater stagnation point to the nearest potential receptor located 0.25 miles downgradient. The stagnation point, the location where the downgradient limit of the zone of influence from pumping RW-2 ends and the natural prevailing gradient resumes, is estimated to be roughly 60 feet south of RW-2. Since the average concentrations of total chromium in RW-2 and MW-11 (measured in May 1996, August 1996, and February 1997) are roughly 5,800 and 1,400 μg/L, respectively, and the distance between these two points is roughly 210 feet, the concentration of total chromium at the stagnation point used for these calculations is 4,500 μg/L. (It is not possible to estimate if the concentration following start up of the collection system in 1987 was higher or lower than the 4,500 μg/L used for this evaluation.)

Distance of receptor from source **(x):**

The distance from the stagnation point to the nearest known potential receptor is roughly 0.25 miles. This is the distance used for calculating travel times for total chromium downgradient of BB&S.

Duration of pulse **(t_0):**

The duration of the pulse is the length of time that the contaminant source persists. For the purpose of this analysis, the "source" location is considered the stagnation point and the contaminant "source" is therefore considered to be beyond the capture zone of the recovery system. There is no way to estimate a decaying concentration of the source or to determine if the source will have a finite duration; therefore, to be conservative, the contaminant source is assumed to persist indefinitely. Thus, only the first solution from Ogata and Banks (1961) presented above is applied in this analysis.

4.0 RESULTS

The results indicate that solute transport in this hydraulic setting is very sensitive to K_d (see Table 1 and Figure 1). Comparisons of travel times are based on breakthrough to a total chromium concentration of 50 μg/L, the Class "GA" Groundwater Quality Standard (6 NYCRR 703.5) for total chromium at the receptor. Assuming that the K_d equals 2.65 L/kg, as estimated from samples collected at SB-2 and MW-5, total chromium concentrations may exceed 50 μg/L at a distance of 0.25 miles downgradient

TABLE 1
BB&S TREATED LUMBER SITE
FEASIBILITY STUDY

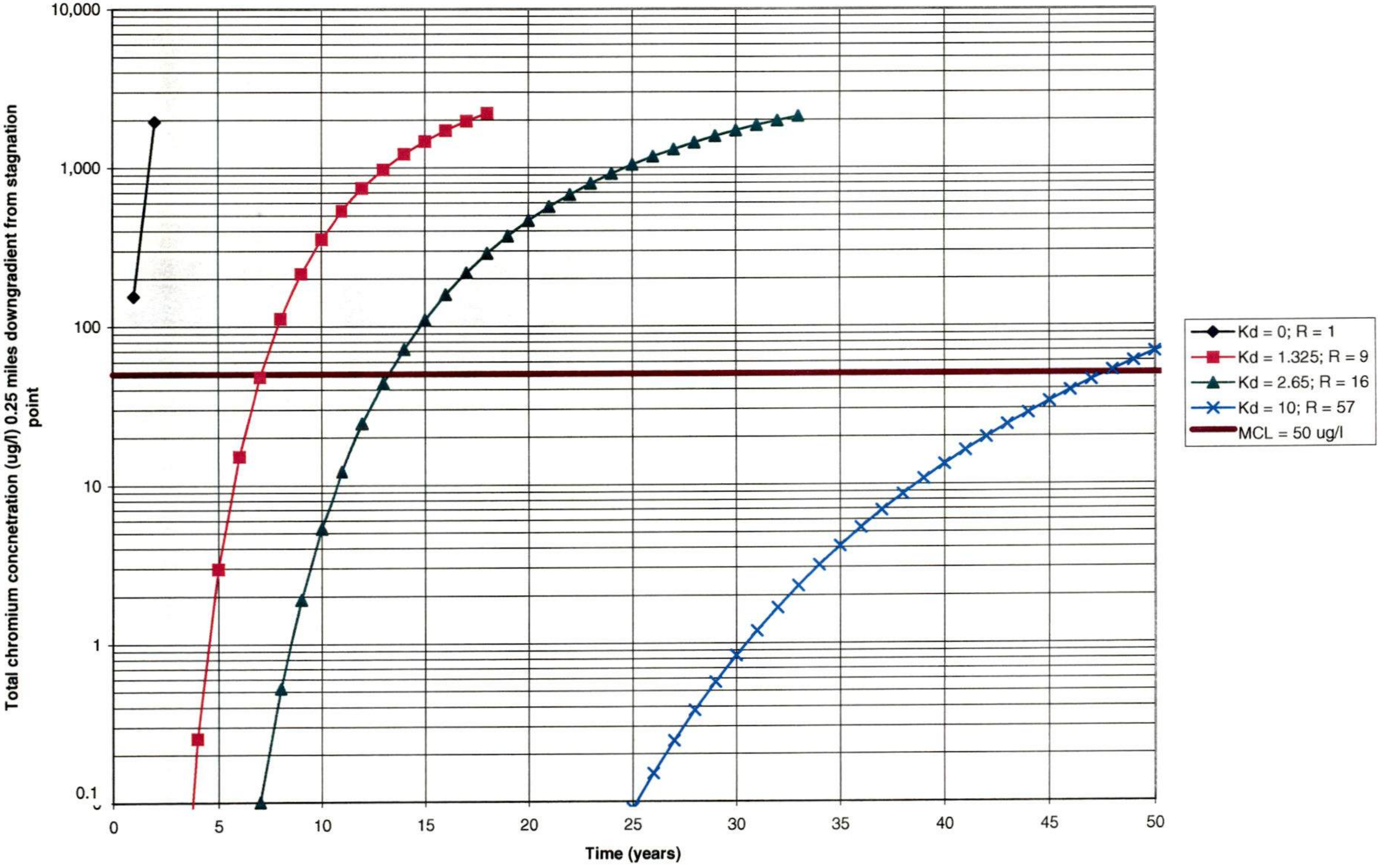
COMPARISON OF SOLUTE TRANSPORT RATE TO DISTRIBUTION COEFFICIENT (K_d)

K_d (L/kg)	Travel Time[1] (Years)
0	1
1.33	7
2.65	14
10	50

Note:

(1) Travel time to reach NYS Groundwater Quality Standard for chromium at nearest receptor well 0.25 miles downgradient of the stagnation point.

Figure 1
BB&S Treated Lumber Site
Influence of Kd (or Retardation) on Total Chromium Transport



11/17/98; 1:52 PM

only 14 years from the onset of contamination at the stagnation point. The onset of contamination at the stagnation point is impossible to determine, but for the purposes of this analysis, we are assuming that a concentration of 4,500 µg/L was present at the stagnation point in 1987. Therefore, 14 years from the onset of contamination would be May 2001.

If, however, the K_d is half the estimated value (1.33 L/kg), chromium concentrations 0.25 miles downgradient may exceed 50 µg/L in only 7 years from the onset of contamination, in 1994; and if there is no apparent retardation, like that observed at the Nassau County Superfund site, then chromium concentrations would have exceeded 50 µg/L due to a dispersion front within 1 year from the onset of contamination. At the other extreme, if the K_d is as great as 10 (i.e., the retardation factor is 57), then it may take as long as 50 years from the onset of contamination for chromium concentrations exceeding 50 µg/L to appear 0.25 miles downgradient of the stagnation point

5.0 CONCLUSIONS

Based on a review of the RI Report (revised June 1998) and the results presented above, the following conclusions can be made:

(1) Detections of Cr(VI), total chromium and other dissolved constituents in MW-11 and MW-14, downgradient of the zone of influence of the recovery system, indicate that these constituents migrated beyond the influence of the proposed recovery system.

(2) Using reasonable assumptions with the best available data for the site, total chromium concentrations exceeding 50 µg/L (the Class "GA" Groundwater Quality Standard (6 NYCRR 703.5) for total chromium) would appear 0.25 miles downgradient from the stagnation point in less than 14 years from the onset of contamination. Assuming that the onset of contamination coincided with start up of the collection system in 1987, the chromium concentration at the downgradient receptor could reach 50 µg/L in 2001. Experience with chromium contamination at a Superfund site in Nassau County demonstrates that Cr(VI) attenuation in a similar hydrogeologic setting can be negligible, resulting in Cr(VI) migration at the rate of groundwater movement.

(3) Given the limitations and demonstrated impact of K_d, it is not possible to give a narrower range of results without site-specific K_d values. Also, given the significance of speciation on chromium toxicity and fate characteristics, the groundwater chemistry near the source and potential receptor(s) should be characterized for more accurate determination. Equilibrium speciation models such as MINTEQ may be used to estimate speciation and the extent of precipitation.

(4) Based on the documented mobility of chromium (and other metals) in the subsurface at the BB&S site, the toxicity of Cr(VI), the detection of Cr(VI) and other constituents downgradient of the capture zone, and the location of at least one potential receptor within 0.25 miles of RW-2, the need for development of a more site-specific, numerical solute transport model is warranted. The model results will provide the basis for a quantitative evaluation of remedial alternatives at the BB&S site to establish if more aggressive remedial action is indicated.

(5) The most recent sampling of downgradient receptor wells was performed in March 1996. These wells should be sampled to verify the accuracy of this modeling effort and provide more site-specific data if further modeling is pursued.

6.0 REFERENCES

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MALCOLM
PIRNIE

APPENDIX C

SCDHS ANALYTICAL DATA REPORT
NOVEMBER 1998 - JANUARY 1999

[illegible]

SUFFOLK COUNTY DEPARTMENT OF HEALTH SERVICES
DIVISION OF ENVIRONMENTAL QUALITY
PUBLIC AND ENVIRONMENTAL HEALTH LABORATORY - ELAP #10528

POTABLE WATER ANALYSIS

Field#: 404-459-981214
Collector: HESSNER
Collection Date: 12/14/98

Lab#: 12-98-00404
Submission Date 12/14/98
Labworks ID: FL00404

Source: FID#5120070 Playground Environment, 1480 Speonk-Riverhead Rd., Speonk - br cwt

Metal Analyses - EPA Method 200.8

DB#	Analyte	Result	Units
126	Silver	< 5	ug/L
132	Aluminum	< 5	ug/L
120	Arsenic	< 2	ug/L
121	Barium	18	ug/L
426	Beryllium	< 1	ug/L
122	Cadmium	< 1	ug/L
128	Cobalt	< 1	ug/L
104	Chromium	1.42	ug/L
102	Copper	139	ug/L
124	Mercury	< .4	ug/L
101	Manganese	32.8	ug/L
129	Molybdenum	< 1	ug/L
131	Nickel	1.2	ug/L
123	Lead	3.51	ug/L
427	Antimony	< 1	ug/L
125	Selenium	< 2	ug/L
62	Thorium	< 1	ug/L
416	Titanium	< 1	ug/L
425	Thallium	< 1	ug/L
115	Vanadium	< 1	ug/L
103	Zinc	783	ug/L

Analyst(s):__________ Date(s) of analysis__________

Metal Analyses - Method SM#18 3111

DB#	Analyte	Result	Units
100	Iron	0.112	mg/L
106	Sodium	13.3	mg/L

Analyst(s): Ud Date(s) of analysis__________

Report Date: 12/17/98

Bro. Lu - North

SUFFOLK COUNTY DEPARTMENT OF HEALTH SERVICES
DIVISION OF ENVIRONMENTAL QUALITY
PUBLIC AND ENVIRONMENTAL HEALTH LABORATORY - ELAP #10528

POTABLE WATER ANALYSIS

eld#: 504-459-990120

Lab#: 01-99-00325

Collector: HESSNER

Submission Date: 1/20/99

Collection Date: 1/20/99

Labworks ID: GA00325

Source: Brody Buildings, 101-2 Speonk/Riverhead Rd., Speonk

Metal Analyses - EPA Method 200.8

DB#	Analyte	Result	Units
126	Silver	< 5	ug/L
132	Aluminum	10.3	ug/L
120	Arsenic	< 2	ug/L
121	Barium	11.3	ug/L
426	Beryllium	< 1	ug/L
122	Cadmium	< 1	ug/L
128	Cobalt	< 1	ug/L
104	Chromium	1.21	ug/L
102	Copper	233	ug/L
124	Mercury	< .4	ug/L
101	Manganese	16.6	ug/L
129	Molybdenum	< 1	ug/L
131	Nickel	< 1	ug/L
123	Lead	< 1	ug/L
427	Antimony	< 1	ug/L
125	Selenium	< 2	ug/L
62	Thorium	< 1	ug/L
416	Titanium	< 1	ug/L
425	Thallium	< 1	ug/L
115	Vanadium	< 1	ug/L
103	Zinc	581	ug/L

Analyst(s):__________ Date(s) of analysis__________

Metal Analyses - Method SM#18 3111

DB#	Analyte	Result	Units
100	Iron	0.12	mg/L
106	Sodium	11.5	mg/L

Analyst(s):__________ Date(s) of analysis__________

port Date: 1/22/99

[redacted]

SUFFOLK COUNTY DEPARTMENT OF HEALTH SERVICES
DIVISION OF ENVIRONMENTAL QUALITY
PUBLIC AND ENVIRONMENTAL HEALTH LABORATORY - ELAP #10528

POTABLE WATER ANALYSIS

eld#: 420-459-990120

Lab#: 01-99-00321

ollector: HESSNER

Submission Date: 1/20/99

ollection Date: 1/20/99

Labworks ID: GA00321

ource: Best Building and Supply, 1338 Speonk/Riverhead Rd., Speonk-Bath (BB+S)

Metal Analyses - EPA Method 200.8

DB#	Analyte	Result	Units
126	Silver	< 5	ug/L
132	Aluminum	8.01	ug/L
120	Arsenic	< 2	ug/L
121	Barium	9.3	ug/L
426	Beryllium	< 1	ug/L
122	Cadmium	< 1	ug/L
128	Cobalt	< 1	ug/L
104	Chromium	1.11	ug/L
102	Copper	55.6	ug/L
124	Mercury	< .4	ug/L
101	Manganese	3.08	ug/L
129	Molybdenum	< 1	ug/L
131	Nickel	< 1	ug/L
123	Lead	< 1	ug/L
427	Antimony	< 1	ug/L
125	Selenium	< 2	ug/L
62	Thorium	< 1	ug/L
416	Titanium	< 1	ug/L
425	Thallium	< 1	ug/L
115	Vanadium	< 1	ug/L
103	Zinc	4450	ug/L

Analyst(s):__________ Date(s) of analysis__________

Metal Analyses - Method SM#18 3111

DB#	Analyte	Result	Units
100	Iron	< .1	mg/L
106	Sodium	4.8	mg/L

Analyst(s): UA Date(s) of analysis__________

port Date: 1/22/99

[illegible] South [illegible]

SUFFOLK COUNTY DEPARTMENT OF HEALTH SERVICES
DIVISION OF ENVIRONMENTAL QUALITY
PUBLIC AND ENVIRONMENTAL HEALTH LABORATORY - ELAP #10528

POTABLE WATER ANALYSIS

ield#: 419-459-990120

Collector: HESSNER

Collection Date: 1/20/99

Lab#: 01-99-00320

Submission Date: 1/20/99

Labworks ID: GA00320

Source: Klein's Window and Mill , 1448-2 Seonk/Riverhead Rd., Speonk-Bath

Metal Analyses - EPA Method 200.8

DB#	Analyte	Result	Units
126	Silver	< 5	ug/L
132	Aluminum	9.68	ug/L
120	Arsenic	< 2	ug/L
121	Barium	1.68	ug/L
426	Beryllium	< 1	ug/L
122	Cadmium	< 1	ug/L
128	Cobalt	< 1	ug/L
104	Chromium	1.4	ug/L
102	Copper	217	ug/L
124	Mercury	< .4	ug/L
101	Manganese	9.03	ug/L
129	Molybdenum	< 1	ug/L
131	Nickel	6.33	ug/L
123	Lead	4.03	ug/L
427	Antimony	< 1	ug/L
125	Selenium	< 2	ug/L
62	Thorium	< 1	ug/L
416	Titanium	< 1	ug/L
425	Thallium	< 1	ug/L
115	Vanadium	< 1	ug/L
103	Zinc	211	ug/L

Analyst(s):__________ Date(s) of analysis__________

Metal Analyses - Method SM#18 3111

DB#	Analyte	Result	Units
100	Iron	0.124	mg/L
106	Sodium	9.9	mg/L

Analyst(s):__________ Date(s) of analysis__________

eport Date: 1/22/99

SUFFOLK COUNTY DEPARTMENT OF HEALTH SERVICES
DIVISION OF ENVIRONMENTAL QUALITY
PUBLIC AND ENVIRONMENTAL HEALTH LABORATORY - ELAP #10528

POTABLE WATER ANALYSIS

Field#: 2-347-981125

llector: FELICE

Collection Date: 11/25/98

Lab#: 11-98-00612

Submission Date 11/25/98

Labworks ID: FK00612

Source: SPEONK MHP WELL #1, SPEONK-WELL

Metal Analyses - EPA Method 200.8

DB#	Analyte	Result	Units
126	Silver	< 5	ug/L
132	Aluminum	11.7	ug/L
120	Arsenic	< 2	ug/L
121	Barium	29.9	ug/L
426	Beryllium	< 1	ug/L
122	Cadmium	< 1	ug/L
128	Cobalt	< 1	ug/L
104	Chromium	2.15	ug/L
102	Copper	13.4	ug/L
124	Mercury	< .4	ug/L
101	Manganese	6.04	ug/L
129	Molybdenum	< 1	ug/L
131	Nickel	< 1	ug/L
123	Lead	< 1	ug/L
427	Antimony	< 1	ug/L
125	Selenium	< 2	ug/L
62	Thorium	< 1	ug/L
416	Titanium	< 1	ug/L
425	Thallium	< 1	ug/L
115	Vanadium	< 1	ug/L
103	Zinc	771	ug/L

Analyst(s):________ Date(s) of analysis________

Metal Analyses - Method SM#18 3111

DB#	Analyte	Result	Units
100	Iron	< .1	mg/L
106	Sodium	36.6	mg/L

Analyst(s): C.I.T Date(s) of analysis________

Report Date: 12/4/98

Field#: 2-347-981125

Collection Date: 11/25/98

Lab#: 11-98-00612

Submission Date: 11/25/98

Labworks ID: FK00612

SUFFOLK COUNTY DEPARTMENT OF HEALTH SERVICES
DIVISION OF ENVIRONMENTAL QUALITY
PUBLIC AND ENVIRONMENTAL HEALTH LABORATORY - ELAP #10528

POTABLE / NON-POTABLE WATER ANALYSIS

Source SPEONK MHP WELL #1, SPEONK-WELL

Type: PUBLIC

Collected By: FELICE

VOLATILE ORGANIC ANALYSIS - EPA Method 524.2 / 624

DB#	Analyte	Result ug/L
615	Chlorodifluoromethane	
436	Dichlorodifluoromethane	
C0612	Chloroethane	
C0611	Bromomethane	
C0610	Chloromethane	
C0439	Trichlorofluoromethane	
306	Vinyl chloride	
305	Methylene chloride	
323	1,1-Dichloroethane	
309	trans-1,2-Dichloroethene	
300	Chloroform	
324	1,2-Dichloroethane	
321	1,1,1-Trichloroethane	
304	Carbon tetrachloride	
294	1-Bromo-2-chloroethane	
405	1,2-Dichloropropane	
310	Trichloroethene	
303	Chlorodibromomethane	
420	2-Bromo-1-chloropropane	
301	Bromoform	
311	Tetrachloroethene	
308	cis-1,2-Dichloroethene	
320	Freon 113	
292	Dibromomethane	
C0613	1,1-Dichloropropene	

DB#	Analyte	Result ug/L
307	1,1-Dichloroethene	
302	Bromodichloromethane	
406	2,3-Dichloropropene	
407	cis-1,3-Dichloropropene	
408	trans-1,3-Dichloropropene	
322	1,1,2-Trichloroethane	
409	1,1,1,2-Tetrachloroethane	
295	1,1,2,2-Tetrachloroethane	
433	1,2,3-Trichloropropane	
450	2,2-Dichloropropane	
451	1,3-Dichloropropane	
C0290	Bromochloromethane	
C0650	tert-Butyl-Ethyl-Ether	
C0651	tert-Amyl-Methyl-Ether	
250	Benzene	
251	Toluene	
258	Chlorobenzene	
259	Ethylbenzene	
254	o-Xylene	
252	m-Xylene	
253	p-Xylene	
255	T. Xylene	
266	2-Chlorotoluene	
267	3-Chlorotoluene	
268	4-Chlorotoluene	

DB#	Analyte	Result ug/L
265	T. Chlorotoluene	
419	1,3,5-Trimethylbenzene	
418	1,2,4-Trimethylbenzene	
415	m,p-Dichlorobenzene	
412	1,2-Dichlorobenzene (o)	
432	p-Diethylbenzene	
435	1,2,4,5-tetramethylbenzene	
437	1,2,4-Trichlorobenzene	
438	1,2,3-Trichlorobenzene	
600	Ethenylbenzene (Styrene)	
601	1-Methylethylbenzene	
602	n-Propylbenzene	
603	tert-Butylbenzene	
604	sec-Butylbenzene	
605	Isopropyltoluene(p-cymene	
606	n-Butylbenzene	
607	Hexachlorobutadiene	
614	Methyl-tert-butyl-ether	
701	Naphthalene	
59	1,4-Dichlorobutane	
620	Methyl sulfide	
58	Dimethyldisulfide	
C0257	Bromobenzene	
619	2-Butanone (MEK)	<20
621	Tetrahydrofuran	<20

All results are <0.5 ug/L unless otherwise indicated

Analyst(s): W

Remarks:

Date(s) of analysis: 12.1.98

DIVISION OF ENVIRONMENTAL QUALITY
PUBLIC AND ENVIRONMENTAL HEALTH LABORATORY - ELAP #10528

POTABLE WATER ANALYSIS

Field#: 1-347-981125

lector: FELICE

Collection Date: 11/25/98

Lab#: 11-98-00611

Submission Date 11/25/98

Labworks ID: FK00611

Source: SPEONK MHP WELL #2, SPEONK-WELL

Metal Analyses - EPA Method 200.8

DB#	Analyte	Result	Units
126	Silver	< 5	ug/L
132	Aluminum	< 5	ug/L
120	Arsenic	< 2	ug/L
121	Barium	28.3	ug/L
426	Beryllium	< 1	ug/L
122	Cadmium	< 1	ug/L
128	Cobalt	< 1	ug/L
104	Chromium	2.5	ug/L
102	Copper	4.79	ug/L
124	Mercury	< .4	ug/L
101	Manganese	4.6	ug/L
129	Molybdenum	< 1	ug/L
131	Nickel	< 1	ug/L
123	Lead	< 1	ug/L
427	Antimony	< 1	ug/L
125	Selenium	< 2	ug/L
62	Thorium	< 1	ug/L
416	Titanium	< 1	ug/L
425	Thallium	< 1	ug/L
115	Vanadium	< 1	ug/L
103	Zinc	88.6	ug/L

Analyst(s):____________ Date(s) of analysis____________

Metal Analyses - Method SM#18 3111

DB#	Analyte	Result	Units
100	Iron	0.16	mg/L
106	Sodium	21.3	mg/L

Analyst(s): [illegible] Date(s) of analysis____________

Report Date: 12/4/98

Field#: 1-347-981125

ollection Date: 11/25/98 ---

Lab#: 11-98-00611

Submission Date: 11/25/98

Labworks ID: FK00611

SUFFOLK COUNTY DEPARTMENT OF HEALTH SERVICES
DIVISION OF ENVIRONMENTAL QUALITY
PUBLIC AND ENVIRONMENTAL HEALTH LABORATORY - ELAP #10528

POTABLE / NON-POTABLE WATER ANALYSIS

Source SPEONK MHP WELL #2, SPEONK-WELL

Type: PUBLIC

Collected By: FELICE

VOLATILE ORGANIC ANALYSIS - EPA Method 524.2 / 624

DB#	Analyte	Result ug/L
615	Chlorodifluoromethane	
436	Dichlorodifluoromethane	
C0612	Chloroethane	
C0611	Bromomethane	
C0610	Chloromethane	
C0439	Trichlorofluoromethane	
306	Vinyl chloride	
35	Methylene chloride	
323	1,1-Dichloroethane	
309	trans-1,2-Dichloroethene	
300	Chloroform	
324	1,2-Dichloroethane	
321	1,1,1-Trichloroethane	
304	Carbon tetrachloride	
294	1-Bromo-2-chloroethane	
405	1,2-Dichloropropane	
310	Trichloroethene	
303	Chlorodibromomethane	
420	2-Bromo-1-chloropropane	
301	Bromoform	
311	Tetrachloroethene	
308	cis-1,2-Dichloroethene	
320	Freon 113	
292	Dibromomethane	
C0613	1,1-Dichloropropene	

DB#	Analyte	Result ug/L
307	1,1-Dichloroethene	
302	Bromodichloromethane	
406	2,3-Dichloropropene	
407	cis-1,3-Dichloropropene	
408	trans-1,3-Dichloropropene	
322	1,1,2-Trichloroethane	
409	1,1,1,2-Tetrachloroethane	
295	1,1,2,2-Tetrachloroethane	
433	1,2,3-Trichloropropane	
450	2,2-Dichloropropane	
451	1,3-Dichloropropane	
C0290	Bromochloromethane	
C0650	tert-Butyl-Ethyl-Ether	
C0651	tert-Amyl-Methyl-Ether	
250	Benzene	
251	Toluene	
258	Chlorobenzene	
259	Ethylbenzene	
254	o-Xylene	
252	m-Xylene	
253	p-Xylene	
255	T. Xylene	
266	2-Chlorotoluene	
267	3-Chlorotoluene	
268	4-Chlorotoluene	

DB#	Analyte	Result ug/L
265	T. Chlorotoluene	
419	1,3,5-Trimethylbenzene	
418	1,2,4-Trimethylbenzene	
415	m,p-Dichlorobenzene	
412	1,2-Dichlorobenzene (o)	
432	p-Diethylbenzene	
435	1,2,4,5-tetramethylbenzene	
437	1,2,4-Trichlorobenzene	
438	1,2,3-Trichlorobenzene	
600	Ethenylbenzene (Styrene)	
601	1-Methylethylbenzene	
602	n-Propylbenzene	
603	tert-Butylbenzene	
604	sec-Butylbenzene	
605	Isopropyltoluene(p-cymene	
606	n-Butylbenzene	
607	Hexachlorobutadiene	
614	Methyl-tert-butyl-ether	
701	Naphthalene	
59	1,4-Dichlorobutane	
620	Methyl sulfide	
58	Dimethyldisulfide	
C0257	Bromobenzene	
619	2-Butanone (MEK)	<20
621	Tetrahydrofuran	<20

All results are <0.5 ug/L unless otherwise indicated

Analyst(s):

Remarks:

Date(s) of analysis: 12·1·98

MALCOLM
PIRNIE

APPENDIX D

MODFLOW SIMULATIONS

MODFLOW GROUNDWATER MODELING

1.0 INTRODUCTION

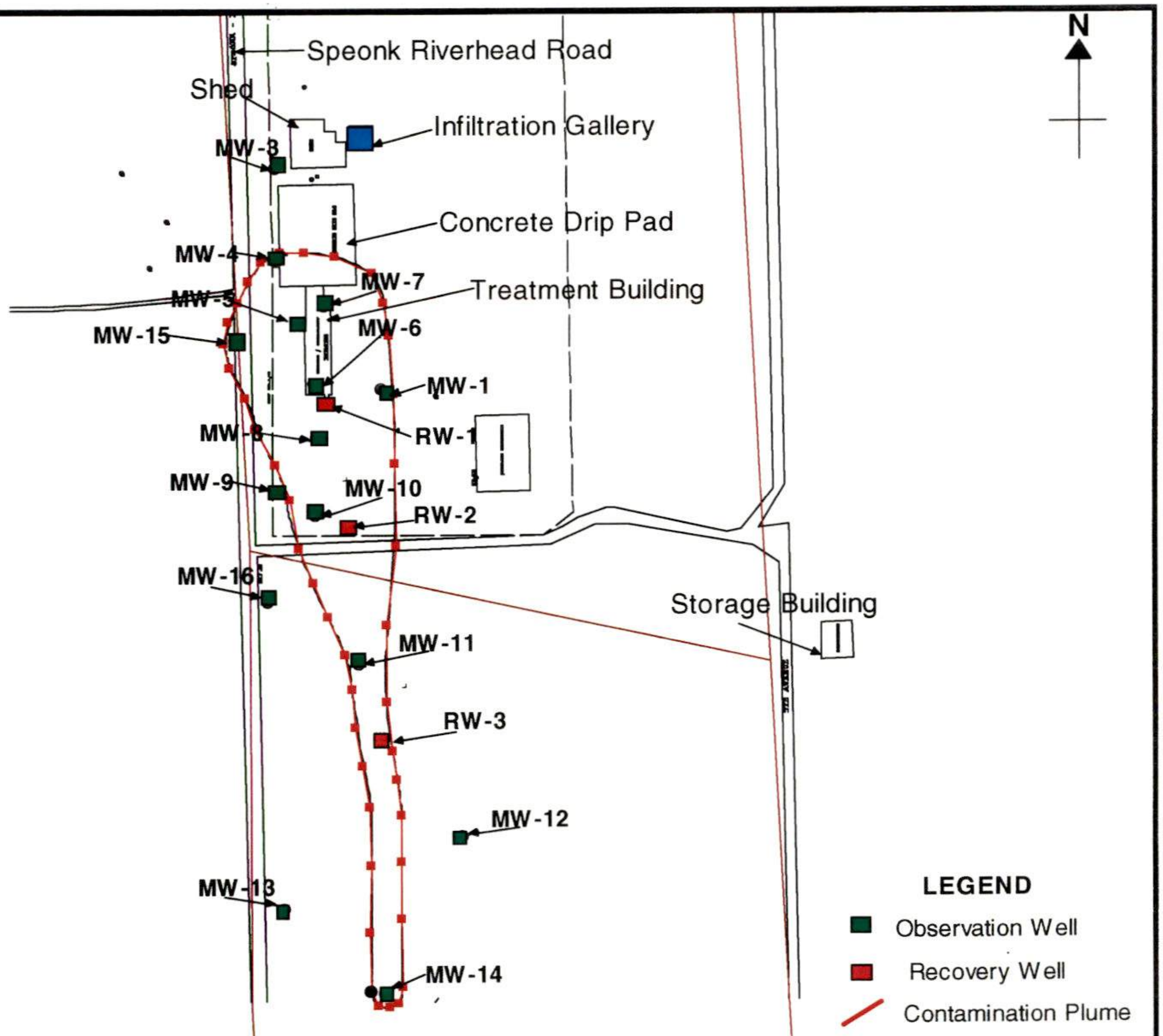
A groundwater model was developed to aid the feasibility study (FS) for a groundwater pump and treat system at the BB&S Treated Lumber Site. Figure 1 shows the site map, the locations of all the observation and recovery wells and plume configuration defined from analytical data obtained in November 1996. A fully saturated two-layer groundwater flow model was used to simulate the remedial alternatives. We simulated two remedial alternatives using the groundwater model. The first alternative included the existing set-up of recovery wells (On-Site Groundwater Remedial Scenario). The second alternative included addition of a fourth recovery well RW-4 (On-Site and Off-Site Groundwater Remedial Scenario). The assumed location of proposed recovery well RW-4 is approximately 550 feet downgradient of recovery well RW-3.

2.0 OBJECTIVES

The objectives of the groundwater model were to simulate the groundwater flow system in the study area and to evaluate alternative configurations of the proposed groundwater pump-and-treat system. The information gained from the model was used to estimate pumping rates to capture the plume. The pumping estimates are intended to assist in evaluating costs for the groundwater remedial alternatives presented in the FS. It is important to note that the groundwater modeling was based solely on the limited available site data.

3.0 CONCEPTUAL MODEL

Conceptually, groundwater enters the study area either through recharge as a percentage of precipitation or as an underflow from adjacent drainage basins. The aquifer underlying the BB&S site consists primarily of sand and gravel of the upper glacial aquifer.



BB&S TREATED LUMBER SITE
Speonk, New York

Site Map and Monitoring Well Locations
Scale: 1 in = 300 ft

Figure 1

p:\0266323\model98\figures\sitemap.sup

The site lies to the south of the major groundwater flow divide that exists along the Ronconcamo Terminal Moraine. Average annual precipitation in eastern Long Island is around 46 inches, about half of which reaches the groundwater recharge ("Hydrologic Appraisal of the Fine Barrens, Suffolk County, New York", Richard Krulikas, 1986). Overland runoff is estimated to be around 0.5 inches per year, and evapotranspiration is around 23 inches per year. Groundwater discharges to streams and into the bays along the south shore of Long Island. Water entering the flow system as recharge flows through the upper glacial aquifer and discharges to the bay. The model assumes that flow remains within the upper glacial aquifer. However, water that enters the system further inland (closer to the flow divide) may flow downward to deeper aquifers and then to the ocean.

4.0 NUMERICAL MODELING COMPUTER PROGRAM

The model was constructed in the groundwater modeling pre- and post- processor Groundwater Modeling System (GMS) developed by Brigham Young University for the United States Department of Defense. GMS is one of the most sophisticated groundwater modeling pre-processors available at this time and incorporates three dimensional data analyses and visualization with advanced model pre- and post processing. GMS was used to compile the various site characteristics so that they could be incorporated into the groundwater model. The modeling engine used to simulate groundwater flow was the USGS's three-dimensional finite difference groundwater flow modeling program MODGLOW (McDonald and Harbaugh, 1998). MODFLOW is the industry standard three-dimensional groundwater modeling program that allows for sophisticated evaluation of complex groundwater flow systems. The MODFLOW results were evaluated in GMS and through the use of the USGS particle tracking model post-processor MODPATH (Pollack, 1989). MODPATH was used to assess the flow path of water within the model domain and was used to determine the extent of the capture zones to evaluate the effectiveness of the various remedial alternatives.

5.0 MODEL SETUP

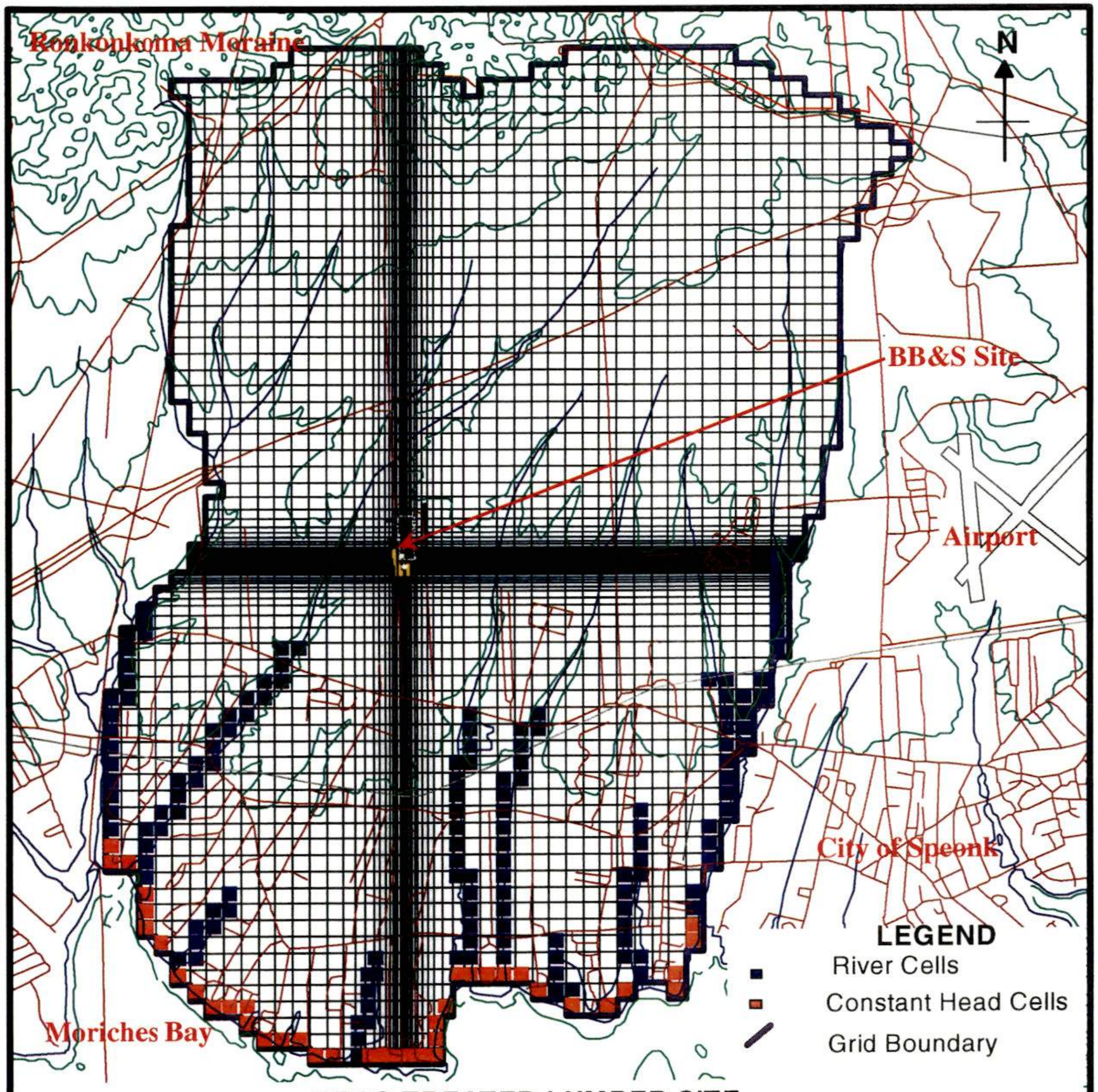
The model grid is oriented in the north-south direction, which is approximately the direction of the groundwater flow system. A variably spaced grid was designed to focus the model on the BB&S site and the source of the contamination. The model grid covers approximately 24,000 feet across the site (east-west direction) and 31,760 feet in the north-south direction. The grid consists of 98 columns with cell width varying from 28 feet to 510 feet and 69 rows with cell length varying from 25 feet to 510 feet. Figure 2 shows the model grid setup and the extent of the model boundaries. The model simulates the upper glacial aquifer and is divided in two layers. The division of the aquifer is based on the depth of the pumping wells (recovery wells) and the site stratigraphy.

6.0 MODEL BOUNDARIES

The model is bounded by no-flow boundaries on the northern sides of the modeled area. The streams and rivers leading to the ocean in the southwest and southeastern portions of the model have been simulated as river cells. The southern boundary is the bay. The bay is simulated as constant head cells. The boundary conditions are illustrated in Figure 2. The water budget was evaluated to assure that the no-flow boundary conditions did not affect the flow in the study area significantly. The pumping wells were simulated using the MODFLOW well package. The recovery wells at the site are assumed to be approximately fully penetrating, which is simulated in the model.

7.0 AQUIFER PROPERTIES

The hydrogeologic properties used in the model were based on the results of the field investigations and the pumping test conducted at RW-1. The ratio of horizontal to vertical hydraulic conductivity for calculating the vertical conductance was assumed as 10:1. The hydraulic conductivity used in the model was equivalent to a transmissivity of 250,000 gallons per day per foot derived from the pumping test. The recharge values specified at 23



BB&S TREATED LUMBER SITE
Speonk, New York

Model Grid and Boundary Conditions

Figure 2

p:\0266323\model98\figures\modelgrid.sup

Scale: 1 in = 6000 ft

inches per year in accordance with the USGS estimates for Suffolk County, New York.

8.0 MODEL CALIBRATION

Model calibration was performed for steady state conditions and a controlled transient stress used for the pumping test. The calibration targets for the steady state conditions and transient simulations were based on the latest water level information collected from 15 observation wells and 7 observation wells, respectively. All these wells are screened in the top layer. A trial and error method was used to calibrate the steady state model by adjusting individual parameters within a range of site-specific values. The model heads were compared interactively to the measured heads until simulated head values were within a minimal amount of error.

9.0 STEADY STATE CALIBRATION

Model calibration for steady state conditions was achieved by comparing observed heads with the model predicted heads as well as vertical gradients at the site. The calibration study included evaluating the difference in the observed versus modeled heads using the Mean Error, Absolute Mean Error, and the Root Mean Square Error. The statistics were based on a confidence of 95% and an interval of 1 for the steady state simulation. The results from the steady state analysis calibration statistics for all the monitoring wells included in the observation are listed in Table 1. The calibration targets along with the groundwater flow gradients are shown in Figure 3.

10.0 TRANSIENT CALIBRATION

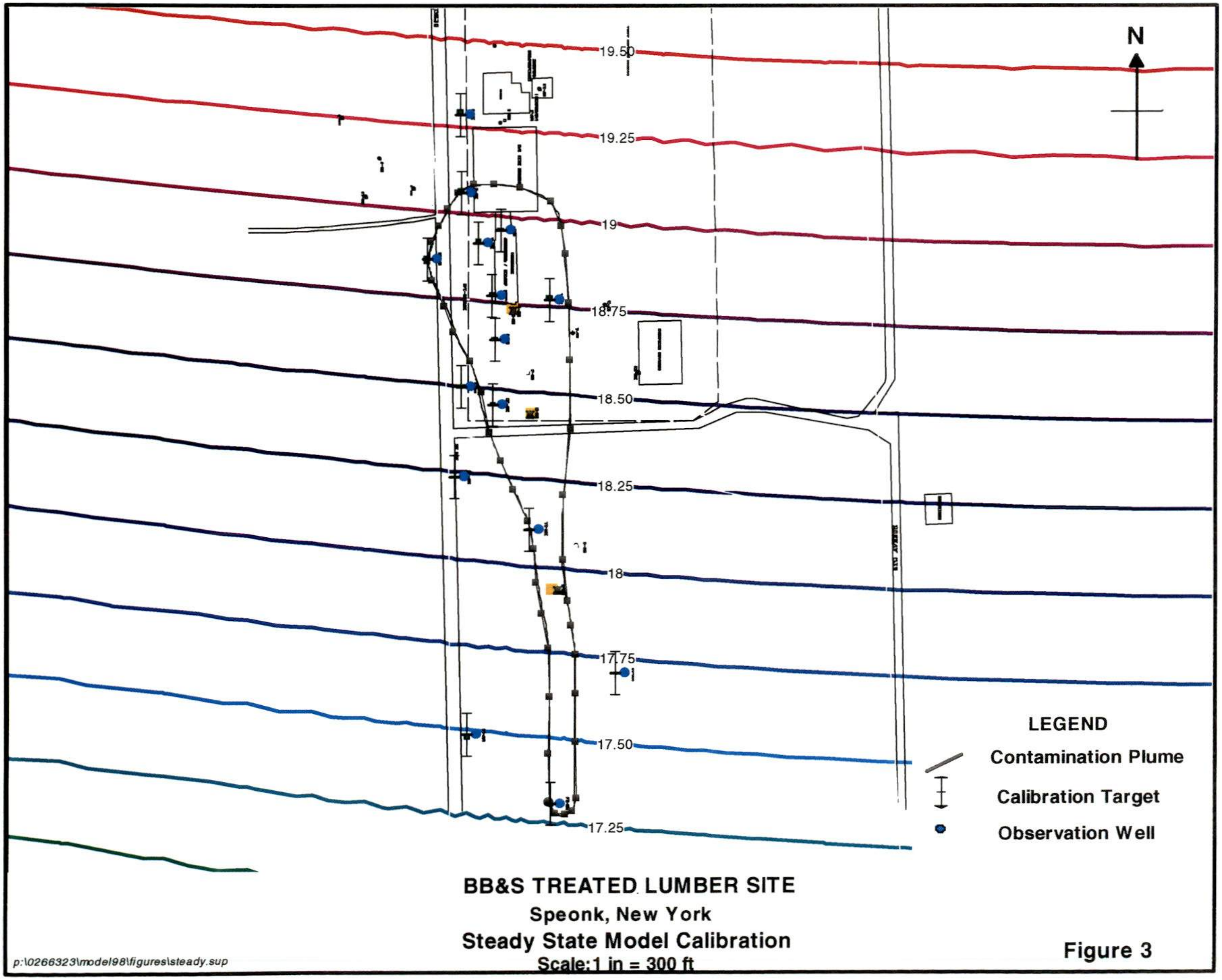
The model was tested to assess the effects of transient stresses on the groundwater flow system by simulating the pumping test conducted at the BB&S Treated Lumber Site. The transient simulations were performed to provide a more accurate representation of the modeled area. Therefore, the statistical analysis was conducted using a confidence of 95%

TABLE 1

BB&S TREATED LUMBER SITE
FEASIBILITY STUDY

STEADY STATE CALIBRATION STATISTICS

Well ID	Observed Heads	Model Predicted Heads
MW-3	19.05	19.282481
MW-4	18.9	19.05884
MW-7	18.85	18.958974
MW-5	18.72	18.916551
MW-15	18.72	18.859716
MW-6	18.66	18.771496
MW-1	18.61	18.771236
MW-8	18.54	18.643027
MW-9	18.42	18.499692
MW-10	18.37	18.456185
MW-16	18.25	18.238897
MW-11	18.09	18.105568
MW-12	17.7	17.710088
MW-13	17.69	17.496195
MW-14	17.41	17.314917
Mean Error		0.073591
Mean Absolute Error		0.11359
Root Mean Square Error		0.131452



BB&S TREATED LUMBER SITE

Speonk, New York

Steady State Model Calibration

Scale:1 in = 300 ft

Figure 3

and an interval of 0.25.

The hydraulic properties from the calibrated steady state simulation were used in the transient simulation. For this pumping test, recovery well RW-1 was pumped at a 100 gpm for a 24-hour period. The results from the transient simulation were compared to the entire 24-hour duration that the test was conducted. The Mean Error, Absolute Mean Error, and Root Mean Squared Error were calculated to compare predicted results of predicted versus observed drawdown data. The calibration statistics of the transient simulation using the properties established in the steady state conditions are listed in Table 2. Figure 4 illustrates the calibration targets and the total drawdown at the end of the simulated pumping test from the transient simulation.

11.0 PREDICTIVE SIMULATIONS

After the model was calibrated under steady state conditions and the results verified under transient conditions, it was used for simulations. Various alternatives were simulated to estimate the amount of water that must be pumped to capture the plume. The results of the simulations that provided the greatest amount of capture with minimum pumping were chosen for the estimated pumping rates. Particle tracking was used to evaluate the configuration's ability to capture the contaminated groundwater.

11.1 ON-SITE GROUNDWATER REMEDIAL SCENARIO

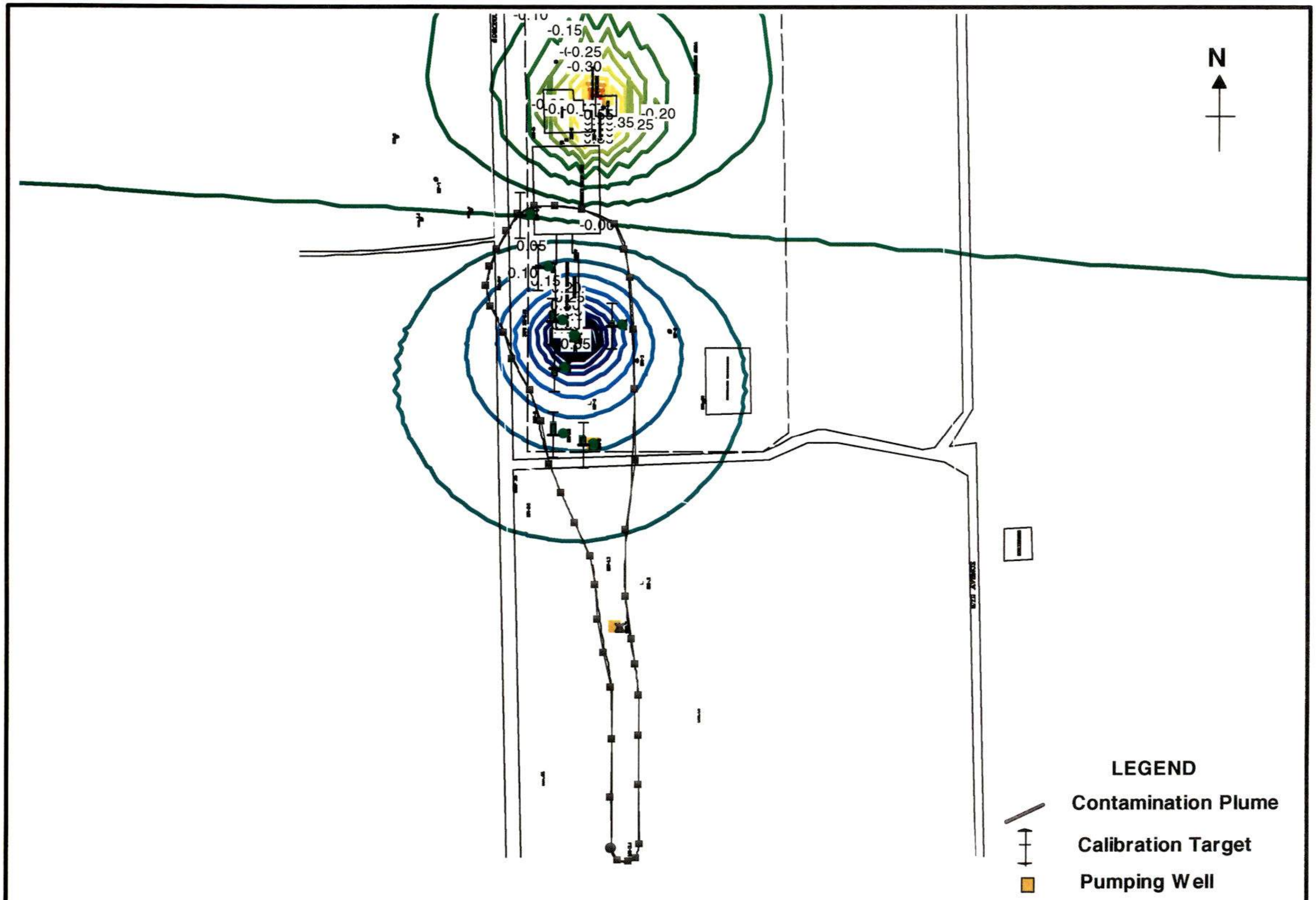
The scenario for remediating the site under existing conditions included steady state pumping from the recovery wells RW-1, RW-2 and RW-3. Various pumping rates were estimated to determine the minimum amount of pumping required for achieving capture of the plume. The optimum conditions that would capture all but the portion of the plume downgradient of recovery well RW-3 included pumping rates in RW-1 at 50 gpm, RW-2 at 25 gpm, and RW-3 at 30 gpm. In order to define the extent of plume capture, backward particle tracking was performed at the three recovery wells. The capture zones defined by the particle tracking simulations are shown in Figure 5. This scenario was configured strictly

TABLE 2

BB&S TREATED LUMBER SITE
FEASIBILITY STUDY

STEADY STATE CALIBRATION STATISTICS

Well ID	Observed Heads	Model Predicted Heads
RW-2	0.015	0.106136
MW-10	-0.015	0.119705
MW-8	0.41	0.326968
MW-6	0.322	0.429425
MW-5	0.095	0.115479
MW-4	0.001	-0.00502
MW-1	0.199	0.235626
Mean Error		0.029366
Mean Absolute Error		0.062286
Root Mean Square Error		0.077565



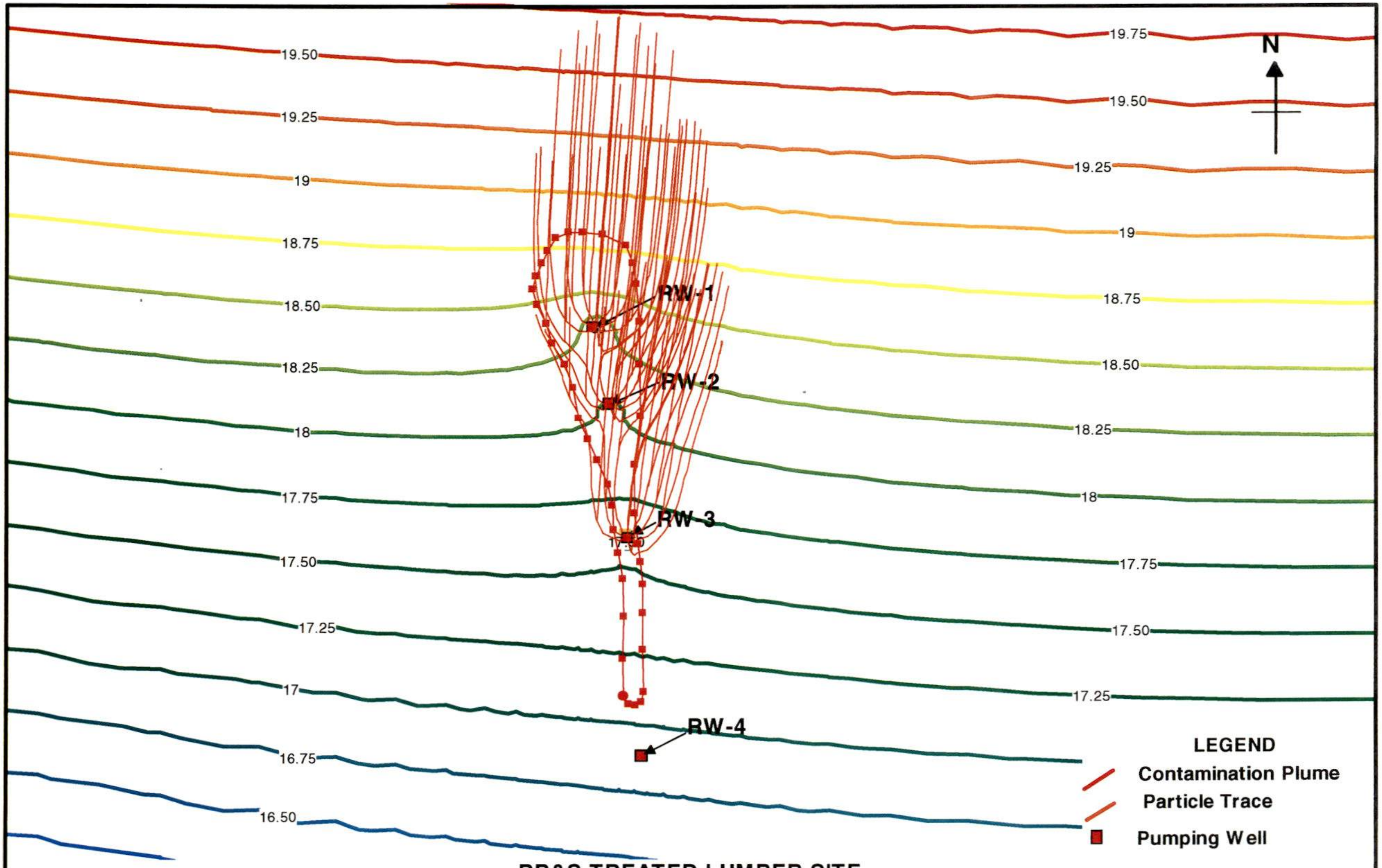
BB&S TREATED LUMBER SITE
Speonk, New York

Transient Model Calibration

Scale: 1 in = 300 ft

Figure 4

p:\0266323\model98\figures\transient.sup



BB&S TREATED LUMBER SITE
Speonk, New York

Scenario A

Scale:1 in = 500 ft

Figure 5

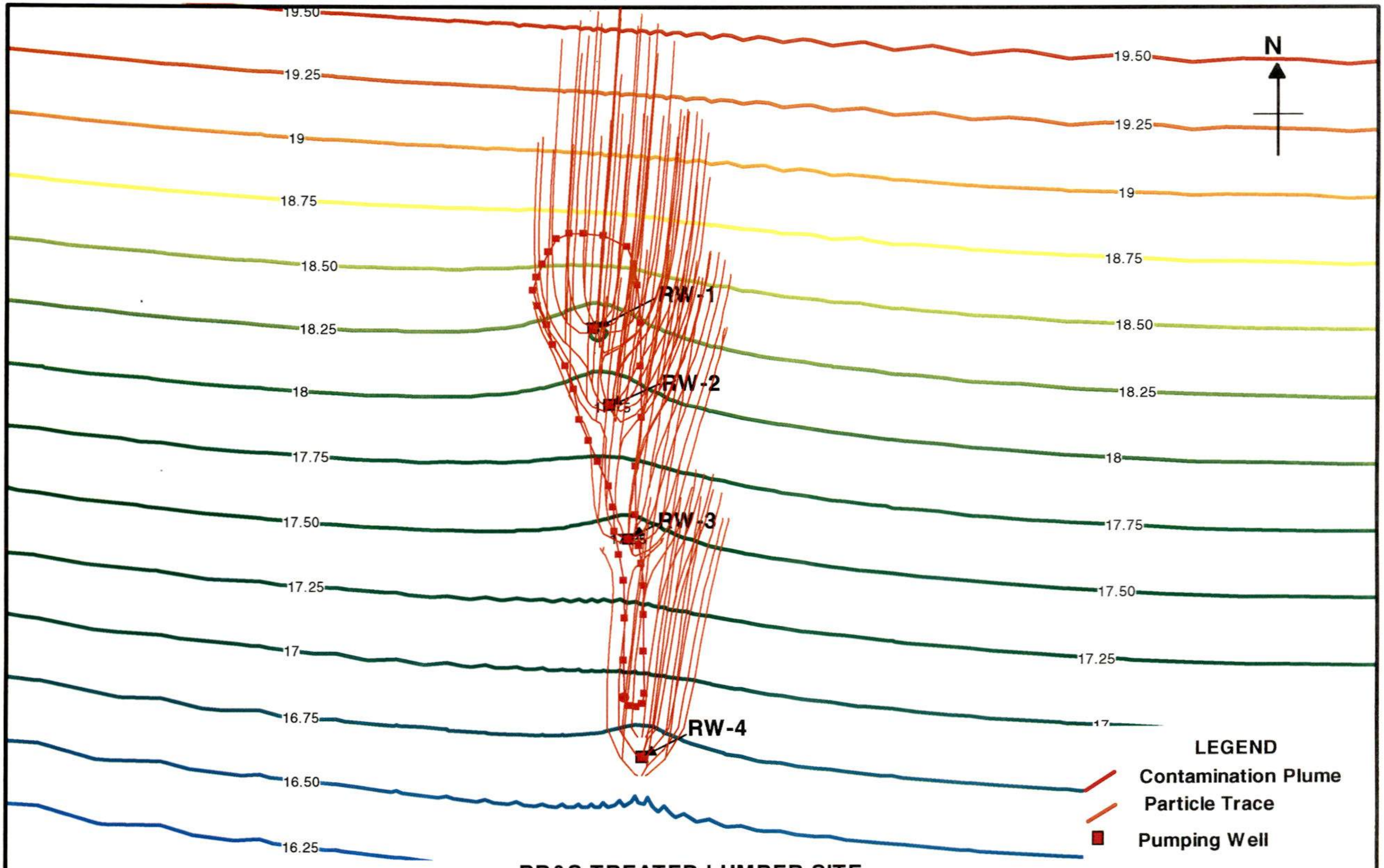
p:\0266323\model98\figures\scenarioA.sup to capture the plume configuration defined in the remedial investigation report submitted in November 1996.

11.2 ON-SITE AND OFF-SITE GROUNDWATER REMEDIAL SCENARIO

This scenario was simulated with identical pumping rates used in the On-Site Groundwater Remedial Scenario, but included an additional pumping well (RW-4) located at the downgradient edge of the plume (defined based on the November 1996 data) to recover the portion of the plume that escaped capture in The Three-Well Scenario. The location of the proposed recovery well was based on the plume as estimated by the analytical data collected prior to November 1996. Recovery wells RW-1, RW-2, RW-3, and RW-4 were simulated at 50 gpm, 25 gpm, 30 gpm, and 30 gpm respectively. Backward particle tracking was conducted to determine the capture zones based on the proposed pumping rates. The results from the MODFLOW and MODPATH simulations are illustrated in Figure 6. Since the leading edge of the plume based on current analytical data has not been defined, the location of recovery well RW-4 cannot be used for determining the preliminary design of the groundwater pump-and-treat system.

12.0 CONCLUSIONS

Based on the calibration, the model setup can be considered reliable, however, the results from the MODFLOW predictive calculations are highly uncertain because the volumes of groundwater to be pumped are sensitive to several parameters that have not been adequately characterized during field investigations. More detailed investigations of the aquifer properties would need to be conducted to better refine the accuracy of the model predictions. Also the definition of the plume downgradient of monitoring well MW-14 (and redefinition of the site) must be conducted before the appropriate placement of an additional recovery well can be made. Considering the limitations of the data, the current model results show that the On-Site and Off-Site Groundwater Remedial Scenario could capture the plume



BB&S TREATED LUMBER SITE
Speonk, New York

Scenario B

Scale:1 in = 500 ft

Figure 6

p:\0266323\model98\figures\scenarioB.sup with a combined flow rate of approximately 135 gpm. However, because of the limitations of the data, it is very prudent to base the feasibility estimates of flow to a treatment on twice this flow rate (i.e., 270 gpm). This modeling effort is for evaluation purposes only and should not be considered as the basis for a remedial design. The actual design of the treatment system will require additional definition of the aquifer properties through an adequately designed pumping test(s) and more detailed investigations of the plume geometry.

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APPENDIX E.1

RECOVERY AND SENTINEL WELL INSTALLATION

BY ________ DATE 1/18/99
CHKD. BY ________ DATE 1/18/99

BBS Treated Lumber Site
Feasibility Study Cost Estimate

RECOVERY AND SENTINEL WELL INSTALLATION

Description	Units	Estimated Quantity	SJB Services Unit Cost	SJB Services Total	Advanced Drilling Unit Cost	Advanced Drilling Total	Average Cost
Recovery Wells (2):							
12" borehole drilled[1]	FT	240	$ 50	$ 12,000	$ 35	$ 8,400	$ 10,200
Split spoon sampling	EA	48	$ 10	$ 480	$ 30	$ 1,440	$ 960
8" PVC well installed	FT	244	$ 50	$ 12,200	$ 28	$ 6,832	$ 9,516
12" stickup protective case	EA	2	$ 400	$ 800	$ 195	$ 390	$ 595
Drums-development water[2]	EA	20	$ 50	$ 1,000	$ 45	$ 900	$ 950
Sentinel Wells (3):							
4" borehole drilled[1]	FT	150	$ 15	$ 2,250	$ 15	$ 2,250	$ 2,250
Split spoon sampling	EA	30	$ 10	$ 300	$ 30	$ 900	$ 600
2" PVC installed	FT	156	$ 15	$ 2,340	$ 14	$ 2,184	$ 2,262
4" stickup protective case	EA	3	$ 200	$ 600	$ 160	$ 480	$ 540
Drums-development water[2]	EA	9	$ 50	$ 450	$ 45	$ 405	$ 428
Miscellaneous:							
Mobilization/demobilization	LS	1	$ 6,500	$ 6,500	$ 900	$ 900	$ 3,700
Temporary decon. pad	LS	1	$ 400	$ 400	$ 400	$ 400	$ 400
Standby time[3]	HR	24	$ 150	$ 3,600	$ 155	$ 3,720	$ 3,660
Total Capital Cost for Recovery and Sentinel Well Installation =							**$ 36,061**

SENTINEL WELL INSTALLATION (INSTITUTIONAL CONTROLS)

Description	Units	Estimated Quantity	SJB Services Unit Cost	SJB Services Total	Advanced Drilling Unit Cost	Advanced Drilling Total	Average Cost
Sentinel Wells (3):							
4" borehole drilled[1]	FT	150	$ 15	$ 2,250	$ 15	$ 2,250	$ 2,250
Split spoon sampling	EA	30	$ 10	$ 300	$ 30	$ 900	$ 600
2" PVC installed	FT	156	$ 15	$ 2,340	$ 14	$ 2,184	$ 2,262
4" stickup protective case	EA	3	$ 200	$ 600	$ 160	$ 480	$ 540
Drums-development water[2]	EA	9	$ 50	$ 450	$ 45	$ 405	$ 428
Miscellaneous:							
Mobilization/demobilization	LS	1	$ 6,500	$ 6,500	$ 900	$ 900	$ 3,700
Temporary decon. pad	LS	1	$ 400	$ 400	$ 400	$ 400	$ 400
Standby time[3]	HR	16	$ 150	$ 2,400	$ 155	$ 2,480	$ 2,440
Total Capital Cost for Sentinel Well Installation =							**$ 12,620**

Notes:

[1] Assumes that all cuttings will be disposed, if necessary, with on-site impacted soils.

[2] Development water will be disposed in groundwater treatment system.

[3] Steam cleaning, drum handling, well development, site clean-up, etc.

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APPENDIX E.2

GROUNDWATER MONITORING PROGRAM

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.

BY Lori Vicker DATE 1/18/99

CHKD. BY ______ DATE 1/18/99

BBS Treated Lumber Site
Feasibility Study Cost Estimate

GROUNDWATER MONITORING PROGRAM

Item/Material	Units	Quantity	Unit Cost	1999$ Estimated Cost
Analysis for TAL Metals:				
Monitoring wells: MW-1 through MW-16 (no MW-2)	EA	15	$ 110	$ 1,650
Sentinel wells	EA	3	$ 110	$ 330
Drinking wells: DW-1, DW-2	EA	2	$ 110	$ 220
QA/QC: MS, MSD, blind duplicates	EA	4	$ 110	$ 440
Total Analytical				**$ 2,640**
Labor:				
Field technicians (2 @ $75/hr, 10hr/day)	Day	2	$ 1,500	$ 3,000
Total Labor:				**$ 3,000**
Expenses:				
Sample shipping	Day	2	$ 50	$ 100
Travel (250 miles/day @ $0.44/mile)	Day	2	$ 110	$ 220
Meals ($30/day/technician)	Day	2	$ 60	$ 120
Total Expenses:				**$ 440**
Sampling Equipment:				
HNu (PID)	Day	2	$ 100	$ 200
Generator	Day	2	$ 60	$ 120
Conductivity meter	Day	2	$ 25	$ 50
Temperature meter	Day	1	$ 10	$ 10
pH meter	Day	2	$ 10	$ 20
Turbidity meter	Day	2	$ 25	$ 50
Water level meter	Day	2	$ 30	$ 60
Electrical submersible 2" pump	Day	2	$ 100	$ 200
3' disposable bailers	EA	20	$ 10	$ 200
Miscellaneous (rope, ice, baggies, gloves, towels)	Day	2	$ 20	$ 40
Total Sampling Equipment:				**$ 950**
Total Cost for Groundwater Monitoring Event:				**$ 7,030**

Item/Material	Units	Quantity	Unit Cost	1999$ Estimated Cost
On-Site Groundwater Remedial Scenario:				
Semi-Annual Monitoring Event	EA	2	$ 7,030	$ 14,060
30-Year Present Worth (5% interest)				**$ 216,137**
On-Site and Off-Site Groundwater Remedial Scenario:				
Annual Monitoring Event	EA	1	$ 7,030	$ 7,030
30-Year Present Worth (5% interest)				**$ 108,069**

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APPENDIX E.3

ELECTROCHEMICAL GROUNDWATER MONITORING PROGRAM

MALCOLM PIRNIE, INC.

BY ____ DATE 1/18/99

CHKD. BY ____ DATE 1/18/99

BBS Treated Lumber Site
Feasibility Study Cost Estimate

ELECTROCHEMICAL GROUNDWATER TREATMENT: ON-SITE GROUNDWATER REMEDIAL SCENARIO

(ANDCO Environmental Processes, Inc.)

Item	Unit	Unit Cost	Quantity	Total
Capital Cost				
Site Work:				
Building and foundation[1]	LS	$200,000	1	$ 200,000
Reinjection system (150-210 gpm)	LS	$480,000	1	$ 480,000
Collection System:				
Recovery and sentinel well installation	Appendix D.1	$ 36,061	1	$ 36,061
Submersible well pump and motor	EA	$ 2,600	3	$ 7,800
Motor control box	EA	$ 400	3	$ 1,200
Interconnecting piping	LF	$ 30	1,200	$ 36,000
Remediation Contractor:				
Treatability study[2]	LS	$ 1,500	1	$ 1,500
Mobilization[3]	LS	$115,000	1	$ 115,000
Demobilization[4]	LS	$ 75,000	1	$ 75,000
Treatment system installed	LS	$290,600	1	$ 290,600
Compressed air system (100 psig)[5]	EA	$ 9,450	1	$ 9,450
Subtotal Capital Cost:				**$ 1,252,611**
15% Engineering and Legal:				$ 187,892
20% Contingency:				$ 250,522
Total Capital Cost:				**$ 1,691,024**
Annual O&M Cost				
Labor[6]	HR	$ 50	548	$ 27,375
Analytical (SPDES permit)	MN	$ 500	12	$ 6,000
Power[7]	1,000 GAL	$ 0.19	83,045	$ 15,779
Off-Site Disposal:				
Waste transportation	TON	$ 65	195	$ 12,653
Sludge treatment/disposal	TON	$ 100	195	$ 19,467
Rolloff rental fee	WK/ROLLOFF	$ 100	52	$ 5,200
Rolloff spot charge	SPOT	$ 1,525	10	$ 15,250
Chemical Costs:				
Steel plates	1,000 GAL	$ 0.16	83,045	$ 13,287
Oxidant	1,000 GAL	$ 0.06	83,045	$ 4,983
Polymer	1,000 GAL	$ 0.09	83,045	$ 7,474
Caustic	Insignificant (approx. 200 lbs per year)			
Subtotal O&M Cost:				**$ 127,467**
30-Year Present Worth of O&M:				$ 1,959,493
30-Year Present Worth of Groundwater and Effluent Monitoring:				$ 380,316
Total Cost for Alternative:				**$ 4,030,832**

Notes:

[1] Includes footings, foundation, lowest priced 80-ft by 40-ft building shell, elec., plumb., HVAC, instrum.

[2] Treatability Study includes analysis of 1 sample to determine the efficiency of process.

[3] Includes freight to site, installation, and 2 construction supervision visits.

[4] Andco does not demobilize the equipment but estimated cost to be less than mobilization.

[5] Compressed air used to operate sludge pumps, filter press, pneumatic valves, and multi-media.

[6] Labor includes the daily removal of sludge from the filter press and daily dumping of the sludge hopper; a forklift will need to be on-site to empty the sludge hopper into roll-offs.

[7] Includes electrochemical cell power and other system power based on 1,000 gal treated.

MALCOLM PIRNIE, INC.

BY DATE 1/18/99

CHKD. BY DATE 1/19/99

BBS Treated Lumber Site
Feasibility Study Cost Estimate

ELECTROCHEMICAL GROUNDWATER TREATMENT:
ON-SITE AND OFF-SITE GROUNDWATER REMEDIAL SCENARIO

(ANDCO Environmental Processes, Inc.)

Item	Unit	Unit Cost	Quantity	Total
Capital Cost				
Site Work:				
Building and foundation[1]	LS	$200,000	1	$ 200,000
Reinjection system (150-210 gpm)	LS	$480,000	1	$ 480,000
Collection System:				
Recovery and sentinel well installation	Appendix D.1	$ 36,061	1	$ 36,061
Submersible well pump and motor	EA	$ 2,600	4	$ 10,400
Motor control box	EA	$ 400	4	$ 1,600
Interconnecting piping	LF	$ 30	1,800	$ 54,000
Remediation Contractor:				
Treatability study[2]	LS	$ 1,500	1	$ 1,500
Mobilization[3]	LS	$115,000	1	$ 115,000
Demobilization[4]	LS	$ 75,000	1	$ 75,000
Treatment system installed	LS	$330,600	1	$ 330,600
Compressed air system (100 psig)[5]	EA	$ 9,450	1	$ 9,450
			Subtotal Capital Cost:	**$ 1,313,611**
			15% Engineering and Legal:	$ 197,042
			20% Contingency:	$ 262,722
			Total Capital Cost:	**$ 1,773,374**
Annual O&M Cost				
Labor[6]	HR	$ 50	548	$ 27,375
Analytical (SPDES permit)	MN	$ 500	12	$ 6,000
Power[7]	1,000 GAL	$ 0.19	106,697	$ 20,272
Off-Site Disposal:				
Waste transportation	TON	$ 65	243	$ 15,817
Sludge treatment/disposal	TON	$ 100	243	$ 24,333
Rolloff rental fee	WK/ROLLOFF	$ 100	52	$ 5,200
Rolloff spot charge	SPOT	$ 1,525	10	$ 15,250
Chemical Costs:				
Steel plates	1,000 GAL	$ 0.16	106,697	$ 17,071
Oxidant	1,000 GAL	$ 0.06	106,697	$ 6,402
Polymer	1,000 GAL	$ 0.09	106,697	$ 9,603
Caustic	Insignificant (approx. 200 lbs per year)			
			Subtotal O&M Cost:	**$ 147,323**
			30-Year Present Worth of O&M:	$ 2,264,729
			30-Year Present Worth of Groundwater and Effluent Monitoring:	$ 272,247
			Total Cost for Alternative:	**$ 4,310,350**

Notes:

[1] Includes footings, foundation, lowest priced 80-ft by 40-ft building shell, elec., plumb., HVAC, instrum.

[2] Treatability Study includes analysis of 1 sample to determine the efficiency of process.

[3] Includes freight to site, installation, and 2 construction supervision visits.

[4] Andco does not demobilize the equipment but estimated cost to be less than mobilization.

[5] Compressed air used to operate sludge pumps, filter press, pneumatic valves, and multi-media.

[6] Labor includes the daily removal of sludge from the filter press and daily dumping of the sludge hopper; a forklift will need to be on-site to empty the sludge hopper into roll-offs.

[7] Includes electrochemical cell power and other system power based on 1,000 gal treated.

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APPENDIX E.4

CHEMICAL PRECIPITATION

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.

BY DATE 1/15/9

CHKD. BY AUM DATE 1/18/99

BBS Treated Lumber Site
Feasibility Study Cost Estimate

CHEMICAL PRECIPITATION:
ON-SITE GROUNDWATER REMEDIAL SCENARIO

Item	Unit	Unit Cost	Quantity	Total
Capital Cost				
Site Work:				
Building and foundation[1]	LS	$ 200,000	1	$ 200,000
Reinjection system (150-210 gpm)	LS	$ 480,000	1	$ 480,000
Collection System:				
Recovery and sentinel well installation	Appendix D.1	$ 36,061	1	$ 36,061
Submersible well pump and motor	EA	$ 2,600	3	$ 7,800
Motor control box	EA	$ 400	3	$ 1,200
Interconnecting piping	LF	$ 30	1,200	$ 36,000
Remediation Contractor:				
Treatability study	LS	$ 7,000	1	$ 7,000
Treatment system[2]	LS	$ 250,000	1	$ 250,000
Subtotal Capital Cost:				**$ 1,018,061**
15% Engineering and Legal:				$ 152,709
20% Contingency:				$ 203,612
Total Capital Cost:				**$ 1,374,382**
Annual O&M Cost:				
Labor[3]	HR	$ 50	548	$ 27,375
Analytical (SPDES permit)	MN	$ 500	12	$ 6,000
Power[4]	kWH	$ 0.11	163,374	$ 17,971
Off-Site Disposal:				
Waste transportation	TON	$ 65	195	$ 12,653
Sludge treatment/disposal	TON	$ 100	195	$ 19,467
Rolloff rental fee	WK/ROLLOFF	$ 100	52	$ 5,200
Rolloff spot charge	SPOT	$ 1,525	12	$ 18,300
Chemical Costs:				
Lime, ferrous sulfate/sulfide	1,000 GAL	$ 0.25	83,045	$ 20,761
Subtotal O&M Cost:				**$ 127,727**
30-Year Present Worth of O&M:				$ 1,963,489
30-Year Present Worth of Groundwater and Effluent Monitoring:				$ 380,316
Total Cost for Alternative:				**$ 3,718,186**

Notes:

[1] Includes footings, foundation, lowest priced 80-ft by 40-ft building shell, elec., plumb., HVAC, instrum.

[2] Installed cost includes mobilization.

[3] Includes daily removal of sludge from the filter press and daily reagent make-up.

[4] Total power consumption estimated at less than 25 hp.

MALCOLM PIRNIE, INC.

BY DATE 1/15/9

CHKD. BY DATE 1/18/99

BBS Treated Lumber Site
Feasibility Study Cost Estimate

CHEMICAL PRECIPITATION:
ON-SITE AND OFF-SITE GROUNDWATER REMEDIAL SCENARIO

Item	Unit	Unit Cost	Quantity	Total
Capital Cost				
Site Work:				
Building and foundation[1]	LS	$ 200,000	1	$ 200,000
Reinjection system (150-210 gpm)	LS	$ 480,000	1	$ 480,000
Collection System:				
Recovery and sentinel well installation	Appendix D.1	$ 36,061	1	$ 36,061
Submersible well pump and motor	EA	$ 2,600	4	$ 10,400
Motor control box	EA	$ 400	4	$ 1,600
Interconnecting piping	LF	$ 30	1,800	$ 54,000
Remediation Contractor:				
Treatability study	LS	$ 7,000	1	$ 7,000
Treatment system[2]	LS	$ 285,000	1	$ 285,000
Subtotal Capital Cost:				**$ 1,074,061**
15% Engineering and Legal:				$ 161,109
20% Contingency:				$ 214,812
Total Capital Cost:				**$ 1,449,982**
Annual O&M Cost:				
Labor[3]	HR	$ 50	548	$ 27,375
Analytical (SPDES permit)	MN	$ 500	12	$ 6,000
Power[4]	kWH	$ 0.11	163,374	$ 17,971
Off-Site Disposal:				
Waste transportation	TON	$ 65	243	$ 15,817
Sludge treatment/disposal	TON	$ 100	243	$ 24,333
Rolloff rental fee	WK/ROLLOFF	$ 100	52	$ 5,200
Rolloff spot charge	SPOT	$ 1,525	12	$ 18,300
Chemical Costs: Lime, ferrous sulfate/sulfide	1,000 GAL	$ 0.25	106,697	$ 26,674
Subtotal O&M Cost:				**$ 141,670**
30-Year Present Worth of O&M:				$ 2,177,827
30-Year Present Worth of Groundwater and Effluent Monitoring:				$ 272,247
Total Cost for Alternative:				**$ 3,900,056**

Notes:

[1] Includes footings, foundation, lowest priced 80-ft by 40-ft building shell, elec., plumb., HVAC, instrum.

[2] Installed cost includes mobilization.

[3] Includes daily removal of sludge from the filter press and daily reagent make-up.

[4] Total power consumption estimated at less than 25 hp.

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APPENDIX E.5

TREATMENT SYSTEM EFFLUENT MONITORING

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.

BY Lori Decker DATE 1/18/99

CHKD. BY ACM DATE 1/18/99

BBS Treated Lumber Site
Feasibility Study Cost Estimate

TREATMENT SYSTEM EFFLUENT MONITORING

Item/Material	Units	Quantity	Unit Cost	1999$ Estimated Cost
Monthly Effluent Monitoring:				
Analysis for TAL Metals:				
Sample of treatment system effluent	EA	1	$ 110	$ 110
			Total Analytical:	**$ 110**
Labor:				
Field technicians (1 @ $75/hr, 5 hr/day)	Day	1	$ 375	$ 375
			Total Labor:	**$ 375**
Expenses:				
Sample shipping	Day	1	$ 25	$ 25
Travel (250 miles/day @ $0.44/mile)	Day	1	$ 110	$ 110
Meals ($15/day/technician)	Day	1	$ 15	$ 15
			Total Expenses:	**$ 150**
Sampling Equipment:				
Conductivity meter	Day	1	$ 25	$ 25
Temperature meter	Day	1	$ 10	$ 10
pH meter	Day	1	$ 10	$ 10
Turbidity meter	Day	1	$ 25	$ 25
Miscellaneous (ice, baggies, gloves, towels)	Day	1	$ 10	$ 10
			Total Sampling Equipment:	**$ 80**
Reporting:				
Labor (1 @ 75/hr, 2 hr/report)	Mo	1	$ 150	$ 150
Expenses	Mo	1	$ 25	$ 25
			Total Reporting:	**$ 175**
			Total Cost for Monthly Effluent Monitoring Event:	**$ 890**
			Annual Cost for Treatment System Effluent Monitoring:	**$ 10,680**
			30-Year Present Worth (5% interest):	**$ 164,178**

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APPENDIX E.6

ASPHALT COVER ON-SITE SOILS/DISPOSAL OF OFF-SITE SOILS

MALCOLM PIRNIE

BY Lori Hucker DATE 1/18/99
CHKD. BY AWM DATE 1/18/99

BBS Treated Lumber Site
Feasibility Study Cost Estimate

ASPHALT COVER ON-SITE/DISPOSAL OF OFF-SITE SOILS

CLEAN-UP SCENARIOS A AND B

Item	Unit	Unit Cost	Quantity[1]	Total
Capital Cost				
Site Work:				
Secure fence, post signs	LS	$ 10,000	1	$ 10,000
Off-site clearing	LS	$ 4,000	1	$ 4,000
Excavation	CY	$ 30	1,500	$ 45,000
Clean backfill/regrade	CY	$ 25	1,500	$ 37,500
Seed tributary	SY	$ 5	1,333	$ 6,667
Asphalt Cover (on-site):				
Fill material and grading	CY	$ 25	5,000	$ 125,000
6" crushed stone (3/4")	SY	$ 8	31,223	$ 249,787
4" binder course	SY	$ 7	31,223	$ 218,563
2" top course	SY	$ 4	31,223	$ 124,893
Woven geotextile[2]	SY	$ 2	31,223	$ 62,447
Drainage:				
Concrete perimeter drain, installed[3]	LF	$ 105	2,500	$ 262,500
Conveyance piping, installed[4]	LF	$ 30	1,000	$ 30,000
Drywells	EA	$ 2,500	10	$ 25,000
Off-Site Disposal:				
Treatment/disposal of haz. waste	TON	$ 95	2,100	$ 199,500
Transportation of waste	TON	$ 65	2,100	$ 136,500
			Subtotal Capital Cost:	**$ 1,537,357**
			15% Engineering and Legal:	$ 230,604
			20% Contingency:	$ 307,471
			Total Capital Cost:	**$ 2,075,432**
Annual O&M Cost				
All weather patching mix[5]	TON	$ 30	169	$ 5,073
			Subtotal O&M Cost:	**$ 5,073**
			30-Year Present Worth of O&M:	$ 77,984
			Total Present Worth Cost for Alternative:	**$ 2,153,415**

Notes:

[1] Total coverage of on-site areas = 273,510 square feet; assumes additional 3 feet around perimeter.

[2] Geotextile placed in lumberyard because of truck traffic.

[3] Concrete perimeter drain (1' by 3' deep), 3/4" stone backfill, metal grating.

[4] Conveyance piping from drain to drywells (100' ea.); 6" PVC pipe installed at 3 feet below grade.

[5] Assumes 10% of on-site areas would need patching to a depth of 1 inch at 145 lbs per cu.ft.

APPENDIX E.7

IN SITU SOLIDIFICATION/STABILIZATION (S/S)

BY Lori Becker DATE 1/18/99

CHKD.BY AWM DATE 1/18/99

BBS Treated Lumber Site
Feasibility Study Cost Estimate

IN SITU SOLIDIFICATION/STABILIZATION (S/S)

Clean-Up Scenario A				
Item	**Unit**	**Unit Cost**	**Quantity**	**Total**
Site Work:				
Secure fence, post signs	LS	$ 10,000	1	$ 10,000
Off-site clearing	LS	$ 4,000	1	$ 4,000
Excavating, stockpiling	CY	$ 30	1,500	$ 259,500
Disposal pit excavation[1]	CY	$ 30	8,650	$ 45,000
Backfill/regrade off-site area	CY	$ 15	1,500	$ 22,500
Seed tributary	SY	$ 5	1,333	$ 6,667
Remediation Contractor:				
Treatability study[2]	LS	$ 13,000	1	$ 13,000
Project review	LS	$ 4,500	1	$ 4,500
Phase II treatability study	LS	$ 12,500	1	$ 12,500
Mobilization/demobilization	Included in treatment costs			
Treatment reagent	TON	$ 8.5	20,020	$ 170,170
S/S (on- and off-site soils)	TON	$ 4	20,020	$ 80,080
On-Site Disposal:				
Compliance sampling[3]	1,000 TON	$ 190	30	$ 5,706
Cover solidified mass	CY	$ 15	5,065	$ 75,975
Place in disposal pit	CY	$ 15	8,650	$ 129,750
			Subtotal Capital Cost:	**$ 839,347**
			15% Engineering and Legal:	$ 125,902
			20% Contingency:	$ 167,869
			Total Capital Cost:	**$ 1,133,119**

Notes:

[1] On-site excavation area would hold off-site soils x 1.5 for volume increase
and excess soil product from on-site S/S (half the on-site volume).

[2] Includes analytical/physical testing; initial characterization; reagent formulation; final testing.

[3] One sample analyzed per 1,000 tons of treated S/S product for TCLP metals with 48-hr TAT.

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.

BY______ DATE 1/18/99

CHKD.BY AUM DATE 1/18/99

BBS Treated Lumber Site
Feasibility Study Cost Estimate

IN SITU SOLIDIFICATION/STABILIZATION (S/S)

Clean-Up Scenario B

Item	Unit	Unit Cost	Quantity	Total
Site Work:				
Secure fence, post signs	LS	$ 10,000	1	$ 10,000
Off-site clearing	LS	$ 4,000	1	$ 4,000
Excavating, stockpiling	CY	$ 30	1,500	$ 127,500
Disposal pit excavation[1]	CY	$ 30	4,250	$ 45,000
Backfill/regrade off-site area	CY	$ 15	1,500	$ 22,500
Seed tributary	SY	$ 5	1,333	$ 6,667
Remediation Contractor:				
Treatability study[2]	LS	$ 13,000	1	$ 13,000
Project review	LS	$ 4,500	1	$ 4,500
Phase II treatability study	LS	$ 12,500	1	$ 12,500
Mobilization/demobilization	Included in treatment costs			
Treatment reagent	TON	$ 15	7,700	$ 115,500
S/S (on- and off-site soils)	TON	$ 12	7,700	$ 92,400
On-Site Disposal:				
Compliance sampling[3]	1,000 TON	$ 190	12	$ 2,195
Cover solidified mass	CY	$ 15	2,194	$ 32,916
Place in disposal pit	CY	$ 15	4,250	$ 63,750
			Subtotal Capital Cost:	**$ 552,428**
			15% Engineering and Legal:	$ 82,864
			20% Contingency:	$ 110,486
			Total Capital Cost:	**$ 745,777**

Notes:

[1] On-site excavation area would hold off-site soils x 1.5 for volume increase and excess soil product from on-site S/S (half the on-site volume).

[2] Includes analytical/physical testing; initial characterization; reagent formulation; final testing.

[3] One sample analyzed per 1,000 tons of treated S/S product for TCLP metals with 48-hr TAT.

MALCOLM
PIRNIE

APPENDIX E.8

IN SITU ELECTROKINETIC REMEDIATION

MALCOLM PIRNIE

BY Lori Dickie DATE 1/15/99
CHKD. BY DATE 1/18/99

BBS Treated Lumber Site
Feasibility Study Cost Estimate

IN SITU ELECTROKINETIC REMEDIATION

(Geokinetics International, Inc)

Clean-Up Scenario A				
Item	**Unit**	**Unit Cost**	**Quantity**	**Total**
Site Work:				
Secure fence, post signs	LS	$ 10,000	1	$ 10,000
Excavating, stockpiling	CY	$ 30	2,500	$ 75,000
Clean fill	CY	$ 25	2,500	$ 62,500
Turn Key Treatment System: [1]				
On-Site Soils In-Place/Excavated	CY	$ 140	13,425	$ 1,879,500
Off-Site Soils Excavated	CY	$ 140	1,500	$ 210,000
Off-Site Disposal:				
Precipitate transportation[2]	TON	$ 65	42	$ 2,703
Prec. treatment/disposal (on-site)	TON	$ 100	33	$ 3,338
Prec. treatment/disposal (off-site)	TON	$ 100	8	$ 820
			Subtotal Capital Cost:	**$ 2,243,861**
			15% Engineering and Legal:	$ 336,579
			20% Contingency:	$ 448,772
			Total Capital Cost:	**$ 3,029,213**

Notes:

[1] This "planning level" estimate includes treatability study, design, operation, mobilization, demobilization, reporting, and expenses. Also includes a 2-3 day on-site survey using a non-intrusive 3D ERT process to determine the additional detail of mass and distribution required to complete the design and optimization process. Includes final compliance sampling.

[2] Estimated total mass of contaminants based on maximum concentrations observed and quantity of soil treated. Multiplied calculated weight by 2 for a conservative estimate of dry precipitate.

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.

BY ______ DATE 1/16/99
CHKD. BY ______ DATE 1/18/99

BBS Treated Lumber Site
Feasibility Study Cost Estimate

IN SITU ELECTROKINETIC REMEDIATION

(Geokinetics International, Inc)

Clean-Up Scenario B				
Item	**Unit**	**Unit Cost**	**Quantity**	**Total**
Site Work:				
Secure fence, post signs	LS	$ 10,000	1	$ 10,000
Excavating, stockpiling	CY	$ 30	1,600	$ 48,000
Clean fill	CY	$ 25	1,600	$ 40,000
Turn Key Treatment System: [1]				
On-site areas	CY	$ 270	4,400	$ 1,188,000
Off-site areas	CY	$ 270	1,500	$ 405,000
Off-Site Disposal:				
Precipitate transportation[2]	TON	$ 65	19	$ 1,244
Prec. treatment/disposal (on-site)	TON	$ 100	11	$ 1,094
Prec. treatment/disposal (off-site)	TON	$ 100	8	$ 820
			Subtotal Capital Cost:	**$ 1,694,159**
			15% Engineering and Legal:	$ 254,124
			20% Contingency:	$ 338,832
			Total Capital Cost:	**$ 2,287,114**

Notes:

[1] This "planning level" estimate includes treatability study, design, operation, mobilization, demobilization, reporting, and expenses. Also includes a 2-3 day on-site survey using a non-intrusive 3D ERT process to determine the additional detail of mass and distribution required to complete the design and optimization process. Includes final compliance sampling.

[2] Estimated total mass of contaminants based on maximum concentrations observed and quantity of soil treated. Multiplied calculated weight by 2 for a conservative estimate of dry precipitate.

APPENDIX E.9

EX SITU SOLIDIFICATION/STABILIZATION (S/S)

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.

BY Lori DATE 1/18/99

CHKD. BY DATE 1/18/99

BBS Treated Lumber Site Feasibility Study Cost Estimate

EX SITU SOLIDIFICATION/STABILIZATION (S/S)

Clean-Up Scenario A

Item	Unit	Unit Cost	Quantity	Total
Site Work:				
Secure fence, post signs	LS	$ 10,000	1	$ 10,000
Off-site clearing	LS	$ 4,000	1	$ 4,000
Excavating, stockpiling	CY	$ 30	14,300	$ 259,500
Disposal pit excavation[1]	CY	$ 30	8,650	$ 45,000
Backfill/regrade off-site area	CY	$ 15	1,500	$ 22,500
Seed tributary	SY	$ 5	1,333	$ 6,667
Remediation Contractor:				
Treatability study[2]	LS	$ 13,000	1	$ 13,000
Project review	LS	$ 4,500	1	$ 4,500
Phase II treatability study	LS	$ 12,500	1	$ 12,500
Mobilization/demobilization	Included in treatment costs			
Treatment reagent	TON	$ 8.5	20,020	$ 170,170
S/S (on- and off-site soils)	TON	$ 4	20,020	$ 80,080
On-Site Disposal:				
Compliance sampling[3]	1,000 TON	$ 190	30	$ 5,706
Place on-site in excavation	CY	$ 15	12,800	$ 192,000
Place in disposal pit	CY	$ 15	8,650	$ 129,750
Subtotal Capital Cost:				**$ 955,372**
15% Engineering and Legal:				$ 143,306
20% Contingency:				$ 191,074
Total Capital Cost:				**$ 1,289,753**

Notes:

[1] On-site excavation area would hold off-site soils x 1.5 for volume increase and excess soil product from on-site S/S (half the on-site volume).

[2] Includes analytical/physical testing; initial characterization; reagent formulation; final testing.

[3] One sample analyzed per 1,000 tons of treated S/S product for TCLP metals with 48-hr TAT.

MALCOLM PIRNIE, INC.

BY Lori Decker DATE 1/15/99

CHKD. BY ____ DATE 1/18/99

BBS Treated Lumber Site
Feasibility Study Cost Estimate

EX SITU SOLIDIFICATION/STABILIZATION (S/S)

Clean-Up Scenario B				
Item	**Unit**	**Unit Cost**	**Quantity**	**Total**
Site Work:				
Secure fence, post signs	LS	$ 10,000	1	$ 10,000
Off-site clearing	LS	$ 4,000	1	$ 4,000
Excavating, stockpiling	CY	$ 30	5,500	$ 127,500
Disposal pit excavation[1]	CY	$ 30	4,250	$ 45,000
Backfill/regrade off-site area	CY	$ 15	1,500	$ 22,500
Seed tributary	SY	$ 5	1,333	$ 6,667
Remediation Contractor:				
Treatability study[2]	LS	$ 13,000	1	$ 13,000
Project review	LS	$ 4,500	1	$ 4,500
Phase II treatability study	LS	$ 12,500	1	$ 12,500
Mobilization/demobilization	Included in treatment costs			
Treatment reagent	TON	$ 15	7,700	$ 115,500
S/S (on- and off-site soils)	TON	$ 12	7,700	$ 92,400
On-Site Disposal:				
Compliance sampling[3]	1,000 TON	$ 190	12	$ 2,195
Place on-site in excavation	CY	$ 15	4,000	$ 60,000
Place in disposal pit	CY	$ 15	4,250	$ 63,750
			Subtotal Capital Cost:	**$ 579,511**
			15% Engineering and Legal:	$ 86,927
			20% Contingency:	$ 115,902
			Total Capital Cost:	**$ 782,340**

Notes:

[1] On-site excavation area would hold off-site soils x 1.5 for volume increase and excess soil product from on-site S/S (half the on-site volume).

[2] Includes analytical/physical testing; initial characterization; reagent formulation; final testing.

[3] One sample analyzed per 1,000 tons of treated S/S product for TCLP metals with 48-hr TAT.

MALCOLM PIRNIE

APPENDIX E.10

EX SITU SOIL WASHING

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.

BY Lori Hickie DATE 1/15/99

CHKD. BY AUM DATE 1/18/99

BBS Treated Lumber Site Feasibility Study Cost Estimate

EX SITU SOIL WASHING

Clean-Up Scenario A				
Item	**Unit**	**Unit Cost**	**Quantity**	**Total**
Site Work:				
Secure fence, post signs	LS	$ 10,000	1	$ 10,000
Off-site clearing	LS	$ 4,000	1	$ 4,000
Excavating, stockpiling	CY	$ 30	14,300	$ 429,000
Disposal pit excavation	CY	$ 30	28,600	$ 858,000
Backfilling on-site/off-site	CY	$ 15	11,655	$ 174,818
Clean fill[1]	CY	$ 25	2,646	$ 66,138
Seed tributary	SY	$ 5	1,333	$ 6,667
Remediation Contractor:				
Treatability study[2]	LS	$ 11,500	1	$ 11,500
Mobilization/demobilization	LS	$ 71,500	1	$ 71,500
Site Preparation[3]	LS	$ 90,000	1	$ 90,000
Insurance	LS	$ 11,192	1	$ 11,192
Processing[4]	TON	$ 44	20,020	$ 880,880
Utilities:				
Water usage (25 gpm)	TON	$ 1.25	20,020	$ 25,025
Electrical usage (1,000 hp)	kWH	$ 0.11	497,831	$ 54,761
Off-Site Disposal:				
Sludge transportation	TON	$ 65	3,704	$ 240,741
Sludge treatment/disposal	TON	$ 100	3,704	$ 370,370
On-Site Disposal:				
Place in disposal pit	CY	$ 15	16,316	$ 244,745
			Subtotal Capital Cost:	**$ 3,549,335**
			15% Engineering and Legal:	$ 532,400
			20% Contingency:	$ 709,867
			Total Capital Cost:	**$ 4,791,602**

Notes:

[1] Approximately 18.5% of soil is contaminated fines that must be disposed off-site; clean fill must be used to fill the excavation.

[2] Treatability study includes one site visit, backhoe, analytical, and disposal.

[3] Assumes on-site surface sufficiently compact to hold processing equipment. Vendor to provide sludge containment system.

[4] Includes labor, travel, equipment rental, maintenance, consumables, and process sampling.

MALCOLM PIRNIE

MALCOLM PIRNIE, INC.

BY ____ DATE 1/18/99

CHKD. BY AUM DATE 1/18/99

BBS Treated Lumber Site
Feasibility Study Cost Estimate

EX SITU SOIL WASHING

Clean-Up Scenario B				
Item	**Unit**	**Unit Cost**	**Quantity**	**Total**
Site Work:				
Secure fence, post signs	LS	$ 10,000	1	$ 10,000
Off-site clearing	LS	$ 4,000	1	$ 4,000
Excavating, stockpiling	CY	$ 30	5,500	$ 165,000
Disposal pit excavation	CY	$ 30	11,000	$ 330,000
Backfilling on-site/off-site	CY	$ 15	4,483	$ 67,238
Clean fill[1]	CY	$ 25	1,018	$ 25,438
Seed tributary	SY	$ 5	1,333	$ 6,667
Remediation Contractor:				
Treatability study[2]	LS	$ 11,500	1	$ 11,500
Mobilization/demobilization	LS	$ 71,500	1	$ 71,500
Site preparation[3]	LS	$ 90,000	1	$ 90,000
Insurance	LS	$ 11,192	1	$ 11,192
Processing[4]	TON	$ 44	7,700	$ 338,800
Utilities:				
Water usage (25 gpm)	TON	$ 1.25	7,700	$ 9,625
Electrical usage (1,000 hp)	kWH	$ 0.11	191,473	$ 21,062
Off-Site Disposal:				
Sludge transportation	TON	$ 65	1,425	$ 92,593
Sludge treatment/disposal	TON	$ 100	1,425	$ 142,450
On-Site Disposal:				
Place in disposal pit	CY	$ 15	6,276	$ 94,133
			Subtotal Capital Cost:	**$ 1,491,196**
			15% Engineering and Legal:	$ 223,679
			20% Contingency:	$ 298,239
			Total Capital Cost:	**$ 2,013,114**

Notes:

[1] Approximately 18.5% of soil is contaminated fines that must be disposed off-site; clean fill must be used to fill the excavation.

[2] Treatability study includes one site visit, backhoe, analytical, and disposal.

[3] Assumes on-site surface sufficiently compact to hold processing equipment. Vendor to provide sludge containment system.

[4] Includes labor, travel, equipment rental, maintenance, consumables, and process sampling.

APPENDIX E.11

OFF-SITE TREATMENT AND DISPOSAL

MALCOLM PIRNIE, INC.

BY Lori [illegible] DATE 1/13/99

CHKD. BY AMM DATE 1/18/99

BBS Treated Lumber Site
Feasibility Study Cost Estimate

OFF-SITE TREATMENT AND DISPOSAL

Clean-Up Scenario A				
Item	**Unit**	**Unit Cost**	**Quantity**	**Total**
Site Work:				
Secure fence, post signs	LS	$ 10,000	1	$ 10,000
Off-site clearing	LS	$ 4,000	1	$ 4,000
Excavation	CY	$ 30	14,300	$ 429,000
Clean backfill/regrade	CY	$ 25	14,300	$ 357,500
Seed tributary	SY	$ 5	1,333	$ 6,667
Off-Site Disposal:				
Treatment/disposal of haz. waste	TON	$ 90	20,020	$ 1,801,800
Transportation of waste	TON	$ 65	20,020	$ 1,301,300
			Subtotal Capital Cost:	**$ 3,910,267**
			15% Engineering and Legal:	$ 586,540
			20% Contingency:	$ 782,053
			Total Capital Cost:	**$ 5,278,860**

Cleanu-Up Scenario B				
Item	**Unit**	**Unit Cost**	**Quantity**	**Total**
Site Work:				
Secure fence, post signs	LS	$ 10,000	1	$ 10,000
Off-site clearing	LS	$ 4,000	1	$ 4,000
Excavation	CY	$ 30	5,500	$ 165,000
Clean backfill/regrade	CY	$ 25	5,500	$ 137,500
Seed tributary	SY	$ 5	1,333	$ 6,667
Off-Site Disposal:				
Treatment/disposal of haz. waste	TON	$ 90	7,700	$ 693,000
Transportation of waste	TON	$ 65	7,700	$ 500,500
			Subtotal Capital Cost:	**$ 1,516,667**
			15% Engineering and Legal:	$ 227,500
			20% Contingency:	$ 303,333
			Total Capital Cost:	**$ 2,047,500**

LEGEND

- ⊖ DRINKING WELL
- ✧ MONITORING WELL
- ◻ HYDROPUNCH
- ✧ SOIL BORING
- ⊗ SURFACE SOIL SAMPLE
- —X— FENCE
- ⊠ PRODUCTION WELL
- ▲ RECOVERY WELL
- ◙ CATCH BASIN
- ⊔ OUTFALL

SP17-98 SURFACE SOIL SAMPLE (0"-2")
SP17-98I INTERMEDIATE SURFACE SOIL SAMPLE (1"-1.5")
SP17-98D DEEP SURFACE SOIL SAMPLE (2.5'-3')
(SP39-98) BLIND DUPLICATE

▨ CLEAN-UP SCENARIO A

- —— GROUNDWATER CONTAMINANT PLUME (GROUNDWATER CHROMIUM CONCENTRATIONS EXCEEDING 50 ug/l)
- ● SURFACE SOIL SAMPLE COLLECTED NOT ANALYZED
- ◓ SOIL SAMPLE LOCATION FROM SEPTEMBER 30, 1998 (SAMPLING EVENT CONDUCTED BY NYSDEC)

NOTES:

1. SURVEY COMPLETED BY WENDEL SURVEYORS
   7405 CANAL ROAD
   LOCKPORT, N.Y. 14095
2. VERTICAL DATUM: NAVD 1988
   HORIZONTAL DATUM: NAD 1927

WARNING – IT IS A VIOLATION OF NEW YORK EDUCATION LAW, SECTION 7209.2, FOR ANY PERSON, UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER OR LAND SURVEYOR, TO ALTER THIS DOCUMENT IN ANY WAY. IF ALTERED, THE ALTERING PERSON SHALL COMPLY WITH THE REQUIREMENTS OF NEW YORK LAW, SECTION 7209.2.

MALCOLM PIRNIE

REVISIONS			
NO.	BY	DATE	REMARKS

DES
DWN
CKD

N.Y.S.D.E.C.
SPEONK, NEW YORK

BB & S TREATED LUMBER SITE

FIGURE 2-1
AREAL EXTENT OF IMPACTED SOILS
CLEAN-UP SCENARIO A
1" = 60'

DATE JANUARY 1999
SHEET 1 OF 1
CAD FILE NO. 0266G021

516 02663232700 I:\ACAD\PROJ\02663232\0266G021 Scale: 1:1i Date: 01/11/1999 Time: 13:53

7516 0266323700 P:\ACAD\PROJ\02663232\0266G022 Scale: 1:1 Date: 01/15/1999 Time: 13:25

LEGEND

⊖ DRINKING WELL
⊕ MONITORING WELL
□ HYDROPUNCH
⊕ SOIL BORING
⊗ SURFACE SOIL SAMPLE
—X— FENCE
⊠ PRODUCTION WELL
▲ RECOVERY WELL
◙ CATCH BASIN
⊔ OUTFALL

SP17-98 SURFACE SOIL SAMPLE (0"-2")
SP17-98I INTERMEDIATE SURFACE SOIL SAMPLE (1'-1.5')
SP17-98D DEEP SURFACE SOIL SAMPLE (2.5'-3')
(SP39-98) BLIND DUPLICATE

▨ CLEAN-UP SCENARIO B

— GROUNDWATER CONTAMINANT PLUME
(GROUNDWATER CHROMIUM CONCENTRATIONS EXCEEDING 50 ug/l)
● SURFACE SOIL SAMPLE COLLECTED NOT ANALYZED
◒ SOIL SAMPLE LOCATION FROM SEPTEMBER 30, 1998
(SAMPLING EVENT CONDUCTED BY NYSDEC)

NOTES:

1. SURVEY COMPLETED BY WENDEL SURVEYORS
7405 CANAL ROAD
LOCKPORT, N.Y. 14095
2. VERTICAL DATUM: NAVD 1988
HORIZONTAL DATUM: NAD 1927

WARNING - IT IS A VIOLATION OF NEW YORK EDUCATION LAW, SECTION 7209.2, FOR ANY PERSON, UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER OR LAND SURVEYOR, TO ALTER THIS DOCUMENT IN ANY WAY. IF ALTERED, THE ALTERING PERSON SHALL COMPLY WITH THE REQUIREMENTS OF NEW YORK LAW, SECTION 7209.2.

MALCOLM PIRNIE

REVISIONS

NO.	BY	DATE	REMARKS

DES ____
DWN ____
CKD ____

N.Y.S.D.E.C.
SPEONK, NEW YORK

BB & S TREATED LUMBER SITE

FIGURE 2-2

AREAL EXTENT OF IMPACTED SOILS CLEAN-UP SCENARIO B

1" = 60'

DATE JANUARY 1999
SHEET 1 OF 1
CAD FILE NO. 0266G022