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VOLUME II

ROWE INDUSTRIES GROUND-WATER CONTAMINATION SITE

SAG HARBOR, NEW YORK

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ROWE INDUSTRIES SITE
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A Ground Water Medium

A.1 No Action

A.1.1 None

A.1.1.1 Not Applicable

Description: No further action is taken.

Applicability: This process option must be considered regardless of applicability.

Preliminary Screening: Retained; option must be retained.

Secondary Screening: Retained; option must be retained.
Effectiveness: Does not achieve remedial action objectives.
Implementability: Not acceptable to local, state or federal government.
Cost: None.

A.2 Institutional Actions

A.2.1 Access Restrictions

A.2.1.1 Deed Notations

Description: Deed notations are legally enforceable land-use restrictions that are placed on a site. This process can be used to eliminate exposure to soil or ground water or both on properties where soil and ground-water contamination exists.

Applicability: This process is applicable in all jurisdictions that have deed restricting authority.

Limitations: This process alone does not reduce the toxicity, mobility or volume of contaminants; it only reduces the risk of human exposure. The effectiveness of this process depends on continued enforcement.

Preliminary Screening: Retained.

Secondary Screening: Retained.

Effectiveness: The effectiveness of the deed notations is dependent on the continued future implementation. Deed notations do not reduce the levels of contamination or reduce contaminant migration.

Implementability: Implementability is dependent on local requirements and jurisdictional authority.

Cost: Very low capital, no operation and maintenance (O&M).

A.2.1.2 Well Permitting

Description: Ground water use is legally restricted by selective issuance of well permits to eliminate ground-water exposure routes.

Applicability: This process is applicable in all jurisdictions that issue well permits.

Limitations: This process alone does not reduce the toxicity, mobility or volume of contaminants; it only reduces the risk of human exposure. The effectiveness of this process depends on continued enforcement.

Preliminary Screening: Retained.

Secondary Screening: Retained.

Effectiveness: The effectiveness of a well permit is dependent on its continued future implementation. Well permits do not reduce the levels of contamination or reduce contaminant migration.

Implementability: Implementability is dependent on local requirements and jurisdictional authority.

Cost: Very low capital; no O&M.

A.2.1.3 Physical Restrictions

Description: Land use is physically restricted by erecting barriers to eliminate ground-water exposure routes.

Applicability: This process is applicable to all sites where site conditions and legal circumstances will permit the construction of physical barriers.

Limitations: This process alone does not reduce the toxicity, mobility or volume of contaminants; it only reduces the risk of human exposure. The effectiveness of this process depends on continued upkeep of the barriers.

Preliminary Screening: Retained.

Secondary Screening: Rejected; effectiveness.

Effectiveness: Physical restrictions are only effective at the point of ground-water withdrawal or use. Because ground water is not withdrawn for potable use at the Rowe site, physical restrictions at the site would do nothing to reduce the primary exposure route of ingesting contaminated ground-water, to reduce the level of contaminants in the ground water or to reduce contaminant migration.

Implementability: Physical restrictions are already in place at the site, therefore, this process is easily implementable.

Cost: No capital; no O&M.

A.2.2 Ground-Water Monitoring

A.2.2.1 Periodic Ground-Water Monitoring

Description: Ground-water samples are collected and analyzed on a routine basis.

Applicability: This process is applicable to all sites with contaminated ground water.
Preliminary Screening: Retained.

Secondary Screening: Retained.

Effectiveness: This process is useful for documenting site conditions, but does not reduce risk by itself.

Implementability: Periodic ground-water monitoring is easy to implement as long as the site is owned by the current owner.

Cost: Very low capital, low to moderate O&M.

A.2.2.2 Continuous Ground-Water Monitoring

Description: This process involves automated screening of ground water on a continuous basis using remote sampling and analysis techniques.

Applicability: This process is applicable to all sites with contaminated ground water.

Preliminary Screening: Retained.

Secondary Screening: Rejected; implementability and cost.

Effectiveness: This process is useful for documenting conditions, but does not reduce risk by itself.

Implementability: Continuous ground-water monitoring is a difficult process to implement and maintain.

Cost: Moderate capital, low to moderate O&M.

A.3 Containment

A.3.1 Vertical Barrier

A.3.1.1 Slurry Wall

Description: Vertical slurry-cutoff walls are erected to divert ground-water flow. The walls are constructed by excavating a narrow trench using an engineered fluid for wall stabilization and back filling with soil-bentonite, cement-bentonite or composite slurries.

Applicability: This process is useful for containing floating contaminants, such as fuel oil, within a bermed area.

Preliminary Screening: Rejected; floating contaminants are not a concern at the Rowe site.

A.3.1.2 Grout Curtain

Description: A vertical grout curtain is erected to divert ground-water flow.

Applicability: This process is useful for containing floating contaminants, such as fuel oil, within a bermed area.

Preliminary Screening: Rejected; floating contaminants are not a problem at the Rowe site.

A.3.1.3 Vibrating Beam

Description: A hollow beam is installed which is vibrated into position and slowly removed as grout is pumped down the hollow center.

Applicability: This process is useful for containing floating contaminants, such as fuel oil, within a bermed area.

Preliminary Screening: Rejected; floating contaminants are not a problem at the Rowe site.

A.3.2 Horizontal Barrier

A.3.2.1 Grout Injection

Description: A horizontal barrier is installed by grout injection to divert ground-water flow.

Applicability: This process is useful for restricting the vertical transport of contaminants.

Preliminary Screening: Rejected; vertical transport of contaminants in the saturated zone is not a major mechanism of contaminant transport at the Rowe site.

A.4 Extraction

A.4.1 Pumping

A.4.1.1 Recovery Wells

Description: Wells are used to recover contaminated ground water. Wells that may be used include, but are not limited to, existing wells, new wells, and well points.

Applicability: This process is useful for recovering contaminated ground water for treatment or discharge or both.

Preliminary Screening: Retained.

Secondary Screening: Retained.

Effectiveness: This process is effective in recovering contaminated ground water resulting in ultimate contaminant reduction.

Implementability: This process is easily implemented by conventional construction techniques, but local approvals or permits may be required.

Cost: Moderate capital, low O&M.

A.4.1.2 Collector Trench

Description: A collector trench is used to recover ground water.

Applicability: This process is useful for recovering contaminated ground water for treatment or disposal or both.

Preliminary Screening: Retained; potentially applicable.

Secondary Screening: Rejected; implementability and cost.

Effectiveness: This process is effective in recovering contaminated ground water resulting in ultimate contaminant reduction.

Implementability: This process utilizes conventional and sometimes specialized construction techniques and local approvals or permits may be required. May not be possible to construct trench to the required depth.

Cost: High capital, low O&M.

A.5 Treatment

A.5.1 No Treatment

A.5.1.1 No Treatment

Description: Ground water is collected, but not treated before discharge.

Applicability: This process can be used with all waste waters that do not require treatment prior to discharge.

Preliminary Screening: Rejected; there is no acceptable discharge point to receive the untreated ground water.

A.5.2 Liquid/Liquid Separation

A.5.2.1 Solvent Extraction

Description: Miscible liquids are partitioned by adding a third liquid that is a solvent to one of the liquids, but is insoluble to the other.

Applicability: This process is applicable to waste waters containing miscible organics.

Byproducts: Spent solvents are produced which require disposal.

Limitations: Complete separation is rarely achieved, so that some form of post treatment is required for each separated stream. To effectively recover solvents and solutes from the process, other treatments are needed such as distillation or stripping.

Preliminary Screening: Retained.

Secondary Screening: Rejected; effectiveness, implementability and cost.

Effectiveness: This process is effective at treating waste streams only to the parts per million (ppm) range and would, therefore, require secondary treatment to meet the remedial objective. This process is not compatible with the projected waste stream.

Implementability: This process requires secondary treatment to meet the remedial objective.

Cost: Moderate capital; very high O&M.

A.5.2.2 Oil/Water Separation

Description: The influent water is introduced to an oil/ water separator, a specially designed tank conducive to phase separation in liquids. The immiscible oil/water mix is allowed to settle so that liquid/liquid separation occurs. The oil is then skimmed off for recovery, and the water is discharged.

Applicability: Wastewaters containing immiscible oils can be treated by this process.

Byproducts: Recovered oil which can be recycled and water which may require further treatment are produced by this process.

Benefits: Treatment systems are available that require no chemicals, absorbents, filter cartridges and have no moving parts. The system performance does not depend on the skill of the operator, and little maintenance is required.

Limitations: Gravity separation is dependent upon the density of the immiscible oil and diameter of oil droplets (Stokes' Law). The treatment efficiency will decrease if the wastewater contains compounds that interfere with the coalescing process.

Preliminary Screening: Rejected; there are no free-phase immiscible oils or fluids at the Rowe site.

A.5.2.3 Freezing

Description: The waste stream is slowly frozen to promote the formation of ice crystals which naturally exclude all contaminants from the ice crystal matrix. Therefore, when water containing hazardous waste is cooled below its freezing point, pure water crystallizes and may be physically separated from the hazardous constituents. This process uses a secondary freezing concept, i.e., the refrigerant does not come into direct contact with the contaminated solution and, therefore, does not have to be separated from the waste stream.

Applicability: Liquid wastes containing ions, metals, halogenated solvents, aromatic solvents, and pesticide rinse waters are suitable for this process. Four potential sites for the CBI Freeze demonstrations are under EPA
review for hazardous waste applications.

Limitations: The flow rate per unit is less than 20 gpm (gallons per minute) and a full time attendant is required.

Preliminary Screening: Retained.

Secondary Screening: Rejected; effectiveness, implementability and cost.

Effectiveness: The flow rates are too low to treat the projected waste stream effectively.

Implementability: This process is very difficult to implement due to the need for skilled personnel to operate the equipment on a 24-hour basis.

Cost: Very high capital; very high O&M.

A.5.3 Solids Removal

A.5.3.1 Filtration

Description: Suspended solids are removed from a liquid by passing the liquid through a porous medium.

Applicability: Wastewaters containing suspended solids can be treated with this process.

Byproducts: Sludge is produced which may require treatment prior to disposal.

Benefits: Various media are available; some are capable of removing particles less than 1 micron in diameter.

Limitations: Contaminants may build up (fouling) which will decrease the hydraulic capacity of the filter.

Preliminary Screening: Retained.

Secondary Screening: Retained.

Effectiveness: This process is effective in removing suspended solids.

Implementability: Can be used as a pretreatment to prevent fouling of other treatment equipment.

Cost: Low capital, low O&M.

A.5.3.2 Evaporation

Description: Evaporation is the physical separation of a liquid from dissolved as well as suspended solids. The process involved the application of energy to evaporate the liquid.

Applicability: This process can be used to treat any mixture of liquids and nonvolatile solids provided the liquid is volatile enough to evaporate under reasonable heating or vacuum conditions (both the liquid and solid should be stable under those conditions).

Byproducts: Residual solids are produced which may require treatment before disposal.

Preliminary Screening: Rejected; evaporation is effective at treating waste water containing solids at low flow rates. The process is not designed to treat dilute solutions at high flow rates typical of the ground water that would be recovered at the Rowe site.

A.5.3.3 Sedimentation/Clarification

Description: Wastewater is introduced to a containment vessel (clarifier) where heavy solids settle by gravity and collect at the bottom of the vessel resulting in liquid/ solid separation.

Applicability: Solids with a specific gravity greater than water.

Benefits: Flocculation and clarification can be combined with the aid of chemical coagulants. Parallel coalescing plates can be used to aid in settling, and thereby, reduce the time required by conventional clarifiers.

Limitations: This process is not suitable for wastes containing emulsified water.

Byproducts: Sludge is produced which may require treatment before disposal.

Preliminary Screening: Retained.

Secondary Screening: Rejected; cost.

Effectiveness: This process is effective at removing suspended solids.

Implementability: This process can be easily implemented as a pretreatment to prevent fouling of other treatment equipment.

Cost: Moderate to high capital, low O&M.

A.5.3.4 Centrifugation

Description: Components of a fluid mixture are separated, based on their relative density, by rapidly rotating the fluid mixture within a rigid vessel.

Applicability: This process can be used for dewatering sludges, separating oils from water, clarification of viscous gums and resins.

Byproducts: Sludge is produced which may require treatment before disposal.

Limitations: Centrifuges often cannot be used for clarification since they may fail to remove less dense solids and those which are small enough to remain in suspension.

Preliminary Screening: Rejected; centrifugation is effective at dewatering sludges. The process is not designed to treat dilute solutions at high flow rates typical of the ground water that would be recovered at the Rowe site.

A.5.3.5 Flocculation

Description: The wastewater is mixed with a flocculating chemical. Flocculants adhere to suspended solids so the resultant particles are too large to remain in suspension and settle out. This process is used in conjunction with sedimentation/clarification (see Section A.5.3.3).

Applicability: Wastewater containing suspended solids (primarily inorganics) can be treated with this process.

Byproducts: Sludge is produced which may require treatment before disposal.

Limitations: The time required for complete flocculation is dependent upon the flow rate of the waste stream and the composition and pH of the waste stream. This process is not recommended for high viscosity waste streams.

Preliminary Screening: Retained.
Secondary Screening: Rejected; cost.

Effectiveness: This process is effective at removing suspended solids.
Implementability: This process can be easily implemented as a pretreatment to prevent fouling of other treatment equipment.
Cost: Moderate capital, low O&M.

A.5.3.6 Dissolved Air Flotation

Description: Wastewater is treated in a dissolved air flotation chamber. Dissolved air is precipitated out of solution to form micro bubbles which adhere onto small particles causing them to float. A skimmer then removes the floating waste.

Applicability: Wastewater containing solids with densities close to water can be treated with this process.

Byproducts: Sludge and off gases are produced which may require treatment before discharge or disposal.

Preliminary Screening: Retained.
Secondary Screening: Rejected; cost.

Effectiveness: This process is effective at removing suspended solids.
Implementability: This process can be easily implemented as a pretreatment to prevent fouling of other treatment equipment.
Cost: Moderate capital, low O&M.

A.5.4 Chemical Treatment

A.5.4.1 Chemical Precipitation

Description: The pH of an aqueous waste stream is adjusted to the point of a metal's minimum solubility. At this point the dissolved metal ions form a solid which precipitates out of solution, usually as a hydroxide molecule.

Applicability: Wastewater containing dissolved metals can be treated with this process.

Limitations: Pretreatment is sometimes required to remove substances that interfere with the precipitation process. Cyanide and ammonia form complexes with many metals that limit the removal achieved by precipitation.

Byproducts: Metal hydroxide sludge is produced which may require treatment prior to disposal.

Preliminary Screening: Rejected; dissolved metals concentrations in the ground water are not the primary concern at the Site.

A.5.4.2 Chemical Oxidation

Description: Oxidants, such as chlorine, ozone, hydrogen peroxide and potassium permanganate are introduced to a wastewater to oxidize contaminants to terminal end products or to intermediate products that are more readily biodegradable or more readily removed by adsorption. This process may be enhanced by ultra violet light.

Applicability: Wastewater with low concentrations of organic compounds, dissolved iron and manganese, phenols and odorous contaminants can be treated with this process.

Benefits: If carried to completion, the reaction products of hydrocarbon oxidation are carbon dioxide and water. No vapor emissions or solid residue remain.

Limitations: The effectiveness is pH and catalyst dependent, and also depends on the type and concentration of organic contaminants, the light transmittance of the wastewater, the UV and hydrogen peroxide dosage and the mixing efficiency.

Byproducts: No hazardous byproducts are produced.

Preliminary Screening: Retained; potentially applicable.

Secondary Screening: Rejected; cost.

Effectiveness: Unsaturated chlorinated compounds are easily treated by this process.

Implementability: This process can be easily implemented and requires no supervision.

Cost: High capital, low O&M.

A.5.4.3 Wet Air Oxidation

Description: Wet air oxidation destroys organics in wastewater by breaking down complex molecular structures into simpler components. Organics are oxidized in the absence of flames, in water, at pressures of 500 to 3,000 psig.

Applicability: Organic wastewater too dilute to incinerate economically and too toxic to biologically treat can be treated with this process.

Preliminary Screening: Retained.

Secondary Screening: Rejected; cost.

Effectiveness: Effective at treating dilute organic waste streams.

Implementability: This process is easily implementable.

Cost: High capital, high O&M.

A.5.4.4 Hydroxyl Radical Treatment

Description: Municipal sewage or industrial effluents that contain from as low as 0.1 percent to as high as 10 percent salt (NaCl) are passed through reactor electrodes to liberate nascent chlorine, ozone and their respective hydroxyl/free radicals. These agents destroy, neutralize and oxidize all oxidizable organics. This process also sterilizes the wastewater and removes color and odors, rendering the effluent safe and legal to be disposed of.

Applicability: Wastewater containing oxidizable organics (PCBs, dioxin, carbon tetrachloride, toluene, etc.) can be treated with this process.

Benefits: Rock salt can be added to increase the salt concentration. No other chemicals are required. Treatment systems can be designed for flow rates of up to 4,000 gpm.

Preliminary Screening: Retained.

Secondary Screening: Rejected; effectiveness, implementability and cost.

Effectiveness: The effectiveness of this process can not be guaranteed due to the refractory nature of PCE.

Implementability: This process is easy to install but daily cleaning is required.

Cost: High capital, moderate O&M.

A.5.5 Gas-Phase Separation

As a general rule, compounds having Henry's Law Constant greater than 10^{-3} atm m^3/mol are "easy to strip". Those with Henry's Law Constants between 10^{-3} and 10^{-4} atm m^3/mol are "difficult to strip", and below 10^{-4} atm m^3/mol are "non-strippable".

A.5.5.1 Spray Aeration

Description: Wastewater is pumped through spray nozzles that break the liquid stream into fine droplets. The volatile contaminants in the wastewater volatilize into the vapor phase via mass transfer processes. The wastewater can injected into the open air or into a tower to provide contact between the atmospheric air and the water.

Applicability: Wastewater containing contaminants with high volatility (high Henry's Law Constant) can be treated with this process (see Section A.5.5).

Byproducts: This process produces air emissions which may require treatment.

Preliminary Screening: Retained.

Secondary Screening: Rejected; effectiveness.

Effectiveness: This process is limited to a maximum removal efficiently of 90 percent.

Implementability: This is a proven and established process that is easily implementable.

Cost: Moderate capital, low to moderate O&M.

A.5.5.2 Mechanical Aeration

Description: The volatile contaminants in the wastewater volatilize into the vapor phase via mass transfer processes. Air is introduced to the wastewater by mechanical means. The contents of a tank are circulated providing continuous contact between the atmospheric air and the water.

Applicability: Wastewater containing contaminants with high volatility (high Henry's Law Constant) can be treated with this process (see Section A.5.5).

Byproducts: This process produces air emissions which may require treatment.

Benefits: A model is available that is self-cleaning and can handle up to 15 mgd (millions gallons per day). Aerators utilize water falling through a rotor for aspiration and rotation. An air flow damper is provided for control of oxygen input and evaporation.

Preliminary Screening: Retained.

Secondary Screening: Rejected; effectiveness.

Effectiveness: This process is limited to a maximum removal efficiency of 90 percent.

Implementability: Proven and established process that is easily implementable.

Cost: Moderate capital, low to moderate O&M.

A.5.5.3 Packed Tower Aeration

Description: Volatile contaminants in the wastewater volatilize into the air phase via mass transfer processes. Mass transfer takes place in a stripping tower filled with a packing material with a large surface area. The water flows down through the packed bed, exposing a large surface area for mass transfer into the air which enters at the bottom of the tower. Packing material can be randomly dumped or stacked in the column.

Applicability: Wastewater containing contaminants with high volatility (high Henry's Law Constant) can be treated with this process (see Section A.5.5).

Byproducts: This process produces air emissions which may require treatment.

Benefits: This process is available with air emission control devices. Removal efficiencies in excess of 99.9 percent are possible.

Limitations: Mineral oxidation may result in the accumulation of precipitates in the packing. To prevent this, the packing must be cleaned and changed periodically. The stripping efficiency will vary with changes in the ambient temperature as well as the presence of suspended solids in the waste stream.

Preliminary Screening: Retained.

Secondary Screening: Retained.

Effectiveness: This process is effective in removing 99.99 percent of PCE in the waste stream.

Implementability: Commercially available and readily implementable.

Cost: Moderate capital, low to moderate O&M.

A.5.5.4 Tray Aeration

Description: Volatile contaminants in the wastewater are volatilized into the air phase via mass transfer processes. Mass transfer takes place in a stripping tower filled with regularly spaced trays or plates allowing for staged contact between the liquid and vapor phases. The vapor passes through openings in each tray and contacts the liquid flowing across the tray. A quantity of liquid is retained on each tray by a weir. To reach the next stage, the liquid flows over the weir through a downcomer which provides sufficient volume and enough residence time for the liquid to be freed of entrained vapor before entering the next tray.

Applicability: Wastewater containing contaminants with high volatility (high Henry's Law Constant) can be treated with this process (see Section A.5.5).

Byproducts: This process produces air emissions which may require treatment.

Preliminary Screening: Retained.

Secondary Screening: Rejected; effectiveness.

Effectiveness: This process is effective for treating chlorinated solvents, however it is generally less efficient than packed tower aeration.

Implementability: Proven and established process that is easily implementable.

Cost: Moderate capital, low to moderate O&M.

A.5.5.5 Diffused Aeration

Description: Volatile contaminants in the wastewater are volatilized into the air phase via mass transfer processes. Air is injected into the wastewater using a sparging device or porous diffusers which produce a multitude of fine bubbles. As the bubbles rise, mass transfer occurs across the water-air interface until the bubble either leaves the water column or becomes saturated with the contaminant.

Applicability: Wastewater containing contaminants with high volatility (high Henry's Law Constant) can be treated with this process (see Section A.5.5).

Byproducts: This process produces air emissions which may require treatment.

Preliminary Screening: Retained.

Secondary Screening: Rejected; effectiveness and implementability.

Effectiveness: This process is limited to a maximum removal efficiency of 90 percent for PCE.

Implementability: This process has generally not been designed with the intent to remove volatile organics.

Cost: Moderate capital, moderate O&M.

A.5.5.6 Steam Stripping

Description: Steam is used to evaporate volatile organics from wastewater. This process operates like an air stripper, only steam is used instead of air.

Applicability: Wastewater containing compounds less volatile and more soluble than those for which air stripping is applicable (see Section A.5.5) can be treated with this process. This process is most effective for low continuous flows or batch treatment of concentrated volatile organic aqueous mixtures.

Benefits: Products of treatment are high quality water and a very small volume of nearly 100 percent liquid organic compounds.

Byproducts: This process produces air emissions and contaminated steam condensate which may require treatment.

Preliminary Screening: Rejected; this process is designed to volatilize contaminants at low flow rates. The process is not designed to treat dilute solutions at high flow rates typical of the ground water that would be recovered at the Rowe site.

A.5.5.7 Distillation

Description: Wastewater is evaporated and condensed to separate out volatile organics.

Applicability: Wastewater containing miscible organic solvents can be treated by this process.

Byproducts: Sludge and recovered contaminants are produced which may require treatment before disposal.

Limitations: Distillation for recovery can be limited by the presence of either volatile or thermally reactive suspended solids.

Preliminary Screening: Rejected; this process is designed to separate concentrated solutions at low flow rates. The process is not designed to treat dilute solutions at high flow rates typical of the ground water that would be recovered at the Rowe site.

A.5.6 Adsorption

Description: Wastewater is brought in contact with an adsorbent by a variety of means. Contaminants in the wastewater adhere to the surface of the adsorbent medium, and the wastewater is discharged.

A.5.6.1 GAC Adsorption

Description: Wastewater is passed through a bed of activated carbon. Organics in the wastewater adsorb onto the carbon.

Applicability: Wastewater containing organic chemicals with low solubility, certain metals, total organic carbon (TOC) and ammonia can be treated with this process.

Byproducts: Spent carbon is produced which requires disposal or regeneration.

Benefits: This process offers both adsorption and filtration. Segregated carbon regeneration is available.

Limitations: To control carbon expenditure, rule of thumb guidelines indicate that concentrations of organic solutes, suspended solids, dissolved inorganics and oil and grease should be less than 10,000, 50, 10 and 10 ppm, respectively. When daily carbon usage approaches a thousand pounds per day, onsite carbon regeneration may become cost effective (capital cost - $1,000,000 for a 2,000 pound per day regeneration system).

Preliminary Screening: Retained.

Secondary Screening: Retained; effectiveness.

Effectiveness: Very effective at treating dilute waste streams containing volatile organic compounds (VOCs).

Implementability: Easily implemented, however disposal or regeneration facilities may not be readily available.

Cost: Moderate capital, moderate O&M.

A.5.6.2 Resin Adsorption

Description: Wastewater is passed through a vessel containing an adsorptive media onto which cations and anions adsorb. Typical media include aluminum oxides, iron oxides, silica, clays and synthetic zeolites and resins.

Applicability: Wastewater containing metal cations and anions can be treated with this process.

Limitations: The process is highly pH dependent; the pH must be monitored closely.

Byproducts: Spent sorbents are produced which require disposal or regeneration.

Preliminary Screening: Retained.

Secondary Screening: Rejected; implementability and cost.

Effectiveness: Effective for treating groundwater containing metal cations.

Implementability: Because this technology is highly dependent on pH, continuous monitoring and adjustment is required.

Cost: High capital; moderate to high O&M.

A.5.6.3 Ion Exchange

Description: Wastewater is passed through a bed of ion exchange resin. Non-hazardous ions on the resin are exchanged for hazardous ions in the wastewater.

Applicability: Wastewater containing toxic metals can be treated with this process.

Byproducts: Spent resin and spent regenerants (acid, caustic or brine) are produced which require disposal or regeneration.

Limitations: The efficiency of this process is affected by selective competition, pH and suspended solids. Concentrated (25,000 mg/l contaminants) waste streams can usually be separated more cost effectively by other means. High solids concentrations (greater than about 50 mg/l) may cause resin blinding.

Preliminary Screening: Retained.

Secondary Screening: Rejected; implementability and cost.

Effectiveness: Effective for treating groundwater containing metal cations.

Implementability: Because this technology is highly dependent on pH, continuous monitoring and adjustment is required.

Cost: High capital; moderate to high O&M.

A.5.7 Membrane Filtration

A.5.7.1 Membrane Filtration

Description: Wastewater flows across a membrane surface. Water and low molecular weight solutes pass through the membrane and are removed as permeate. Emulsified oils and suspended solids are rejected by the membrane and are removed as concentrate.

Applicability: Wastewater containing emulsified oils and suspended solids can be treated by this process.

Byproducts: A concentrated solution is produced which may require further treatment.

Benefits: Cross flow prevents filter cake build up, and high filtration rates can be maintained continuously.

Preliminary Screening: Rejected; the ground water at the Rowe site does not contain emulsified oils.

A.5.7.2 Reverse Osmosis

Description: A pressurized semi-permeable membrane attracts contaminants from a dilute waste stream to a more concentrated solution (opposite of normal osmosis).

Applicability: Wastewater containing dissolved organics and dissolved salts can be treated with this process.

Byproducts: A concentrated solution is produced which may require further treatment.

Limitations: For an efficient reverse osmosis process, the chemical and physical properties of the semi-permeable membrane must be compatible with the waste stream's chemical and physical characteristics. Some membranes may be dissolved by certain wastes. Suspended solids and certain organics will clog the membrane material, and low-solubility salts may precipitate onto the membrane surface. A very high quality feed is required to operate a reverse osmosis unit efficiently. The pH of the feed should be adjusted to a range of 4.0 to 7.5 to inhibit scale formation.

Preliminary Screening: Rejected; this process is not applicable to the waste stream at the Rowe site.

A.5.7.3 Electrodialysis

Description: Wastewater is passed through alternately placed cation-permeable and anion-permeable membranes. The ions in the water are separated and concentrated.

Applicability: Wastewater containing brackish water and metal salts (metal plating rinse water) can be treated with this process.

Byproducts: A concentrated ionic solution is produced which may require further treatment.

Preliminary Screening: Rejected; this process is not applicable to the waste stream at the Rowe site.

A.5.8 Anaerobic Digestion

Description: Organic wastes are reduced to methane and carbon dioxide in an anaerobic environment.

Applicability: Organic wastes with both high and low nutrient concentrations can be treated by this process. It is particularly useful for the stabilization of concentrated sludges produced during wastewater treatment.

Byproducts: Methane, carbon dioxide and sludge are produced by this process.

Benefits: Nutrient requirements are lower than aerobic treatment systems.

Limitations: Slow growth rate of methanogenic bacteria requires a retention time of 15 to 60 days. Operational problems result from imbalances of microbial populations. The system requires close supervision, and cannot be shut down for extended periods of time (two weeks or longer).

Preliminary Screening: Rejected; the process is not applicable to the waste stream at the Rowe site. This waste stream contains low concentrations of organics and is not suitable to promote or maintain biological growth and activity. Also, biological processes require continuous operating conditions which can not be guaranteed.

A.5.8.1 Anaerobic Contact Process

Description: Wastewater is mixed in a contact chamber and then passed through a degasifier and a clarifier. The solids from the clarifier are recycled to the contact chamber, and the water is discharged. The hydraulic retention time is between 6 and 12 hours.

Preliminary Screening: Rejected; see Section A.5.8.

A.5.8.2 Anaerobic Filter (Packed Bed)

Description: Wastewater is passed, by upflow or downflow, through a packed filter media. The filter media, in addition to retaining biological solids, also provides a mechanism for separating the solids and the gas produced in the digestion process. Off gases are vented and treated and the water is recycled and discharged.

Preliminary Screening: Rejected; see Section A.5.8.

A.5.8.3 Upflow Anaerobic Sludge Bed Reactor

Description: Wastewater is directed to the bottom of a reactor where it must be distributed uniformly. The wastewater flows upward through a blanket of biologically formed granules which consume the waste as it passes through the blanket. Methane and carbon dioxide gas bubbles rise and are captured in a gas dome. Liquid passes into the settling portion of the reactor where solid-liquid separation takes place. The solids return to the blanket area while the liquid exits over weirs.

Preliminary Screening: Rejected; see Section A.5.8.

A.5.8.4 Fluidized Bed Reactor

Description: Wastewater is pumped upward through a sand bed on which microbial growth has been developed. Recycle of effluent is returned to mix with the influent in quantities dictated by the strength of the wastewater and the required fluidization velocity.

Preliminary Screening: Rejected; see Section A.5.8.

A.5.8.5 ADI-BVF Process

Description: Wastewater is passed through a low-rate anaerobic reactor with intermittent mixing and sludge recycling. The reactor has two zones: a reaction zone at the inlet end and a clarification zone at the outlet end. The reactor can be an above-ground tank or a lined earthen basin with a floating insulated membrane cover for gas recovery and temperature and odor control. Because of the large reactor volume, equalization requirements are minimized.

Preliminary Screening: Rejected; see Section A.5.8.

A.5.8.6 Baffled Reactor

Description: Wastewater is passed through a contact chamber containing a series of baffles. Solids are retained by the baffles and the treated liquid is recirculated or discharged.

Preliminary Screening: Rejected; see Section A.5.8.

A.5.9 Aerobic Digestion:

Description: Organic wastes are broken down to carbon dioxide and water in an aerobic environment.

Applicability: Organic wastes with high nutrient concentrations can be treated by this process.

Byproducts: Carbon dioxide, water and sludge are produced.

Limitations: All microorganisms require adequate levels of inorganic and organic nutrients, water, oxygen, carbon dioxide, and sufficient biological space for survival and growth. Aerobic degradation is usually carried out in processes in which all or many of the requisite environmental conditions can be controlled. To continue to produce and function properly, an organism must have a source of energy and carbon for the synthesis of new cellular material: carbon dioxide and/or organic matter.

Preliminary Screening: Rejected; process is not applicable to the waste stream at the Rowe site. This waste stream contains low concentrations of organics and is not suitable to promote or maintain biological growth and activity. Also, biological processes require continuous operating conditions which can not be guaranteed.

A.5.9.1 Complete Mix Activated Sludge

Description: Wastewater and sludge are mixed by an agitator in an aeration chamber. The effluent is passed to a clarifier where the sludge is collected and recycled to the aeration chamber, and the liquid is discharged.

Applicability: Refractory wastewater; process provides a buffer for shock loads (organics, pH, etc.).

Preliminary Screening: Rejected; see Section A.5.9.

A.5.9.2 Plug Flow Reactor

Description: Wastewater and sludge are passed through an aeration chamber, but do not mix. The effluent is passed to a clarifier where the sludge is collected and recycled to the aeration chamber and the liquid is discharged.

Limitations: Control of water quality variations is needed.

Preliminary Screening: Rejected; see Section A.5.9.

A.5.9.3 Fixed Film Reactor

Description: Microorganisms degrade organic contaminants which are immobilized in a submerged, fixed film bioreactor.

Applicability: Organic wastes with high nutrient concentrations can be treated by this process.

Limitations: A proper environment for microorganisms must be maintained (i.e., dissolved oxygen levels, pH, and concentration of inorganic nutrients).

Preliminary Screening: Rejected; see Section A.5.9.

A.5.9.4 Pact Process

Description: This process uses a combination of biological treatment, powdered activated carbon treatment (PACT), and wet air oxidation.

Applicability: This process is applicable to both municipal and industrial wastewater containing organic contaminants. The literature indicates that this process is most suitable to waste streams with high organic concentrations, high BOD and high COD.

Benefits: The biomass is protected against toxic upset. The combination of physical adsorption with biological oxidation and assimilation in the PACT system has been shown to be particularly effective in treating dilute wastewater which is variable in concentration and composition, highly colored, or contains materials that are refractive or poten-tially toxic to biological growth.

Limitations: The performance depends on the amount of carbon carried in the aerator and the solids residence time of the system. The upper limit of waste strength for an aerobic PACT system may be approximately 50 g/l (waste strength must exceed 50 mg/l).

Preliminary Screening: Rejected; see Section A.5.9.

A.6 Discharge

A.6.1 Discharge to Treatment Works:

A.6.1.1 Discharge to Village of Sag Harbor POTW:

Description: The treated effluent is discharged to the Village of Sag Harbor publicly owned treatment works.

Preliminary Screening: Retained.

Secondary Screening: Rejected; implementability and cost.
Effectiveness: Potentially very effective as a discharge option.
Implementability: The Village of Sag Harbor has reported that the existing POTW cannot except this industrial discharge due to the current capacity.
Cost: High to very high capital, moderate O&M.

A.6.2 Discharge to Surface Water

A.6.2.1 Discharge to Ligonee Brook

Description: The treated effluent is discharged to the Ligonee Brook.

Limitations: A SPDES permit must be obtained for discharge.

Preliminary Screening: Retained; potentially applicable.

Secondary Screening: Retained.
Effectiveness: Potentially very effective as a discharge option.
Implementability: Easily implementable using standard construction techniques. A SPDES permit is required.
Cost: Low to moderate capital, low O&M.

A.6.2.2 Discharge to Sag Harbor Cove

Description: The treated effluent is discharged to the Sag Harbor Cove.

Limitations: A SPDES permit must be obtained for discharge.

Preliminary Screening: Retained; potentially applicable.

Secondary Screening: Retained.

Effectiveness: Potentially very effective as a discharge option.

Implementability: Easily implementable using standard construction techniques. SPDES permit is required.

Cost: Low to moderate capital, low O&M.

A.6.3 Discharge to Ground Water

A.6.3.1 Discharge to Injection Wells

Description: The treated effluent is discharged to injection wells to recharge the aquifer.

Preliminary Screening: Retained; potentially applicable.

Secondary Screening: Retained.

Effectiveness: Potentially very effective in replenishing the ground-water supply with treated waste water.

Implementability: Construction and operation of injection wells is a proven and well established technique and should be readily implementable at this site. The aquifer is capable of receiving large flows.

Cost: Moderate to high capital, moderate O&M.

A.6.3.2 Discharge to Leaching Galleries

Description: The treated effluent is discharged to leaching galleries to recharge the aquifer.

Preliminary Screening: Retained; potentially applicable.

Secondary Screening: Rejected; implementability and cost.

Effectiveness: This process is effective in high permeable soils.

Implementability: This process requires a large land area and is labor intensive.

Cost: High capital, very low O&M.

A.6.3.3 Discharge to Settling Basin

Description: The treated effluent is discharged to a settling basin to recharge the aquifer.

Preliminary Screening: Retained; potentially applicable.

Secondary Screening: Rejected; implementability and cost.

Effectiveness: This process is effective in high permeable soils.
Implementability: Requires a large land area.
Cost: Moderate capital, low O&M.

A.7 In-Situ Ground-Water Remediation

A.7.1 In-Situ Ground-Water Aeration

A.7.1.1 In-Situ Ground-Water Aeration (Air Sparging)

Description: Air is injected to the ground water through air injection wells. The air serves to strip volatile organics and enhance biological degradation.

Applicability: Ground water containing dissolved volatile organics can be treated with this process.

Benefits: Air increases the rate of natural biodegradation resulting in the decontamination of both soil and ground water.

Limitations: Laboratory studies must be made of the contaminated ground and ground water to determine the optimum conditions for maximum biodegradation.

Preliminary Screening: Retained.

Secondary Screening: Rejected; effectiveness, implementability and cost.

Effectiveness: This process would not be effective in remediating the ground water because of the depth and areal extent of contamination.

Implementability: This process would be very difficult to implement on a scale necessary to remediate the Rowe site.

Cost: Very high capital, very high O&M.

A.7.2 In-Situ Ground-Water Bioremediation

A.7.2.1 In-Situ Ground-Water Bioremediation

Description: In-situ ground-water bioremediation can be performed both aerobically or anaerobically using naturally-occurring microorganisms or adapted microorganisms that are injected into the ground water. Water enriched with nutrients and/or microorganisms is injected to the ground water if the aquifer is deficient in these materials. A source of oxygen, such as hydrogen peroxide, is added if aerobic bioremediation is to take place. A carbon source can be added if the total organic carbon level in the ground water is too low to sustain the microorganisms if anaerobic bioremediation is to take place. This recharge enriches a zone around ground-water wells, allowing microorganisms to oxidize metals and biodegrade organics.

Applicability: Ground water containing oxidizable metals and degradable organics can be treated with this process.

Limitations: This process is new, and its effectiveness has not been established for many types of contaminants.

Preliminary Screening: Retained.

Secondary Screening: Rejected; effectiveness and implementability.

Effectiveness: The degradation of PCE and TCE results in the formation of vinyl chloride. Vinyl chloride is more resistant to bioremediation than it's parent compounds, and vinyl chloride has a greater toxicity than the parent compounds (EBASCO, 1987 after Cline and Viste, 1984). Therefore, in-situ bioremediation may result in the conversion of TCE and PCE to vinyl chloride which would create a worse problem than already exists.

Implementability: Operating problems are common because of chemical precipitation and clogging of the aquifer material.

Cost: High capital, high O&M.

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ROWE INDUSTRIES SITE
SAG HARBOR, NEW YORK

Appendix B
Identification and Screening of Remedial Technologies for the Soil Medium

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1.0 No Action

1.1 No Action:

Description: No action is taken.

Applicability: For CERCLA feasibility studies, this process must be considered regardless of applicability.

Preliminary Screening: Retained; option must be retained.

Secondary Screening: Retained; option must be retained.

Effectiveness: Does not achieve remedial action objective.

Implementability: Not acceptable to local, state, or federal government.

Cost: None.

2.0 Institutional Actions

2.1 Access Restrictions:

2.1.1 Deed Notations:

Description: Deed notations are legally enforceable land use restrictions that are placed on a property. This process can be used to eliminate exposure to soil or ground water or both on properties where soil and ground-water contamination exists.

Applicability: This process is applicable in all jurisdictions that have deed restricting authority.

Limitations: This process alone does not reduce the toxicity, volume or mobility of contaminants. Deed notations can reduce the risk to human health by minimizing or eliminating exposure routes.

Preliminary Screening: Retained.

Secondary Screening: Retained.

Effectiveness: The effectiveness of deed notation is dependent on the continued future implementation. Deed notations do not reduce the levels of contamination or reduce contaminant migration.

Implementability: The implementability is dependent on local requirements and jurisdictional authority.

Cost: Very low capital, no O&M.

2.1.2 Physical Restrictions:

Description: The land use is physically restricted by erecting barriers to eliminate soil exposure routes.

Applicability: This process is applicable to all sites where site conditions and legal circumstances will permit the construction of physical barriers.

Limitations: This process alone does not reduce the toxicity, mobility or volume of contaminants; it only reduces the risk of human exposure.

Preliminary Screening: Retained.

Secondary Screening: Retained.

Effectiveness: Physical restrictions are effective in reducing the human health exposure risks by limiting the exposure paths. Physical restrictions do not reduce the levels of contamination or reduce contaminant migration.
Implementability: Physical restrictions could be constructed around the soils disposal area very easily.
Cost: Low capital, very low O&M.

2.2 Monitoring:

2.2.1 Periodic Soil Monitoring/Sampling:

Description: Soil samples are collected and analyzed on a routine basis.

Applicability: This process is applicable to all sites where soil contamination exists.

Preliminary Screening: Retained.

Secondary Screening: Retained.
Effectiveness: This process is useful for documenting site conditions, but does not reduce risk by itself.
Implementability: Periodic soil monitoring is easy to implement as long as access to the site can be assured.
Cost: Very low capital, low to moderate O&M.

3.0 Onsite Soil Remediation

3.1 Soil Incineration:

3.1.1 Mobile Rotary Kiln Incinerator:

Description: Excavated soil is thermally treated in a rotary kiln incinerator - a long inclined rotating oxidation chamber. Soil is fed into the high end of the chamber and tumbled as it passes through the chamber. The tumbling action provides efficient thermal destruction of the contaminants on the soil.

Applicability: This process is intended primarily for combustible solids, but liquids and gases may be coincinerated with solids. Combustible wastes include most types of solid, liquid and organic wastes.

Benefits: Organic contaminants are destroyed instead of transferred from one phase to another.

Byproducts: High particulate and acid gas emissions require removal through a gas scrubber.

Preliminary Screening: Retained.

Secondary Screening: Rejected; implementability and cost.

Effectiveness: Incineration is capable of treating the VOCs in the soil at the SHI site.

Implementability: High energy consumption and numerous mobilization and demobilization considerations. This technology is best suited for a larger volume of soil than at the SHI site.

Cost: High capital, low to moderate O&M.

3.1.2 Mobile Electric Fluid Wall Incinerator:

Description: Soil is excavated and fed to an onsite electric reactor. Carbon electrodes in the reactor heat the reactor core to incandescence (2,200°C (degrees Celsius)). Contaminants are broken down to non-hazardous compounds by heat.

Applicability: This process is used to treat soils containing combustible organics.

Byproducts: Off gases and ash are produced.

Preliminary Screening: Rejected; this technology is unproven in field applications.

3.1.3 Infrared Incineration:

Description: Excavated soil is thermally treated in an infrared incinerator. Infrared heat incinerates soil conveyed through the furnace on a woven wire belt where the soil is heated to between 500 and 1850°F (degrees Farenheit). Infrared energy is provided by silicon carbide resistance heating elements. Off gases are heated in a secondary combustion chamber (2300°C) to destroy gaseous contaminants. This process has been adapted to transportable installations with capacities of 150 lbs/hr (pounds per hour).

Applicability: This process is used primarily to treat solids, sludges and contaminated soils, but liquid or gaseous injection systems are also available.

Benefits: The quiescent combustion zone results in low particulate emissions and low gaseous pollutant emissions.

Preliminary Screening: Retained.

Secondary Screening: Rejected; cost.

Effectiveness: Incineration is capable of treating the VOCs in the soil at the Rowe site.

Implementability: High energy consumption and numerous mobilization and demobilization considerations.

Cost: High to very high capital, low to moderate operation and maintenance (O&M).

3.1.4 Plasma Incineration:

Description: Excavated soil is thermally treated in a plasma incinerator. The solid components are melted and cast or granulated for disposal, and the volatile compounds are vaporized and destroyed in an afterburner.

Applicability: Liquid and solid compounds can be treated by this process. It is most suitable for soils and sludges contaminated with metals and hard-to-destroy organic compounds.

Benefits: This technology can treat soils containing metals and hard-to-destroy organic compounds that lower temperature incineration processes cannot.

Limitations: This process is not capable of treating large quantities of waste and has not yet been used for hazardous waste cleanup.

Preliminary Screening: Retained.

Secondary Screening: Rejected; implementability and cost.

Effectiveness: This technology is capable of treating both VOCs and metals.

Implementability: The EPA is currently investigating plasma incineration technology for hazardous waste cleanup under the Superfund Innovative Technology Evaluation (SITE) program. This technology has not been proven in field applications.

Cost: Very high capital, high O&M.

3.1.5 Fluidized Bed Incineration:

Description: Slurries and sludges are thermally treated in a fluidized bed incinerator. Fluidized bed incinerators use a turbulent bed of granular material to improve the transfer of heat to the waste stream. Air is blown up through the bed to suspend the granular material. The heated granular material comes in contact with the waste introduced to the combustion chamber and effectively destroys it.

Applicability: Slurries and sludges can be treated with this, but not bulky wastes such as soil.

Limitations: The waste must have small homogeneous particle sizes, have a low sodium content, have a low heavy metal content and be fully destroyed at temperatures of 750 to 1000°C. Maintenance requirements are high for this process.

Byproducts: Particulate and gaseous emissions may require removal with a gas scrubber.

Preliminary Screening: Rejected; fluidized bed incineration technology is not suited for bulky wastes (soil).

3.1.6 Pyrolysis:

Description: Chemicals are degraded by heating the soil in the absence of oxygen. Soil is heated in a primary combustion chamber and off gases are destroyed in a secondary combustion chamber.

Applicability: Viscous liquids, sludges, solids, high-ash materials, salts and metals which contain combustible organics may be treated by this process.

Limitations: Auxiliary fuel is required and the process has a small waste capacity.

Byproducts: Ash is produced.

Preliminary Screening: Rejected; pyrolysis technology is inappropriate for the soil constituents to be treated at the Rowe site.

3.1.7 Low Temperature Treatment:

Description: Excavated soil is treated in a low temperature treatment unit. First the excavated soil is fed into a scalping screen to remove large material and debris (generally greater than 2 inches in diameter). The soil is then fed into a thermal processor where it is exposed to temperatures between 450 and 850°F (indirect heat) to volatilize the contaminants from the soil. Residence times range from 60 to 300 minutes. Units are available that can process more than 20,000 lbs/hr of contaminated soil. The off gases are recovered or incinerated in an after burner.

Applicability: Soils and sludges containing less than 10 percent organics with high boiling points, such as PCB's, can be treated by this process.

Benefits: This process uses much less fuel to treat soil than other incineration processes.

Limitations: Soils and sludges containing organics with very high boiling points and metals or containing organics in excess of 10 percent cannot be treated by this process.

Byproducts: Vapor phase volatile organics must be recovered or destroyed in an afterburner.

Preliminary Screening: Rejected; the soil at the Rowe site contains more than 10 percent organics.

3.1.8 Dehydration:

Description: A dehydration system is similar to the proven rotary drum dehydration concept.

Applicability: Organic compounds with boiling points of up to 800° F can be treated by this process.

Preliminary Screening: Retained.

Secondary Screening: Rejected; cost.

Effectiveness: This technology is capable of treating the VOCs in the soil at the Rowe site.

Implementability: High energy consumption and numerous mobilization and demobilization considerations.

Cost: High to very high capital, low to moderate O&M.

3.2 Biological Treatment:

3.2.1 Biological Land Farming/Composting:

Description: Excavated soil is seeded with bacteria and nutrients and stockpiled so biodegradation can occur. Soil homogenizer/mixer units condition excavated soil and control the microbial environment.

Applicability: This process is applicable for soils containing biodegradable organics.

Benefits: Contaminants are destroyed, not transferred from one media to another, but unlike other destructive processes, no fuel is required for biological treatment.

Byproducts: This process does not produce any harmful byproducts.

Preliminary Screening: Rejected; the soil at the Rowe site to be treated contains chlorinated solvents which are not readily biodegradable and cannot be treated by this process.

3.2.2 Liquid-Solid Contact Digestion:

Description: Excavated soil is biologically treated in a liquid-solid contact digester. First, sludges or soils contaminated with organic compounds are mixed with water and emulsifiers. The waste then undergoes aerobic biological treatment in a batch digester and is transferred to a polishing cell for final treatment. Following the completion of the process, the supernatant from the polisher is recycled to the primary contact tank, and the sludge is treated in land farms or reactors onsite.

Applicability: Sludges and soils containing halogenated and non-halogenated organic compounds, PCBs, dioxins and pesticides can be treated by this process.

Byproducts: Organic laden sludge is produced which must be treated or recycled.

Preliminary Screening: Rejected; the soil at the Rowe site to be treated contains chlorinated solvents which are not readily biodegradable and cannot be treated by this process.

3.2.3 White-Rot Fungus:

Description: This process is similar to Biological Land Farming/Composting except white-rot fungus is introduced to the excavated soil instead of bacteria. White-rot fungus is capable of treating harder-to-biodegrade wastes that cannot be treated by bacteria.

Applicability: This process is applicable for most soils containing aliphatic, aromatic and heterocyclic compounds, including: lindane, benzo(a)pyrene, DDT, TCDD and PCBs.

Byproducts: This process does not produce harmful byproducts.

Preliminary Screening: Rejected; white-rot fungus technology has not been proven in field applications.

3.2.4 Augmented Bioreclamation:

Description: Augmented bioreclamation uses a detergent leaching process to reduce the concentrations of biodegradable organics in excavated soil. First the leachate then the soil is fed through a bioreactor where selectively adapted cultures break down refractory components at accelerated rates. The remediated soil is then replaced in the excavation.

Applicability: Soils containing biodegradable organics can be treated by this process.

Byproducts: This process does not produce harmful byproducts.

Preliminary Screening: Rejected; the soil at the Rowe site to be treated contains chlorinated solvents which are not readily biodegradable and cannot be treated by this process.

3.3 Soil Stabilization/Solidification:

3.3.1 Lime Based Possolan Process:

Description: The contaminated soil is excavated, mixed with large amounts of siliceous material, combined with a settling agent such as lime or gypsum and placed in molds. The mixture then hardens, resulting in dewatered stabilized solidified blocks which are then buried back in the excavation or disposed of elsewhere.

Applicability: Soils containing metals, waste oils, and solvents can be stabilized with this process.

Benefits: This process produces a series of chemical reactions capable of dechlorination, oxidation, and immobilization of heavy metals.

Limitations: Borates, sulfates and carbohydrates interfere with the process. Curing time is necessary and the final product must be disposed of or used.

Byproducts: A solidified block of material is produced requiring disposal.

Preliminary Screening: Retained.

Secondary Screening: Rejected; implementability.

Effectiveness: This process is not intended to reduce the concentration of contaminants in the soil, however, it is effective in reducing the mobility of the contaminants at the Rowe site.

Implementability: This process is best suited for sites larger than the Rowe site. Implementability is difficult because of numerous mobilization/demobilization considerations.

Cost: Moderate to high capital, moderate O&M.

3.3.2 Portland Cement Possolan Process:

Description: The contaminated soil is excavated, mixed with large amounts of siliceous material, combined with a settling agent such as portland cement and placed in molds. The mixture then hardens, resulting in dewatered stabilized solidified blocks which are then buried back in the excavation or disposed of elsewhere.

Applicability: Soils containing metal cations, latex and solid plastic wastes can be stabilized with this process.

Limitations: Large amounts of dissolved sulfate salts or metallic anions such as arsenate or borates will hamper solidification. Organic matter, lignite, silt or clay will increase settling time. The process was designed for aqueous based wastestreams, not organic solvent based wastestreams. The waste must contain about 20 percent available water for the chemical reactions to work. The process is complex and is not as successful on low molecular weight organics such as alcohols, ketones and glycols.

Byproducts: A solidified block of material is produced requiring disposal.

Preliminary Screening: Rejected; the soil at the Rowe site to be treated contains organics which have been shown to be deleterious to the strength and stability of portland cement/concrete mixtures.

3.3.3 Asphalt-Based (Thermoplastic) Microencapsulation:

Description: The contaminated soil is excavated, heated, dried, mixed with an asphalt bitumen, paraffin or polyethylene matrix, and placed in molds. The mixture then hardens, resulting in dewatered stabilized solidified blocks which are then buried back in the excavation or disposed of elsewhere.

Applicability: Soils containing hazardous wastes that are complex and difficult to treat can be stabilized with this process.

Limitations: This process is not appropriate for waste with high water content, strongly oxidizing contaminants, anhydrous inorganic salts, tetraborates, iron and aluminum salts and organics with low molecular weights and high vapor pressures.

Preliminary Screening: Rejected; low molecular weight organics have been identified at the Rowe site.

3.3.4 Containment in Onsite Landfill:

Description: Excavated soil is placed in an onsite landfill which would conform to RCRA standards. Because the site is a CERCLA site, a RCRA permit is not required, however the landfill is required to meet all of the substantive requirements under RCRA.

Applicability: Soils containing chemicals that are not banned from landfilling under RCRA may be disposed of using this process.

Limitations: This process provides no treatment of soils, only containment. Extensive monitoring requirements must be followed for this process option.

Byproducts: Leachate from the landfill may require collection and treatment.

Preliminary Screening: Rejected; the site is not intended to serve as an on-site RCRA landfill. Establishment of an on-site RCRA landfill will limit potential future site usage. Furthermore, this process provides no treatment of soils and extensive monitoring requirements must be followed for this process option.

3.4 Chemical Extraction:

3.4.1 Soil Washing:

Description: Soil is sized to less than 1/4 inch by standard crushing and screening equipment and fed as a 30 percent solids slurry to a conditioning tank. In the conditioning tank, alkaline agents and surfactants are added to liberate the contaminants from the soil mineral particles. The clean soil is returned to the original excavation site, and the froth is dewatered with the contaminant-rich froth cake and incinerated, biodegraded, or dechlorinated.

Applicability: This process can treat organics and inorganics. Process rates for a full-scale facility can be varied from as low as 5 tons per day (tpd) to as large as 5,000 tpd depending on cleanup rate desired. Typically, for every 100 tons of contaminated soil treated on-site, approximately 90 tons of cleaned, washed soil can be replaced on-site with the remaining 10 tons requiring final disposition.

Limitations: This process is not effective for fine soils.

Preliminary Screening: Retained.

Secondary Screening: Rejected; cost.

Effectiveness: Soil washing can effectively remove organics and inorganics from soil. Well suited for sands and other porous materials.

Implementability: Soil washing is a field-proven technology. The technology is commercially available with technical support and trained field personnel.

Cost: Very high capital, low to moderate O&M.

3.4.2 Supercritical Water Oxidation:

Description: This oxidation process uses temperatures and pressures of supercritical water (above 374°C and over 218 atmospheres) to convert hazardous organics to carbon dioxide and other less harmful products. The sediments are fed to the oxidizer as a pressurized, heated slurry (20 to 40 percent solids). Pressurized oxygen and a source of organic fuel (required to provide the energy needs of the oxidation process) are also added to the oxidizer. In the oxidizer, chlorine atoms from chlorinated organics are transformed to chloride ions, nitrogen to nitrogen gas, sulfur to sulfates and phosphorous to phosphates. By adding cations (e.g., Na^+, Mg^{++}, Ca^{++}), inorganic salts are formed. The effluent from the oxidizer is then fed to a salt and sediment separator where solids are removed as a slurry.

Applicability: This process can treat soil containing organics including chlorinated organics.

Byproducts: Sludge and off gases are produced.

Preliminary Screening: Retained.

Secondary Screening: Rejected; cost.

Effectiveness: This technology is capable of treating the VOCs in the soil.

Implementability: High energy consumption and numerous mobilization and demobilization considerations.

Cost: High to very high capital, low to moderate O&M.

3.4.3 Liquified Gas Solvent Extraction:

Description: Liquified gases (propane or carbon dioxide) are used to remove organic constituents from excavated soils, sludges, and liquid wastes. The system uses vapor recompression and conventional distillation to recycle the solvents and concentrate the organic constituents.

Applicability: Soils, sludges and liquids containing organics can be treated by this process.

Benefits: The solvents used (i.e. CO_2, propane, etc.) have high solubilities for most listed hazardous organic compounds, are inexpensive, environmentally safe, and are easily separated from the oil, solids and water fractions that result from the extraction. May 8, 1990, liquefied gas solvent extraction listed as EPA "Best Demonstrated Available Technology" for treating hazardous wastes produced by United States petroleum refineries. There are no extraneous emissions.

Byproducts: Wastewater, spent solvents and concentrated organics are produced which must be recycled or disposed.

Preliminary Screening: Retained.

Secondary Screening: Rejected; implementability.

Effectiveness: This technology is capable of treating the VOCs in the soil.

Implementability: This technology is best suited for sites larger than Rowe because of the size of the equipment needed and the mobilization/demobilization effort required.

Cost: Moderate to high capital, low to moderate O&M.

3.4.4 Basic Extraction Sludge Treatment Process:

Description: The basic extraction sludge treatment process is used to dewater and de-oil contaminated sludges and soils. The process uses differences in chemical solubility of triethylamine (TEA) in water at different temperatures to break waste into three constituents: dischargeable water, oil and organics, and dry oil-free solids. Heavy metals are isolated by conversion to hydrated oxides which precipitate out and exit the process with the solids fraction. Mobil units are available with capacities of 24 to 90 cubic yards per day.

Applicability: Soil and sludge containing organics.

Benefits: This process costs less than incineration, releases no air emissions, and treats wet and dry wastes. Removal efficiencies of 99 percent or more depending on the number of extraction stages and matrix characteristics.

Byproducts: Wastewater and concentrated organics are produced which require disposal.

Preliminary Screening: Rejected; the soil at the Rowe site to be treated does not contain oil.

3.4.5 Heavy Media Separation:

Description: Heavy media separation is a process for separating two solid materials which have significantly different absolute densities. The mixed solids to be separated are placed into a fluid whose specific gravity is chosen or adjusted so that the lighter solids float while the heavier solids sink. Usually, the heavy media separating fluid is a suspension of magnetite in water. Magnetite can be easily recovered magnetically from rinsewaters and spills and then reused.

Applicability: Soils containing mixed solids of different densities can be treated using this process.

Limitations: The possibility exists of dissolving the solids. Solids of similar density to those whose separation is desired cannot be effectively treated by this process.

Byproducts: Wastewater is produced which requires disposal.

Preliminary Screening: Rejected; heavy media separation is not well suited at the Rowe site because the densities of the primary VOCs requiring treatment are not significantly different.

3.4.6 Solvent Extraction:

Description: Excavated soil is screened, dried, crushed and slurried with a solvent, surfactant or chelating molecule in a mixing extractor. The contaminants are extracted from the soil into the solvent. The treated soil is then separated and redried, and the spent solvent is recovered and treated for contaminant removal.

Applicability: Soils containing inorganic and as well as organic compounds can be treated by this process.

Benefits: Removal efficiencies as high as 99 percent (depending on the contaminant concentration and soil properties) can be achieved with this process.

Limitations: This process is not effective for fine soils. The amount of soil finer than 38 um should not exceed 20 to 30 percent by weight.

Byproducts: Spent solvent must be recovered and recycled or disposed of.

Preliminary Screening: Rejected; Obtaining a solvent or solvent mixture capable of extracting the contaminants of concern at the Rowe site is highly unlikely and may be prohibitively expensive.

4.0 In-Situ Soil Remediation

4.1 In-Situ Bioremediation:

Description: Microorganisms and nutrients are introduced to the soil so that aerobic or anaerobic biodegradation can occur. This process enhances the naturally occurring microbial growth by supplementing the soils with required nutrients and altering the environmental conditions.

Applicability: Soils containing biodegradable organics can be treated with this process. Benefits: This process can be used as a primary treatment method or in conjunction with other techniques to reduce ground-water contamination to acceptable levels.

Benefits: This process can be used as a primary treatment method or in conjunction with other techniques to reduce soil contamination to acceptable levels.

Limitations: The effectiveness of this process is site specific; it depends on the site microbiology, hydrogeology and chemistry. Remediation time is longer using this process than most other in-situ processes.

Byproducts: No hazardous byproducts are produced with this process.

Preliminary Screening: Rejected; the soil at the Rowe site to be treated contains chlorinated solvents which are not readily biodegradable and cannot be treated by this process.

4.2 In-Situ Containment/Encapsulation:

4.2.1 Slurry-Cutoff Walls:

Description: Subsurface water flow is contained by installing vertical slurry-cutoff walls. The walls are constructed by excavating a narrow trench under an engineered fluid and back filling with soil-bentonite, cement-bentonite or composite slurries.

Applicability: This process is applicable for all soil and water contaminants

Byproducts: Excavated soil may require disposal.

Preliminary Screening: Retained.

Secondary Screening: Rejected; implementability and cost.

Effectiveness: Slurry walls are effective in preventing contaminants from leaching into water supplies. An impermeable cap will be required.
Implementability: Slurry walls typically are implemented for larger sites. The Rowe site is classified as very small. Periodic monitoring will be required.
Cost: High capital, high O&M.

4.2.2 Capping/Lining:

Description: This process utilizes multimedia caps, paving materials, or synthetic covers in conjunction with geomembrane liners to isolate contaminated soils. The cap prevents infiltration through the soil, and the liner prevents leachate movement out of the soil, thereby reducing the possibility of ground water contamination. Double liners may be implemented with sampling ports.

Applicability: This process can be used to isolate any unsaturated soil.

Limitations: Capping/lining does not treat the soils; it only prevents the spread of contaminants.

Byproducts: This process does not produce hazardous byproducts.

Preliminary Screening: Retained.

Secondary Screening: Retained.

Effectiveness: This process is capable of isolating both volatile organics and metals and is well suited to the soil type at the Rowe site.
Implementability: Soil excavation, lining and capping require minimal design effort and short-term field operations. Periodical monitoring will be required.
Cost: Low to moderate capital, low O&M.

4.3 In-Situ Soil Flushing:

Description: This process is accomplished by passing extractant solvents through the soils using an injection/recirculation process. These solvents may include water, water surfactant mixtures, acids or bases (for organics), chelating agents, oxidizing agents or reducing agents. The use of surfactants can increase the solubility and recovery of slightly soluble organic contaminants.

Applicability: Soils containing inorganic and organic compounds can be treated with this process.

Limitations: Soil washing fluids must have good extraction coefficients, low volatility and toxicity, be safe and easy to handle and be recoverable/recyclable. Problems are likely in dry or in organic rich soils.

Byproducts: Wastewater is produced which must be treated and disposed.

Preliminary Screening: Retained.

Secondary Screening: Rejected; implementability.

Effectiveness: This process is potentially very effective in treating the soil at the Rowe site.

Implementability: Obtaining a solvent or solvent mixture capable of extracting all the contaminants to be treated at the Rowe site is highly unlikely and may be prohibitively expensive.

Cost: Moderate to high capital, moderate to high O&M.

4.4 In-situ Heating:

4.4.1 Radio Frequency In-situ Decontamination:

Description: Tubular electrodes are inserted into the contaminated soil. Electricity is converted to radio frequency energy which excites the electrodes and heats the soil. The soil is heated to 400°C, and volatiles and semi-volatiles are boiled to the surface where they are collected in a vapor hood for treatment.

Applicability: Soils containing chemicals with boiling points less than 400°C can be treated with this process.

Benefits: The soil can be treated without excavation. Contaminants can be removed at temperatures lower than their natural boiling points because of the naturally occurring distillation process which lowers the boiling point of the organics and increases their volatility. Removal efficiencies in excess of 99 percent are possible. The remediation time is short compared to other in-situ treatment processes.

Limitations: The effectiveness of this process depends on soil type, moisture content and depth of the contamination. The process works best with contaminants that have boiling points of less than 300°C and that extend to depths less than 20 feet. Contaminants must have the ability to vaporize. This process will not treat heavy metals. The soil moisture content must be between 20 to 25 percent for reasonable cost. Heat loss will make this process less economical in the winter. This process is infeasible for soil containing buried metal objects.

Byproducts: Volatile and semi-volatile organic air emissions are produced which may require treatment.

Preliminary Screening: Retained.

Secondary Screening: Rejected; implementability and cost.

Effectiveness: This technology is capable of treating the VOCs in the soil at the Rowe site.

Implementability: Several factors, listed above, are involved which alter the effectiveness of this technology, therefore continuous monitoring and experienced field personnel are required.

Cost: High to very high capital, low to moderate O&M.

4.4.2 In-Situ Vitrification:

Description: The vitrification process thermally destroys organic constituents and converts contaminated soil or sludge into a glass and crystalline product utilizing very high temperatures. The process is carried out by inserting large electrodes into contaminated soils containing significant levels of silicates. Graphite on the surface connects the electrodes to the soil. High current electricity passes through the electrodes and graphite. The heat causes a melt that gradually works downward through the soil. Organic contaminants are destroyed by pyrolysis and inorganic contaminants are immobilized within the vitrified mass. Both the airborne organic and inorganic combustion byproducts are collected in a negatively pressurized hood which draws the contaminants into an off-gas treatment system that removes particulates and other contaminants of concern.

Applicability: Unsaturated soils containing most hard-to-destroy contaminants can be treated by this process.

Benefits: Organic contaminants are destroyed, and inorganic contaminants are permanently immobilized by this process.

Limitations: The soil must be pre-dried and energy requirements are high. this process is infeasible for sites with buried utilities. The effectiveness depends on the chemical and physical properties of contaminants, melt chemistry and temperature, contaminants dwell time in the treatment zone and extent of over melting. The total organic concentration cannot exceed 5 to 10 percent by weight, and the metals concentration cannot exceed 16 percent by weight.

Byproducts: Volatile off gases are produced which must be treated.

Preliminary Screening: Retained.

Secondary Screening: Rejected; cost.

Effectiveness: Organic contaminants are destroyed, and inorganic contaminants are permanently immobilized by this technology.

Implementability: Technology is well suited for the soils at the Rowe site. Periodic monitoring will be required.

Cost: High capital, low to moderate O&M.

4.5 In-Situ Gas Phase Separation:

4.5.1 Soil Vapor Extraction:

Description: A vacuum pump or fan is connected to one or more vapor extraction wells. Typically, the extraction wells are installed to penetrate the contaminant plume near the zone of highest VOC concentration. When suction is applied to the well(s), subsurface airflow is induced radially toward the extraction well. The extracted air is then treated and released or released straight to the atmosphere.

Applicability: Permeable soils containing volatile organics can be treated with this process.

Limitations: The major factors to be considered in applying this process are contaminant volatility, site soil porosity and the site specific clean-up level. This process is effective only in unsaturated zone and for compounds with Henry's constant greater than 0.001.

Byproducts: This process produces air emissions which may require treatment.

Preliminary Screening: Retained.

Secondary Screening: Retained.

Effectiveness: This technology is capable of treating the VOCs in the soil at the Rowe site and is well suited for small areas.

Implementability: This technology requires minimal mobilization effort and can be easily implemented at the Rowe site.

Cost: Moderate capital, low to moderate O&M.

4.5.2 Steam Stripping:

Description: Specially designed auger blades mix the soil in-situ and introduce steam and air from the auger tips to the surrounding soil. The steam and air strip the organic contaminants from the mixed soil and transport them in the vapor phase to the ground surface. A shroud covers the treatment area to collect the stripped volatiles. The collected vapor is treated in a condenser where the water and organics are separated and recovered.

Applicability: Soil containing volatile and semi-volatile organics with boiling points of less than 300 to 350°F can be treated using this process.

Benefits: This process is quicker than traditional soil vapor recovery and can treat less organics that are only moderately volatile.

Limitations: The remediation depth must be less than 27 feet, and the soil should contain no obstacles greater than 14 inches in diameter.

Byproducts: This process produces organic vapors which require treatment.

Preliminary Screening: Retained.

Secondary Screening: Rejected; cost.

Effectiveness: This technology is capable of treating the VOCs in the soil at the Rowe site and is well suited for small areas.

Implementability: This technology requires moderate mobilization effort and can be easily implemented at the Rowe site.

Cost: High capital, low to moderate O&M.

4.6 In-Situ Soil Stabilization/Solidification:

4.6.1 Shallow Soil Mixing:

Description: This process uses auger blades to uniformly mix hazardous soils with treatment chemicals to produce a solidified or stabilized end product, while capturing vapors and dust that are produced.

Applicability: Soils containing organic and inorganic compounds can be treated.

Benefits: Soils of variable moisture content, ranging from dry soil to fluid sludge, can be treated by this process.

Limitations: This process can only be used to depths of 40 feet.

Byproducts: Vapors and dust may be produced which require capture and treatment.

Preliminary Screening: Retained.

Secondary Screening: Rejected; implementability, cost.

Effectiveness: This process is applicable for both volatile organics and inorganics such as metals and is well suited for the Rowe site.

Implementability: Shallow soil mixing is typically suited for larger sites. Mobilization requirements are extensive.

Cost: High capital, low to moderate O&M.

4.6.2 Deep Soil Mixing:

Description: A multiple auger with overlapping mixing paddles is used to uniformly mix hazardous soils with treatment chemicals. During auger penetration, 60 to 80 percent of the treatment chemicals are injected; the remainder are injected during auger withdrawal. This process can be used above and below the ground-water table to depths of 150 feet.

Applicability: Soils containing organic and inorganic compounds can be treated with this process.

Benefits: This process can be used above and below the water table, therefore, dewatering is not required. This process is effective for a wide variety of soil conditions.

Preliminary Screening: Rejected; deep soil mixing is designed to treat soil from 60 to 140 feet in depth. Soil remediation at the Rowe site is targeted for soil at a depth of 12 feet or less.

5.0 Off-Site Soil Remediation/Disposal

5.1 Incineration:

Description: Excavated soil is transported to an incineration facility.

Applicability: Soils containing combustible organics can be treated with this process.

Benefits: Remediation time is very short, and no onsite remediation equipment is required.

Limitations: Transport costs can be high.

Byproducts: No onsite hazardous byproducts are produced with offsite treatment and disposal options.

Preliminary Screening: Retained; provided the soil containing metals may be landfilled.

Secondary Screening: Rejected; cost.

Effectiveness: Off-site incineration coupled with off-site landfilling will remove all contaminants from the site.

Implementability: Remediation time is short and no onsite remediation equipment is required. Regulations may dictate permitting requirements and other potential liabilities.

Cost: High capital costs, no O&M costs.

5.2 Chemical Waste Landfill:

Description: Excavated soil is transported to a chemical waste landfill for disposal.

Applicability: Soils containing contaminants that are not banned by RCRA for land disposal.

Benefits: Remediation time is very short, and no onsite remediation equipment is required.

Limitations: Potential liabilities are incurred with offsite disposal options.

Byproducts: No onsite hazardous byproducts are produced with offsite treatment and disposal options.

Preliminary Screening: Retained.

Secondary Screening: Retained.

Effectiveness: No on-site hazardous byproducts are produced with offsite treatment and disposal. Well suited for the small volume of soil requiring remediation.

Implementability: The small volume of soil to be disposed of helps the feasibility. Remediation time is very short, and no onsite remediation equipment is required. Potential liabilities are incurred with offsite disposal options.

Cost: Moderate capital, no O&M.

5.3 Biological Treatment:

Description: Excavated soil is transported to a biological treatment facility for treatment and disposal.

Applicability: Soils containing biodegradable organics can be treated with this process.

Benefits: Remediation time is very short, and no onsite remediation equipment is required.

Limitations: Potential liabilities are incurred with offsite treatment options.

Byproducts: No onsite hazardous byproducts are produced with offsite treatment and disposal options.

Preliminary Screening: Rejected; the soil at the Rowe site to be treated contains chlorinated solvents which are not readily biodegradable and cannot be treated by this process.

APPENDIX C

COST CALCULATIONS FOR TREATMENT AND DISCHARGE PROCESS OPTIONS

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C.1.0. COST CALCULATIONS

The cost calculated for the process options of Section 5.0 include the following:

- direct and indirect capital cost;
- direct and indirect annual operation and maintenance (O&M) costs;
- 7-year present worth costs; and
- 12-year present worth costs.

The capital cost calculations are based on the quantity of the required treatment component units (items) multiplied by the material, labor and equipment costs per unit. If a subcontractor can supply the item at a known cost, then the number of items is multiplied by the unitemized cost per unit. The item costs are summed to provide a subtotal of the capital cost. This subtotal is then marked up to account for contractor's overhead and profit, administrative, contingency and engineering costs. The marked-up cost is the "total capital cost" of the process option.

The O&M cost calculations are based on the quantity of required items per year multiplied by the material, labor and equipment costs per unit. If a subcontractor can supply the item at a known cost, then the number of items is multiplied by the unitemized cost per unit. The item costs are summed to provide a subtotal of annual cost. This subtotal is then marked up to account for contractor's overhead and profit and administrative costs. The marked-up cost is the "total annual O&M cost" of the process option.

The 7- and 12-year present worth costs are calculated by summing the total capital and total O&M costs for each year to provide a total annual cost for each year. The total annual cost for each year is then multiplied by a discount factor to provide the present worth of the total annual cost for each year. The present worth costs are then summed to provide the total present worth cost for the process option.

The discount factor is based on a 5-percent discount rate, compounded annually. This is equivalent to an assumed inflation rate of 5 percent and an interest rate of 10 percent.

C.1.1. PACKED TOWER AERATION

The cost calculations for the packed tower aeration system described in Section 5.1.1.1. are based on two flow rates, 150 gpm for four recovery wells and 600 gpm for seven recovery wells. The proposed influent concentrations and effluent requirements are given on table 5.1.1. To treat the 150 gpm wastestream, the size of the tower is four feet in diameter and is 29 feet tall with 20 feet of packing. A 5-hp blower is required to provide 7,900 scfm of air to the tower. The tower also will be equipped with an air-flow switch to guard against reduced efficiency resulting from a reduced air flow.

To treat the 600 gpm wastestream, the size of the tower is seven feet in diameter and is 45 feet tall with 35 feet of packing. A 5-hp blower is required to provide 7,600 scfm of air to the tower. The tower would also be equipped with an air-flow switch to guard against reduced efficiency resulting from a reduced air flow.

The annual O&M costs include power for the blower and biennial, analysis of the packing material to verify that it is inert prior to disposal, biennial disposal of packing, and biennial replacement of the packing.

C.1.1.1. Packed Tower Aeration: Capital Cost

NABISCO BRANDS, INC.
OWE INDUSTRIES SITE
Sag Harbor, New York

Ground-Water Medium (150 gpm)
Packed Tower Aeration - Capital Cost
Section 5.1.1.4

Item	Qty	Unit	Unit Cost Unitemized	Unit Cost Material	Unit Cost Labor	Unit Cost Equip.	Total Cost Unitem.	Total Cost Material	Total Cost Labor	Total Cost Equip.	Total Direct Cost
Packed Tower Aeration											
- Aeration Tower & Packing	1	Each		26,225.00	8,400.00	1,350.00		26,225	8,400	1,350	35,975
- Blower, Motor & Enclosure	1	Each		2,000.00	800.00	400.00		2,000	800	400	3,200
- Air-Flow Switch	1	Each		650.00	250.00	130.00		650	250	130	1,030
Subtotal							0	28,875	9,450	1,880	40,205
Contractor's Overhead & Profit at 10% of Equipment Cost										188	188
Contractor's Overhead & Profit at 10% of Material Cost								2,888			2,888
Total Direct Cost							0	31,763	9,450	2,068	43,281
Engineering Cost at 10% of Total Direct Cost											4,328
Project Administration Cost at 15% of Direct Labor Cost									1,418		1,418
Project Administration Cost at 5% of Direct Material Cost								1,588			1,588
Project Administration Cost at 10% of Direct Unitemized Cost							0				0
Project Administration Cost at 15% of Engineering Cost											649
Total Field Cost							0	33,351	10,868	2,068	51,263
Contingency at 20% of Total Field Cost											10,253
Total Capital Cost											$61,516

5.1.1.2. Packed Tower Aeration: Capital Cost

NABISCO BRANDS, INC.
NE INDUSTRIES SITE
g Harbor, New York

Ground-Water Medium (600 gpm)
acked Tower Aeration - Capital Cost
ection 5.1.1.4

Item	Qty	Unit	Unit Cost Unitemized	Material	Labor	Equip.	Total Cost Unitem.	Material	Labor	Equip.	Total Direct Cost
acked Tower Aeration											
Aeration Tower & Packing	1	Each		52,000.00	16,640.00	2,600.00		52,000	16,640	2,600	71,240
Blower, Motor & Enclosure	1	Each		2,000.00	800.00	400.00		2,000	800	400	3,200
Air-Flow Switch	1	Each		650.00	250.00	130.00		650	250	130	1,030
ubtotal							0	54,650	17,690	3,130	75,470
Contractor's Overhead & Profit at 10% of Equipment Cost										313	313
Contractor's Overhead & Profit at 10% of Material Cost								5,465			5,465
otal Direct Cost							0	60,115	17,690	3,443	81,248
Engineering Cost at 10% of Total Direct Cost											8,125
roject Administration Cost at 15% of Direct Labor Cost									2,654		2,654
roject Administration Cost at 5% of Direct Material Cost								3,006			3,006
Project Administration Cost at 10% of Direct Unitemized Cost							0				0
Project Administration Cost at 15% of Engineering Cost											1,219
otal Field Cost							0	63,121	20,344	3,443	96,251
Contingency at 20% of Total Field Cost											19,250
otal Capital Cost											$115,501

5.1.2.1. Packed Tower Aeration: Annual O&M Cost

NABISCO BRANDS, INC.
[illegible]ME INDUSTRIES SITE
[illegible]ag Harbor, New York

Ground-Water Medium (150 gpm)
[illegible]acked Tower Aeration - O&M Cost
[illegible]ection 5.1.1.4

Item	Qty	Unit/Yr	Unit Cost Unitemized	Unit Cost Material	Unit Cost Labor	Unit Cost Equip.	Annual Cost Unitem.	Annual Cost Material	Annual Cost Labor	Annual Cost Equip.	Total Annual Cost
[illegible]eration Tower Power											
- Blower (5 hp)	32,675	kW-hr	0.10				3,268				3,268
Aeration Tower Maintenance											
- Replacement Packing	250	CF		17.00	2.70	0.00		4,250	675	0	4,925
- Packing Disposal	9.3	CY	20.00	0.00		0.00		0	0	0	0
- Packing Analysis	1	Each	300.00				300				300
[illegible]ubtotal							3,568	4,250	675	0	8,493
Contractor's Overhead & Profit at 10% of Equipment Cost										0	0
Contractor's Overhead & Profit at 10% of Material Cost								425			425
[illegible]otal Direct Cost							3,568	4,675	675	0	8,918
Project Administration Cost at 15% of Direct Labor Cost									101		101
[illegible]Project Administration Cost at 5% of Direct Material Cost								234			234
[illegible]roject Administration Cost at 10% of Direct Unitemized Cost							357				357
Total Field Cost							3,924	4,909	776	0	9,609
[illegible]otal Annual O&M Cost											$9,609

C.1.2.2. Packed Tower Aeration: Annual O&M Cost

NABISCO BRANDS, INC.
DME INDUSTRIES SITE
ag Harbor, New York

Ground-Water Medium (600 gpm)
acked Tower Aeration - O&M Cost
ection 5.1.1.4

Item	Qty	Unit/Yr	Unit Cost Unitemized	Material	Labor	Equip.	Annual Cost Unitem.	Material	Labor	Equip.	Total Annual Cost
eration Tower Power											
- Blower (5 hp)	32,675	kW-hr	0.10				3,268				3,268
Aeration Tower Maintenance											
- Replacement Packing	1,350	CF		17.00	2.70	0.00		22,950	3,645	0	26,595
- Packing Disposal	50	CY	20.00	0.00		0.00		0	0	0	0
- Packing Analysis	1	Each	300.00				300				300
ubtotal							3,568	22,950	3,645	0	30,163
Contractor's Overhead & Profit at 10% of Equipment Cost										0	0
ontractor's Overhead & Profit at 10% of Material Cost								2,295			2,295
otal Direct Cost							3,568	25,245	3,645	0	32,458
Project Administration Cost at 15% of Direct Labor Cost									547		547
roject Administration Cost at 5% of Direct Material Cost								1,262			1,262
roject Administration Cost at 10% of Direct Unitemized Cost							357				357
Total Field Cost							3,924	26,507	4,192	0	34,623
otal Annual O&M Cost											$34,623

C.1.3.2. Packed Tower Aeration: 12-Year Present Worth Cost

NABISCO BRANDS, INC
OWE INDUSTRIES SITE
ag Harbor, New York

Ground-Water Medium (600 gpm)
acked Tower Aeration - Present Worth Analysis (12 year)
ection 5.1.2.4
Discount Rate = 0.05

Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
apital Cost	115,501	0	0	0	0	0	0	0	0	0
O&M Costs	0	34,623	34,623	34,623	34,623	34,623	34,623	34,623	35,809	35,809
Total Annual Cost	115,501	35,809	34,623	34,623	34,623	34,623	34,623	34,623	35,809	35,809
iscount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	115,501	34,104	31,404	29,909	28,484	27,128	25,836	24,606	24,237	23,083

Cost Component	10	11	12
Capital Cost	0	0	0
O&M Costs	34,623	34,623	34,623
Total Annual Cost	34,623	34,623	34,623
Discount Factor	0.61391	0.58468	0.55684
resent Worth	21,256	20,243	19,279

otal Present Worth ($'s)	425,070

C.2.1. GAC ADSORPTION

The cost calculations for the GAC adsorption systems described in Section 5.1.2.1. are based on flow rates of 150 gpm and 600 gpm and the proposed influent concentrations and effluent requirements as presented on table 5.1.1. The projected treatment system for the 150 gpm wastestream would consist of two seven-foot diameter, nine-foot high GAC colums arranged in series. For the 600 gpm wastestream, six seven-foot diameter, nine-foot high GAC columns arranged in three parallel groups of two columns in series would be required. Each column would contain approximately 6,000 pounds of activated carbon. The costs of standard flow controls (valves, meters, etc.) and process controls (pressure sensors, water-level sensors, etc.) are included in the costs of the GAC units. Based on the projected carbon usage rates, 94,170 pounds of carbon will be replaced every year for the 150 gpm flow rate and 295,650 pounds of carbon will be replaced annually for the 600 gpm flow rate. The replacement cost for carbon is included in the O&M cost.

C.2.1.1. GAC Adsorption: Capital Cost

NABISCO BRANDS, INC.
NOME INDUSTRIES SITE
Sag Harbor, New York

Ground-Water Medium (150 gpm)
GAC Adsorbers - Capital Cost
Section 5.1.2.4

Item	Qty	Unit	Unit Cost Unitemized	Material	Labor	Equip.	Total Cost Unitem.	Material	Labor	Equip.	Total Direct Cost
GAC Adsorbers											
- Adsorber Units	3	Each		18000	6000	900	0	54000	18000	2700	74700
- Controls	1	LS	3000				3000	0	0	0	3000
Subtotal							3000	54000	18000	2700	77700
Contractor's Overhead & Profit at 10% of Equipment Cost										270	270
Contractor's Overhead & Profit at 10% of Material Cost								5400			5400
Total Direct Cost							3000	59400	18000	2970	83370
Engineering Cost at 10% of Total Direct Cost											8337
Project Administration Cost at 15% of Direct Labor Cost									2700		2700
Project Administration Cost at 5% of Direct Material Cost								2970			2970
Project Administration Cost at 10% of Direct Unitemized Cost							300				300
Project Administration Cost at 15% of Engineering Cost											1251
Total Field Cost							3300	62370	20700	2970	98928
Contingency at 20% of Total Field Cost											19786
Total Capital Cost											$118,713

C.2.1.2. GAC Adsorption: Capital Cost

NABISCO BRANDS, INC.
OWE INDUSTRIES SITE
Sag Harbor, New York

Ground-Water Medium (600 gpm)
AC Adsorbers - Capital Cost
ection 5.1.2.4

Item	Qty	Unit	Unit Cost Unitemized	Material	Labor	Equip.	Total Cost Unitem.	Material	Labor	Equip.	Total Direct Cost
GAC Adsorbers											
- Adsorber Units	8	Each		18000	6000	900	0	144000	48000	7200	199200
- Controls	1	LS	5000				5000	0	0	0	5000
Subtotal							5000	144000	48000	7200	204200
Contractor's Overhead & Profit at 10% of Equipment Cost										720	720
Contractor's Overhead & Profit at 10% of Material Cost								14400			14400
Total Direct Cost							5000	158400	48000	7920	219320
Engineering Cost at 10% of Total Direct Cost											21932
Project Administration Cost at 15% of Direct Labor Cost									7200		7200
Project Administration Cost at 5% of Direct Material Cost								7920			7920
Project Administration Cost at 10% of Direct Unitemized Cost							500				500
Project Administration Cost at 15% of Engineering Cost											3290
Total Field Cost							5500	166320	55200	7920	260162
Contingency at 20% of Total Field Cost											52032
Total Capital Cost											$312,194

C.2.2.1. GAC Adsorption: Annual O&M Cost

NABISCO BRANDS, INC
ROWE INDUSTRIES SITE
Sag Harbor, New York

Ground-Water Medium (150 gpm)
GAC Adsorbers - O&M Cost
Section 5.1.2.4

Item	Qty	Unit/Yr	Unit Cost Unitemized	Unit Cost Material	Unit Cost Labor	Unit Cost Equip.	Annual Cost Unitem.	Annual Cost Material	Annual Cost Labor	Annual Cost Equip.	Total Annual Cost
GAC Adsorber Maintenance											
- Replacement Carbon	94170	Pound		1.00	0.12	0.10	0	94,170	11,300	9,417	114,887
- Carbon Regeneration	94170	Pound		1.00	0.12	0.10	0	94,170	11,300	9,417	114,887
- Carbon Analysis	1	LS	300.00				300	0	0	0	300
Subtotal							300	188,340	22,601	18,834	230,075
Contractor's Overhead & Profit at 10% of Equipment Cost										1,883	1,883
Contractor's Overhead & Profit at 10% of Material Cost								18,834			18,834
Total Direct Cost							300	207,174	22,601	20,717	250,792
Project Administration Cost at 15% of Direct Labor Cost									3,390		3,390
Project Administration Cost at 5% of Direct Material Cost								10,359			10,359
Project Administration Cost at 10% of Direct Unitemized Cost							30				30
Total Field Cost							330	217,533	25,991	20,717	264,571
Total Annual O&M Cost											$264,571

C.2.2.2. GAC Adsorption: Annual O&M Cost

NABISCO BRANDS, INC
ROWE INDUSTRIES SITE
Sag Harbor, New York

Ground-Water Medium (600 gpm)
GAC Adsorbers - O&M Cost
Section 5.1.2.4

Item	Qty	Unit/Yr	Unit Cost Unitemized	Material	Labor	Equip.	Annual Cost Unitem.	Material	Labor	Equip.	Total Annual Cost
GAC Adsorber Maintenance											
- Replacement Carbon	295650	Pound		1.00	0.12	0.10	0	295,650	35,478	29,565	360,693
- Carbon Regeneration	295650	Pound		1.00	0.12	0.10	0	295,650	35,478	29,565	360,693
- Carbon Analysis	1	LS	300.00				300	0	0	0	300
Subtotal							300	591,300	70,956	59,130	721,686
Contractor's Overhead & Profit at 10% of Equipment Cost										5,913	5,913
Contractor's Overhead & Profit at 10% of Material Cost								59,130			59,130
Total Direct Cost							300	650,430	70,956	65,043	786,729
Project Administration Cost at 15% of Direct Labor Cost									10,643		10,643
Project Administration Cost at 5% of Direct Material Cost								32,522			32,522
Project Administration Cost at 10% of Direct Unitemized Cost							30				30
Total Field Cost							330	682,952	81,599	65,043	829,924
Total Annual O&M Cost											$829,924

C.2.3.1. GAC Adsorption: 7-Year Present Worth Cost

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
Sag Harbor, New York

Ground-Water Medium (150 gpm)
GAC Adsorber - Present Worth Analysis (7 year)
Discount Rate = 0.05

Cost Component	Cost/Year Cost Occurs ($'s)							
	0	1	2	3	4	5	6	7
Capital Cost	118,713	0	0	0	0	0	0	0
O&M Costs	0	264,571	264,571	264,571	264,571	264,571	264,571	264,571
Total Annual Cost	118,713	132,121	264,571	264,571	264,571	264,571	264,571	264,571
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068
Present Worth	118,713	125,830	239,974	228,546	217,663	207,298	197,427	188,026

Total Present Worth	$1,523,477

C.2.3.2. GAC Adsorption: 12-Year Present Worth Cost

NABISCO BRANDS, INC
ROWE INDUSTRIES SITE
Sag Harbor, New York

Ground-Water Medium (600 gpm)
GAC Adsorbers - Present Worth Analysis (12 year)
Section 5.1.2.4
Discount Rate = 0.05

Cost Component	Cost/Year Cost Occurs ($'s)									
	0	1	2	3	4	5	6	7	8	9
Capital Cost	312,194	0	0	0	0	0	0	0	0	0
O&M Costs	0	829,924	829,924	829,924	829,924	829,924	829,924	829,924	829,924	829,924
Total Annual Cost	312,194	414,797	829,924	829,924	829,924	829,924	829,924	829,924	829,924	829,924
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	312,194	395,044	752,766	716,920	682,781	650,267	619,302	589,811	561,725	534,976

Cost Component	10	11	12
Capital Cost	0	0	0
O&M Costs	829,924	829,924	829,924
Total Annual Cost	829,924	829,924	829,924
Discount Factor	0.61391	0.58468	0.55684
Present Worth	509,501	485,239	462,133

Total Present Worth ($'s)	7,272,660

C.3.1. DISCHARGE TO LIGONEE BROOK

As discussed in Section 5.2.2, for discharging the treated ground water to the Ligonee Brook, approximately 340 feet of piping will be needed to transport water from the four recovery wells located on the SHI property to the treatment system and about 1,800 feet of piping from the treatment system to Ligonee Brook. The total trench length is about 1,900 feet. For the seven well configuration, approximately 3,100 feet of piping will be needed to transport water from the recovery wells to the treatment system and about 1,800 feet of piping from the treatment system to Ligonee Brook. The total trench length is about 4,200 feet. The total trench lengths are less than the total pipe lengths because some sections of trench contain both influent and effluent piping.

The cost calculations assume that all piping to the treatment shed is composite pipe and all discharge piping is Schedule-40 polyvinyl chloride (PVC). The trenches are backfilled with gravel bedding, sand and native soils.

C.3.1.1. Discharge to Ligonee Brook: Capital Cost

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
Sag Harbor, New York

Ground-Water Medium (150 gpm)
Discharge to Ligonee Brook
Section 5.2.2.2

Item	Qty	Unit	Unit Cost Unitemized	Material	Labor	Equip.	Total Cost Unitem.	Material	Labor	Equip.	Total Direct Cost
Piping to Treatment System											
- Pipe, 4-inch composite	340	LF		8.70	8.45	0.00	0	2,958	2,873	0	5,831
- Trench Excavation	131	CY		0.00	1.17	1.62	0	0	153	212	365
- Trench Bedding & Compaction	16	CY		3.95	5.87	14.88	0	63	94	238	395
- Trench Backfill & Compaction (sand)	48	CY		14.70	6.16	15.80	0	706	296	758	1,760
- Trench Backfill & Compaction (native)	65	CY		0.00	0.46	1.25	0	0	30	81	111
Piping to Discharge											
- Pipe, 6-inch PVC	1800	LF		6.07	9.75	0.00	0	10,926	17,550	0	28,476
- Trench Excavation	610	CY		0.00	1.17	1.62	0	0	714	988	1,702
- Trench Bedding & Compaction	75	CY		3.95	5.87	14.88	0	296	440	1,116	1,853
- Trench Backfill & Compaction (sand)	211	CY		14.70	6.16	15.80	0	3,102	1,300	3,334	7,735
- Trench Backfill & Compaction (native)	300	CY		0.00	0.46	1.25	0	0	138	375	513
Subtotal							0	18,051	23,587	7,103	48,741
Contractor's Overhead & Profit at 10% of Equipment Cost										710	710
Contractor's Overhead & Profit at 10% of Material Cost								1,805			1,805
Total Direct Cost							0	19,856	23,587	7,813	51,257
Engineering Cost at 10% of Total Direct Cost											5,126
Project Administration Cost at 15% of Direct Labor Cost									3,538		3,538
Project Administration Cost at 5% of Direct Material Cost								993			993
Project Administration Cost at 10% of Direct Unitemized Cost							0				0
Project Administration Cost at 15% of Engineering Cost											769
Total Field Cost							0	20,849	27,126	7,813	61,682
Contingency at 20% of Total Field Cost											12,336
Total Capital Cost											$74,018

C.3.1.2. Discharge to Ligonee Brook: Capital Cost

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
Sag Harbor, New York

Ground-Water Medium (600 gpm)
Discharge to Ligonee Brook
Section 5.2.2.2

Item	Qty	Unit	Unit Cost Unitemized	Material	Labor	Equip.	Total Cost Unitem.	Material	Labor	Equip.	Total Direct Cost
Piping to Treatment System											
- Pipe, 4-inch composite	3100	LF		8.70	8.45	0.00	0	26,970	26,195	0	53,165
- Trench Excavation	1194	CY		0.00	1.17	1.62	0	0	1,397	1,934	3,331
- Trench Bedding & Compaction	149	CY		3.95	5.87	14.88	0	589	875	2,217	3,680
- Trench Backfill & Compaction (sand)	435	CY		14.70	6.16	15.80	0	6,395	2,680	6,873	15,947
- Trench Backfill & Compaction (native)	597	CY		0.00	0.46	1.25	0	0	275	746	1,021
Piping to Discharge											
- Pipe, 6-inch PVC	1800	LF		6.07	9.75	0.00	0	10,926	17,550	0	28,476
- Trench Excavation	424	CY		0.00	1.17	1.62	0	0	496	687	1,183
- Trench Bedding & Compaction	53	CY		3.95	5.87	14.88	0	209	311	789	1,309
- Trench Backfill & Compaction (sand)	148	CY		14.70	6.16	15.80	0	2,176	912	2,338	5,426
- Trench Backfill & Compaction (native)	212	CY		0.00	0.46	1.25	0	0	98	265	363
Subtotal							0	47,264	50,787	15,850	113,901
Contractor's Overhead & Profit at 10% of Equipment Cost										1,585	1,585
Contractor's Overhead & Profit at 10% of Material Cost								4,726			4,726
Total Direct Cost							0	51,990	50,787	17,435	120,212
Engineering Cost at 10% of Total Direct Cost											12,021
Project Administration Cost at 15% of Direct Labor Cost									7,618		7,618
Project Administration Cost at 5% of Direct Material Cost								2,600			2,600
Project Administration Cost at 10% of Direct Unitemized Cost							0				0
Project Administration Cost at 15% of Engineering Cost											1,803
Total Field Cost							0	54,590	58,405	17,435	144,254
Contingency at 20% of Total Field Cost											28,851
Total Capital Cost											$173,105

C.3.2.1. Discharge to Ligonee Brook: Annual O&M Cost

There are no O&M costs associated with this process option, therefore, no cost calculations are presented.

C.3.3.1. Discharge to Ligonee Brook: 7-Year Present Worth Cost

There are no O&M costs associated with this process option, therefore, the 7-year present worth cost is equivalent to the capital cost.

C.3.3.2. Discharge to Ligonee Brook: 12-Year Present Worth Cost

There are no O&M costs associated with this process option, therefore, the 12-year present worth cost is equivalent to the capital cost.

C.4.1. Discharge to Sag Harbor Cove

As discussed in Section 5.2.3., for discharging the treated ground water to the Sag Harbor Cove, approximately 340 feet of piping will be needed to transport water from the four recovery wells located on the SHI property to the treatment system and about 3,700 feet of piping from the treatment system to Sag Harbor Cove. The total trench length is about 3,800 feet. For the seven well configuration, approximately 3,100 feet of piping will be needed to transport water from the recovery wells to the treatment system and about 3,700 feet of piping from the treatment system to Sag Harbor Cove. The total trench length is about 3,900 feet. The total trench lengths are less than the total pipe lengths because some sections of trench contain both influent and effluent piping.

The cost calculations assume that all piping to the treatment shed is composite pipe and all discharge piping is Schedule-40 polyvinyl chloride (PVC). The trenches are backfilled with gravel bedding, sand and native soils.

C.4.1.1. Discharge to Sag Harbor Cove: Capital Cost

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
Sag Harbor, New York

Ground-Water Medium (150 gpm)
Discharge to Sag Harbor Cove
Section 5.2.3.2

Item	Qty	Unit	Unit Cost Unitemized	Material	Labor	Equip.	Total Cost Unitem.	Material	Labor	Equip.	Total Direct Cost
Piping to Treatment System											
- Pipe, 4-inch composite	340	LF		8.70	8.45	0.00	0	2,958	2,873	0	5,831
- Trench Excavation	131	CY		0.00	1.17	1.62	0	0	153	212	365
- Trench Bedding & Compaction	16	CY		3.95	5.87	14.88	0	63	94	238	395
- Trench Backfill & Compaction (sand)	48	CY		14.70	6.16	15.80	0	706	296	758	1,760
- Trench Backfill & Compaction (native)	65	CY		0.00	0.46	1.25	0	0	30	81	111
Piping to Discharge											
- Pipe, 6-inch PVC	3700	LF		6.07	9.75	0.00	0	22,459	36,075	0	58,534
- Trench Excavation	1333	CY		0.00	1.17	1.62	0	0	1,560	2,159	3,719
- Trench Bedding & Compaction	167	CY		3.95	5.87	14.88	0	660	980	2,485	4,125
- Trench Backfill & Compaction (sand)	467	CY		14.70	6.16	15.80	0	6,865	2,877	7,379	17,120
- Trench Backfill & Compaction (native)	666	CY		0.00	0.46	1.25	0	0	306	833	1,139
Subtotal							0	33,710	45,244	14,145	93,100
Contractor's Overhead & Profit at 10% of Equipment Cost										1,415	1,415
Contractor's Overhead & Profit at 10% of Material Cost								3,371			3,371
Total Direct Cost							0	37,081	45,244	15,560	97,885
Engineering Cost at 10% of Total Direct Cost											9,789
Project Administration Cost at 15% of Direct Labor Cost									6,787		6,787
Project Administration Cost at 5% of Direct Material Cost								1,854			1,854
Project Administration Cost at 10% of Direct Unitemized Cost							0				0
Project Administration Cost at 15% of Engineering Cost											1,468
Total Field Cost							0	38,935	52,030	15,560	117,783
Contingency at 20% of Total Field Cost											23,557
Total Capital Cost											$141,339

C.4.1.2. Discharge to Sag Harbor Cove: Capital Cost

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
Sag Harbor, New York

Ground-Water Medium (600 gpm)
Discharge to Sag Harbor Cove
Section 5.2.3.2

Item	Qty	Unit	Unit Cost Unitemized	Material	Labor	Equip.	Total Cost Unitem.	Material	Labor	Equip.	Total Direct Cost
Piping to Treatment System											
- Pipe, 4-inch composite	3100	LF		8.70	8.45	0.00	0	26,970	26,195	0	53,165
- Trench Excavation	1194	CY		0.00	1.17	1.62	0	0	1,397	1,934	3,331
- Trench Bedding & Compaction	149	CY		3.95	5.87	14.88	0	589	875	2,217	3,680
- Trench Backfill & Compaction (sand)	435	CY		14.70	6.16	15.80	0	6,395	2,680	6,873	15,947
- Trench Backfill & Compaction (native)	597	CY		0.00	0.46	1.25	0	0	275	746	1,021
Piping to Discharge											
- Pipe, 6-inch PVC	3700	LF		6.07	9.75	0.00	0	22,459	36,075	0	58,534
- Trench Excavation	308	CY		0.00	1.17	1.62	0	0	360	499	859
- Trench Bedding & Compaction	39	CY		3.95	5.87	14.88	0	154	229	580	963
- Trench Backfill & Compaction (sand)	108	CY		14.70	6.16	15.80	0	1,588	665	1,706	3,959
- Trench Backfill & Compaction (native)	154	CY		0.00	0.46	1.25	0	0	71	193	263
Subtotal							0	58,154	68,821	14,749	141,724
Contractor's Overhead & Profit at 10% of Equipment Cost										1,475	1,475
Contractor's Overhead & Profit at 10% of Material Cost								5,815			5,815
Total Direct Cost							0	63,969	68,821	16,224	149,014
Engineering Cost at 10% of Total Direct Cost											14,901
Project Administration Cost at 15% of Direct Labor Cost									10,323		10,323
Project Administration Cost at 5% of Direct Material Cost								3,198			3,198
Project Administration Cost at 10% of Direct Unitemized Cost							0				0
Project Administration Cost at 15% of Engineering Cost											2,235
Total Field Cost							0	67,168	79,144	16,224	179,672
Contingency at 20% of Total Field Cost											35,934
Total Capital Cost											$215,607

C.4.2.1. Discharge to Sag Harbor Cove: Annual O&M Cost

There are no O&M costs associated with this process option, therefore, no cost calculations are presented.

C.4.3.1 Discharge to Sag Harbor Cove: 7-Year Present Worth Cost

There are no O&M costs associated with this process option, therefore, the 7-year present worth cost is equivalent to the capital cost.

C.4.3.2. Discharge to Sag Harbor Cove: 12-Year Present Worth Cost

There are no O&M costs associated with this process option, therefore, the 12-year present worth cost is equivalent to the capital cost.

C.5.1. Discharge to Injection Wells

The costs for this discharge option are calculated based on the 150 gpm wastestream and the 600 gpm wastestream. Approximately 340 feet of piping is required to transport water from the four recovery wells located on the SHI property to the treatment system, and about 210 feet of piping from the treatment system to the injection wells for the 150 gpm wastestream. The total trench length is about 550 feet for this recovery well configuration. Two injection wells, one of which is provided as a backup, discharge the treated water to the aquifer.

Approximately 3,100 feet of piping is required to transport water from the recovery wells to the treatment system, and about 420 feet of piping from the treatment system to the injection wells for the 600 gpm wastestream. The total trench length is about 3,520 feet for this recovery well configuration. Four injection wells, one of which is provided as a backup, discharge the treated water to the aquifer.

The injection wells are 6 inches in diameter and have 100 feet of stainless-steel wire-wrapped screen. Individual pipes convey treated water from the distribution pipe to the injection wellheads. The cost calculations assume that all influent piping is composite pipe and that all effluent pipe is Schedule-40 PVC. The trench lengths are backfilled with gravel bedding, sand, and native soils.

As discussed in Section 5.2.5.2., the injection wells require periodic development. The cost calculations assume that each of the injection wells requires redevelopment each year.

C.5.1.1. Discharge to Injection Wells: Capital Cost

NABISCO BRANDS, INC
ROWE INDUSTRIES SITE
Sag Harbor, New York

Ground-Water Medium (150 gpm)
Discharge to Injection Wells - Capital Cost
Section 5.2.5.3

Item	Qty	Unit	Unit Cost: Unitemized Material	Unit Cost: Labor	Unit Cost: Equip.	Total Cost: Unitem.	Total Cost: Material	Total Cost: Labor	Total Cost: Equip.	Total Direct Cost
Piping to Treatment System										
- Pipe, 4-inch composite	340	LF	8.70	8.45	0.00		2,958	2,873	0	5,831
- Trench Excavation	131	CY	0.00	1.17	1.62		0	153	212	365
- Trench Bedding & Compaction	16	CY	3.95	5.87	14.88		63	94	238	395
- Trench Backfill & Compaction (sand)	48	CY	14.70	6.16	15.80		706	296	758	1,760
- Trench Backfill Compaction (native)	65	CY	0.00	0.46	1.25		0	30	81	111
- Electrical Conduit	340	LF	5.50	3.00	0.00		1,870	1,020	0	2,890
Piping to Discharge										
- Pipe, 12-inch PVC	210	LF	20.00	1.78	0.00		4,200	374	0	4,574
- Trench Excavation	81	CY	0.00	1.17	1.62		0	95	131	226
- Trench Bedding & Compaction	10	CY	3.95	5.87	14.88		40	59	149	247
- Trench Backfill & Compaction (sand)	22	CY	14.70	6.16	15.80		323	136	348	807
- Trench Backfill & Compaction (native)	40	CY	0.00	0.46	1.25		0	18	50	68
Injection Well										
- Injection Well	2	Each	21,450.00	7,800.00	18,200.00		42,900	15,600	36,400	94,900
- Well Head Piping	120	LF	3.75	1.50	0.00		450	180	0	630
- Well Head Fittings & Enclosure	2	Each	5,500.00	2,500.00	1,500.00		11,000	5,000	3,000	19,000
Subtotal						0	64,510	25,927	41,368	131,804
Contractor's Overhead & Profit at 10% of Equipment Cost									4,137	4,137
Contractor's Overhead & Profit at 10% of Material Cost							6,451			6,451
Total Direct Cost						0	70,961	25,927	45,504	142,392
Engineering Cost at 10% of Total Direct Cost										14,239
Project Administration Cost at 15% of Direct Labor Cost								3,889		3,889
Project Administration Cost at 5% of Direct Material Cost							3,548			3,548
Project Administration Cost at 10% of Direct Unitemized Cost						0				0
Project Administration Cost at 15% of Engineering Cost										2,136
Total Field Cost						0	74,509	29,816	45,504	166,204
Contingency at 20% of Total Field Cost										33,241
Total Capital Cost										$199,445

C.5.1.2. Discharge to Injection Wells: Capital Cost

NABISCO BRANDS, INC
:OWE INDUSTRIES SITE
Sag Harbor, New York

Ground-Water Medium (600 gpm)
Discharge to Injection Wells - Capital Cost
Section 5.2.5.3

Item	Qty	Unit	Unit Cost Unitemized Material	Labor	Equip.	Total Cost Unitem.	Material	Labor	Equip.	Total Direct Cost
Piping to Treatment System										
- Pipe, 4-inch composite	3,100	LF	8.70	8.45	0.00		26,970	26,195	0	53,165
- Trench Excavation	1,194	CY	0.00	1.17	1.62		0	1,397	1,934	3,331
- Trench Bedding & Compaction	149	CY	3.95	5.87	14.88		589	875	2,217	3,680
- Trench Backfill & Compaction (sand)	435	CY	14.70	6.16	15.80		6,395	2,680	6,873	15,947
- Trench Backfill Compaction (native)	597	CY	0.00	0.46	1.25		0	275	746	1,021
- Electrical Conduit	3,100	LF	5.50	3.00	0.00		17,050	9,300	0	26,350
Piping to Discharge										
- Pipe, 12-inch PVC	420	LF	20.00	1.78	0.00		8,400	748	0	9,148
- Trench Excavation	162	CY	0.00	1.17	1.62		0	190	262	452
- Trench Bedding & Compaction	20	CY	3.95	5.87	14.88		79	117	298	494
- Trench Backfill & Compaction (sand)	44	CY	14.70	6.16	15.80		647	271	695	1,613
- Trench Backfill & Compaction (native)	80	CY	0.00	0.46	1.25		0	37	100	137
Injection Well										
- Injection Well	4	Each	21,450.00	7,800.00	18,200.00		85,800	31,200	72,800	189,800
- Well Head Piping	240	LF	3.75	1.50	0.00		900	360	0	1,260
- Well Head Fittings & Enclosure	4	Each	5,500.00	2,500.00	1,500.00		22,000	10,000	6,000	38,000
Subtotal						0	168,829	83,643	91,926	344,398
Contractor's Overhead & Profit at 10% of Equipment Cost									9,193	9,193
Contractor's Overhead & Profit at 10% of Material Cost							16,883			16,883
Total Direct Cost						0	185,712	83,643	101,118	370,473
Engineering Cost at 10% of Total Direct Cost										37,047
Project Administration Cost at 15% of Direct Labor Cost								12,546		12,546
Project Administration Cost at 5% of Direct Material Cost							9,286			9,286
Project Administration Cost at 10% of Direct Unitemized Cost						0				0
Project Administration Cost at 15% of Engineering Cost										5,557
Total Field Cost						0	194,997	96,190	101,118	434,910
Contingency at 20% of Total Field Cost										86,982
Total Capital Cost										$521,892

C.5.2.1. Discharge to Injection Wells: Annual O&M Cost

ABISCO BRANDS, INC.
OWE INDUSTRIES SITE
ag Harbor, New York

Ground-Water Medium (150 gpm)
ischarge to Injection Wells - O&M Cost
ection 5.2.5.3

Item	Qty	Unit/Yr	Unit Cost: Unitemized Material	Unit Cost: Labor	Unit Cost: Equip.	Annual Cost: Unitem.	Annual Cost: Material	Annual Cost: Labor	Annual Cost: Equip.	Total Annual Cost
Injection Well Maintenance - Well Redevelopment	2	Each	19,500.00			39,000				39,000
Subtotal						39,000	0	0	0	39,000
Contractor's Overhead & Profit at 10% of Equipment Cost									0	0
Contractor's Overhead & Profit at 10% of Material Cost							0			0
Total Direct Cost						39,000	0	0	0	39,000
Project Administration Cost at 15% of Direct Labor Cost								0		0
Project Administration Cost at 5% of Direct Material Cost							0			0
Project Administration Cost at 10% of Direct Unitemized Cost						3,900				3,900
Total Field Cost						42,900	0	0	0	42,900
Total Annual O&M Cost										$42,900

C.5.2.2. Discharge to Injection Wells: Annual O&M Cost

NABISCO BRANDS, INC.
LOWE INDUSTRIES SITE
Bag Harbor, New York

Ground-Water Medium (600 gpm)
Discharge to Injection Wells - O&M Cost
Section 5.2.5.3

Item	Qty	Unit/Yr	Unit Cost Unitemized	Material	Labor	Equip.	Annual Cost Unitem.	Material	Labor	Equip.	Total Annual Cost
Injection Well Maintenance - Well Redevelopment	4	Each	19,500.00				78,000				78,000
Subtotal							78,000	0	0	0	78,000
Contractor's Overhead & Profit at 10% of Equipment Cost										0	0
Contractor's Overhead & Profit at 10% of Material Cost								0			0
Total Direct Cost							78,000	0	0	0	78,000
Project Administration Cost at 15% of Direct Labor Cost									0		0
Project Administration Cost at 5% of Direct Material Cost								0			0
Project Administration Cost at 10% of Direct Unitemized Cost							7,800				7,800
Total Field Cost							85,800	0	0	0	85,800
Total Annual O&M Cost											$85,800

C.5.3.1. Discharge to Injection Wells: 7-Year Present Worth Cost

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
Sag Harbor, New York

Ground-Water Medium (150 gpm)
Discharge to Injection Wells - Present Worth Analysis (7 year)
Discount Rate = 0.05 Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7
Capital Cost	199,445	0	0	0	0	0	0	0
O&M Costs	0	42,900	42,900	42,900	42,900	42,900	42,900	42,900
Total Annual Cost	199,445	42,900	42,900	42,900	42,900	42,900	42,900	42,900
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068
Present Worth	199,445	40,857	38,912	37,059	35,294	33,613	32,013	30,488

Total Present Worth	$447,680

C.5.3.2. Discharge to Injection Wells: 12-Year Present Worth Cost

NABISCO BRANDS, INC
COWE INDUSTRIES SITE
Bag Harbor, New York

Ground-Water Medium (600 gpm)
Discharge to Injection Wells - Present Worth Analysis (12 year)
Section 5.1.2.4
Discount Rate = 0.05 Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	521,892	0	0	0	0	0	0	0	0	0
O&M Costs	0	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800
Total Annual Cost	521,892	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800	85,800
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	521,892	81,714	77,823	74,117	70,588	67,227	64,025	60,976	58,073	55,307

Cost Component	10	11	12
Capital Cost	0	0	0
O&M Costs	85,800	85,800	85,800
Total Annual Cost	85,800	85,800	85,800
Discount Factor	0.61391	0.58468	0.55684
Present Worth	52,674	50,165	47,777

Total Present Worth ($'s)	1,282,359

APPENDIX D

COST CALCULATIONS FOR REMEDIAL ALTERNATIVES FOR THE GROUND-WATER MEDIUM

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D.1.0. GROUND WATER MEDIUM COST CALCULATIONS

The costs calculated for the remedial alternatives for the ground water medium include the following:

- direct and indirect capital costs;
- direct and indirect annual operation and maintrnance (O&M) costs;
- 7-year present worth costs; and
- 12-year present worth costs.

The capital cost calculations are based on the quantity of required treatment component units (items) multiplied by the material, labor and equipment costs per unit. If a subcontractor can supply the item at a known cost, then the number of items is multiplied by the unitemized cost per unit. The item costs are summed to provide a subtotal of the capital cost. This subtotal is then marked-up to account for contractor's overhead and profit, administrative, contingency and engineering costs. The marked-up cost is the "total capital cost" of the remedial alternative.

The O&M cost calculations are based on the quantity of required items per year multiplied by the material, labor and equipment costs per unit. If a subcontractor can supply the item at a known cost, then the number of items is multiplied by the unitemized cost per unit. The item costs are summed to provide a subtotal of the annual cost. This subtotal is then marked-up to account for contractor's overhead and profit and administrative costs. The marked-up cost is the "total annual O&M cost" of the remedial alternative.

The 7- and 12-year present worth costs were calculated by summing the total capital and total O&M costs for each year to provide a total annual cost for each year. The total cost for each year was then multiplied by a discount factor to provide the present worth of the total annual cost for each year. The present worth costs were then summed to provide the present worth cost for the remedial alternative. The discount factor is based on a 5-percent discount rate, compounded annually. This was determined based on an assumed inflation rate of 5 percent and an interest rate of 10 percent.

D.1.1. ALTERNATIVE 1

Alternative 1, the "No Action" alternative, does not have any costs associated with it, therefore, no cost calculations are presented here.

D.2.0. ALTERNATIVE 2

The cost calculations for Alternative 2, described in Section 6.2.1., are based on the fees involved with obtaining deed notations. These fees include the cost of research time for a deed/title search and the legal fees for securing deed notations.

Annual O&M costs are for yearly ground-water monitoring using 19 of the existing monitor wells. Monitoring costs include sample collection costs, sampler expenses (such as hotel accommodations, meals, etc.), laboratory analysis of the collected samples, reporting the findings, and disposal of the well water that was withdrawn and contained during sample collection.

D.2.1. ALTERNATIVE 2: CAPITAL COST

ABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
Sag Harbor, New York
---
round-Water Medium
lternative Number 2 - Capital Cost
Section 6.2.4

Item	Qty	Unit	Unit Cost: Unitemized	Unit Cost: Material	Unit Cost: Labor	Unit Cost: Equip.	Total Cost: Unitem.	Total Cost: Material	Total Cost: Labor	Total Cost: Equip.	Total Direct Cost
Institutional Actions											
- Deed Notations											
- Deed/Title Search	1	LS	1,500.00				1,500				1,500
- Legal Fees	1	LS	25,000.00				25,000				25,000
Subtotal							26,500	0	0	0	26,500
ontractor's Overhead & Profit at 10% of Equipment Cost										0	0
ontractor's Overhead & Profit at 10% of Material Cost								0			0
Total Direct Cost							26,500	0	0	0	26,500
ngineering Cost at 10% of Total Direct Cost											2,650
Project Administration Cost at 15% of Direct Labor Cost									0		0
Project Administration Cost at 5% of Direct Material Cost								0			0
roject Administration Cost at 10% of Direct Unitemized Cost							2,650				2,650
roject Administration Cost at 15% of Engineering Cost											398
Total Field Cost							29,150	0	0	0	32,198
Contingency at 20% of Total Field Cost											6,440
Total Capital Cost											$38,637

D.2.2. ALTERNATIVE 2: ANNUAL O&M COST

BISCO BRANDS, IMC.
WE INDUSTRIES SITE
Sag Harbor, New York

Ground-Water Medium
Alternative Number 2 - O&M Cost
Section 6.2.4

Item	Qty	Unit/Yr	Unit Cost Unitemized	Material	Labor	Equip.	Annual Cost Unitem.	Material	Labor	Equip.	Total Annual Cost
Periodic Ground-Water Monitoring											
- Sampling (yearly)	64	Hour		20.00	50.00	0.00		1,280	3,200	0	4,480
- Sampler Expenses	1	LS		1,500.00	0.00	0.00		1,500			1,500
- Laboratory Analysis	19	Each	350.00				6,650				6,650
- Reporting	40	Hour		0.00	50.00	0.00		0	2,000	0	2,000
- Well Water Disposal	19	LS	600.00				11,400				11,400
Subtotal							18,050	2,780	5,200	0	26,030
Contractor's Overhead & Profit at 10% of Equipment Cost										0	0
Contractor's Overhead & Profit at 10% of Material Cost								278			278
Total Direct Cost							18,050	3,058	5,200	0	26,308
Project Administration Cost at 15% of Direct Labor Cost									780		780
Project Administration Cost at 5% of Direct Material Cost								153			153
Project Administration Cost at 10% of Direct Unitemized Cost							1,805				1,805
Total Field Cost							19,855	3,211	5,980	0	29,046
Total Annual O&M Cost											$29,046

D.2.3. ALTERNATIVE 2: 5-YEAR PRESENT WORTH COST

ABISCO BRANDS,INC.
ROWE INDUSTRIES SITE
Sag Harbor, New York
---
round-Water Medium
lternative 2- Present Worth Analysis (30 Year)
Section 6.2.4

Discount Rate = 0.05	Cost/Year Cost Occurs ($'s)					
Cost Component	0	1	2	3	4	5
apital Cost	38,637	0	0	0	0	0
O&M Costs	0	29,046	29,046	29,046	29,046	29,046
otal Annual Cost	38,637	29,046	29,046	29,046	29,046	29,046
iscount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353
Present Worth	38,637	27,663	26,346	25,091	23,896	22,758

otal Present Worth ($'s)	164,391

D.2.4. ALTERNATIVE 2: 30-YEAR PRESENT WORTH COST

ABISCO BRANDS,INC.
OWE INDUSTRIES SITE
Sag Harbor, New York

round-Water Medium
lternative 2- Present Worth Analysis (30 Year)
ection 6.2.4

Discount Rate = 0.05

Cost Component	Cost/Year Cost Occurs ($'s) 0	1	2	3	4	5	6	7	8	9
apital Cost	38,637	0	0	0	0	0	0	0	0	0
O&M Costs	0	29,046	29,046	29,046	29,046	29,046	29,046	29,046	29,046	29,046
otal Annual Cost	38,637	29,046	29,046	29,046	29,046	29,046	29,046	29,046	29,046	29,046
iscount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	38,637	27,663	26,346	25,091	23,896	22,758	21,675	20,642	19,659	18,723

	10	11	12	13	14	15	16	17	18	19
apital Cost	0	0	0	0	0	0	0	0	0	0
&M Costs	29,046	29,046	29,046	29,046	29,046	29,046	29,046	29,046	29,046	29,046
Total Annual Cost	29,046	29,046	29,046	29,046	29,046	29,046	29,046	29,046	29,046	29,046
Discount Factor	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573
resent Worth	17,832	16,983	16,174	15,404	14,670	13,972	13,306	12,673	12,069	11,494

	20	21	22	23	24	25	26	27	28	29
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	29,046	29,046	29,046	29,046	29,046	29,046	29,046	29,046	29,046	29,046
otal Annual Cost	29,046	29,046	29,046	29,046	29,046	29,046	29,046	29,046	29,046	29,046
Discount Factor	0.37689	0.35894	0.34185	0.32557	0.31007	0.29530	0.28124	0.26785	0.25509	0.24295
Present Worth	10,947	10,426	9,929	9,457	9,006	8,577	8,169	7,780	7,409	7,057

	30
apital Cost	0
&M Costs	29,046
Total Annual Cost	29,046
Discount Factor	0.23138
resent Worth	6,721
Total Present Worth ($'s)	485,145

D.3.0 ALTERNATIVE 3-I

The cost calculations for Alternative 3-I, described in Section 6.3.1., are based on the recovery of contaminated ground water from four new recovery wells at a combined flow rate of 150 gpm. This water will be piped approximately 340 feet to the treatment system.

Following iron treatment, the water will flow, under pressure, through a sediment filter then to a packed tower for aeration. The tower will be skid mounted and installed on a 6-inch thick concrete foundation. The effluent from the tower will flow into a sump from which it will be piped through approximately 1,800 feet of piping to discharge at Ligonee Brook. All influent piping and fittings will be made of composite material and all discharge piping will be PVC.

Prior to constructing the treatment system, the site will be surveyed, cleared, and grubbed. Erosion control measures will also be taken. Field office trailers, storage units, sanitary facilities, and temporary utility hookups are included in the cost calculations. Deed notations and monitor wells, as described in Alternative 2, are also included in this alternative.

O&M costs include all those described in Alternative 2 in addition to power for the aeration blower, sump pump and recovery well pumps, analysis of the packing to verify that it is inert prior to disposal, and disposal and replacement of packing. The influent to and effluent from the tower will be sampled monthly, and, following laboratory analysis of the samples, a report will be written detailing the findings.

Other O&M costs include replacement of the sediment filter bags, maintenance of the recovery wells and well pumps, and system monitoring.

D.3.1. ALTERNATIVE 3-I: CAPITAL COST

BISCO BRANDS, INC.
WE INDUSTRIES SITE
Sag Harbor, New York
---
ound-Water Medium
ternative Number 3-I - Capital Cost
ection 6.3.4

Item	Qty	Unit	Unit Cost Unitemized	Unit Cost Material	Unit Cost Labor	Unit Cost Equip.	Total Cost Unitem.	Total Cost Material	Total Cost Labor	Total Cost Equip.	Total Direct Cost
Common Items	1	LS	199,746.00				199,746				199,746
Institutional Actions											
Deed Notations											
- Deed/Title Search	1	LS	1,500.00				1,500				1,500
- Legal Fees	1	LS	25,000.00				25,000				25,000
Piping to Treatment System											
- Pipe, 4-inch composite	340	LF		8.70	8.45	0.00		2,958	2,873	0	5,831
- Trench Excavation	131	CY		0.00	1.17	1.62		0	153	212	365
- Trench Bedding & Compaction	16	CY		3.95	5.87	14.88		63	94	238	395
- Trench Backfill & Compaction (sand)	48	CY		14.70	6.16	15.80		706	296	758	1,760
- Trench Backfill & Compaction (native)	65	CY		0.00	0.46	1.25		0	30	81	111
- Electrical Conduit	340	LF		6.00	3.50	0.00		2,040	1,190	0	3,230
Piping to Discharge											
- Pipe, 6-inch PVC	1,800	LF		6.07	9.75	0.00		10,926	17,550	0	28,476
- Trench Excavation	601	CY		0.00	1.17	1.62		0	703	974	1,677
- Trench Bedding & Compaction	75	CY		3.95	5.87	14.88		296	440	1,116	1,853
- Trench Backfill & Compaction(sand)	211	CY		14.70	6.16	15.80		3,102	1,300	3,334	7,735
- Trench Backfill & Compaction (native)	300	CY		0.00	0.46	1.25		0	138	375	513
Piping at Treatment System											
- Pipe, Misc.	25	LF		20.00	1.78	0.00		500	45	0	545
- Pipe Fittings	1	LS		5,000.00	2,000.00	1,000.00		5,000	2,000	1,000	8,000
eration Tower											
- Aeration Tower & Packing	1	Each		26,225.00	8,400.00	1,350.00		26,225	8,400	1,350	35,975
- Blower, Motor & Enclosure	1	Each		2,000.00	800.00	400.00		2,000	800	400	3,200
- Air-Flow Switch	1	Each		650.00	250.00	130.00		650	250	130	1,030
- Tower Foundation	10	CY		58.00	11.65	3.84		580	117	38	735
ther Treatment System Items											
- Controls & Electrical	1	LS	15,000.00				15,000				15,000
- Sediment Filter	1	Each		5,000.00	2,000.00	1,000.00		5,000	2,000	1,000	8,000
- Sump	1	Each		10,000.00	4,000.00	2,000.00		10,000	4,000	2,000	16,000
- Sump Pump	1	Each		2,000.00	800.00	400.00		2,000	800	400	3,200
ecovery Well											
- Recovery Well, New	4	LS	25,000.00				100,000				100,000
- Well Redevelopment	4	LS	15,000.00				60,000				60,000
- Well Header Piping	60	LF		7.00	1.36	0.00		420	82	0	502
- Riser Pipe, 50'/well	200	LF		26.54	18.40	0.00		5,308	3,680	0	8,988
- Well Pump	4	Each		2,000.00	800.00	400.00		8,000	3,200	1,600	12,800
- Pump Controls	4	Each		1,000.00	400.00	200.00		4,000	1,600	800	6,400
- Well Head Fittings & Enclosure	4	Each		5,000.00	2,000.00	1,000.00		20,000	8,000	4,000	32,000
ubtotal							401,246	109,774	59,740	19,807	590,566

ALTERNATIVE 3-I: CAPITAL COST (CONTINUED)

BISCO BRANDS, INC.
[illegible]E INDUSTRIES SITE
Sag Harbor, New York

[illegible]ound-Water Medium
[illegible]ternative Number 3-I - Capital Cost
Section 6.3.4

Subtotal	401,246	109,774	59,740	19,807	590,566
[illegible]ntractor's Overhead & Profit at 10% of Equipment Cost				1,981	1,981
[illegible]ntractor's Overhead & Profit at 10% of Material Cost		10,977			10,977
Total Direct Cost	401,246	120,751	59,740	21,787	603,524
[illegible]gineering Cost at 10% of Total Direct Cost					60,352
Project Administration Cost at 15% of Direct Labor Cost			8,961		8,961
Project Administration Cost at 5% of Direct Material Cost		6,038			6,038
[illegible]oject Administration Cost at 10% of Direct Unitemized Cost	40,125				40,125
[illegible]oject Administration Cost at 15% of Engineering Cost					9,053
Total Field Cost	441,371	126,789	68,700	21,787	728,052
[illegible]ntingency at 20% of Total Field Cost					145,610
Total Capital Cost					$873,663

D.3.2. ALTERNATIVE 3-I: ANNUAL O&M COST

BISCO BRANDS, INC.
ROME INDUSTRIES SITE
Sag Harbor, New York

ound-Water Medium
ternative Number 3-I - O&M Cost
Section 6.3.4

Item	Qty	Unit/Yr	Unit Cost Unitemized	Material	Labor	Equip.	Annual Cost Unitem.	Material	Labor	Equip.	Total Annual Cost
Aeration Tower Power											
- Blower (5.0 hp)	32,675	kW-hr	0.10				3,268	0	0	0	3,268
ration Tower Maintenance											
- Replacement Packing	125	CF		17.00	2.70	0.00	0	2,125	338	0	2,463
- Packing Disposal	4.7	CY		0.00	20.00	0.00	0	0	94	0	94
- Packing Analysis	0.5	Each	300.00				150	0	0	0	150
her Treatment System Items											
- Sump Pump Power	65,350	kW-hr	0.10		0.00	0.00	6,535	0	0	0	6,535
- Replace. Filter Bags	16	Each		50.00	20.00	0.00	0	800	320	0	1,120
- System Monitor	520	Hour		0.00	50.00	0.00	0	0	26,000	0	26,000
Recovery Well Power											
- Pump, New Well	130,700	kW-hr	0.10		0.00	0.00	13,070	0	0	0	13,070
covery Well Maintenance											
- Pump, Maintenance	640	Hour		6.25	40.00	0.00	0	4,000	25,600	0	29,600
- Well Redevelopment	4	LS	2,000.00				8,000	0	0	0	8,000
fluent Monitoring											
- Sampling (monthly)	60	Hour		10.00	50.00	0.00	0	600	3,000	0	3,600
- Laboratory Analysis	60	Each	300.00				18,000	0	0	0	18,000
- Reporting	120	Hour		0.00	50.00	0.00	0	0	6,000	0	6,000
- Expenses	12	LS	500.00				6,000	0	0	0	6,000
fluent Monitoring											
- Sampling (monthly)	12	Hour		10.00	50.00	0.00	0	120	600	0	720
- Laboratory Analysis	24	Each	300.00				7,200	0	0	0	7,200
- Reporting	48	Hour		0.00	50.00	0.00	0	0	2,400	0	2,400
Periodic Ground-Water Monitoring											
- Sampling (yearly)	64	Hour		20.00	50.00	0.00	0	1,280	3,200	0	4,480
- Sampler Expenses	1	LS		1,500.00	0.00	0.00	0	1,500	0	0	1,500
- Laboratory Analysis	19	Each	350.00				6,650	0	0	0	6,650
- Reporting	40	Hour		0.00	50.00	0.00	0	0	2,000	0	2,000
- Well Water Disposal	19	Each	600.00				11,400	0	0	0	11,400
Subtotal							80,273	10,425	69,552	0	160,249
ntractor's Overhead & Profit at 10% of Equipment Cost										0	0
ntractor's Overhead & Profit at 10% of Material Cost								1,043			1,043
Total Direct Cost							80,273	11,468	69,552	0	161,292
roject Administration Cost at 15% of Direct Labor Cost									10,433		10,433
roject Administration Cost at 5% of Direct Material Cost								573			573
Project Administration Cost at 10% of Direct Unitemized Cost							8,027				8,027
otal Field Cost							88,300	12,041	79,984	0	180,325
Total Annual O&M Cost											$180,325

D.3.3. ALTERNATIVE 3-I: 7-YEAR PRESENT WORTH COST

BISCO BRANDS, INC.
[illegible]E INDUSTRIES SITE
Sag Harbor, New York

[illegible]ound-Water Medium
[illegible]ternative 3-I - Present Worth Analysis (7 Year)
Section 6.3.4

Discount Rate = 0.05	Cost/Year Cost Occurs ($'s)							
Cost Component	0	1	2	3	4	5	6	7
[illegible]pital Cost	873,663	0	0	0	0	0	0	0
O&M Costs	0	180,325	180,325	180,325	180,325	180,325	180,325	180,325
[illegible]tal Annual Cost	873,663	180,325	180,325	180,325	180,325	180,325	180,325	180,325
[illegible]scount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068
Present Worth	873,663	171,738	163,560	155,772	148,354	141,289	134,561	128,154

[illegible]tal Present Worth ($'s)	1,917,091

D.4.0 ALTERNATIVE 3-II

The cost calculations for Alternative 3-II, described in Section 6.3.5, are based on the recovery of contaminated groundwater from seven new recovery wells at a combined flow rate of 600 gpm. This water will be piped approximately 3,100 feet to the treatment system.

Following iron treatment, the water will flow, under pressure, through a sediment filter then to a packed tower for aeration. The tower will be skid mounted and installed on a 6-inch thick concrete foundation. The effluent from the tower will flow into a sump from which it will be piped through approximately 1,800 feet of piping to discharge at Ligonee Brook. All influent piping and fittings will be made of composite material and all discharge piping will be PVC.

Prior to constructing the treatment system, the site will be survey, cleared, and grubbed. Erosion control measures will be taken also. Field office trailers, storage units, sanitary facilities, and temporary utility hookups are included in the cost calculations. Deed notations and monitor wells, as described in Alternative 2, are included in this alternative also.

O&M costs include all those described in Alternative 2 in addition to power for the aeration blower, sump pump and recovery well pumps, analysis of the packing to verify that it is inert prior to disposal, and disposal and replacement of packing. The influent to and effluent from the tower will be sampled monthly, and, following laboratory analysis of the samles, a report will be written detailing the findings.

Other O&M costs include replacement of the sediment filter bags, maintenance of the recovery wells and well pumps, and system monitoring.

D.4.1. ALTERNATIVE 3-II: CAPITAL COST

BISCO BRANDS, INC.
WE INDUSTRIES SITE
Sag Harbor, New York
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ound-Water Medium
ternative Number 3-II - Capital Cost
Section 6.3.8

Item	Qty	Unit	Unit Cost Unitemized	Unit Cost Material	Unit Cost Labor	Unit Cost Equip.	Total Cost Unitem.	Total Cost Material	Total Cost Labor	Total Cost Equip.	Total Direct Cost
Common Items	1	LS	199,746.00				199,746				199,746
Institutional Actions											
Deed Notations											
- Deed/Title Search	1	LS	1,500.00				1,500				1,500
- Legal Fees	1	LS	25,000.00				25,000				25,000
Piping to Treatment System											
Pipe, 4-inch composite	3,100	LF		8.70	8.45	0.00		26,970	26,195	0	53,165
Trench Excavation	1,194	CY		0.00	1.17	1.62		0	1,397	1,934	3,331
Trench Bedding & Compaction	149	CY		3.95	5.87	14.88		589	875	2,217	3,680
- Trench Backfill & Compaction (sand)	435	CY		14.70	6.16	15.80		6,395	2,680	6,873	15,947
Trench Backfill & Compaction (native)	597	CY		0.00	0.46	1.25		0	275	746	1,021
- Electrical Conduit	3,100	LF		6.00	3.50	0.00		18,600	10,850	0	29,450
Piping to Discharge											
Pipe, 6-inch PVC	1,800	LF		6.07	9.75	0.00		10,926	17,550	0	28,476
Trench Excavation	424	CY		0.00	1.17	1.62		0	496	687	1,183
Trench Bedding & Compaction	53	CY		3.95	5.87	14.88		209	311	789	1,309
Trench Backfill & Compaction(sand)	148	CY		14.70	6.16	15.80		2,176	912	2,338	5,426
Trench Backfill & Compaction (native)	212	CY		0.00	0.46	1.25		0	98	265	363
Piping at Treatment System											
Pipe, Misc.	25	LF		20.00	1.78	0.00		500	45	0	545
Pipe Fittings	1	LS		5,000.00	2,000.00	1,000.00		5,000	2,000	1,000	8,000
Aeration Tower											
- Aeration Tower & Packing	1	Each		52,000.00	16,640.00	2,600.00		52,000	16,640	2,600	71,240
- Blower, Motor & Enclosure	1	Each		2,000.00	800.00	400.00		2,000	800	400	3,200
- Air-Flow Switch	1	Each		650.00	250.00	130.00		650	250	130	1,030
- Tower Foundation	10	CY		58.00	11.65	3.84		580	117	38	735
ther Treatment System Items											
- Controls & Electrical	1	LS	15,000.00				15,000				15,000
- Sediment Filter	1	Each		5,000.00	2,000.00	1,000.00		5,000	2,000	1,000	8,000
- Sump	1	Each		10,000.00	4,000.00	2,000.00		10,000	4,000	2,000	16,000
- Sump Pump	1	Each		2,000.00	800.00	400.00		2,000	800	400	3,200
ecovery Well											
- Recovery Well, New	7	LS	25,000.00				175,000				175,000
- Well Redevelopment	7	LS	15,000.00				105,000				105,000
- Well Header Piping	105	LF		7.00	1.36	0.00		735	143	0	878
- Riser Pipe, 50'/well	300	LF		26.54	18.40	0.00		7,962	5,520	0	13,482
- Riser Pipe, 70'/well	70	LF		26.54	18.40	0.00		1,858	1,288	0	3,146
- Well Pump (5 hp)	4	Each		2,000.00	800.00	400.00		8,000	3,200	1,600	12,800
- Well Pump (10 hp)	3	Each		4,000.00	1,600.00	800.00					
- Pump Controls	7	Each		1,000.00	400.00	200.00		7,000	2,800	1,400	11,200
- Well Head Fittings & Enclosure	7	Each		5,000.00	2,000.00	1,000.00		35,000	14,000	7,000	56,000
Subtotal							521,246	204,149	115,239	33,418	874,052

ALTERNATIVE 3-II: CAPITAL COST (CONTINUED)

HISCO BRANDS, INC.
E INDUSTRIES SITE
Sag Harbor, New York

Ground-Water Medium
Alternative Number 3-II - Capital Cost
Section 6.3.8

Subtotal	521,246	204,149	115,239	33,418	874,052
Contractor's Overhead & Profit at 10% of Equipment Cost				3,342	3,342
Contractor's Overhead & Profit at 10% of Material Cost		20,415			20,415
Total Direct Cost	521,246	224,564	115,239	36,760	897,808
Engineering Cost at 10% of Total Direct Cost					89,781
Project Administration Cost at 15% of Direct Labor Cost			17,286		17,286
Project Administration Cost at 5% of Direct Material Cost		11,228			11,228
Project Administration Cost at 10% of Direct Unitemized Cost	52,125				52,125
Project Administration Cost at 15% of Engineering Cost					13,467
Total Field Cost	573,371	235,792	132,525	36,760	1,081,695
Contingency at 20% of Total Field Cost					216,339
Total Capital Cost					$1,298,034

D.4.2. ALTERNATIVE 3-II: ANNUAL O&M COST

BISCO BRANDS, INC.
WE INDUSTRIES SITE
Sag Harbor, New York

Ground-Water Medium
ternative Number 3-II - O&M Cost
ction 6.3.8

Item	Qty	Unit/Yr	Unit Cost Unitemized	Material	Labor	Equip.	Annual Cost Unitem.	Material	Labor	Equip.	Total Annual Cost
eration Tower Power											
- Blower (5.0 hp)	32,675	kW-hr	0.10				3,268				3,268
eration Tower Maintenance											
- Replacement Packing	675	CF		17.00	2.70	0.00		11,475	1,823	0	13,298
- Packing Disposal	25	CY		0.00	20.00	0.00		0	500	0	500
- Packing Analysis	0.5	Each	300.00				150				150
Other Treatment System Items											
- Sump Pump Power	130,700	kW-hr	0.10				13,070				13,070
- Replace. Filter Bags	16	Each		50.00	20.00	0.00		800	320	0	1,120
- System Monitor	520	Hour		0.00	50.00	0.00		0	26,000	0	26,000
Recovery Well Power											
- Pump, New Wells	130,700	kW-hr	0.10				13,070				13,070
covery Well Power											
- Pump, New Wells	196,050	kW-hr	0.10				19,605				19,605
Recovery Well Maintenance											
- Pump, Maintenance	1,120	Hour		6.25	40.00	0.00		7,000	44,800	0	51,800
- Well Redevelopment	7	LS	2,000.00				14,000				14,000
fluent Monitoring											
- Sampling (monthly)	60	Hour		10.00	50.00	0.00		600	3,000	0	3,600
- Laboratory Analysis	60	Each	300.00				18,000				18,000
- Expenses	12	LS	500.00				6,000				6,000
- Reporting	120	Hour		0.00	50.00	0.00		0	6,000	0	6,000
fluent Monitoring											
- Sampling (monthly)	12	Hour		10.00	50.00	0.00		120	600	0	720
- Laboratory Analysis	24	Each	300.00				7,200				7,200
- Reporting	48	Hour		0.00	50.00	0.00		0	2,400	0	2,400
riodic Ground-Water Monitoring											
- Sampling (yearly)	64	Hour		20.00	50.00	0.00		1,280	3,200	0	4,480
- Sampler Expenses	1	LS		1,500.00	0.00	0.00		1,500	0	0	1,500
- Laboratory Analysis	19	Each	350.00				6,650				6,650
- Reporting	40	Hour		0.00	50.00	0.00		0	2,000	0	2,000
- Well Water Disposal	19	Each	600.00				11,400				11,400
Subtotal							112,413	22,775	90,643	0	225,830
ntractor's Overhead & Profit at 10% of Equipment Cost										0	0
Contractor's Overhead & Profit at 10% of Material Cost								2,278			2,278
tal Direct Cost							112,413	25,053	90,643	0	228,108
roject Administration Cost at 15% of Direct Labor Cost									13,596		13,596
Project Administration Cost at 5% of Direct Material Cost								1,253			1,253
roject Administration Cost at 10% of Direct Unitemized Cost							11,241				11,241
tal Field Cost							123,654	26,305	104,239	0	254,198
tal Annual O&M Cost											$254,198

D.4.3. ALTERNATIVE 3-II: 12-YEAR PRESENT WORTH COST

BISCO BRANDS,INC.
WE INDUSTRIES SITE
Sag Harbor, New York

Ground-Water Medium
ternative 3-II - Present Worth Analysis (12 Year)
ction 6.3.8
Discount Rate = 0.05

Cost Component	Cost/Year Cost Occurs ($'s) 0	1	2	3	4	5	6	7	8	9
pital Cost	1,298,034	0	0	0	0	0	0	0	0	0
M Costs	0	254,198	254,198	254,198	254,198	254,198	254,198	254,198	254,198	254,198
Total Annual Cost	1,298,034	254,198	254,198	254,198	254,198	254,198	254,198	254,198	254,198	254,198
scount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	1,298,034	242,093	230,565	219,586	209,129	199,171	189,686	180,654	172,051	163,858

	10	11	12
Capital Cost	0	0	0
M Costs	254,198	254,198	254,198
Total Annual Cost	254,198	254,198	254,198
Discount Factor	0.61391	0.58468	0.55684
resent Worth	156,056	148,624	141,547

otal Present Worth ($'s)	3,551,055

D.5.0. ALTERNATIVE 4-I

The cost calculations for Alternative 4-I, described in Section 6.4.1., are based on the recovery of contaminated ground water from four new recovery wells at a combined flow rate of 150 gpm. This water will be piped approximately 340 feet to the treatment system.

Following iron treatment, the water will flow, under pressure, through a sediment filter then to a packed tower for aeration. The tower will be skid mounted and installed on a 6-inch thick concrete foundation. The effluent from the tower will flow into a sump from which it will be piped through approximately 3,700 feet of piping to discharge at Sag Harbor Cove. All influent piping and fittings will be made of composite material and all discharge piping will be PVC.

Prior to constructing the treatment system, the site will be surveyed, cleared, and grubbed. Erosion control measures will also be taken. Field office trailers, storage units, sanitary facilities, and temporary utility hookups are included in the cost calculations. Deed notations and monitor wells, as described in Alternative 2, are also included in this alternative.

O&M costs include all those described in Alternative 2 in addition to power for the aeration blower, sump pump and recovery well pumps, analysis of the packing to verify that it is inert prior to disposal, and disposal and replacement of packing. The influent to and effluent from the tower will be sampled monthly, and, following laboratory analysis of the samples, a report will be written detailing the findings.

Other O&M costs include replacement of the sediment filter bags, maintenance of the recovery wells and well pumps, and system monitoring.

D.5.1. ALTERNATIVE 4-I: CAPITAL COST

BISCO BRANDS, INC.
WE INDUSTRIES SITE
Sag Harbor, New York
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ound-Water Medium
ternative Number 4-I - Capital Cost
ection 6.4.4

Item	Qty	Unit	Unit Cost Unitemized	Unit Cost Material	Unit Cost Labor	Unit Cost Equip.	Total Cost Unitem.	Total Cost Material	Total Cost Labor	Total Cost Equip.	Total Direct Cost
Common Items	1	LS	199,746.00				199,746				199,746
Institutional Actions											
Deed Notations											
- Deed/Title Search	1	LS	1,500.00				1,500				1,500
- Legal Fees	1	LS	25,000.00				25,000				25,000
Piping to Treatment System											
- Pipe, 4-inch composite	340	LF		8.70	8.45	0.00		2,958	2,873	0	5,831
Trench Excavation	131	CY		0.00	1.17	1.62		0	153	212	365
Trench Bedding & Compaction	16	CY		3.95	5.87	14.88		63	94	238	395
- Trench Backfill & Compaction (sand)	48	CY		14.70	6.16	15.80		706	296	758	1,760
Trench Backfill & Compaction (native)	65	CY		0.00	0.46	1.25		0	30	81	111
- Electrical Conduit	340	LF		6.00	3.50	0.00		2,040	1,190	0	3,230
Piping to Discharge											
Pipe, 6-inch PVC	3,700	LF		6.07	9.75	0.00		22,459	36,075	0	58,534
Trench Excavation	1,333	CY		0.00	1.17	1.62		0	1,560	2,159	3,719
Trench Bedding & Compaction	167	CY		3.95	5.87	14.88		660	980	2,485	4,125
Trench Backfill & Compaction(sand)	467	CY		14.70	6.16	15.80		6,865	2,877	7,379	17,120
Trench Backfill & Compaction (native)	666	CY		0.00	0.46	1.25		0	306	833	1,139
Piping at Treatment System											
Pipe, Misc.	25	LF		20.00	1.78	0.00		500	45	0	545
Pipe Fittings	1	LS		5,000.00	2,000.00	1,000.00		5,000	2,000	1,000	8,000
Aeration Tower											
- Aeration Tower & Packing	1	Each		26,225.00	8,400.00	1,350.00		26,225	8,400	1,350	35,975
Blower, Motor & Enclosure	1	Each		2,000.00	800.00	400.00		2,000	800	400	3,200
- Air-Flow Switch	1	Each		650.00	250.00	130.00		650	250	130	1,030
- Tower Foundation	10	CY		58.00	11.65	3.84		580	117	38	735
Other Treatment System Items											
Controls & Electrical	1	LS	15,000.00				15,000				15,000
Sediment Filter	1	Each		5,000.00	2,000.00	1,000.00		5,000	2,000	1,000	8,000
- Sump	1	Each		10,000.00	4,000.00	2,000.00		10,000	4,000	2,000	16,000
Sump Pump	1	Each		2,000.00	800.00	400.00		2,000	800	400	3,200
Recovery Well											
Recovery Well, New	4	LS	25,000.00				100,000				100,000
- Well Redevelopment	4	LS	15,000.00				60,000				60,000
- Well Header Piping	60	LF		7.00	1.36	0.00		420	82	0	502
Riser Pipe, 50'/well	200	LF		26.54	18.40	0.00		5,308	3,680	0	8,988
Well Pump	4	Each		2,000.00	800.00	400.00		8,000	3,200	1,600	12,800
Pump Controls	4	Each		1,000.00	400.00	200.00		4,000	1,600	800	6,400
- Well Head Fittings & Enclosure	4	Each		5,000.00	2,000.00	1,000.00		20,000	8,000	4,000	32,000
Subtotal							401,246	125,433	81,406	26,864	634,950

ALTERNATIVE 4-I: CAPITAL COST (CONTINUED)

BISCO BRANDS, INC.
WE INDUSTRIES SITE
Sag Harbor, New York
---
ound-Water Medium
ternative Number 4-I - Capital Cost
ection 6.4.4

Subtotal	401,246	125,433	81,406	26,864	634,950
ntractor's Overhead & Profit at 10% of Equipment Cost				2,686	2,686
ntractor's Overhead & Profit at 10% of Material Cost		12,543			12,543
Total Direct Cost	401,246	137,977	81,406	29,550	650,179
gineering Cost at 10% of Total Direct Cost					65,018
Project Administration Cost at 15% of Direct Labor Cost			12,211		12,211
Project Administration Cost at 5% of Direct Material Cost		6,899			6,899
oject Administration Cost at 10% of Direct Unitemized Cost	40,125				40,125
oject Administration Cost at 15% of Engineering Cost					9,753
Total Field Cost	441,371	144,876	93,617	29,550	784,184
ntingency at 20% of Total Field Cost					156,837
Total Capital Cost					$941,021

D.5.2. ALTERNATIVE 4-I: ANNUAL O&M COST

BISCO BRANDS, INC.
WE INDUSTRIES SITE
g Harbor, New York

Ground-Water Medium
ternative Number 4-I - O&M Cost
ction 6.4.4

Item	Qty	Unit/Yr	Unit Cost Unitemized	Material	Labor	Equip.	Annual Cost Unitem.	Material	Labor	Equip.	Total Annual Cost
ration Tower Power											
- Blower (5.0 hp)	32,675	kW-hr	0.10				3,268				3,268
Aeration Tower Maintenance											
- Replacement Packing	125	CF		17.00	2.70	0.00		2,125	338	0	2,463
- Packing Disposal	4.7	CY		0.00	20.00	0.00		0	94	0	94
- Packing Analysis	0.5	Each	300.00				150				150
Other Treatment System Items											
- Sump Pump Power	65,350	kW-hr	0.10				6,535				6,535
- Replace. Filter Bags	16	Each		50.00	20.00	0.00		800	320	0	1,120
- System Monitor	520	Hour		0.00	50.00	0.00		0	26,000	0	26,000
Recovery Well Power											
- Pump, New Well	130,700	kW-hr	0.10				13,070				13,070
covery Well Maintenance											
- Pump, Maintenance	640	Hour		6.25	40.00	0.00		4,000	25,600	0	29,600
- Well Redevelopment	4	LS	2,000.00				8,000				8,000
Influent Monitoring											
- Expenses	12	LS	500.00				6,000				6,000
- Sampling (monthly)	60	Hour		10.00	50.00	0.00		600	3,000	0	3,600
- Laboratory Analysis	60	Each	300.00				18,000				18,000
- Reporting	120	Hour		0.00	50.00	0.00		0	6,000	0	6,000
Effluent Monitoring											
- Sampling (monthly)	12	Hour		10.00	50.00	0.00		120	600	0	720
- Laboratory Analysis	24	Each	300.00				7,200				7,200
- Reporting	48	Hour		0.00	50.00	0.00		0	2,400	0	2,400
Periodic Ground-Water Monitoring											
- Sampling (yearly)	64	Hour		20.00	50.00	0.00		1,280	3,200	0	4,480
- Sampler Expenses	1	LS		1,500.00	0.00	0.00		1,500	0	0	1,500
- Laboratory Analysis	19	Each	350.00				6,650				6,650
- Reporting	40	Hour		0.00	50.00	0.00		0	2,000	0	2,000
- Well Water Disposal	19	Each	600.00				11,400				11,400
btotal							80,273	10,425	69,552	0	160,249
Contractor's Overhead & Profit at 10% of Equipment Cost										0	0
ntractor's Overhead & Profit at 10% of Material Cost								1,043			1,043
Total Direct Cost							80,273	11,468	69,552	0	161,292
roject Administration Cost at 15% of Direct Labor Cost									10,433		10,433
oject Administration Cost at 5% of Direct Material Cost								573			573
roject Administration Cost at 10% of Direct Unitemized Cost							8,027				8,027
Total Field Cost							88,300	12,041	79,984	0	180,325
Total Annual O&M Cost											$180,325

D.5.3. ALTERNATIVE 4-I: 7-YEAR PRESENT WORTH COST

BISCO BRANDS, INC.
WE INDUSTRIES SITE
Sag Harbor, New York

Ground-Water Medium
ternative 4-I - Present Worth Analysis (7 Year)
ction 6.4.4
Discount Rate = 0.05

Cost Component	Cost/Year Cost Occurs ($'s) 0	1	2	3	4	5	6	7
pital Cost	941,021	0	0	0	0	0	0	0
M Costs	0	180,325	180,325	180,325	180,325	180,325	180,325	180,325
Total Annual Cost	941,021	180,325	180,325	180,325	180,325	180,325	180,325	180,325
scount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068
Present Worth	941,021	171,738	163,560	155,772	148,354	141,289	134,561	128,154

Total Present Worth ($'s)	1,984,449

D.6.0. ALTERNATIVE 4-II

The cost calculations for Alternative 4-II, described in Section 6.4.5., are based on the recovery of contaminated ground water from seven new recovery wells at a combined flow rate of 600 gpm. This water will be piped approximately 3,100 feet to the treatment system.

Following iron treatment, the water will flow, under pressure, through a sediment filter then to a packed tower for aeration. The tower will be skid mounted and installed on a 6-inch thick concrete foundation. The effluent from the tower will flow into a sump from which it will be piped through approximately 3,700 feet of piping to discharge at Sag Harbor Cove. All influent piping and fittings will be made of composite material and all discharge piping will be PVC.

Prior to constructing the treatment system, the site will be surveyed, cleared, and grubbed. Erosion control measures will also be taken. Field office trailers, storage units, sanitary facilities, and temporary utility hookups are included in the cost calculations. Deed notations and monitor wells, as described in Alternative 2, are also included in this alternative.

O&M costs include all those described in Alternative 2 in addition to power for the aeration blower, sump pump and recovery well pumps, analysis of the packing to verify that it is inert prior to disposal, and disposal and replacement of packing. The influent to and effluent from the tower will be sampled monthly, and, following laboratory analysis of the samples, a report will be written detailing the findings.

Other O&M costs include replacement of the sediment filter bags, maintenance of the recovery wells and well pumps, and system monitoring.

D.6.1. ALTERNATIVE 4-II: CAPITAL COST

BISCO BRANDS, INC.
ME INDUSTRIES SITE
Sag Harbor, New York
---
ound-Water Medium
ternative Number 4-II - Capital Cost
Section 6.4.8

Item	Qty	Unit	Unit Cost Unitemized	Unit Cost Material	Unit Cost Labor	Unit Cost Equip.	Total Cost Unitem.	Total Cost Material	Total Cost Labor	Total Cost Equip.	Total Direct Cost
Common Items	1	LS	199,746.00				199,746				199,746
Institutional Actions											
Deed Notations											
- Deed/Title Search	1	LS	1,500.00				1,500				1,500
- Legal Fees	1	LS	25,000.00				25,000				25,000
Piping to Treatment System											
- Pipe, 4-inch composite	3,100	LF		8.70	8.45	0.00		26,970	26,195	0	53,165
- Trench Excavation	1,194	CY		0.00	1.17	1.62		0	1,397	1,934	3,331
- Trench Bedding & Compaction	149	CY		3.95	5.87	14.88		589	875	2,217	3,680
- Trench Backfill & Compaction (sand)	435	CY		14.70	6.16	15.80		6,395	2,680	6,873	15,947
- Trench Backfill & Compaction (native)	597	CY		0.00	0.46	1.25		0	275	746	1,021
- Electrical Conduit	3,100	LF		6.00	3.50	0.00		18,600	10,850	0	29,450
Piping to Discharge											
- Pipe, 6-inch PVC	3,700	LF		6.07	9.75	0.00		22,459	36,075	0	58,534
- Trench Excavation	308	CY		0.00	1.17	1.62		0	360	499	859
- Trench Bedding & Compaction	39	CY		3.95	5.87	14.88		154	229	580	963
- Trench Backfill & Compaction(sand)	108	CY		14.70	6.16	15.80		1,588	665	1,706	3,959
- Trench Backfill & Compaction (native)	154	CY		0.00	0.46	1.25		0	71	193	263
Piping at Treatment System											
- Pipe, Misc.	25	LF		20.00	1.78	0.00		500	45	0	545
- Pipe Fittings	1	LS		5,000.00	2,000.00	1,000.00		5,000	2,000	1,000	8,000
Aeration Tower											
- Aeration Tower & Packing	1	Each		52,000.00	16,640.00	2,600.00		52,000	16,640	2,600	71,240
- Blower, Motor & Enclosure	1	Each		2,000.00	800.00	400.00		2,000	800	400	3,200
- Air-Flow Switch	1	Each		650.00	250.00	130.00		650	250	130	1,030
- Tower Foundation	10	CY		58.00	11.65	3.84		580	117	38	735
ther Treatment System Items											
- Controls & Electrical	1	LS	15,000.00				15,000				15,000
- Sediment Filter	1	Each		5,000.00	2,000.00	1,000.00		5,000	2,000	1,000	8,000
- Sump	1	Each		10,000.00	4,000.00	2,000.00		10,000	4,000	2,000	16,000
- Sump Pump	1	Each		2,000.00	800.00	400.00		2,000	800	400	3,200
ecovery Well											
- Recovery Well, New	7	LS	25,000.00				175,000				175,000
- Well Redevelopment	7	LS	15,000.00				105,000				105,000
- Well Header Piping	105	LF		7.00	1.36	0.00		735	143	0	878
- Riser Pipe, 50'/well	300	LF		26.54	18.40	0.00		7,962	5,520	0	13,482
- Riser Pipe, 70'/well	70	LF		26.54	18.40	0.00		1,858	1,288	0	3,146
- Well Pump (5 hp)	4	Each		2,000.00	800.00	400.00		8,000	3,200	1,600	12,800
- Well Pump (10 hp)	3	Each		4,000.00	1,600.00	800.00					
- Pump Controls	7	Each		1,000.00	400.00	200.00		7,000	2,800	1,400	11,200
- Well Head Fittings & Enclosure	7	Each		5,000.00	2,000.00	1,000.00		35,000	14,000	7,000	56,000
Subtotal							521,246	215,039	133,273	32,317	901,875

ALTERNATIVE 4-II: CAPITAL COST (CONTINUED)

BISCO BRANDS, INC.
WE INDUSTRIES SITE
Sag Harbor, New York
---
ound-Water Medium
ternative Number 4-II - Capital Cost
ection 6.4.8

Subtotal	521,246	215,039	133,273	32,317	901,875
ntractor's Overhead & Profit at 10% of Equipment Cost				3,232	3,232
Contractor's Overhead & Profit at 10% of Material Cost		21,504			21,504
tal Direct Cost	521,246	236,542	133,273	35,549	926,610
ngineering Cost at 10% of Total Direct Cost					92,661
Project Administration Cost at 15% of Direct Labor Cost			19,991		19,991
oject Administration Cost at 5% of Direct Material Cost		11,827			11,827
oject Administration Cost at 10% of Direct Unitemized Cost	52,125				52,125
Project Administration Cost at 15% of Engineering Cost					13,899
tal Field Cost	573,371	248,369	153,264	35,549	1,117,113
Contingency at 20% of Total Field Cost					223,423
tal Capital Cost					$1,340,536

D.6.2. ALTERNATIVE 4-II: ANNUAL O&M COST

BISCO BRANDS, INC.
ROWE INDUSTRIES SITE
Sag Harbor, New York
---
ound-Water Medium
ternative Number 4-II - O&M Cost
Section 6.4.8

Item	Qty	Unit/Yr	Unit Cost Unitemized	Material	Labor	Equip.	Annual Cost Unitem.	Material	Labor	Equip.	Total Annual Cost
Aeration Tower Power											
- Blower (5.0 hp)	32,675	kW-hr	0.10				3,268				3,268
ration Tower Maintenance											
- Replacement Packing	675	CF		17.00	2.70	0.00		11,475	1,823	0	13,298
- Packing Disposal	25	CY		0.00	20.00	0.00		0	500	0	500
- Packing Analysis	0.5	Each	300.00				150				150
her Treatment System Items											
- Sump Pump Power	130,700	kW-hr	0.10				13,070				13,070
- Replace. Filter Bags	16	Each		50.00	20.00	0.00		800	320	0	1,120
- System Monitor	520	Hour		0.00	50.00	0.00		0	26,000	0	26,000
Recovery Well Power											
- Pump, New Wells	130,700	kW-hr	0.10				13,070				13,070
covery Well Power											
- Pump, New Wells	196,050	kW-hr	0.10				19,605				19,605
Recovery Well Maintenance											
- Pump, Maintenance	1,120	Hour		6.25	40.00	0.00		7,000	44,800	0	51,800
- Well Redevelopment	7	LS	2,000.00				14,000				14,000
fluent Monitoring											
- Sampling (monthly)	60	Hour		10.00	50.00	0.00		600	3,000	0	3,600
- Laboratory Analysis	60	Each	300.00				18,000				18,000
- Reporting	120	Hour		0.00	50.00	0.00		0	6,000	0	6,000
- Expenses	12	LS	500.00				6,000	0	0	0	6,000
Effluent Monitoring											
- Sampling (monthly)	12	Hour		10.00	50.00	0.00		120	600	0	720
- Laboratory Analysis	24	Each	300.00				7,200				7,200
- Reporting	48	Hour		0.00	50.00	0.00		0	2,400	0	2,400
riodic Ground-Water Monitoring											
- Sampling (yearly)	64	Hour		20.00	50.00	0.00		1,280	3,200	0	4,480
- Sampler Expenses	1	LS		1,500.00	0.00	0.00		1,500	0	0	1,500
- Laboratory Analysis	19	Each	350.00				6,650				6,650
- Reporting	40	Hour		0.00	50.00	0.00		0	2,000	0	2,000
- Well Water Disposal	19	Each	600.00				11,400				11,400
Subtotal							112,413	22,775	90,643	0	225,830
Contractor's Overhead & Profit at 10% of Equipment Cost										0	0
Contractor's Overhead & Profit at 10% of Material Cost								2,278			2,278
otal Direct Cost							112,413	25,053	90,643	0	228,108
Project Administration Cost at 15% of Direct Labor Cost									13,596		13,596
Project Administration Cost at 5% of Direct Material Cost								1,253			1,253
oject Administration Cost at 10% of Direct Unitemized Cost							11,241				11,241
Total Field Cost							123,654	26,305	104,239	0	254,198
otal Annual O&M Cost											$254,198

D.6.3. ALTERNATIVE 4-II: 12-YEAR PRESENT WORTH COST

BISCO BRANDS,INC.
NE INDUSTRIES SITE
Sag Harbor, New York
---
ound-Water Medium
ternative 4-II - Present Worth Analysis (12 Year)
ection 6.4.8
Discount Rate = 0.05

Cost Component	Cost/Year Cost Occurs ($'s) 0	1	2	3	4	5	6	7	8	9
pital Cost	1,340,536	0	0	0	0	0	0	0	0	0
M Costs	0	254,198	254,198	254,198	254,198	254,198	254,198	254,198	254,198	254,198
tal Annual Cost	1,340,536	254,198	254,198	254,198	254,198	254,198	254,198	254,198	254,198	254,198
scount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	1,340,536	242,093	230,565	219,586	209,129	199,171	189,686	180,654	172,051	163,858

	10	11	12
apital Cost	0	0	0
M Costs	254,198	254,198	254,198
Total Annual Cost	254,198	254,198	254,198
Discount Factor	0.61391	0.58468	0.55684
esent Worth	156,056	148,624	141,547

Total Present Worth ($'s) 3,593,557

D.7.0. COMMON COSTS: CAPITAL

BISCO BRANDS, INC.
E INDUSTRIES SITE
Sag Harbor, New York

ound-Water Medium
mon Capital Cost

Item	Qty	Unit	Unit Cost Unitemized Material	Labor	Equip.	Total Cost Unitem.	Material	Labor	Equip.	Total Direct Cost
ron Treatment	1	LS	100,000			100,000				100,000
Installing Power	1	LS	5,000			5,000				5,000
Clearing	1	LS	10,000			10,000				10,000
te Security	1	LS	3,000			3,000				3,000
eatment Shed	1	LS	25,000			25,000				25,000
Concrete Pad	1	LS	3,000			3,000				3,000
Shed Plumbing	1	LS	7,000			7,000				7,000
T System	1	LS	2,000			2,000				2,000
te Restoration	1	LS	60,000			60,000				60,000
ilities	1	LS	22,000			22,000				22,000
Subtotal						137,000	0	0	0	137,000
ntractor's Overhead & Profit at 10% of Equipment Cost									0	0
Contractor's Overhead & Profit at 10% of Material Cost							0			0
tal Direct Cost						137,000	0	0	0	137,000
gineering Cost at 10% of Total Direct Cost										13,700
Project Administration Cost at 15% of Direct Labor Cost								0		0
oject Administration Cost at 5% of Direct Material Cost							0			0
oject Administration Cost at 10% of Direct Unitemized Cost						13,700				13,700
Project Administration Cost at 15% of Engineering Cost										2,055
tal Field Cost						150,700	0	0	0	166,455
Contingency at 20% of Total Field Cost										33,291
tal Capital Cost										$199,746

D.7.1. COMMON COSTS: ANNUAL O&M

BISCO BRANDS, INC.
E INDUSTRIES SITE
g Harbor, New York

Ground-Water Medium
mon O&M Cost

Item	Qty	Unit/Yr	Unit Cost Unitemized	Material	Labor	Equip.	Annual Cost Unitem.	Material	Labor	Equip.	Total Annual Cost
on Treatment	1	LS	50,000.00	0.00	0.00	0.00	50,000	0	0	0	50,000
Site Monitoring	1	LS	24,000.00	0.00	0.00	0.00	24,000	0	0	0	24,000
Heat for Shed	1	LS	1,000.00	0.00	0.00	0.00	1,000	0			1,000
T System	1	LS	1,000.00	0.00	0.00	0.00	1,000				1,000
ilities	1	LS	2,000.00	0.00	0.00	0.00	2,000	0	0	0	2,000
Subtotal							78,000	0	0	0	78,000
ntractor's Overhead & Profit at 10% of Equipment Cost										0	0
Contractor's Overhead & Profit at 10% of Material Cost								0			0
tal Direct Cost							78,000	0	0	0	78,000
Project Administration Cost at 15% of Direct Labor Cost									0		0
Project Administration Cost at 5% of Direct Material Cost								0			0
roject Administration Cost at 10% of Direct Unitemized Cost							7,800				7,800
tal Field Cost							85,800	0	0	0	85,800
tal Annual O&M Cost											$85,800

APPENDIX E

COST CALCULATIONS FOR REMEDIAL ALTERNATIVES FOR THE SOIL MEDIUM

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E.0 COST CALCULATIONS - SOIL MEDIUM

The costs calculated for the remedial alternatives of Section 10.0 include the following:

- the direct and indirect capital costs;
- the direct and indirect annual operation and maintenance (O&M) costs;
- the 10-year present worth costs; and
- the 30-year present worth costs.

The capital cost calculations are based on the quantity of required treatment component units (items) multiplied by the material, labor and equipment costs per unit. If a subcontractor can supply the item at a known cost, then the number of items is multiplied by the unitemized cost per unit. The item costs are summed to provide a subtotal of the capital cost. This subtotal is then marked-up to account for contractor's overhead and profit, administrative, contingency and engineering costs. The marked-up cost is the "total capital cost" of the remedial alternative.

The O&M cost calculations are based on the quantity of required items per year multiplied by the material, labor and equipment costs per unit. If a subcontractor can supply the item at a known cost, then the number of items is multiplied by the unitemized cost per unit. The item costs are summed to provide a subtotal of the annual cost. This subtotal is then marked-up to account for contractor's overhead and profit and administrative costs. The marked-up cost is the "total annual O&M cost" of the remedial alternative.

The 10- and 30-year present worth costs are calculated by summing the total capital and total O&M costs for each year to provide a total annual cost for each year. The total annual cost for each year is then multiplied by a discount factor to provide the present worth of the total annual cost for each year. The present worth costs are then summed to provide the total present worth cost for the process option. The discount factor is based on a 5-percent discount rate, compounded annually. This is equivalent to an assumed inflation rate of 5 percent and an interest rate of 10 percent.

E.1.0 ALTERNATIVE 1

Alternative 1, the "No Action" alternative, does not have any costs associated with it. Therefore, no cost calculations are presented here.

E.2.0 ALTERNATIVE 2

The cost calculations for Alternative 2, described in Section 10.2.1., are based on the fees involved with obtaining deed notations and providing physical restrictions. The deed notation fees include the cost of research time for a deed/title search, a parcel survey, the legal fees for securing deed notations and the costs required to obtain a closure permit. The site will be secured by installing a 6-foot high industrial grade chainlink fence and by posting two, 20- by 14-inch warning signs on each side of the fence.

Annual O&M costs are for periodic soil monitoring. Every six months, soil samples will be collected and analyzed for VOCs and metals using the TCLP method. The results of this analysis will be compiled for reporting.

E.2.1. Alternative 2: Capital Cost

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
Sag Harbor, New York

Deed Notation/Physical Restrictions
Alternative Number 2 - Capital Cost

Item	Qty	Unit	Unit Cost Unitem.	Unit Cost Mater.	Unit Cost Labor	Unit Cost Equip.	Total Cost Unitem.	Total Cost Mater.	Total Cost Labor	Total Cost Equip.	Total Direct Cost
Institution Actions											
Deed Notions											
Deed/Title Search	1	LS	1,500				1,500	0	0	0	1,500
Parcel Survey	1	LS	1,000				1,000	0	0	0	1,000
Legal Fees	1	LS	10,000				10,000	0	0	0	10,000
Closure Permit	1	LS	10,000				10,000	0	0	0	10,000
Physical Restrictions											
Security Fence	140	LF		10.90	3.13	2.00	0	1,526	438	280	2,244
Corner Posts	4	Each		55.00	19.57	12.55	0	220	78	50	348
Braces	4	Each		15.21	9.75	6.27	0	61	39	25	125
Gate, 12' Wide	1	Each		300.00	200.00	140.00	0	300	200	140	640
Warning Signs	8	Each	220.00				1,760	0	0	0	1,760
Subtotal							24,260	2,107	755	495	27,618
Contractor's Overhead & Profit at 10% of Equipment Cost										50	50
Contractor's Overhead & Profit at 10% of Material Cost								211			211
Total Direct Cost							24,260	2,318	755	545	27,878
Engineering Cost at 10% of Total Direct Cost											2,788
Project Administration Cost at 15% of Direct Labor Cost									113		113
Project Administration Cost at 5% of Direct Material Cost								116			116
Project Administration Cost at 10% of Direct Unitemized Cost							2,426				2,426
Project Administration Cost at 15% of Engineering Cost											418
Total Field Cost							26,686	2,433	869	545	33,739
Contingency at 20% of Total Field Cost											6,748
Total Capital Cost											$40,487

E.2.2. Alternative 2: Annual O&M Cost

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
Sag Harbor, New York

Deed Notation/Physical Restrictions
Alternative Number 2 - O&M Cost

Item	Qty	Unit/Yr	Unit Cost Unitem.	Unit Cost Mater.	Unit Cost Labor	Unit Cost Equip.	Annual Cost Unitem.	Annual Cost Material	Annual Cost Labor	Annual Cost Equip.	Total Annual Cost
Monitoring											
Lab Analyses	10	Each	1100.00				11,000	0	0	0	11,000
Sampling/Sampler Expenses	2	LS		1000.00			0	2,000	0	0	2,000
Reporting	20	Hour			55.00		0	0	1,100	0	1,100
Subtotal							11,000	2,000	1,100	0	14,100
Contractor's Overhead & Profit at 10% of Equipment Cost										0	0
Contractor's Overhead & Profit at 10% of Material Cost								200			200
Total Direct Cost							11,000	2,200	1,100	0	14,300
Project Administration Cost at 15% of Direct Labor Cost									165		165
Project Administration Cost at 5% of Direct Material Cost								110			110
Project Administration Cost at 10% of Direct Unitemized Cost							1,100				1,100
Total Field Cost							12,100	2,310	1,265	0	15,675
Total Annual O&M Cost											$15,675

E.2.3. Alternative 2: 10-year Present Worth Cost

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
Sag Harbor, New York

Deed Notation/Physical Restrictions
Alternative Number 2 - Present Worth Analysis (10 Year)
Discount Rate = 0.05

Cost Component	Cost/Year Cost Occurs ($'s)									
	0	1	2	3	4	5	6	7	8	9
Capital Cost	40,487	0	0	0	0	0	0	0	0	0
O&M Costs	0	15,675	15,675	15,675	15,675	15,675	15,675	15,675	15,675	15,675
Total Annual Cost	40,487	15,675	15,675	15,675	15,675	15,675	15,675	15,675	15,675	15,675
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	40,487	14,929	14,218	13,541	12,896	12,282	11,697	11,140	10,609	10,104

Cost Component	10
Capital Cost	0
O&M Costs	15,675
Total Annual Cost	15,675
Discount Factor	0.61391
Present Worth	9,623
Total Present Worth ($'s)	161,525

E.2.4. Alternative 2: 30-year Present Worth

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
Sag Harbor, New York

Deed Notation/Physical Restrictions
Alternative Number 2 - Present Worth Analysis (30 Year)
Discount Rate = 0.05

Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	40,487	0	0	0	0	0	0	0	0	0
O&M Costs	0	15,675	15,675	15,675	15,675	15,675	15,675	15,675	15,675	15,675
Total Annual Cost	40,487	15,675	15,675	15,675	15,675	15,675	15,675	15,675	15,675	15,675
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	40,487	14,929	14,218	13,541	12,896	12,282	11,697	11,140	10,609	10,104

	10	11	12	13	14	15	16	17	18	19
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	15,675	15,675	15,675	15,675	15,675	15,675	15,675	15,675	15,675	15,675
Total Annual Cost	15,675	15,675	15,675	15,675	15,675	15,675	15,675	15,675	15,675	15,675
Discount Factor	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573
Present Worth	9,623	9,165	8,728	8,313	7,917	7,540	7,181	6,839	6,513	6,203

	20	21	22	23	24	25	26	27	28	29
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	15,675	15,675	15,675	15,675	15,675	15,675	15,675	15,675	15,675	15,675
Total Annual Cost	15,675	15,675	15,675	15,675	15,675	15,675	15,675	15,675	15,675	15,675
Discount Factor	0.37689	0.35894	0.34185	0.32557	0.31007	0.29530	0.28124	0.26785	0.25509	0.24295
Present Worth	5,908	5,626	5,358	5,103	4,860	4,629	4,408	4,199	3,999	3,808

	30
Capital Cost	0
O&M Costs	15,675
Total Annual Cost	15,675
Discount Factor	0.23138
Present Worth	3,627
Total Present Worth ($'s)	281,450

E.3.0. ALTERNATIVE 3

The cost calculations for Alternative 3, described in Section 10.3.1, are based on installing a cap in accordance with RCRA specifications. Material, labor and equipment costs for liner construction include geotextile membrane fabric, geocomposite membrane liner, 40-mil HDPE liner, mason sand, sandy loam and topsoil. Material, labor and equipment costs for installing the filter trench include mobilization, demobilization, excavation, crushed stone and 6-inch perforated PVC pipe. A set unit price was used for construction of a grass lined diversion channel. Institutional costs incurred through deed notations and physical restrictions for capital costs have been previously discussed in Alternative 2.

Annual O&M costs include semiannual site visits to inspect the cap and associated items and periodic ground-water sampling and analysis.

E.3.1. Alternative 3: Capital Cost

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
Sag Harbor, New York

Capping/Deed Notations/Physical Restrictions/Monitoring
Alternative Number 3 - Capital Cost

Item	Qty	Unit	Unit Cost Unitem.	Mater.	Labor	Equip.	Total Cost Unitem.	Mater.	Labor	Equip.	Total Direct Cost
Site Preperation											
Tree Removal	0.06	Acre			1325	1575	0	0	80	95	174
Grubbing	0.06	Acre			490	1475	0	0	29	89	118
Compaction	8	Hour			32	15.25	0	0	256	122	378
Mobilization/Demobilization	1	LS			2050.00	3350.00	0	0	2,050	3,350	5,400
Liner Construction											
Geocomposite Membrane Liner	1950	SF		1.1	0.9		0	2,145	1,755	0	3,900
Geotextile Membrane Fabric	900	SF		0.32	0.26		0	288	234	0	522
40-mil HDPE	1950	SF		0.32	0.26		0	624	507	0	1,131
Select Fill	15	CY		15.80	6.16	15.80					
Mason Sand	20	CY		14.70	6.16	15.80	0	294	123	316	733
Sandy Loam	20	CY		15.80	6.16	15.80	0	316	123	316	755
Topsoil	40	CY		14.28	6.16	15.80	0	571	246	632	1,450
Seeding	300	SY		0.15	0.91	0.2	0	45	273	60	378
Waterway Construction							0	0	0	0	0
Trench Excavation	20	CY			1.17	1.62	0	0	23	32	56
3/8" Crushed Stone	20	CY		16.25	5.87	14.88	0	325	117	298	740
6" Perforated PVC	130	LF		7.07	9.75		0	919	1,268	0	2,187
Grass Lined Channel	830	LF	3.50				2,905	0	0	0	2,905
Institutional Action											
Deed Notations											
Deed/Title Search	1	LS	1,500				1,500	0	0	0	1,500
Parcel Survey	1	LS	1,000				1,000	0	0	0	1,000
Legal Fees	1	LS	10,000				10,000	0	0	0	10,000
Closure Permit	1	LS	10,000				10,000	0	0	0	10,000
Physical Restrictions											
Security Fence	180	LF		10.90	3.13	2.00	0	1,962	563	360	2,885
Corner Posts	4	Each		55.00	19.57	12.55	0	220	78	50	348
Braces	4	Each		15.21	9.75	6.27	0	61	39	25	125
Gate, 12' Wide	1	Each		300.00	200.00	140.00	0	300	200	140	640
Warning Signs	8	Each	220.00				1,760	0	0	0	1,760
Subtotal							27,165	5,925	3,796	2,229	39,115
Contractor's Overhead & Profit at 10% of Material Cost								593			593
Total Direct Cost							27,165	6,518	3,796	2,229	39,708
Engineering Cost at 10% of Total Direct Cost											3,971
Project Administration Cost at 15% of Direct Labor Cost									569		569
Project Administration Cost at 5% of Direct Material Cost								326			326
Project Administration Cost at 10% of Direct Unitemized Cost							2,717				2,717
Project Administration Cost at 15% of Engineering Cost											596
Total Field Cost							29,882	6,844	4,365	2,229	47,886
Contingency at 20% of Total Field Cost											9,577
Total Capital Cost											$57,463

E.3.2. Alternative 3: Annual O&M Cost

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
Sag Harbor, New York

Capping/Deed Notations/Physical Restrictions/Monitoring
Alternative Number 3 - O&M Cost

Item	Qty	Unit/Yr	Unit Cost Unitem.	Mater.	Labor	Equip.	Annual Cost Unitem.	Material	Labor	Equip.	Total Annual Cost
Monitoring											
Lab Analyses	9	Each	350.00				3,150	0	0	0	3,150
Sampler Expense	2	LS	1000.00				2,000	0	0	0	2,000
Inspection	30	Hour			55.00						
Reporting	20	Hour			55.00		0	0	1,100	0	1,100
Subtotal							5,150	0	1,100	0	6,250
Contractor's Overhead & Profit at 10% of Equipment Cost										0	0
Contractor's Overhead & Profit at 10% of Material Cost								0			0
Total Direct Cost							5,150	0	1,100	0	6,250
Project Administration Cost at 15% of Direct Labor Cost									165		165
Project Administration Cost at 5% of Direct Material Cost								0			0
Project Administration Cost at 10% of Direct Unitemized Cost							515				515
Total Field Cost							5,665	0	1,265	0	6,930
Total Annual O&M Cost											$6,930

3.3. Alternative 3: 10-year Present Worth Cost

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
g Harbor, New York

pping/Deed Notations/Physical Restrictions/Monitoring
Alternative Number 3 - Present Worth Analysis (10 Year)
Discount Rate = 0.05

Cost Component	0	1	2	3	4	5	6	7	8	9
	Cost/Year Cost Occurs ($'s)									
Capital Cost	57,367	0	0	0	0	0	0	0	0	0
M Costs	0	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930
tal Annual Cost	57,367	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
esent Worth	57,367	6,600	6,286	5,986	5,701	5,430	5,171	4,925	4,690	4,467

	10
pital Cost	0
O&M Costs	6,930
tal Annual Cost	6,930
scount Factor	0.61391
Present Worth	4,254
Total Present Worth ($'s)	110,879

.3.4. Alternative 3: 30-year Present Worth

NABISCO BRANDS, INC.
ROME INDUSTRIES SITE
g Harbor, New York

Capping/Deed Notations/Physical Restrictions/Monitoring
Alternative Number 3 - Present Worth Analysis (30 Year)
Discount Rate = 0.05

Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	57,367	0	0	0	0	0	0	0	0	0
M Costs	0	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930
otal Annual Cost	57,367	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
esent Worth	57,367	6,600	6,286	5,986	5,701	5,430	5,171	4,925	4,690	4,467

	10	11	12	13	14	15	16	17	18	19
apital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930
otal Annual Cost	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930
iscount Factor	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573
Present Worth	4,254	4,052	3,859	3,675	3,500	3,333	3,175	3,024	2,880	2,742

	20	21	22	23	24	25	26	27	28	29
Capital Cost	0	0	0	0	0	0	0	0	0	0
M Costs	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930
Total Annual Cost	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930	6,930
Discount Factor	0.37689	0.35894	0.34185	0.32557	0.31007	0.29530	0.28124	0.26785	0.25509	0.24295
resent Worth	2,612	2,487	2,369	2,256	2,149	2,046	1,949	1,856	1,768	1,684

	30
apital Cost	0
O&M Costs	6,930
otal Annual Cost	6,930
iscount Factor	0.23138
Present Worth	1,603
Total Present Worth ($'s)	163,898

E.4.0. ALTERNATIVE 4

The cost calculations for Alternative 4, described in Section 10.4.1., are based on permitting, purchasing, installing and operating a soil-vapor extraction system (SVE) for a two-year operation time with periodic monitoring.

Costs for extraction well construction include drilling, casing and pipe/screen installation, sand backfill and a bentonite seal. The cost for the vacuum extraction module (VEM) include a 10 hp blower which operates between 100 and 200 SCFM at a pressure equivalent to 6 inches of mercury, a motor starter with necessary electrical wiring, filters, gauges, valves and a skid and cabinet enclosure. The costs for a vapor/liquid separator module include a 75 gallon capacity vessel, a demister and controls. The costs to direct liquid from the vapor/liquid separator to the ground-water treatment system include a 1.0 hp pump and PVC pipe. An impermeable, 40-mil HDPE, cap will include the costs associated with material and placement. The costs for permit applications include filing to the NYSDEC for vapor phase emissions and well construction.

Annual O&M costs for power requirements include power consumption for the blower and pump. Monitoring costs include system monitoring, soil sampling, laboratory analyses and reporting. The system will be operated one year followed by shutdown, soil sampling, analyses and reporting. This process will be repeated for a second year to compare contamination levels and determine whether further operation is necessary. O&M costs after two years include periodic soil sampling, analyses and reporting.

E.4.1. Alternative 4: Capital Cost

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
Sag Harbor, New York

Soil Vapor Extraction (SVE)
Alternative Number 4 - Capital Cost

Item	Qty	Unit	Unit Cost Unitem.	Mater.	Labor	Equip.	Total Cost Unitem.	Mater.	Labor	Equip.	Total Direct Cost
Extraction Well Construction Casing, screen, sand pack bentonite seal.	13	FT		40.00	45.00		0	520	585	0	1,105
Vapor Extraction Module Blower(10hp, 200SCFM, 6"Hg) motor starter and electrical wiring, inlet filter, guages valves, cabinet and skid.	1	Each				14,500	0	0	0	14,500	14,500
Vapor Liquid Separator Module 500 CFM, 75 gallon capacity vessel, de-mister and controls	1	Each				3,500	0	0	0	3,500	3,500
Pump (1 hp)	1	Each				2,000	0	0	0	2,000	2,000
1" PVC Pipe	100	LF		7.07	9.75		0	707	975	0	1,682
Cover (40 mill HDPE)	180	SY		0.32	0.26		0	58	47	0	104
Permit Applications	1	LS	2,000				2,000	0	0	0	2,000
Subtotal							2,000	1,285	1,607	20,000	24,891
Contractor's Overhead & Profit at 10% of Equipment Cost										2,000	2,000
Contractor's Overhead & Profit at 10% of Material Cost								128			128
Total Direct Cost							2,000	1,413	1,607	22,000	27,020
Engineering Cost at 10% of Total Direct Cost											2,702
Project Administration Cost at 15% of Direct Labor Cost									241		241
Project Administration Cost at 5% of Direct Material Cost								71			71
Project Administration Cost at 10% of Direct Unitemized Cost							200				200
Project Administration Cost at 15% of Engineering Cost											405
Total Field Cost							2,200	1,484	1,848	22,000	30,639
Contingency at 20% of Total Field Cost											6,128
Total Capital Cost											$36,767

E.4.1.1. Alternative 4: Annual O&M Cost (for first 2 years)

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
Sag Harbor, New York

Soil Vapor Extraction (SVE)
Alternative Number 4 - O&M Cost (first two years)

Item	Qty	Unit/Yr	Unit Cost Unitem.	Mater.	Labor	Equip.	Annual Cost Unitem.	Material	Labor	Equip.	Total Annual Cost
Power Requirements											
Blower (10 hp)	65,700	kw-hr	0.10				6,570	0	0	0	6,570
Pump (1 hp)	6,570	kw-hr	0.10				657	0	0	0	657
Monitoring											
Lab Analyses (TCLP)	6	Each	1100.00				6,600	0	0	0	6,600
Sampler Expense	1	LS		1000.00			0	1,000	0	0	1,000
System Inspection	156	Hour			40.00		0	0	6,240	0	6,240
Reporting	60	Hour			55.00		0	0	3,300	0	3,300
Subtotal							13,827	1,000	9,540	0	24,367
Contractor's Overhead & Profit at 10% of Equipment Cost										0	0
Contractor's Overhead & Profit at 10% of Material Cost								100			100
Total Direct Cost							13,827	1,100	9,540	0	24,467
Project Administration Cost at 15% of Direct Labor Cost									1,431		1,431
Project Administration Cost at 5% of Direct Material Cost								55			55
Project Administration Cost at 10% of Direct Unitemized Cost							1,383				1,383
Total Field Cost							15,210	1,155	10,971	0	27,336
Total Annual O&M Cost											$27,336

E.4.1.2. Alternative 4: Annual O&M Cost (after 2 years)

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
Sag Harbor, New York

Soil Vapor Extraction (SVE)
Alternative Number 4 - O&M Cost After System Operations

Item	Qty	Unit/Yr	Unit Cost Unitem.	Mater.	Labor	Equip.	Annual Cost Unitem.	Material	Labor	Equip.	Total Annual Cost
Monitoring											
Lab Analyses (TCLP)	6	Each	1100.00				6,600	0	0	0	6,600
Sampler Expense	1	LS		1000.00			0	1,000	0	0	1,000
Reporting	20	Hour			55.00		0	0	1,100	0	1,100
Subtotal							6,600	1,000	1,100	0	8,700
Contractor's Overhead & Profit at 10% of Equipment Cost										0	0
Contractor's Overhead & Profit at 10% of Material Cost								100			100
Total Direct Cost							6,600	1,100	1,100	0	8,800
Project Administration Cost at 15% of Direct Labor Cost									165		165
Project Administration Cost at 5% of Direct Material Cost								55			55
Project Administration Cost at 10% of Direct Unitemized Cost							660				660
Total Field Cost							7,260	1,155	1,265	0	9,680
Total Annual O&M Cost											$9,680

E.4.2. Alternative 4: 10-year Present Worth Cost

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
Sag Harbor, New York

Soil Vapor Extraction (SVE)
Alternative Number 4 - Present Worth Analysis (10 Year)
Discount Rate = 0.05 Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	36,767	0	0	0	0	0	0	0	0	0
O&M Costs	0	27,336	27,336	9,680	9,680	9,680	9,680	9,680	9,680	9,680
Total Annual Cost	36,767	27,336	27,336	9,680	9,680	9,680	9,680	9,680	9,680	9,680
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	36,767	26,034	24,795	8,362	7,964	7,585	7,223	6,879	6,552	6,240

Cost Component	10
Capital Cost	0
O&M Costs	9,680
Total Annual Cost	9,680
Discount Factor	0.61391
Present Worth	5,943
Total Present Worth ($'s)	144,343

E.4.3. Alternative 4: 30-year Present Worth

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
Sag Harbor, New York

Soil Vapor Extration (SVE)
Alternative Number 4 - Present Worth Analysis (30 Year)
Discount Rate = 0.05

Cost/Year Cost Occurs ($'s)

Cost Component	0	1	2	3	4	5	6	7	8	9
Capital Cost	36,767	0	0	0	0	0	0	0	0	0
O&M Costs	0	27,336	27,336	9,680	9,680	9,680	9,680	9,680	9,680	9,680
Total Annual Cost	36,767	27,336	27,336	9,680	9,680	9,680	9,680	9,680	9,680	9,680
Discount Factor	1.00000	0.95238	0.90703	0.86384	0.82270	0.78353	0.74622	0.71068	0.67684	0.64461
Present Worth	36,767	26,034	24,795	8,362	7,964	7,585	7,223	6,879	6,552	6,240

	10	11	12	13	14	15	16	17	18	19
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	9,680	9,680	9,680	9,680	9,680	9,680	9,680	9,680	9,680	9,680
Total Annual Cost	9,680	9,680	9,680	9,680	9,680	9,680	9,680	9,680	9,680	9,680
Discount Factor	0.61391	0.58468	0.55684	0.53032	0.50507	0.48102	0.45811	0.43630	0.41552	0.39573
Present Worth	5,943	5,660	5,390	5,134	4,889	4,656	4,435	4,223	4,022	3,831

	20	21	22	23	24	25	26	27	28	29
Capital Cost	0	0	0	0	0	0	0	0	0	0
O&M Costs	9,680	9,680	9,680	9,680	9,680	9,680	9,680	9,680	9,680	9,680
Total Annual Cost	9,680	9,680	9,680	9,680	9,680	9,680	9,680	9,680	9,680	9,680
Discount Factor	0.37689	0.35894	0.34185	0.32557	0.31007	0.29530	0.28124	0.26785	0.25509	0.24295
Present Worth	3,648	3,475	3,309	3,152	3,001	2,859	2,722	2,593	2,469	2,352

	30
Capital Cost	0
O&M Costs	9,680
Total Annual Cost	9,680
Discount Factor	0.23138
Present Worth	2,240
Total Present Worth ($'s)	218,402

E.5.0. ALTERNATIVE 5

The cost calculations for Alternative 5, described in Section 10.5.1., are based on disposing of the soils contaminated at the SHI site to a chemical waste landfill. Costs for landfill acceptance are laboratory analyses to characterize the soil according to 40 CFR Part 268 of the Land Disposal Restrictions and applications for landfill verification. The cost for excavation and transportation include equipment and labor, whereas disposal costs are charged by the ton. Costs associated with backfilling include purchasing, transporting, filling and compacting.

There are no annual O&M costs associated with this alternative, therefore, no O&M or present worth cost calculations are presented here.

E.5.1. Alternative 5: Capital Cost

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ROWE INDUSTRIES SITE
Sag Harbor, New York

Chemical Waste Landfill
Alternative Number 5 - Capital Cost

Item	Qty	Unit	Unit Cost Unitem.	Material	Labor	Equip.	Total Cost Unitem.	Material	Labor	Equip.	Total Direct Cost
Transportation	22000	MILE	4.05				89,100	0	0	0	89,100
Excavation	230	CY			3.25	6.70	0	0	748	1,541	2,289
Backfill	230	CY		3.40	6.77	16.97	0	782	1,557	3,903	6,242
Disposal	350	TON	200.00				70,000	0	0	0	70,000
Testing/Analyses	5	LS	1600.00				8,000	0	0	0	8,000
Reporting	1	LS	500.00				500	0	0	0	500
Subtotal							159,100	782	2,305	5,444	167,631
Contractor's Overhead & Profit at 10% of Equipment Cost										544	544
Contractor's Overhead & Profit at 10% of Material Cost								78			78
Total Direct Cost							159,100	860	2,305	5,989	168,253
Engineering Cost at 10% of Total Direct Cost											16,825
Project Administration Cost at 15% of Direct Labor Cost									346		346
Project Administration Cost at 5% of Direct Material Cost								43			43
Project Administration Cost at 10% of Direct Unitemized Cost							15,910				15,910
Project Administration Cost at 15% of Engineering Cost											2,524
Total Field Cost							175,010	903	2,650	5,989	203,901
Contingency at 20% of Total Field Cost											40,780
Total Capital Cost											$244,681

APPENDIX F

ENGINEERING CALCULATIONS

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JOB NABISCO BRANDS, INC. ROWE INDUSTRIES SITE SAG HARBOR, NEW YORK

SHEET NO 1 OF 4

CALCULATED BY CP DATE 06/30/92

CHECKED BY TJS DATE 07/1/92

SCALE

AERATION TOWER
PRELIMINARY DESIGN - ON AND OFFSITE WELLS

CALCULATE THE HEIGHT AND DIAMETER OF A PACKED TOWER FOR REMOVAL OF TETRACHLOROETHYLENE (PCE) IN WASTEWATER FROM 1,230 ug/L to 5 ug/L. THE OPERATING TEMPERATURE IS 20°C AND THE FLOW RATE IS 600 gpm.

1. THE SELECTED PACKING IS 2" PLASTIC JAEGER TRI-PACKS®
2. THE STRIPPING FACTOR WAS ASSUMED $R = 20$
3. THE ACCEPTABLE FLOW PER SQUARE FOOT OF TOWER RANGES BETWEEN 20-30 gpm/ft². THE FLOW PER SQUARE FOOT OF TOWER WILL BE ASSUMED AT 25 gpm/ft²

DETERMINE TOWER DIAMETER

$$A = \frac{600 \text{ gpm}}{25 \text{ gpm/ft}^2} = 24 \text{ ft}^2$$

INCREASE THE AREA, A, BY 50% TO ALLOW CAPACITY TO BE MAINTAINED WITH SOME REDUCTION IN AREA FROM FOULING

$$A = 24 \times 1.5 = 36 \text{ ft}^2$$

$$D = \sqrt{\frac{4A}{\pi}} = \sqrt{\frac{36(4)}{\pi}} = 6.8 \text{ ft} \quad \text{ROUND TO } 7 \text{ ft}$$

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SHEET NO 2 OF 4

CALCULATED BY CP DATE 06/30/92

CHECKED BY TJS DATE 07/1/92

SCALE

THE LIQUID LOADING RATE IS GIVEN BY

$$L' = \frac{Q}{A} = \frac{600 gpm\,(0.06309\ kg/sec/gpm)}{\frac{\pi(7)^2}{4} ft^2\,(0.09290\ m^2/ft^2)} = \frac{37.85}{3.58} = 10.57\ kg/m^2\text{-sec}$$

$$L = \frac{L'}{MW_{H_2O}} = \frac{10.57\ kg/m^2\text{-sec}}{18\ kg/Kmol} = 0.59\ Kmol/m^2\text{-SEC}$$

HENRY'S CONSTANT IS GIVEN BY

$$\log H = \frac{-\Delta H^\circ}{RT} + C$$

FOR PCE: $\Delta H^\circ = 4290$ KCAL/KMOL
$C = 10.38$
$R = 1.987$ KCAL/KMOL °K
T - degrees KELVIN

$$\log H = \frac{-4290\ KCAL/KMOL}{1.987\ KCAL/KMOL \cdot K\,(293^\circ K)} + 10.38$$

$\log H = 3.01$
$H = 1026$ atm

MANUFACTURER'S RECOMMENDED VALUE OF H = 770 atm

USE H = 770 atm

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SAG HARBOR, NEW YORK

SHEET NO 3 OF 4

CALCULATED BY CP DATE 6/30/92

CHECKED BY TJS DATE 7/1/92

SCALE

THE AIR TO WATER RATIO IS GIVEN BY:

$$\frac{G}{L} = \frac{RP_t}{H} = \frac{20(1\,atm)}{770\,atm} = 0.026$$

$$G = (0.59)(0.026) = 0.015 \text{ KMOL/m}^2\text{-SEC}$$

$$= 0.015 \frac{Kmol}{m^2\text{-sec}} \left(28.8 \frac{kg}{Kmol}\right)\left(35^2 \pi\, ft^2\right)\left(0.0929 \frac{m^2}{ft^2}\right)\left(\frac{35.3\,ft^3/m^3}{1.29\,kg/m^3}\right)\left(60 \frac{sec}{min}\right)$$

$$= 2536 \text{ cfm}$$

TO ENSURE ADEQUATE AIR FLOW TO REMOVE GROUNDWATER COCs, INCREASE AIR FLOW RATE BY A SAFETY FACTOR OF 3.

$$G = 2536 \times 3 = 7608 \text{ cfm}$$

$$G' = G(MW_{AIR}) = 0.015 \frac{KMOL}{M^2\text{-SEC}} (28.8\,kg/KMOL) = 0.43 \text{ kg/m}^2\text{-SEC}$$

CHECK FOR FLOODING:

$$G = 0.015 \frac{Kmol}{m^2\,sec}\left(\frac{0.0929\,m^2}{ft^2}\right)\left(\frac{3600\,sec}{hr}\right)\left(\frac{28.8\,kg}{Kmol}\right)\left(\frac{2.2\,lb}{kg}\right) = 317.9 \text{ lb/hr-ft}^2$$

$$L = 0.59 \frac{Kmol}{m^2\,sec}\left(\frac{0.0929\,m^2}{ft^2}\right)\left(\frac{3600\,sec}{hr}\right)\left(\frac{18\,kg}{Kmol}\right)\left(\frac{2.2\,lb}{kg}\right) = 7814 \text{ lb/hr-ft}^2$$

CHECKING THE FLOODING RATES WITH PACKING DATA INDICATES THE TOWER IS WELL BELOW THE FLOODING POINT FOR 2" PACKING

FLOODING AT 4400 lb/hr-ft^2 > 317.9 lb/hr-ft^2

NO FLOODING

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SHEET NO 4 OF 4

CALCULATED BY CP DATE 06/30/92

CHECKED BY TJS DATE 7/1/92

SCALE

THE REQUIRED NUMBER OF TRANSFER UNITS IS:

$$NTU = \frac{R}{R-1} \ln\left[\frac{(C_{in}/C_{OUT})(R-1)+1}{R}\right]$$

$$= \frac{20}{19} \ln\left[\frac{(1230/5)(19)+1}{20}\right]$$

$$= 5.74$$

THE HEIGHT OF THE TRANSFER UNIT IS

$$HTU = \frac{L}{K_L a\, C_o}$$

WHERE $K_L a = 0.0176\ m^3/m^3 S$ *

C_o = MOLAR DENSITY OF WATER 55.6 KMOL/m^3

$$HTU = \frac{0.59}{(0.0176)(55.6)} = 0.60\ m$$

THE HEIGHT OF THE TRANSFER UNIT IS

$$Z = 5.74\ (0.60)$$
$$= 3.4\ m$$
$$= 11.15\ ft$$

USE A FACTOR OF SAFETY OF 3

$$Z = 11.15 \times 3 = 33.45\ ft$$

THE HEIGHT OF PACKING WILL BE 35 ft

* PROVIDED BY JAEGER PRODUCTS

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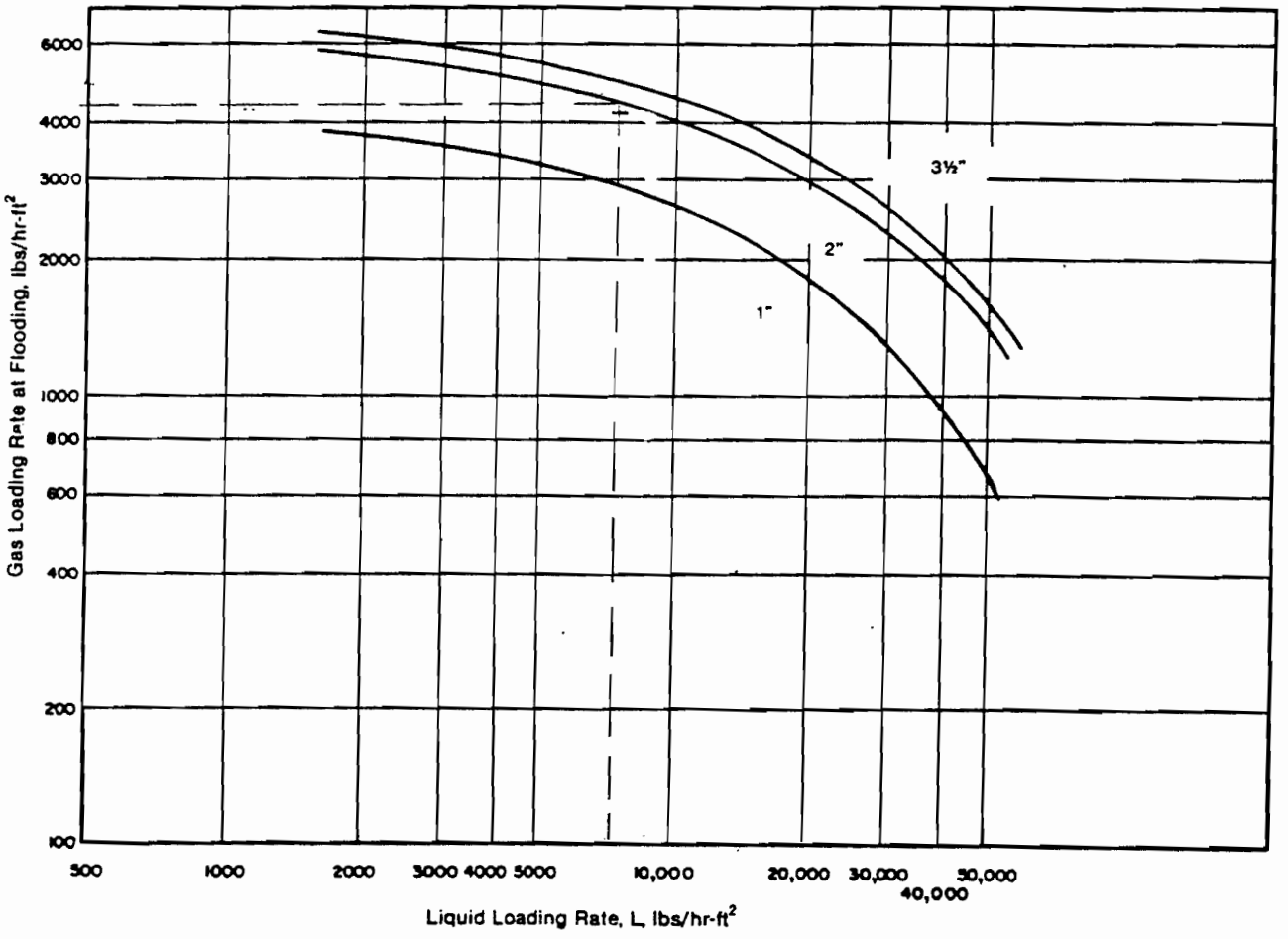
HIGH PERFORMANCE TOWER PACKINGS
AND COLUMN INTERNALS
P.O. BOX 1563
SPRING, TX 77383
(713) 444-9500
(800) 678-0345

PRODUCT DATA PD-607

PLASTIC JAEGER TRI-PACKS®

Flooding Points of Plastic Jaeger Tri-Packs®
Air-Water System, 1 atm, 70°F



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SHEET NO 1 OF 1

CALCULATED BY CP DATE 06/30/92

CHECKED BY TJS DATE 7/1/92

SCALE

AIR EMISSIONS - AERATION TOWER

DETERMINE THEORETICAL WORST CASE STACK CONCENTRATIONS BY ASSUMING ALL VOCS IN WATER ARE TRANSFERRED TO AIR

$Q_1 = 150$ gpm , $Q_2 = 600$ gpm

$$\frac{lb}{hr} = \frac{Cug}{L} \cdot \frac{1g}{10^6 ug} \cdot \frac{1lb}{453.59g} \cdot \frac{3.785l}{gal} \cdot \frac{Q\ gal}{min} \cdot \frac{60min}{hr}$$

$$= \frac{Cug}{L} \cdot \frac{Q\ gal}{min} \cdot 5.01 \times 10^{-7}$$

	DESIGN CONCENTRATION ug/l		EMISSIONS lb/hr	
COMPOUND	Q_1	Q_2	Q_1	Q_2
Tetrachloroethylene	2266	1229	1.70E-1	3.69E-1
1,1,1-trichloroethane	428	406	3.21E-2	1.22E-1
Trichloroethylene	233	181	1.75E-2	5.43E-2
1,1-dichloroethane	8.1	12	6.05E-4	3.49E-3
1,1-dichloroethylene	6.9	23	5.17E-4	6.86E-3
1,2-dichloroethylene	120	67	9.01E-3	2.02E-2
Freon-113	373	190	2.80E-2	5.68E-2
Xylenes	172	87	1.29E-2	2.61E-2
Toluene	2.6	2.1	195E-4	6.24E-4
Ethylbenzene	44	22	330E-3	6.61E-3
Acetone	55	29	4.12E-3	8.74E-3
Methylene chloride	74	38	5.55E-3	1.13E-2
TOTAL	3783	2286	2.84E-1	6.86E-1

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SHEET NO 1 OF 1

CALCULATED BY CP DATE 06/30/92

CHECKED BY TJS DATE 7/1/93

SCALE

GRANULAR ACTIVATED CARBON

FOR 150 gpm, OPERATE TWO - 6000 lb CANISTERS IN SERIES

CARBON USAGE RATE: 258 lb/day
BREAKTHROUGH ON LEAD CANISTER: 23 days
COST FOR VIRGIN CARBON: $1/lb

CAPITAL COST : 3 x $18,000 = $54,000 (1 CANISTER ON STANDBY)
CONTROLS : GAUGES, SAMPLE PORTS, ETC = $3,000

REPLACEMENT CARBON: $\frac{258\ lb}{day} \times \frac{365\ day}{YR} = 94,170\ \frac{lb}{YR}$

$94,170/YR

(ONE CANISTER ON STANDBY

FOR 600 gpm, OPERATE SIX - 6000 lb CANISTERS IN THREE PARALLEL SYSTEMS OF TWO CANISTERS IN SERIES

CARBON USAGE RATE: 810 lb/day (TOTAL)
BREAKTHROUGH ON LEAD CANISTERS: 22 days
COST FOR VIRGIN CARBON : $1/lb

CAPITAL COST: 8 x $18,000 = $144,000
CONTROLS: GAUGES, SAMPLE PORTS, ETC = $5,000
REPLACEMENT CARBON: $\frac{810\ lb}{day} \times \frac{365\ DAY}{YR} = 295650\ lb/YR$

$295,650/YR

(2 CANISTERS ON STANDBY)

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SHEET NO 1 OF 7

CALCULATED BY CP DATE 06/30/92

CHECKED BY TJS DATE 7/1/92

SCALE

GRANULAR ACTIVATED CARBON
PRELIMINARY DESIGN - ON SITE WELLS

CALCULATE THE HEIGHT AND DIAMETER OF EACH COLUMN BED ASSUMING:

FLOW = 150 gpm

EBCT = 15 min. (EMPTY BED CONTACT TIME BASED ON 10-50 MINUTE RANGE)[1]

HLR = 6.4 gpm/ft² (HYDRAULIC LOADING RATE BASED ON 2-10 gpm/ft² RANGE AND MANUFACTURER'S LITERATURE)[1,3]

DETERMINE VOLUME OF CARBON BED:

$$\frac{150\,gal}{min}(15\,min)\left(\frac{ft^3}{7.48\,gal}\right) = 300\,ft^3$$

DETERMINE THE DIAMETER OF BED:

$$\frac{150\,gpm}{6.4\,gpm/ft^2} = 23.4\,ft^2 = \frac{\pi D^2}{4}$$

$$D = \sqrt{\frac{4(23.4)}{\pi}} = 5.5\,ft$$

DETERMINE THE HEIGHT OF BED:

$$\frac{VOLUME}{AREA} = \frac{300\,ft^3}{23.4\,ft^2} = 12.8\,ft$$

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SHEET NO 2 OF 7

CALCULATED BY CP DATE 06/30/92

CHECKED BY TJS DATE 7/1/92

SCALE

OVERALL ADSORBER HEIGHT, INCLUDING SKID, ELLIPTICAL TOPS AND BOTTOMS AND ALLOWANCE FOR BACKFLUSH IS APPROXIMATELY 35% HIGHER THAN THE BED HEIGHT [3]

$$1.35(12.8) = 17.3 \text{ ft}$$

(THE MANUFACTURER'S COST QUOTE USED IS FOR A 9.25 ft HIGH TOWER WITH A 7ft DIAMETER. THE VOLUME PROVIDED IS 364 ft^3) [4]

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SHEET NO 3 OF 7

CALCULATED BY CP DATE 06/30/92

CHECKED BY TJS DATE 7/1/92

SCALE

GRANULAR ACTIVATED CARBON COLUMNS
CARBON REQUIREMENT - ON SITE WELLS

DETERMINE THE GAC REQUIREMENT USING THE FREUNDLICH ISOTHERM MODEL:

$$\frac{X}{M} = KC^{1/n}$$

WHERE:
X - MASS OF SOLUTE ADSORBED
M - MASS OF CARBON ADSORBENT
C - EQUILIBRIUM SOLUTE CONCENTRATION IN AQUEOUS PHASE
K,n - FREUNDLICH ISOTHERM CONSTANTS

CARBON IS SPENT WHEN C = CINFLUENT = 2.27 mg/l PCE

FOR PCE
K = 51 [2]
1/n = 0.56 [2]
C = 2270 ug/L (2.27 mg/L) of PCE

$$\frac{X}{M} = 51(2.27)^{0.56} = 80.7 \text{ mg/g} \quad (8.07 \times 10^{-2} \text{ lb/lb})$$

CALCULATE MASS OF PCE ADSORBED DAILY AT A FLOW RATE OF 150 gpm

$$\frac{150 \text{ gal}}{\text{min}} \times \left(\frac{2270 \text{ ug}}{\text{L}}\right)\left(\frac{3.785 \text{ L}}{\text{gal}}\right)\left(\frac{1 \text{ Kg}}{10^9 \text{ ug}}\right)\left(\frac{2.2 \text{ lb}}{\text{Kg}}\right)\left(\frac{1440 \text{ min}}{\text{day}}\right) = 4.1 \frac{\text{lb}}{\text{day}} \text{ PCE}$$

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SHEET NO 4 OF 7

CALCULATED BY CP DATE 06/30/92

CHECKED BY TJS DATE 7/1/92

SCALE

CALCULATE DAILY CARBON USAGE AT A FLOW RATE OF 150 gpm TO REMOVE 4.1 lb/day OF PCE:

$$4.1 \frac{lb}{day} \times \frac{lb\ CARBON}{8.07 \times 10^{-2}\ lb\ PCE} = 51 \frac{lb}{day}\ CARBON$$

COMPOUNDS OTHER THAN PCE WILL BE ADSORBED ONTO THE CARBON. TO ACCOUNT FOR THESE OTHER COMPOUNDS, ASSUME A SAFETY FACTOR OF THREE

$$USAGE\ RATE = 51 \frac{lb}{day} \times 3 = 153 \frac{lb}{day}\ CARBON$$

A 55 ft DIAMETER, 13 ft HIGH CARBON BED CONTAINS APPROXIMATELY 6,000 lb OF CARBON [4]

$$2\ ADSORBERS \left(\frac{6{,}000\ lb\ CARBON}{ADSORBER} \right) \left(\frac{DAY}{153\ lb} \right) = 78\ DAYS\ (2.5\ MONTHS)$$

THE MANUFACTURER'S USAGE RATE FOR THIS WASTE STREAM IS 258 lb/day [4]

$$2\ ADSORBERS \left(\frac{6{,}000\ lb\ CARBON}{ADSORBER} \right) \left(\frac{DAY}{258\ lb} \right) = 46\ DAYS\ (1.5\ MONTHS)$$

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SHEET NO 5 OF 7

CALCULATED BY CP DATE 06/30/92

CHECKED BY RS DATE 7/1/92

SCALE

IN ORDER TO MAXIMIZE CARBON USAGE EFFICIENCY AND TO PROVIDE FLEXIBILITY WITH CARBON REPLACEMENT SCHEDULING, ONE ADDITIONAL UNIT SHOULD BE ON STANDBY.

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SAC- HARBOR, NEW YORK

SHEET NO 6 OF 7

CALCULATED BY CP DATE 06/30/92

CHECKED BY TJS DATE 7/1/92

SCALE

GRANULAR ACTIVATED CARBON
PRELIMINARY DESIGN - ON AND OFFSITE WELLS

USING THE SAME PROCEDURE AS PRESENTED ON SHEETS A FLOW RATE OF 400 gpm AND AN INFLUENT PCE CONCENTRATION OF 1,230 ug/L, THE FOLLOWING PARAMETERS WERE CALCULATED:

VOLUME OF CARBON BED	1200 ft^3	(USE 3 STREAMS))
VOLUME OF EACH BED	400 ft^3	(2 BEDS)
DIAMETER OF EACH BED	6.3 ft	(2 BEDS)
HEIGHT OF CARBON IN EACH BED	12.8 ft	(2 BEDS)
OVERALL HEIGHT	17 ft	(2 BEDS)
X/M	5.7×10^{-2} lb/lb	
MASS OF PCE ADSORBED	8.8 lb/day	(ALL STREAMS)
ADJUSTED USAGE RATE	810* lb/day CARBON	
TIME UNTIL 6-60000 lb BEDS ARE SPENT	44 DAYS (1.5 MONTHS)	

USE PARALLEL CONFIGURATION WITH 2-60000 lb ADSORBERS IN SERIES. TWO ADDITIONAL UNITS SHOULD BE ON STANDBY

* MANUFACTURER'S USAGE RATE

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SHEET NO 7 OF 7

CALCULATED BY CP DATE 06/30/92

CHECKED BY _____ DATE _____

SCALE _____

1) VIESSMAN, WARREN AND MARK J. HAMMER
WATER SUPPLY AND POLLUTION CONTROL, 4TH ED.
HARPER AND ROW PUBLISHERS, NEW YORK 1985 pp 678-679

2) THE "K" AND "1/n" VALUES ARE BASED ON PULVERIZED CALGON FILTASORB 300 ACTIVATED CARBON AND WERE TAKEN FROM PATTERSON, J.W. INDUSTRIAL WASTEWATER TREATMENT TECHNOLOGY, 2nd ED. BLITTERWORTH PUBLISHERS, STONEHAM, MA. 1985 pp 331-337

3) WESTATES CARBON

4) TIGG CORPORATION

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SHEET NO 1 OF 3

CALCULATED BY CP DATE 07/02/92

CHECKED BY DED DATE 7/15/92

SCALE

NEW YORK GUIDELINES FOR EMISSION OF TOXIC AIR CONTAMINANTS

AgC - ANNUAL GUIDELINE CONCENTRATION - ug/m^3
SgC - SHORT TERM GUIDELINE CONCENTRATION - ug/m^3
C_{mass} - CONCENTRATION OF CONTAMINANT IN AIR - ug/m^3
C_{ppm} - VOLUME PER VOLUME CONCENTRATION IN AIR - ppm
MW - MOLECULAR WEIGHT - g/gmol

EXAMPLE CALCULATION:
CONVERT: AgC AND SgC FOR TETRACHLOROETHYLENE (PCE) FROM ug/m^3 TO PPM

$AgC_{PCE} = 0.075\ ug/m^3$ $\quad MW_{PCE} = 165.8\ g/gmol$
$SgC_{PCE} = 81{,}000\ ug/m^3$

IDEAL GAS LAW:

$$\frac{M_p}{V_t} = \frac{P}{RT}\,\frac{V_p}{V_t}\,MW_p$$

WHERE
M_p - mass of pollutant
V_t - total volume
V_p - volume of pollutant
P - atmospheric pressure (atm)
R - Universal Gas Constant
0.08206 ℓ-atm/gmol-°K
T - ambient temperature = 293°K
MW_p - molecular weight of pollutant
M_p/V_t = C_{mass} WITH APPROPRIATE CONVERSION
V_p/V_t = C_{ppm} WITH APPROPRIATE CONVERSION

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SHEET NO 2 OF 3

CALCULATED BY CP DATE 07/02/92

CHECKED BY DEJ DATE 7/15/92

SCALE

$$\frac{P}{RT} = \frac{1\ atm}{0.08206\ \frac{l\ atm}{gmol\cdot °K} \times 293°K} = 0.0416\ \frac{g\cdot mol}{l}$$

CONVERT UNITS

$$0.0416\ \frac{g\cdot mol}{l} \times \frac{1000\ l}{m^3} = 41.6\ \frac{g\cdot mol}{m^3}$$

THEREFORE

$$\frac{Mp}{Vt} = 41.6\ \frac{Vp}{Vt}\ MW_p$$

CONVERT $\frac{Mp}{Vt}$ FROM $\frac{g}{m^3}$ to $\frac{ug}{m^3}$

$$\frac{1g}{m^3} \times \frac{10^6 ug}{g} = 10^6\ \frac{ug}{m^3} = 10^6\ C_{mass}$$

CONVERT $\frac{Vp}{Vt}$ from VOLUME FRACTION TO PPM

$$\frac{Vp}{Vt} \times 10^6 = C_{ppm}$$

THEREFORE

$$C_{mass} = 41.6\ C_{ppm} \cdot MW_p$$

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SHEET NO 3 OF 3

CALCULATED BY CP DATE 07/02/92

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SCALE

DETERMINE "PPM" CONCENTRATION IN AIR BASED ON AgC FOR PCE:

$$C_{ppm} = \frac{C_{mass}}{41.6 \times MW_p} = \frac{0.075\ ug/m^3}{41.6\ \frac{g\cdot mol}{m^3} \times \frac{165.8\ g}{mol}} = 1.09 \times 10^{-5}\ ppm$$

DETERMINE "lb/hr" EMISSION FOR PCE USING AgC

Q - FLOW RATE IN AIR = 7900 cfm

$$C_{lb/hr} = C_{ppm} \times \frac{1\ g}{1 \times 10^6\ ug} \times \frac{1\ mol}{22.4\ l} \times MW_p\ \frac{g}{mol} \times \frac{1\ lb}{453.59\ g} \times \frac{28.3\ l}{1\ ft^3} \times \frac{Q\ ft^3}{min} \times \frac{60\ min}{hr}$$

$$= 1.67 \times 10^{-7} \times C_{ppm} \times MW_p \times Q$$

$$= 1.67 \times 10^{-7} \times 1.09 \times 10^{-5} \times 165.8 \times 7900$$

$$= 2.39 \times 10^{-6}\ lb/hr$$

FOLLOWING THE SAME PROCEDURE AS ABOVE, THE EMISSION RATE FOR PCE USING SgC IS 2.57 lb/hr

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SHEET NO 1 OF 3

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CHECKED BY A GRAHAM DATE 7/14/92

SCALE

RCRA CAP - ALTERNATING 3

- DETERMINE AREA TO BE PREPARED (TREE REMOVAL & GRUBBING)
  - SQUARE AREA

CENTRAL CAP	=		= 20'
INFILTRATION TRENCH	=	2 (2.5')	= 5'
SLOPE TO GRADE	=	2 (10')	= 20'
			45'

SAFETY FACTOR

∴ AREA = (45')(45') $\left(\frac{\text{ACRE}}{43{,}560\text{ FT}^2}\right)$ × 1.3 ≈ 0.06 ACRES

- DETERMINE AMOUNT OF MATERIAL REQUIRED FOR THE CAP
  - GEOCOMPOSITE MEMBRANE LINER

AREA = $\left(20' + 2(30/12) + 2(22/12) + 2(5)\right)^2$ × 1.3 ≈ 1,950 SF ✓

  - 40 mil HDPE LINER

AREA = $\left(20' + 2(52/12) + 2(5)\right)^2$ × 1.3 ≈ 1,950 SF ✓

  - GEOTEXTILE MEMBRANE LINER

TRENCH FILTER = (2 × 2.5 + 2 × 22/12)(80) × 1.3 ≈ 900 SF ✓

  - SELECT FILL

VOLUME = ½ (25')(1')(25') × 1.3 ≈ 410 CF
≈ 15 CY

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SCALE

RCRA CAP - ALTERNATIVE 3

- MASONS SAND

VOLUME = (20')(20')(1') × 1.3 = 520 CF ≈ 20 CY

- SANDY LOAM

VOLUME = (20')(20')(1') × 1.3 = 520 CF ≈ 20 CY

- TOPSOIL

VOLUME = [(25')(25')(1') + 2(10')(10')(1')] × 1.3 = 1,100 CF ≈ 40 CY

- SEEDING

AREA = (45')(45') × 1.3 = 2,650 SF ≈ 300 SY

WATERWAY CONSTRUCTION

- TRENCH EXCAVATION

VOLUME = (2.5')(22/12)(90') × 1.3 = 550 CF ≈ 20 CY

- 3/8" CRUSHED STONE

VOLUME = (2.5')(22/12)(90') × 1.3 = 540 CF ≈ 20 CY

- 6" PERFORATED PVC

LENGTH = [22.5 × 4 + 10'] × 1.3 = 130 FT

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SCALE

— GRASS LINED CHANNEL :

LENGTH = [(4)(22.5) + 550'] × 1.3 = 820 FT

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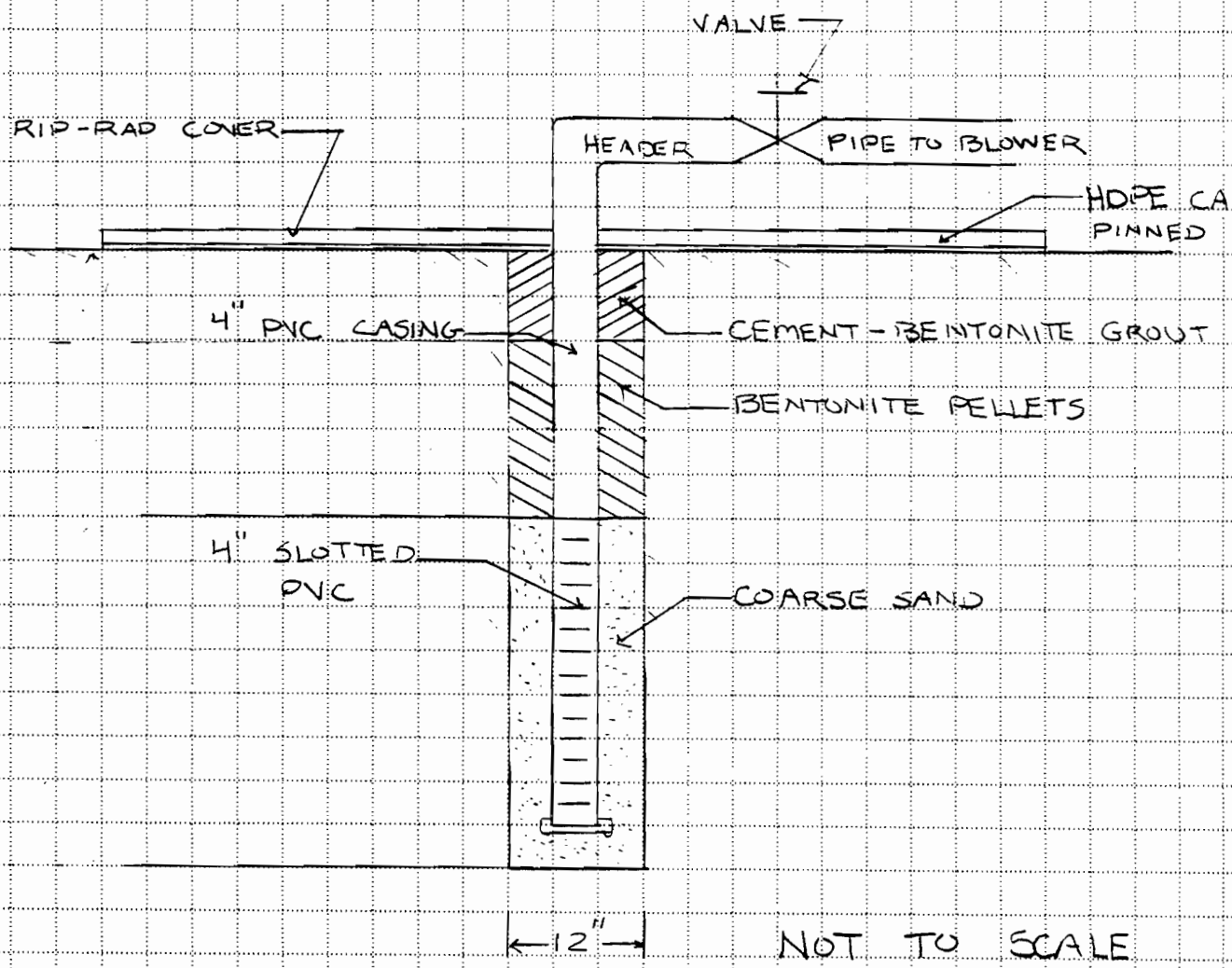
SCALE

ALTERNATING 4" SVE



NOT TO SCALE

TYPICAL EXTRACTION WELL CONSTRUCTION

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SHEET NO 2 OF 4

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SCALE

SOIL VAPOR EXTRACTION

1. DETERMINE REPRESENTATING PID READING FOR DRUM STORAGE AREA

BORING NO.	PID HIGHEST MEASUREMENT (PPM)
B-9	300
B-10	300
B-11	300
B-12	190
B-13	330
B-14	400

AVERAGE = 300 ppm ✓
FACTORED AVE* = 400 ppm ✓

* A FACTUR OF 1.3 WAS USED

2. DETERMINE REPRESENTATIVE MOLECULAR WEIGHT OF CONTAMINANTS BY TAKING A WEIGHTED AVERAGE

	(PPM) B-9	(PPM) B-10	(PPM) B-13	TOTAL	% comp	MW (g)
PCE	19	97	2.1	118.1 ✓	62.7%	165.9
TCE	—	0.62	—	0.62 ✓	0.3%	131.4
XYLENE	—	66	.021	66.02 ✓	35.1%	106.2
TOLUENE	—	2.1	.13	2.23 ✓	1.2%	92.1
ACETONE	—	1.3	—	1.3	0.7%	58.1
METHYLENE CHLORIDE	—	—	.009	.009 ✓	0.%	84.9
				188.3 ✓	100%	

WEIGHTED MW = 143.1g ✓

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SCALE

3. DETERMINE EMISSIONS RATE (IN lb/hr).
ASSUME: 100% REMOVAL
∴ PID VALUES ARE REPRESENTATIVE
200 SCFM AIR FLOW RATE

$$Conc_{AIR} \times \frac{1\,g}{1\times10^6\,g} \times \frac{mole}{22.4\,l} \times \frac{1\,lb}{453.59\,g} \times \frac{28.3\,l}{1\,ft^3} \times \frac{60\,min}{hr} \times \frac{MW\ (g/mole)}{} \times \frac{Q_{AIR}\ (ft^3/min)}{} =$$

$$Conc_{AIR}\,(1.67\times10^{-7}) \times MW \times Q_{AIR} = Conc_{AIR}\ (lb/hr)$$

$$400\,ppm \times 1.67\times10^{-7} \times \frac{143.1\,g}{mole} \times \frac{200\,ft^3}{min} = 1.91\ lb/hr$$

$$Conc_{AIR} = 1.91\ lb/hr$$

4. CONVERT TO ANNUAL EMISSIONS (TONS/YR)
ASSUME CONTINUOUS OPERATION

$$\frac{1.91\,lb}{hr} \times \frac{24\,hr}{day} \times \frac{365\,days}{yr} \times \frac{TON}{2000\,lb} = 8.38$$

∴ ANNUAL EMISSIONS = 8.4 TONS/YR

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SCALE

SOIL VAPOR EXTRACTION (10 hp) ALTERNATIVE 4

ASSUME: CONTINUOUS OPERATION
ELECTRICITY COST = $0.10/KW-hr

COST = 0.75 × hp × rate × hours
(0.75 ← CONVERSION FACTOR (KW/hp))

DETERMINE HOURS OF OPERATION FOR ANNUM

$1\ yr \times \frac{365\ days}{yr} \times \frac{24\ hrs}{day} = 8,760\ hrs$ ✓

DETERMINE BLOWER KW-hr

$0.75 \times 10\ hp \times rate \times 8760\ hrs = 65,700\ KW\ hr$

DETERMINE PUMP KW-hr

$0.75 \times 1.0\ hp \times rate \times 8760\ hrs = 6,570\ Kw\text{-}hr$

INSPECTION

1st MONTH: $\frac{1\ DAY}{WEEK} \times \frac{8\ hr}{DAY} \times 4\ WEEKS = 32\ hrs$ ✓

FOLLOWING 11 MONTHS: $\frac{1\ DAY}{MONTH} \times \frac{8\ hr}{DAY} \times 11\ MONTHS = 88\ hrs$ ✓

120 hrs
× F.S = × 1.3
156 hrs ✓

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SCALE

EXCAVATION & DISPOSAL TO CHEMICAL WASTE LANDFILL
ALTERNATIVE - 5

SOIL CALCULATIONS

VOLUME = (25')(20')(12') x 1.3 = 6,240 CF ✓
= 230 CY ✓

WEIGHT = 230 CY x $\frac{1.5 \text{ TONS}}{\text{CY}}$ = 350 TONS ✓

TRANSPORTATION

TRUCK CAPACITIES: 20CY OR 16 TON LIMIT

230CY x $\frac{\text{TRUCK}}{20\text{CY}}$ = 12 TRUCKS

350 TONS x $\frac{\text{TRUCK}}{16 \text{ TONS}}$ ≈ 22 TRUCKS ✓

∴ SELECT 16 TRUCK LOADS

TOTAL MILES

ESTIMATE: 1,000 MILES SITE TO FILL,
ROUND TRIP

22 TRIPS x $\frac{1{,}000 \text{ MI.}}{\text{TRIP}}$ = 22,000 MILES

APPENDIX G

GROUND-WATER FLOW AND CONTAMINANT TRANSPORT MODELING

Prepared by

Kenneth Taylor, Hydrogeologist

LEGGETTE, BRASHEARS & GRAHAM, INC.

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G.1.0. INTRODUCTION

A three-dimensional ground-water flow and contaminant transport model has been developed by Leggette, Brashears & Graham, Inc. (LBG) to simulate the steady-state ground-water flow system and the solvent plume migration at the Rowe site. The model was used to evaluate plume degradation following the hypothetical removal of the source and to evaluate the effectiveness of several remedial pumping alternatives.

G.2.0. BACKGROUND

G.2.1. Model Selection

The computer code utilized for the numerical simulation was the Princeton Transport Code (PTC), a three-dimensional flow and contaminant transport finite element model (D. K. Babu and G. F. Pinder, 1986). PTC was chosen because it has three-dimensional flow and transport, mass balance and retardation capabilities. The PTC is well documented and has been successfully applied to many situations, as evidenced by its wide use.

G.2.2. Elevation Control for Surface and Ground Water

Topographical and surveyed data consist of USGS topographic maps, surveyed elevations of observation wells, and surveyed water-surface elevations of local ponds and selected points on Ligonee Brook.

Observation well data consist of borehole logs and numerous rounds of measurements of head and contaminant concentration. Data on the vertical distribution of head is provided by 15 of these wells, located in 5 clusters of 3 wells each, giving information at three different depths.

G.2.3. Model Domain

The finite-element grid (design for use by the PTC), consists of 40 columns, 32 rows and 5 layers, with each model layer consisting of 1,353 nodes and 1,280 elements (figure 1). The model utilizes a variable-spaced grid. On the SHI property,

the grid spacing is finest, with node area dimensions of 17.5 feet by 17.5 feet. The distant aquifer border areas have node area dimensions of up to 300 feet by 300 feet.

The grid is oriented approximately along the direction of ground-water flow and centered approximately along the axis of the plume. Its northwest edge runs along Morris Cove and Upper Sag Harbor Cove. The northeast edge runs along the northeast side of Upper Sag Harbor Cove, Otter Pond, the swampy area between Otter Pond and Round Pond, Round Pond and Little Round Pond. The southeast edge continues from Little Round Pond through Long Pond and Little Long Pond, with Lily Pond in the grid interior, near the south corner.

G.2.4. Layer Definition

The model consists of five layers of nodes, of which each layer has been assigned to represent one stratigraphic unit. The model layers represent unconsolidated glacial outwash which consists of coarse to fine sand, gravel, silt and clay. Layer 5, the shallowest layer, is unconfined and Layers 4 through 1 are semi-confined because of clays and silts in the overlying deposits. The elevation of the bottom of each model layer is as follows: Layer 5 - 1.0 ft bmsl (foot below mean sea level), Layer 4 - 10.0 ft bmsl, Layer 3 - 25.0 ft bmsl, Layer 2 - 60.0 ft bmsl and Layer 1 - 90.0 ft bmsl. In comparison, the ground water at the SHI property is found at a depth of about 16 feet below grade or about 7 feet above msl. The model was divided in this manner so that vertical contamination transport could be simulated near screened zones of observation wells. Figure 2 illustrates the model layers with respect to some of the observation well screens.

G.2.5. Flow Boundary Conditions

Boundaries for the flow portion to the PTC take the form of constant-head nodes (water-table discharge areas, model edges and coastlines), leaky nodes (perched water, streams and model edges), or constant-flow nodes (areal recharge and wells).

Morris Cove and Upper Sag Harbor Cove are represented by a constant-head boundary condition in Layer 5. The nodes at these locations were assumed to have a head of zero to represent mean sea level. Otter Pond, Round Pond, Little Round Pond, Long Pond, Little Long Pond, an unnamed pond east of the SHI property and Lily Pond were also represented by a constant-head boundary condition in Layer 5. The surveyed surface elevations of these bodies of water provided control elevations for model boundary head values and some interior node-head values.

Another important boundary condition in Layer 5 is Ligonee Brook. Ligonee Brook runs from Long Pond to the northwest boundary of the model. The brook was represented in the model as a leaky boundary from the northwest model boundary to Main Street (near Piezometer 2, see figure 1). Historical data indicate that the portion of the brook from Main Street to Long Pond is usually dry. Therefore, this portion of the brook was not simulated in the model. Initial heads for the leaky nodes were obtained from piezometer data. The conductance values for the brook ranged from 0.07 to 3.2 ft/day (feet per day) and were derived during model calibration.

Constant-head nodes were also located along the southwest edge of the model (a portion of the grid which has no standing water) to represent a flux boundary. The heads for the nodes on this boundary were approximately parallel to the direction of the ground-water flow. These constant-head nodes either contribute or take relatively small amounts of water to the model and are sufficiently far from the area of interest to have little or no effect on modeled results.

G.2.6. Water Sources and Sinks

Sinks, defined as features which would remove water from the model domain, are associated with the discharge of ground water to Ligonee Brook, Morris Cove and Upper Sag Harbor Cove.

Sources of water to the model were simulated as infiltration of precipitation to Layer 5 (average areal recharge is known to be about 24.5 inches per year in the region (NOAA)), and constant-head nodes representing ponds and flux boundaries.

G.2.7. Hydraulic Conductivity

Hydraulic conductivity values for the model domain were obtained from previous published studies (Pinder, 1973) and the slug tests completed during the RI (LBG, 1990). These data indicate that horizontal permeability ranges from 200 to 300 ft/day. A hydraulic conductivity of 250 ft/day was used for each of the model layers. Vertical permeability was assumed to be on the order of one-tenth of the horizontal permeability for each layer (25 ft/day).

G.2.8. Transport Boundary Conditions

Boundary conditions for the transport portion of the PTC model take the form of constant concentration (a source of pure concentration) or constant concentration flux (a case of known recharge and known concentration).

Morris Cove, Upper Sag Harbor Cove and the above-mentioned ponds are all represented in the model with a constant concentration. A constant concentration of zero was used for the ponds because the ponds act as ground-water sources and are not contaminated. Morris Cove and Upper Sag Harbor Cove have a constant concentration of zero because contamination which enters these areas leaves the ground-water system and, therefore, is no longer considered by the model, and because of dilution.

G.2.9. Transport Sources and Sinks

The SHI property (and a portion of an adjacent property once thought to be part of the SHI property) is where the suspected source of the contamination was and is located. The solvents which were discharged on the property have migrated off of the property and are discharging into Sag Harbor Cove.

G.2.10. Contaminant Transport Data

The PTC requires four inputs in order to simulate solute transport: porosity, longitudinal dispersivity, transverse dispersivity and retardation properties. All of these inputs were adjusted during calibration. Porosity values ranging from 10 to 25 percent

were used during the simulation. Longitudinal dispersivity and transverse dispersivity were simulated as 50 feet and 0.50 foot, respectively.

G.3.0. CALIBRATION OF MODEL

G.3.1. Calibration of Ground-Water Flow

The calibration of a model is a process which refines the values of various parameters by adjusting them until the model duplicates actual events. In the case of the Rowe site model, calibration of the flow solution was completed by comparing observed aquifer water levels in the area of interest with simulated water levels. Model parameters were then adjusted so that the simulated water levels more closely reproduced observed water levels. Parameters which were changed during the calibration process were vertical permeability, vertical conductance of Ligonee Brook and constant heads outside the study area. These parameters were adjusted because physical data of their actual values were limited. Table A lists the final values used in the calibrated model, as well as a qualitative indication of the sensitivity of the model to adjustment of the parameters.

Horizontal hydraulic conductivity was not adjusted during calibration because 250 ft/day is a realistic value for permeability in the study area, and changing the value significantly could move the horizontal hydraulic conductivities out of realistic ranges. The storage coefficient was not adjusted during calibration because the model was calibrated under steady-state conditions.

During calibration of the flow solution, the primary focus was placed on calibrating the study area. Small areas within the model, along the borders or in ponds far away from the study area, were not of major concern. It should be noted, however, that system-wide errors, such as the water table having the wrong orientation, were investigated and eliminated when possible.

The head distribution from the model was compared with actual head data obtained from the site in October 1991. October 1991 was chosen for comparative purposes because ground-water levels in this month were most representative of average-

annual conditions based on review of available historical data. The minor differences between observed and computed water level in the study area (figure 3) were anticipated in the modeling analysis. These differences are too small to invalidate the calibration of the flow portion of the model or its capability to simulate steady-state events. Although the water-table maps do not match exactly, two important conditions have been simulated. First, the simulated hydraulic gradient from the site to the brook and the actual gradient were very similar; 0.0021 ft/ft and 0.0023 ft/ft, respectively, and secondly, the upward vertical gradient existing beneath Ligonee Brook, Morris Cove and Sag Harbor Cove has been simulated.

G.3.2. Calibration of Contaminant Transport

The transport phase of the PTC model was calibrated using the available data for PCE. PCE was chosen for calibration purposes for two reasons: 1) it was and is the primary contaminant at the Rowe site, and 2) its retardation factor is higher or similar to that of the secondary contaminants (with concentration of greater than 100 ppb (parts per billion)) at the site.

To calibrate the solute transport portion of the model, it was necessary to make several assumptions. One assumption was that the plume has been fully developed since 1984 and is currently in a semi-steady-state condition. This is a valid assumption because data from the Department of Health study in 1984 indicated that the plume was fully developed at the time of that study, and data collected from 1989 through 1991 during the RI indicate that, although concentrations may vary at all locations, the general shape of the plume has remained relatively stable.

Another assumption made to make model calibration possible was that the source of the contamination was located on or near the SHI property. Water-quality data from the observation wells indicate that this is a reasonable assumption.

The last assumption made was that contamination started on the SHI property between 1956 and 1965. A review of the LBG remedial investigation report indicates that this is a valid assumption.

The above-mentioned assumptions were important for calibration of the solute transport portion of the model because they provide a time range (between 20 and 25 years) for plume development. The assumptions also define a location (the SHI property) for the contaminant source.

Calibration of the solute transport portion of the model was completed in two phases. During the first phase of the calibration process, a constant concentration of 5,000 ppb was placed at the assumed source location. The model was then run until the PCE plume reached steady state. The concentration chosen as the source, 5,000 ppb, was approximately the same magnitude as the highest concentrations of PCE observed on the SHI property during the last round of sampling.

The steady-state model results were then compared to field measurements. Adjustments were made to the width and depth (i.e., layer of model plume reached) of the plume by adjusting longitudinal and transverse dispersivity. A longitudinal dispersivity of 50 feet and a transverse dispersivity of 0.05 foot were the values developed by the calibration process. Changes in the values of both the longitudinal and transverse dispersivity had only a moderate effect on the width of the plume, but had a great effect on the depth to which the plume migrated.

The second phase of the transport calibration process addressed the time it took the model's transport phase to reach steady state. The goal of this stage of calibration was to adjust the model so that it reached steady state in the time frame, between 20 and 25 years, established by the assumptions outlined above. This adjustment was done by varying the absorption coefficient until the steady state time criteria was achieved. The absorption coefficient development by the calibration process was 0.75. Changes in the absorption coefficient had a great effect on plume development time.

Table B compares results of the calibrated model with observed field results. Differences between the actual and simulated concentrations are to be expected and do not invalidate the calibration of the transport portion of the model. The reason for these differences are two-fold. First, the model was not set up to account for non-homogeneous conditions; a small band of clay or silt could change flow patterns and,

therefore, affect contaminant migration. Second, there are unknowns about the contaminant source. The model assumes that the source was injected at a continuous concentration at the same location, when in actuality the source may have occurred at different locations, had a constantly changing concentration, or may have been introduced to the ground water in concentrated slugs.

Although the simulated concentrations and measured field concentrations do not exactly match, the model has simulated several important characteristics of the plume.

1. The plume has the correct orientation and enters Ligonee Brook at the correct location;
2. The plume has approximately the correct width;
3. The depth of the plume increases with distance from the source; and
4. The plume is reasonably simulated in vertical extent, without undue exaggeration.

The calibrated model will provide good estimates of plume remediation time, provided source unknowns (concentration, location, rate and volume) are taken into account during model simulations.

To offset for the source unknowns (concentrations, location, rate and volume) discussed above, actual ground-water quality data were input into the model as starting concentrations prior to running the remediation scenarios. Concentrations from the 1991 round of water-quality data were placed in the corresponding node and layer where limited information was available. Historical water-quality data and interpolation were used to fill blank nodes. Starting the simulations from current conditions and projecting into the future avoids the problems associated with simulating the source and non-homogeneous material.

G.4.0. REMEDIATION SIMULATIONS

G.4.1. No-Action Alternative

The calibrated model was used to simulate the proposed remediation scenario of removing the source material of the plume. The intent of the scenario was to determine how long the plume would take to naturally degrade if the source was removed. This scenario was simulated by using the starting concentrations discussed above and running the model for a 50-year period without an active source. Results indicate that the plume would take the plume a little over 25 years to naturally degrade below the 5 ppb PCE action limit. Figures 4 through 8 illustrates the simulated plume boundary, based on the 5 ppb of PCE, for each layer of the model after 5, 10, 15, 20 and 25 years of flow. The figures illustrate that between 5 and 10 years would transpire before the SHI property had concentrations of PCE below the action limit. The figures also indicate that most of the contamination would have dispersed below the 5 ppb action level between 20 and 25 years, with the only exception occurring in Layer 2 in the area of Sag Harbor Cove.

G.4.2. Pumping Alternative 1 - 150 gpm Extraction Rate

The calibrated model was used to simulate the pumping rate necessary to contain the portion of the plume on the SHI property and determine how long it would take the entire plume to degrade with ground-water extraction from wells located on the SHI property. The pumping rate necessary to contain the plume was determined by simulating four wells (four wells were used in an effort to minimize pumping rate) pumping at the combined rates of 100, 150, 200 and 500 gpm (gallons per minute). The well locations are shown on figure 9. The combined capture zone of the wells at each pumping rate was delineated by evaluating the modeled ground-water flow patterns at each rate. This analysis indicates that the capture zone of the wells pumping at 150 gpm was sufficiently large to contain the portion of the plume on the SHI property. Figure 10 shows the capture zone of the wells pumping at a combined rate of 150 gpm compared to the currently defined extent of the PCE plume. Figure 10 illustrates that the four wells pumping at 150 gpm will contain the portion of the plume on the SHI property.

The second phase of this simulation was used to determine how long it would take the entire plume to degrade by extracting ground water at 150 gpm from the four recovery wells located on the SHI property. The same procedure as described in the no action simulation was used for this phase. The only difference between the simulations is that four wells are pumping. Figures 11 through 15 illustrate the simulated plume boundaries at 5, 10, 15, 20, and 25 years based on 5 ppb of PCE for each layer. Figures 11, 12 and 13 show that the portion of the plume on the SHI property would disperse between 5 and 10 years. It should be noted, however, that figures 11 through 15 illustrate the time for the entire plume to disperse to action levels remains at a little over 25 years. The reason that the dispersion time for the overall plume remained at over 25 years is that pumping on the SHI property lowered the gradient between Sag Harbor Cove and SHI. The lower gradient caused the flow velocity to decrease, which caused the plume to move slower toward Sag Harbor Cove (the plume discharge location).

Because the dispersion time of the total plume increased when pumping was introduced on the SHI property, the second phase of the simulation was repeated. This time, however, the four recovery wells were turned off after five years. The four wells on the SHI property were turned off because remediation of the portion of the plume on SHI property, as shown by figures 11 through 15, had achieved the action levels.

Turning off the wells would also decrease the amount of water pumped and would enable the ground-water gradient to recovery to its natural position. The results of the second run of this scenario, shown on figures 16 through 20, illustrate the dispersion time for the entire plume had declined from over 25 years to around 20 years.

G.4.3. Pumping Alternative 2 - 600 gpm Extraction Rate

Three simulations were run to determine the affect that extracting ground water from wells located downgradient of the SHI property would have on plume recovery and dispersion time. The first simulation used the same basic extraction scenario as described for Pumping Alternative 1 with the exception being that an additional recovery well was

added to the scenario. The recovery well (RW-1) added for this scenario was simulated to pump at a rate of 150 gpm, a rate large enough to contain the plume, thereby yielding a combined pumping rate of 300 gpm. RW-1 was located between Monitor Well Cluster MW-49 and Well N-1 (figure 9) because it would be near the center of the plume. Results of this simulation are shown on figures 21 through 25. These figures illustrate that the plume no longer crosses Sag Harbor Cove. The figures also show that after every 5-year interval, the plume is smaller than it was when only the four recovery wells on the SHI property were pumping. It should be noted that even though the overall size of the plume was small with the addition of RW-1, the dispersion time for the plume is still around 20 years.

For the second simulation, another recovery well, RW-2, was added to the scenario. RW-2 was located near well N-16 (figure 9) and was simulated to operate at a rate of 150 gpm, thereby yielding a combined pumping rate of 450 gpm. During this scenario, RW-1, the four wells on the SHI property and RW-2 were pumped continuously. Results of this simulation (figures 26 and 30) show that the dispersion time for the plume stayed at about 20 years.

The last simulation adds a third well to the scenario (RW-3). The location of RW-3 as shown on figure 9, was chosen because it is near the center of the plume. RW-3 was also simulated to operate at 150 gpm, bringing the simulation total to 600 gpm. Figures 31 through 34 show that the plume is significantly smaller at the end of 5-years than that of the second simulation with six wells operating. The figures also illustrate that after 10 years, a larger portion of the plume has dispersed and that after 15 years the entire plume had been remediated to below action levels.

G.4.4. Modeling Summary

The calibrated PTC model was used to evaluate three different remediation scenarios, no action (i.e., the plume disperses naturally), extraction of ground water at 150 gpm from four recovery wells on the SHI property, and extraction of ground water at a rate of 600 gpm from seven recovery wells located on and off the SHI property. Results from the analysis indicate that the plume would take a little over 25 years to disperse below action levels if the no action alternative was chosen. If the first pumping scenario was chosen, only four wells would have to be pumped at a combined rate of 150 gpm for approximately five years to remediate the portion of the plume on the SHI property below action levels. The remainder of the plume would disperse in about 20 years if this scenario was used. If the second pumping scenario was chosen, after 10 years, a large portion of the plume would be remediated and at 15 years the entire plume would be remediated below action limits.

TABLE A

NABISCO BRANDS, INC.
SAG HARBOR, NEW YORK

Final Values and Sensitivity Analysis
for Adjusting Parameters

Parameter	Range	Final	Sensitivity
Vertical permeability	0.75 - 25	25	High
Vertical conductance of Ligonee Brook	0.01 - 100	0.07 and 3.2	Moderate
Horizontal permeability	200 - 300	250	Low
Heads at the southwest grid corner	9 - 15	11	Low
Adjustment of head in boundary ponds	--	--	Low

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TABLE B

NABISCO BRANDS, INC.
SAG HARBOR, NEW YORK

Simulated PCE Concentration Compared With Observed Field Concentrations

Well	Simulated PCE concentration (ppb)[1/]	Actual PCE concentration (ppb)
MW48A	ND	ND
MW48B	ND	ND
MW44A	852	700 - 520
MW44B	144	1,700 - 4,600
MW44C	9.16	16 - 2
MW42A	58	65 - 34
MW42B	22	ND - 0.6
MW42C	2	ND - 0.6
MW43A	101	140 - 28
MW43B	72	4 - 70
MW43C	12	ND - 13
MW49A	37	12 - 31
MW49B	89	370 - 470
MW49C	22	28 - 29
MW50A	ND	ND
MW50B	ND	ND
MW50C	ND	ND
N-19	ND	ND

1/ Parts per billion.
ND Not detected.

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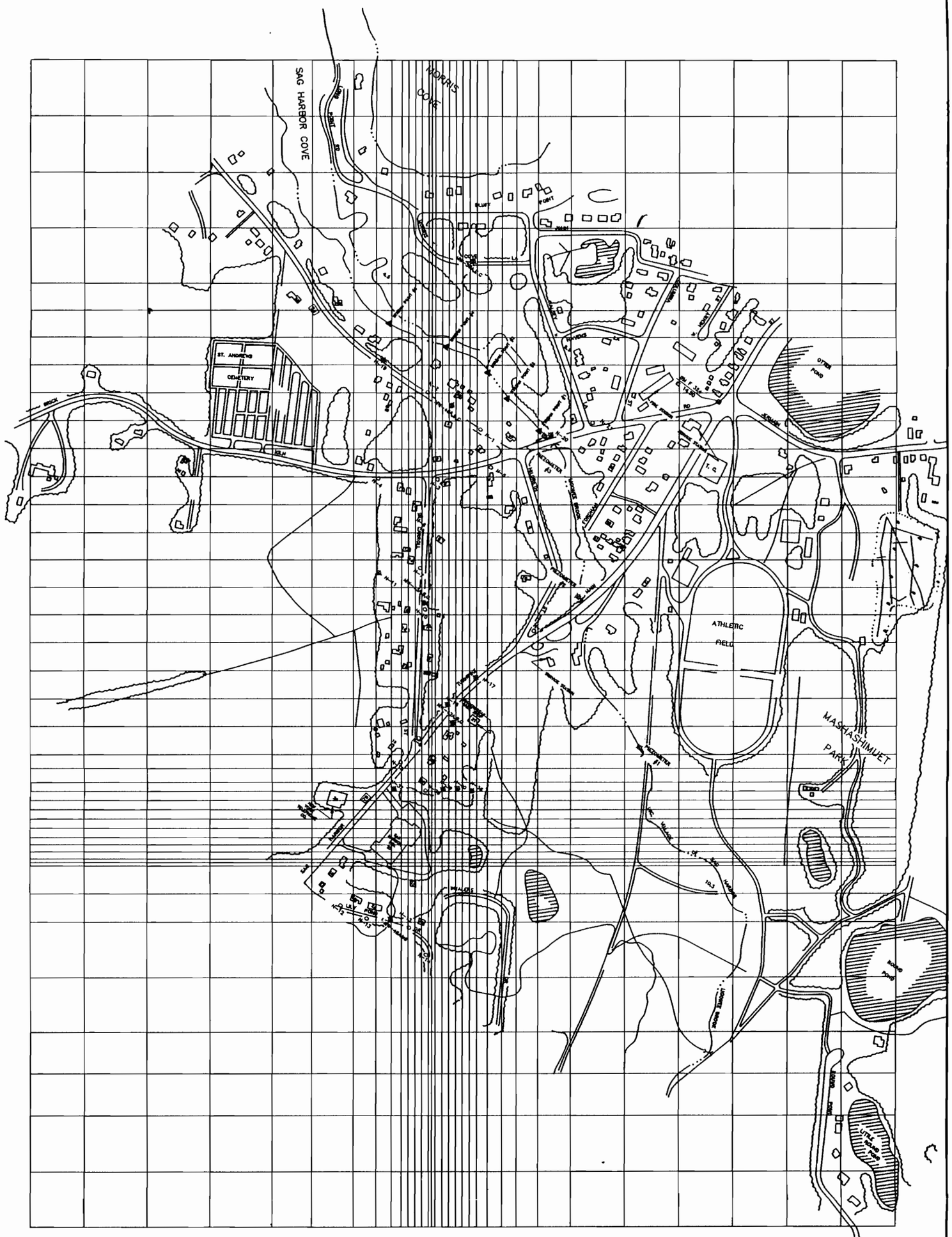

LEGEND

N-37 LOCATED SCDHS WELLS

N-13 UNLOCATED SCDHS WELLS

PROPERTY OWNERS' WELLS

STREAM POINT SAMPLING LOCATION

MW-43A WELL(S) INSTALLED FOR RI/FS

PIEZOMETER #2 PIEZOMETER LOCATION

0 525

SCALE IN FEET

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
SAG HARBOR, NEW YORK

FINITE ELEMENT MODEL GRID FOR MODEL

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 7/9/92 FIGURE: 1

NORTHWEST

A

SOUTHEAST

A'

MW50 SAG HARBOR COVE N-19 MW49 N-20 V-06 N-11 MW43 N-17 N-16 MW42 N-39 MW44 N-28 MW45 MW48

LAYER 5

LAYER 4

LAYER 3

LAYER 2

VERY FINE TO VERY COARSE SAND MIXED WITH SOME SILT AND SILTY CLAY BANDS; TRACE GRAVEL AND CLAY

LAYER 1

40 30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100

ELEVATION (FEET MSL)

LEGEND

WATER TABLE ELEVATION ON 10/25/91

SCREEN SETTING

DEPTH OF BORING

0 300

HORIZONTAL SCALE IN FEET

0 20

VERTICAL SCALE IN FEET

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
SAG HARBOR, NEW YORK

MODEL LAYERS WITH RESPECT TO SCREEN SETTINGS

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
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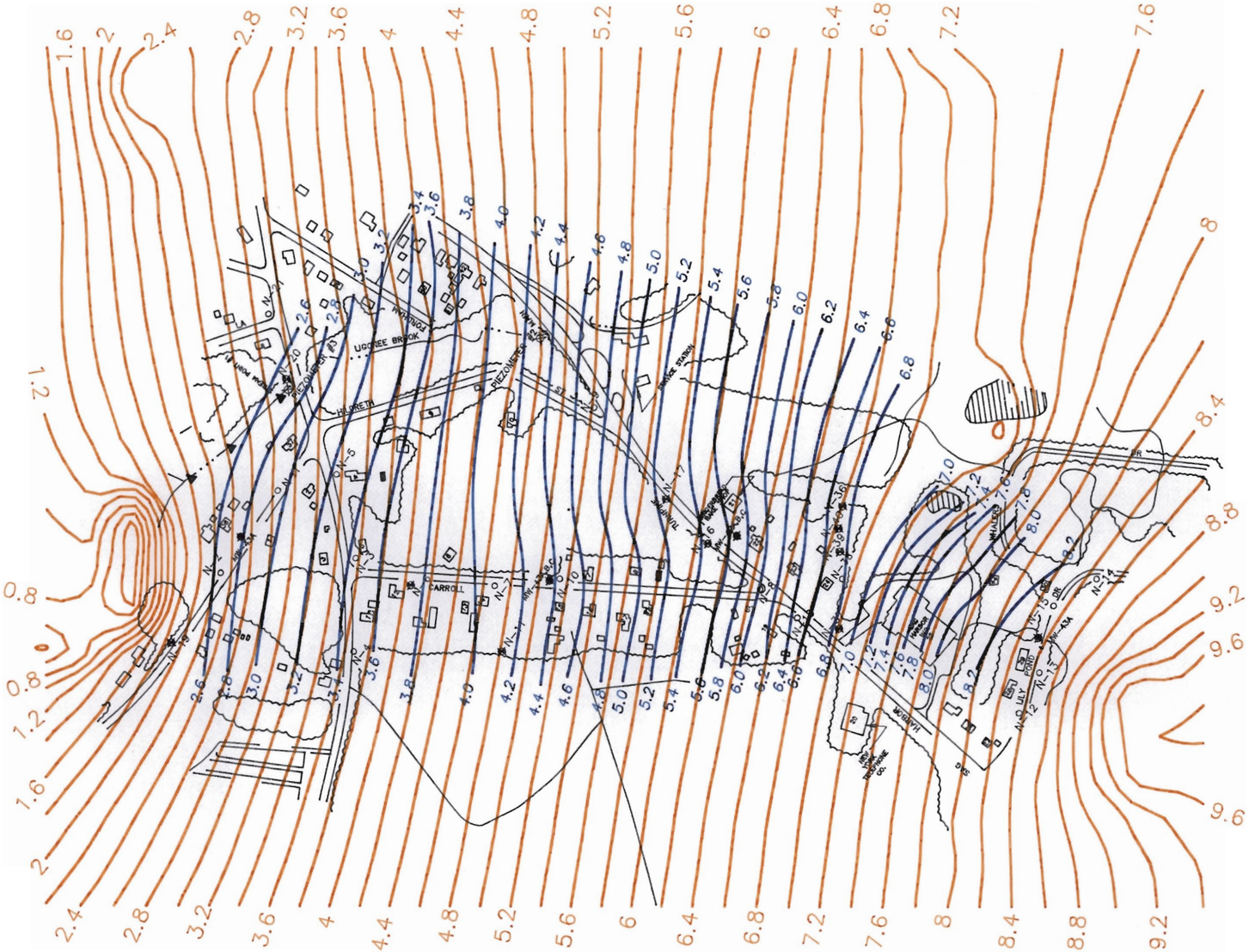
(203) 762-1207

DATE: 7/9/92 FIGURE: 2


1.6
2
2.4
2.8
3.2
3.6
4
4.4
4.8
5.2
5.6
6
6.4
6.8
7.2
7.6
8
8.4
8.8
9.2
9.6
1.2
0.8
0.8
1.2
1.6
2
2.4
2.8
3.2
3.6
4
4.4
4.8
5.2
5.6
6
6.4
6.8
7.2
7.6
8
8.4
8.8
9.2
9.6
LIGONEE BROOK
CARROLL
HAUBEIN
PIEZOMETER #1
PIEZOMETER #2
PIEZOMETER #3
MW-43A
MW-43B
MW-43C
N-13
N-14
N-15
N-16
N-17
N-18
N-19
N-20
N-21
N-22
N-23
N-24
N-25
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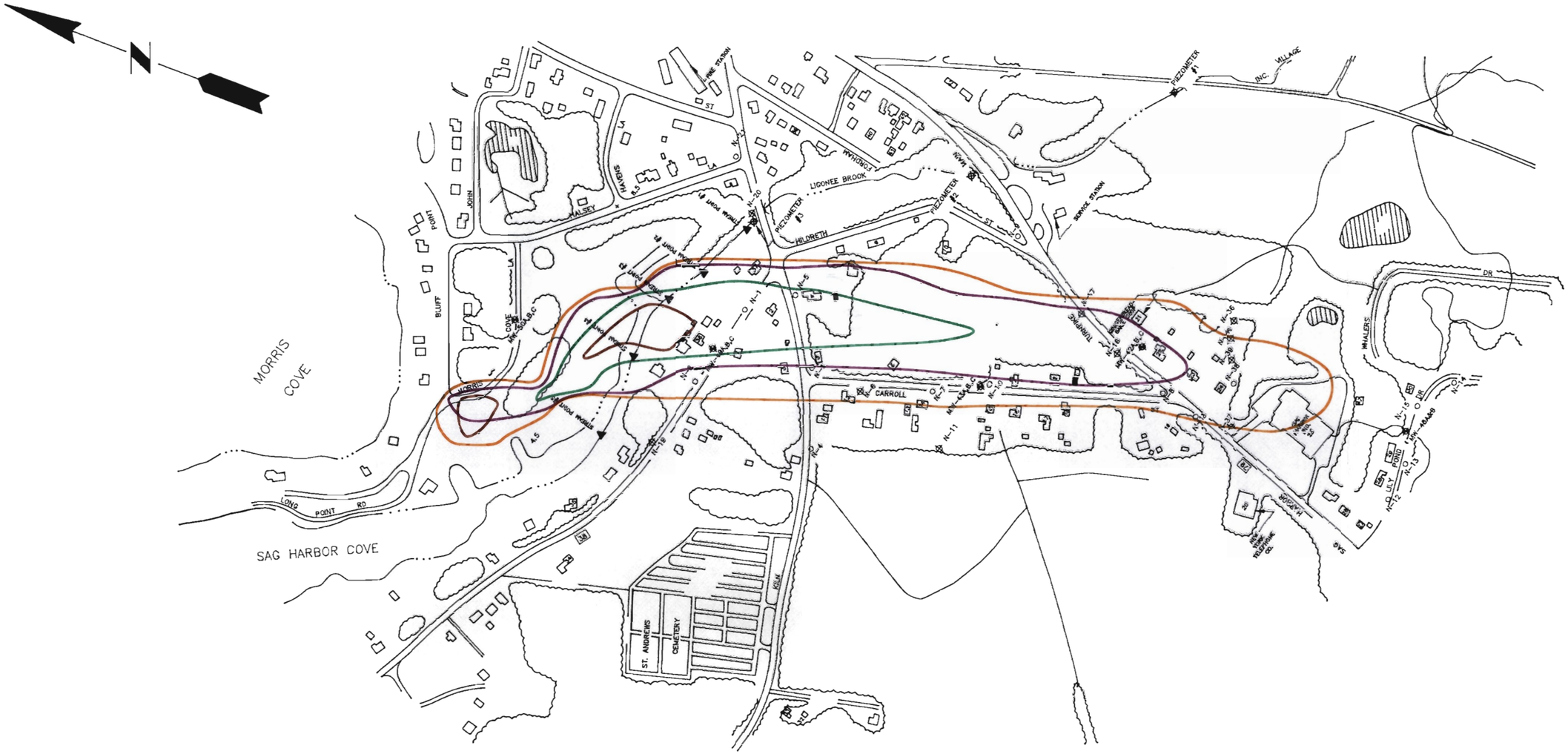
N-51
N-52



LEGEND

- N-37 ⊠ — LOCATED SCDHS WELLS
- N-13 ○ — UNLOCATED SCDHS WELLS
- 27 — PROPERTY OWNERS' WELLS
- ▲ — STREAM POINT SAMPLING LOCATION
- MW-43A — WELL(S) INSTALLED FOR RI/FS
- PIEZOMETER #2 — PIEZOMETER LOCATION

- 5 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 10 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 15 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 20 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

0 450
SCALE IN FEET

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
SAG HARBOR, NEW YORK

SIMULATED PLUME BOUNDARY BASED ON 5 PPB OF PCE IF NO ACTION IS TAKEN FOR LAYER 5

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
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(203) 762-1207

DATE: 6/29/92 FIGURE: 4

N
MORRIS COVE
SAG HARBOR COVE
LONG POINT RD
JOHN
POINT
BLUFF
COVE
MALSEY
HILDRETH
CARROLL
UGONEE BROOK
PIEZOMETER #1
PIEZOMETER #2
PIEZOMETER #3
INC. VILLAGE
SERVICE STATION
FIRE STATION
TURNPIKE
MAIN ST
DR
WHALERS
WYCKOFF
KILN
ST. ANDREWS CEMETERY
MW-43A,B,C
MW-44A,B,C
MW-45A,B,C
MW-46A,B,C
MW-47A,B,C
MW-48A,B,C
MW-49A,B,C
MW-50A,B,C
MW-51A,B,C
MW-52A,B,C
MW-53A,B,C
MW-54A,B,C
MW-55A,B,C
MW-56A,B,C
MW-57A,B,C
MW-58A,B,C
MW-59A,B,C
MW-60A,B,C
MW-61A,B,C
MW-62A,B,C
MW-63A,B,C
MW-64A,B,C
MW-65A,B,C
MW-66A,B,C
MW-67A,B,C
MW-68A,B,C
MW-69A,B,C
MW-70A,B,C
MW-71A,B,C
MW-72A,B,C
MW-73A,B,C
MW-74A,B,C
MW-75A,B,C
MW-76A,B,C
MW-77A,B,C
MW-78A,B,C
MW-79A,B,C
MW-80A,B,C
MW-81A,B,C
MW-82A,B,C

LEGEND

- N-37 ⊠ LOCATED SCDHS WELLS
- N-13 O UNLOCATED SCDHS WELLS
- 27 PROPERTY OWNERS' WELLS
- ▲ STREAM POINT SAMPLING LOCATION
- NW-43A WELL(S) INSTALLED FOR RI/FS
- PIEZOMETER #2 PIEZOMETER LOCATION

- 5 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 10 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 15 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 20 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

0 450
SCALE IN FEET

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
SAG HARBOR, NEW YORK

SIMULATED PLUME BOUNDARY BASED ON 5 PPB OF PCE IF NO ACTION IS TAKEN FOR LAYER 3

DATE	REVISED

PREPARED BY:
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72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 6/29/92 FIGURE: 6

LEGEND

- N-37 ⊠ LOCATED SCDHS WELLS
- N-13 ○ UNLOCATED SCDHS WELLS
- 27 PROPERTY OWNERS' WELLS
- ▲ STREAM POINT SAMPLING LOCATION
- MW-43A WELL(S) INSTALLED FOR RI/FS
- PIEZOMETER #2 PIEZOMETER LOCATION

- 5 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 10 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 15 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 20 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 25 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

0 450
SCALE IN FEET

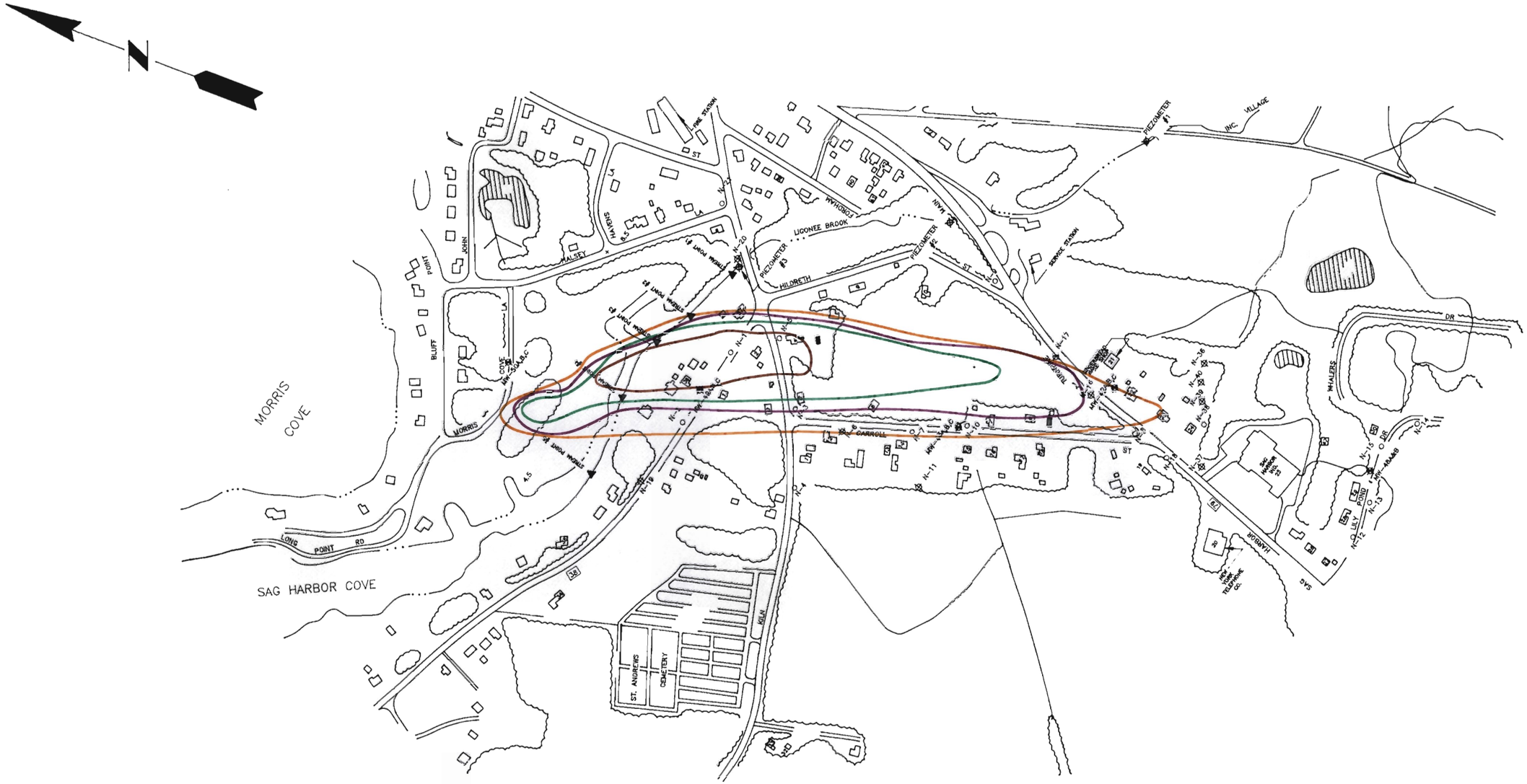
NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
SAG HARBOR, NEW YORK

SIMULATED PLUME BOUNDARY BASED ON 5 PPB OF PCE IF NO ACTION IS TAKEN FOR LAYER 2

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 6/29/92 FIGURE: 7



LEGEND

N-37 ⊠	LOCATED SCDHS WELLS
N-13 ○	UNLOCATED SCDHS WELLS
27	PROPERTY OWNERS' WELLS
▲	STREAM POINT SAMPLING LOCATION
MW-43A	WELL(S) INSTALLED FOR RI/FS
PIEZOMETER #2	PIEZOMETER LOCATION

- 5 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 10 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 15 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 20 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

0 450

SCALE IN FEET

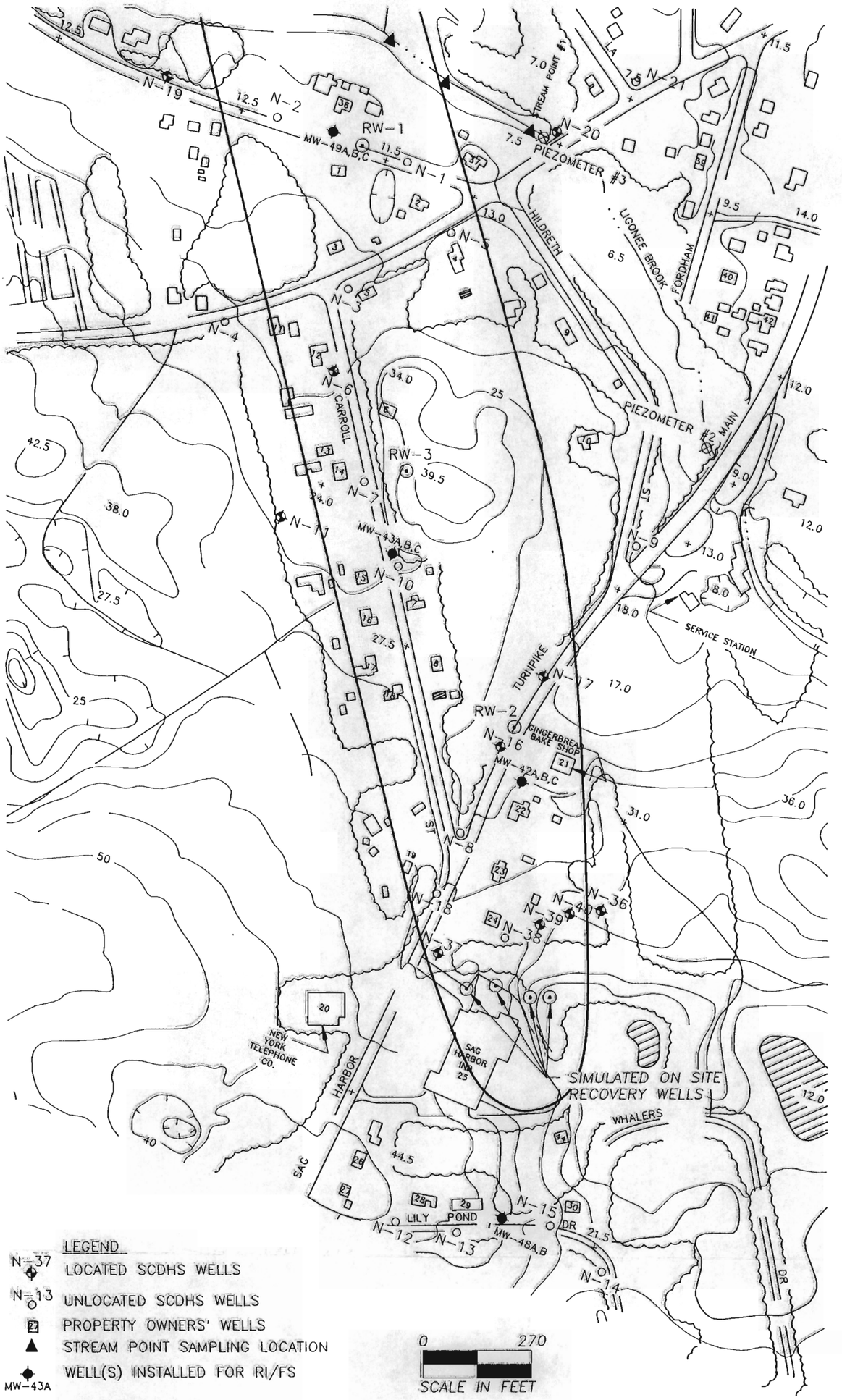
NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
SAG HARBOR, NEW YORK

SIMULATED PLUME BOUNDARY BASED ON 5 PPB OF PCE IF NO ACTION IS TAKEN FOR LAYER 1

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 6/29/92 FIGURE: 8



LEGEND

- N-37 — LOCATED SCDHS WELLS
- N-13 — UNLOCATED SCDHS WELLS
- 27 — PROPERTY OWNERS' WELLS
- ▲ — STREAM POINT SAMPLING LOCATION
- MW-43A — WELL(S) INSTALLED FOR RI/FS
- PIEZOMETER #2 — PIEZOMETER LOCATION
- PLUME BOUNDARY BASED ON 1 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- ⊙ — SIMULATED RECOVERY WELL

LAND SURFACE CONTOUR INTERVAL = 5 FEET

CONTOUR MAP IS BASED ON OCTOBER 25, 1991 WATER ELEVATIONS.

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
SAG HARBOR, NEW YORK

THEORETICAL RECOVERY WELL LOCATION MAP

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
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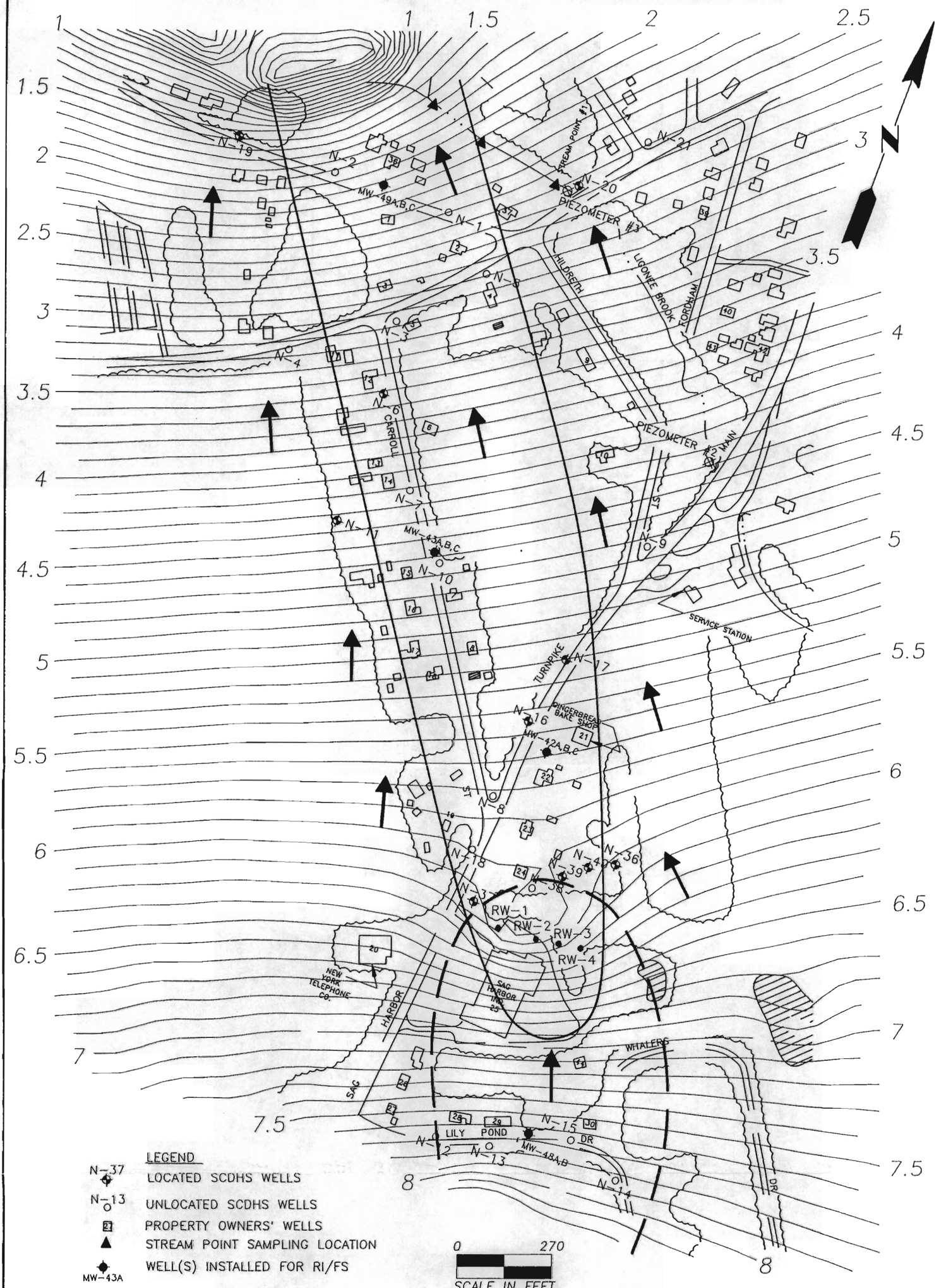
Wilton, CT 06897
(203) 762-1207

DATE: 7/9/92 FIGURE: 9



LEGEND

- N-37 — LOCATED SCDHS WELLS
- N-13 — UNLOCATED SCDHS WELLS
- 21 — PROPERTY OWNERS' WELLS
- ▲ — STREAM POINT SAMPLING LOCATION
- MW-43A — WELL(S) INSTALLED FOR RI/FS
- PIEZOMETER #2 — PIEZOMETER LOCATION
- RW-1 — RECOVERY WELL
- GROUND-WATER FLOW DIRECTION
- 1 — GROUND-WATER CONTOUR LINE
- PLUME BOUNDARY BASED ON 1 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- CAPTURE ZONE OF ON SITE WELLS

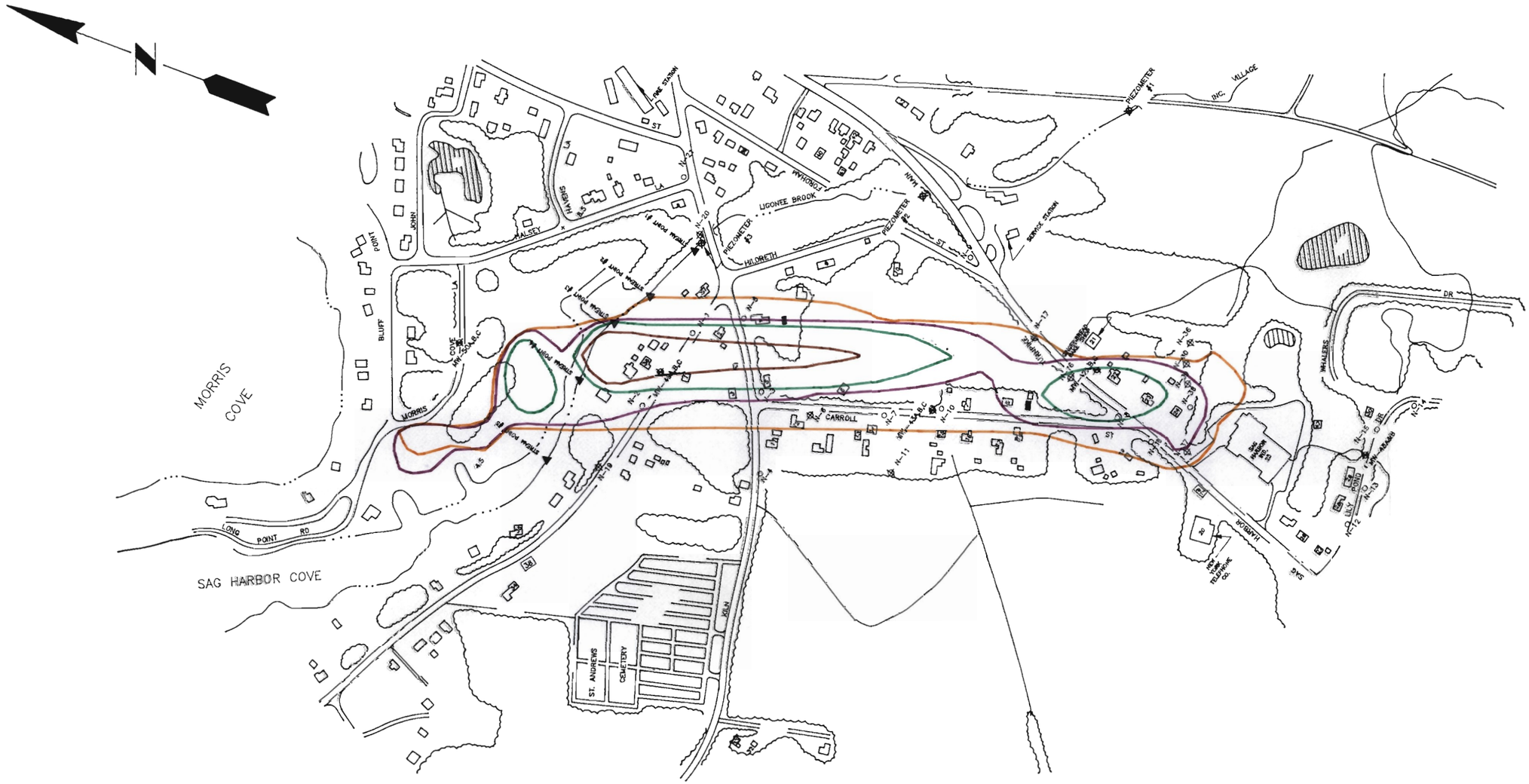
NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
SAG HARBOR, NEW YORK

MODELLED GROUND-WATER FLOW PATTERNS AND CAPTURE ZONES FOR 150 GPM EXTRACTION RATE

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 7/9/92 | FIGURE: 10



LEGEND

- N-37 ⊠ LOCATED SCDHS WELLS
- N-13 ○ UNLOCATED SCDHS WELLS
- 27 PROPERTY OWNERS' WELLS
- ▲ STREAM POINT SAMPLING LOCATION
- MW-43A WELL(S) INSTALLED FOR RI/FS
- PIEZOMETER #2 PIEZOMETER LOCATION

- 5 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 10 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 15 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 20 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

0 450
SCALE IN FEET

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
SAG HARBOR, NEW YORK

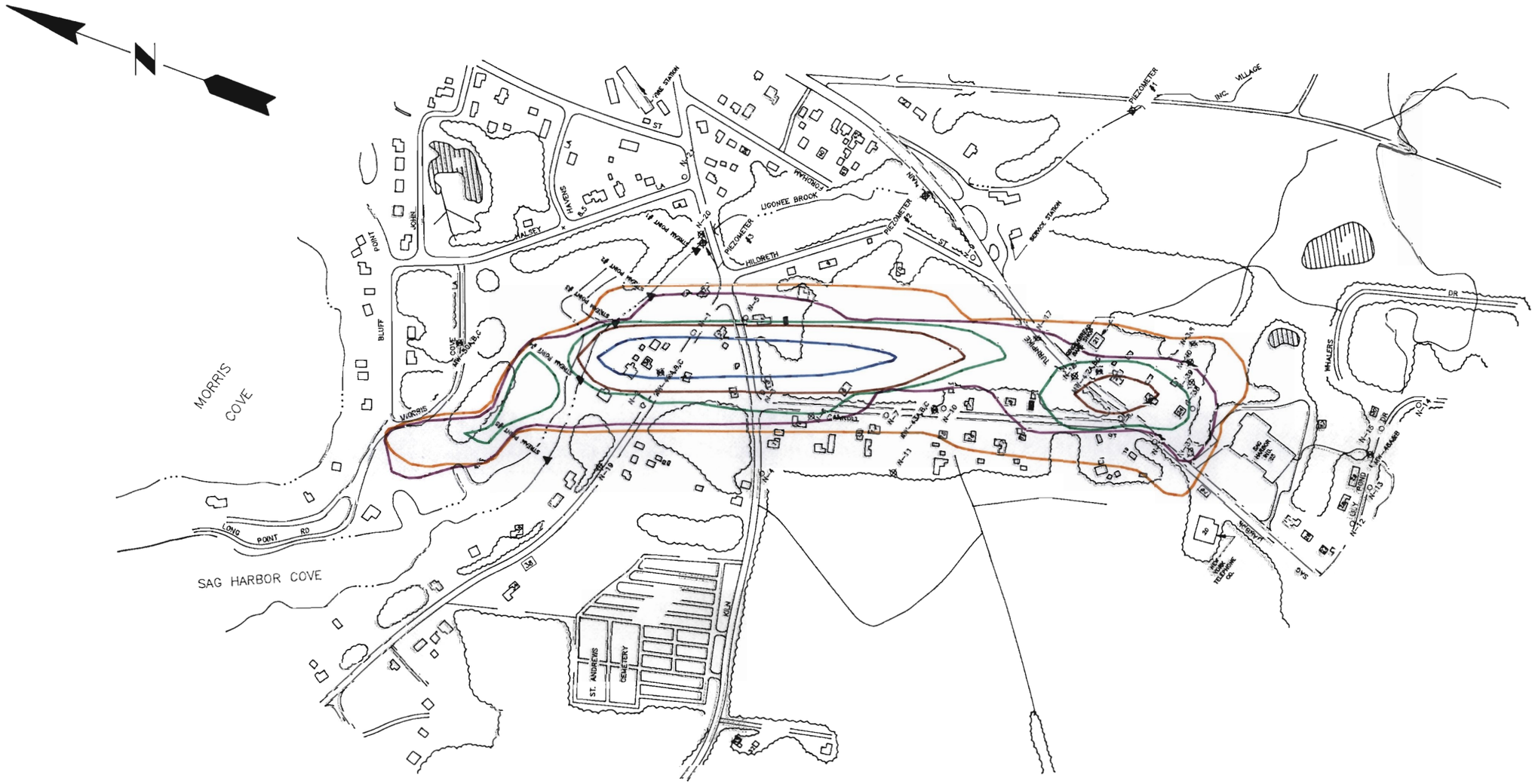
SIMULATED PLUME BOUNDARY BASED ON 5 PPB OF PCE WITH ONSITE PUMPAGE AT 150 GPM FOR LAYER 5

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 7/7/92 FIGURE: 11

MORRIS COVE
SAG HARBOR COVE
LONG POINT RD
JOHN HALSEY HOUSE
BLUFF POINT LA
MORRIS COVE
FIRE STATION
HAINES
HILORETH
LIGONEE BROOK
PIEZOMETER #3
PIEZOMETER #4
PIEZOMETER #1
SERVICE STATION
WHALERS DR
CARROLL
ST. ANDREWS CEMETERY
KILN
MW-43A,B,C
MW-44A,B,C
MW-45A,B,C
MW-46A,B,C
MW-47A,B,C
MW-48A,B,C
MW-49A,B,C
MW-50A,B,C
MW-51A,B,C
MW-52A,B,C
MW-53A,B,C
MW-54A,B,C
MW-55A,B,C
MW-56A,B,C
MW-57A,B,C
MW-58A,B,C
MW-59A,B,C
MW-60A,B,C
MW-61A,B,C
MW-62A,B,C
MW-63A,B,C
MW-64A,B,C
MW-65A,B,C
MW-66A,B,C
MW-67A,B,C
MW-68A,B,C
MW-69A,B,C
MW-70A,B,C
MW-71A,B,C
MW-72A,B,C
MW-73A,B,C
MW-74A,B,C
MW-75A,B,C
MW-76A,B,C
MW-77A,B,C
MW-78A,B,C
MW-79A,B,C
MW-80A,B,C
MW-81A,B,C
MW-82A,B,C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BLUFF
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COVE
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WALSEY
HAVENS
ST
FIRE STATION
HYWARD
LIGONEE BROOK
PIEZOMETER #3
HILDRETH
PIEZOMETER #2
PIEZOMETER #1
INC. VILLAGE
SERVICE STATION
TURNPIKE
DR
WHALERS
HOLLY
POND
WATER
TOWER
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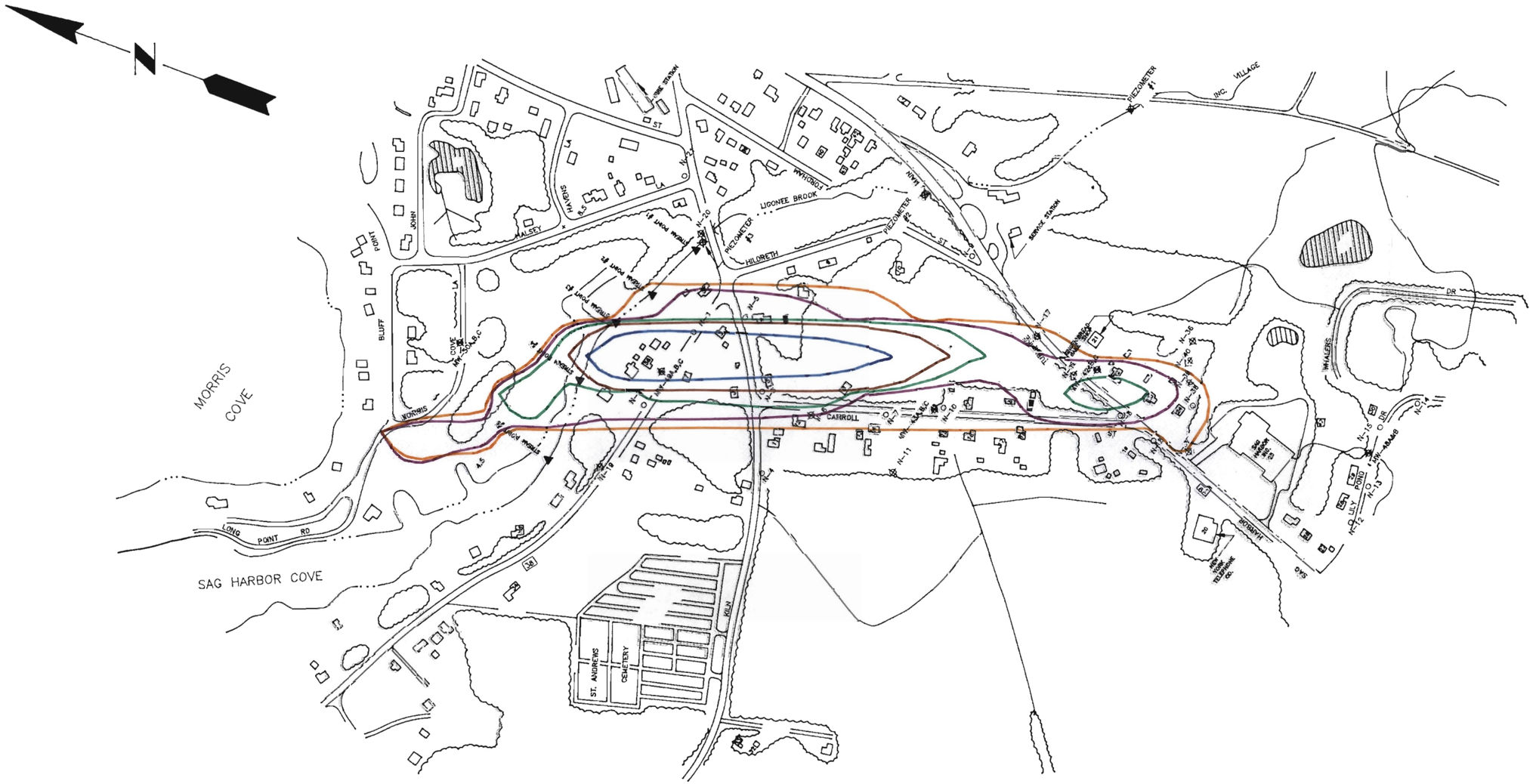


LEGEND

- N-37 ⊠ LOCATED SCDHS WELLS
- N-13 ○ UNLOCATED SCDHS WELLS
- 27 PROPERTY OWNERS' WELLS
- ▲ STREAM POINT SAMPLING LOCATION
- ◆ NW-43A WELL(S) INSTALLED FOR RI/FS
- ⊠ PIEZOMETER #2 PIEZOMETER LOCATION

- 5 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 10 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 15 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 20 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 25 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

0 450
SCALE IN FEET

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
SAG HARBOR, NEW YORK

SIMULATED PLUME BOUNDARY BASED ON 5 PPB OF PCE WITH ONSITE PUMPAGE AT 150 GPM FOR LAYER 2

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 7/7/92 FIGURE: 14

LEGEND

- N-37 ⊠ LOCATED SCDHS WELLS
- N-13 ○ UNLOCATED SCDHS WELLS
- 27 PROPERTY OWNERS' WELLS
- ▲ STREAM POINT SAMPLING LOCATION
- NW-43A WELL(S) INSTALLED FOR RI/FS
- PIEZOMETER #2 PIEZOMETER LOCATION

- 5 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 10 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 15 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 20 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 25 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

0 450
SCALE IN FEET

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
SAG HARBOR, NEW YORK

SIMULATED PLUME BOUNDARY BASED ON 5 PPB OF PCE WITH ONSITE PUMPAGE AT 150 GPM FOR LAYER 1

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 7/7/92 FIGURE: 15

LEGEND

N–37 ⊠	LOCATED SCDHS WELLS
N–13 ○	UNLOCATED SCDHS WELLS
27	PROPERTY OWNERS' WELLS
▲	STREAM POINT SAMPLING LOCATION
MW–43A	WELL(S) INSTALLED FOR RI/FS
PIEZOMETER #2	PIEZOMETER LOCATION

- 5 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 10 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 15 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 20 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

0 450
SCALE IN FEET

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
SAG HARBOR, NEW YORK

SIMULATED PLUME BOUNDARY BASED ON 5 PPB OF PCE WITH ONSITE PUMPAGE AT 150 GPM FOR 5 YEARS ONLY FOR LAYER 5

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 7/7/92 FIGURE: 16

LEGEND

- N-37 ⊠ LOCATED SCDHS WELLS
- N-13 ○ UNLOCATED SCDHS WELLS
- 27 PROPERTY OWNERS' WELLS
- ▲ STREAM POINT SAMPLING LOCATION
- NW-43A WELL(S) INSTALLED FOR RI/FS
- PIEZOMETER #2 PIEZOMETER LOCATION

- 5 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 10 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 15 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
- 20 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

0 450
SCALE IN FEET

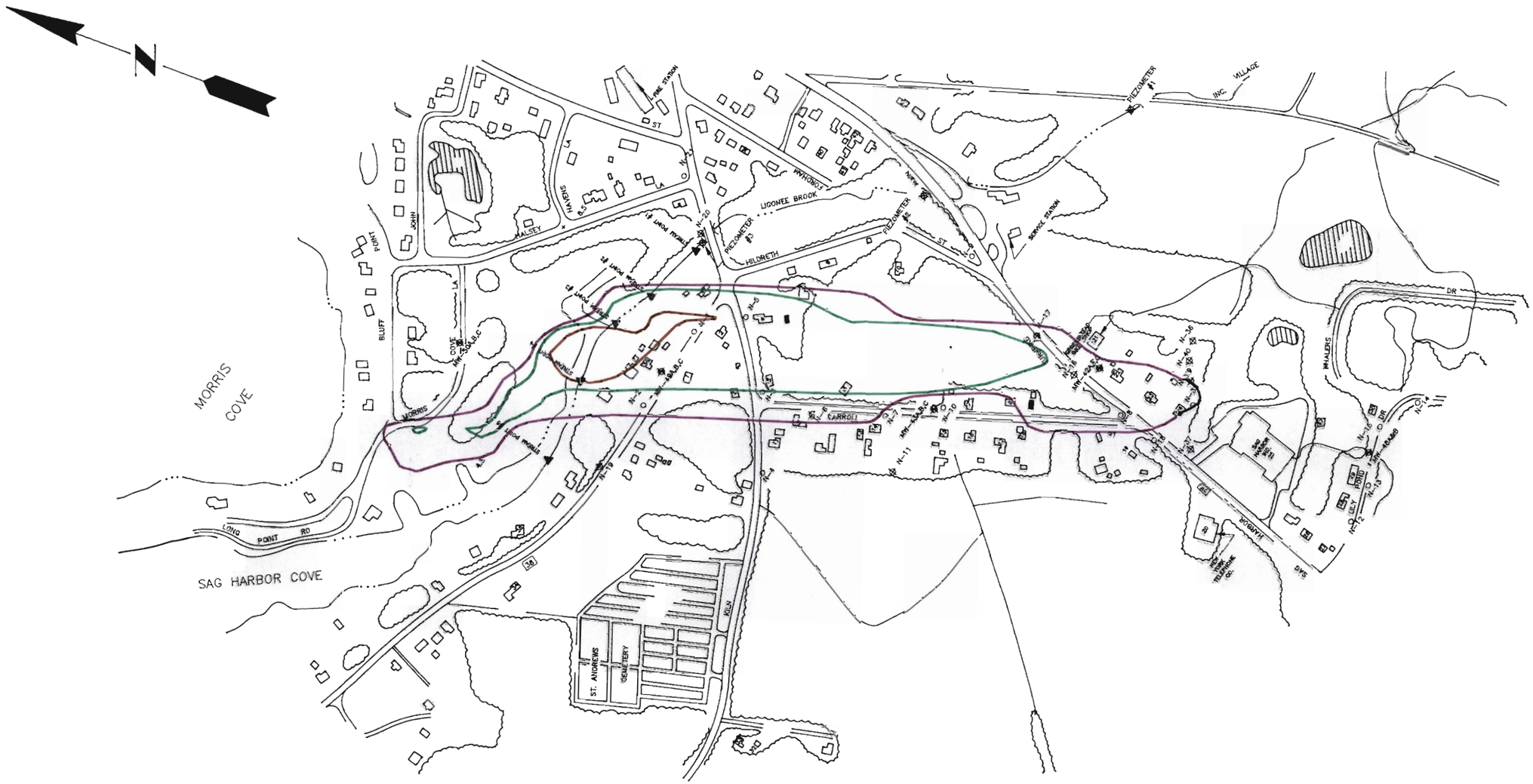
NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
SAG HARBOR, NEW YORK

SIMULATED PLUME BOUNDARY BASED ON 5 PPB OF PCE WITH ONSITE PUMPAGE AT 150 GPM FOR 5 YEARS ONLY FOR LAYER 4

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 7/7/92 FIGURE: 17


N
MORRIS COVE
SAG HARBOR COVE
LONG POINT RD
JOHN
POINT
BLUFF
COVE
HALSEY
LA
FIRE STATION
ST
WHALEBOAT
LIGONEE BROOK
PIEZOMETER #3
HILDRETH
PIEZOMETER #2
MAIN
ST
SERVICE STATION
PIEZOMETER #1
INC. VILLAGE
DR
WHALERS
CARROLL
MORGAN
ST. ANDREWS CEMETERY
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N-37
MW-30A,B,C
MW-40A,B,C
MW-41A,B,C
MW-42A,B,C
MW-43A,B,C
MW-44A,B,C
MW-45A,B,C
MW-46A,B,C
MW-47A,B,C
MW-48A,B,C
MW-49A,B,C
MW-50A,B,C
MW-51A,B,C
MW-52A,B,C
MW-53A,B,C
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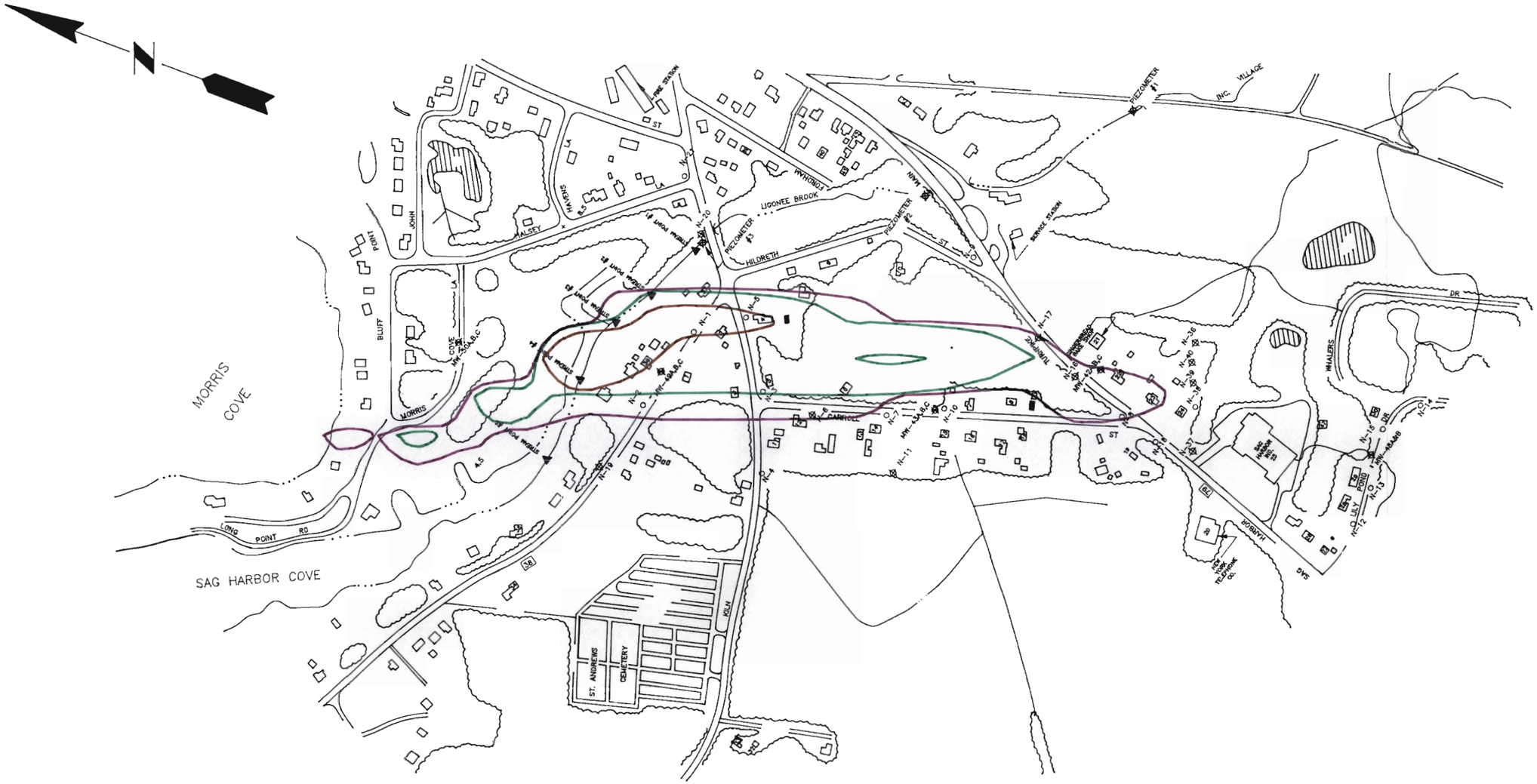
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LONG POINT RD
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MORRIS
HALSEY
HAVENS
FIRE STATION
ST
HILDRETH
LIGONEE BROOK
PIPHONEY
PIEZOMETER #3
PIEZOMETER #2
PIEZOMETER #1
MAIN
INC. VILLAGE
SERVICE STATION
CARROLL
TIMOTHY
WHALERS
DR
LILY
POND
HOBART
KILN
ST. ANDREWS
CEMETERY
MW-43A,B,C
MW-44A,B,C
MW-45A,B,C
MW-46A,B,C
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LONG POINT RD
JOHN MALSEY
POINT BLUFF
COVE
MORRIS
HARRIS
WATER TOWER
WRIGHTS
LIGONEE BROOK
HILDRETH
PIEZOMETER #1
PIEZOMETER #2
PIEZOMETER #3
SERVICE STATION
INC. VILLAGE
TURNPIKE
CARROLL
WHALERS
DR
HARBOR
ST. ANDREWS CEMETERY
ROAD
MW-30A,B,C
MW-40A,B,C
MW-41A,B,C
MW-42A,B,C
MW-43A,B,C
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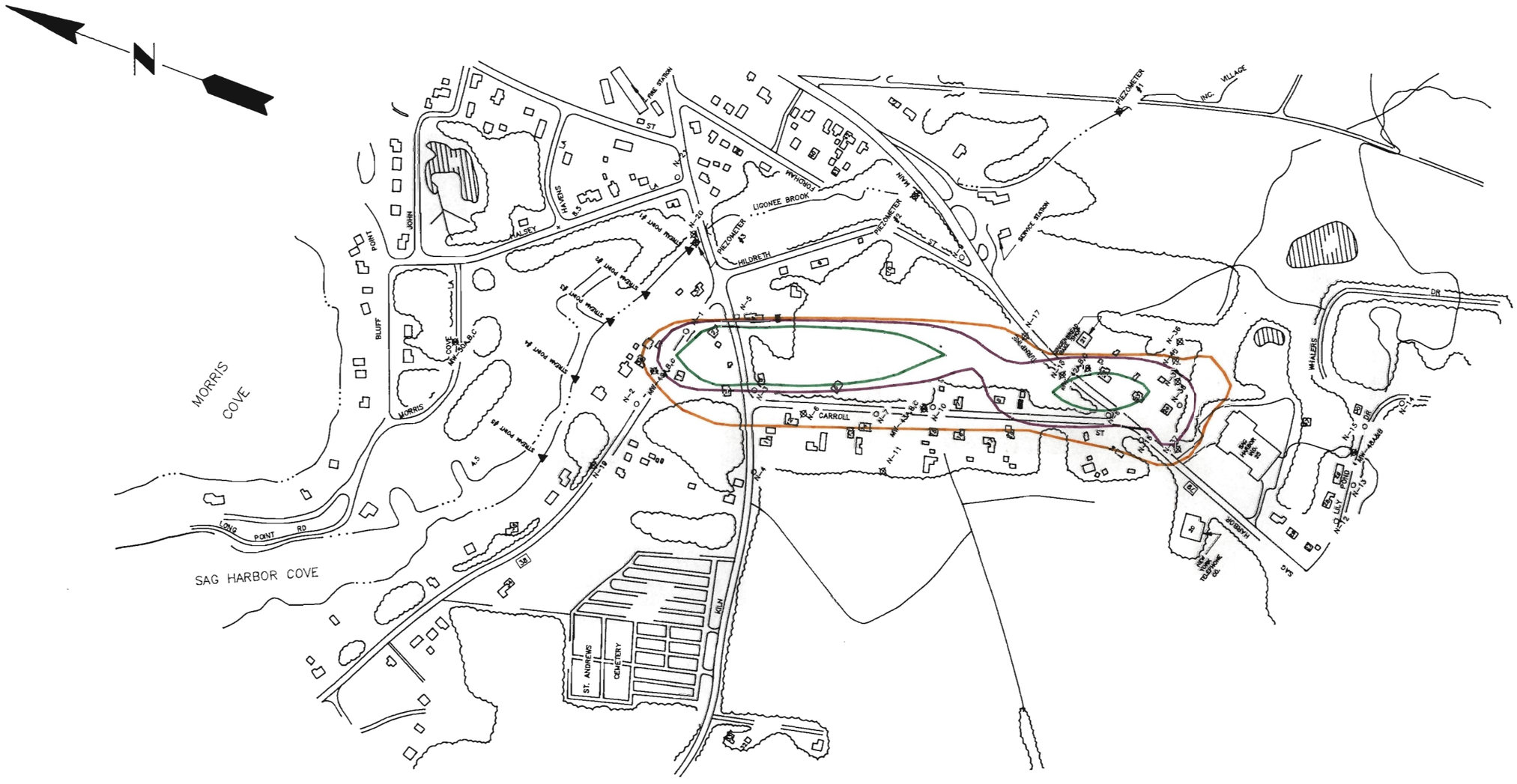
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MW-48A,B,C
MW-49A,B,C
MW-50A,B,C
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MW-81A,B,C
MW-82A,B,C

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SAG HARBOR COVE
LONG POINT RD
MORRIS LA
BLUFF
JOHN
PORT
HALSEY
FIRE STATION
ST
FORDHAM
LIGONEE BROOK
PIEZOMETER
HILDRETH
STRAW POINT
CARROLL
TERRENCE
WHALERS
DR
INC. VILLAGE
SERVICE STATION
MAIN
ST. ANDREWS CEMETERY
MAIN
NEW YORK TELEPHONE CO.
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LEGEND

N-37 ⊠	LOCATED SCDHS WELLS
N-13 ○	UNLOCATED SCDHS WELLS
67	PROPERTY OWNERS' WELLS
▲	STREAM POINT SAMPLING LOCATION
◆ NW-43A	WELL(S) INSTALLED FOR RI/FS
⊠ PIEZOMETER #2	PIEZOMETER LOCATION

5 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

10 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

15 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

20 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

0 450

SCALE IN FEET

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
SAG HARBOR, NEW YORK

SIMULATED PLUME BOUNDARY BASED ON 5 PPB OF PCE WITH RW-1 AND ONSITE PUMPAGE FOR LAYER 3

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 7/7/92 FIGURE: 23

N
MORRIS COVE
SAG HARBOR COVE
LONG POINT RD
JOHN PT
BLUFF LA
COVE
MORRIS
HALSEY
HAYENS
FIRE STATION
ST
LIGONEE BROOK
HILDRETH
PIEZOMETER #1
PIEZOMETER #2
PIEZOMETER #3
MW-20A,B,C
MW-21A,B,C
MW-22A,B,C
MW-23A,B,C
MW-24A,B,C
MW-25A,B,C
MW-26A,B,C
MW-27A,B,C
MW-28A,B,C
MW-29A,B,C
MW-30A,B,C
MW-31A,B,C
MW-32A,B,C
MW-33A,B,C
MW-34A,B,C
MW-35A,B,C
MW-36A,B,C
MW-37A,B,C
MW-38A,B,C
MW-39A,B,C
MW-40A,B,C
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MW-42A,B,C
MW-43A,B,C
MW-44A,B,C
MW-45A,B,C
MW-46A,B,C
MW-47A,B,C
MW-48A,B,C
MW-49A,B,C
MW-50A,B,C
MW-51A,B,C
MW-52A,B,C
MW-53A,B,C
MW-54A,B,C
MW-55A,B,C
MW-56A,B,C
MW-57A,B,C
MW-58A,B,C
MW-59A,B,C

LEGEND

N-37 ⊠	LOCATED SCDHS WELLS
N-13 ○	UNLOCATED SCDHS WELLS
27	PROPERTY OWNERS' WELLS
▲	STREAM POINT SAMPLING LOCATION
◆ MW-43A	WELL(S) INSTALLED FOR RI/FS
⊠ PIEZOMETER #2	PIEZOMETER LOCATION

5 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

10 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

15 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

20 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

0 450

SCALE IN FEET

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
SAG HARBOR, NEW YORK

SIMULATED PLUME BOUNDARY BASED ON 5 PPB OF PCE WITH RW-1 AND ONSITE PUMPAGE FOR LAYER 1

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 7/7/92 FIGURE: 25

LEGEND

N-37 ⊠	LOCATED SCDHS WELLS
N-13 ○	UNLOCATED SCDHS WELLS
27	PROPERTY OWNERS' WELLS
▲	STREAM POINT SAMPLING LOCATION
NW-43A	WELL(S) INSTALLED FOR RI/FS
PIEZOMETER #2	PIEZOMETER LOCATION

———	5 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
———	10 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
———	15 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
———	20 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

0 450

SCALE IN FEET

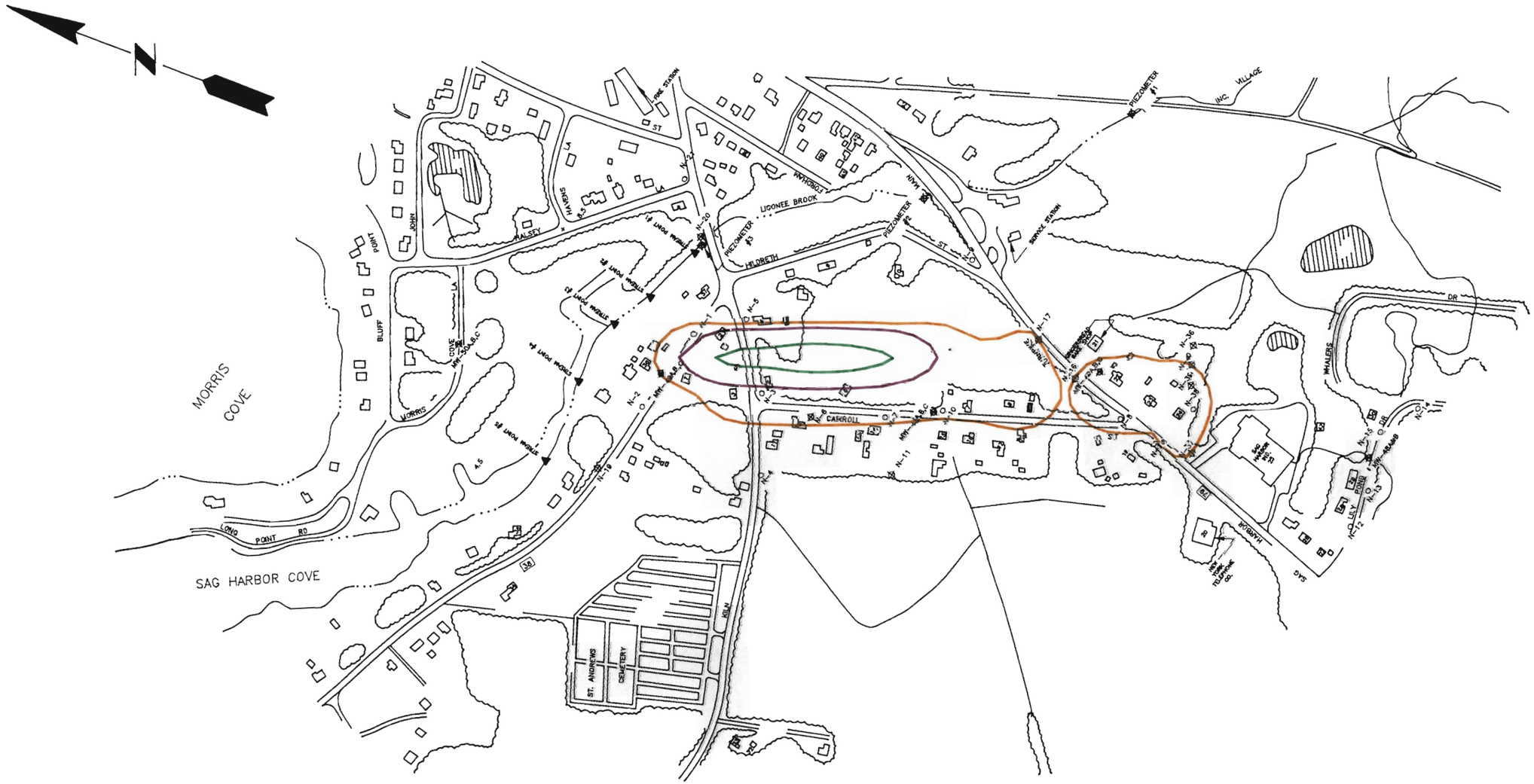
NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
SAG HARBOR, NEW YORK

SIMULATED PLUME BOUNDARY BASED ON 5 PPB OF PCE WITH RW-1, RW-2 AND ONSITE PUMPAGE FOR LAYER 5

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 7/7/92 FIGURE: 26


N
MORRIS COVE
SAG HARBOR COVE
LONG POINT RD
BLUFF POINT
JOHN
HALSEY
MORRIS
COVE
MW-30A,B,C
FIRE STATION
ST
SWEARNS
LANE
NW-2
NW-20
PIEZOMETER #3
LIGONEE BROOK
HILDRETH
PIEZOMETER #2
NW-1
NW-5
NW-17
SERVICE STATION
PIEZOMETER #1
INC.
VILLAGE
DR
WHALERS
NW-16
MW-35A,B,C
NW-36
NW-37
NW-15
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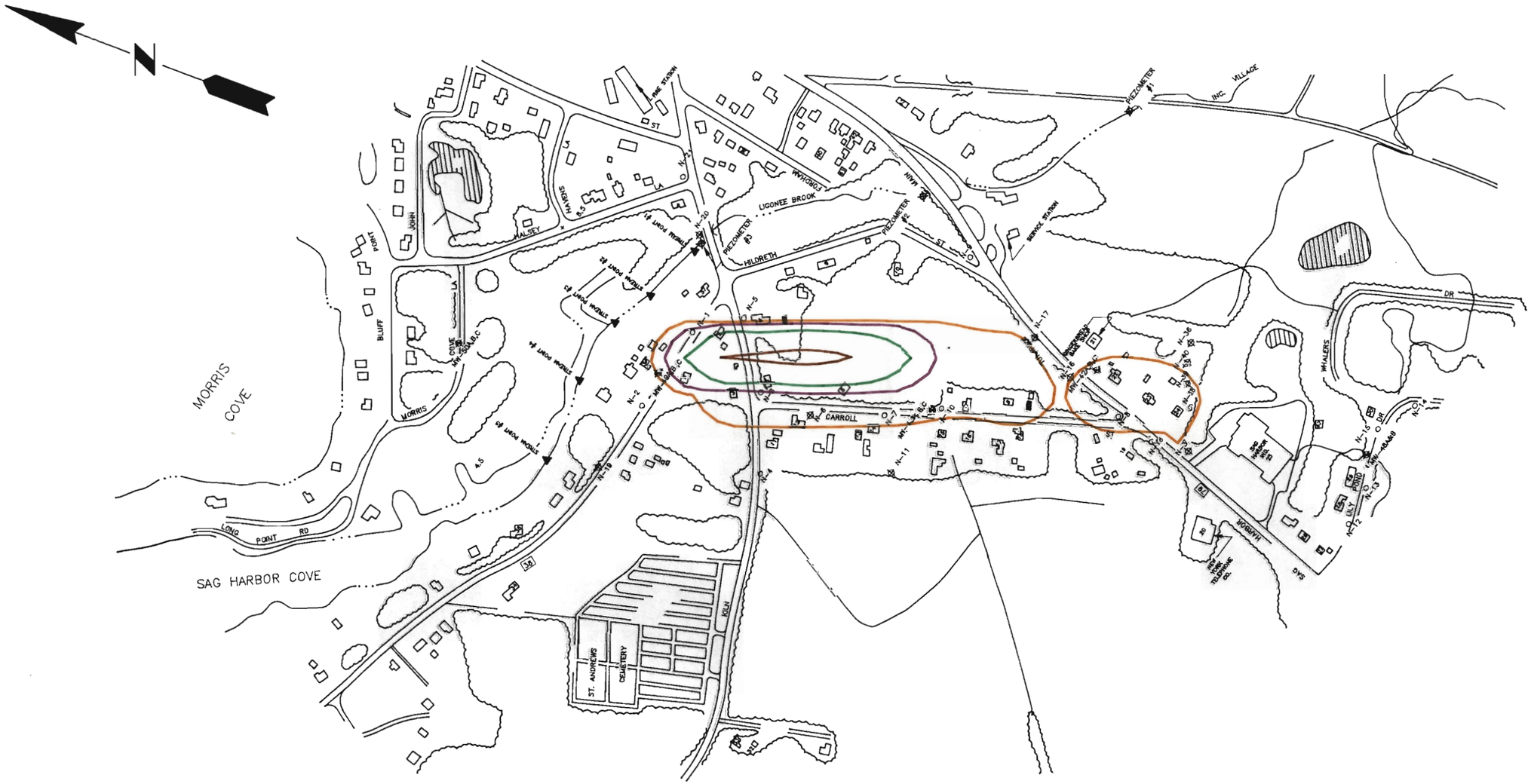
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SAG HARBOR COVE
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BLUFF
JOHN
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HAYNES
FIRE STATION
HILDRETH
LIGONEE BROOK
PIEZOMETER #3
PIEZOMETER #2
PIEZOMETER #1
MAIN
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INC. VILLAGE
SERVICE STATION
CARROLL
WHALERS
DR
POND
HOBART
KILN
ST. ANDREWS CEMETERY
MW-20A,B,C
MW-19A,B,C
MW-18A,B,C
MW-17A,B,C
MW-16A,B,C
MW-14A,B
MW-13A,B,C
MW-12A,B
MW-10A,B,C
MW-9A,B,C
MW-8A,B,C
MW-7A,B,C
MW-6A,B,C
MW-5A,B,C
MW-4A,B
MW-3A,B,C
MW-2A,B,C
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BLUFF
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COVE
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MALSEY
MARSHALL
HILDRETH
LIGONEE BROOK
PIEZOMETER #3
PIEZOMETER #4
PIEZOMETER #1
INC. VILLAGE
FIRE STATION
SERVICE STATION
TURNPIKE
CARROLL
WHALERS
DR
BOSBYTH
LILY
POND
ST. ANDREWS
CEMETERY
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NW-43A
NW-43B,C
NW-44A,B,C
NW-45A,B,C
NW-46A,B,C
NW-47A,B,C
NW-48A,B,C
NW-49A,B,C
NW-50A,B,C
NW-51A,B,C
NW-52A,B,C
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NW-56A,B,C
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NW-72A,B,C
NW-73A,B,C
NW-74A,B,C
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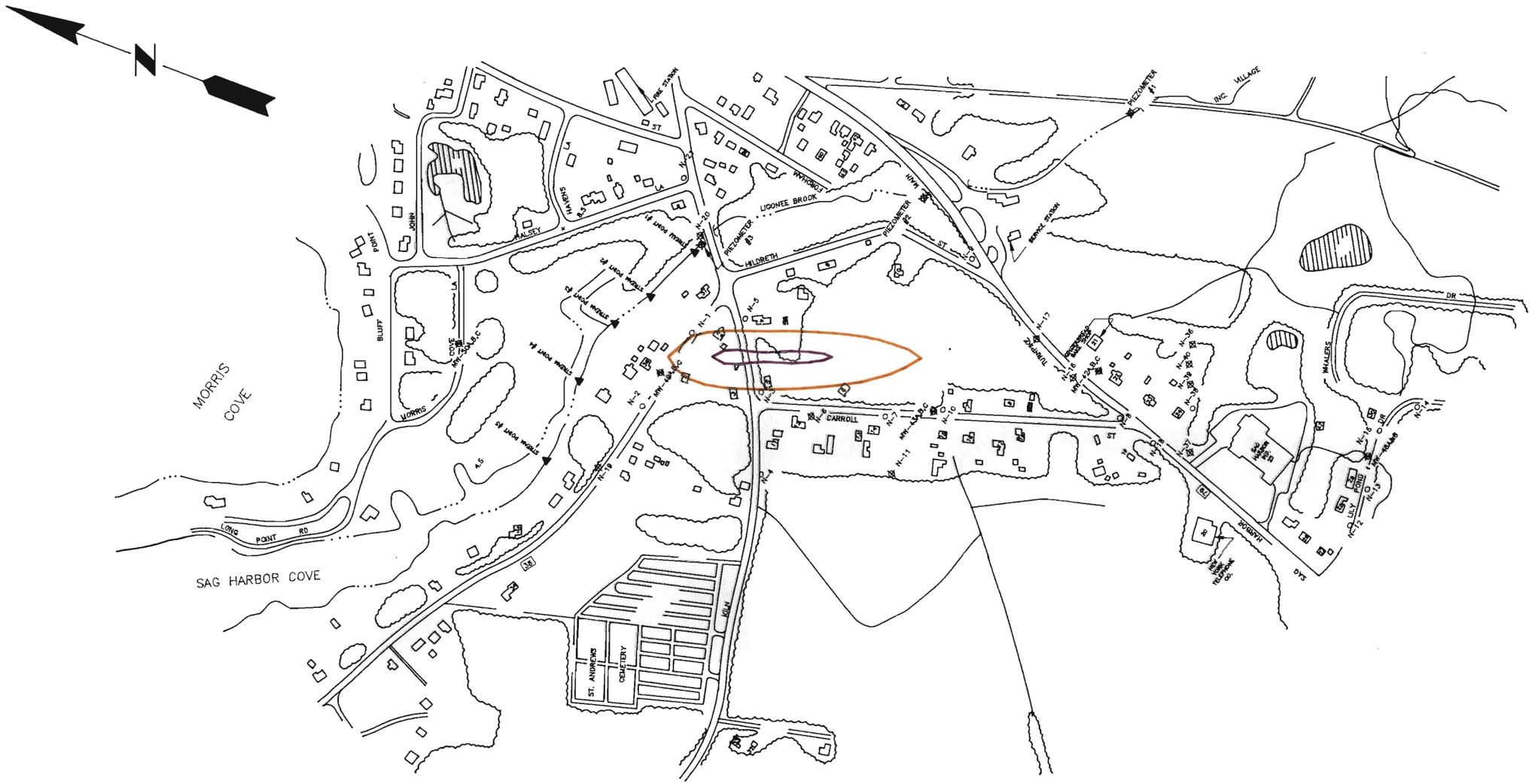
N
MORRIS COVE
SAG HARBOR COVE
LONG POINT RD
JOHN
POINT
BLUFF
COVE
MORRIS
HALSEY
HARRIS
WATERMILL
LIGONEE BROOK
PIEZOMETER #3
HILDRETH
PIEZOMETER #2
PIEZOMETER #1
INC. VILLAGE
SERVICE STATION
TIMOTHY
CARROLL
WHALERS
POND
ST. ANDREWS
CEMETERY
RUN
DR
ST
RT 114
RT 38
RT 39
RT 27
RT 27A
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MW-43A,B,C
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MW-48A,B,C
MW-49A,B,C
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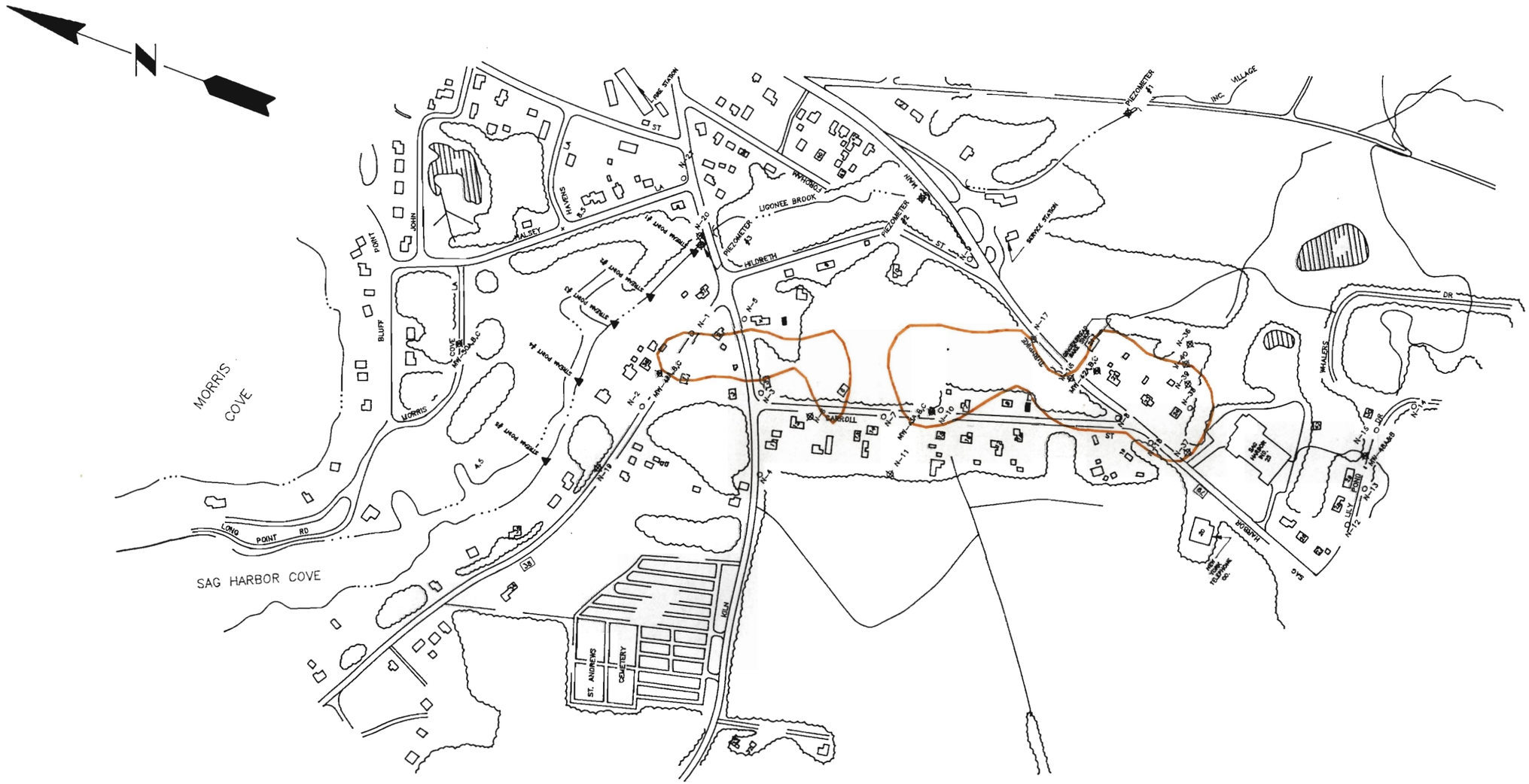


LEGEND

N-37 ⊠	LOCATED SCDHS WELLS
N-13 ○	UNLOCATED SCDHS WELLS
27 ⊡	PROPERTY OWNERS' WELLS
▲	STREAM POINT SAMPLING LOCATION
⊕ NW-43A	WELL(S) INSTALLED FOR RI/FS
⊠ PIEZOMETER #2	PIEZOMETER LOCATION

	5 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
	10 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
	15 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
	20 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

0 450
SCALE IN FEET

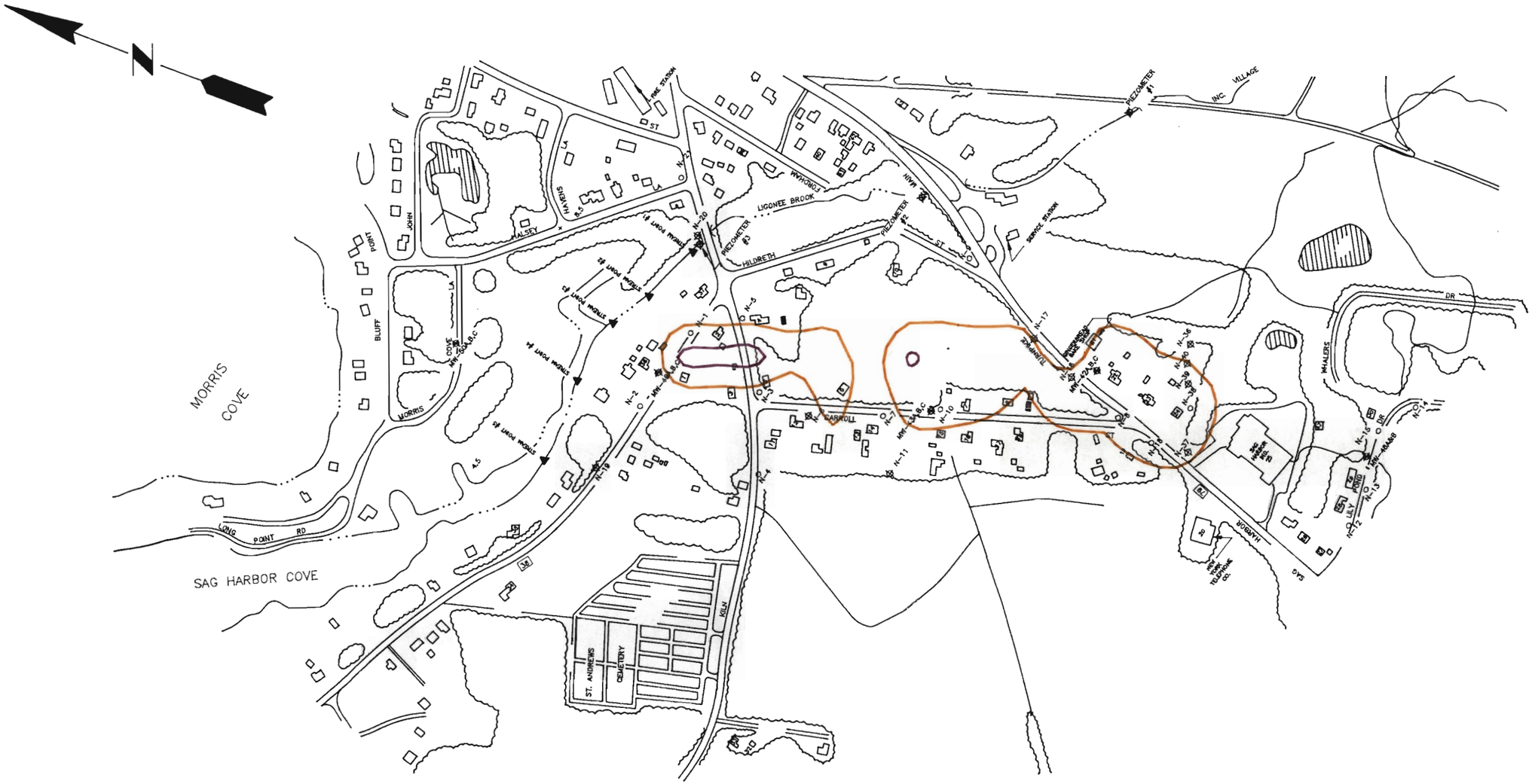
NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
SAG HARBOR, NEW YORK

SIMULATED PLUME BOUNDARY BASED ON 5 PPB OF PCE WITH RW-1, RW-2, RW-3 AND ONSITE PUMPAGE FOR LAYER 5

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 7/7/92 FIGURE: 31



LEGEND

N-37 ⊠	LOCATED SCDHS WELLS
N-13 ○	UNLOCATED SCDHS WELLS
27	PROPERTY OWNERS' WELLS
▲	STREAM POINT SAMPLING LOCATION
⊕ MW-43A	WELL(S) INSTALLED FOR RI/FS
⊠ PIEZOMETER #2	PIEZOMETER LOCATION

	5 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
	10 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
	15 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
	20 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

0 450
SCALE IN FEET

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
SAG HARBOR, NEW YORK

SIMULATED PLUME BOUNDARY BASED ON 5 PPB OF PCE WITH RW-1, RW-2, RW-3 AND ONSITE PUMPAGE FOR LAYER 4

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 7/7/92 FIGURE: 32

LEGEND

N-37 ⊠	LOCATED SCDHS WELLS
N-13 ○	UNLOCATED SCDHS WELLS
27	PROPERTY OWNERS' WELLS
▲	STREAM POINT SAMPLING LOCATION
◆ MW-43A	WELL(S) INSTALLED FOR RI/FS
⊠ PIEZOMETER #2	PIEZOMETER LOCATION

———	5 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
———	10 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
———	15 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
———	20 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

0 450
SCALE IN FEET

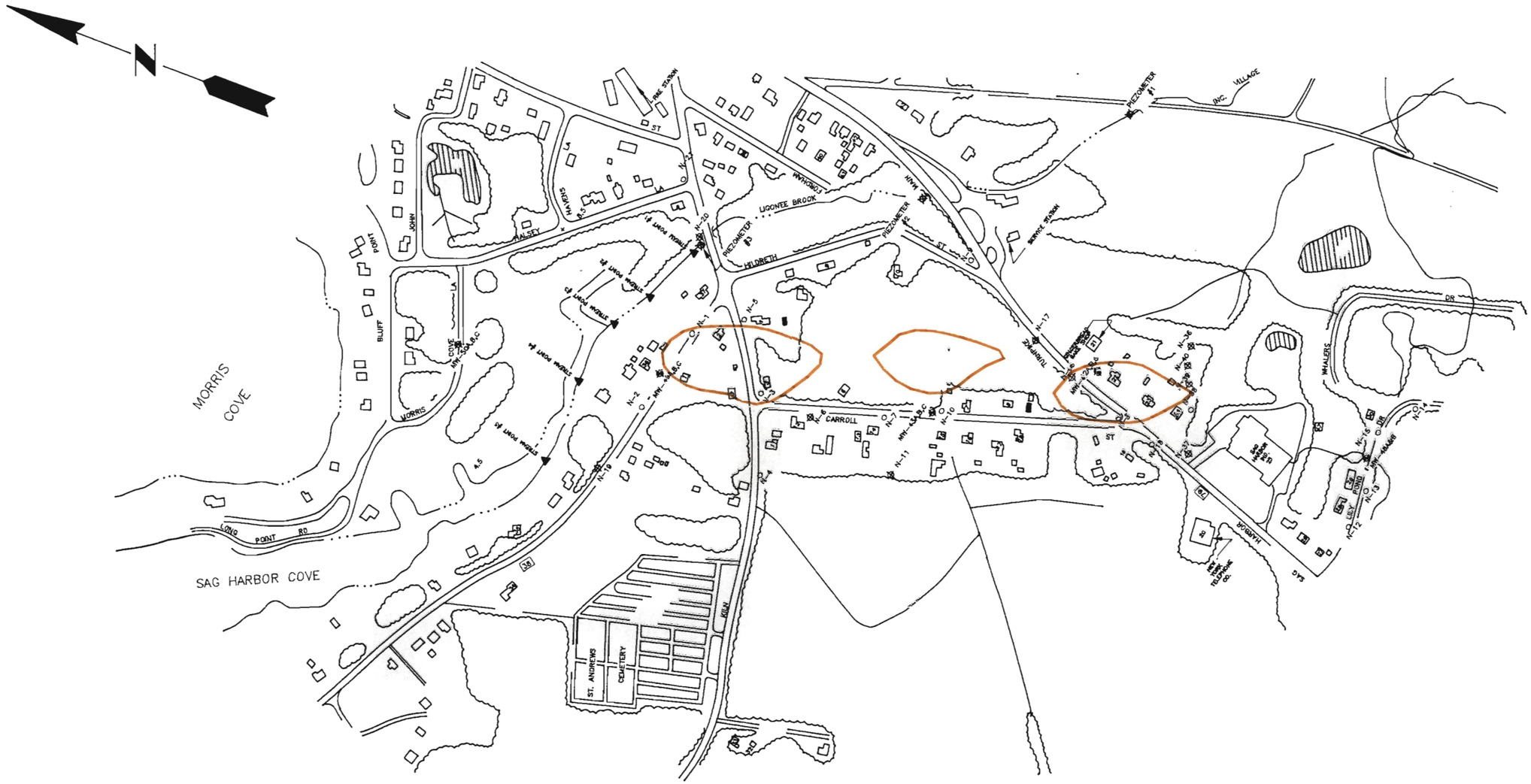
NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
SAG HARBOR, NEW YORK

SIMULATED PLUME BOUNDARY BASED ON 5 PPB OF PCE WITH RW-1, RW-2, RW-3 AND ONSITE PUMPAGE FOR LAYER 3

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 7/7/92 FIGURE: 33



LEGEND

N-37 ⊠	LOCATED SCDHS WELLS
N-13 ○	UNLOCATED SCDHS WELLS
27	PROPERTY OWNERS' WELLS
▲	STREAM POINT SAMPLING LOCATION
◆ MW-43A	WELL(S) INSTALLED FOR RI/FS
⊠ PIEZOMETER #2	PIEZOMETER LOCATION

———	5 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
———	10 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
———	15 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT
———	20 YEAR PLUME BOUNDARY BASED ON 5 PPB OF ANY DETECTED PRIMARY PLUME CONSTITUENT

NABISCO BRANDS, INC.
ROWE INDUSTRIES SITE
SAG HARBOR, NEW YORK

SIMULATED PLUME BOUNDARY BASED ON 5 PPB OF PCE WITH RW-1, RW-2, RW-3 AND ONSITE PUMPAGE FOR LAYER 2

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Ground-Water Consultants
72 Danbury Road
Wilton, CT 06897
(203) 762-1207

DATE: 7/7/92 FIGURE: 34