REPORT

Phase 1 Final Design Report Hudson River PCBs Superfund Site

Attachment I – Air Quality Modeling Methodology and Results

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Air Quality Modeling Methodology

1.0 OVERVIEW

This report describes the methodology and results of an air quality assessment for Phase 1 of the remedial action for the Upper Hudson River, which was selected by the U.S. Environmental Protection Agency (EPA) in its 2002 Record of Decision (ROD). While the methods to assess air quality were previously described in the *Phase 1 Intermediate Design Report* (Phase 1 IDR) (Blasland, Bouck & Lee, Inc. [BBL] 2005), this report provides a revised and more detailed description of the air quality assessment, including potential sources, emission rate equations, dispersion models, and assumptions. This report also provides the results of the modeling described herein, including mitigation plans or controls, and is attached to the *Phase 1 Final Design Report* (Phase 1 FDR) (BBL 2006).

The air quality standards applicable to Phase 1 of the Upper Hudson River remedial project are provided in the Final Quality of Life Performance Standards (Hudson QoLPS) (EPA 2004). The Hudson QoLPS for air quality includes numerical criteria and modeling requirements for polychlorinated biphenyls (PCBs) in ambient air, as well as requirements for modeling of certain pollutants that are subject to the National Ambient Air Quality Standards (NAAQS). These criteria and requirements are as follows:

For PCBs in ambient air, the Hudson QoLPS establishes the following numerical criteria: a Concern Level of 0.08 $\mu g/m^3$ and a Standard Level of 0.11 $\mu g/m^3$ (both as 24-hour average concentrations) in residential areas; and a Concern Level of 0.21 $\mu g/m^3$ and a Standard Level of 0.26 $\mu g/m^3$ (both as 24-hour average concentrations) in commercial/industrial areas. The Hudson QoLPS requires that the design of Phase 1 include modeling, using EPA-approved modeling methodologies, to project ambient concentrations of PCBs so as to demonstrate attainment of those numerical criteria. The "points of compliance" for demonstrating such attainment are the locations of residential or commercial/industrial receptors.

For the NAAQS pollutants, the Hudson QoLPS requires a modeling assessment, during design, of the project's ability to achieve the NAAQS for the following pollutants: sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), particulate matter less than 10 micrometers in diameter (PM_{10}), particulate matter less than 2.5 micrometers in diameter

($PM_{2.5}$), and ozone (O_3) (to be evaluated using its precursors NO_x and volatile organic compounds [VOCs]). This assessment is required to consist of repeating the assessment previously conducted by EPA and reported in EPA's White Paper titled *Air Quality Evaluation* [TAMS 2002] (which was included in the *Responsiveness Summary* [RS] accompanying the ROD), using project-specific design data, so as to validate EPA's assumptions. If this assessment validates EPA's conclusions in that document that the project activities will not cause exceedances of the NAAQS, no additional monitoring or control for these pollutants is required.

1.1 Modeling Scope

In accordance with the Hudson QoLPS, the modeling presented in this report includes modeling of 24-hour average concentrations of PCBs resulting from various Phase 1 activities, and comparison of the modeled concentrations with the above-mentioned Concern and Standard Levels. Where exceedances are predicted, mitigation measures are discussed that would result in predicted attainment of those criteria.

For the NAAQS pollutants, this report presents modeling of predicted concentrations (or, for ozone, a separate assessment), using the assumptions presented in EPA's above-cited White Paper together with project-specific design data, for comparison to the NAAQS. For these purposes, the averaging times are:

CO: 1 hour and 8 hours
SO_2: 3 hours, 24 hours and annual
NO_x: Annual
PM_{10} 24 hours and annual
$PM_{2.5}$: 24 hours and annual

1.2 Modeling Requirements

To provide appropriate modeling, the following steps must be accomplished:

1. A model is selected.
2. Emissions are calculated.
3. The characteristics of the source are determined:
    - Point, area or volume source;

    - Height above ground;
    - Area or volume of such sources; and
    - For point sources, the exit temperature, flow rate and stack height and diameter. There are no stationary point sources for this project.
4. Representative meteorological data are obtained.
5. Evaluation points (e.g., boundaries, such as shorelines, property lines, or fence lines, as well as locations of nearby residential and commercial receptors) are identified.

1.3 General Description of Model Construct

Modeling was performed for the following scenarios:

1. PCBs and NAAQS pollutants from dredging operations in the channel east of Rogers Island;
2. PCBs from dredging operations east of Griffin Island;
3. PCBs from barges queued at Lock 7, the entrance to the Champlain Canal;
4. PCBs and NAAQS emissions from the processing facility;
5. NAAQS emissions during construction of the processing facility; and
6. Cumulative impact of all these operations together.

For these modeling efforts, emissions were modeled using various procedures described in this report, and ambient air concentrations were modeled using an EPA-approved dispersion model, the Industrial Source Complex (ISC) Model. For this project, the following evaluation points have been used:

- For PCBs, the evaluation points for determining attainment of the applicable criteria are the nearest residences and commercial establishments. Evaluation points are also placed at the river shore and the processing facility fence line (the locations where monitoring of the operations will be conducted).
- For NAAQS pollutants, the evaluation points are placed at the river shore and the processing facility

If attainment of the relevant Concern or Standard Level is predicted at a point between the source and a receptor, then evaluation of air quality at the receptor location is not necessary.

Sections 2.0 and 3.0 provide analyses of PCB emission sources and the calculation of PCB emissions. Sections 4.0 and 5.0 present the NAAQS emission sources, while Section 6.0 describes the ISC model input/output parameters. Section 7.0 contains the PCB model results and mitigation options and Section 8.0 contains the NAAQS model results.

2.0 EMISSION INVENTORY FOR PCBs

This section describes the methods used to calculate the emission rates of PCBs to the air from the activities that are subject to modeling. The following sources have been modeled:

1. PCB emissions during dredging operations, which include:
   i. Emissions from the water column during dredging for two scenarios: (a) dredging operations in which no resuspension containment is being used; and (b) dredging operations where resuspension containment is being used; plus
   ii. Emissions from loaded barges of sediment at the dredge locations for all Phase 1 areas.
2. PCB emissions from loaded barges of sediment at two other locations:
   i. Entering and waiting to enter Lock 7; and
   ii. Tied up at the wharf of the sediment processing facility.
3. PCB emissions from the processing facility during the barge unloading, processing, storage, and loading of processed sediment onto rail cars.
4. The cumulative impact of these dredging, barging, and processing sources.

2.1 Dredging Operations

Air emissions of PCB by volatilization may occur when the sediments are dredged from the river. Emissions from dredging operations at Phase 1 areas were based on the dredging production rate and sequence. Emissions from the barges moored near dredges and emissions resulting from volatile losses from the river during the period of dredging were calculated, as follows:

1. The volatile PCB emissions from the river were predicted by the resuspension model, which was presented in Appendix E of the Phase 1 IDR (BBL 2005). A description of the volatile loss estimates for each cell of the resuspension model was provided in the IDR and is also provided below. The resolution of this model is based on cell dimensions used to predict hydrodynamic characteristics of the river. As an illustration, Figure I-1 shows river cells near Rogers Island and Figure I-2 shows the cells near Griffin Island. There are two scenarios of emission prediction by river cell: a) Dredging in all areas without resuspension controls; and b) Dredging behind resuspension control structures. In the second case, PCB volatilization from the river is higher because containing resuspended sediment results in higher water

concentrations in the contained areas.

2. For predicting emissions from barges loaded with sediment, the model resolution can be coarser than the river volatilization model. The barge model only needs to spatially and temporally locate a barge that is being loaded by a dredge. Barge locations during loading have been adequately modeled by the logistics model described in Attachment D. The same grid cells used for the logistics model, referred to as Sediment Removal Units (SRUs), have been applied in this barge emissions model. Each SRU consists of approximately 1,000 cubic yards (cy) of *in situ* sediment, about the amount that would fill one full-size barge. As illustrations, Figure I-3 shows the barge grid near Rogers Island and Figure I-4 shows the barge grid near Griffin Island. Emissions from barges during transit have not been modeled because the duration that the barge is in transit is much shorter than the time that the barge is being loaded by the dredge (approximately 8 hours) and the time the barge may be moored near Lock 7 (see Section 2.2).

The dredge schedule which was presented in the Phase 1 IDR (Table 3-22) provides the basis for determining barge locations and river cells which contain resuspended sediment (and thus have a volatile emission component). The Phase 1 IDR dredge plan provided the dredging rates and sequence, which were necessary to relate source locations to calendar day, thus meteorological conditions based on historical data. The final Phase 1 Dredge Schedule, presented in Table 2-1 of this Phase 1 FDR, differs in minor ways from the dredge plan used as a basis for these model evaluations. Since the Phase 1 sediment volume dredged (annual production rate) has not been modified, the differences are not expected to significantly impact the model results.

Barges are located on the riverward (towards the center of the channel) side of these dredge cells. A specific emission rate for each model cell is determined, as described in Section 3.0. The emissions from each barge location and each river cell over the entire Phase 1 period are used together to obtain the cumulative impact of both sources.

The volume-weighted average PCB concentrations (total and by homolog) of sediment in each SRU were used to calculate emissions from the barges. The greatest total PCB concentration in a Phase 1 SRU is 1081 mg/kg. Table I-1 contains the assumed homolog distribution for various ranges of PCB concentrations, based on an average of data collected during the Sediment Sampling and Analysis Program (SSAP). This table is used to convert total PCB concentrations to homolog concentrations, prior to determining emission factors. It should be noted that this distribution is heavily weighted toward mono and di-chlorobiphenyls, which are more volatile than the higher chlorinated homologs. For lower total PCB concentrations, these two homologs account for 90% of the emitted PCBs and for higher total PCB concentrations, they account for 97% of the total emitted PCBs (see Figure I-5).

2.2 Barging Operations

The Final Design has located two mooring locations in the Hudson River near Lock 7. Therefore, two full barges may be moored while a third barge is waiting at Lock 7 for passage north on the Champlain Canal. Although it is unlikely that three full barges will occupy this area for any 24-hour period, a conservative scenario of three barges was modeled at this location: one barge in the lock and two waiting at the mooring locations (see Figure I-6).

For this scenario, barges may have originated from any of the SRUs discussed in the barge emission model above. Therefore, the barges are assumed to contain the most common sediment type. For Phase 1, the most common sediment type is S2. The physical and chemical parameters of S2 are described in the Phase 1 IDR (Section 3.6.4 and Attachment G). This material class has a fine content (passing 74 μm) of 23% and an average PCB concentration of 77.2 mg/kg. For modeling PCB air emissions, the homolog distribution from Table I-1 is assumed, approximately: 18% mono, 39% di, 27% tri, 16% tetra, and 2% penta-chloro biphenyl. Approximately 74% by volume of the Phase 1 sediment targeted for removal, based on the averaged SSAP data, is type S2.

2.3 Processing Facility Operations

The potential sources of PCB emissions to air at the processing facility include open tanks, material stockpiles, fugitive emissions from buildings, and barges moored at the unloading wharf. Emissions from these sources were not combined with the emissions from dredging operations or at Lock 7, because they are geographically separated from on river sources by at least 2 miles. A separate assessment of cumulative effects (if any) has been completed (Section 2.4). The following processing facility operations were modeled:

1. Three barges containing sediment with S-2 average properties and located at the unloading wharf.
2. Tanks, stockpiles, and fugitive emissions from building with characteristics shown in Table I-2. The PCB concentrations in the slurry or water phase within each source will vary during processing operations, depending on the feed characteristics, separation efficiencies, and dewatering efficiencies. A nominal PCB material balance analysis was used to estimate the concentrations at each source. (The overall mass balance calculations for the processing facility were described in Section 3.6.4.1 of the Phase 1 IDR and updated to reflect the conditions described in the Phase 1 FDR.) The PCB concentration in sources modeled ranges from 22.2 to 310 mg/kg, as shown on Table I-2.
3. Dispersion analyses were conducted for emission rates from barges at the wharf and the fixed processing facility sources (representing the cumulative impact from all processing facility sources) to predict PCB concentrations in air at the facility fence line, east shore of the Champlain Canal, nearby commercial properties, and nearby residences.

2.4 Cumulative Assessment for Dredging and Processing Sources

A cumulative analysis of all sources described above were modeled together in order to assure that concentrations from multiple sources are not additive at locations in the entire modeled area (i.e., dredging isn't adding concentrations at the processing area and vice versa). These results are presented in Section 7.4.

3.0 PCB EMISSION RATE MODELS

This section describes the method used to calculate the emission rates of PCBs from saturated sediment or slurry conditions. Air emission rate models were constructed for:

- Resuspended solids in the river water column downstream of dredging;
- Submerged sediment in barges at the dredging location;
- Submerged sediment in the barges waiting for passage through Lock 7;
- Submerged sediment in barges at the processing facility wharf;
- Slurries in opened top process tanks; and
- Dewatered solids in various stockpiles staged at the processing facility.

Emission rates depend on PCB concentration, homolog distribution, temperature (water and/or air), and wind speed. The emission rates were calculated every hour during the operating season (assumed to be 135 days from May 20 through October 1) of each of 5 years, using representative meteorological data for the years 1997 through 2000 and 2002 to predict emissions for Phase 1.

FORTRAN programs were written to carry out the emission rate calculations. The model output provides hourly emission rate files that are input to the ISC dispersion model. The emission rate models are described below.

3.1 Calculation of PCB Flux Rates from Resuspended Sediment in the River Water Column

3.1.1 River PCB Emission Rates During Dredging Operations

Volatilization is the process by which PCBs are transported across the air-water interface. A chemical's tendency to volatilize is determined by the ratio of its equilibrium fugacities in air and water (Henry's Constant). This ratio is a fundamental property of the chemical that is defined by Henry's Law. The value of Henry's Constant may be calculated from the vapor pressure of the chemical and its solubility in water (i.e., Henry's Constant equals the vapor pressure divided by the solubility) or it may be calculated from the equilibrium ratio of gas phase and water phase concentrations in a laboratory experiment. A high Henry's Constant is indicative of a volatile chemical that preferentially accumulates in the air phase. A low Henry's Constant is indicative of a non-volatile chemical that preferentially accumulates in the water phase. Values of Henry's Constant are presented either in units of partial pressure per unit aqueous concentration (e.g., atm-m^3/mol) or as a dimensionless ratio of concentrations (e.g., (mol/m^3)/(mol/m^3)). The dimensionless ratio is derived from the dimensioned ratio by dividing by the product of the universal gas constant and absolute temperature (i.e., RT), thus converting pressure into concentration using the ideal gas law.

Numerous experimental determinations of Henry's Constants for PCBs have been published (e.g., Bopp 1983, Burkhard et al. 1985, Murphy et al. 1987, Dunnivant and Elzerman 1988, Brunner et al. 1990, Bamford et al. 2002). These studies have used various methodologies that have yielded differing estimates. Values range from about 0.05 to 0.0005. Values for Aroclors 1242 and 1254, as reported by Murphy et al. (1987) are about 0.1 and 0.008, respectively.

The PCB Henry's Constants have a positive dependency on temperature. Laboratory data indicate an approximate doubling of the Henry's Constant for every 10 degrees Celsius (ºC) temperature increase (Tateya et al. 1988, ten Hulscher et al. 1992); however, for modeling volatilization from the water column, the Henry's Constant was held constant at the 25º C value

The rate at which volatilization occurs is dependent on the mass transfer coefficient at the air-water interface and the concentration of PCBs in the water column. Only freely-dissolved PCBs can be transported across the interface and sorption to particulate or dissolved organic carbon reduces volatilization. The equation used to describe PCB flux due to volatilization is as follows:

$$F_i = k_{wi}\left(C_{wi} - \frac{C_{ai}}{H_i'}\right) \qquad \text{(Eq. 1)}$$

where:

Fi = PCB volatilization flux of congener i, g/m^2-s
k_{wi} = volatilization mass transfer coefficient, m/s
C_{wi} = dissolved phase concentration of congener i in water, g/m^3
C_{ai} = vapor-phase PCB concentration of congener i in air, g/m^3
H_i' = dimensionless Henry's Constant of congener i.

Classic two-film theory of transfer (Lewis and Whitman 1924) postulates that the volatilization mass transfer is mediated by two thin layers at the air-water interface. One layer represents the liquid film and the other the gas film. The overall mass transfer coefficient (K_{OL}) is dependent on the rates of mass transfer through these thin layers of water and air (O'Connor 1983, 1984) and is given by:

$$\left(K_{OL}\right)_i = \frac{k_{ai}\ k_{wi}}{k_{ai} + \frac{k_{wi}}{H_i'}} \qquad \text{(Eq. 2)}$$

where: k_{ai} = air-phase mass transfer coefficient of congener *i*
k_{wi} = water-phase mass transfer coefficient of congener *i*

For flowing systems, the mass transfer coefficient k_{wi} is based on the rate of surface renewal and can be estimated by the O'Connor-Dobbins equation (O'Connor and Dobbins 1958):

$$k_{wi} = \sqrt{\frac{D_{wi} * U}{h_w}} \qquad \text{(Eq. 3)}$$

where: D_{wi} = diffusivity of PCB congener *i* in water
U = depth-average water velocity.

For quiescent systems, the liquid film mass transfer coefficient is affected by the shearing action of winds at the water surface. Mackay and Yeun (1983) estimated the transfer coefficient as:

$$k_{wi} = \frac{0.0144 * (U^*)^{2.2}}{Sc_w^{\ 0.5}} \qquad U^* < 0.3 \qquad \text{(Eq. 4a)}$$

$$k_{wi} = \frac{0.00341 * U^*}{Sc_w^{\ 0.5}} \qquad U^* > 0.3 \qquad \text{(Eq. 4b)}$$

where: Sc_w = Schmidt number for PCB congener *i* in water
U* = the friction velocity (m/s) given by:

$$U^* = U_{10}(6.1 + 0.63U_{10})^{0.5} * 10^{-2} \qquad \text{(Eq. 5)}$$

and U_{10} is the wind speed at a height of 10m (m/s).

The gas film transfer coefficient is also estimated by Mackay and Yeun (1983):

$$k_{ai} = \frac{0.0462 * U^*}{Sc_a} \qquad \text{(Eq. 6)}$$

where Sc_a is the Schmidt number for PCB congener *i* in air.

Mackay and Yeun (1983) recommend minimum still air values of k_{wi} and k_{ai} of 10^{-6} and 10^{-3} m/s respectively.

3.1.2 Application to Dredging Operations

The model used to calculate the Hudson River emission rates of PCBs during dredging is the same as was described in Attachment E (Dredge Resuspension Modeling) to the Phase 1 IDR (BBL 2005). This model estimates the volatilization of total PCBs resulting from dredge resuspension losses to the water column of the river. It considers the spatially and temporally variable water column PCB concentrations as well as the varying river conditions. The model predicts the emission rates for each part of the model grid shown in Figures E-3-1a through E-3-1e of the Phase 1 IDR for the entire dredge season (May 21 through October 2, 2007). The base case model scenario assumes the 0.35% dredge resuspension loss, median flow conditions, and average wind speed of 2.3 meters per second (m/s).

For flowing river conditions, Equation 3 is used to calculate the water film coefficient. For quiescent conditions, i.e. inside the impoundments created by sheet pile control structures, Equations 4a and 4b are used. For all conditions, the air film coefficient is estimated from Equation 6. Values of both coefficients are adjusted to meet the still air values cited above (10^{-6} and 10^{-3} m/s respectively). The overall volatilization mass transfer coefficient is calculated from water phase and vapor phase mass transfer coefficients and from Henry's Constant as indicated in Equation 2. The PCB flux is calculated by Equation 1 assuming that the ambient PCB concentration in the air is negligible.

The Henry's Constant for total PCBs used in the model calculations is estimated as the average of the values for the di-chlorinated congeners reported by Brunner et al. (1990) at 25º C. Both experimentally determined and calculated Henry's Constants are included in the average to yield a Henry's Constant of 24 Pa-m^3/mol (0.0096 unitless). Brunner's predictive equation calculates

Henry's Constants based on the total number of chlorine atoms N_{Cl} and number of chlorine atoms in the ortho (2, 2', 6, or 6') position ($N_{o\text{-}Cl}$) per PCB molecule:

$$\text{Log}_{10}\, H' = -1.38 - 0.32(N_{Cl}) + 0.18(N_{o\text{-}Cl}) \qquad \text{(Eq. 7)}$$

For comparison, Bamford et al. (2002) reported measured values at 11^{o} C for 5 di-chlorinated congeners that average 9 Pa-m^3/mol. Using a Henry's Constant representative of di-chlorinated PCBs is appropriate given that this is the largest component of Total PCBs in the water column of the Upper Hudson. Application of the 25^{o} C value for the entire dredging season provides a conservative estimate of the air emissions resulting resuspension of dredged sediments.

3.2 Calculation of PCB Flux Rates from Saturated Solids and Slurries

Two models have been used to calculate PCB flux rates from saturated sediment or slurries containing PCBs: Equilibrium Partitioning Model and Transport Limited Model. Both models describe mass transfer across the air-water interface using two-film theory and mass transfer rate constants calculated from Equations 4 and 6.

The Equilibrium Partitioning Model uses a method that is consistent with the White Paper titled *PCB Releases to Air* (EPA 2002) provided with EPA's RS accompanying the ROD. This model assumes equilibrium partitioning between solid and liquid, constant mixing of sediment and an infinite source of PCBs associated with the sediment. Therefore, the model will tend to over-predict the PCB emission rate from barges. Therefore, this model is an effective screening-level model. This simple transport model has been used to model emissions from the complex system of dredging, assuming the source is mobile and therefore the spatial relationship between the sources and receptors are frequently changing. This conservative model has been used to identify conditions in Phase 1 that will have the greatest impact at fixed receptors. Then, the more complex Transport Limited Model is used to reassess impacts for these cases.

The Transport Limited Model has been developed based on a conceptual model in which the sediments are covered by a thin water layer and diffusion of PCBs from the underlying sediments impacts volatilization. This model also accounts for that portion of the sediment PCBs that desorbs slowly and does not contribute PCBs to the water phase in the time frames (approximately 8 hours to 24 hours) in which sediments will be contained in barges (see Carroll, 1994). This model results in lower PCB concentration in the water phase within the barge and, therefore, a lower emission rate to the air in comparison to the Equilibrium Partitioning Model.

A description of the Equilibrium Partitioning Model follows immediately. A description of the Transport Limited Model is in Section 3.2.8 and a demonstration of the differences in emission estimates is provided in Section 7.1.

3.2.1 Equilibrium Partitioning Model

Due to the relatively high hydrophobicity of PCBs, which typically is measured by the octanol-water partition coefficient (K_{ow}), PCB concentrations at equilibrium are much higher in the solid phase than in the liquid phase. As PCBs are lost from the water phase due to volatilization, PCBs desorb from the sediments into the water phase. The equilibrium partitioning model assumes that the rate of desorption into the water phase is sufficient to keep up with the volatilization from the water. It also assumes that the PCBs from the solids are evenly and completely mixed into the water phase.

The PCB concentrations in the water C_{wi} are computed from the PCB concentrations on the solid C_{si}, which are given in parts per million by weight, which can be expressed as mg PCB / kg of solid. The equilibrium equation for the concentration of PCB congener *i* in water is:

$$C_{wi} = \frac{C_{si}}{(K_{oc})_i \, f_{oc}} \qquad \text{(Eq. 8)}$$

where:

C_{wi} = concentration of PCB congener *i* in water, mg/L or g/m^3
f_{oc} = mass fraction organic carbon in the solid
C_{si} = concentration of PCB congener *i* on sediment, mg/kg
$(K_{oc})_i$ = organic carbon partitioning coefficient, L/kg

3.2.2 Partitioning Into Water

Partial lists of organic carbon partitioning coefficients (K_{oc}) for some PCB congeners, and a list of octanol/water partition coefficients (K_{ow}) for all PCB congeners, are found in Hawker and Connell (1988).

For PCB congeners where K_{oc} is unavailable, the octanol/water partition coefficient K_{ow} was used in place of K_{oc} in Equation 8. The actual distribution of the PCB content of the solids in Hudson River sediments has been characterized through the SSAP. From this data the average mass fractions of PCB homologs as a function of total PCB concentration in the sediment was obtained. These data are based on a statistical analysis of laboratory results from thousands of sediment samples. These averages are shown in Table I-1.

The properties (Henry's Constants and partition coefficients) of PCBs in the sediment at this Site are best represented by the following:

- mono-chlorobiphenyls are assumed to be 2-monochlorobiphenyl,
- di-chlorobiphenyls are assumed to be 2,2'-di-chlorobiphenyl, and
- tri-, tetra, penta-, and hexa-chlorobiphenyls and are represented by average values for the properties of their respective congeners.
- Hepta-, octa-, nona-, and deca-chlorobiphenyl are assumed to be negligible because these have a very low mass faction in the sediment, are recalcitrant to desorption, and have low volatility.

3.2.3 Flux of PCBs from Water into Air

According to McKay and Yuen (1983), the flux rate (mass rate per unit area) of a PCB congener *i* across the air/water interface is proportional to the concentration difference between the water phase and air phase as shown in Equations 1 and 2 above. These equations are used to calculate the flux rate from the barges.

3.2.4 Henry's Constants

The dimensionless Henry's Constant is the ratio of the air-side concentration to the water-side concentration at equilibrium, where both concentrations are expressed in gmol/m^3:

$$H_i' = \left(\frac{C_{ai}}{C_{wi}}\right)_{eq} \qquad \text{(Eq. 9)}$$

The Henry's Constant can be redefined as dimensionless Henry's Constant as a function of the Henry's Constant (Schwarzenbach et al., 1993).

$$H'_i = \frac{H_i}{RT_a} \quad \text{(Eq. 10)}$$

It should be noted that the Henry's Constant (in atm-m^3/gmol) is a function of water temperature T_w, but the dimensionless Henry's Constant also depends on the air temperature T_a, since the ideal-gas phase is at the air temperature. By convention, the appropriate temperature is assumed to be the water temperature representing the temperature at the air/water interface.

In the technical literature, Henry's Constants (in atm-m^3/gmol) are given at a standard temperature T_0 (usually 25° C = 298.15 K). It is assumed that the Henry's Constants vary proportionately to the vapor pressure of the pure compound, according to the Clauseus-Clapeyron equation:

$$\ln P_{vi} = A_i - \frac{B_i}{T_w} \quad \text{(Eq. 11)}$$

where A_i and B_i are constants for each PCB congener. If the vapor pressure P_{vi0} is known at the standard temperature T_0, and the atmospheric boiling point T_b is known (for which the vapor pressure is the atmospheric pressure P_a = 1 atm = 760 mmHg), substituting the ordered pairs (T_w=T$_0$, $P_{vi} = P_{vi0}$) and (T_w=T_b, $P_{vi} = P_a$) into Equation 11 results in two equations in A_i and B_i.

Subtracting one equation from the other eliminates A_i, from which:

$$B_i = \frac{\ln\left(P_a \big/ P_{vi0} \right)}{\left(\frac{1}{T_0} - \frac{1}{T_b} \right)} \quad \text{(Eq. 12)}$$

If it is assumed that the Henry's Constant also varies according to Equation 11, (with a different value for A_i) and the Henry's Constant at the standard temperature T_0 is H_{i0}, then the Henry's Constant at any other temperature T_w is given by:

$$H_i(T_w) = H_{i0} \exp\left(\frac{B_i}{T_0} - \frac{B_i}{T_w} \right) \quad \text{(Eq. 13)}$$

where B_i is calculated using Equation 12. The dimensionless Henry's coefficient H'_i is calculated by substituting Equation 13 into Equation 10:

$$H_i' = \frac{H_i}{RT_a} = \frac{H_{i0}}{RT_a}\exp\left(\frac{B_i}{T_0} - \frac{B_i}{T_w}\right) \quad \text{(Eq. 14)}$$

3.2.5 Water-side Film Coefficients

This section describes the procedures used to calculate the water-side film coefficient k_{wi} as a function of water temperature T_w and the wind speed u_{10} measured at 10 meters above the ground.

Depending on the value of the friction velocity, one of two equations (Equations 4a and 4b from above) is used to calculate the water-film mass transfer coefficient k_{wi}, in m/s:

For calm conditions, Mackay and Yeun (1983) recommend a value of $k_{wi} = 1(10^{-6})$ m/s. For this project, this value of k_{wi} was assumed for all wind speeds where the value of k_{wi} as calculated above was lower than the calm value of $1(10^{-6})$ m/s.

Mackay and Yeun (1983) give the following correlations for estimating the viscosity of water and the diffusivity of PCB congeners in water:

$$\log_{10}\mu_w = \frac{1301}{998.333 + 8.1855(T_w - 293.15) + 0.00585(T_w - 293.15)^2} - 3.30233 \quad \text{(Eq. 15)}$$

$$D_{wi} = \frac{1.326(10^{-4})}{(100\mu_w)^{1.14} V_{mi}^{\ 0.589}} \quad \text{(Eq. 16)}$$

In Equation 16, V_{mi} is the molar volume of the PCB congener i in cm^3/gmol. This is estimated by dividing the molecular weight M_i of the congener (in g/gmol) by the density ρ_i of the congener (in g/cm^3):

$$V_{mi} = \frac{M_i}{\rho_i} \quad \text{(Eq. 17)}$$

For wind speeds greater than 1.0 m/s, the overall procedure for calculating the water-side film coefficient k_{wi} can be summarized as:

1. Calculate the friction velocity u^* using Equation 5.

2. Calculate the viscosity of water using Equation 15.
3. Calculate the molar volume of congener *i* using Equation 17.
4. Calculate the diffusivity of congener *i* in water using Equation 16.
5. Calculate the Schmidt number in water.
6. According to the value of the friction velocity u^*, calculate the water-side film coefficient k_{wi} using either Equation 4a or 4b.
7. If the calculated value of $k_{wi} < 10^{-6}$ m/s, set it equal to 10^{-6} m/s.

Steps 1 and 2 above only need to be performed once per simulated hour (the friction velocity and viscosity of water do not depend on congener *i*), while the remaining steps must be repeated for each congener.

3.2.6 Air-Side Mass Transfer Coefficients

As was the case for the water-side mass-transfer coefficient, a special value is used for the air-side mass-transfer coefficient is used for "calm" conditions to avoid dividing by zero. The default value for k_{ai} is 10^{-3} m/s.

According to Mackay and Yeun (1983), the air-side mass-transfer coefficient k_{ai} is calculated using Equation 6 as follows:

$$k_{ai} = \frac{0.0462u^*}{Sc_a} \qquad \text{(Eq. 18)}$$

where u^* is the friction velocity calculated using Equation 5, and Sc_a is the Schmidt number <u>in air</u> given by:

$$Sc_a = \frac{\nu_a}{D_{ai}} \qquad \text{(Eq. 19)}$$

where:

ν_a = kinematic viscosity of air, m^2/s
D_{ai} = diffusivity of congener *i* in air, m^2/s

The kinematic viscosity of air is estimated using the following equation:

$$\nu_a = [1.32 + 0.009(T_a - 273.15)](10^{-5}) \qquad \text{(Eq. 20)}$$

It should be noted that $T_a - 273.15$ represents the air temperature in degrees Celsius, if T_a is assumed to be in degrees Kelvin.

The diffusivity of PCB congener *i* in air (in m^2/s) is estimated using the following equation:

$$D_{ai} = \frac{1.9\left(10^{-4}\right)}{M_i^{0.67}} \qquad \text{(Eq. 21)}$$

where: M_i is the molecular weight of congener *i*. It should be noted that the molecular weights of all isomers of the same homolog (having the same number of chlorine atoms) are equal.

The procedure for calculating the air-side mass-transfer coefficient can be summarized as follows:

1. Calculate the kinematic viscosity of air using Equation 20.
2. Calculate the diffusivity of congener *i* in air using Equation 21.
3. Calculate the Schmidt number for congener *i* in air using Equation 19.
4. Calculate the air-side mass-transfer coefficient of congener *i* using Equation 18.
5. If calculated k_{wi} is less than 10^{-3}, set equal to 10^{-3}.

The kinematic viscosity of air depends only on air temperature, and only needs to be calculated once for each hour. The remaining steps above must be repeated for each homolog (group of congeners having the same number of chlorine atoms).

Once the values have been obtained (for each congener) for the dimensionless Henry's Constant (Equation 14), the water-side mass-transfer coefficient (Equation 4a or 4b), and the air-side mass-transfer coefficient (Equation 18), the overall mass-transfer coefficient for congener *i* across the water/air interface is calculated by solving Equation 2 for (K_{OL}).

The flux rate (emission rate per unit area) of each congener across the water/air interface is obtained by multiplying the overall mass-transfer coefficient by the concentration of PCB congener *i* in the liquid (water) phase, according to Equation 1.

3.2.7 Summary of PCB Flux Calculation from Slurry

For each hour of the simulated period, and for each PCB congener *i*, the dimensionless Henry's coefficient H'_i is calculated using Equation 14, the water-side mass-transfer coefficient k_{wi} is calculated using the procedures described in Section 3.2.5, and the air-side mass-transfer coefficient k_{ai} is calculated using the procedures described in Section 3.2.6.

Once these calculations have been made, the overall mass-transfer coefficients $(K_{OL})_i$ are calculated from Equation 2 for each homolog, and the flux rate (g/m^2-s) of homolog *i* is calculated using Equation 1. The flux rate may be multiplied by the surface area of the source to obtain the mass emission rate:

$$E_i = F_i A_e \qquad \text{(Eq. 23)}$$

where:

E_i = mass emission rate of congener *i*, g/s
A_e = surface area of emitting source, m^2.

3.2.8 Transport Limited Model

A rate-dependent calculation was made of the mass transfer from sediment to water. The model is conceptually identical to the model used by GE to simulate PCB fate within the river (QEA 1999), consisting of a thin column of water overlying a column of sediments. PCBs are lost from the water column via volatilization and are transported to the water column from the underlying sediments. Volatilization is modeled using Equation 1 and the transfer coefficients defined by Equations 4 and 6. Transport from the sediments is modeled as a diffusive process defined by the following equation (dropping the congener subscript for convenience):

$$F_s = k_f\left[\left(C_w + C_{dom}\right)_s - \left(C_w + C_{dom}\right)_w\right] \qquad \text{(Eq. 24)}$$

where:

F_s = Flux of PCBs from sediments to water column
k_f = diffusive mass transfer coefficient,
C_{dom} is the concentration of PCBs bound to dissolved organic matter (DOM), and the subscripts s and w refer to the water column and the underlying sediments, respectively.

The mass transfer coefficient (k_f) is an empirical parameter that incorporates all processes that transport PCBs between the water column and the sediment. It was set at 0.8 centimeters per day (cm/d), a value reflective of low biological activity and turbulence at the sediment-water interface.

Vertical pore water diffusive transport within the sediment between layers i and j ($F_{i,j}$ in mass per unit area per unit time) is mathematically described as a Fickian process, in which the diffusive flux is expressed as the product of the vertical gradient of dissolved plus DOM bound pore water concentration and a diffusion coefficient (D_s).

$$F_{i,j} = \frac{D_s}{l_{i,j}} \left[\left(C_w + C_{dom} \right)_i - \left(C_w + C_{dom} \right)_j \right] \quad \text{(Eq. 25)}$$

The mixing length between adjacent bed segments i and j ($l_{i,j}$) is set at the distance between segment midpoints (1 cm). The pore water diffusion coefficient is based on the molecular diffusion coefficient for PCBs in aqueous solution, adjusted for the tortuosity of the sediment bed. The effect of tortuosity is to decrease the rate of diffusion, as the solid matrix impedes the Brownian motion of dissolved PCBs with three or more chlorine atoms. Experimental data have shown that the effect of tortuosity can be expressed by multiplying the molecular diffusion coefficient in solution by the bed porosity raised to an exponent of approximately 2 (Lerman 1978). The resulting diffusion coefficient varies slightly by homolog, but is about 0.2 square centimeters per day (cm^2/d) when the porosity is 0.62.

The concentrations of dissolved and DOM-sorbed PCB components may be expressed as fractions of the total concentration of PCBs, C_T:

$$C_d = f_d C_w \quad \text{(Eq. 26)}$$

$$C_{dom} = f_{dom} C_w \quad \text{(Eq. 27)}$$

where: f_d = fraction dissolved
f_p = fraction sorbed to Dissolved Organic Matter.

Using Equation 8 and expressing the product $K_{oc}f_{oc}$ as K_p and the analogous partition coefficient for DOM as K_{doc}, the expressions for fraction dissolved and fraction sorbed to DOM are:

$$f_d = \frac{\theta}{\theta + K_p m + K_{doc} m_{doc}} \quad \text{(Eq. 28)}$$

$$f_{dom} = \frac{K_{doc} m_{doc}}{\theta + K_p m + K_{doc} m_{doc}} \quad \text{(Eq. 30)}$$

where K_{doc} = partition coefficient between PCBs sorbed to DOM and freely dissolved (liter/kg organic carbon)

m_{doc} = concentration of dissolved organic matter expressed in terms of organic carbon (kg organic carbon/liter)

θ = porosity (water volume/total volume)

m = the concentration of suspended or bed solids.

For initial application of the model, DOM was not considered and the f_{oc} of the sediment was set at 0.03.

3.3 PCB Emission Flux Calculation for Barges during Dredging

3.3.1 Overview

Emission rates of total PCBs were predicted for every active hour during Phase 1, assuming a range of meteorological data over a 5-year period, for the following three sources:

- Barges on the river during dredging operations;
- Barges waiting at the lock at the entrance of the Champlain Canal; and
- Barges tied up at the sediment processing facility unloading wharf.

All emission calculations are based on the methods described in Section 3.0, but certain particularities are required for each of the above sources. This section describes the methods used to calculate hourly emission rates for barges on the river during dredging operations.

Model inputs are represented as a table that shows, for each SRU, the following assumptions:

- SRU index number (from 1 to 255);
- UTM easting (X) and northing (Y) coordinates of centroid of dredging location;
- Start of dredging (day, hour, and minute) ;
- End of dredging (day, hour and minute);
- Total PCB concentration (volume-weighted average) in dredged sediment removed from given cell (mg/kg); and
- Sediment type (S1, S2, S3, and S4).

In a few instances where the sediment to be cut is thick, multiple SRUs (each representing one barge load) are co-located. For these cases, dredging takes longer and barges would be replaced by empty barges after the fill-cycle is completed (approximately 8 hours per barge).

During dredging operations, it is assumed that the wet, dredged sediment placed into the barge will be at least partially submerged in river water. It is assumed during a single dredging operation that the temperature of this water remains constant at the river water temperature, since any warming or cooling from ambient air, sunlight, or rainfall is likely to be very slow, due to the large mass and high specific heat of accumulated water, and the fact that fresh sediment at the river water temperature is continually added to the barge.

However, the river water temperature does vary seasonally. During dredging operations from late May through early October, it tends to rise during May and June, reach a maximum during July and August, and then decrease during September. The river water temperature does affect the PCB volatilization rate, due to the dependence of the Henry's Constant on temperature. This effect has been included in the model. A file of river water temperatures (in ^{o} C) measured at irregular intervals (approximately weekly) during the years 1996 through 2000. This file is shown in Attachment 2. For dates not listed in this file, the water temperature was obtained by linear interpolation. The river water temperature is assumed to be constant for all hours of a given day, with any temperature change between days assumed to occur at midnight.

3.3.2 Flux Pro-Rate Factors for Partial Hours

The model uses 230 distinct locations (cells) at which barges will be moored while the dredge is filling the barge. In the Industrial Source Complex (ISC) dispersion model input, each of these locations is represented by a rectangular "area source," whose length and width are equal to those of the barges which receive the dredged material.

For multi-source dispersion modeling with variable emission rates, the ISC dispersion model requires the input of an "hourly emissions" input file which gives an emission rate (or flux in g/m^2-s for an area source) for every hour during the modeling period. This file contains one line per source per hour, including a zero emission rate for area sources not active during a given hour.

If a given hour overlaps the starting or ending times for a cell, the calculated flux rate will be prorated according to the number of minutes during that hour that the cell was operating. It may be noted that, if a barge receives dredged material for many hours from the same cell, the amount of dredged material in the barge increases with time from one hour to the next. It was assumed that the water layer for a partially-filled barge (even if it was only filled to a few percent of capacity) would cover the entire surface area of the barge, and would emit PCBs at the same rate as a full barge.

3.3.3 Hourly Flux Rate for PCB Homologs

If a given cell, *n,* is actively dredging during at least part of a given hour h_s, flux rates F_{nh} are calculated for each of the PCB homologs from h = 1 (mono-chlorobiphenyls) to h = 6 (hexa-chlorobiphenyls). For the total PCB concentration C_{Tn} (obtained from the dredge schedule file in Attachment 1), the program finds the appropriate homolog fraction f_h from Table I-1 for the appropriate range, and sets the concentration of homolog h in the solid equal to:

$$C_{snh} = C_{Tn} f_h \qquad \text{(Eq. 31)}$$

This concentration of homolog h in the sediment in a barge (based on corresponding SRU properties) in the *s*olid is substituted for C_{si} in Equation 8 to calculate the concentration of homolog h in the water phase, and the normal hourly flux F_{h0} (=F_i in Section 3.0) of homolog h is calculated using the procedures described in Section 3.0, with physical properties for each homolog defined as described in Section 6.0.

Once the standard hourly flux F_{h0} is calculated (which assumes that dredging occurred for the full hour), it is multiplied by the flux pro-rate factor to calculate the actual flux F_{nh} of homolog h for SRU number n:

$$F_{nh} = F_{h0} f_{sn} \qquad \text{(Eq. 32)}$$

The flux prorated factor is equal to the number of minutes during the hour when the barge is active, divided by 60. This factor is zero for barges not active during the hour, one for barges active for the entire hour and fractional for barges whose activity during the entire hour and fractional for barges whose activity started or ended part way through the given hour.

For each barge number n, and for each simulated hour, the program calculates the total flux of all PCBs F_{Tn} by summing the fluxes of each homolog F_{nh}:

$$F_{Tn} = \sum_{h=1}^{6} F_{nh} \qquad \text{(Eq. 33)}$$

3.3.4 Temperatures for Flux Calculations

For the flux calculations from the barges (during dredging or parked at the locks), it was assumed that the liquid temperature T_w (used in the calculation of Henry's Constants, viscosity of water, and diffusion coefficients in water) was equal to the temperature of river water temperature obtained (or interpolated) from the river water temperature file in Attachment 2. This assumption was based on the large mass of water in the barge, whose temperature would not fluctuate much from its original temperature due to sunlight or contact with the atmosphere.

3.3.5 Generation of Hourly Emissions Files

The calculated output gives hourly PCB emissions (fluxes of each homolog and total PCBs) from barges during dredging, which can be used as input to the ISC dispersion model.

3.4 Calculation of PCB Fluxes from Barges at Locks

This section describes the procedures used to calculate the flux rate of PCB homologs from barges waiting for passage through Lock 7 at the entrance to the Champlain Canal from the Hudson River. For this calculation, it is assumed that three barges are always present, one in the lock, and two waiting slightly downstream for passage after the first barge passes. This is a conservative assumption, because there are likely many hours during which fewer than three barges will be at the lock, but three is considered to be the maximum number of barges which could be at the lock at one time.

The emission rate (flux) is calculated by the same method described above for a barge supporting the dredging, except:

- The properties of Type S-2 sediment have been assumed;
- The barge locations are fixed and a full barge is conservatively assumed to be present for 24 hours per day, 7 days per week.

3.5 Calculation of PCB Emissions from Processing Facility

3.5.1 Introduction

This section describes the procedures used to calculate the emission rates of PCB homologs from various process units in the processing facility. This processing facility includes the following:

- Dewatering processes;
- Filtering processes to separate solid particles of various sizes;
- Solids conveyor belts;
- Holding and transfer tanks for liquid streams and slurries;
- Piles for temporary storage of solids; and
- Large staging areas for storage of solids prior to being loaded on railcars.

For the current calculation, the flux rates of PCB homologs are calculated using the procedures described in Section 3.2.

3.5.2 Types of Source Configurations

In the parlance of the ISC model, the processing facility contains some rectangular sources (vibrating screens, conveyor belts), some circular sources (slurry storage tanks, solid storage piles assumed to be conical), and some volume sources (fugitive emissions in the Filter Press and Wastewater Treatment buildings).

The ISC dispersion model allows for several different types of source configurations, three of which are appropriate for various parts of the processing facility:

3.5.2.1 Rectangular Area Sources

This source type assumes that a pollutant is emitted at an input flux rate (in g/m^2-s) at all points within a flat rectangular surface, which may be located at or above ground level. The "source parameter" input required for a rectangular area source includes:

- Length and width of rectangle in meters;
- Height of the emission surface above the ground in meters;
- UTM coordinates of one corner of the rectangle; and
- Angle between one side of the rectangle relative to north.

This source type, identified in the ISC dispersion model by the AREA keyword, is appropriate for process units having a flat rectangular emitting surface, such as the solids receiving hopper, the vibrating screen, and rectangular staging areas near the railway. This source type was also used for emissions from barges on the river. For variable emission rates, the "hourly emission file" contains flux rates for each hour in g/m^2-s.

3.5.2.2 Circular Area Sources

This source type assumes that a pollutant is emitted at an input flux rate (in g/m^2-s) at all points within a flat circular surface, which may be located at or above ground level. The "source parameter" input required for a circular area source includes:

- Radius of the circle in meters;
- Height of the emission surface above the ground in meters; and
- UTM coordinates of the center of the circle.

This source type, identified in ISC by the AREACIRC keyword, is appropriate for process units having a flat circular emitting surface, such as cylindrical slurry types whose liquid surface is open to the atmosphere, or conical solid storage piles. For variable emission rates, the "hourly emission file" contains flux rates for each hour in g/m^2-s.

It is also possible to input an "initial sigma z" for a circular area source, which is a measure of the vertical distribution of the emitted pollutant. This parameter is zero for emission from the flat liquid surface in a cylindrical tank, but has a finite value for emission from a conical solid storage pile whose emission is vertically distributed between the base and the apex of the cone.

3.5.2.3 Volume Sources

This source type assumes that a pollutant is emitted at an input total mass rate (in gram per second [g/s]) over a volume near the ground, and that the emitted pollutant cloud has an initial horizontal width and vertical height as it is emitted. The "source parameter" input required for a volume source includes:

- Height of centroid of volume source above the ground in meters;
- UTM coordinates of centroid of volume source;
- Initial horizontal dimension (sigma y) in meters; and

- Initial vertical dimension (sigma z) in meters.

This source type, identified in the ISC dispersion model by the VOLUME keyword, is appropriate for processing units located inside a rectangular building, such as those inside the Filter Press and Wastewater Treatment buildings. For variable emission rates, the "hourly emission file" contains mass emission rates (not flux rates) for each hour in g/s.

For emission from a rectangular building, the sigma y (σ_y) and sigma z (σ_z) parameters are calculated as follows:

$$\sigma_y = \frac{L_s}{4.3} \qquad \text{(Eq. 34)}$$

$$\sigma_z = \frac{Z_s}{2.15} \qquad \text{(Eq. 35)}$$

where:

L_s = length of the longest horizontal dimension of the building in meters
Z_s = height of the building in meters

In the case of multiple emission sources located within the same building (such as the filter cake boxes and dewatering tank in the Filter Press Building, and the four tanks in the Wastewater Treatment Building), the "source parameters" for all sources in the building correspond to the dimensions of the building, not of the actual emission source. In the dispersion model, this has the effect of superimposing the emissions from four "co-located" sources in the volume occupied by the building.

3.5.3 Source Parameters for Processing Facility Emission Sources

In the processing facility, the mass of water present in any process unit is much less than that in a barge. Additionally, processed slurries and solids have longer residence times in contact with the atmosphere, especially in storage piles and staging areas. It is therefore assumed that liquid temperatures (represented by T_w) are equal to ambient air temperatures (represented by T_a), which are measured hourly in the meteorological data file.

This results in a much greater fluctuation of flux rates between daylight and nighttime hours in the processing facility than was calculated for the barges, whose water temperature was assumed constant for an entire day.

Table I-2 lists the "source parameters" input to the ISC dispersion model for the emission sources modeled in the processing facility. The second column, which normally contains the emission rate or flux rate, has been set to 1.00 for all sources, because variable emission rates or fluxes are entered in separate "hourly emission files." The column headed PCB concentration provides the concentration in the sediment at each stage of the process and the next column shows whether the stage is in solid form or in a water borne slurry. The last column of Table I-2, labeled "Source Description", describes the emission source to the reader of this document, but is not input to the ISC dispersion model.

3.5.4 Plot Plan Area and Emission Area

In the ISC dispersion model, the emission flux rate must be input in grams per second per square meter of "plot plan area" (i.e., the area of the source measured in a horizontal plane). For a rectangular area source, this area is equal to the length times the width of the source:

$$A_{ps} = L_s W_s \tag{Eq. 36}$$

and for a circular area source, the plot plan area is equal to:

$$A_{ps} = \pi r_s^{\,2} \tag{Eq. 37}$$

where: r_s is the radius of the circular area source.

However, in certain cases, the surface area of emission (by which the flux must be multiplied to obtain the total mass emission rate) is greater than the plot plan area. The mass emission rate simulated by ISC is equal to the input ISC flux rate times the plot plan area:

$$E_{ISC} = F_{ISC} A_{ps} \tag{Eq. 38}$$

where as the actual mass emission rate E_a is equal to the calculated flux rate times the emission area A_e:

$$E_a = F_{calc} A_e \tag{Eq. 39}$$

In order for the simulated mass emission rate E_{ISC} to be equal to the actual mass emission rate E_a, the input flux rate must be equal to:

$$F_{ISC} = F_{calc}\frac{A_{es}}{A_{ps}} \qquad \text{(Eq. 40)}$$

In most cases, the emission area is equal to the plot plan area ($A_{es} = A_{ps}$), and no flux correction is needed.

3.5.5 Debris Pile

The "debris pile" is assumed to contain large objects dredged from the river bottom which are separated from the dredged material during the initial size separation steps at the processing facility wharf. They are assumed to be covered with a thin layer of PCB-laden soil, which can still emit to the atmosphere. A worst-case scenario for the debris pile is assumed to be the presence of one or more large trees which may have fallen into the river and only partially decayed, whose total surface area (of trunk plus branches) is assumed to be equal to the plot plan area, as described below.

3.5.6 Conical Solid Storage Piles

For a solid storage pile assumed to be conical in shape, the plot plan area (input to ISC) is:

$$A_{ps} = \pi r_b^{\,2} \qquad \text{(Eq. 41)}$$

where: r_b is the radius of the base of the cone.

However, the emitting area is the total lateral area of the sides of the cone, which is greater than the plot plan area. If Z_c represents the height of the apex of the cone, the horizontal radius of the cone at a height z above the ground is given by:

$$r(z) = r_b\left(1 - \frac{z}{Z_c}\right) \qquad \text{(Eq. 42)}$$

so the circumference of the cone at height z would be given by:

$$c(z) = 2\pi r(z) = 2\pi r_b\left(1 - \frac{z}{Z_c}\right) \qquad \text{(Eq. 43)}$$

The slant height of the cone, along a line from the apex to a point on the edge of the base would be, by the law of Pythagoras:

$$S = \sqrt{r_b^{\,2} + Z_c^{\,2}} \qquad \text{(Eq. 44)}$$

For a differential element of height dz, the corresponding differential element of length along the slanted side would be:

$$ds = \frac{S}{Z_c}dz = \frac{\sqrt{r_b^{\,2} + Z_c^{\,2}}}{Z_c}dz \qquad \text{(Eq. 45)}$$

The slant area of the cone is found by integrating over height:

$$A_{es} = \int_0^{Z_c} c(z)ds = \int_0^{Z_c} 2\pi r_b\left(1 - \frac{z}{Z_c}\right)\frac{\sqrt{r_b^{\,2} + Z_c^{\,2}}}{Z_c}dz \qquad \text{(Eq. 46)}$$

Factoring the constant terms out of the integral sign and integrating results in:

$$A_{es} = \pi r_b\sqrt{r_b^{\,2} + Z_c^{\,2}} \qquad \text{(Eq. 47)}$$

Equation 47 was used to calculate the emission area for the "oversize pile" (sizes from $^3/_8$ to 6 inches) and the "coarse solids pile" (sizes from 75 µm to $^3/_8$ inch). Since the plot plan area is given by Equation 41, Equation 47 shows that the emission area is greater than the plot plan area when $Z_c > 0$ (when the cone has a finite, non-zero height).

3.5.7 Emission Areas for Volume Sources

Table I-2 contains the source-specific input used to calculate PCB emission rates for the processing facility, and also gives "emission areas" for volume sources. These areas are required because the procedures described in Section 3.0 only calculate PCB flux rates (mass rate per unit area), whereas ISC requires mass emission rates to be input for volume sources.

The mass emission rate E_{sh} (in g/s) of a given PCB homolog h for a given hour for a given source s is obtained by multiplying the calculated flux rate (F_{sh}, in g/m^2-s) of the PCB homolog for that hour by the emission area A_{es}:

$$E_{sh} = F_{sh} A_{es} \qquad \text{(Eq. 48)}$$

Emission areas for volume sources are calculated using the standard equations: Equation 35 for a source inside a building having a rectangular emission surface, and Equation 36 for a source having a circular emission surface (such as a cylindrical tank). For the filter boxes inside the Filter Press building, it was assumed that 6 of the 12 filter boxes were active at any given time, so the emission area is equal to 6 times the top area of a single filter box.

3.5.8 Effect of PCB Concentrations in Process Streams

According to Table I-2, the PCB content in solids handled in various process units varies from 22.8 to 310 mg/kg. Contributions form the storm water basins were also considered since they have a relatively high surface area compared to other sources. The low concentration of PCB's expected in the storm water contained in these basins, relative to other modeled sources, resulted in the basins not being a significant contributing source of emissions.

This material balance results for a feed stream to the processing facility for S-2 sediment, which is assumed to contain 77.2 mg/kg total PCBs. The homolog distribution for all these sources is assumed to have the same distribution as the feed stream, namely: 18% mono, 39% di, and 27% tri, 16% tetra, and 2% penta-chloro biphenyl.

The procedures described in Section 3.0 show that, for a given temperature and wind speed, the calculated flux rate F_h of any PCB homolog is linearly proportional to the concentration of that homolog in the solid C_{sh}. If the distribution of concentrations between homologs is constant (equivalent to the third row of Table I-1), the concentration of any homolog in the solid is proportional to the concentration of total PCBs. The flux rates were therefore calculated using a fixed total PCB concentration of 77.2 mg/kg (standard S-2), then multiplied by the ratio C_{Ts} / 77.2, where C_{Ts} is the concentration of total PCBs in the solids for source s.

As described earlier, for area sources, the resulting flux rates were then multiplied by the ratio of the emission area to the plot plan area (see Equation 40) before being output to the ISC input files. For volume sources, the calculated flux rates were multiplied by the emission area (see Equation 48) to obtain hourly mass emission rates to be output to the ISC input files.

3.6 Physical Properties of PCB Homologs

3.6.1 Introduction

The calculation method described in previous sections assumes the same physical properties for all PCB congeners of a given homolog (having the same number of chlorine atoms per molecule), although the physical properties do vary between one homolog and another. This section describes how the values assumed for these physical properties were obtained, and the sources in the technical literature which were consulted.

The physical properties needed for these calculations include:

- Molecular weight, in g/gmol;
- Molar volume, in cm^3/gmol;
- Henry's coefficient at 25^o C, in atm-m^3/gmol;
- Temperature variation of Henry's coefficient K;
- Octanol-water partition coefficient (K_{ow}), L/kg; and
- Organic partition coefficient (K_{oc}), L/kg.

The values are shown in Attachment 4.

3.6.2 Molecular Weight

According to Equation 21, the molecular weight of a PCB homolog is required to calculate the diffusion coefficient D_{ai} of PCB in air. The molecular formula of a PCB homolog containing h chlorine atoms is:

$C_{12}Cl_hH_{10-h}$

Since there are 10 positions on the biphenyl molecule to which either a chlorine or hydrogen atom can be bonded. The molecular weight of the PCB homolog is therefore the sum of the atomic weights of all the atoms in the molecule:

$$M_h = 12M_C + hM_{Cl} + (10-h)M_H \qquad \text{(Eq. 49)}$$

where:

M_C = Atomic mass of carbon = 12.01115 g/gmol

M_{Cl} = Atomic mass of chlorine = 35.453 g/gmol
M_H = Atomic mass of hydrogen = 1.0079 g/gmol

and the atomic masses were taken from a periodic table of the elements given in Perry and Chilton (1973).

3.6.3 Molar Volume

The molar volume V_{mi} is needed to calculate the diffusion coefficient of the PCB through water using Equation 16. The molar volume in cm^3/gmol is estimated by dividing the molecular weight M_i of the congener (in g/gmol) by the density ρ_i of the congener (in g/cm^3):

$$V_{mi} = \frac{M_i}{\rho_i} \qquad \text{(Eq. 50)}$$

Values of the molecular weight M_i were obtained using Equation 49, and values for densities of PCB homologs were obtained from Mackay et al. (1992). Although this reference gives values of density for several PCB congeners, these density values were found to be identical for all isomers of a given homolog.

3.6.4 Henry's Constants

Henry's Constants H_{i0} at the standard temperature of 25° C (298.15 K) were obtained for all mono- through hexa-chlorobiphenyls congeners for which they were available from the Syracuse Research Corporation's (2005) online chemical database (which can be accessed at: http://www.syrres.com/esc/datalog.htm), or from base-10 logarithmic values given in Achman et al. (1993), which quoted values measured by Brunner et al. (1990).

The Syracuse Research Corporation database (2005) included both experimentally measured values (by Brunner et al. [1990] for dichlorobiphenyls and higher congeners) and values "estimated" using Brunner's empirical correlation as a function of total number of chlorine atoms and chlorine atoms in the "ortho" (2 or 6) position. For purposes of this calculation, only experimentally measured Henry's Constants were taken into account from the Syracuse Research Corporation database, since the "estimated" values for missing congeners tended to be lower than the experimentally-measured values.

If, for a given congener, experimentally measured values were available from both the Syracuse Research Corporation database (2005) and the Achman et al. (1993) article, and were different, the values from the Syracuse Research Corporation database were used. Henry's Constants from both literature sources were given in units of atm-m^3/gmol. They were converted internally by the FLXHLG subroutine to dimensionless Henry's coefficients, where the ideal-gas constant was assumed to be $R = 8.2057(10^{-5})$ atm-m^3/gmol-K.

As the flux calculation programs only calculate mass fluxes of homologs (all PCBs having the same number of chlorine atoms per molecule) and not individual congeners (arrangements of chlorine atoms around the molecule), the effective homolog values of the Henry's constant at 25^o C were calculated as follows:

- Mono-chlorobiphenyls: assumed to be 2-chlorobiphenyl, which has the highest Henry's Constant of the three isomers.
- Di-chlorobiphenyls: assumed to be 2,2'-dichlorobiphenyl, whose Henry's Constant is very close to the average of the values for the 12 isomers.
- Tri- through hexa-chlorobiphenyls: the homolog Henry's Constant is assumed to be the arithmetic average of all known experimental Henry's Constants for congeners.

3.6.5 Variation of Henry's Constant with Temperature

Henry's Constants are assumed to vary with temperature according to the Clauseus-Clapeyron relation:

$$\ln H_i(T) = A_i - \frac{B_i}{T} \qquad \text{(Eq. 51)}$$

where A_i and B_i are constants. If the Henry's Constant H_{i0} is known at a standard temperature T_0 = 25^o C = 298.15 K, the variation with temperature can be defined in terms of only the B_i parameter.

It is also assumed that the variation of Henry's coefficients with temperature are proportional to the variation of vapor pressure with temperature, such that:

$$\ln P_{vi} = A_i - \frac{B_i}{T_w} \qquad \text{(Eq. 52)}$$

where the B_i parameter is identical in Equations 52 and 51, while the A_i parameters are different between the two equations. If the vapor pressure P_{vi0} is known at the standard temperature T_0, and the atmospheric boiling point T_b is known (for which the vapor pressure is the atmospheric pressure P_a = 1 atm = 760 mmHg), substituting the ordered pairs (T_w=T$_0$, $P_{vi} = P_{vi0}$) and (T_w=T_b, $P_{vi} = P_a$) into Equation 9 results in two equations in A_i and B_i.

Eliminating A_i between the two equations results in:

$$B_i = \frac{\ln\left(P_a / P_{vi0} \right)}{\left(\frac{1}{T_0} - \frac{1}{T_b} \right)} \qquad \text{(Eq. 12)}$$

The B_i parameter for the Henry's Constant (Equation 52) can therefore be obtained using Equation 12 for any congener for which the vapor pressure P_{vi0} is known at the standard temperature T_0 and the boiling point T_b at atmospheric pressure is known.

Experimental values of vapor pressure at $T_0 = 25^{o}$ C = 298.15 K were obtained from the Syracuse Research Corporation database (2005), and atmospheric boiling temperatures were obtained for some congeners from Mackay et al. (1992), which enabled the B_i parameter to be calculated using Equation 12 for all congeners for which the standard vapor pressure and atmospheric boiling temperature could be obtained.

As the flux calculation programs only calculate mass fluxes of homologs (all PCBs having the same number of chlorine atoms per molecule) and not individual congeners (arrangements of chlorine atoms around the molecule), the effective homolog values B_i were calculated as follows:

- Mono-chlorobiphenyls: assumed to be 2-chlorobiphenyl.
- Di-chlorobiphenyls: Assumed to be 2,2'-dichlorobiphenyl.
- Tri- through hexa-chlorobiphenyls: The homolog value of B_i is assumed to be the arithmetic average of all known values of B_i for congeners.

3.6.6 Partition Coefficients

Octanol-water partition coefficients $(K_{ow})_i$ were obtained for all PCB congeners in an Excel spreadsheet "bz_properties.xls" sent by Diane Achman (QEA) on October 26, 2005, which cites Hawker and Connell (1988) as a reference.

In addition, this same spreadsheet contains values of the organic-carbon partition coefficient $(K_{oc})_i$ for some, but not all, PCB congeners, which were (according to the spreadsheet) "calculated from USEPA Phase 2 field data collected in 1993."

For each of the mono- through hexa-chlorobiphenyl congeners, the partition coefficient was assumed equal to the organic carbon coefficient $(K_{oc})_i$ if such a value was given, or equal to the octanol-water coefficient $(K_{ow})_i$ if $(K_{oc})_i$ was not available.

The partition coefficient for the mono-chlorobiphenyl homolog was assumed equal to $(K_{oc})_i$ for 2-chlorobiphenyl, which was the lowest of the partition coefficients for the three isomers.

The partition coefficient for the di-chlorobiphenyl homolog was assumed equal to $(K_{oc})_i$ for 2,2'dichlorobiphenyl, which was the lowest of the partition coefficients for the 12 isomers.

For each of the tri- through hexa-chlorobiphenyl homologs, the partition coefficient for the homolog was assumed equal to the reciprocal average of the partition coefficients for each of the corresponding isomers:

$$(K_{oc})_h = \frac{N_h}{\sum_{i=1}^{N_h}\left(\frac{1}{(K_{oc})_i}\right)} \qquad \text{(Eq. 53)}$$

where:

$(K_{oc})_h$ = effective (reciprocal) average partition coefficient for homolog h
N_h = Number of isomers of homolog h
$K_{oc})_i$ = partition coefficient for isomer (congener) i

The reciprocal average of the partition coefficients for the various isomers was used for the homolog average (instead of the arithmetic average) because the congener concentrations in the water are inversely (not directly) proportional to congener partition coefficients.

3.7 Comparison to Responsiveness Summary

A comparison of the methods and data of this analysis to the EPA calculations in the *PCB Releases to Air* White Paper in the RS is provided here to show the relative conservatism of this analysis:

A. Average Sediment Concentration – The RS used an average sediment concentration of 31.2 mg/kg. This analysis used a concentration of 77.2 mg/kg or 2.5 times higher for some calculations. For others, most notably the barges based on SRUs, the calculation used sediment concentrations by barge/SRU, which ranged from 0.3 mg/kg up to 1081 mg/kg. At the processing facility, concentrations ranged up to 310 mg/kg. These higher concentrations would lead to much higher evaporation rates.

B. Organic Fraction – The RS used 4% organic fraction while this analysis uses 3% organic fraction because it is more representative of the SSAP results, leading to 1/3 higher emissions.

C. Partition Coefficient – The RS used an average partition coefficient for total PCBs (530,000 mL/g) while this analysis used partition coefficients by homolog which range as low as 224,000 mL/g for mono-chlorobiphenyls, yielding much higher emission rates.

D. Henry's Constant – The RS used a total PCB Henry's Constant at 25º C of 0.00025 $atm/m^3/mol$ while this analysis used homolog based on Henry's coefficient based on river water or air temperatures. These values ranged up to 0.000736 $atm/m^3/mol$ for mono chlorobiphenyls or three times higher.

E. Other Physical Parameters – Other parameters of this analysis are compared to the RS numbers in Table I-3 along with those above. The most important is the use, in the present analysis, of actual distances to nearby residential locations.

The result is that this analysis is expected to result in much higher maximum concentrations than shown in the RS.

4.0 NAAQS EMISSION SOURCES

Modeling for comparison to NAAQS will be done for the following locations.

4.1 Dredging on the River - Including a Sensitivity Analysis of Two Dredge Operations Within 100 Feet of Each Other

The emission sources are shown in Table I-4 for dredging operations. The debris removal, backfill operations and habitat operations were assumed to be at other locations. It is assumed that operations are 24 hours a day. Where sources are used on a lower percentage basis than 24 hours, their emissions are used at full rates for averaging times less than 24 hours and are multiplied by the percentage for 24 hour averaging times. It is not appropriate to calculate annual average concentrations because the dredge operations will move throughout the summer season.

A separate analysis was done with two dredge operations, i.e., all the equipment in Table I-4 at two different locations separated by 100 feet. In actuality, two operations close together will share some equipment.

4.2 Processing Facility Construction

The equipment to be used to construct the processing facility is listed in Table I-5. While the schedule below shows that not all equipment will be working at once, the construction equipment was modeled that way to be conservative. The civil construction at the facility is expected to take less than 12 months. However, in order to get emission values that can be compared with annual standards and not unnecessarily limit actual durations due to modeling assumption, a protracted (conservative) schedule is assumed:

Grading, Utilities and Drainage	8 months
Paving and Foundation	1 month
Site Restoration	1 month

The “rough grading,” or initial portion of the Grading, Utilities and Drainage activities, has the largest potential to create fugitive dust. The plan is for all 125 acres to be graded in 37 days, which is about 3.4 acres per day. The “fine grading,” or latter portion of the processing facility construction activities, covers 65 acres in 78 days, which is less than 1 acre per day. Therefore the rough grading will account for the maximum fugitive emissions.

4.3 Processing Facility Operations

The emission sources for processing facility operations are shown in Table I-6. They include mobile equipment and emergency generators at point sources. There are three sets of fugitive dust sources:

1. Dropping of sediment onto piles;
2. Fugitive emissions from driving onto paved roads; and
3. Wind-blown fugitive emissions from storage piles.

The processing facility will operate 227 days from May 21st to October 31st. After river dredging has been completed for the year, it is expected that loading sediments onto rail cars may continue until the end of the year. Emissions after October 31st will come from front-end loaders and fugitive dust from loading into railcars, paved roads and wind-blown dust from the storage bins.

5.0 NAAQS EMISSION CALCULATIONS

5.1 Dredging Operations

Emission factors for most diesel equipment are based on emission factors from Caterpillar Corporation. When other equipment is used, emission factors are based on gallons/hour of fuel consumed during typical operations.

There is no fugitive dust emissions associated with these sources. The emission rates and calculated emissions are shown in Table I-7. It has been assumed that $PM_{2.5}$ emissions for diesel engine sources are equivalent to PM_{10} emissions and are not separately presented in the table. These emissions will occur at a specific location for a period of up to 4 days. As a result, emissions on an annual average basis, including those for NO_x, (for which the NAAQS is an annual average standard) are not calculated.

5.2 Processing Facility Construction

Table I-8 contains the emission factors and calculated emissions for the machinery used to construct the processing facility. Again, $PM_{2.5}$ is assumed to be equivalent to PM_{10}, except for fugitive dust which is estimated to consist of 50% $PM_{2.5}$ (with the remainder consisting of larger particles). The basis of each emission factor is given in the footnotes. All of this equipment will not operate simultaneously. Emissions have been calculated on a daily basis. The fugitive dust emission rate of 20 lbs/acre/day has been multiplied by the average of 3.4 acres per day for "rough grading" but is an overestimate for other operations.

5.3 Processing Facility Operations

Table I-9 contains the emission factors and emission rates for sources during operations at the processing facility. Fugitive emissions were assumed to be 30% $PM_{2.5}$. Mobile equipment emission factors come from Caterpillar Corporation where emergency generator emission factors come from EPA's Compilation of Emission Factors (AP-42). Emissions from emergency generators are for testing and maintenance.

Emission factors for fugitive emissions from sediment handling operations have used the AP-42 "drop" equation. Emissions from paved roads have used the AP-42 equations with the distances of the various movement operations. Emissions for wind-blown fugitives from storage piles using the AP-42 equations resulted in insignificant emissions due to the moist content of the piles and the size distribution of the coarse piles.

6.0 DISPERSION MODELING

6.1 Model Selection

The current version of the ISCST3 model [02035] was used. The terrain in the immediate area of the dredging and processing areas is sufficiently flat so that terrain has not been entered into the model analyses. In addition, the terrain is "rural" as opposed to "urban".

6.2 Meteorological Data

There are no on-site or nearby meteorological data that could be used for this evaluation. The nearest National Weather Service site is Glens Falls. The data capture for this site is shown in Table I-10. The dredging program is expected to proceed from May until the end of October. A wind rose for the period June through October of the Glen Falls data is shown in Figure I-7.

Five years of data from Glens Falls (1997, 1998, 1999, 2000, and 2002) were selected for the model analysis. The data for 2001 were insufficient (particularly in the May to October period), so the data captured in the 5 selected years was used for model analyses.

An hourly stability class was determined by wind speed and cloud cover from the Glens Falls airport data. Missing data were filled in from Albany.

6.3 Background Concentrations

Typical background concentrations of total PCBs (0.002 microgram per cubic meter [$\mu g/m^3$]) for a rural area are assumed for this assessment.

For the NAAQS pollutants (except for ozone, which has been assessed separately), the background concentrations used in EPA's White Paper titled *Air Quality Evaluation* (TAMS 2002), which is part of its RS , were used, as follows:

Pollutant	Time	Concentration ($\mu g/m^3$)
CO	1-hour	7429
	8-hour	4888
NO_2	Annual	30
PM_{10}	24-hour	44
	Annual	18
SO_2	3-hour	31
	24-hour	15
	Annual	3

6.4 Evaluation Points

For each model determination, evaluation points were selected that represent the following three types of locations:

1. The closest point of potential air quality measurement. On the river, this means the shoreline. At the processing facility area, this means the fence line or, in the case of the waterfront operation, the east side of the canal.
2. Commercial establishments in the area (for comparison to the commercial/industrial criteria).
3. Residences in the area (for comparison to the residential criteria).

With these guidelines in mind, the following figures were prepared that show the evaluation points used at each modeling location:

Figure I-8	Evaluation Points Near Rogers Island
Figure I-9	Evaluation Points Near Griffin Island
Figure I-10	Evaluation Points Near Lock 7
Figure I-11	Evaluation Points Near Processing Facility

6.5 Model Outputs

The model was used to generate concentrations of pollutants for the appropriate averaging times at each of the evaluation points. These modeling runs were performed separately using each of the five years of meteorological data, and then the maximum in all five years was determined. The maximum concentrations for each averaging time were compared to the Hudson QoLPS and the NAAQS. Results of this comparison are provided in Section 7.0 for PCBs and Section 8.0 for the NAAQS pollutants.

7.0 PCB MODELING RESULTS

7.1 Model Results for Dredging Operations

As described above, the modeling of PCB emissions from dredging operations was performed using the resuspension model described in the Phase 1 IDR for water column emissions and, initially, the conservative Equilibrium Partitioning Model to predict emissions from the sediments in the open barges. This modeling was used to produce an initial assessment of PCB air quality for the entire Phase 1 operational season. Then, the Transport Limited Model was used to reassess emission rates from the barges for cases in which concentrations were predicted above the applicable Concern Level (0.08 $\mu g/m^3$ for residential receptors or 0.21 $\mu g/m^3$ for commercial/industrial receptors). The contribution from volatilization from the river is very low and results in an air concentration of less than 0.003 $\mu g/m^3$ at the shore line. However, this contribution is added to the barge emissions, as described below.

7.1.1 Barge Emissions- Equilibrium Partitioning Model Results

The evaluation of PCB emissions, using the Equilibrium Partitioning Model for emissions from the sediments in the barges, results in modeled concentrations which are above the levels of the Hudson QoLPS criteria for the nearest receptors during approximately 2% of the Phase 1 dredging season (16 days at residential receptors and 11 days at commercial receptors in the five years of meteorological data modeled). The maximum predicted 24-hour average concentration in 5 years at a receptor (in this case residential) is 0.30 $\mu g/m^3$. The concentrations are nearly entirely mono- and di-chloro biphenyl. As stated above, the volatilization from the river caused by resuspension is minor, but included in these results. The results for the Rogers Island area on a specific worst-case day (with the equivalent meteorology of August 16, 2002) indicate that the shoreline concentration was 0.59 $\mu g/m^3$. The concentration falls off quickly with distance from the source barge to less than 0.08 $\mu g/m^3$ at 218 meters of the source. The maximum annual average concentration for a residential receptor in the vicinity of Rogers Island is predicted to be 0.002 $\mu g/m^3$, which is equal to the typical rural background concentration.

Two conditions lead to these maximum impacts to air quality, as predicted by the Equilibrium Partitioning Model: high PCB concentrations (average greater than 200 mg/kg in the sediments in the loaded barges) and high sustained wind (greater than 10 mph) conditions.

7.1.2 Transport Limited Model Analysis

The Transport Limited Model was applied to three typical PCB concentrations in a loaded barge: 1) 1081 mg/kg (the maximum SRU concentration; 2) 460 mg/kg in the sediment; and 3) 77.2 mg/kg in the sediment (the average concentration of S2 sediments). A comparison of emission rates is as follows:

Comparison of Emission Rates ($\mu g/sec/m^2$)			
PCB Concentration in Sediment	**Equilibrium Model**	**Transport Limited Model (First Hour)**	**Transport-limited Model (8 Hour Average)**
1081	2.1	1.01	0.50
460	1.5	0.73	0.38
77.2	0.12	0.06	0.03

Note:
g/sec/ m^2 = grams per second per square meter
8-hours is the approximate duration for dredge to fill a barge

The table above provides emission rates for the first hour, when the barge is receiving its first load. The Transport Limited Model shows emission rates that are half of those produced by the Equilibrium Partitioning Model for the first hour. This is due to the more slowly desorbing resistant component of PCB partitioning (Carroll, 1994). For an 8-hour average, the Transport Limited model shows a further reduction due to a depletion of PCBs in the water phase associated with the sediment in the barge. Thus, while the Equilibrium Partitioning Model continues to transport PCBs at similar rates to those shown above for the entire time the barge is being filled (adjusted by wind speeds), the Transport Limited Model shows declining rates with time. In last hour of filling a barge (when the sediments would be most susceptible to wind-induced evaporation, since the freeboard is less) and as the barge progresses through Lock 7 to the processing area wharf, the rates are 5% of those predicted by the Equilibrium Partitioning Model.

The concentration at a given evaluation point is proportional to the emission rate that is input into the ISC model. Therefore, assuming that the average emission rates over the 8-hr operation period are one-fourth of those predicted by the Equilibrium Partitioning Model (per table above), the maximum predicted concentration at the residential receptor would be reduced to 0.075 $\mu g/m^3$, which is less than the Level of Concern for residential receptors.

7.1.3 Mitigation

The Transport Limited Model predicts that the air quality Level of Concern will be met, considering the select cases that resulted in the worst case predicted by the Equilibrium Partitioning Model. However, since validation of the input conditions and model prediction will not be possible until Phase 1 operations, the contractor will be required to provide contingency measures. The contingencies will be implemented to control emissions from barges in the event that the PCB air monitoring indicates an exceedance of the Level of Concern.

Because the generation of PCB emissions from the sediments in the open barges is completely dependent on volatilization and because volatilization is dependent upon wind speed, the likely path to control of airborne PCB concentrations is control of wind speed across sediments. For the barges, it was assumed in the initial emission calculations that the wind across the surface of water in the barge was not reduced by the freeboard of the barge while it is being filled, whereas in fact the sides of the barge will effectively be a wind screen during such filling. If the monitoring indicates the need for further control, the contractor will be directed to create a wind break to further reduce the wind velocity over the water surface, leading to less evaporation. Wind breaks of 50% porous polyester screening, 5 to 6 feet in height, around the barge can reduce wind speeds by 70% at the surface of the water which is covering the sediment.

The use of such wind screens would reduce the emissions predicted by the Equilibrium Partitioning Model. That model predicts that the barges containing an average PCB concentration of greater than 200 mg/kg need to be fitted with wind screens. Wind screens are predicted to be an effective control measure for all cases, even the maximum case of PCB sediment concentration (SRU=1081 mg/kg); there would be no PCB concentrations above either the Level of Concern or Standard Levels at either residential or commercial receptors. The results for the model runs with wind screens installed, the maximum 24-hr average concentration (with the equivalent meteorology of August 7, 2002) are predicted to be 0.055 $\mu g/m^3$ at a residential receptor and the maximum commercial/industrial concentration was 0.032 $\mu g/m^3$. The maximum annual average concentration would be reduced to 0.0013 $\mu g/m^3$ in all Phase 1 areas.

Therefore, the contractor will be required during Phase 1 to have the materials necessary to construct wind screens on the loaded barges, and to install those wind screens if the PCB air monitoring program measures PCBs above the Concern Levels during dredging. The contractor will also be allowed to propose other engineering or operational controls if they can be shown to be effective in reducing PCB emissions so as to meet the applicable criteria.

7.2 Model Results for Barging Operation

7.2.1 At Lock 7

The ISC dispersion model was run assuming that three barges are lined up at Lock 7 waiting to enter the Champlain Canal, with one barge is in the lock and the other two moored at specified locations. This assumption was extended for 24 hours a day, 7 days a week using the equilibrium model for emissions. The results of the Equilibrium Partitioning Model, assuming S2 sediment properties, with the additional assumption from the Transport Limited Model that ½ the PCB's do not initially desorb demonstrate that the predicted PCB concentrations at all residential and commercial receptors are below the applicable Concern and Standard Levels. The maximum concentration at any receptor location is 0.031 $\mu g/m^3$ and occurs at the lock maintenance building. This is well below the Level of Concern for commercial receptors. These modeling results are still very conservative due to the assumption that three barges are continuously moored in the Lock 7 area.

Therefore, the Equilibrium Partitioning Model predicts that no mitigation of the emissions from barges at Lock 7 is required. The Transport Limited Model would predict much lower concentrations, therefore does not need to be run.

7.2.2 At Processing Facility Wharf

The barges, once through Lock 7 and taken north on the Champlain Canal, would arrive at the unloading wharf of the processing facility. Here again, the assumption was made that three barges at a time could wait there. As with the Lock 7 analysis, it was assumed three barges are there 24 hours a day, 7 days a week. The maximum concentration at the facility shore line (which is very close to the unloading wharf) is 0.076 $\mu g/m^3$ which is below the residential Concern Level.

Here again, the expectation is that the estimated emissions (and thus the concentrations) are conservative estimates. Therefore, predictions at receptors that are further from the source than the fence are not required.

7.3 Model Results for Processing Facility

7.3.1 Uncontrolled Model Results

The Equilibrium Partitioning Model was used for the processing facility sources (as shown on Table I-2 and Figure I-12). The literature was reviewed for a model that would better represent stockpiles of granular materials that contain no free liquid (the Transport Limited Model cannot be used for non-water covered sediments). However, no more representative model could be identified for these sources. Design decisions will be based on the results of the Equilibrium Partitioning Model; however, air monitoring during Phase 1 will be used to determine the model validity and possibly lead to design modifications for Phase 2.

The maximum 24-hour average concentrations for uncontrolled sources of PCBs emissions at the processing facility were predicted to be above the Concern and Standard Levels at both residential and commercial receptors. Review of the largest contributing sources revealed that the two Fines Storage Areas (near to rail loading area) were the greatest contributors. Secondary contributions occurred due to the gravity thickener and process recycle water storage tank. The situation on the worst-case day indicates that without controls on these sources, the concentration is above the Concern Level out to 1,324 meters from the facility fence line. At residences, maxima exceed 0.08 $\mu g/m^3$ during only 2% of the operational season (16 days in the 5 years of meteorological conditions evaluated).

7.3.2 Mitigation

Even though the model predicts exceedance of the standard to be a rare occurrence, the enclosure or covering of the contributing sources to eliminate or reduce evaporation of PCBs are incorporated into the design. The model was rerun with the following controls:

1. Enclosing both Fines Storage Areas with positive control of PCB emissions; and
2. Covering the recycle water equalization and gravity thickener tanks, which are both large tanks (high surface area).

With such controls in place, the remaining PCB emissions from the tank sources were calculated with the calm wind limit (see Section 3.2.6). The results of this model analysis indicate that on the worst-case day the maximum commercial/industrial concentration was 0.020 $\mu g/m^3$ and the maximum residential concentration was 0.041 $\mu g/m^3$. The maximum annual average concentrations do are less than 0.002 $\mu g/m^3$ at residences in the vicinity of the processing facility.

A subsequent sensitivity analysis found a capture rate at the fines storage enclosures of 90% was sufficient to comply with the Concern Level at residential and commercial/industrial receptors. The ventilation system has been design and will be installed per the plans and specifications. The data gathered during the Phase 1 air monitoring program will guide the operation of the control system. The specifications also include covers for the recycle water equalization tank and the gravity thickener.

7.4 Cumulative Impact

The modeling reveals that none of the individual areas studied has any more than 1 or 2 nanograms per cubic meter (ng/m^3) impact on the other areas. The emissions of PCBs from the river itself due to resuspension are small and result in shoreline concentrations less than 3 ng/m^3 even when the river water is confined. Thus, there are no cumulative impact issues. The addition of 2 to 3 ng/m^3 background concentrations to any of the receptors modeled would also have no appreciable impact on the model results.

8.0 NAAQS MODEL RESULTS

8.1 Dredging Operations

Model analyses for emissions of NAAQS pollutants PM_{10}, $PM_{2.5}$, SO_2, and CO from a dredging operation (see Section 4.1) result in concentrations as shown in Table I-11. Annual averages, including those for NO_x, are not included in Table I-11 because the dredging operation will move. The results for two dredging operations situated 100 feet from each other on the East Channel of Rogers Island are shown on Table I-12. Both of these sets of results show that the emissions of these pollutants are not predicted to cause exceedances of the NAAQS. These results are for shoreline receptors and thus represent concentrations in close proximity to the operations. Concentrations decrease rapidly with distance from the shore. The results thus demonstrate attainment of the NAAQS.

8.2 Processing Facility Construction

The results for the construction of the processing facility are presented in Table I-13. The results demonstrate attainment of the NAAQS.

8.3 Processing Facility Operations

The results for operating the processing facility are presented in Table I-14. The results demonstrate attainment of the NAAQS.

8.4 Ozone Impact Estimate

Ozone has been evaluated separately from the other NAAQS pollutants discussed above. The ozone creation potential of the emission sources at the dredging operation and the construction and operation of the sediment processing plant is dictated by the emissions of NO_x and VOCs. In each case, the ratio of VOCs/NO_x is less than 0.02, meaning that there are substantially more emissions of NO_x than VOCs (primarily diesel emissions). The technique used by EPA (Scheffe, 1988) to screen for ozone suggests that the proposed sources would not create ozone of more than 1 part per hundred million. Since the NAAQS is an 8-hour average of 80 parts per hundred million, no impact on ozone concentrations is expected. The practical answer is that the emissions of NO_x would suppress ozone formation for a considerable distance downwind.

8.5 Cumulative Impact

The results of each individual operation are separated sufficiently so that no cumulative impact (above a few $\mu g/m^3$) would occur.

9.0 MATHEMATICAL NOTATION

9.1 Main Variables

A_e = Surface area for emission, m^2.
A_i = Constant parameter in equation for vapor pressure or Henry's coefficient
A_p = Plot plan area, m^2.

B_i = Constant parameter in equation for vapor pressure or Henry's coefficient, K

C_{ai} = Concentration of PCB congener *i* in air, g/m^3.
C_d = Concentration of PCB dissolved in water
C_{dom} = Concentration of PCBs bound to Dissolved Organic Matter
C_{si} = Concentration of PCB congener *i* in solid, mg/kg (ppm)
C_T = Total concentration of all PCBs in solid, mg/kg (ppm)
C_{wi} = Concentration of PCB congener *i* in water, g/m^3.
$c(z)$ = circumference of cone as function of height *z*, m

D_{ai} = Diffusivity of PCB congener *i* in air, m^2/s
D_s = Diffusivity of PCB congener in pore water
D_{wi} = Diffusivity of PCB congener *i* in water, cm^2/s
d = Day number after start of dredging

E_a = Actual mass emission rate, g/s
E_i = Mass emission rate of congener *i*, g/s
E_{ISC} = Mass emission rate according to ISC model, g/s
E_{sh} = Mass emission rate for homolog *h* from source *s*, g/s.

F_{calc} = Calculated mass flux, g/m^2-s.
F_{h0} = Mass flux of PCB homolog *h* assuming SRU active for entire hour, g/m^2-s.
F_i = Mass flux of PCB congener *i*, g/m^2-s.
$F_{i,j}$ = Mass flux of PCB from water layer *i* to water layer *j*
F_{ISC} = Mass flux input according to ISC model, g/ m^2-s
F_{nh} = Mass flux of PCB homolog *h* for SRU number *n*, g/m^2-s.
F_s = Mass flux of PCB homolog from sediment to water column, g/m^2-s

f_d = Mass fraction of PCBs dissolved in water
f_{doc} = Mass fraction of PCBs sorbed to Dissolved Organic Matter
f_h = Mass fraction homolog *h* in total PCBs in solid, dimensionless.
f_{oc} = Mass fraction of organic carbon in solid, dimensionless.
f_p = Mass fraction of PCBs in pore water
f_{sn} = SRU mass flux pro-rate factor, dimensionless.

H_i = Henry's Constant for PCB congener *i*, atm-m^3/gmol.
H'_i = Dimensionless Henry's Constant for PCB congener *i*.
H_{i0} = Henry's Constant for PCB congener *i* at standard temperature, atm-m^3/gmol.

h = hour after midnight (Equation 32)

h = number of chlorine atoms per PCB molecule (Equation 61)
h_w = depth of water layer over sediment, m
h_b = hour of day for beginning of dredging
h_{bn} = hour sequence number for beginning of dredging for SRU n
h_e = hour of day for end of dredging
h_{en} = hour sequence number for end of dredging for SRU n
h_s = hour sequence number

J = Julian day
J_1 = Julian day for which previous water temperature is available
J_2 = Julian day for which next water temperature is available
J_b = Julian day for beginning of dredging
J_e = Julian day for end of dredging

K_{doc} = Partition coefficient between PCBs sorbed to Dissolved Organic Matter and dissolved in water
$(K_{oc})_i$ = Organic carbon partition coefficient for PCB homolog h, L/kg
$(K_{oc})_i$ = Organic carbon partition coefficient for PCB congener i, L/kg.
$(K_{OL})_i$ = Overall water-air mass-transfer coefficient for PCB congener i, m/s.
$(K_{ow})_i$ = Octanol-water partition coefficient for PCB congener i, L/kg.
K_p = Partition coefficient between PCBs in solid and dissolved in water

k_{ai} = Air-side film mass-transfer coefficient of PCB congener i, m/s
k_f = Mass-transfer coefficient between sediment and water column
k_{wi} = Water-side film mass-transfer coefficient of PCB congener i, m/s

L_s = Length of longest horizontal side of a source, m
$l_{i,j}$ = Distance between midpoints of water layers

M_C = Atomic weight of carbon, g/gmol
M_{Cl} = Atomic weight of chlorine, g/gmol
M_H = Atomic weight of hydrogen, g/gmol
M_h = Molecular weight of PCB homolog h, g/gmol
M_i = Molecular weight of PCB congener i, g/gmol

m = Concentration of solids in slurry
m_{doc} = Mass of Dissolved Organic Matter per volume of water

N_{Cl} = Total Number of chlorine atoms per PCB molecule
N_h = Number of isomers of PCB homolog h
$N_{o\text{-}Cl}$ = Number of chlorine atoms per PCB molecule in ortho position
n_i = Number of gmol of PCB congener i, gmol
n_T = Number of gmol of air, gmol

P_a = Atmospheric pressure, atm
P_i = Partial pressure of PCB congener i, atm
P_{vi} = Vapor pressure of PCB congener i at standard temperature, mmHg.

R = Ideal-gas constant = 8.2057(10^{-5}) atm-m^3/gmol-K
r_b = Radius of base of conical source, m
r_s = Radius of circular area source, m
$r(z)$ = Radius of conical source as a function of height z, m

S = slant height of cone, m
Sc_a = Schmidt number in air, dimensionless
Sc_w = Schmidt number in water, dimensionless

T_0 = Standard temperature = 298.15 K
T_a = Temperature of air, K
T_w = Temperature of water, K

u = Measured wind speed 10 m above the ground, m/s
u^* = Friction velocity, m/s

U = depth-average water velocity, m/s
V_a = Volume of air, m^3.
V_{mi} = Molar volume of PCB congener i, cm^3/gmol
W_s = Width of source, m
y_i = Mole fraction of PCB congener i in air, dimensionless

Z_c = Height of conical source, m
z = Height above ground, m

9.2 Greek Letters

θ = Porosity of sediment/water slurry
μ_w = Viscosity of water, g/cm-s
ν_a = Kinematic viscosity of air, m^2/s
π = Ratio of circumference to diameter of a circle ≈ 3.14159
σ_y = Initial crosswind dispersion length, m
σ_z = Initial vertical dispersion length, m

9.3 Subscripts

a	In air, of atmosphere
b	At base of cone, or boiling
c	Of cone
calc	Calculated
e	Of emission
h	Of PCB homolog, number of chlorine atoms per PCB molecule
ISC	Input to ISC dispersion model
i	Of PCB congener *i*
n	Of SRU number *n*
OL	Overall (for water-air mass transfer)
oc	Organic carbon
ow	Octanol-water (partition coefficient)

p	In plot plan
s	Of or for source
T	Total
v	Of vapor
w	In or of water
0	At standard temperature

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ATTACHMENTS

Attachment 1:
Dredge Schedule File

```
*        UTM's           Start Time       Finish Time     PCB,  Sed
*SRU     X       Y    Julian Hour  Min Julian Hour Min    ppm
*        1         2         3         4         5         6         7
*234567890123456789012345678901234567890123456789012345678901234567890
   29 734741 1616930   140    0    0   140   12   24   10.19   S3
   30 734906 1616830   140   12   24   141   12    2   28.15   S2
   31 735040 1616808   141   12    2   143    8   41    8.96   S2
   32 735063 1616879   143    8   41   150    6   30    8.21   S2
   35 735101 1616943   150    6   30   155   15   39   14.38   S2
   36 735204 1616631   150    6   30   155   15   52   23.87   S2
    1 737094 1596929   154    0    0   154   20   36   17.28   S2
    2 737150 1596743   154   20   36   155   20   58   15.94   S2
   37 735334 1616593   155   15   52   158    4   45   15.58   S2
    3 737188 1596636   155   20   58   156   16    7   21.77   S2
    4 737345 1596800   156   16    7   157   16   42   25.20   S2
    5 737397 1596775   157   16   42   158    9   32  160.53   S2
   38 735394 1616646   158    4   45   162    0   36    8.10   S2
    6 737438 1596715   158    9   32   159    3   21  495.40   S3
    7 737462 1596659   159    3   21   161    1   54  463.74   S3
    8 737446 1596537   161    1   54   161   18    5  169.69   S2
    9 737568 1596583   161   18    5   162   19   16  626.27   S3
   39 735452 1616696   162    0   36   164   21   33    5.73   S2
   10 737481 1596364   162   19   16   163   13   22  333.65   S2
   11 737593 1596379   163   13   22   164    6   38  201.54   S2
   12 737672 1596413   164    6   38   165    5   34  672.26   S3
   40 735723 1615990   164   21   33   168   15   36  407.54   S2
   13 737652 1596255   165    5   34   166    0    6  521.97   S3
   14 737694 1596125   166    0    6   182    0   54  229.25   S2
  110 733475 1616511   168    0    0   169   13   43    8.04   S2
  135 733562 1616664   168    0    0   169   17    1  194.08   S2
   41 735879 1615336   168   15   36   171    0   20  125.10   S2
  136 733739 1616538   169   17    1   171   20   23   57.77   S2
  111 733562 1616376   169   22   11   172    3   44   25.52   S2
   42 735928 1615207   171    0   20   172    7   12   34.72   S2
  137 733823 1616596   171   20   23   173   15    0   14.98   S2
  112 733666 1616307   172    3   44   173   21    0   13.86   S2
   43 735971 1615121   172    7   12   173    8    3  145.16   S2
   44 735967 1615001   173    8    3   175   12   12   11.11   S2
  138 733880 1616448   173   15    0   176    0   23   12.74   S2
  113 733790 1616256   173   21    0   176   20   30   10.18   S2
   45 736030 1615018   175   12   12   176    7    2   65.57   S2
  139 733968 1616413   176    0   23   178    6   25   21.07   S1
   46 736093 1615034   176    7    2   177    0   54  184.47   S2
  114 733892 1616069   176   20   30   178   10   55   14.46   S2
   47 736060 1614894   177    0   54   178    9   35  122.20   S2
  140 734102 1616191   178    6   25   182    1    5    9.70   S2
   48 736030 1614808   178    9   35   180    6   10   29.49   S2
  115 733979 1615968   178   10   55   180   16   37   26.45   S1
   49 736125 1614835   180    6   10   182    1   55   19.59   S2
  116 734056 1615873   180   16   37   183    9   31   41.57   S2
   15 737738 1595998   182    0   54   182   12   36  137.74   S3
  141 734230 1615972   182    1    5   186    0   15  123.89   S2
   50 736031 1614589   182    1   55   183   19    9  188.35   S2
   16 737761 1595905   182   12   36   183   15    6  373.86   S3
  117 734131 1615809   183    9   31   187    1    5   77.45   S2
   17 737808 1595806   183   15    6   186    9   15  384.91   S2
   51 736095 1614604   183   19    9   185   19   34   67.36   S2
   52 736157 1614620   185   19   34   186   15   35   83.95   S2
  142 734420 1615912   186    0   15   189    7   21   51.76   S2
   18 737806 1595708   186    9   15   187   10   48  238.67   S3
   53 736119 1614478   186   15   35   189    4    1  315.14   S2
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118	734218	1615799	187	1	5	190	21	51	45.65	S1
19	737768	1595584	187	10	48	189	8	13	240.60	S2
54	736098	1614357	189	4	1	193	2	24	777.39	S2
143	734513	1615820	189	7	21	194	11	15	92.30	S2
20	737831	1595583	189	8	13	191	4	56	159.92	S2
119	734266	1615761	190	21	51	193	6	6	109.16	S2
21	737895	1595582	191	4	56	191	16	40	117.75	S2
22	737939	1595583	191	16	40	194	4	45	158.31	S3
59	736163	1614370	193	2	24	196	16	9	107.71	S2
120	734297	1615633	193	6	6	198	16	18	84.31	S3
23	737987	1595568	194	4	45	196	17	19	142.79	S3
144	734569	1615771	194	11	15	196	23	52	51.99	S2
62	736229	1614384	196	16	9	198	0	0	47.79	S2
145	734629	1615684	196	23	52	198	6	54	52.63	S2
24	737762	1596222	197	0	0	198	4	58	318.15	S2
64	736292	1614399	198	0	0	199	23	7	143.41	S2
65	736197	1614272	198	0	0	200	9	49	143.41	S2
25	737816	1596133	198	4	58	199	17	45	466.05	S3
146	734713	1615749	198	6	54	199	13	45	17.08	S2
121	734385	1615702	198	16	18	201	11	53	44.99	S2
147	734695	1615535	199	13	45	203	10	45	69.00	S2
26	737858	1596034	199	17	45	200	9	47	346.98	S3
27	737909	1595926	200	9	47	203	3	31	206.46	S3
66	736145	1614112	200	9	49	203	9	50	16.74	S2
122	734357	1615468	201	11	53	204	1	8	258.41	S2
28	737964	1595827	203	3	31	204	6	2	135.94	S3
68	736214	1614119	203	9	50	206	14	32	43.35	S2
148	734780	1615595	203	10	45	204	19	50	50.71	S2
123	734446	1615538	204	1	8	204	20	13	25.09	S2
149	734805	1615470	204	19	50	206	1	16	113.86	S2
124	734483	1615484	204	20	13	205	18	53	10.09	S2
91	736309	1613894	205	0	0	205	21	22	27.13	S2
125	734469	1615363	205	18	53	206	6	11	5.20	S3
92	736379	1613899	205	21	22	207	21	41	246.11	S3
150	734860	1615343	206	1	16	207	8	19	41.59	S2
126	734538	1615418	206	6	11	207	11	46	35.94	S3
70	736283	1614128	206	14	32	208	23	6	106.08	S2
151	734959	1615188	207	8	19	208	14	4	23.45	S2
127	734581	1615367	207	11	46	208	11	21	41.92	S2
93	736318	1613687	207	21	41	210	19	52	29.52	S2
128	734572	1615235	208	11	21	211	13	53	30.84	S1
152	735106	1615132	208	14	4	210	8	32	41.26	S2
72	736351	1614135	208	23	6	212	2	41	70.46	S2
153	735183	1615067	210	8	32	211	18	21	88.23	S2
95	736390	1613683	210	19	52	212	10	33	113.13	S3
129	734614	1615266	211	13	53	213	5	20	22.83	S2
154	735223	1614966	211	18	21	212	13	59	14.74	S2
73	736166	1613891	212	2	41	213	7	41	572.24	S2
96	736295	1613449	212	10	33	214	12	2	87.57	S2
155	735344	1614881	212	13	59	213	6	39	10.77	S2
130	734672	1615267	213	5	20	214	12	58	112.14	S2
74	736238	1613893	213	7	41	214	21	55	208.62	S2
156	734932	1615479	214	0	0	214	19	44	33.98	S2
99	736366	1613430	214	12	2	217	2	26	29.57	S2
100	736366	1613430	214	12	2	217	2	26	29.57	S2
131	734701	1615124	214	12	58	215	9	36	212.68	S3
157	735041	1615471	214	19	44	220	6	6	163.20	S2
76	736173	1613696	214	21	55	215	19	52	634.94	S3
132	734752	1615072	215	9	36	217	4	6	29.70	S2
77	736245	1613691	215	19	52	218	16	40	296.12	S2
101	736263	1613271	217	2	26	218	17	44	62.22	S2
133	734800	1614974	217	4	6	218	1	54	36.11	S2
102	736206	1613211	217	17	56	218	17	44	62.22	S2
134	734861	1614793	218	1	54	219	9	6	56.03	S2
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103	736187	1613131	218	17	44	221	4	14	33.56	S2
159	734931	1614656	219	9	6	220	16	30	41.16	S2
158	735143	1615080	220	6	6	221	5	9	108.11	S2
82	736225	1613465	220	7	1	222	23	58	495.34	S2
160	734939	1614481	220	16	30	222	3	42	24.53	S2
104	736081	1613008	221	4	14	221	19	47	62.26	S2
178	735207	1614705	221	5	9	222	11	32	11.73	S2
105	736028	1612935	221	19	47	222	23	45	134.74	S2
161	735062	1614527	222	3	42	222	22	59	58.17	S2
179	735208	1614577	222	10	36	222	11	11	31.50	S2
162	735031	1614336	222	22	59	225	2	58	55.45	S2
106	735956	1612846	222	23	45	225	13	6	15.47	S2
85	736068	1613266	222	23	58	224	17	29	61.44	S2
180	735301	1614605	224	3	43	225	5	14	21.40	S2
86	736151	1613236	224	17	29	225	17	46	151.90	S2
163	735103	1614297	225	2	58	226	1	39	30.25	S2
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182	735268	1614405	226	4	0	228	13	52	23.47	S2
88	735929	1612997	226	13	40	227	9	7	175.03	S2
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166	735152	1614124	227	7	36	228	3	5	35.23	S2
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90	735814	1612841	228	2	12	229	2	29	460.31	S2
167	735113	1613995	228	3	5	229	5	43	40.79	S2
109	735875	1612689	228	6	46	228	16	3	22.31	S2
183	735329	1614421	228	13	52	228	21	52	11.68	S2
184	735264	1614205	228	21	52	229	21	33	27.99	S3
168	735217	1614006	229	5	43	229	23	39	11.52	S2
185	735354	1614223	229	21	33	231	23	23	15.69	S3
169	735303	1614017	229	23	39	232	9	39	4.22	S2
170	735289	1614009	229	23	39	232	10	16	4.22	S2
186	735363	1614024	231	23	23	233	20	22	2.11	S2
171	735079	1613828	232	10	16	233	7	10	70.60	S2
172	735209	1613839	233	7	10	234	17	2	38.23	S2
189	735423	1614032	233	20	22	235	7	24	1.47	S2
190	735455	1614036	233	20	22	235	13	11	1.47	S2
173	735323	1613850	234	17	2	236	9	20	1.60	S2
191	735382	1613857	235	13	11	238	2	59	2.53	S2
175	735100	1613676	236	9	20	238	12	48	73.13	S2
193	735474	1613865	238	2	59	239	15	52	0.93	S2
176	735251	1613667	238	12	48	239	15	50	29.63	S2
177	735273	1613518	239	15	50	241	5	44	41.38	S2
213	735485	1613551	240	0	0	241	9	18	1.45	S2
194	735312	1613367	241	5	44	242	8	48	69.86	S2
214	735542	1613550	241	9	18	241	22	25	0.30	S3
215	735454	1613373	241	22	25	243	0	8	16.65	S2
195	735264	1613196	242	8	48	243	7	1	17.27	S3
216	735506	1613371	243	0	8	243	18	7	5.77	S2
196	735363	1613194	243	7	1	243	21	3	65.60	S2
217	735499	1613185	243	18	7	247	2	1	39.53	S2
197	735336	1613087	243	21	3	247	9	59	33.78	S2
218	735572	1613127	247	2	1	247	18	45	18.04	S2
198	735378	1613025	247	9	59	248	3	6	24.14	S2
219	735579	1612993	247	18	45	249	3	55	243.48	S2
199	735379	1612919	248	3	6	249	0	51	32.60	S2
200	735447	1612850	249	0	51	249	21	26	50.36	S2
220	735606	1612893	249	3	55	250	9	5	226.34	S3
201	735396	1612716	249	21	26	250	23	13	26.28	S2
221	735660	1612796	250	9	5	252	5	27	121.39	S2
202	735541	1612656	250	23	13	252	19	35	31.98	S3
222	735726	1612588	252	5	27	253	3	43	12.84	S2

203	735633	1612626	252	19	35	253	21	42	23.31	S2
223	735787	1612555	253	3	43	253	15	10	5.07	S2
224	735718	1612459	253	15	10	255	7	54	25.61	S2
204	735407	1612549	253	21	42	254	20	55	35.19	S2
205	735412	1612502	254	20	55	255	21	13	44.60	S2
225	735692	1612412	255	7	54	256	2	8	47.03	S2
206	735491	1612478	255	21	13	256	12	40	63.98	S2
226	735730	1612409	256	2	8	256	4	12	39.69	S2
227	735731	1612358	256	4	12	257	18	57	38.66	S2
207	735559	1612454	256	12	40	257	10	10	36.97	S2
208	735374	1612377	257	10	10	259	7	42	41.01	S2
228	735582	1612242	257	18	57	259	18	33	63.27	S2
209	735434	1612313	259	7	42	260	1	31	20.64	S2
229	735514	1612169	259	18	33	260	14	15	53.60	S2
210	735341	1612229	260	1	31	261	1	33	39.69	S2
230	735469	1612077	260	22	10	261	11	27	44.10	S2
211	735304	1612129	261	1	33	261	20	50	50.87	S2
231	735310	1611958	261	11	27	262	7	9	37.48	S2
212	735147	1611929	261	20	50	263	20	8	24.25	S2
243	735187	1611795	262	7	9	263	6	28	8.89	S3
244	735169	1611644	263	6	28	263	22	16	43.76	S2
232	735028	1611723	263	20	8	264	18	15	4.04	S2
245	735055	1611503	263	22	16	264	22	23	165.10	S3
233	734955	1611598	264	18	15	266	16	30	8.91	S2
246	735015	1611449	264	22	23	266	17	49	126.84	S3
234	735012	1611539	266	16	30	267	11	36	128.10	S3
247	734934	1611377	266	17	49	267	9	3	28.00	S3
248	734924	1611319	267	9	3	268	6	4	94.86	S2
235	734816	1611509	267	11	36	268	8	10	34.96	S2
249	734829	1611250	268	6	4	268	22	23	53.54	S3
236	734824	1611447	268	8	10	269	3	23	84.17	S2
250	734805	1611187	268	22	23	269	19	19	50.53	S2
237	734709	1611385	269	3	23	269	20	21	92.57	S2
251	734720	1611128	269	19	19	270	12	58	25.80	S2
238	734742	1611344	269	20	21	270	15	35	168.91	S2
252	734751	1611064	270	12	58	271	8	36	48.95	S2
239	734603	1611265	270	15	35	271	13	22	42.12	S2
253	734593	1611023	271	8	36	273	1	49	48.59	S2
240	734641	1611217	271	13	22	273	7	55	64.84	S2
254	734648	1610969	273	1	49	273	19	52	38.51	S2
241	734498	1611138	273	7	55	274	4	19	62.11	S2
255	734582	1610914	273	19	52	274	11	53	61.94	S2
242	734527	1611099	274	4	19	274	20	19	69.69	S2

Attachment 2:
Water Temperature File

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  1996  2 28  2.0
  1996  3  6  0.1
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  1996  3 21  3.0
  1996  3 28  4.0
  1996  4  3  7.0
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  1996  6 12 21.0
  1996  6 19 22.0
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  1996 12 11  4.1
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  1997  2 24  1.6
  1997  3  3  0.9
  1997  3 10  2.0
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1998	3	25	0.1
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1998	6	17	19.1

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1998	9	25	18.0
1998	10	2	16.5
1998	10	7	12.0
1998	10	15	14.0
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1998	10	28	10.5
1998	11	4	8.0
1998	11	11	9.0
1998	11	18	5.5
1998	11	23	6.0
1998	11	30	7.0
1998	12	7	8.0
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1999	3	31	5.0
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1999	8	25	24.0
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1999	9	8	24.0
1999	9	15	24.0
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1999	10	27	10.0
1999	11	3	10.0
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1999	12	15	3.0
1999	12	22	2.0
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2000	1	5	1.0
2000	1	12	1.0
2000	1	19	0.0
2000	2	16	1.0
2000	2	23	2.0
2000	3	1	1.0
2000	3	8	3.0
2000	3	15	2.0
2000	3	22	4.0
2000	3	29	4.0
2000	4	5	2.0
2000	4	12	3.0
2000	4	19	6.0
2000	4	26	7.0
2000	5	3	13.0
2000	5	10	15.0
2000	5	17	13.0
2000	5	24	13.0
2000	5	31	17.0
2000	6	7	16.0
2000	6	14	16.0
2000	6	21	25.0
2000	6	28	23.0
2000	7	12	22.0
2000	7	26	22.0
2000	8	2	22.0
2000	8	9	25.0
2000	8	30	22.0
2000	9	6	21.0
2000	9	13	21.0
2000	9	20	19.0
2000	9	27	17.0
2000	10	4	17.0
2000	10	11	13.0
2000	10	18	13.0
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2000	11	8	10.0
2000	11	15	8.0
2000	11	22	5.0
2000	11	29	4.0
2000	12	6	1.0
2000	12	13	0.5
2000	12	20	0.5

Attachment 3:
Processing Facility Source Input File

```
*        1         2         3         4         5         6
*23456789012345678901234567890123456789012345678901234567890
*             MODEL Plot Plan  Emitting   PCB in    Weight
* ISC         1=LIQ     Area      Area     Solid   Fraction
* SOURCEID TYP 2=SLD     m2        m2       ppm     Solids
* Rectangular Area Sources
  HOPPER      1    1     37.16     37.16      77.2   0.64942
  DBRIPILE    1    1    195.10   1950.96      77.2   0.64942
  SLURYTNK    1    1     46.45     46.45      82.1   0.24965
  VIBSCREN    1    1      5.57      5.57      30.4   0.68360
  OVSZBIN1    1    1   3716.12   3716.12      27.8   0.90028
  CORSBIN1    1    1   3716.12   3716.12      22.8   0.84985
  CORSBIN2    1    1   3716.12   3716.12      22.8   0.84985
  FLTRBIN1    1    1   3716.12   3716.12     310.0   0.54962
  FLTRBIN2    1    1   3716.12   3716.12     310.0   0.54962
* Circular Area Sources
  OVSZPILE    2    1     45.60     58.40      27.8   0.90028
  CORSPILE    2    1    308.28    361.98      22.8   0.84985
  CYCOFWEL    2    1     16.42     16.42     310.0   0.06291
  SLRHOLD1    2    1    357.53    357.53     310.0   0.06271
  SLRHOLD2    2    1    357.53    357.53     310.0   0.06271
  THIKENR1    2    1    262.68    262.68     310.0   0.06271
  THIKENR2    2    1    262.68    262.68     310.0   0.06271
  RCYCWELL    2    1      7.30      7.30     278.0   0.00087
  RCYCEQLZ    2    1    882.89    882.89     278.0   0.00087
* Volume   Sources
  BLTFEDER    3    1     33.45     33.45      77.2   0.64942
  OVSZCVYR    3    1     26.01     26.01      27.8   0.90028
  CORSCVYR    3    1     33.45     33.45      22.8   0.84985
  DWTRTNKS    3    1     18.68     18.68     310.0   0.14898
  FILTRBOX    3    1     98.11     98.11     310.0   0.54962
  PWEQLZTK    3    1     45.60     45.60     162.0   0.00149
  PWFLOCTK    3    1     20.07     20.07     162.0   0.00148
  PWCLARIF    3    1     58.37     58.37     162.0   0.00148
  PWCLREFF    3    1     14.59     14.59     257.0   0.00010
```

Attachment 4:
PCB Homolog Physical Properties Input Data File

```
*        1         2         3         4         5         6         7         8
*2345678901234567890123456789012345678901234567890123456789012345678901234567890
*                                   Molar     Henry Law Coeff      Kow    <- Koc ->
* Cng  No.                 MW      Volume    at Std  -d(lnH)/           Y
* No.   Cl  ISC Name      g/mol   cm3/mol     Temp    d(1/T)      mL/g  N  mL/g
    1    1  2MONO        188.66    191.78   7.36E-4    7272.7   2.88E+4 1 3.80E+4
    4    2  2-2DI        223.10    211.75   2.29E-4    7616.5   4.47E+4 1 4.17E+4
   16    3  Cl3-AVG      257.55    224.25   1.99E-4    8547.8   1.86E+5 1 1.86E+5
   40    4  Cl4-AVG      291.99    242.84   1.40E-4    9126.0   4.45E+5 1 4.45E+5
   82    5  Cl5-AVG      326.44    254.97   6.88E-5    9376.0   1.45E+6 1 1.45E+6
  128    6  Cl6-AVG      360.88    267.68   2.77E-5   10114.6   2.83E+6 1 2.83E+6
```

TABLES

Table I-1: Average Mass Fraction Homologs as a Function of Total PCB Concentration

PCB in Solids, ppm	Mass Fraction of PCBs for Number of Chlorine Atoms per Molecule					
	1 (Mono)	2 (Di)	3 (Tri)	4 (Tetra)	5 (Penta)	6 (Hexa)
<10	0.12781	0.34215	0.34454	0.15371	0.02165	0.00470
10 to 50	0.15015	0.35941	0.30044	0.15554	0.02826	0.00563
50 to 100	0.18243	0.38679	0.26914	0.13101	0.02399	0.00580
100 to 200	0.24333	0.41662	0.22396	0.09863	0.01423	0.00267
200 to 300	0.30783	0.42728	0.18200	0.06989	0.01061	0.00207
300 to 400	0.32142	0.43067	0.16855	0.06574	0.01131	0.00180
400 to 500	0.37061	0.41670	0.14483	0.06102	0.00896	0.00076
>500	0.35816	0.43276	0.14072	0.05522	0.01070	0.00205

Table I-2: Source Description

Source ID	$g/s/m^2$	Height (m)	Length (m)	Width (m)		PCB in Solid, ppm	Solid or Slurry	Source Description
Rectangular Area Sources								
HOPPER	1.00	10.668	6.096	6.096		77.2	Slurry	Hopper
DBRIPILE	1.00	3.048	9.700	8.920		77.2	Slurry	Debris Pile
SLURYTNK	1.00	3.048	7.620	6.096		82.1	Slurry	Sediment Slurry Tank
VIBSCREN	1.00	3.048	3.658	1.524		30.1	Slurry	Vibrating Screens
OVSZBIN1	1.00	4.572	121.920	30.480		27.8	Solid	Oversize Solids (>3/8") Staging Bin
CORSBIN1	1.00	4.572	121.920	30.480		22.8	Solid	Coarse Solids (75mm-3/8") Staging Bins
CORSBIN2	1.00	4.572	121.920	30.480		22.8	Solid	Coarse Solids (75mm-3/8") Staging Bins
FLTRBIN1	1.00	4.572	121.920	30.480		310.0	Solid	Filter Cake Staging Bins
FLTRBIN2	1.00	4.572	121.920	30.480		310.0	Solid	Filter Cake Staging Bins
Circular Area Sources								
Source ID	**$g/s/m^2$**	**Height (m)**	**Radius (m)**	**Nverts**	**Sigma Z (m)**	**PCB in Solid, ppm**	**Solid or Slurry**	**Source Description**
OVSZPILE	1.00	1.016	3.81	20	1.101	27.8	Solid	Oversize (3/8-6") Solids Pile
CORSPILE	1.00	2.032	9.906	20	2.201	22.8	Solid	Coarse (75 mm - 3/8") Solids Pile
CYCOFWL1	1.00	3.048	2.286			310.0	Slurry	Hydrocyclone Overflow Wet Well
CYCOFWL2	1.00	3.048	2.286			310.0	Slurry	Hydrocyclone Overflow Wet Well
SLRHOLD1	1.00	7.925	10.668			310.0	Slurry	Dredge Slurry Holding Tanks
SLRHOLD2	1.00	7.925	3.810			310.0	Slurry	Dredge Slurry Holding Tanks
THIKENR1	1.00	6.096	9.906			310.0	Slurry	Gravity Thickeners
THIKENR2	1.00	6.096	9.144			310.0	Slurry	Gravity Thickeners
RCYCWELL	1.00	1.000	1.524			278.0	Water	Recycle Collection Wet Well
RCYCEQLZ	1.00	7.315	16.764			278.0	Water	Recycle Water Equalization Tank

(Table I-2 cont.)							
Source ID	**g/s**	**Height, m**	**Sigma Y, m**	**Sigma Z, m**	**PCB in Solid, ppm**	**Solid or Slurry**	**Source Description**
Volume Sources							
BLTFEDER	1.00	2.500	6.380	2.326	77.2	Solid	Belt Feeder / Inclined Conveyor
OVSZCVYR	1.00	2.500	4.962	2.326	27.8	Solid	Oversize (3/8-6") Solids Conveyor
CORSCVYR	1.00	2.500	6.380	2.326	22.8	Solid	Coarse (75 mm - 3/8") Solids Conveyor
DWTRTNKS	1.00	4.572	17.012	4.253	310.0	Slurry	Dewatering Conditioning Tanks
FILTRBOX	1.00	4.572	17.012	4.253	310.0	Solid	Filter Cake Rollout Boxes
PWEQLZTK	1.00	3.810	12.759	3.544	162.0	Water	Process Water Equalization Tank
PWFLOCTK	1.00	3.810	12.759	3.544	162.0	Water	Process Water Flocculation Tank
PWCLARIF	1.00	3.810	12.759	3.544	162.0	Water	Process Water Clarifier
PWCLREFF	1.00	3.810	12.759	3.544	257.0	Water	PW Clarifier Effluent Tank

Table I-3: Comparison Between the "Equilibrium Model for Final Design" and the EPA "Responsiveness Summary"

SUBJECT	EPA	Basis for Final Design	Difference
PCB Releases to the Air			
Average Sediment PCB Concentrations (mg/kg) Barges at Dredging Barges at Locks Barge at Docks Processing Facility	 31.2 31.2 31.2 31.2	 0.3 to 1081 (by SRU) 77.2 77.2 77.2 to 335*	 max 24-hr based on >400 2.5 times higher 2.5 times higher max factor of 10 higher
Organic Fraction (%)	4	3	1/3 higher emissions
Partition Coefficient (mL/g)	530,000	224,000 to 2,830,066	much higher mono and di emissions
Henry's Law Constant @25ºC ATM/mol/m^3	0.00025	0.000736-0.0000277 (by homolog)	3 times higher for mono
Barge Size	6,000 ft^2	4,900 ft^2	18.5% lower
Processing Facility Total Area	39,900 ft^2	450,000 ft^2	order of magnitude higher
Processing Facility Throughput (nominal cy/day)	3,000	4,300	43% higher than EPA value
Temperature for Evaporation (º C)	18º C (barges) 30º C** (processing) 25º C (river)	13-26º C (water barges) 10-30º C (air processing) 13-26º C (river water)	lower emission rates
Total Processing Area Evaporation Loss (kg)	23.2	45 (controlled 14.3)	double EPA's
Emission Rates (mg/m^2/day)	2.02 (barges) 2.82 (processing) 2.49 (river)	12.4 (max 144.4) 13.7 (max 27.9) 0.00044(max0.132)	(varies by sediment concentrations, temperature and congener)
Residential Locations (m)	300 (processing) 50 (dredging)	15.7(processing) 11.7(dredging)	(actual distances)

Table I-4: Dredging Operations Emission Sources

Source	Engine horsepower	Hour of Operation	Timing Issues Uptime/day	Days	Fuel Usage gal/hr	Height (m)	Temperature (K)	Exit Velocity (m/s)	Stack Diameter (m)
Dredging Excavator PC 750*	454	24/day	70% uptime	85.5					
Dredging Excavator PC 1100	611	24/day	70% uptime	75	135	3.00	394.26	6.10	0.914
Dredging Welding	20	24/day	10% uptime	160	3.63	3.00	394.26	6.10	0.914
Dredged Material Transport Concrete Pump	562	24/day	50% uptime	28	101.88	3.00	394.26	6.10	0.914
Pumps	76	24/day	25% uptime	160	13.78	3.00	394.26	6.10	0.914
Lighting Towers	15	24/day	50% uptime	160	2.72	3.00	394.26	6.10	0.914
Crew Boat	300	24/day	70% uptime	160	135	3.00	394.26	6.10	0.914
Dredging Tender Tug	200	24/day	40% uptime	81.7	135	6.00	394.26	6.10	0.914
Dredging Push Tug	1000	24/day	50% uptime	89	135	6.00	394.26	6.10	0.914

Note:
* Larger excavator used for emissions determination

Table I-5: Construction Emission Source List

Equipment	Number	Hours Per Day	Miles	Horse-power (hp)	Acres
Scraper, Caterpillar 623 (1 engine)	2	10	--	--	--
Roller, Caterpillar CS-433C	2	10	--	--	--
Grader, Caterpillar 14G	1	10	--	--	--
Loader, Caterpillar 936F	2	10	--	--	--
Backhoe, Caterpillar 436B	2	10	--	--	--
Dozer, Caterpillar D8	2	10	--	--	--
Truck, bottom dump	8	10	--	300	--
Paver, Assphalt, Caterpillar AP-800C	1	10	--	130	--
Water Truck, 10 Wheel, 2000 gal	1	10	--	300	--
Excavator, Caterpillar 330 (Barge Slip excavation)	1	10	--	247	--
Employee Vehicle	30	10	2	--	--
Fugitive Dust from Construction activity(1	--	10	--	--	3.4

Note:
1) Based on “rough grading”

Table I-6: Processing Facility Emission Sources

	Number	Engine horsepower	Hour of Operation	Timing Issues		Days		
Point Sources								
Emergency Generator	waterfront	300	16 hours/day	500 hours/year				
Emergency Generator	retention	200	16 hours/day	500 hours/year				
Emergency Generator	lift	750	16 hours/day	500 hours/year				
Emergency Generator	strm water	250	16 hours/day	500 hours/year				
Clam Shell	1	150	16 hours/day	335cy/hour		227		
Front end Loaders	10	475	16 hours/day	continuous		227		
Transport Roll-offs	3	410	16 hours/day	8 dumps/day/press(12)		227		
Other Trucks	6	500	16 hours/day	continuous		227		
Switcher	1	Tier 0	8 hour/day	continuous		227		
Personal Vehicles	50							
Fugitive Dust Sources		Emission Area **x meters**	Emission Area **y meters**	Dry Tons/Day S-Ave	Days	moisture%	%<400mic	Drop Height meters
Drops								
Remove from Barge	6	9.2	44.2	3,717	227	44.8	34.1	3
Coarse Pile	2	30.5	Dia	2,224	227	15	1.4	4.57
Place Coarse in Storage	1	18.2	411.5	2,224	227	10	1.4	3
Coarse Storage	2	30.5	121.9	2,224	227	10	1.4	4.57
Remove roll-out boxes	1	22.8	182.8	1,176	227	45	96.9	1
Fines Storage	2	30.5	121.9	1,466	227	45	80.4	4.57
Place Debris Storage	1	18.2	457.2	290	227	10	1.4	4.57
Load Coarse into Railcar	1	83.8	204.8	2,224	227	10	1.4	3
Load Fine into Railcar	1	83.8	204.8	1,466	227	45	80.4	3
Load Debris into Railcar	1	42.6	204.8	290	227	10	1.4	3
Paved Roads	**~distance (feet)**							
Remove Coarse	1000'	60	-	2,224	227	10	4.6	
Place Fines in Storage	300'	60	-	1,176	227	45	96.3	
Debris into Storage	1000'	60	-	30	227	45	4.6	
Load Coarse into Railcar	672'	75	-	2,224	227	10	4.6	
Load Fine into Railcar	672'	75	-	1,466	227	45	96.3	
Load Debris into Railcar	672'	75	-	290	227	10	4.6	
Piles								Height (m)
Coarse Pile (meters)	1	30.5	diameter	2,224	227	15	4.6	4.57
Coarse Storage	2	30.5	121.9	2,224	227	10	4.6	4.57
Fines Storage	2	30.5	121.9	1,466	227	45	96.3	4.57
Debris Pile	1	30.5	121.9	290	227	10	4.6	4.57

Table I-7: Dredging Location Emission Rate

Source List	Emission Factors					Emission Rates				
	NO_x	VOC	PM_{10}	SO_2	CO	NO_x	VOC	PM_{10}	SO_2	CO
	lb/gal/hp	lb/gal/hp	lb/gal/hp	lb/gal/hp	lb/gal/hp	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr
Dredging Excavator PC 1100	0.00029	0.000018	0.000016	0.0000785	0.000071	23.921	1.485	1.320	6.475	5.856
Dredging Welding	0.00029	0.000018	0.000016	0.0000785	0.000071	0.021	0.001	0.001	0.006	0.005
Dredged Material Transport Concrete Pump	0.00029	0.000018	0.000016	0.0000785	0.000071	16.604	1.031	0.916	4.495	4.065
Pumps	0.00029	0.000018	0.000016	0.0000785	0.000071	0.304	0.019	0.017	0.082	0.074
Lighting Towers	0.00029	0.000018	0.000016	0.0000785	0.000071	0.012	0.001	0.001	0.003	0.003
Crew Boat	0.00029	0.000018	0.000016	0.0000785	0.000071	11.745	0.729	0.648	3.179	2.876
Dredging Tender Tug	0.00029	0.000018	0.000016	0.0000785	0.000071	7.830	0.486	0.432	2.120	1.917
Dredging Push Tug	0.00029	0.000018	0.000016	0.0000785	0.000071	39.150	2.430	2.160	10.598	9.585

Note:
1) Emission factors for tugboat engine are taken from VCAPCD (1994).

Table I-8: Processing Facility Construction Emissions

	EMISSION FACTORS					EMISSION RATES				
Equipment	**NO_x**	**VOC**	**PM_{10}**	**SO_x**	**CO**	**NOx**	**VOC**	**PM10**	**SOx**	**CO**
						lbs/day	lbs/day	lbs/day	lbs/day	lbs/day
Scraper, Caterpillar 623 (1 engine)	5.05 (lb/hr)	0.10 (lb/hr)	0.170 (lb/hr)	0.127 (lb/hr)	0.70 (lb/hr)	101.016	1.940	3.395	2.535	13.977
Roller, Caterpillar CS-433C	2.83 (lb/hr)	0.17 (lb/hr)	0.022 (lb/hr)	0.044 (lb/hr)	0.24 (lb/hr)	56.580	3.351	0.441	0.882	4.868
Grader, Caterpillar 14G	3.08 (lb/hr)	0.14 (lb/hr)	0.037 (lb/hr)	0.074 (lb/hr)	0.10 (lb/hr)	30.777	1.411	0.375	0.744	1.014
Loader, Caterpillar 936F	2.27 (lb/hr)	0.06 (lb/hr)	0.033 (lb/hr)	0.053 (lb/hr)	0.17 (lb/hr)	45.460	1.146	0.661	1.069	3.395
Backhoe, Caterpillar 436B	1.06 (lb/hr)	0.19 (lb/hr)	0.030 (lb/hr)	0.044 (lb/hr)	0.38 (lb/hr)	21.192	3.784	0.605	0.882	7.563
Dozer, Caterpillar D8	3.47 (lb/hr)	0.16 (lb/hr)	0.09 (lb/hr)	0.13 (lb/hr)	0.26 (lb/hr)	69.420	3.175	1.896	2.502	5.291
Truck, bottom-dump (7)	0.011 (lb/hp-hr)	0.002 (lb/hp-hr)	0.00033 (lb/hp-hr)	0.00037 (lb/hp-hr)	0.006 (lb/hp-hr)	259.265	52.911	7.937	8.929	144.000
Paver, asphalt, Caterpillar AP-800C (6)	0.011 (lb/hp-hr)	0.0022 (lb/hp-hr)	0.00033 (lb/hp-hr)	0.00037 (lb/hp-hr)	0.0070 (lb/hp-hr)	14.044	2.866	0.430	0.484	9.100
Water Truck, 10-Wheel, 2000 gal. (7)	0.011 (lb/hp-hr)	0.002 (lb/hp-hr)	0.00033 (lb/hp-hr)	0.00037 (lb/hp-hr)	0.006 (lb/hp-hr)	32.408	6.614	0.992	1.116	18.000
Excavator, Caterpillar 330 (Barge Slip excavation) (5)	0.011 (lb/hp-hr)	0.002 (lb/hp-hr)	0.00033 (lb/hp-hr)	0.00037 (lb/hp-hr)	0.011 (lb/hp-hr)	26.683	5.445	0.817	0.919	27.170
Employee Vehicle	0.0009 (lb/mi)	0.0004 (lb/mi)	0 (lb/mi)	0.00001 (lb/mi)	0.010 (lb/mi)	0.056	0.025	0.002	0.001	0.589
Fugitive dust from construction activity (3,4)	--	--	20 (lbs/ac/day)	--	--	0	0	70	0	0
Totals:						**656.90**	**82.67**	**87.55**	**20.06**	**234.97**

1) Emission factors are from Caterpillar Corporation, ARB 2001 standards, and 1993 SCAQMD CEQA Air Quality Handbook Table A9-8-B.

3) Uncontrolled emission factor for fugitive dust from construction activity is based on 1.2 tons TSP per acre per month, of which 50% is PM10, taken from USEPA (1995).

4) Unpaved area control efficiency set at 50%, based on watering. Hence, controlled emission factor for fugitive dust from construction

5) Horsepower value (247 hp) from Caterpillar website (http://www.cat.com/) for "Excavator 330C L"

6) Horsepower value (130 hp) from Caterpillar website (http://www.cat.com/) for "Asphault Paver (AP-800D)"

7) Assumed horsepower value of 300 hp

Table I-9: Processing Facility Emission Rates

	EMISSION FACTOR							EMISSION RATE					
	NOx	VOC	PM10	SO_2	CO	PM2.5		NOx	VOC	PM10	SO_2	CO	PM2.5
	lb/gal/hp**	lb/gal/hp	lb/gal/hp	lb/gal/hp	lb/gal/hp			lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr
Point Sources													
Emergency Generator	0.031	0.00251	0.0022	0.00205	0.00668			0.496	0.04016	0.0352	0.0328	0.10688	0.0352
Emergency Generator	0.031	0.00251	0.0022	0.00205	0.00668			0.496	0.04016	0.0352	0.0328	0.10688	0.0352
Emergency Generator	0.031	0.00251	0.0022	0.00205	0.00668			0.496	0.04016	0.0352	0.0328	0.10688	0.0352
Emergency Generator	0.031	0.00251	0.0022	0.00205	0.00668			0.496	0.04016	0.0352	0.0328	0.10688	0.0352
Clam Shell	2.65	0.1	0.1	351	1.47			14.00881	0.528634	0.528634	18.55507	7.770925	0.528634
Front end Loaders	2.65	0.1	0.1	351	1.47			443.6123	16.74009	16.74009	18.55507	246.0793	16.74009
Transport Roll-offs	2.65	0.1	0.1	351	1.47			0.280176	0.010573	0.010573	18.55507	0.155419	0.010573
Other Trucks	0.011	0.002	0.00033	0.00037	0.006			1.056	0.192	0.03168	0.03552	0.576	0.03168
Switcher	14	2.1	0.72		8			167.4009	17.62115	10.57269		88.10573	10.57269
Personal Vehicles	290	18	16	78.5	71			123.348	18.5022	6.343612		70.48458	6.343612
							total	751.6902	53.75528	34.36807	55.83192	413.5995	34.36807

Fugitive Dust Sources	PM10	PM2.5	PM10	PM2.5
Drops	lb/ton	lb/ton		
Remove from Barge	2.908E-05	9.14E-06	0.108085	0.033969
Coarse Pile	7.036E-05	2.21E-05	0.156463	0.049174
Place Coarse in Storage	0.0001241	3.9E-05	0.27602	0.086749
Coarse Storage	0.0001241	3.9E-05	0.27602	0.086749
Remove roll-out boxes	1.511E-05	4.75E-06	0.017779	0.005588
Fines Storage	1.511E-05	4.75E-06	0.02216	0.006965
Place Debris Storage	0.0001241	3.9E-05	0.035997	0.011313
Load Coarse into Railcar	0.0001241	3.9E-05	0.27602	0.086749
Load Fine into Railcar	1.511E-05	4.75E-06	0.02216	0.006965
Load Debris into Railcar	0.0001241	3.9E-05	0.035997	0.011313
Paved Roads				
Remove Coarse	0.7906238 lbs/VMT	0.197461 lbs/VMT	41.62754	10.3966
Place Fines in Storage	0.7906238 lbs/VMT	0.197461 lbs/VMT	9.219277	2.302541
Debris into Storage	0.7906238 lbs/VMT	0.197461 lbs/VMT	16.6031	4.146673
Load Coarse into Railcar	0.7906238 lbs/VMT	0.197461 lbs/VMT	27.96946	6.985453
Load Fine into Railcar	0.7906238 lbs/VMT	0.197461 lbs/VMT	21.63991	5.404631
Load Debris into Railcar	0.7906238 lbs/VMT	0.197461 lbs/VMT	11.30772	2.824136
Piles				
Coarse Pile (meters)	0	0	0	0
Coarse Storage	0	0	0	0
Fines Storage	0	0	0	0
Debris Pile	0	0	0	0

Table I-10: Data Capture Summary for Glens Falls

Year	% Data Capture by Quarter 1st	2nd	3rd	4th	% Annual Data Capture	Quarters with Valid Data Capture 1st	2nd	3rd	4th	Years Selected
1973	96.3	96.7	96.2	91.4	95.1	**1**	**1**	**1**	**1**	
1974	96.7	95.5	95.9	95.7	96.0	**1**	**1**	**1**	**1**	
1975	94.9	89.8	95.4	94.7	93.7	1	0	1	1	
1976	96.5	97.1	95.3	97.0	96.5	1	1	1	1	
1977	98.0	97.6	97.7	97.8	97.8	1	1	1	1	
1978	97.5	96.0	95.7	94.8	96.0	1	1	1	1	
1979	96.3	97.7	95.0	94.8	95.9	1	1	1	1	
1980	96.4	95.5	95.7	96.1	95.9	1	1	1	1	
1981	97.4	96.9	94.6	95.2	96.0	1	1	1	1	
1982	94.9	89.1	70.9	93.2	87.0	1	0	0	1	
1983	94.2	93.1	92.8	89.2	92.3	1	1	1	0	
1984	92.2	91.9	93.4	91.5	92.3	1	1	1	1	
1985	92.0	92.6	93.3	92.0	92.5	1	1	1	1	
1986	94.2	92.6	90.4	90.9	92.0	1	1	1	1	
1987	91.5	88.2	94.1	96.3	92.5	1	0	1	1	
1988	97.9	97.4	94.2	96.7	96.6	1	1	1	1	
1989	96.4	87.5	70.0	85.3	84.7	1	0	0	0	
1990	95.7	95.9	95.2	95.3	95.5	1	1	1	1	
1991	94.7	94.7	95.7	94.7	95.0	1	1	1	1	
1992	95.1	93.4	95.3	96.6	95.1	1	1	1	1	
1993	95.7	95.3	96.6	93.9	95.4	1	1	1	1	
1994	91.6	94.4	95.5	88.0	92.4	1	1	1	0	
1995	86.1	93.1	83.7	91.8	88.7	0	1	0	1	
1996	94.0	93.6	35.9	93.2	79.1	1	1	0	1	
1997	92.9	94.1	94.9	93.3	93.8	1	1	1	1	yes
1998	90.5	95.0	93.5	92.7	92.9	1	1	1	1	yes
1999	91.0	93.4	93.4	91.5	92.3	1	1	1	1	yes
2000	92.2	95.8	94.5	94.3	94.2	1	1	1	1	yes
2001	95.2	75.7	63.1	62.1	73.9	1	0	0	0	
2002	88.3	97.5	95.5	97.3	94.7	0	1	1	1	yes
2003	85.9	95.2	92.0	88.2	90.4	0	1	1	0	
2004	93.8	96.6	95.7	91.9	94.5	1	1	1	1	

*Data capture means the simultaneous availability of wind speed, wind direction, temperature and cloud cover

Table I-11
Hudson River - - NAAQS Analysis

Impacts (µg/m³) from Dredging at One Location						
Pollutant:	PM_{10}	SO_2		CO		$PM_{2.5}$
High:	2nd	2nd	2nd	2nd	2nd	2nd
Avg Period:	24-Hour	3-Hour	24-Hour	1-Hour	8-Hour	24-Hour
Year / Standard	150	1300	365	40,000	10,000	65
1997	29.0	444.7	142.2	566.2	244.0	29.0
1998	29.5	335.1	144.7	585.8	211.2	29.5
1999	35.3	395.8	172.8	633.5	284.0	35.3
2000	28.8	447.3	141.0	572.2	253.1	28.8
2002	29.7	378.3	145.8	550.5	253.7	29.7
Max:	35.3	447.3	172.8	633.5	284.0	35.3
background	44.0	31.0	15.0	7429.0	4888.0	
max+back	79.3	478.3	187.8	8062.5	5172.0	
% NAAQS:	52.8%	36.8%	51.5%	20.2%	51.7%	54.3%

Note:
Equipment assumed to operate 24 hours per day in stationary location.

Table I-12
Hudson River - - NAAQS Analysis

Impacts ($\mu g/m^3$) from Dredging Simultaneously at Two Locations						
Pollutant:	PM_{10}	SO_2		CO		$PM_{2.5}$
High:	2nd	2nd	2nd	2nd	2nd	2nd
Avg Period:	24-Hour	3-Hour	24-Hour	1-Hour	8-Hour	24-Hour
Year / Standard	150	1300	365	40,000	10,000	65
1997	53.3	703.8	261.0	920.4	416.8	53.3
1998	52.3	587.2	256.4	828.8	421.2	52.3
1999	61.9	661.7	303.5	872.0	470.1	61.9
2000	51.0	612.2	250.1	911.3	436.4	51.0
2002	51.0	627.7	249.9	851.8	434.7	51.0
Max:	61.9	703.8	303.5	920.4	470.1	61.9
background	44.0	31.0	15.0	7429.0	4888.0	
max+back	105.9	734.8	318.5	8349.4	5358.1	
% NAAQS:	70.6%	56.5%	87.3%	20.9%	53.6%	95.3%

Note:
Equipment assumed to operate 24 hours per day in two stationary locations.

Table I-13
Hudson River - - NAAQS Analysis

Impacts (µg/m³) from Construction Equipment and Fugitive Dust										
Pollutant:	NO_x	PM_{10}		SO_2			CO		$PM_{2.5}$	
High:	1st	2nd	1st	2nd	2nd	1st	2nd	2nd	2nd	1st
Avg Period:	Annual*	24-Hour	Annual*	3-Hour	24-Hour	Annual*	1-Hour	8-Hour	24-Hour	Annual*
Year / Standard	100	150	50	1300	365	80	40,000	10,000	65	15
1997	33.8	58.2	4.5	216.5	13.3	1.032	6777.8	1112.3	29.1	2.3
1998	44.1	78.7	5.9	62.8	18.0	1.344	1485.7	498.7	39.4	2.9
1999	36.7	63.4	4.9	68.1	14.5	1.120	1668.6	419.3	31.7	2.5
2000	42.1	62.5	5.6	82.7	14.3	1.284	1516.2	434.0	31.3	2.8
2002	32.2	59.4	4.3	66.7	13.6	0.983	1666.1	388.2	29.7	2.2
Max:	44.1	78.7	5.9	216.5	18.0	1.3	6777.8	1112.3	39.4	2.9
background	30.0	44.0	18.0	31.0	15.0	3.0	7429.0	4888.0		
max+back	74.1	122.7	23.9	247.5	33.0	4.3	14206.8	6000.3		
% NAAQS:	74.1%	81.8%	47.8%	19.0%	9.0%	5.4%	35.5%	60.0%	60.6%	19.6%

Notes:
* Annual impacts based on average impact for period of May 1 to Sept 22 multiplied by: 145 days/365 days.
Equipment operates 10 hours per day (7:00 am to 5:00 pm).
Fugitive dust occurs 10 hours per day.

Table I-14
Hudson River - - NAAQS Analysis

Impacts (µg/m³) from Processing Area Equipment, Fugitive Dust, and Tug										
Pollutant:	NO_x	PM_{10}		SO_2			CO		$PM_{2.5}$	
High:	1st	2nd	1st	2nd	2nd	1st	2nd	2nd	2nd	1st
Avg Period:	Annual*	24-Hour	Annual*	3-Hour	24-Hour	Annual*	1-Hour	8-Hour	24-Hour	Annual*
Year / Standard	100	150	50	1300	365	80	40,000	10,000	65	15
1997	35.1	84.8	19.9	175.5	57.4	7.8	752.5	213.6	23.1	5.5
1998	35.0	78.7	20.0	151.6	55.9	7.4	728.0	221.6	22.5	5.5
1999	39.4	77.2	21.7	150.1	70.2	8.8	793.4	197.5	22.1	6.0
2000	34.6	74.9	20.0	173.4	62.5	8.1	794.9	221.9	20.2	5.4
2002	37.2	84.4	21.0	179.4	59.3	8.5	666.2	208.6	23.2	5.9
Max:	39.4	84.8	21.7	179.4	70.2	8.8	794.9	221.9	23.2	6.0
background	30.0	44.0	18.0	31.0	15.0	3.0	7429.0	4888.0		
max+back	69.4	128.8	39.7	210.4	85.2	11.8	8223.9	5109.9		
% NAAQS:	69.4%	85.9%	79.3%	16.2%	23.4%	14.8%	20.6%	51.1%	35.8%	39.8%

Notes:
Annual impacts based on average impact for period of May 1 to Oct 31 multiplied by: 184 days/365 days.
Switch operates 8 hours per day.
All other equipment operates 16 hours per day (including fugitive dust).

FIGURES

Figure I-1: River Cells Near Roger's Island

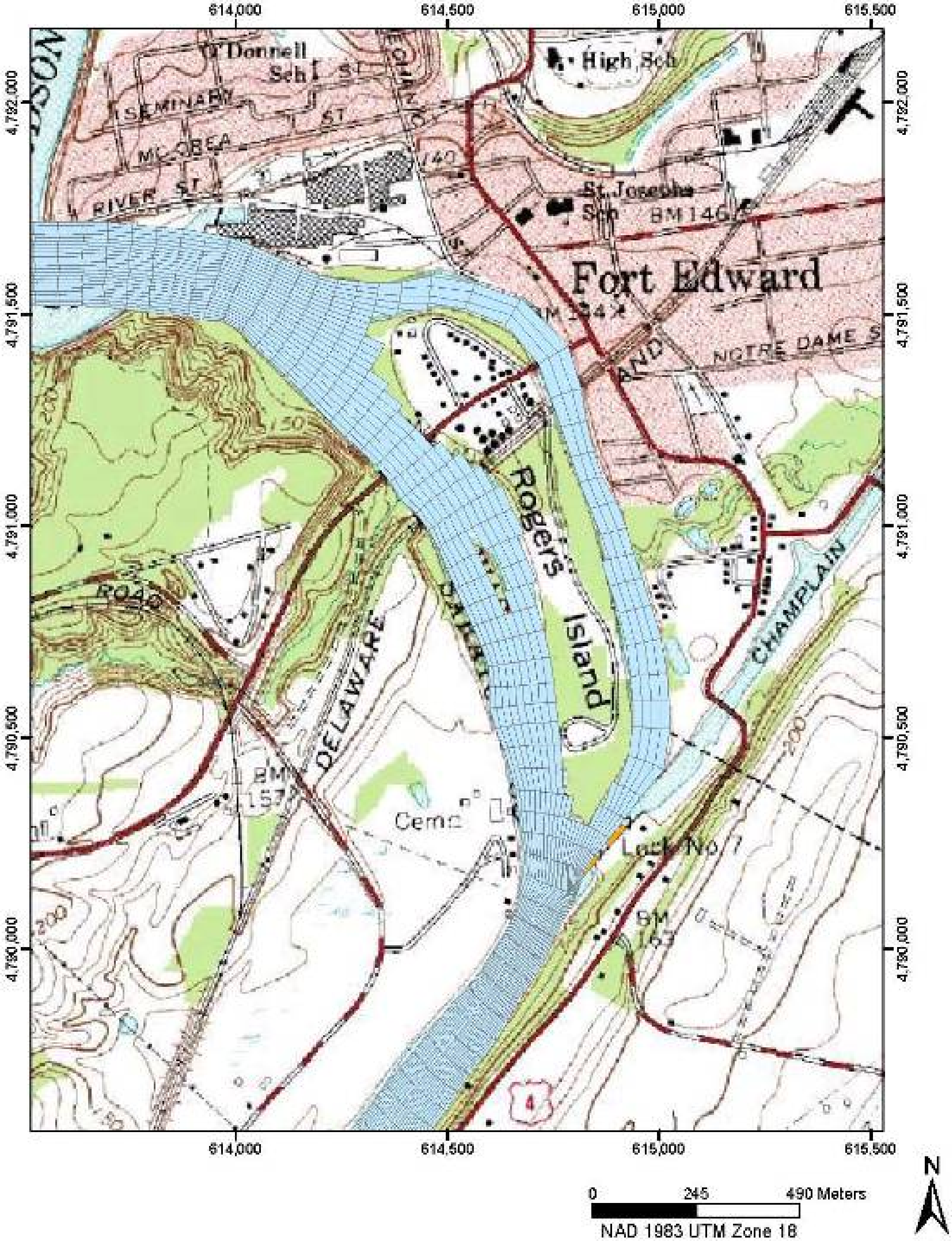
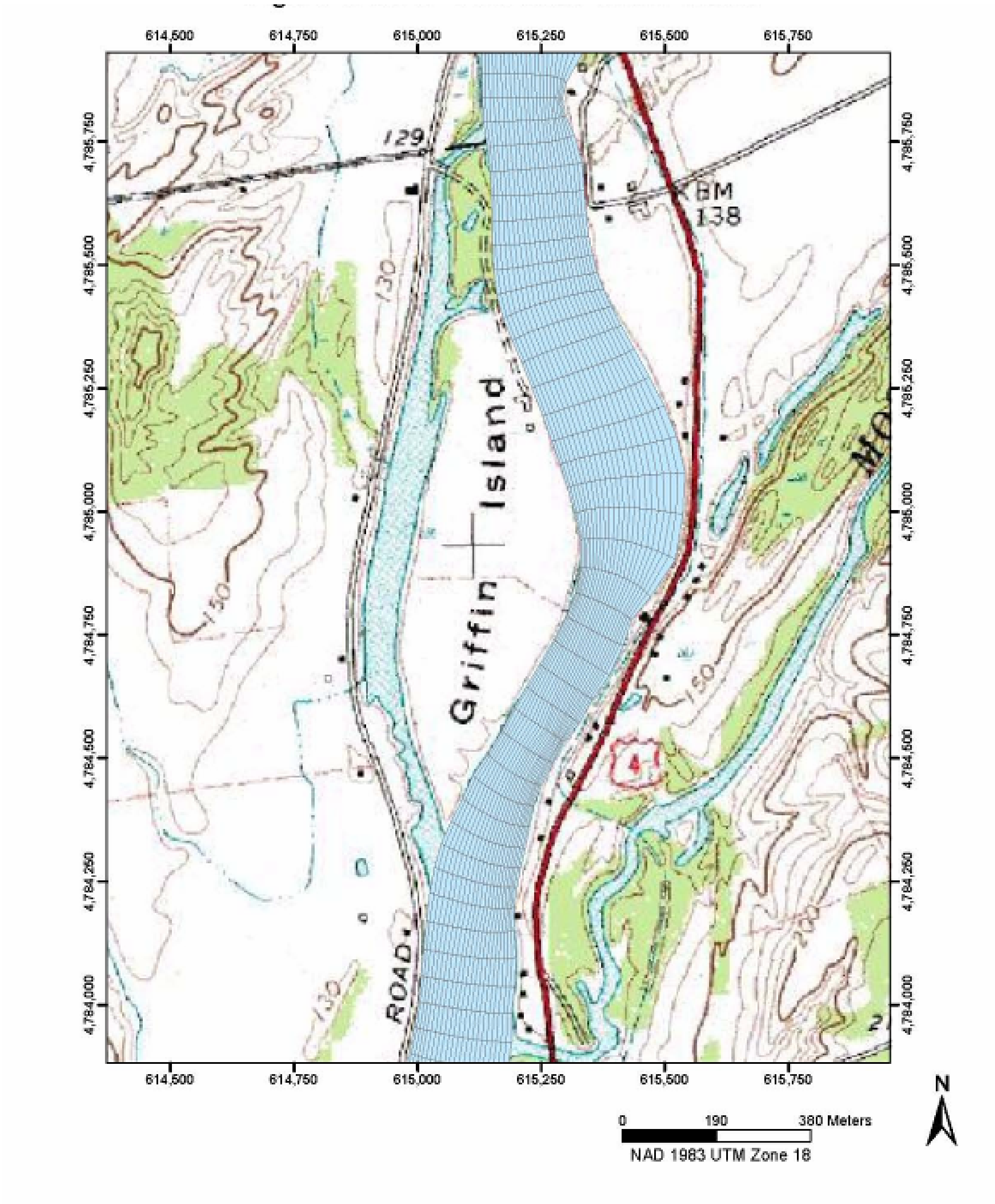
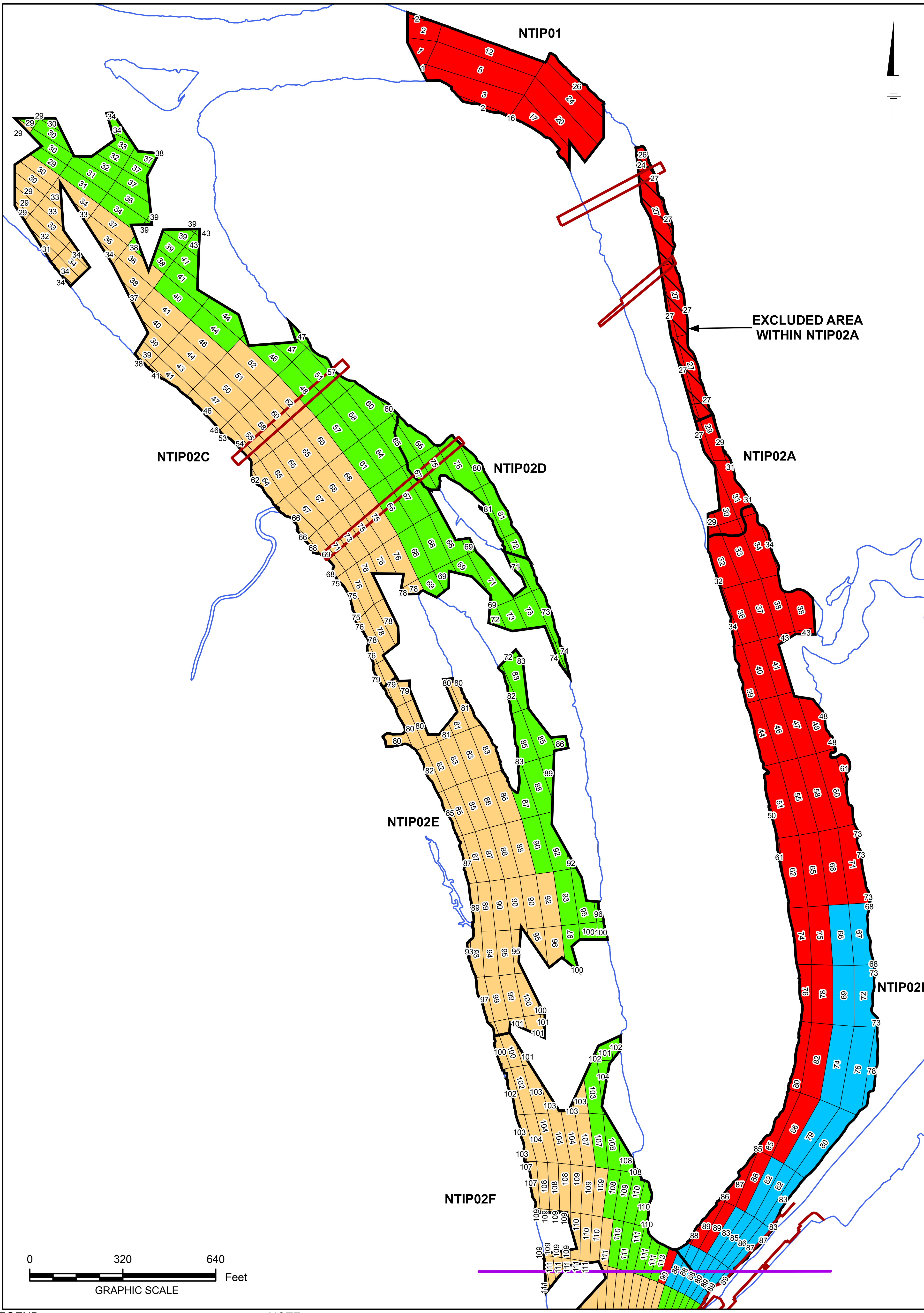


Figure I-2: River Cells Near Griffin Island





LEGEND:

- EXISTING STRUCTURE
- DREDGE AREAS
- SHORELINE
- 15 APPROXIMATE DREDGE DAY

DREDGE ID

- DREDGE 1
- DREDGE 2
- DREDGE 3
- DREDGE 4

NOTE:

1. DREDGE AREAS BASED ON FEBRUARY 28TH PHASE 1 DAD REPORT.
2. GRID CELLS FROM QEA RESUSPENSION MODELING (ATTACHMENT E) WITH MODIFICATIONS BY BBL.
3. SHORELINE AND SHORELINE STRUCTURES BASED ON AERIAL MAPPING PERFORMED BY CHAS H. SELLS, INC IN THE SPRING OF 2002.
4. THE DREDGE PLAN FROM THE INTERMEDIATE DESIGN WAS BASIS OF THE AIR ASSESSMENT. MODIFICATIONS TO THE DREDGE PLAN HAVE BEEN MINOR AND WILL NOT AFFECT THE RESULTS OF THE MODELING.

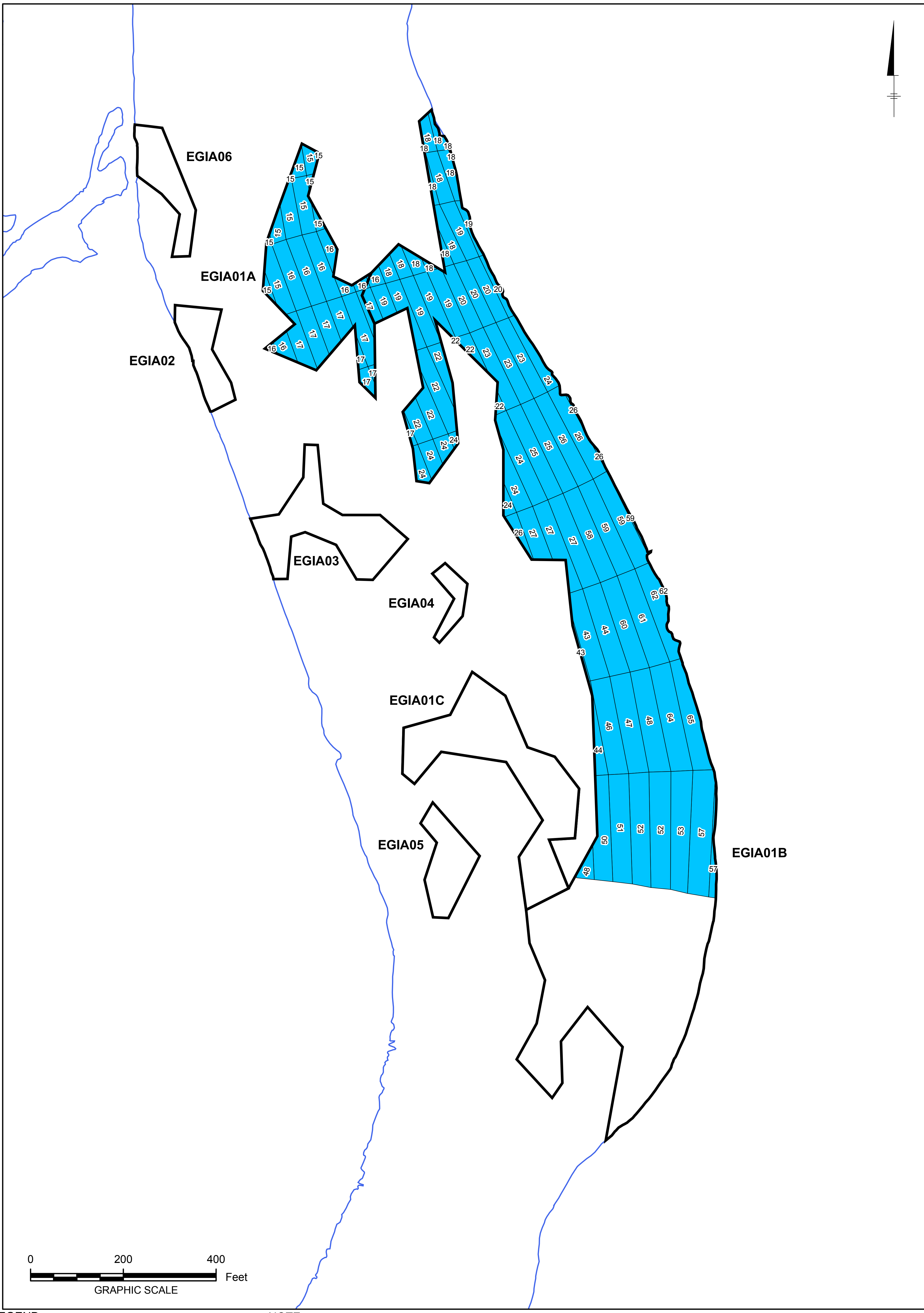
3/17/06 SYR-85 MTK KEW MTK
GE Hudson
G:\GE_GIS\GE-HudsonRiver\Phase1FDR\NoiseAnalysis\mxd\BBL_DredgeCellsbyDredgeDate-NTIPNorth.mxd

GENERAL ELECTRIC COMPANY
HUDSON RIVER PCBs SUPERFUND SITE
PHASE 1 FINAL DESIGN REPORT

BARGE LOCATIONS NEAR ROGERS ISLAND

BBL®
BLASLAND, BOUCK & LEE, INC.
engineers, scientists, economists

FIGURE
I-3



LEGEND:
- EXISTING STRUCTURE
- DREDGE AREAS
- SHORELINE
- 15 APPROXIMATE DREDGE DAY

DREDGE ID
- DREDGE 1
- DREDGE 2
- DREDGE 3
- DREDGE 4

NOTE:
1. DREDGE AREAS BASED ON FEBRUARY 28TH PHASE 1 DAD REPORT.
2. GRID CELLS FROM QEA RESUSPENSION MODELING (ATTACHMENT E) WITH MODIFICATIONS BY BBL.
3. SHORELINE AND SHORELINE STRUCTURES BASED ON AERIAL MAPPING PERFORMED BY CHAS H. SELLS, INC IN THE SPRING OF 2002.
4. THE DREDGE PLAN FROM THE INTERMEDIATE DESIGN WAS BASIS OF THE AIR ASSESSMENT. MODIFICATIONS TO THE DREDGE PLAN HAVE BEEN MINOR AND WILL NOT AFFECT THE RESULTS OF THE MODELING.

3/17/06 SYR-85 MTK KEW MTK
GE Hudson
G:\GE_GIS\GE-HudsonRiver\Phase1FDR\NoiseAnalysis\mxd\BBL_DredgeCellsbyDredgeDate-EGIA.mxd

GENERAL ELECTRIC COMPANY
HUDSON RIVER PCBs SUPERFUND SITE
PHASE 1 FINAL DESIGN REPORT

BARGE LOCATIONS NEAR GRIFFIN ISLAND

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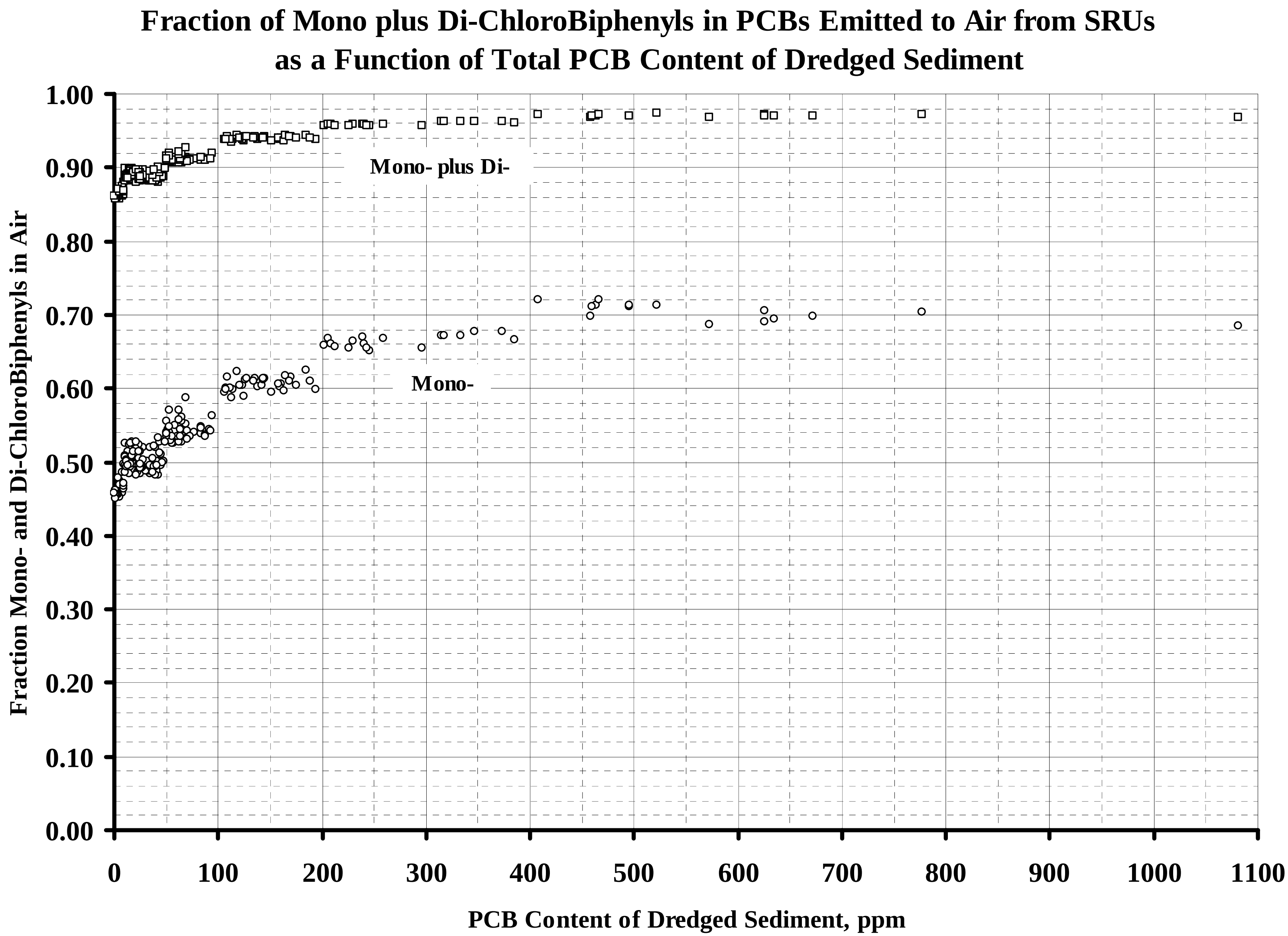
engineers, scientists, economists

FIGURE
I-4

Figure I-5



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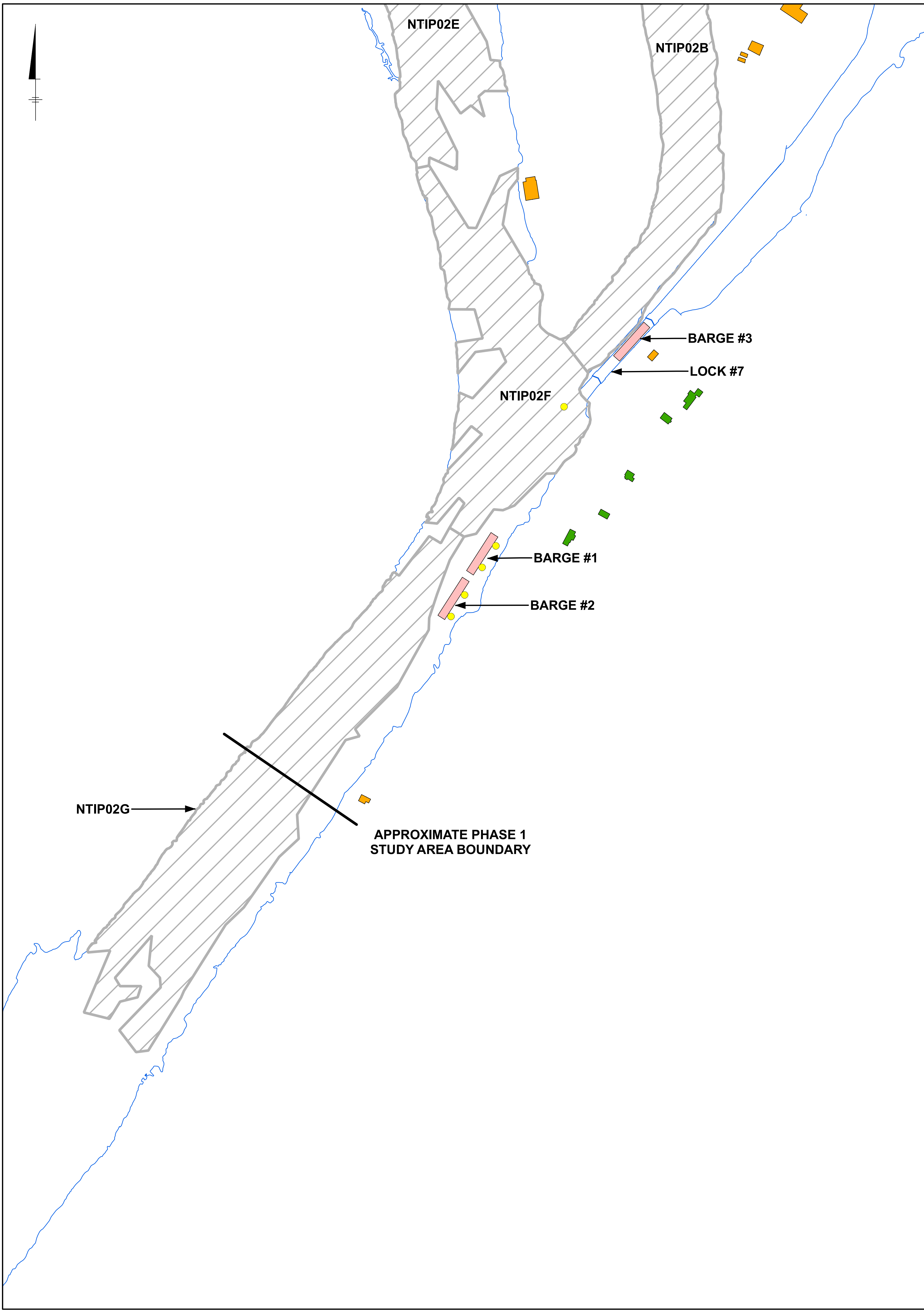

LEGEND:

DOLPHIN

SHORELINE

DREDGE AREA

RECEPTORS:

NON-RESIDENTIAL

RESIDENTIAL

NOTE:

1. SHORELINE AND SHORELINE STRUCTURES BASED ON AERIAL MAPPING PERFORMED BY CHAS H. SELLS, INC IN THE SPRING OF 2002.

0 400 800 Feet

GRAPHIC SCALE

3/17/06 SYR-85 MTK
GE Hudson
G:\GE_GIS\GE-HudsonRiver\Phase1FDR\NoiseAnalysis\mxd\DredgeCells-NTIPCentral.mxd

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BARGE LOCATIONS NEAR LOCK 7

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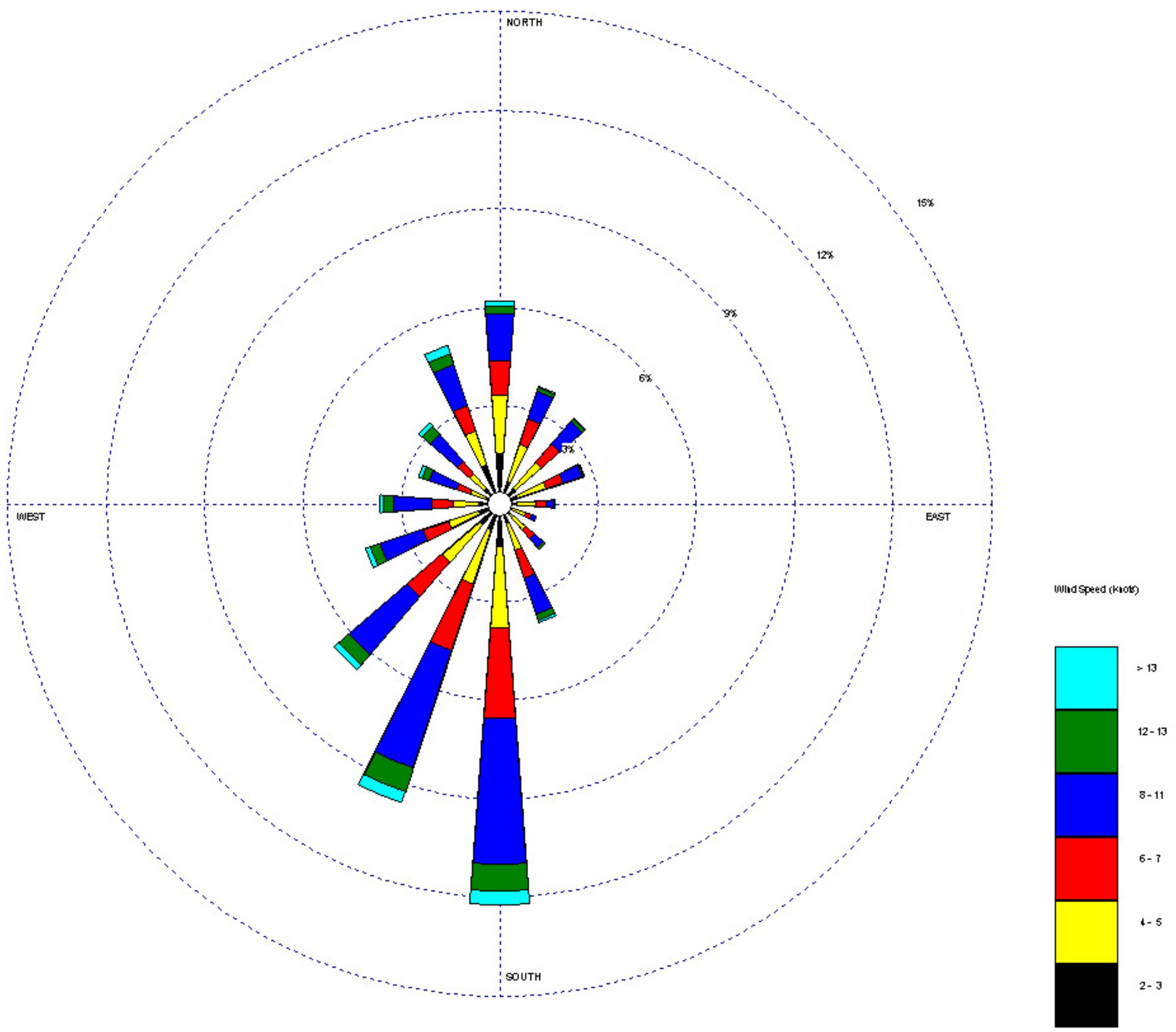
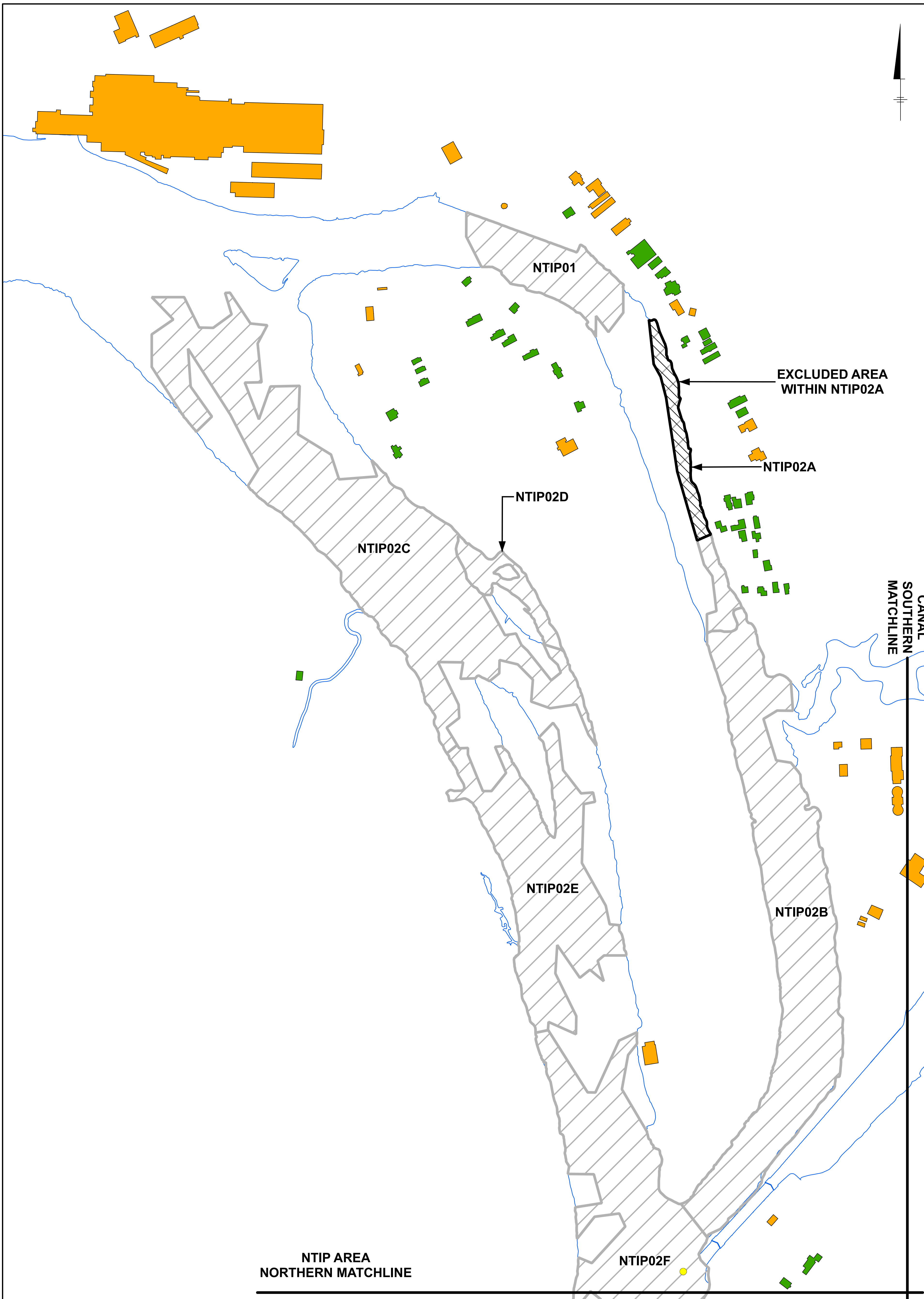
FIGURE
I-6

Figure I-7: Wind Rose for the Period June through October of the Glen Falls Data





LEGEND:

- DOLPHIN
- SHORELINE
- DREDGE AREA

RECEPTORS:

- NON-RESIDENTIAL
- RESIDENTIAL

NOTE:

1. SHORELINE AND SHORELINE STRUCTURES BASED ON AERIAL MAPPING PERFORMED BY CHAS H. SELLS, INC IN THE SPRING OF 2002.

0 400 800 Feet

GRAPHIC SCALE

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HUDSON RIVER PCBs SUPERFUND SITE
PHASE 1 FINAL DESIGN REPORT

EVALUATION POINTS NEAR ROGERS ISLAND

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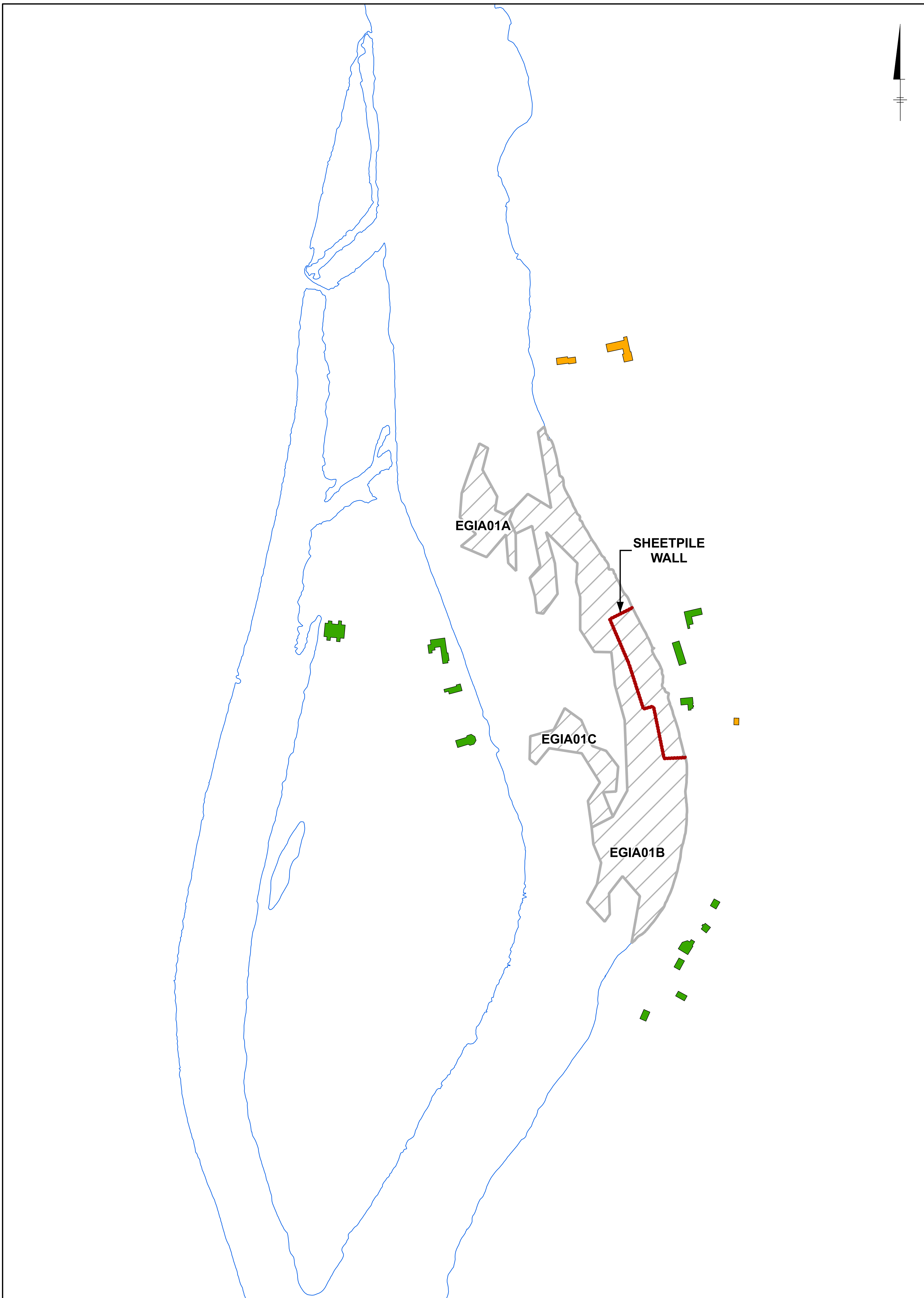
FIGURE
I-8

3/17/06 SYR-85 MTK
GE Hudson
G:\GE_GIS\GE-HudsonRiver\Phase1FDR\NoiseAnalysis\mxd\DredgeCells-NTIPNorth.mxd



LEGEND:

SHORELINE

DREDGE AREA

RECEPTORS:

NON-RESIDENTIAL

RESIDENTIAL

NOTE:

1. SHORELINE AND SHORELINE STRUCTURES BASED ON AERIAL MAPPING PERFORMED BY CHAS H. SELLS, INC IN THE SPRING OF 2002.

0 400 800 Feet

GRAPHIC SCALE

GENERAL ELECTRIC COMPANY
HUDSON RIVER PCBs SUPERFUND SITE
PHASE 1 FINAL DESIGN REPORT

EVALUATION POINTS NEAR GRIFFIN ISLAND

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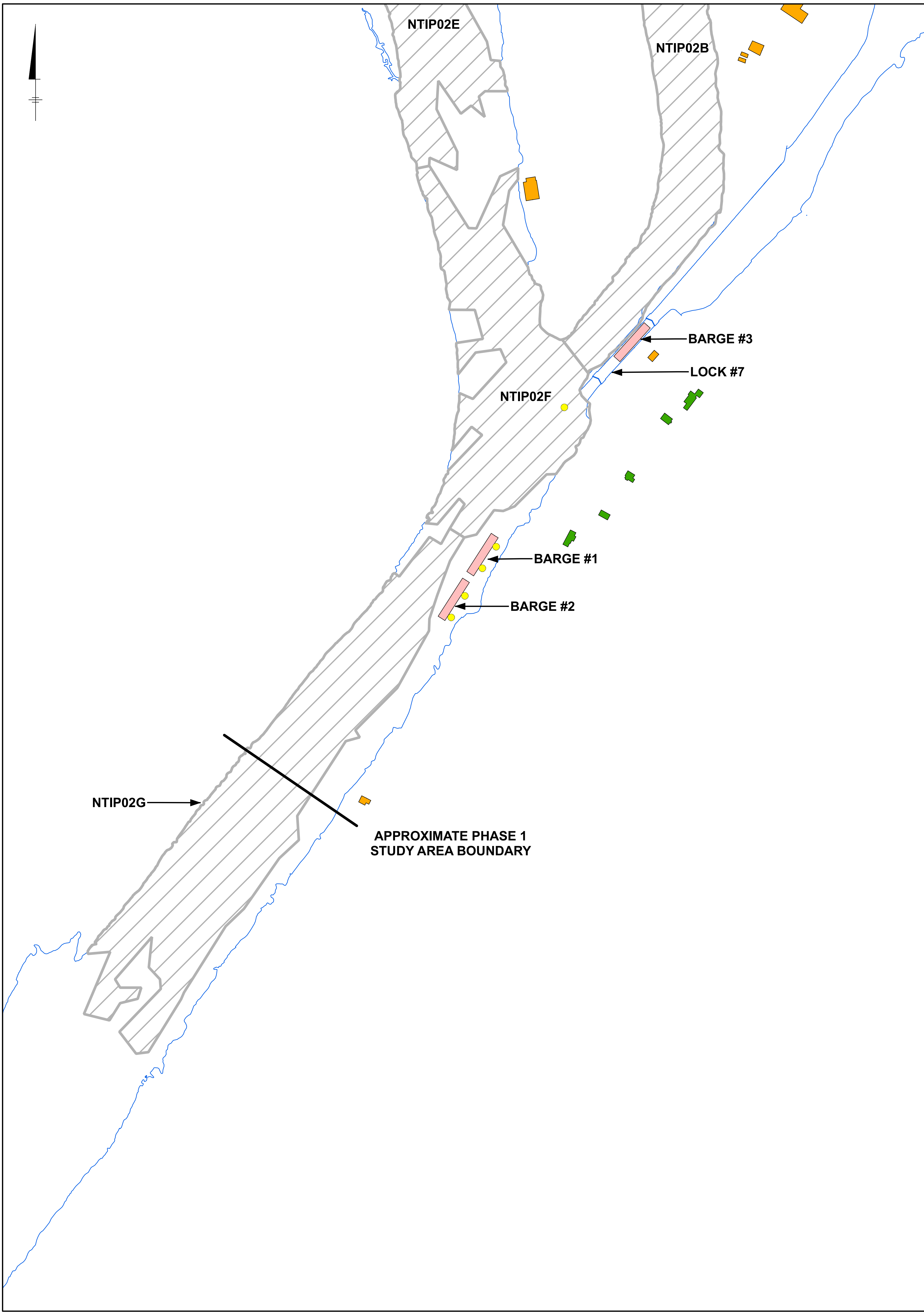
FIGURE
I-9

3/17/06 SYR-85 MTK
GE Hudson
G:\GE_GIS\GE-HudsonRiver\Phase1FDR\NoiseAnalysis\mxd\DredgeCells-EGIA.mxd



LEGEND:

- DOLPHIN
- SHORELINE
- DREDGE AREA

RECEPTORS:

- NON-RESIDENTIAL
- RESIDENTIAL

NOTE:

1. SHORELINE AND SHORELINE STRUCTURES BASED ON AERIAL MAPPING PERFORMED BY CHAS H. SELLS, INC IN THE SPRING OF 2002.

0 400 800 Feet

GRAPHIC SCALE

3/17/06 SYR-85 MTK
GE Hudson
G:\GE_GIS\GE-HudsonRiver\Phase1FDR\NoiseAnalysis\mxd\DredgeCells-NTIPCentral_Fig1-6.mxd

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HUDSON RIVER PCBs SUPERFUND SITE
PHASE 1 FINAL DESIGN REPORT

EVALUATION POINTS NEAR LOCK 7

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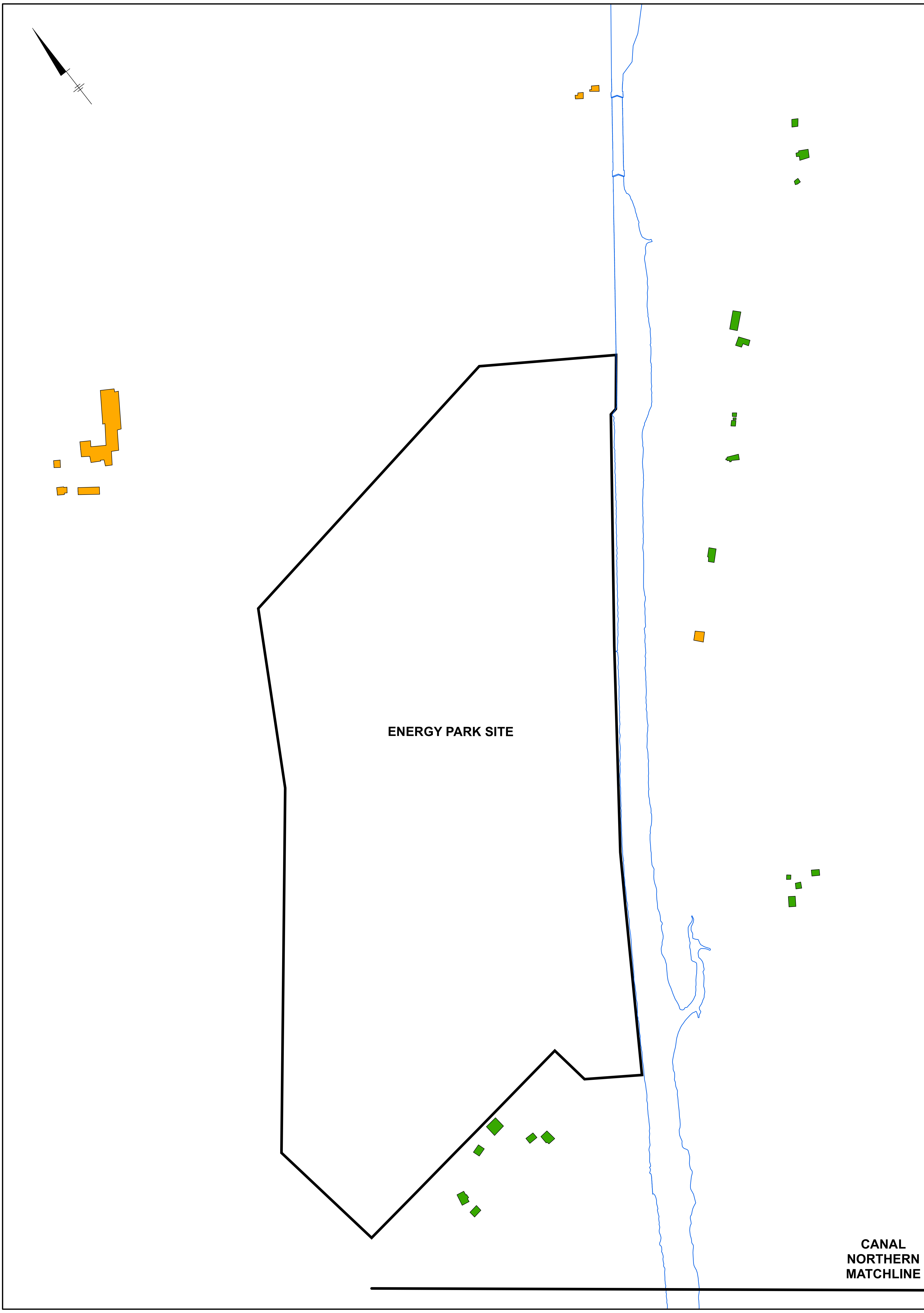
FIGURE
I-10



LEGEND:

SHORELINE

RECEPTORS:

NON-RESIDENTIAL

RESIDENTIAL

NOTE:

1. SHORELINE AND SHORELINE STRUCTURES BASED ON AERIAL MAPPING PERFORMED BY CHAS H. SELLS, INC IN THE SPRING OF 2002.

0 400 800 Feet

GRAPHIC SCALE

GENERAL ELECTRIC COMPANY
HUDSON RIVER PCBs SUPERFUND SITE

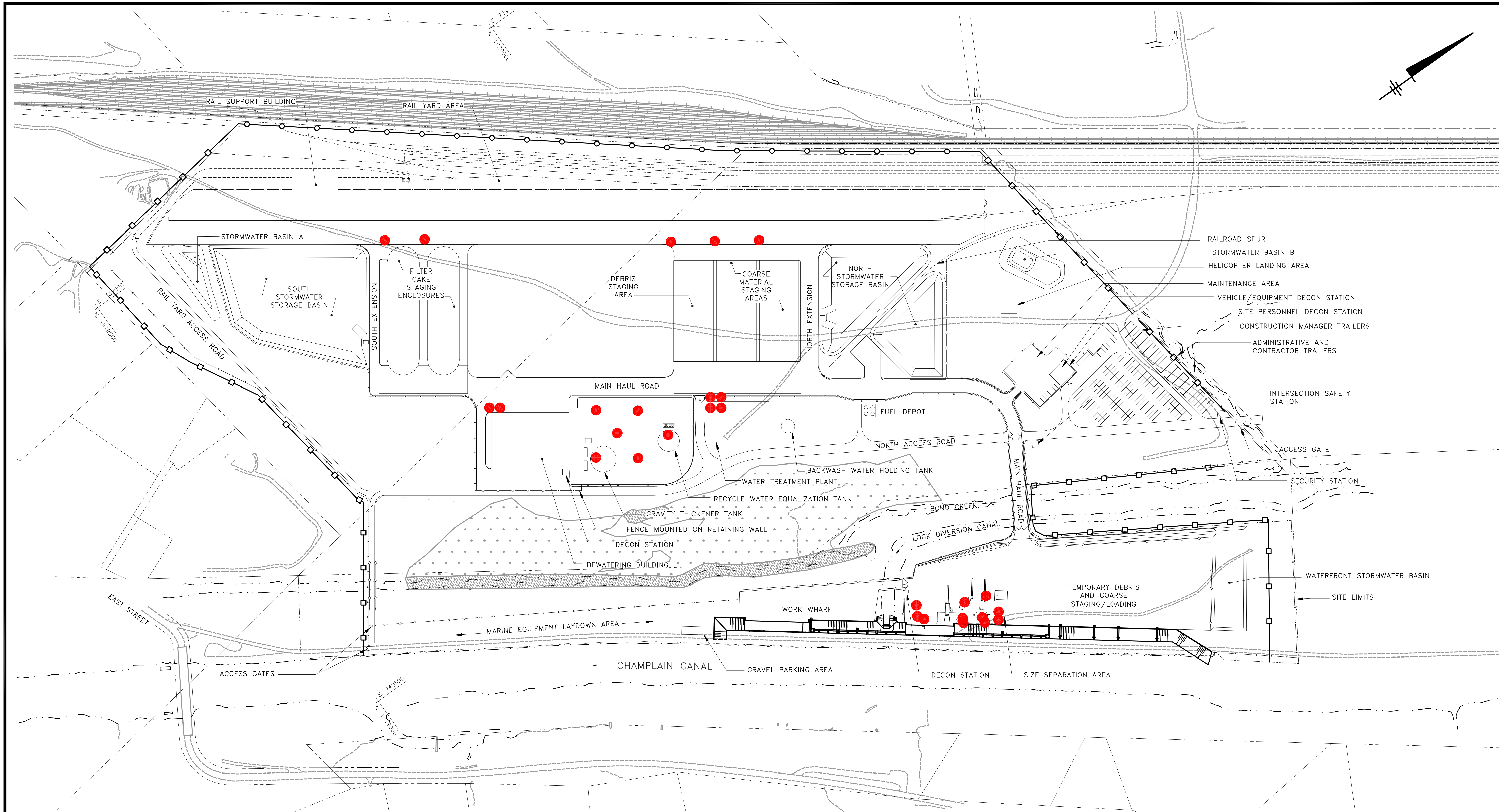
PHASE 1 FINAL DESIGN REPORT

EVALUATION POINTS NEAR PROCESSING FACILITY

BLASLAND, BOUCK & LEE, INC.
engineers, scientists, economists

FIGURE
I-11

3/17/06 SYR-85 MTK
GE Hudson
G:\GE_GIS\GE-HudsonRiver\Phase1FDR\NoiseAnalysis\mxd\DredgeCells-CanalNorth.mxd



LEGEND:

● MODELED EMISSION SOURCES

0 300' 600'
GRAPHIC SCALE

GENERAL ELECTRIC COMPANY
HUDSON RIVER PCBs SUPERFUND SITE
PHASE 1 FINAL DESIGN REPORT

PROCESSING FACILITY AIR EMISSION SOURCES

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FIGURE
I-12

X: C\20426005\FDR-CON\XREF\XGN-EX01.dwg, XGN-EX01.dwg, XGN-EX01.dwg
L: ON=*, OFF=*REF*
P: PAGESET/SYR-BL1
3/17/06 SYR-85-RLP KLS GMS
N/20426005/AIRMOD/20426B04.DWG