MEMPHIS
ENVIRONMENTAL
CENTER, INC.

CYPRESS CREEK DRAINAGE CHANNEL INVESTIGATION AND PRELIMINARY HUMAN HEALTH RISK EVALUATION

Prepared For:

Velsicol Chemical Corporation
Memphis, Tennessee

Prepared By:

Memphis Environmental Center, Inc.
Memphis, Tennessee

January 2002

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VIA UPS OVERNIGHT

January 10, 2002

Mr. J. M. Apple, Director
Tennessee Department of Environment and Conservation
Division of Solid Waste Management
401 Church Street
Nashville, Tennessee 37243-1535

Re: Final Report - Cypress Creek Drainage Channel Investigation and Preliminary Human Health Risk Evaluation Velsicol Chemical Corporation, Memphis, Tennessee Facility Identification No. TND 007-024-664

Dear Mr. Apple:

Enclosed, on behalf of Velsicol Chemical Corporation, is the Final Report on the 2001 Cypress Creek investigations. The report has been revised and completed pursuant to our review meeting of October 29, 2001 and your subsequent written comments dated December 5, 2001.

We have enclosed four partial hard copies and one complete hard copy of the report. We have also enclosed an electronic copy on a CD. Please incorporate the four partial copies into the large binders that were provided with the September 28, 2001 Agency Review Draft Report. To do this, you should replace the cover and spine and the following sections or appendices in their entirety:

- The text of the main report.
- Appendix A, Pertinent Work Plan Documents.
- Appendix E, GeoSyntec's Report.

Also add Appendix G, which presents TDEC's December 5, 2001 Comments and Velsicol's responses on the Agency Review Draft Report. The remainder of the document, namely the Figures and Tables of the main report and Appendices B, C, D and F, have not been revised.

Sincerely,

Memphis Environmental Center, Inc.

Gary Hermann

Gary J. Hermann, P.E.
Senior Environmental Projects Manager

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Enclosures

c: Glenda Akins, Velsicol Chemical Corporation
Paul Patterson, City of Memphis (2 copies)
Chris Saranko, GeoSyntec Consultants, Inc.

CYPRESS CREEK DRAINAGE CHANNEL

INVESTIGATION

AND

PRELIMINARY HUMAN HEALTH RISK EVALUATION

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CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Gary Herman

Gary J. Hermann, P.E.
Senior Environmental Projects Manager
Memphis Environmental Center, Inc.

Date January 10, 2002

EXECUTIVE SUMMARY

The objectives of the Cypress Creek Drainage Channel investigation were as follows:

- Collect and analyze soil and sediment samples from areas along the Channel that had not been sampled in previous investigations.
- Compare the historic and new sample data to screening criteria and perform a preliminary evaluation of human health risks to identify areas of concern that may warrant additional investigation and/or corrective action.

The study area included the creek channel and certain adjacent floodplain areas between Scott Street, which is just upstream from Velsicol Chemical Corporation's (Velsicol's) storm water outfall, and the Wolf River. This area is shown on ***Figure 1***. The investigation findings are presented in terms of five sub-areas, as follows:

- Sub-Area I: The industrial areas outside of the channel from Scott Street to 200 feet downstream of Jackson Avenue.
- Sub-Area II: The channel bottom under the concrete liner from Scott Street to Evergreen Street.
- Sub-Area III: The predominantly residential area adjacent to the channel, from 200 feet downstream of Jackson Avenue to Evergreen Street.
- Sub-Area IV: The open space area from Evergreen Street to Chelsea Avenue, including the Upper Surge Basin.
- Sub-Area V: The open space area from Chelsea Avenue to the Wolf River, including the Lower Surge Basin.

Velsicol collected 37 soil and sediment samples, and the Tennessee Department of Environment and Conservation (TDEC) collected an additional 16 samples to supplement the data development effort. A project database was assembled, which includes both the new and useable historic data, and includes more than 8,500 lines of data.

The investigation focused on three groups of compounds as follows: polycyclic aromatic hydrocarbons (PAHs), non-volatile organochlorides, which are commonly referred to as chlorinated pesticides, and metals. The primary constituentss of concern found in the study area soil and sediment samples were PAHs and pesticides. PAHs are combustion products and are commonly found in urban area soils and in and near water bodies that receive storm water runoff from streets. The potential sources of the pesticides include the Velsicol manufacturing facility as well as many years of agricultural, residential, and mosquito control pesticide usage. Data trend analyses found that pesticide concentrations in the 0 to 3-inch soil depth were generally much less than in the 0 to 12-inch depth. The opposite trend was found for the PAHs.

An initial screening analysis was performed by Velsicol in which the full database was compared to generic preliminary remediation goals (PRGs) established by the U.S. Environmental Protection Agency (USEPA). This analysis found that all five sub-areas had samples with a number of constituent concentrations exceeding the generic PRGs and that each sub-area warranted more detailed health risk evaluations.

Human health risk assessors at GeoSyntec Consultants conducted the more detailed evaluations. These evaluations were based on risk based screening approaches recommended by USEPA and consideration of site specific exposure conditions. A summary of their findings follows:

- Several of the Sub-Area III soil samples exceed relevant preliminary remediation goals (PRGs) for a number of constituents. In the other four sub-areas, a more limited number of constituents were found to exceed the relevant PRGs.
- A Preliminary Risk Evaluation (PRE) was performed to further evaluate potential human health risks. The PRE found that the concentrations of constituents identified in the various Sub-Areas do not represent a level of potential risk to current receptors that requires immediate action. Risks estimated for chemicals in Sub-Areas I, II, IV, and V were not above USEPA's target risk range. Risks estimated for dieldrin, endrin ketone, endrin and isodrin in Sub-Area III may exceed USEPA's target risk level. However, the risks corresponding to TDEC's sampling of the shallowest soil layers in this area were not above this target range. The available data represent only the areas immediately adjacent to the channel banks.

The following recommendations are made based on the findings of this investigation:

- The data and findings of this report should be provided to appropriate parties for their information and use.
- The investigation findings should be used as a basis of discussions with TDEC and others to establish future courses of action.

1.0 INTRODUCTION

1.1 Project Objectives

An investigation of soil and sediment along the Cypress Creek Drainage Channel was performed by Velsicol Chemical Corporation (Velsicol) in 2001 (the Investigation). The Investigation is part of an ongoing Resource Conservation and Recovery Act (RCRA) Corrective Action Program (CAP) that Velsicol is performing at its chemical manufacturing plant located in an industrial area at 1199 Warford Street, Memphis, Tennessee. The project objectives and scope of work were defined in a Work Plan approved by the United States Environmental Protection Agency (USEPA) and the Tennessee Department of Environment and Conservation (TDEC) (the Agencies). The Work Plan was defined through a series of documents dating from December 1999 through January 2001. Pertinent portions of those documents are presented in ***Appendix A*** for ease of reference.

On December 14, 2000, the Agencies issued a Joint Conditional Approval letter to Velsicol with direction to begin implementation of the Work Plan. The Agencies' letter addressed additional issues of the stream classification and the need for an ecological risk assessment. In a letter to the Agencies dated January 16, 2001, Velsicol responded with recommendations for resolution of those issues (MEC, 2001a). Memphis Environmental Center, Inc. (MEC) is an operating division of Velsicol and is managing the Corrective Action Program, including the Cypress Creek Investigation, on behalf of Velsicol.

The general objectives of the Investigation were as follows:

- Collect and analyze soil and sediment samples primarily in areas not previously sampled, so as to fill in data gaps.
- Use screening tools and human health risk-based approaches to identify areas of concern that may require additional investigation and/or corrective action.

The results of the Investigation will be used in discussions with the Agencies, the City of Memphis, and others to determine further courses of action.

The specific scope of work, based on the above-noted work plan documents, is summarized as follows:

- Collect 37 soil and sediment samples at specified locations and depths.
- Analyze and validate the samples in accordance with approved protocols.
- Present the sampling methods and analytical data and evaluate both the recent and historic data from previous sampling efforts by others.
- Perform a preliminary human health risk assessment using the above data, as appropriate, and present findings in the project report.

1.2 Report Organization

The text of the report is organized as follows:

- The remainder of ***Section 1.0*** presents a summary of stakeholder involvement, a description of the Study Area and background information, and a summary of previous investigations.
- ***Section 2.0*** describes the 2001 soil and sediment sampling locations and methods.
- ***Section 3.0*** presents an evaluation of the new and historic data quality and usability. It includes an evaluation of the nature and extent of contamination in terms of a preliminary screening against USEPA Region IX Preliminary Remediation Goals (PRGs).
- ***Section 4.0*** presents a summary of preliminary human heath risk evaluations performed by GeoSyntec Consultants as a contractor to Velsicol. ***Appendix F*** is a copy of GeoSyntec's full report and includes detailed information on the risk evaluation.
- ***Section 5.0*** presents a summary of the Investigation findings, conclusions, and recommendations.

1.3 Stakeholder Involvement

As summarized below, several meetings and information sharing sessions between interested parties occurred during the course of the Investigation:

- On October 4, 1999, a site meeting and tour was held to gather and share available information to form the basis of the initial Work Plan. The attendees included USEPA, TDEC, City of Memphis, Velsicol, and MEC.
- Between early October and late December 1999, MEC staff visited various City of Memphis Departments to research historic information on the Cypress Creek straightening and concrete lining work. During this time, MEC also obtained historic investigation information from the Agencies.

- On February 13, 2001, Velsicol and MEC representatives met with representatives of the Vollintine-Evergreen Community Association (VECA) to discuss the planned investigation and to obtain data from their 1999-2000 sampling program.

- TDEC and USEPA representatives observed MEC's March 5, 6, and 9, 2001, soil and sediment sampling work. TDEC also collected supplemental samples from the Lower Surge Basin and split a number of samples with MEC.

- On April 25, 2001, preliminary analytical results from Velsicol's March 2001 sampling event were provided to TDEC and the City of Memphis.

- TDEC collected additional supplemental samples of the soil surface on May 7, 2001.

- On May 8, 2001, a conference call was held to discuss Velsicol's preliminary data. The conferees included Velsicol, MEC, GeoSyntec Consultants, TDEC staff in Nashville and at TDEC's Environmental Assistance Center (EAC) in Memphis, and the Tennessee Department of Health (TDOH). The need for any immediate corrective action was discussed. It was decided that surficial samples collected by TDEC on May 7, 2001, would be evaluated before TDEC and the Department of Health would make any decisions regarding the need for immediate action.

- On June 1, 2001, a meeting was held at TDEC's offices in Nashville to discuss the project status and a preliminary evaluation of the more complete database. The expanded database at that point included the available historic data as well as Velsicol's new data and data from split and supplemental samples collected by TDEC during March and May 2001. Attendees included Velsicol, MEC, TDEC staff in Nashville and via phone from the Memphis EAC, and the TDOH. TDEC and the Department of Health indicated that no immediate action was likely to be warranted. However, they decided to postpone confirming a decision on that issue until after all of VECA's investigation data was obtained and reviewed.

- On June 19, 2001, MEC provided a copy of the final project database to TDEC. This version included the remaining VECA data.

- An Agency Review Draft of this report were provided to TDEC, USEPA, TDOH, and the City of Memphis on September 28, 2001. A meeting between Velsicol, TDEC, USEPA and TDOH representatives was held in Nashville on October 29, 2001 to discuss the draft report. In addition, TDEC provided written comments on the draft report on Decemebr 5, 2001. Velsicol's responses to those comments are presented in ***Appendix G*** of this final report.

1.4 Cypress Creek Study Area Description and Background Information

The Study Area, as defined in the Work Plan documents, is the Cypress Creek Storm Water Drainage Channel and certain adjacent overbank and undeveloped floodplain areas along the Channel from Scott Street to the Wolf River. It includes the storm water reservoir areas located upstream from the Cypress Creek Pumping Station to

Evergreen Street. The study area also includes the reach downstream from the Pumping Station to its confluence with the Wolf River. It does not include the Bellevue Avenue Landfill, the North Watkins Street Site, tributaries to Cypress Creek or other non-contiguous areas.

A map showing the location of the Cypress Creek Drainage Channel is presented in ***Figure 1***. Cypress Creek is an approximately 7.5 mile long storm water collection and conveyance channel for the City of Memphis, Tennessee. It flows from generally the center of town northwest to the Wolf River, which subsequently discharges into the Mississippi River. Beginning in about 1940, the Memphis District, United States Army Corps of Engineers (USCOE) constructed a levee system to prevent flooding of the northern section of Memphis. Concurrent with the levee construction, the Cypress Creek Pumping Station was completed in August 1944 to lift storm water from Cypress Creek to the Wolf River during periods of high water levels in the Wolf River. During normal flow conditions, storm water from Cypress Creek flows via gravity to the Wolf River through floodgates, which are normally left open.

A relatively wide and undeveloped portion of the Cypress Creek floodplain, which serves as a storm water storage basin during periods of high runoff, exists from the pumping station upstream to Evergreen Street. This floodplain/storage basin area is commonly referred to as the Surge Basin. For purposes of this investigation and report, the Surge Basin has been discussed in terms of a Lower Surge Basin (i.e., from the Pumping Station to Chelsea Avenue) and an Upper Surge Basin (i.e., from Chelsea Avenue to Evergreen Street).

Historically, Cypress Creek was a natural watercourse that served as the discharge point for agricultural and then urban storm water and sanitary and industrial wastewater discharges. The channel was modified, beginning during the 1930's, to improve drainage and provide flood control benefits. The following general time frames for these modifications have been estimated based on a review of aerial photographs and other records. Copies of the historic aerial photos mentioned below were obtained during June 2001 from the Shelby County Agricultural Service Center, the Natural Resource Conservation Service and the USCOE in Memphis. Copies of the aerial photos are included in ***Appendix B***.

- The channel was straightened and/or widened during the period of about the 1930s to about the late 1950s. An August 10, 1937, aerial photo shows that significant portions of the Creek had been straightened at that time, and some work was currently underway. A later aerial photo shows that the major straightening work was completed before March 4, 1958.

- The concrete lining work, which may have included additional widening and minor straightening work, began sometime after 1958 and was completed prior to 1971. The March 4, 1958, aerial photo does not indicate any concrete lining. Lining construction was completed in some areas and was underway in another area during 1965, as indicated on a September 27, 1965, aerial photo. The lining work was completed sometime prior to late 1971, based on a November 7, 1971, aerial photo.

- Based on drawings obtained from the City of Memphis, the following is an approximate timeframe for the construction of the concrete lining in the Study Area:

Pre-1960	Scott Street to Jackson Avenue
1960	Jackson Avenue to Meagher Street
1964	Staten Avenue to Tunica Street
1965	Meagher Street to Staten Avenue
1965	Tunica Street to University Street
1968	University Street to Evergreen Street

Cypress Creek is now concrete lined from its headwaters at Carnes Avenue to Evergreen Street. The channel is unlined from the Evergreen Street Bridge to the Wolf River. However, some reaches of the unlined section are covered with large rock riprap. Based on discussions with City staff, they periodically dredged the main channel in the Lower Surge Basin in the past to remove accumulated sediments. The sediments were spread over areas within the Lower Surge Basin and adjacent to the channel.

Prior to the construction of the City of Memphis' Wastewater Collection System (Wolf River Interceptor) in the late 1950s, Cypress Creek received storm water, sanitary wastewater and industrial wastewater from several companies, including Velsicol. By June 1963, Velsicol had ceased discharging process wastewater to the creek and was discharging to the Wolf River Interceptor system. Records are not clear on exactly when this change over occurred. The other industrial companies probably followed a similar time frame on when they ceased wastewater discharges to the creek. It is likewise reasonable to assume that sanitary wastewater discharges to the creek also ended during the same late 1950s to early 1960s period.

From 1963 to the mid-1970s, Velsicol discharged only storm water and possibly non-contact process water (e.g., cooling water) to Cypress Creek. From the mid 1970s to the present, Velsicol has discharged only storm water to Cypress Creek. This discharge is regulated under a National Pollutant Discharge Elimination System (NPDES) Permit.

During the course of this Investigation it was observed that the concrete lined sections of the channel are almost completely free of sediments. This is the result of periodic flushing that occurs during storm water runoff events. The nature of the concrete lining is that the collected storm waters flow at high velocity and carry away most sediments and debris. High peak flowrates also result from the nature of urban landscapes, which contain high percentages of impermeable surfaces, such as rooftops, parking lots and streets that cause rapid runoff. The ability of the storm water collection and flood control system to stay free of sediment and to quickly transport the storm water away from the developed lands are intended design features of urban storm water flood control systems. However, these features also result in a channel that is subject to rapid flowrate increases, which can be a drowning hazard. Trash and debris are flushed from the lined section and end up being deposited in the channel and along its banks in the Upper Surge Basin.

On May 17, 1977, the Tennessee Water Quality Board "FOUND and DETERMINED that Rule 1200-4-4-.01-(1), Tennessee Department of Health, Bureau of Environmental Health Services, Division of Water Quality Control is not applicable to the storm water drainage channel (in the Memphis Area Basin) designated 'Cypress Creek' which is a tributary to the Wolf River at Mile 2.8, said storm water drainage channel not being a stream" (Tennessee Water Quality Control Board, 1977). This Finding is commonly referred to as the 1977 Declaratory Ruling.

1.5 Previous Investigations

A number of environmental investigations, which consisted of soil and sediment sample collection and analyses, have been performed related to the Cypress Creek Drainage Channel. The majority of these previous investigations have focused on the Lower Surge Basin and nearby waste disposal sites (i.e., Bellevue Avenue Landfill and North Watkins Street Site). These investigations indicated the presence of polycyclic aromatic hydrocarbons (PAHs), non-volatile organochlorides, which are commonly referred to as pesticides, and metals, with the highest concentrations of those compounds detected in the Lower Surge Basin itself. The analytical data from the previous investigations are discussed and presented in subsequent sections of this report. Specific sources of the investigation information are listed in ***Section 6***.

A summary of the known historical sampling events within the Cypress Creek Drainage Channel study area follows:

Year	Sampling Event
1964	USEPA collected five sediment samples on two different dates along Cypress Creek from the Jackson Avenue overpass to the Cypress Creek pumping station. Only endrin and dieldrin were reported.
1964	Correspondence was located which suggests that the City of Memphis conducted limited sampling for endrin and dieldrin along backyards in the Bingham Street and Meagher Street vicinity in 1964. This information was not included in the database because: 1) it is not specific to location, 2) the levels detected were low (1 part per million for endrin, 0 for dieldrin), and 3) no information exists as to sampling and analytical methodology.
1980	USEPA collected three sediment samples along the Cypress Creek Drainage Channel from Evergreen Street to the pumping station. Volatile organic compounds (VOCs), PAHs, and pesticides were reported.
1981	Memphis/Shelby County Health Department collected three sediment and four overbank soil samples along Cypress Creek from Evergreen Street to the pumping station. Only pesticides were reported.
1992	Dynamac Corporation (for USEPA Region IV) collected six sediment and six soil overbank samples along Cypress Creek from Evergreen Street to the Wolf River. Additionally, a "background sample" was collected upstream of the study area, at the headwaters of Cypress Creek. Analytes included VOCs, PAHs, pesticides, and metals.
1993	Black & Veatch (for USEPA Region IV) collected five sediment and five soil overbank samples along Cypress Creek from Watkins Street to the Wolf River. Analytes included VOCs, PAHs, pesticides, and metals.
1999-2000	Vollintine-Evergreen Community Association (VECA) collected samples from three locations within Cypress Creek and the Upper Surge Basin during four separate sampling events. Samples were collected with assistance from Rhodes College. Analytes included PAHs, polychlorinated biphenyls (PCBs), pesticides, and metals.

On September 15, 1997, TDEC Division of Superfund sent letters to Buckman Laboratories, Inc., Buckeye Cellulose Corporation, Velsicol, and the City of Memphis requesting information regarding the recipients' relationship to the Cypress Creek "Site" and other relevant information. Velsicol is unaware of any further action taken by TDEC following their receipt of the submitted responses.

During 1997, USEPA and TDEC considered a plan to aggregate Cypress Creek with the Bellevue Avenue Landfill and the North Watkins Dump into a single Site for placement on the National Priorities List (NPL) with subsequent investigation and potentially cleanup under Superfund. The City and Shelby County did not support the proposal and no further action was taken in that direction.

In September 1997, impacted soils were encountered at the Jackson Avenue Viaduct reconstruction site approximately 270 feet west of the southwest corner of Velsicol's facility. Utility company workers observed odors while excavating to move underground lines away from new bridge support pier locations. Soil samples were collected and analyzed for the Tennessee Department of Transportation. The samples had elevated concentrations of aldrin, dieldrin, endrin, endrin ketone, heptachlor, and alpha and gamma chlordane (TVG Environmental Inc., 1997). It was determined that the excavation had occurred near Velsicol's underground storm water discharge pipeline (i.e., Outfall #003) at a location that is approximately 600 feet north of its point of discharge to the channel and approximately 650 feet east of where the channel passes under the viaduct. These impacts are believed to be related to historic leakage from the underground pipeline at that location and are hundreds of feet from the channel. This pipeline was sliplined in 1982 and recent video inspections show that it is in very good condition. Therefore, historic leakage from this pipeline is not considered to be a source of Cypress Creek contamination and the data from this location were not included the current Investigation.

During development of the Work Plan, MEC searched for available information on creek sediment excavation or dredging and placement and the concrete lining construction work. The objective of this research was to determine where impacted sediments might have been deposited, so that the sampling effort could be focused in those areas. This work included file reviews at TDEC, USCOE, and the City of Memphis Engineering Department. The Memphis/Shelby County Health Department and Memphis/Shelby County Historical Society were also contacted regarding similar records. However, this research effort did not discover any information that could be used to identify specific sediment deposition areas for sampling.

A comparison of the Cypress Creek channel alignment and width, using a topographic map from 1955 and an aerial photo from 1995, was also conducted during Work Plan development in an attempt to locate potential sediment deposition areas. The year 1955 was chosen since the City of Memphis maintains a topographical survey map from that date, that depicts what is believed to be the location of Cypress Creek prior to major concrete lining work. This comparison, which was imprecise due to the scale of the maps, indicated that the location of Cypress Creek did not change significantly between 1955 and 1995.

2.0 FIELD INVESTIGATION

As noted in ***Section 1.1***, the Investigation objectives included collection and analysis of soil and sediment samples primarily from areas not previously sampled. The Investigation goal was to determine constituent levels in those areas to supplement the historic data in developing a more complete picture of the contamination along Cypress Creek Drainage Channel. This section describes the Investigation sampling locations, and sampling and analytical methodology. The Investigation was performed in accordance with the Agencies approved Sampling and Analysis Procedures for the RCRA Corrective Action Program (the SAP) (MEC, 2001b) and the Work Plan, unless otherwise noted.

Concurrent with the Investigation, TDEC collected split samples and samples from additional areas to support the data development effort. The TDEC sampling and analysis work is also summarized herein.

2.1 Velsicol Sampling Locations

The recent soil and sediment sampling locations are shown on ***Figure 2***, along with the historic sample collection locations within the study area. (Note: Sample CC-SS-01 location is shown on ***Figure 1***.) All of the Velsicol samples were collected from City of Memphis property or permanent drainage easement. Along the concrete lined sections of the channel, the easement is generally a 10-foot wide strip of land located outside of the concrete sidewalls and fence. Details on the new and historic sampling locations are presented in ***Table 1***. ***Appendix C*** includes photographs of the new sampling locations and depicts the methods utilized for sample collection.

Velsicol collected samples at eleven locations as follows:

- Six transects labeled as T1 to T6.
- Four shallow overbank samples labeled as HA-1 to HA-4.
- One channel bottom sediment sample labeled as F7.

2.1.1 Transect Sample Locations

A typical layout of the transect sampling locations in the concrete lined sections (i.e., T1 through T5) is presented in ***Figure 3.*** At each concrete lined transect location, one sample was collected from the bottom of the channel bottom after boring through the concrete. These samples were collected as close to the middle as practical, but outside the low flow channel, and on the inside of significant bends in the channel alignment, if present. Two samples were collected from the overbank on each side of the channel. One was shallow (generally 0 to 12 inches), the other was deeper (generally 2 to 4 feet) and from within the same borehole.

T1 is located approximately 500 feet upstream of Velsicol's Outfall #003 on the upstream or east side of the Scott Street bridge. The channel is concrete lined at this location and the nearby land use is industrial. An entrance to Buckeye Technologies Inc. is located adjacent to T1. The overbank samples were collected on March 5, 2001, and the channel bottom sample was collected on March 6, 2001.

T2 is located approximately 600 feet downstream of Outfall #003 on the downstream or north side of the westbound service road bridge beneath the Jackson Avenue Viaduct. The channel is concrete lined at this location and the nearby land use is generally industrial. Memphis Light Gas and Water's (MLGW's) central maintenance yard and a Sprint Cellular tower/relay station are located on the east and west sides of the channel at T2, respectively. During the recently (2000) completed viaduct re-construction project, the ground surface elevations on the east and west sides of the channel were raised about 4 and 5 feet, respectively, by the placement of new backfill above the top elevation of the concrete sidewalls. The overbank surficial samples at T2 were collected from the surface at each location. The deep samples were collected at the 2 to 4 foot depth relative to the top of the concrete sidewalls, the actual sample depths were 6 to 8, and 7 to 9 feet below the existing grade, to reflect the pre-construction soil conditions. The overbank samples were collected on March 5, 2001, the channel bottom sample was collected on March 6, 2001.

T3 is located on the downstream or west side of the Hollywood Street Bridge. The channel is concrete lined at this location and the land use is a mix of industrial, commercial, and residential. A vacant industrial/commercial building is located on the south side of the channel, west of T3. An auto repair facility is located on the north side of the channel. The ground surface elevations on the north and south ends of the bridge slope upwards about 3 and 2 feet above the respective channel sidewalls at the sample collection location. The surficial overbank samples were initially collected on March 5, 2001, at the 0 to 12-inch depth, relative to the concrete sidewall tops (i.e., from 3 to 4 and 2 to 3 feet, respectively, below the ground surface). However, those samples were subsequently discarded without being analyzed and new samples were collected from 0 to 12 inches below the current ground surface elevation on March 9, 2001. This approach was used at T3 because the actual surface soil at this transect was considered to be more indicative of nearby surface soil conditions. The deep samples were collected on March 5, 2001, at the 2 to 4 foot-depths, relative to the concrete side wall top elevations. The channel bottom sample was collected on March 6, 2001.

T4 is located between Springdale Street and University Street at the Cypress Creek Junior High School. The channel is concrete lined at this location and the land use is a mix of schoolyard/recreational and residential. An industrial area, which includes Buckman Laboratories, is located approximately 600 to 1,300 feet north of the channel between University Street and McClean Boulevard. The T4 south overbank samples were collected on March 5, 2001, and the bottom sample was collected on March 6, 2001. The north overbank samples were collected on March 9, 2001, from a location approximately 500 feet downstream of the March 5 and 6 sampling locations, on the east side of the University Street Bridge. The north overbank samples could not be collected in the same area as the south overbank and bottom samples because it was not readily accessible.

T5 is located on the west side of the McLean Boulevard Bridge. The channel is concrete lined at this location and the nearby land use is a mix of vacant or open space and residential. The land north and south of the channel and immediately west of McClean Boulevard is vacant. An asphalt bike path is located along the south bank of the channel at this location. The grade elevation on the north and south sides of the bridge is 3 feet above the elevation at the channel sidewalls. The overbank surficial samples were collected on March 9, 2001, from the 0 to 12-inch depth interval. Similar to T3, the surficial samples at this location were originally collected from the depth of the top of the concrete sidewalls and then subsequently discarded. The deep samples were collected on March 5, 2001, at the 2 to 4-foot depths, relative to the top of the sidewalls. The channel bottom sample was collected on March 6, 2001.

T6 is located in the Upper Surge Basin between Evergreen Street and Chelsea Avenue. The channel is not concrete lined at this location. The concrete lining terminates on the west or downstream side of the Evergreen Street Bridge. This transect is in an open space area where storm water is allowed to overflow the channel banks at times of high storm water runoff that exceeds the capacity at the Cypress Creek Pumping Station. The open space varies from about 50 to 800 feet in width. Residential and some industrial property is located above the floodplain elevation to the south of the open space. The land use is a mixture of residential and industrial/commercial along the north side of the open space area.

T6 included a total of seven samples. They included the typical one bottom sample and the two sets of surficial and deep near-overbank samples, similar to Transects T1 through T5. T6 also included two additional surficial samples that were collected approximately 40 feet out from the south and north near-overbank locations. All of the T6 samples were collected on March 5, 2001, with the exception of the bottom sample, which was collected on March 9, 2001. Collection of the bottom sample was delayed because storm water from a 1.2-inch rainfall event on March 4 had left the channel filled with water. The channel bottom sample was collected on March 9, 2001, after the storm water had receded and it was safe to enter the channel.

A sediment sample (labeled F7) was collected from the bottom of the unlined channel, approximately 1,150 feet upstream of T6. This location is also about 250 feet upstream of where an exposed sewer pipeline crosses the channel. This sample was added because the channel bottom material at T6 is stiff clay that is often scoured clean of sediment accumulations. The F7 location was added to represent more typical sediment conditions in the area just downstream from where the concrete lining terminates. The F7 sediment sample was also collected on March 9, 2001.

2.1.2 Supplemental Shallow Overbank Samples

Four additional shallow (0 to 12-inch depth) overbank soil samples were collected on March 5, 2001. The four additional overbank sample locations are as follow:

- HA-1 is located south of the concrete lined channel on the west side of the Springdale Street Baptist Church, on a narrow grass strip between the Church's parking lot and the sidewall fence. The area land use is generally residential.
- HA-2 is located north of the concrete lined channel on a narrow grass strip between an entrance road to the OakRidge Apartments and the sidewall fence. The area land use is residential.
- HA-3 is located south of the channel, between the concrete lined channel and the Cypress Creek Junior High School main building, near the sidewall fence. This location is approximately 350 feet upstream or east of T4.
- HA-4 is located south of the channel, a few feet from the sidewall fence, and approximately 400 feet west or downstream of T4. A small park area, University Park, is located south of this sampling location and contiguous with the Cypress Creek Junior High schoolyard.

2.1.3 Quality Assurance/Quality Control Samples

The following Quality Assurance/Quality Control (QA/QC) Field Samples were also collected in accordance with the SAP to achieve Level III Data Quality Objectives (DQOs) (MEC, 2001b):

- Two Field Duplicate Samples were collected. These samples were analyzed to check for sampling and analytical reproducibility and are given a unique sample identifier separate from the "original" sample.
- Two Rinsate Blank samples were collected. These samples were collected from the sampling equipment itself during the final rinse step. The purpose for collecting and analyzing these blanks is to verify the cleanliness and proper decontamination of the sampling equipment.

- Two Field Blank Samples were collected. These samples were collected from the water used for equipment decontamination and are used to detect contamination that may be introduced into the samples through decontamination rinse water.

2.2 Sample Collection Methods

The sample collection and handling, equipment decontamination, and investigation derived waste disposal methods used by MEC were similar to those used on other elements of Velsicol's Corrective Action Program and were in accordance with the SAP, unless otherwise noted. The soil and sediment samples were collected using direct push and hand auger methods, as discussed in the following subsections.

2.2.1 Direct Push Sampling

Most of the soil and sediment samples were collected on March 5 and 6, 2001, using the direct push method. The exceptions were the channel bottom samples collected from T6 and F7 and the replacement overbank surficial soil samples collected at T2, T3, and T5, which were all collected on March 9, 2001. The direct push samples were collected using a pickup truck mounted, hydraulically actuated SIMCO® direct push unit. Tri-State Testing Services, Inc. of Memphis, Tennessee, provided the direct push sampling equipment and services under MEC's direction.

The direct push unit utilized 4-foot long sample barrels. New disposable vinyl acetate sleeves were inserted into the barrel for each sample. The sample sleeves, excess soil, wash and rinse water, and gloves were collected and disposed of at the Velsicol Facility in accordance with the SAP and Facility policies. The sample barrels, stainless steel bowls, trowels, and other sampling equipment were decontaminated between samples with an Alconox® wash followed by a water rinse. The field decontamination procedures inadvertently did not include equipment rinsing with reagent grade solvent, as specified in the SAP.

At sampling locations where concrete was present, a drill bit was used to core through the concrete to gain access to the underlying soil. At all locations, the sample barrel was pushed hydraulically to the desired sampling depth and then retrieved. The sample barrel was opened and the sleeve containing the desired sampling interval was removed and checked. The sleeve was first cut open, the soil was then screened with a photo-ionization detector (PID) and described in a field logbook.

Representative soil or sediment from the desired sampling interval was placed in a stainless steel bowl and composited or mixed with a stainless steel trowel. Following mixing, the samples were placed in method-appropriate, pre-labeled, laboratory supplied containers and then put on ice in a cooler. The samples were kept under Chain-of-Custody control and on ice until delivered to the laboratory for analysis. Photographs of the direct push unit and sampling technique are provided in ***Appendix C***.

2.2.2 Hand Auger Sampling

Hand augers were used to collect all of the samples on March 9, 2001. The materials were placed directly from the auger into stainless steel bowls and composited or mixed and subsequently handled in the same manner as the samples collected by the direct push method. Most of the hand auger samples extended only to 12-inch depths. The single exception is the deep overbank sample on the north side of the channel at T4 (as relocated to University Boulevard). The shallow sample was collected first using one hand auger. Then a second hand auger was used in the same hole to collect the deep sample from the 2 to 4-foot sample depth.

The channel bottom sediment samples from T6 and F7 were collected from about 6 to 12 inches below the water surface. At F7, a special technique was necessary to collect the sediment sample so that the borehole would not collapse and so that the sample would not be washed out of the auger by the flowing creek water. This consisted of driving a 4-inch diameter poly vinyl chloride (PVC) pipe into the channel bottom, removing the water from the pipe by the use of a small pump, and then using the hand auger to remove the sample under relatively dry conditions. At T6, the sediment was a very cohesive and stiff clay and did not require the use of special techniques.

Each hand auger was decontaminated between samples with an Alconox® wash followed by a water rinse. Again, the field decontamination procedures inadvertently did not include rinsing with reagent grade solvent, as specified in the SAP.

2.3 Laboratory Analyses

The samples were transported by MEC staff to GTW Analytical Services, LLC in Memphis, Tennessee, (GTW) for analysis. The samples collected on March 5 and 6, 2001, were delivered to GTW on March 6, 2001, and the samples collected on March 9, 2001, were delivered to GTW that same day. The soil and sediment sample analyses were performed in accordance with the following laboratory methods, as described in the SAP:

- Base/Neutral and Acid Extractables (also commonly referred to as Semi-Volatile Organic Compounds [SVOCs] or Polycyclic Aromatic Hydrocarbons [PAHs]) by USEPA Test Method SW-846; 3550B/8270C.

- Non-volatile organochlorides (also commonly referred to as Pesticides) by SW-846; 3550B/8081A.

- Metals, except mercury, by SW-846; 3050B/6010B. Mercury by SW-846; 7471A.

Following the laboratory analyses, the reported data were transmitted to MEC via reports generated in both written and electronic format. The data was validated (see ***Appendix D***) and imported electronically into the project database, as discussed in ***Section 3***. A summary of the new analytical data, as well as historic data, is presented in ***Table 2***. Copies of the laboratory reports from GTW are presented in ***Appendix F***.

2.4 Agency Oversight and Supplemental Sampling

Agency personnel provided oversight during MEC's sample collection work. On March 5 and 6, 2001, Mr. Roger Donovan, Mr. Chris Schaefer and Ms. Leighann Gipson of TDEC and Leo Romanowski, Jr. of USEPA observed the fieldwork. On March 9, 2001, Chris Schaefer and Leighann Gipson of TDEC were present.

On March 5 and 6, 2001, TDEC representatives collected six splits of the following Velsicol samples: T2-F1, T3-NB1, T4-F1, T4-SB1, T5-SB1, and T6-NB1. TDEC also collected ten supplemental samples on March 7, 2001, and May 7, 2001.

The March 7, 2001, supplemental samples were collected from the 0 to 12-inch depth in overbank areas of the Upper and Lower Surge Basin and from near the City of Memphis' Lucille Price Park, which is located near the Lower Surge Basin. On May 7, 2001, TDEC collected surficial samples from the 0 to 3-inch depth at sample locations HA-3, T4-SB1, T6-NB1, SB-1, and SB-3. MEC staff observed TDEC's May 7, 2001, sampling work, which was performed by Mr. Mark Thomas and Mr. Chris Schaefer. The State of Tennessee Environmental Laboratories analyzed TDEC's samples. Velsicol received a copy of TDEC's analytical results on May 30, 2001, and incorporated the data into the project database. TDEC also provided a copy of their field notes, which are summarized above.

3.0 DATA EVALUATION

This section presents an evaluation of the quality and usability of the historic and recent soil and sediment analytical data, the project database, and an evaluation of the nature and extent of contamination along the channel. The nature and extent of contamination were evaluated by a number of methods with the objective of identifying areas and specific constituents to be further evaluated in the subsequent Preliminary Human Health Risk Evaluation. The nature and extent evaluation included a screening of the data against generic USEPA Region IX Preliminary Remediation Goals (PRGs) and data trend analyses. The Preliminary Human Health Risk Evaluation findings are presented in ***Section 4.0***.

3.1 Data Quality and Usability

The data quality and usability were evaluated for the historic (1964 through 2000) data sets, the Velsicol (March 2001) sampling event and the TDEC (March and May 2001) sampling events.

3.1.1 Historic Data

All of the available historic data, with the exception of the 1964 City of Memphis information (as discussed in ***Section 1.4***), was included in the project database. The full project database was used in the nature and extent evaluations and data trends analyses. The project database was also provided to GeoSyntec for their use in the preliminary human health risk evaluation. The quality of the historic data varies because differing methods of sample collection and analyses were used. Limited or no detailed records are available for some data sets regarding where and how the samples were collected and analyzed or on field and laboratory Quality Assurance/Quality Control (QA/QC) measures. These data quality issues are discussed for each of the historic data sets in the following paragraphs. Certain assumptions that were necessary to use the data are also noted. Available details on the historic sampling locations are presented in ***Table 1***. The general sampling locations are also shown on ***Figure 2***.

The 1964 USEPA sampling event included the collection of three sediment samples from the now concrete-lined section of the channel that extends to Evergreen Street and two samples downstream from within the unlined section from Watkins Street to the Cypress Creek Pumping Station. Based on a September 27, 1965, aerial photo, it is not clear if the creek was concrete lined at the time the 1964 samples were taken. Only two analytes were reported - endrin and dieldrin. The available information did not include detailed information on the sample locations, sampling depths, sample collection and handling methods, or laboratory analytical and QA/QC procedures. In 1964 generally accepted analytical methodologies for soil/solid waste analyses were not available for determining with reasonable certainty the identification of constituents, therefore the data would be, at best, only usable for qualitative purposes. It was only in 1986 that the USEPA Test Methods for Evaluating Solid Waste (SW-846) first became available, setting uniform procedures for sample collection, quality control and analysis.

The 1980 USEPA sampling event included the collection of three sediment samples from the unlined portion of the channel between Evergreen Street and the pumping station. VOCs, PAHs, and pesticides were reported. The available information did not include detailed information on sample collection and handling methods, or laboratory analytical and QA/QC procedures. These analyses pre-dated SW-846.

The 1981 Memphis and Shelby County Health Department sampling event included collection of seven samples from within the Upper and Lower Surge Basins. Three sediment samples were collected from the channel bottom and four soil samples were collected from the north and south overbanks in the Lower Surge Basin. Pesticides were the only reported analytes. The available information did not include detailed information on the sample collection and handling methods, or laboratory and QA/QC procedures. These analyses also pre-dated SW-846.

The 1992 USEPA sampling event was performed by Dynamac Corporation. It included collection of six sediment samples from the channel bottom in the Upper and Lower Surge Basins and six soil samples from the north and south overbanks in the Lower Surge Basin. USEPA also collected a sample at the headwaters of Cypress Creek, which was included in the database. The reported analytes included VOCs, PAHs, pesticides and metals. Substantial sampling details, laboratory analytical methods and QA/QC quality information were available on these samples.

In 1993, Black & Veatch (for USEPA Region IV) collected five sediment samples from the channel bottom in the Lower Surge Basin, and five soil samples from the north and south overbanks within the Lower Surge Basin. Analytes included VOCs, PAHs, pesticides, and metals. Substantial sampling details, laboratory analytical methods and QA/QC quality information were available on these samples.

On October 11, 1999, November 6, 1999, February 5, 2000, and March 21, 2000, Vollintine-Evergreen Community Association (VECA) collected samples from three locations within the channel and from the North overbank within the Upper Surge Basin. Samples were collected with assistance from Rhodes College. Analytes included PAHs, polychlorinated biphenyls (PCBs), pesticides and metals. Substantial sampling details, laboratory analytical methods and QA/QC quality information were available on these samples.

3.1.2 MEC March 2001 Data

The laboratory analytical data from the samples collected by MEC were evaluated, and validated in accordance with the SAP and Work Plan to achieve Data Quality Objective Level III prior to data transfer into the project database. The resulting Analytical Data Quality Assessment and Validation Report (Validation Report), located in ***Appendix D***, is summarized as follows:

- *Sample Delivery* - The Validation Report indicated that the samples were transported, handled, and analyzed per the requirements of the SAP.
- *Holding Time Periods* - Sample extraction and analyses were performed within the holding times specified by the SAP and appropriate Test Methods.
- *Laboratory Blank Analyses* - The Validation Report indicated that no laboratory contamination occurred during sample analyses.
- *Matrix Spike/Matrix Spike Duplicate (MS/MSD) Analyses* - For the PAH and pesticide analyses the MS/MSD data were within control limits, indicating that no qualification of the data was necessary. For

the metals analyses, the MS/MSD data were outside control limits, and the results were qualified as estimated, and were flagged as "J."

- *Blank Spike/Surrogate Compound Recovery* - The Validation Report indicated that the recoveries for both of these internal QA/QC tests were within control limits for the analytical methods.

- *Field Duplicate Analyses* - Two field duplicate samples were collected and analyzed. The Validation Report indicates that some of the compounds detected were outside the Relative Percent Difference control limits used to compare the results of the primary and duplicate sample. The results, which were outside the control limits for both the primary and duplicate sample, were qualified as estimated and flagged as "J."

- *Field Blank Analysis* - The results indicated that the water used for decontamination did not introduce constituents to the samples.

- *Rinse Blank Analysis* - The results indicated that the field decontamination procedures used were sufficient in decontaminating the sampling equipment.

- *Miscellaneous Quality Control* - Several pesticide samples required qualification due to non-confirmation of results due to matrix interference. These data were qualified as estimated and flagged as "UC."

- *Data Completeness* - Completeness is a measure of the amount of valid data compared to the amount under normal conditions. The Validation Report indicated that the estimated data (J-flags) are usable as qualified, and that the completeness of the data is 98%, compared to the SAP's stated expectation of 85% completeness for laboratory data.

3.1.3 TDEC March and May 2001 Data

TDEC collected soil and sediment samples during the March 2001 sampling event. They also collected additional surficial samples (0 to 3-inch depth) on May 7, 2001, from 5 of the locations sampled during the March 2001 sampling event. The TDEC samples are described below. The sample locations are shown on ***Figure 2.***

- Split samples were collected from locations T2-F1, T3-NB1, T4-F1, T4-SB1, T5-SB1, and T6-NB1 on March 5 and 6, 2001.

- Additional samples were collected from the following areas on March 7, 2001:

- BT-1 was collected between F7 and T6 from the North side of the channel near a sewer conveyance pipe, which crosses the channel at this location.
- SB-2 and SB-3 were collected from the South overbank within the Lower Surge Basin.
- SB-4 was collected from the North overbank within the Lower Surge Basin.
- SB-1 was collected from the City of Memphis' Lucille Price Playground above the Lower Surge Basin.
- On May 7, 2001, TDEC collected surficial samples (0 to 3-inch depth) at the following locations from which samples were collected during March 2001: SB-1, T6-NB1, HA-3, T4-SB1, SB-3.

The TDEC sample results were received by MEC and entered into the project database as qualified on their laboratory reports. The split sample results were evaluated and it was determined that the analytical results from GTW and TDEC's laboratory were similar (generally within 10 percent of reported constituent values). Therefore, at locations where split samples were collected, the MEC laboratory results were utilized in the data evaluations because they had undergone the extra step of Data Validation.

3.1.4 Overall Data Quality and Validity

The historic data varies by collector, collection method, location, analyte suite, test methods, and various degrees of analytical method and equipment precision. For the purposes of this investigation, the historical data was used as originally qualified by the available reports for each sampling event. The majority of the historical data was only available on summary tables, i.e. the reports from the analytical laboratory could not be located. However, for the purposes of this ***Section 3.0*** data evaluation, all of the data in the database is considered useable as qualified.

Additionally, due to the varying level of detail used to describe the various historic sample locations, the precise location (both horizontally and vertically) for some of the samples can not be determined. MEC's interpretation of the historic sample locations, based on the available descriptions, is depicted on ***Figure 2***.

3.2 Project Database

The data was entered into a Microsoft® Excel® spreadsheet containing the following fields:

Sample Information

- Date (Date sample collected, if known)
- Identification (unique sample number or name given to it by the sampler)
- Location (lineal feet downstream or upstream of the Scott Street Bridge, which was chosen by MEC as the baseline)
- Sample Depth (if known)

Analytical Information

- Analytical Group (i.e. PAHs, metals, pesticides, etc.)
- Parameter (i.e. aluminum, aldrin, benzo(a)pyrene, etc.)
- Laboratory Reported Result
- Flag (any qualifier given to the data by the laboratory or data validator)
- Units (unit of reported result)

General Information Regarding the Sample as Available

- Report Number (listing the report the data came from)
- Lab Comments (laboratory comments, notes on flags, etc.)
- Sample Notes (description of sampling methodology, location, etc.)
- General Comments (additional description of sample location, field notes, etc.)

Following entry, the data was checked by a person who was not involved in the data entry process, the database was corrected as necessary and checked again. The database was updated upon receipt of new data or information. The database currently contains 8,547 lines of data, each line contains sample information in the fields described above. A summary of the laboratory data, as taken from the project database, is provided in ***Table 2***. Sample location information is summarized on ***Table 1***. The complete laboratory reports for the samples collected by MEC, including a copy of chain of custody forms and the laboratory QA reports, are provided in ***Appendix F***.

The data was then imported into Microsoft® Access® to perform data evaluation, sorting, and querying as described in the following sections.

3.3 Nature and Extent Evaluations

The nature and extent evaluations consisted of two approaches, which are presented in the following subsections. In the first evaluation, the analytical data was compared to standard published generic USEPA Region IX Preliminary Remediation Goals (PRGs) dated November 1, 2000. Sub-areas where soil and/or sediment constituent concentrations exceed the initial PRG screening values were identified for further evaluation by GeoSyntec Consultants in the preliminary human health risk evaluation. In the second approach, the analytical data were evaluated to determine if spatial (i.e., sample location) or temporal (i.e., time frame) relationships could be correlated with the analytical data. The objective was to determine if data trends exist that could be used to fill data gaps and to project changes in constituent concentrations in the future. All of the historic and 2001 data in the project database was used in the evaluations presented in Section 3.3.

3.3.1 Initial PRGs Screening

The first step of the initial PRGs screening evaluation was to partition the soil and sediment samples into sub-areas based on differing Creek Channel and land use conditions. On July 2, 2001, a Study Area tour was held with a human health risk assessor and site investigation specialist from GeoSyntec Consultants. Based on that tour, the Study Area was divided into five sub-areas by soil/sediment sample locations as follows:

- Sub-Area I. Overbank Samples in Industrial Land Use Area
  Sub-Area I is the area between the Scott Street Bridge and 200 feet North or downstream of the Jackson Avenue Overpass. Sub-Area I is represented by the shallow and deep overbank samples collected from Transects T1 and T2. The land use of Sub-Area I is industrial surrounding the Scott Street Bridge (T1 location) and industrial/commercial at the Jackson Avenue Overpass (T2 location). These sample results were compared to Industrial Land Use PRG screening values.

- Sub-Area II. Samples Beneath the Concrete Liner from Scott Street to Evergreen Street
  Sub-Area II represents areas that would typically be accessed only by utility or construction workers. Samples collected from beneath the concrete channel in 2001 and sediment samples collected by USEPA in 1964 are regarded as representative of Sub-Area II. The concrete liner covers the channel bottom and exposure would be limited to occasional utility or construction workers. A portion of the City of Memphis's

wastewater sewer runs beneath the concrete liner on the north side of the channel from Staten Avenue to Evergreen Street. These sample results were compared to Industrial PRG screening values.

- Sub-Area III. Overbank Samples in the Residential Area from 200 feet North of the Jackson Avenue Overpass to the Evergreen Street Bridge
  The land use of Area III is generally residential. Some commercial property, a school, public parkland, a church and apartments also exist in Area III. The shallow sample results (surface to two feet depth) were compared to Residential PRGs. Samples from deeper depths were compared to Industrial PRGs because exposure to deeper soil is expected to be limited to occasional utility workers.

- Sub-Area IV. Soil and Sediment Samples from Within the Upper Surge Basin - Evergreen Street to Chelsea Avenue
  This open space area is a surge basin (floodplain) where storm water ponds at times of high flow exceeding the outfall capacity at the pumping station. Residential and some industrial property is located above the floodplain elevation to the South, to the North a mixture of industrial/commercial and residential property exists. The shallow sample results were screened against Residential PRGs. Deeper samples were screened against Industrial PRGs because exposure to deeper soil is expected to be limited to occasional utility workers.

- Sub-Area V. Soil and Sediment Samples from Within the Lower Surge Basin and from the Cypress Creek Pumping Station to the Wolf River – Chelsea Avenue to the Wolf River
  The open area between Chelsea Avenue and the pumping station is a surge basin (floodplain) where storm water ponds at times of high flow exceeding the outfall capacity at the pumping station. Residential property is located above the floodplain elevation in the Southeast corner, and to the west of Area V. The area east of the Lower Surge Basin also contains the Memphis Area Transit Authority (MATA) bus barn and a garbage transfer station. The Lucille Price Playground is located above the floodplain elevation near the south side of the Lower Surge Basin. This area floods more frequently than the Upper Surge Basin. The area between the pumping station and the Wolf River is currently undeveloped. The sample results were screened against Industrial PRGs. Only shallow samples have been collected from this area.

All of the soil and sediment data in the project database was compared to the generic Industrial or Residential Soil PRGs to identify sub-areas with samples that exceed PRGs. The PRG value for each detected constituent was used in the initial screening evaluation, if one existed. Some compounds have isomers (i.e., Gamma-Chlordane) which do not have a published PRG value. These were evaluated against the PRG value for the parent compound (i.e., Chlordane). If a constituent does not have a related PRG value, or if it was reported as not detected at an elevated detection limit above the PRG value, it was not considered as an exceedance of the screening criteria in this evaluation.

Tables 3 through *7* present the results of the initial screening of each sub-area against Region IX generic PRGs. These tables include a list of the constituents by chemical group that exceed PRGs, the PRG values used as the basis of screening and the number of PRG exceedances. Information on the number of PRG exceedances is presented in comparison to the number of samples analyzed and the number of times the compound was detected. The ranges of values and average constituent concentrations are also presented in the tables. A summary of the initial screening findings follows.

3.3.1.1 Sub-Area I

As indicated on ***Table 3***, three PAHs and two pesticide compounds were detected above the generic Industrial PRG values. These compounds and their sampling locations are shown on ***Figure 4.*** Based on the results of this screening evaluation, Sub-Area I was carried forward for analysis in the preliminary human health risk evaluation.

3.3.1.2 Sub-Area II

As indicated on ***Table 4***, two PAHs and six pesticide compounds were detected above the generic Industrial PRG values. These compounds and their sampling locations are shown on ***Figure 5.*** Based on the results of this screening evaluation, Sub-Area II was carried forward for analysis in the preliminary human health risk evaluation.

3.3.1.3 Sub-Area III

As indicated on ***Table 5***, five PAH and seven pesticide compounds were detected above the generic Residential PRGs in the shallow samples. One PAH and five pesticide compounds were detected above generic Industrial PRG values in the deep samples. These compounds and their sampling locations are shown on ***Figures 6*** and *7* for the shallow and deep samples, respectively. Based on the results of this screening evaluation, Sub-Area III was carried forward for analysis in the preliminary human health risk evaluation.

3.3.1.4 Sub-Area IV

As indicated on ***Table 6***, seven PAH and 13 pesticide compounds were detected above the generic Residential PRGs in the shallow samples. Two PAH and seven pesticide compounds were detected above generic Industrial PRG values in the deep samples. These compounds and their sampling locations are shown on ***Figure 8*** and ***9*** for shallow and deep samples, respectively. Based on the results of this screening evaluation, Sub-Area IV was carried forward for analysis in the preliminary human health risk evaluation.

3.3.1.5 Sub-Area V

As indicated on ***Table 7***, six PAH and three pesticide compounds were detected above the generic Industrial PRG values. These compounds and their sampling locations are shown on ***Figure 10.*** Based on the results of this screening evaluation, Sub-Area V was carried forward for analysis in the preliminary human health risk evaluation.

3.3.1.6 Cypress Creek Headwaters (Background Sample Location)

The PRG screening evaluation identified four PAHs (i.e., benzo(a)anthracene, benzo(b and/or k)fluoranthene, benzo(a)pyrene, and indeno(1,2,3-cd)pyrene) that exceed generic Residential PRGs at Sample Location CC-SS-01. This sample was collected in 1992 at the headwaters of Cypress Creek at Location –18,800'. It was not included in any of sub-areas because it is considered to be a background sample location relative to the Investigation Study Area.

3.3.2 Trend Analyses

3.3.2.1 Upstream to Downstream Along Channel

Constituent concentrations were evaluated to determine if they consistently increase or decrease in the direction of the creek flow. No trends were identified along the channel. However, this apparent absence of trends may be due to the differences in the sampling and analytical methods used in the historic and 2001 sampling events as well as changes at specific locations due to the impacts of sediment mobilization and re-deposition.

3.3.2.2 Distance From Channel in Sub-Area IV

Five transects (i.e., T6-SB[south bank], T6-NB[north bank], V-1, V-2 and V3) were sampled in Sub-Area IV, the Upper Surge Basin. These transects were specifically intended to evaluate concentration trends relative to distance from the creek channel in the overbank areas. The evaluation looked at surficial samples where generic Residential PRGs were exceeded in at least two of the sample locations. The locations of these transects are shown on ***Figure 8***.

Figure 11 illustrates the trends for dieldrin, which generally correspond to trends found for other compounds in Sub-Area IV. The dieldrin concentration increased significantly in going from the bottom sediment samples to the nearest overbank samples. In moving from the near-overbank sample to the more distant overbank sample, the dieldrin concentration decreased in four transects and increased in the fifth. At all five transects, the dieldrin concentration exceeded the Residential PRG at the sample location farthest from the creek channel. This analysis shows that significant soil impacts may extend beyond the farthest sampled distances from the creek channel. This analysis also indicates that the bottom sediments are relatively clean as compared to the overbank soils.

Historic aerial photos were evaluated in an attempt to explain the presence of contamination outside the creek channel. An August 10, 1937, aerial photo shows that Cypress Creek had been straightened in the Upper Surge Basin by that date. This was several years prior to the construction and operation of chemical manufacturing facilities at the present day Velsicol location. A comparison of the 1937 aerial photo to March 4, 1958 and September 27, 1965 aerial photos indicates that the channel may have moved one or two channel widths (perhaps 25 to 75 feet) toward the southwest in the area where the flow direction changes from west to northwest in the vicinity of Transects V-2, V-3, and T6. This is not unexpected because streams normally erode their outside bank and deposit sediments on their inside bank at bends. Field conditions observed during the March 2001 sampling event also support this condition. The south bank at Transect 6 is nearly vertical, which is indicative of erosion, and the north bank is more gently sloped, which is indicative of deposition. The movement of the channel to the south/southwest in this particular area might be one explanation of the northside overbank soil concentrations.

Additionally, a review of aerial photos of the Upper Surge Basin revealed that large trees were generally absent from the banks of the channel until approximately 1965 and that some sort of work (i.e., possibly channel cleaning) was occurring on both banks of the channel prior to that date. Channel cleaning, as well as flood deposition could also be factors in explaining the overbank contamination.

3.3.2.3 Surficial Versus Shallow Soil Samples

The March 2001 "shallow" soil samples were collected from the 0 to 12-inch depth in accordance with the Work Plan. In May 2001, TDEC collected "surficial" samples at the 0 to 3-inch depth at five locations where shallow samples had been collected during March. An objective of TDEC's supplemental sampling was to determine if there is a significant difference in constituent concentration between the two sampling depths. A difference could be expected due to the higher rate of organic compound degradation by biological and physical processes that are generally believed to occur at the soil surface. As part of MEC's trend analyses, the shallow and surficial soil sample concentrations of each pesticide and PAH compound detected at each of the five sample locations were compared to determine if this expectation held true.

The results of this trend analysis are summarized as follows:

- Pesticide concentrations in the surficial samples were lower than the pesticide concentration in the shallow samples in 22 of 24 comparisons. This result appears to confirm the above expectation.
- PAH concentrations in the surficial samples were higher than the PAH concentration in the shallow samples in 28 of 33 comparisons. This result does not conform to the expectation. An explanation of this follows.

The PAHs include combustion products and are commonly found in soils in urban areas where the density of combustion engine vehicles is high. The are deposited by air and are commonly identified around urban water bodies that carry extensive loads from street runoff. These compounds are still being deposited on the ground surface today and would, therefore, be expected at higher concentrations in surficial soils than in deeper soils.

3.3.2.4 Chlorinated Pesticide Half-Lives and Degradation Products

MEC evaluated constituent concentrations in the available soil and sediment analytical data from 1964 through 2001 to see if there was any correlation of concentrations with time that might indicate degradation rates. However, this evaluation was limited by the differences in sample locations, collection methods, and analytical methods and was unable to identify any trends. Therefore, GeoSyntec Consultants assembled the following summary from available information on pesticide half-lives and degradation products.

The chlorinated pesticides are generally highly persistent in the environment compared with other types of pesticides and other chemicals. Even among the chlorinated forms, some cyclodiene pesticides, such as dieldrin and endrin, are particularly persistent. Several cyclodiene pesticides have been identified in samples associated with the Cypress

Creek Drainage Channel so their persistence and fate in the environment are discussed in the following list. Also, chemicals related to the chlordane/heptachlor family of compounds have been identified and similar information is provided for these chemicals. Finally, DDT breakdown products have been identified in one sub-area, so the persistence and fate of these chemicals is discussed.

- Aldrin. Among the chlorinated pesticides, aldrin has a relatively short half-life and is not highly persistent in soil. The half-life for aldrin in soil ranges from approximately 20-100 days, and it is primarily degraded by aerobic epoxidation to dieldrin (HSDB, 2001). There are indications that the rate of conversion to dieldrin varies substantially depending on soil conditions and biological activity in soil. Therefore, it is not feasible to estimate historical aldrin levels using the estimated half-life alone. Also, aldrin is subject to anerobic degradation, and half-lives in anerobic sludges (wastewater treatment) are substantially faster (approximately one week)(ATSDR, 2000). When exposed to sunlight, aldrin is converted to photo-aldrin, and eventually to photo-dieldrin even more rapidly. These photo-rearranged compounds are highly stable in the environment (Crosby and Moilanen, 1974).

- Dieldrin. Dieldrin is highly persistent in soils with an estimated soil half-life of about 7 years. It also has a similar half-life in water (Nash and Woolson, 1967). Dieldrin levels may remain measurable for more than 20 years following its application as a foundation termiticide. The primary way in which dieldrin levels decline in soil is through volatilization, not biological or chemical degradation. Note that the volatility of dieldrin is very low, meaning that this primary mechanism of dieldrin loss operates very slowly (Altschuh et al., 1999). There is some microbiological degradation of dieldin, and the resulting products can include aldrin (which would re-convert to dieldrin) and some partially dechlorinated metabolites. Anerobic conditions do not appear to accelerate the degradation of dieldrin as loss from flooded fields is slower than upland fields and experiments with wastewater treatment sludge show a relatively slow rate of dieldrin loss (Tabak et al., 1981). Accordingly, anerobic conditions may help accelerate the transformation of aldrin to dieldrin, but do not support subsequent breakdown of the more stable form. Dieldrin is very strongly adsorbed to organic matter in the soil, meaning that it has very limited mobility in soil (Felsot and Wilson 1980; Sharom et al., 1980). The shortest estimate made based on soil conditions most conducive to transport is that it would take 270 years for dieldrin to be transported 3 meters through soil.

- Isodrin. Isodrin is chemically very similar to aldrin (stereoisomers) (Verschueren, 1996). It shares chemical properties with aldrin, and is also expected to degrade primarily through similar microbial pathways resulting in rearrangement to a related compound, in this case endrin. The degradation of isodrin to endrin appears to be slower than that from aldrin to dieldrin, however, with soil half-lives estimated between 6 and 14 years based on field studies (Nash and Woolson, 1967). Laboratory studies indicate that soil conditions are critical to the rate of degradation and that plants may transform isodrin to endrin more rapidly as well. Like aldrin, isodrin exposed to sunlight can degrade to a photodegradation product, photoisodrin, that is also very stable in the environment (Kearney et al., 1969).

- Endrin. Similar to dieldrin, endrin is an extremely stable form that is a breakdown product from isodrin, in addition to being a directly used pesticide (Nash and Woolson, 1967). There is, however, slow transformation from endrin to endrin ketone and lesser amounts of endrin aldehyde in soil. These same transformation reactions appear to occur in plants on treated soil and are accelerated under hot conditions. Endrin mobility in soil is expected to be extremely limited and, similar to dieldrin, volatilization, especially when soil is moist, may represent the primary mechanism of loss from soil (HSDB, 2001). The volatilization half-life has been reported as 63 days from a specific, moist soil type (Nash, 1983). Under natural, field conditions the measured half-life is approximately 4-8 years (Menzie, 1972). In contrast to dieldrin, the anerobic conditions may significantly accelerate the breakdown of endrin (Syracuse Research Corporation, 1980). Experimentally flooded soils and laboratory tests suggest that the half-life could be dramatically reduced (down to a couple of weeks). However, the effectiveness of anerobic processes in degrading aged endrin in the field is expected to be limited due to the strong adsorption to soil particles, limiting the ability of microorganisms to metabolize the chemical (HSDB, 2001).

- Chlordane. The pesticide chlordane is a complex mixture of chemical compounds with varying persistence and volatility. The predominant compounds are alpha-chlordane and gamma-chlordane (Verschueren, 1996). Chlordene and heptachlor are also notable components of chlordane pesticides (technical chlordane) (IARC, 1979). Under field conditions, chlorodane may persist for long periods of time with a mean half-life of 3.3 years (Rao and Davidson, 1982). The proportions of alpha-chlordane and gamma-chlordane change during degradation and it appears that gamma-chlordane may degrade somewhat faster, but then conversion of alpha-chlordane to gamma-chlordane continues to keep levels of this isomer measureable. The finding of chlordane residue in soil at least 10 years after the last known application indicates that it biodegrades slowly in soil. The biodegradation of chlordane appears to be a very limited factor in loss from soil, with slow volatilization playing a more important role. Conversions from the chlordane isomers to substituted chlordenes, oxychlordane, and heptachlor have all been observed through specific microorganismal degradation (Beeman and Matsumura, 1981). Chlordane does not apparently degrade substantially under anerobic conditions.

- Heptachlor. In addition to being a component and breakdown product of technical chlordane, heptachlor was isolated and used as a pesticide on its own. Heptachlor was derived from chemical reactions involving chlordene, so this compound can also be present in association with heptachlor (IARC, 1979). Heptachlor's persistence in soil is only moderate, with a soil half-life of around 6 months (USEPA, 1985). However, the major degradation product in soil, heptachlor epoxide, is very persistent, remaining in soils for many years. In addition to heptachlor epoxide, chlordane and 1-hydroxychlordene are breakdown products that result from hydrolysis of heptachlor in moist soils (HSDB, 2001). Heptachlor is also subject to substantial anerobic degradation. Both heptachlor and heptachlor epoxide have very limited mobility in soil (HSDB, 2001).

- DDx Compounds. DDT and its primary stable metabolites DDE and DDD are typically considered together with regard to fate and transport properties. By typical comparisons, all are highly persistent in the environment. DDD can be produced under anerobic conditions from DDT, and anerobic conditions appear to substantially accelerate DDT degradation. DDE is produced from DDT under aerobic conditions, though at an slower rate. The soil half-life of DDT appears to range from about 2 to 15 years, depending on soil conditions (Lichtenstein and Schultz, 1959; Tu and Miles, 1976; Jury et al., 1988; Stewart and Chisholm, 1971). DDE has an even longer half-life (Callahan et al.,1979). The DDx compounds all have extremely limited mobility in soil due to their strong adsorption to organic matter in the soil (HSDB, 2001). While extensive metabolic and degradation pathways for DDx compounds have been characterized, the three primary forms are relatively so stable that they are clearly the dominant forms in environmental samples.

3.4 Summary

The available historic and 2001 data was assembled into a database for nature and extent evaluations and data trend analyses. The sample results were analyzed in terms of five sub-areas based on differing Creek channel and land use conditions and then compared to generic USEPA Region IX PRG values. The Initial PRG Screening found that all five sub-areas warrant being carried forward through the Preliminary Human Health Risk Evaluation. The trend analyses were inconclusive in some respects but did indicate the following: the bottom sediments in the Upper Surge Basin are relatively clean as compared to the overbank soils, the soils are generally less impacted by pesticides in the top 3 inches than in the top 12 inches, where direct comparisons could be made, the soils are generally more contaminated by PAHs in the top 3 inches than in the top 12 inches, and the predominant pesticides found in the soils and sediments and their breakdown products have variable persistence in the environment.

4.0 PRELIMINARY HUMAN HEALTH RISK EVALUATION

The project database and the findings of the nature and extent evaluations (i.e., ***Section 3.0***) were provided to GeoSyntec Consultants for their use in performing the Preliminary Human Health Risk Evaluation. GeoSyntec's full report, which was written for a technical audience, is presented in ***Appendix E***. A summary of GeoSyntec's report follows.

The complete project database was reviewed and sorted to identify analytical results to be included in characterizing potential risks in various portions of the creek. The goal was to identify current surface soil and sediment constituent concentrations that would be relevant for evaluating potential exposures. The most representative data available for each of the five sub-areas (see ***Section 3.3.1***) and related specific exposure scenarios were identified and used in the evaluations. In general, only the most recently obtained data was used where both new and historic data existed.

These analytical results were then compared with the most conservative USEPA risk-based screening values (i.e., the Residential PRGs) to identify constituents from each sample that should be considered with regard to potential human heath risks. These constituents are referred to as constituents of potential concern or COPCs. A number of additional compounds that do not have published PRGs were also included in the COPCs if they were identified in the analytical data and are associated with chlorinated pesticide manufacturing. The identified COPCs included predominantly chlorinated pesticides, polycyclic aromatic hydrocarbons (PAHs) and metals.

The Velsicol plant was one potential source for chlorinated pesticides, degradation products, and related manufacturing intermediates found along the Cypress Creek Channel. However, these chlorinated pesticides were also used extensively in agricultural, residential, and mosquito control applications for many years. All of these uses also could have resulted in contributions to Cypress Creek Drainage Channel concentrations.

PAHs are combustion products and are commonly identified around urban water bodies that carry extensive loads from street runoff. Storm water related deposition adds to general ambient airborne deposition of PAHs that occurs in urban areas where the density of combustion engine vehicles is high.

Likewise, metals levels are often elevated around urban water bodies heavily impacted by road runoff. Contributions come from the road materials themselves (asphalt), petroleum combustion, brake linings and various urban uses.

GeoSyntec more specifically defined the most conservative exposures that would occur (i.e., receptor scenarios) in each sub-area and these were utilized in the more detailed evaluations. These are summarized as follows:

- Sub-Area I: Industrial Worker
- Sub-Area II: Utility Worker
- Sub-Area III: Residential
- Sub-Area IV: Groundskeeper, Recreator, and Channel Maintenance Worker
- Sub-Area V: Groundskeeper, Recreator, and Channel Maintenance Worker

The standard, or so called default (generic) PRGs were used in the evaluations for Industrial and Residential exposures. Additional PRGs for the utility worker, groundskeeper, recreator, and channel maintenance worker receptors were developed using the USEPA Region IX approach and equations.

The standard and alternate PRGs were then compared to maximum detected concentrations, as well as to exposure point concentrations (EPCs) representing overall exposure levels, for each sub-area and exposure scenario as a further screening evaluation. (Note: EPCs are a statistical representation of the data. Where an adequate number of samples was available, the 95% upper confidence limit of the mean was used as the EPC.) A summary of this screening evaluation follows:

- With the exception of Sub-Area III, there were a limited number of constituents that were identified with maximum or EPC concentrations exceeding the PRGs relevant to the sub-areas.

- In Sub-Area I, only combustion-related PAHs were identified above industrial PRGs.

- In Sub-Area II, three pesticides or related chemicals were identified with maximum concentrations exceeding utility worker PRGs.

- In Sub-Area III, a number of pesticides and PAHs exceed residential PRGs.

- In Sub-Area IV, two pesticides exceeded the groundskeeper scenario PRGs, several more pesticides and other constituents exceeded the recreator PRGs, and one pesticide exceeded the channel maintenance worker scenario PRGs. TDEC's surficial soil sampling at the location with the highest specific concentration of dieldrin indicated that the 0 to 3-inch surficial soil had a concentration below the PRGs.

- In Sub-Area V, one pesticide and one PAH exceeded the groundskeeper scenario PRGs, two additional PAHs exceeded the recreator PRGs, and one PAH exceeded the channel maintenance worker scenario PRGs. TDEC's surficial sampling at the location with the highest specific concentration of dieldrin indicated that the 0 to 3-inch surficial soil had a concentration below the PRGs.

Since there were observable exceedances of PRGs from at least one sampling location in each sub-area, the scope of work for this evaluation was expanded to include a Preliminary Risk Evaluation (PRE) risk estimation process to further evaluate potential risks. A summary of the results of the PRE follows:

- In Sub-Area I, the PRE risk estimates indicated that the constituents identified above industrial PRGs would not be expected to produce chemical-specific excess cancer risks greater than USEPA's target risk range of $1x10^{-6}$ to $1x10^{-4}$.

- In Sub-Area II, the PRE risk estimates indicated that the constituents identified above utility worker PRGs would not be expected to produce chemical-specific excess cancer risks greater than USEPA's target range.

- In Sub-Area III, the PRE risk estimates indicated that constituents identified above residential PRGs could represent a risk to nearby residents above USEPA's target risk range. These constituents included dieldrin, endrin ketone, endrin and isodrin. Dieldrin exceeded USEPA's target excess cancer risk range and the non-cancer risk estimates for endrin ketone, endrin and isodrin exceeded the EPA threshold HQ of one. This indicates that potential risk from these constituents could be considered significant if residential exposures actually occurred to the concentrations found in sampling. The distribution of elevated constituent concentrations in this area is not clear, and TDEC re-sampling efforts helped clarify that pesticide levels in the shallowest layer of surface soil, where current exposures would most likely occur, appear to represent substantially less of a risk than those at somewhat deeper levels. The current data provide information on constituent concentrations immediately adjacent to the channel banks and may not be representative of conditions further from the channel.

- In Sub-Area IV, the PRE risk estimates indicated that the constituents identified above groundskeeper, recreator, or channel maintenance worker PRGs would not be expected to produce chemical-specific risks greater than USEPA's target range for excess cancer risk or greater than background risks for soil arsenic.

- In Sub-Area V, the PRE risk estimates indicated that the constituents identified above groundskeeper, recreator, or channel maintenance worker PRGs would not be expected to produce chemical-specific excess cancer risks greater than USEPA's target range.

- The PRE results demonstrated that the concentrations of constituents identified along the various segments of the Cypress Creek Channel do not represent a level of potential risk to current receptors that requires immediate action.

The findings of the PRE only apply to the specific sample locations and exposure scenarious described herein, and should not be extrapolated to other areas or land use conditions.

5.0 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Summary and Conclusions

The investigation methods and findings are summarized in the following:

- The objectives of the Investigation were as follows:
  - Collect and analyze soil and sediment samples primarily in areas that had not been sampled in historic investigations, so as to fill in data gaps.
  - Use screening tools and a preliminary human health risk evaluation to identify areas of concern that may require additional investigation and/or corrective action.

- The Investigation Study Area is the Cypress Creek Storm Water Drainage Channel and certain adjacent overbank and undeveloped floodplain areas along the Channel from Scott Street to the Wolf River. It does not include tributaries to Cypress Creek or other non-contiguous areas.

- The investigation findings are presented in terms of five sub-areas, as follows:
  - Sub-Area I: The industrial areas outside of the channel from Scott Street to 200 feet downstream of Jackson Avenue.
  - Sub-Area II: The channel bottom under the concrete liner from Scott Street to Evergreen Street.
  - Sub-Area III: The predominantly residential area outside of the channel, from 200 feet downstream of Jackson Avenue to Evergreen Street.
  - Sub-Area IV: The open space area from Evergreen Street to Chelsea Avenue, including the Upper Surge Basin.
  - Sub-Area V: The open space area from Chelsea Avenue to the Wolf River, including the Lower Surge Basin.

- During March 2001, Velsicol collected and analyzed a total of 37 soil and sediment samples from six transect locations, four separate over bank locations and one additional bottom sample location. TDEC provided oversight of Velsicol's field investigation and collected 5 supplemental samples. TDEC also analyzed 6 samples that had been split with Velsicol and collected 5 surficial (0 to 3-inch depth) soil samples during May 2001.

- Velsicol evaluated the quality and usability of the 2001 sampling results, as well as historic data from a number of prior investigations. The historic investigations had occurred over the period of 1964 through 2000. All of the useable data was assembled into a project database. This database includes 8,547 lines of data.

- Velsicol performed an initial screening of the analytical data with the limited objective of identifying sub-areas that warranted further evaluation. This screening used USEPA Region IX standard or generic preliminary remediation goals (PRGs) as the basis. This evaluation found that all five sub-areas warranted further evaluation.

- Data trend analyses indicate the following:

  - Creek bottom sediments in the Upper Surge Basin are relatively clean as compared to the overbank soils
  - The soils are generally less contaminated by pesticides in the top 0 to 3-inch than in the top 0 to 12-inch. This trend is reversed for PAHs
  - The predominant pesticides found in the soils and sediments and their breakdown products are generally persistent in the environment, however, the persistence varies significantly.

- As a second sub-area screening evaluation, standard, and site-specific (alternate) PRGs were compared to maximum detected constituent concentrations and statistically derived exposure point concentrations (EPCs) for applicable exposure scenarios. This screening evaluation found that, with the exception of Sub-Area III, there were a limited number of constituents that exceed the PRGs relevant to the sub-areas.

- A Preliminary Risk Evaluation (PRE) risk estimation process was performed to further evaluate potential risks. Overall, the PRE results demonstrate that the concentrations of constituents identified along the various segments of the Cypress Creek Drainage Channel do not represent a level of potential risk to current receptors that requires immediate action. Risks estimated for chemicals above PRGs in Sub-Areas I, II, IV, and V did not appear to be above USEPA's target risk range. Risks estimated for dieldrin, endrin ketone, endrin and isodrin were above PRGs in Sub-Area III and may exceed USEPA's target risk level. However, the risks corresponding to TDEC's resampling of shallowest soil layers in this area were not above this target range and the available data represent only the areas immediately adjacent to the channel banks. It is not known if these data represent conditions further from the banks of the channel.

5.2 Recommendations

- The data and findings of this report should be provided to appropriate parties for their information and use.

- The investigation findings should be used as the basis of discussions with TDEC and others to establish future courses of action.

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