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JAN 31 2001

Group No._____ File No. 62
ID No. TND 002 591 311

January 30, 2001

Mr. David Dorian
U.S. EPA Region IV
Sam Nunn Federal Center
61 Forsyth Street, SW
Atlanta, GA 30303-1304

Subject: **Former Scovill-Schrader Automotive Division Site, Dickson, Tennessee**
**U.S. EPA ID Number TND 002 591 311**
**Conceptual Groundwater Model**

Dear Mr. Dorian:

Enclosed are two (2) copies of the draft Conceptual Groundwater Model for the Former Scovill-Schrader Automotive Division Site, Dickson Tennessee. This model was prepared using regional, local, and site-specific geologic and hydrologic data collected and compiled over the past several years. We have also included in this conceptual model our interpretation of contaminant migration pathways based on our understanding of the groundwater flow system. Finally, we incorporated information that was specifically requested during the conference call between USEPA and IT on October 20, 2000 (see attached teleconference meeting minutes).

We are submitting this model for your review prior to submitting the final RFI report so that comments can be incorporated into the final RFI report, if necessary. To facilitate your review, we would like to schedule a conference call with you, Dave Jenkins, and Roger Donovan, at your earliest convenience, to present the specific features of this site conceptual model.

Should you have any questions, please call me at (865) 690-3211.

Sincerely,

Patricia Thompson

Patricia Thompson
Project Manager

Enclosure

cc: Roger Donovan, Tennessee Division of Environment
Charles Perry, Hunton and Williams
Nick Bauer, Saltire Industrial Inc.
Kathleen Huber, IT Corporation

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# MEMORANDUM

| | |
|---|---|
| TO: | David Dorian, Region IV, EPA<br>Dave Jenkins, Region IV, EPA<br>Nick Bauer, Saltire Industrial, Inc. |
| FROM: | Patricia Thompson, IT Corp.<br>Kathleen Huber, IT Corp. |
| cc: | Roger Donovan, TDEC |
| DATE: | October 26, 2000 |
| REF: | **Meeting Minutes for Conference Call held on October 20, 2000 to discuss the approach for presentation of the hydrogeologic information for the Final RFI Report, Former Scovill-Schrader Automotive Facility, Dickson, TN EPA ID# TND 002-591-311** |

A conference call was held on October 20th with David Dorian, Dave Jenkins, Kathleen Huber, and Patricia Thompson to discuss the hydrogeologic information that EPA considers important for inclusion in the Final RFI report for the facility. It is IT's understanding that the questions raised by EPA were based on their review of the *Draft Groundwater Summary Report, Groundwater Monitoring Program, June 20, 2000*. The topics discussed are summarized below.

*Overall Groundwater Flow System*

- Dave Jenkins made introductory statements expressing his concerns that the levels and extent of contamination had not been clearly defined for the site and that it is important to find "the other end of the flow system" at the Dickson site (i.e., identify off site groundwater flowpaths and receptors). He indicated that he is working on other sites in Tennessee where karst is an issue and that these systems can be defined through groundwater studies. Dave commented that he has not seen a three dimensional characterization for the flow system or a detailed conceptual model for the site that shows the relationship of groundwater flow regimes within a regional picture. He did not recommend detailed modeling, however, he indicated that putting all available data into a conceptual model that included the three dimensional information is imperative for the design of a long term monitoring program. He noted that Saltire needs to present a detailed conceptual model to support the contention that groundwater migration is being contained either with the current interim measures groundwater treatment system or through corrective measures that would be initiated for the site over the long term. He indicated that without acceptance of a conceptual model that proves Saltire's understanding of the hydrogeology (locally and regionally), EPA may question whether Saltire has defined the nature and extent of contamination which may lead to an alternate conclusion (by EPA) that contaminant discharge is occurring but not being detected due to an insufficient monitoring network.

- Kathleen Huber then provided a general statement concerning the environmental work completed at the site over the last 10 years. She pointed out that Saltire has completed extensive site characterization studies and the data presented in the ground water monitoring program summary report did not include these data simply because this was not the focus of that particular document. Saltire's conceptual model of the site was reported in several RFI and related reports that have been submitted to USEPA in the past. The dye trace study, which was a very comprehensive study provided Saltire with a good understanding of the hydrogeologic conditions specific to the site vicinity. Kathleen summarized the basic features of the site conceptual model: a low-permeability residuum overlying a fractured karst bedrock where VOCs in the site source areas are hung up in the saturated zone of the residuum, slowly bleeding down into the bedrock fractures. Kathleen also noted that in the past EPA had requested Saltire to review the environmental data generated from the Lewisburg site and other sites in Tennessee so these sites could be used as a model for site investigations at Dickson. Saltire did look at these data, however, the karst environment at Lewisburg is quite different from what is present at Dickson due to an entirely different type of limestone (i.e., clean Ordovician limestones in Lewisburg versus muddy Mississippian limestones in Dickson) and that comparisons between the two karst systems are not appropriate.

- David Dorian asked about the ISM performance—why had only 10 pounds been recovered from the system as per the June meeting. He asked IT's opinion on that.

- Kathleen briefly described ISM operation and the startup period, the role of the thick residuum at the site and how the residuum slows the migration of contaminants into the bedrock aquifer, and also into the recovery wells. She noted that the interim groundwater treatment system continues to remove mass from the source areas but the limiting factor is the tightness of the residuum unit. She further mentioned that defining a "capture zone" in this type of environment is not possible due to the non-porous flow conditions beneath the residuum unit and that the idea of "capture" should be carefully considered when discussing the remedial goals for the site. The issue of flow nets was brought up during this discussion and Kathleen stated her reluctance to present flow nets in the quantitative sense due to the complexities of the site because they would not accurately depict site conditions. Flow directions can and have been approximated on existing site figures.

- Dave Jenkins agreed that traditional flow nets might not depict an accurate picture for the overall flow system. However, Dave re-stated that a very good case will need to be made by Saltire regarding predictions of where contaminated groundwater should be expected (both on-site and off-site) and where Saltire would expect to see discharge (based on a sound conceptual model).

*Natural Attenuation*

- Dave Jenkins made the statement that based on the data he had seen, it appears the natural attenuation is going on to some extent and that Saltire needs to present data that would show this and perform an evaluation for this in the RFI. He suggested plotting dissolved oxygen levels across the site and off site springs and use this as a preliminary base to see how much attenuation may be going on. He also stated that Saltire needs to collect data for other parameters for natural attenuation evaluation such as nitrates, sulfates, iron, etc. These data are required before EPA will accept monitored natural attenuation as a remedy selection and EPA believes that natural attenuation will be a component to any long term corrective measure. He stipulated that four quarters of monitoring are required to establish whether natural attenuation is occurring and how effective it could be as a corrective measure. David Dorian agreed that these data should be collected to expand our site characterization through geochemistry.

- Patricia Thompson stated that an evaluation of natural attenuation would most likely be done during corrective measure studies and that we do not want to hold up the RFI to include this type of data in the report. David Dorian indicated that this would be acceptable.

- Kathleen Huber asked Dave Jenkins to provide a reference list of EPA guidance documents and other research papers that he considers essential for the evaluation of natural attenuation. Dave will provide references for this.

*Summary*

- In summary, Dave Jenkins suggested that in order to finalize the RFI Saltire will need to 1) nail down discharge areas based on the regional conceptual model; 2) show our predictions of degradation vs. distance to support the fact that by the time any contamination could reach a discharge point it would have minimal to no adverse environmental effects; 3) show that DNAPL is being contained by virtue of the site conditions, i.e., residual DNAPL trapped in a thick residuum; and 4) lower concentrations of dissolved compounds are bleeding off, but don't necessarily present adverse affects to off site receptors.

- Kathleen Huber recommended that the USEPA receive the conceptual model portion of the final RFI before the entire document was submitted so that any outstanding issues could be sorted out prior to the document completion.

- At the conclusion of the conference call, Dave Jenkins suggested that EPA and Saltire have a working meeting where Saltire could present the conceptual model with supporting data such that EPA could provide suggestions and or guidance to ensure that the information presented would be sufficient to finalize the RFI. EPA indicated that the last two weeks in November would be convenient for them.

- Patricia Thompson told EPA that we would keep them abreast on the progress of the development of the conceptual model. She also stated that data collection for natural attenuation would be performed during the CMS.

DSWM, L&C

# Hydrogeologic Conceptual Model Packet

## Draft

## Former Scovill-Schrader Automotive Division Facility Dickson, Tennessee EPA ID No.: TND 002-591-311

**Submitted to:**

**U.S. Environmental Protection Agency**
**Region IV**

**Prepared for:**
**Saltire Industrial, Inc.**

**Prepared by:**
**IT Corporation**
**312 Directors Drive**
**Knoxville, Tennessee 37923**

**January 2001**

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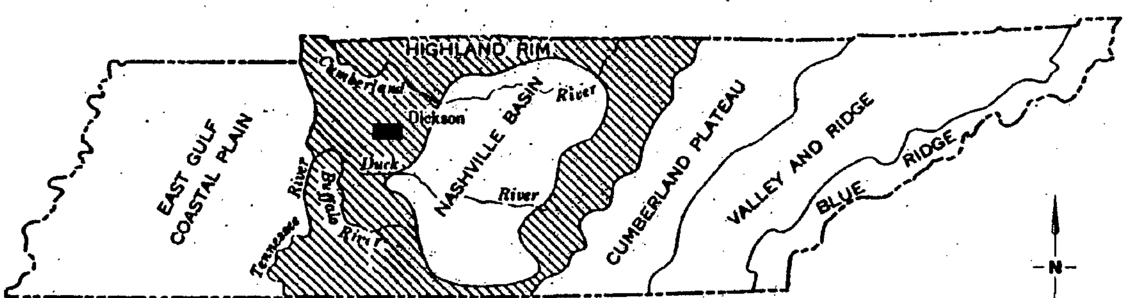
*Figure 1. Physiographic Map of Tennessee.*

As shown in this figure, Dickson County is located on the Western Highland Rim of Tennessee. The Highland Rim is an escarpment facing inward toward the center of the Nashville Dome, an ancient feature, the center of which is now eroded away to form a topographic basin. On the surrounding Highland Rim, strata dip gently away from the former dome center. In Dickson County, northwesterly dips are very slight, on the order of less than 1 percent (Marcher, et al., 1964). Mississippian-aged limestone formations are exposed at the surface on the Western Highland Rim. ***These limestone formations—the St. Louis, Warsaw, and Fort Payne formations—are all characterized by abundant chert and relatively high clay content.*** These "muddy" limestones result in an very different type of karst system than limestones in other areas of the Central Basin . For example, the Lewisburg, TN site, was cited as a comparable geologic/karst location for Dickson (USEPA, 1997; meeting notes); however, it is located in "clean" Ordovician-aged limestones which form more classic karst features (e.g., sinkholes, swallets, losing streams).

# FIGURE 1
# PHYSIOGRAPHIC LOCATION MAP: DICKSON ON WESTERN HIGHLAND RIM




NOT TO SCALE

Source: "Ground-Water Geology of the Dickson, Lawrenceburg, and Waverly Areas in the Western Highland Rim, Tennessee", USGS, 1964.

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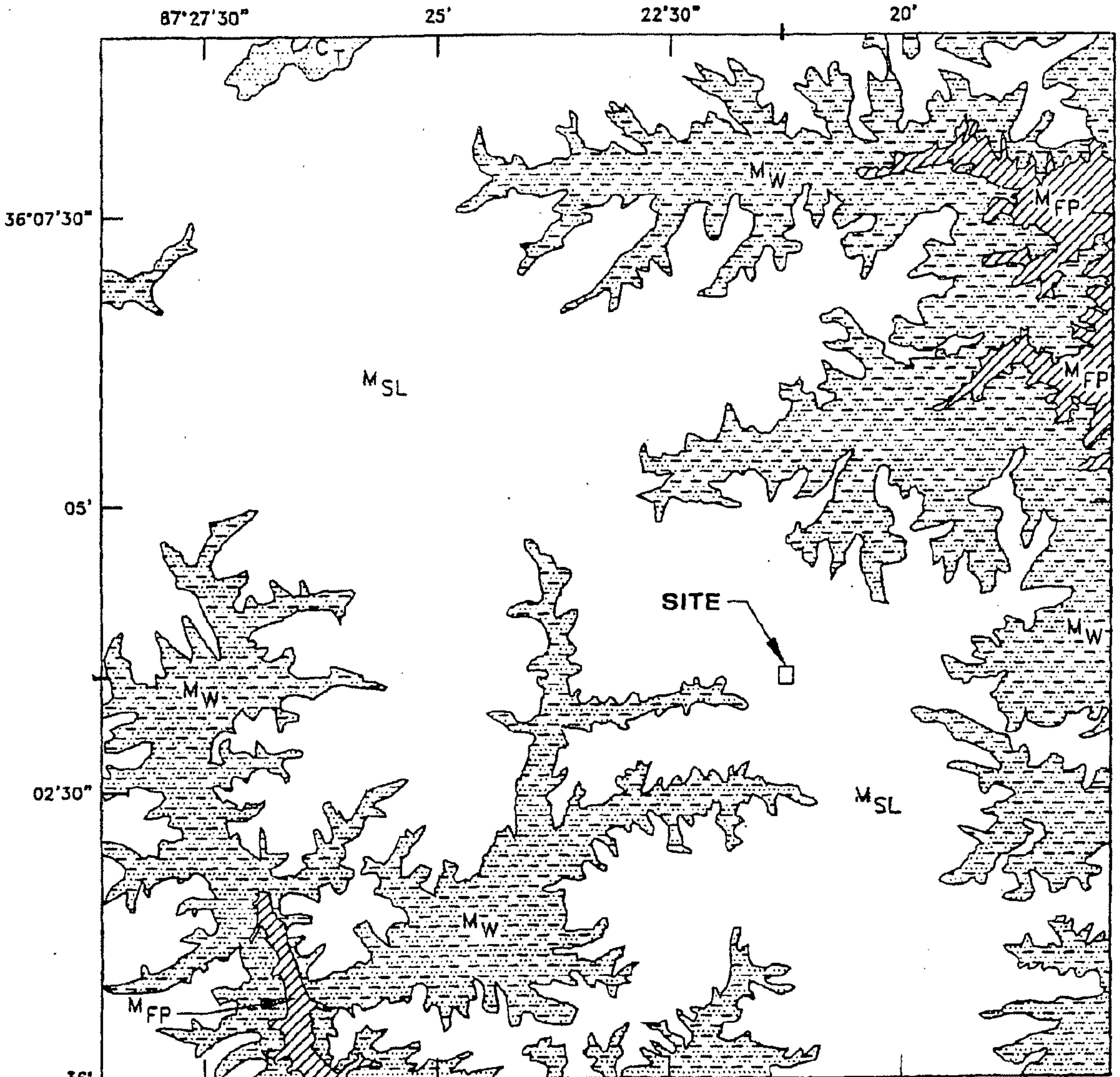
***Figure 2. Geology Map in Site Vicinity.***

This figure shows the outcrop areas of the primary geologic formations in the vicinity of the site. The oldest unit present is the Fort Payne formation and it is approximately 250 feet thick. It outcrops only in the deeply incised valleys of the two major rivers draining the area, the Piney River to the west and Jones Creek to the north and east. The Warsaw Formation is the next oldest unit. It conformably overlies the Fort Payne Formation and it is approximately 100 feet thick in the site vicinity. The Warsaw outcrops in most of the intermediate-sized stream valleys and much of the highland area between basins. It is the formation where the majority of springs issue due to it's relatively lower percentage of chert (versus the Fort Payne and St. Louis formations). ***Therefore, the outcrop area of the Warsaw Formation is the zone of groundwater discharge for the aquifer system.*** The St. Louis formation is the youngest unit exposed in the site vicinity, however, it is difficult to identify due to the presence of a highly weathered residuum. The residuum unit is a mantel of deeply weathered limestone that (1) is very clay and chert rich, (2) is dense, (3) exhibits a very low permeability and, (4) includes a cherty rubble zone just above competent bedrock.

## FIGURE 2
# GEOLOGIC MAP OF DICKSON AREA




Source: "Ground–Water Geology of the Dickson, Lawrenceburg, and Waverly Areas in the Western Highland Rim, Tennessee," Plate 3, USGS, 1964.

***LEGEND:***

**CRETACEOUS**

$C_T$ TUSCALOOSA GRAVEL

**MISSISSIPPIAN**

$M_{SL}$ ST. LOUIS LIMESTONE

$M_W$ WARSAW LIMESTONE

$M_{FP}$ FORT PAYNE FORMATION

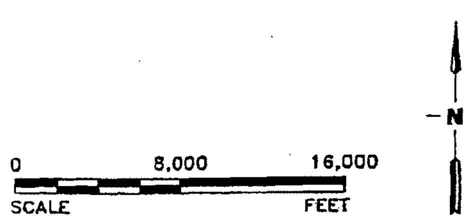




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***Figure 3. Generalized Stratigraphic Column and Conceptual Weathering Profile.***

As shown in this figure, geologic formations present in the vicinity of Dickson have been subject to erosion and weathering, resulting in a complex boundary between the competent St. Louis Formation and the overlying residuum derived from the chemical weathering of the St. Louis. For this reason, the St. Louis formation is difficult to identify based on geologic boring data alone. It's presence is estimated using both geologic data and structure maps provided in Marcher et al. (1964).

***The thickness of the residuum overburden ranges between 10 to more than 80 feet as determined from borings completed as part of the RFI process.*** It is believed that competent bedrock encountered at the site belongs to either the lower St. Louis Formation or the upper Warsaw Formation, depending on the elevation at which it was encountered.

# FIGURE 3
# GENERALIZED STRATIGRAPHIC COLUMN AND CONCEPTUAL WEATHERING PROFILE

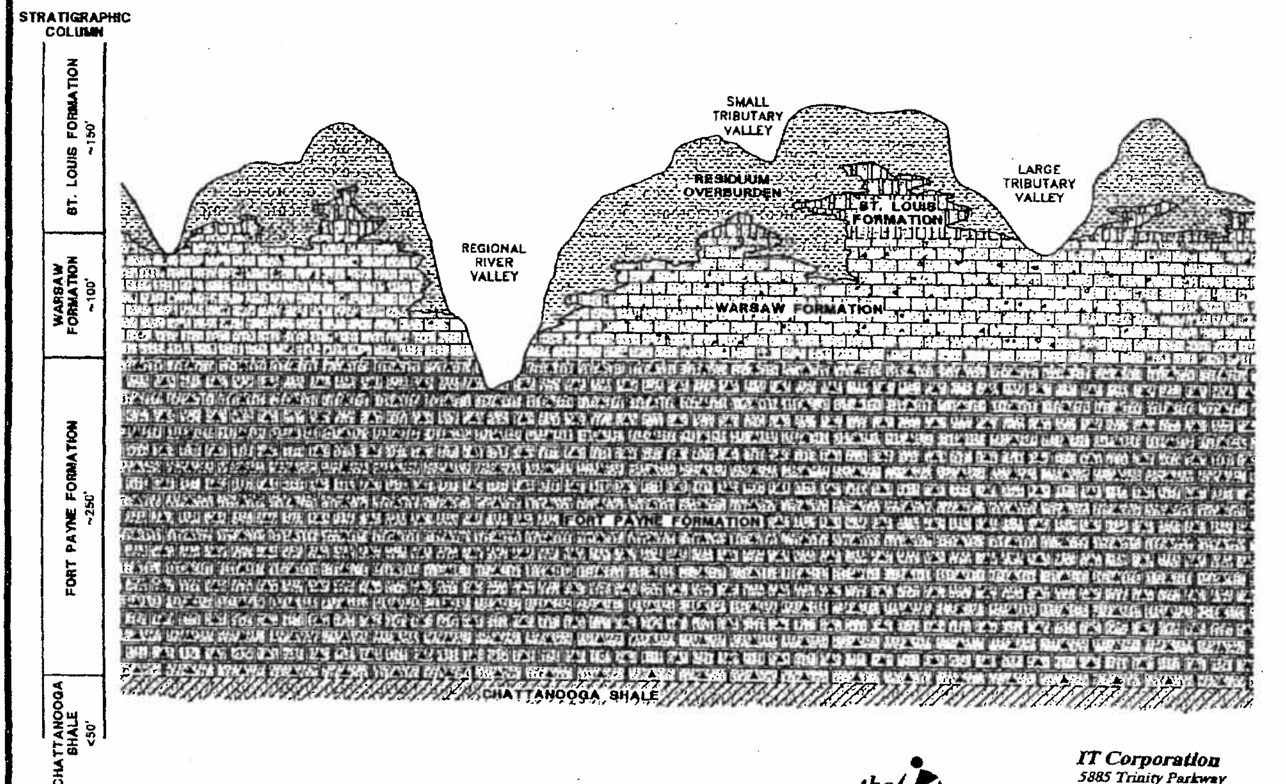


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*Figure 4. Shaded Relief Topography Map.*

This figure shows the regional topography in a shaded relief format so that the landscape surrounding the site is more easily visualized[1]. The approximate site location is shown in outline to the center right of the figure. Beaverdam Creek, Spicer Creek, Will Hall Creek and Willow Branch are labeled. The approximate location of the regional surface water divide is indicated with the yellow dashed line. The approximate outcrop of the lower Warsaw/upper Fort Payne formations is depicted by blue shading. ***This stratigraphic interval is believed to be the bottom of the karst system due to (1) the abundance of chert in the Fort Payne formation (i.e., effective permeability of the unit is greatly reduced from the Warsaw Fm. above), and (2) the stream bed elevations, which serve as drains for the aquifer system, are primarily within the outcrop of the Warsaw Formation.*** Therefore, the extent of the aquifer system in the vicinity of the site is approximated by the non-shaded areas, significant portions of which are not hydraulically related to the site due to the presence of the surface water divide. (In general, flow directions will be at right angles to this divide line; therefore, flow away from the site is not expected to occur parallel to this divide line).

Linear features are evident in the landscape depicted on these maps, most notably as the stream valleys. Large tributary streams of the Piney River (lower left of the Dickson map) enter the main stream at nearly right angles, suggesting a fracture origin for the stream bed. Fractures along the regional surface water divide are not easily observed due to the lack of stream incision and the masking of fracture patterns by a thick residuum overburden.

***Site groundwater flow appears to be limited toward two main areas: (1) to the east and north in the valleys of Beaverdam Creek and Will Hall Creek; and (2) to the west in the valley of Willow Branch. Groundwater discharge points in these valleys include springs, seeps, and bedrock partings in the stream bed.***

[1] Two digital elevation models are combined to create this figure, the Dickson topographic quadrangle on the left and the Burns topographic quadrangles on the right (USGS, DEM files downloaded from the USGS web site). The black dashed line down the middle of the figure is the boundary between the two quadrangles.

# FIGURE 4

# SHADED RELIEF TOPOGRAPHY MAP

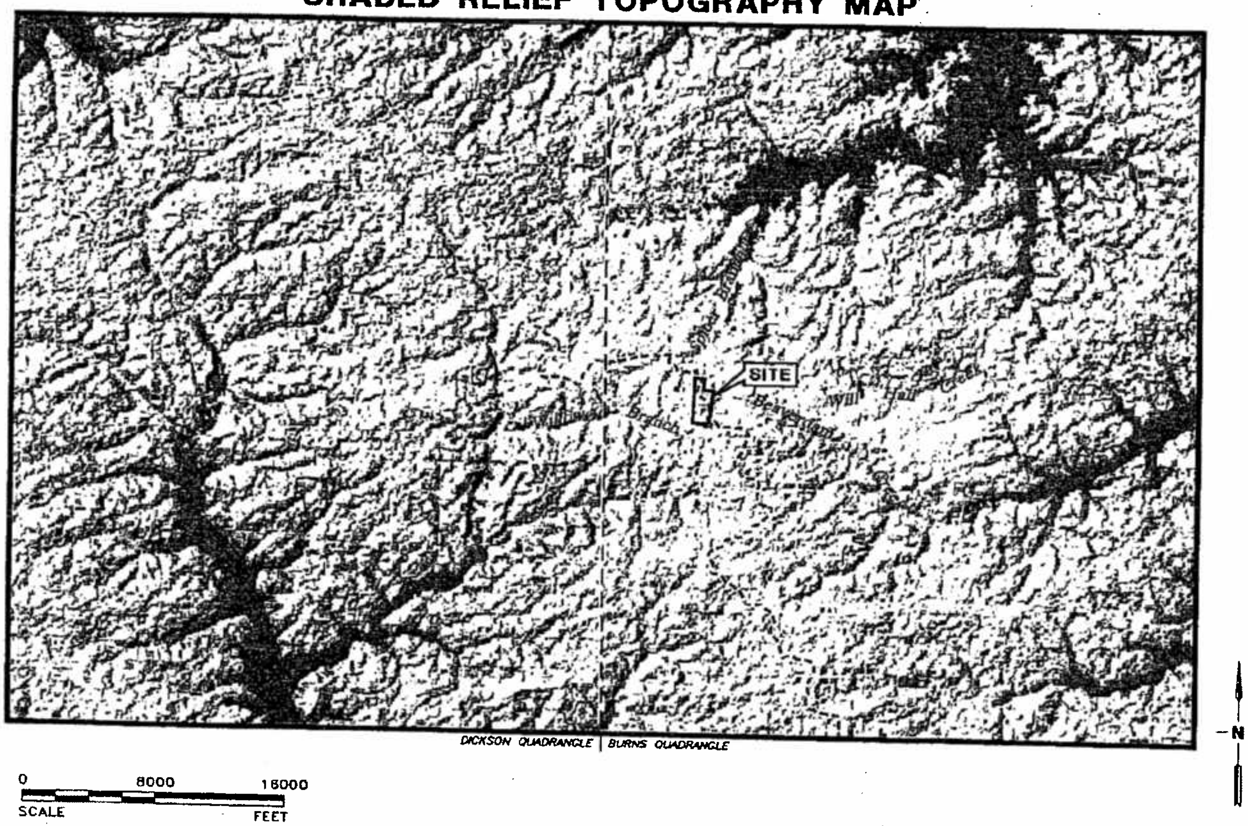


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***Figure 5. Regional SW-NE Geologic Cross Section.***

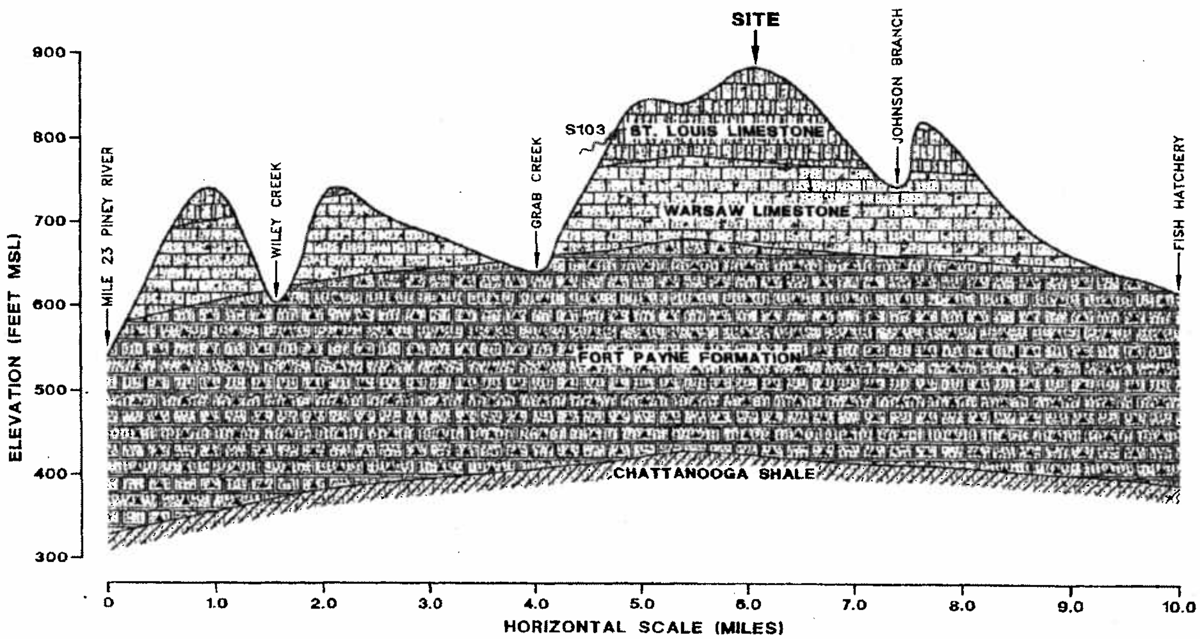
Approximately 10 miles across[2], this generalized geologic cross section shows the nearest Fort Payne outcrops to the Site—near mile 23 of the Piney River on the southwest and near the fish hatchery in the northeast. Geologic unit thicknesses and structure are obtained from regional references (Marcher, et al., 1964 and Bradley, 1985).

This section illustrates the vertical geologic conditions in the vicinity of the site. It is reported that the Warsaw Formation is the dominant water-bearing unit in the vicinity of Dickson (Bradley, 1985). Groundwater is collected in the upland areas, is stored in the residuum overburden, migrates downward to the fracture/solution network in the Warsaw, and is discharged in local streams via springs and gaining reaches. ***This figure shows how the St. Louis/Warsaw (i.e., residuum/bedrock) aquifer system is perched on top of the Fort Payne Formation. Deeper flow into the Fort Payne is not likely due to both the abundance of chert in this unit and the location of significant aquifer drains (i.e., local streams) at higher elevations.***

The following three cross sections provide a more detailed look in the area of the site.

[2]See cross section location map as Attachment A.

# FIGURE 5
## REGIONAL SW-NE GEOLOGICAL CROSS SECTION BETWEEN NEAREST FORT PAYNE OUTCROPS




*NOTE:*
GEOLOGIC CONTACTS ESTIMATED FROM STRUCTURE MAP PRESENTED IN BRADLEY (1985)

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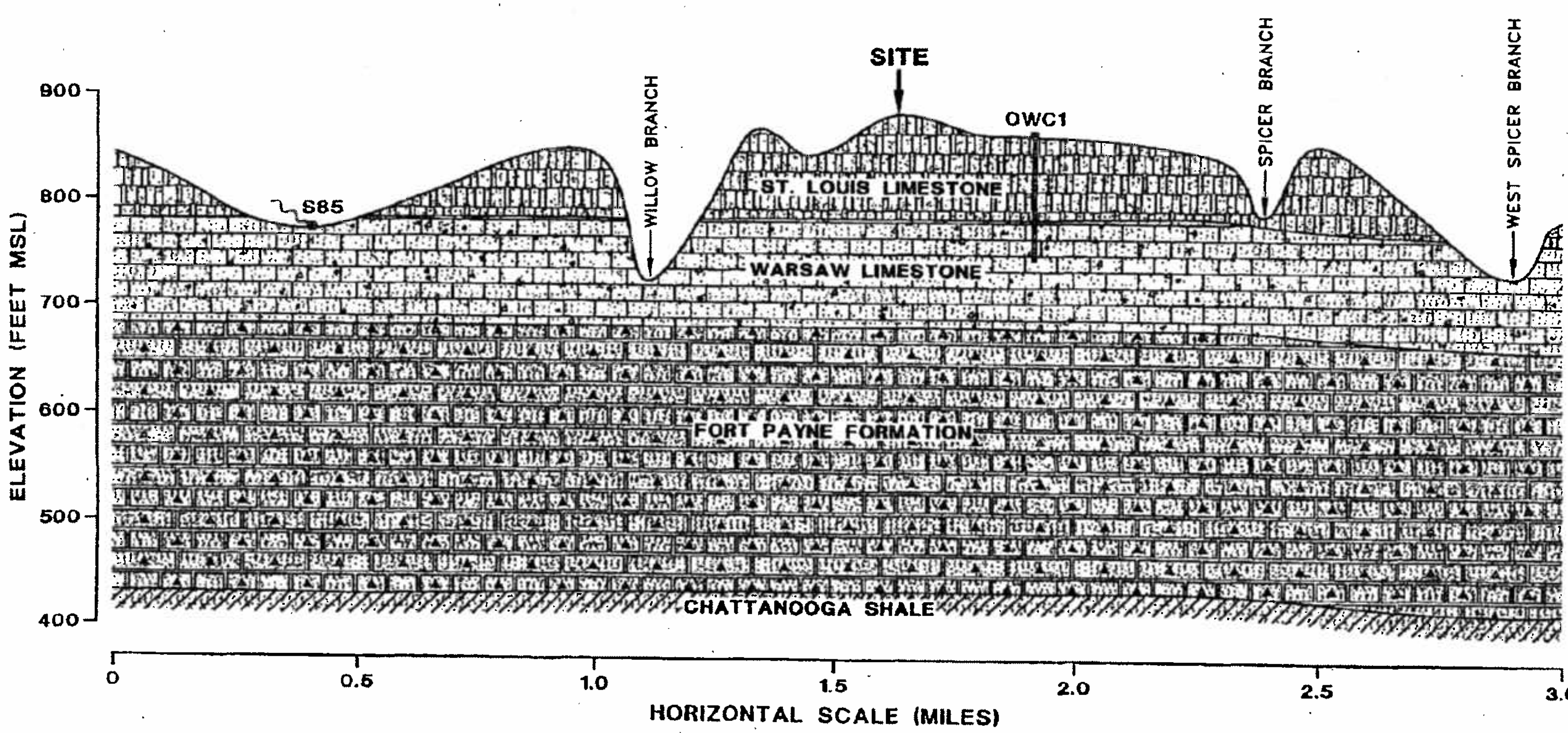
*Figure 6. S-N Cross Section through Site.*

Roughly parallel to regional divide trace, this section depicts the greatest lateral extent of the St. Louis Formation—which is believed to exist primarily as weathered residuum. ***As shown in this figure, Willow Branch and West Spicer Branch have eroded through the St. Louis into Warsaw Formation.***

## FIGURE 6
## SOUTH-NORTH GEOLOGICAL CROSS SECTION THROUGH SITE APPROXIMATELY ALONG SURFACE WATER DIVIDE




***NOTE:***
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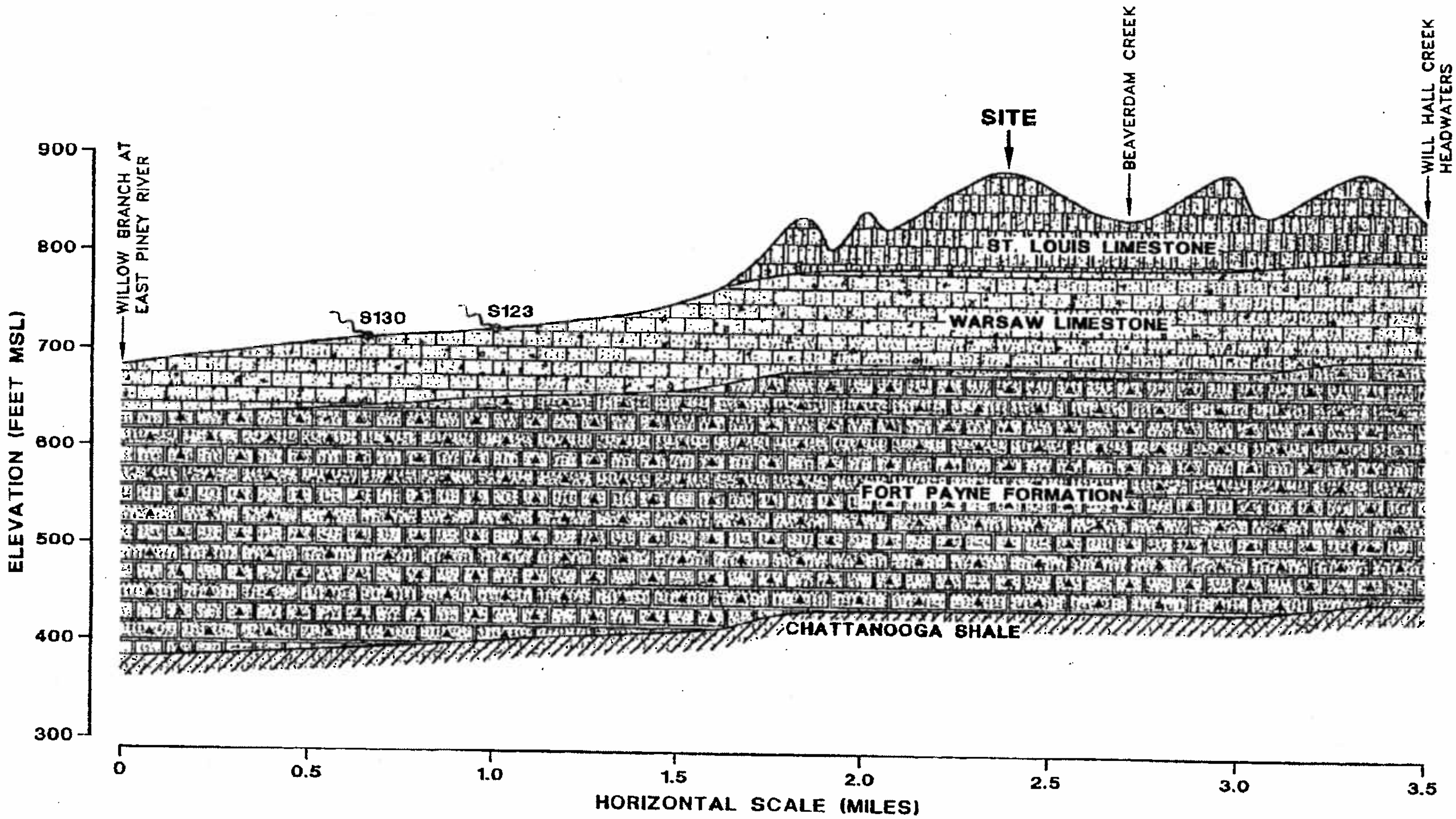
*Figure 7. SW-NE Cross Section through Site.*

This section roughly traces the lower reaches of Willow Branch, across Site, then on to headwaters of Will Hall Creek. Springs shown issue from the Warsaw Formation. ***Willow Branch appears to flow within the Warsaw formation from near its headwaters to its confluence with the East Piney River.***

## FIGURE 7
# WSW-ENE GEOLOGICAL CROSS SECTION ALONG WILLOW BRANCH




***NOTE:***
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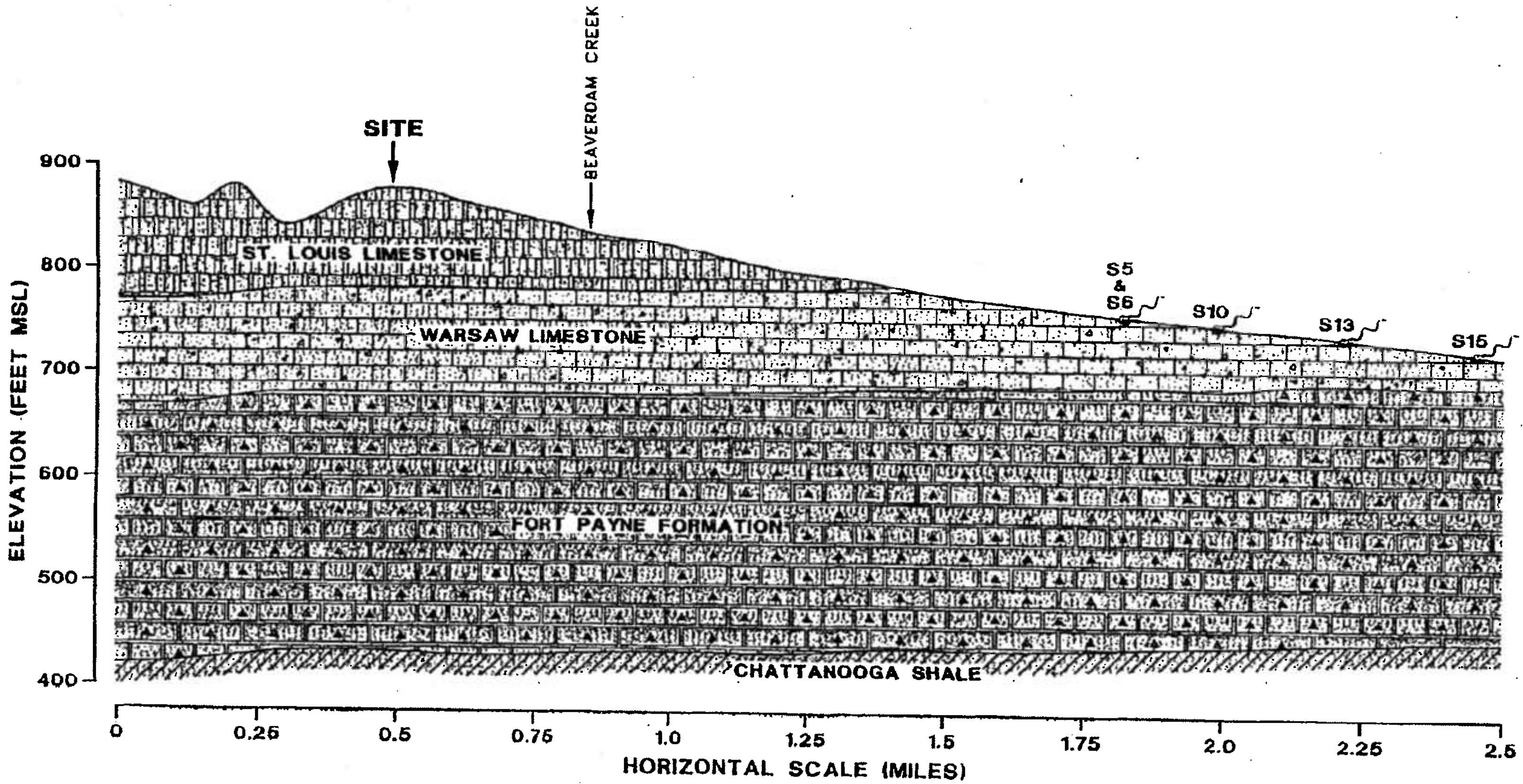
***Figure 8. NW-SE Cross Section through Site***

This section extends roughly along Beaverdam Creek from northwest of the northern portion of Site. ***The large springs shown issue from Warsaw Formation.***

# FIGURE 8
# NORTHWEST-SOUTHEAST GEOLOGICAL CROSS SECTION ALONG BEAVERDAM CREEK




***NOTE:***
GEOLOGIC CONTACTS ESTIMATED FROM STRUCTURE MAP PRESENTED IN BRADLEY (1985)


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*Figure 9. Spring Location Map from Karst Survey.*

This figure shows all the springs within a 2 mile radius of the site as located during karst survey in 1993. Of the nearly 200 springs located during this survey (including those beyond 2-mile radius), more than 80% issue from the Warsaw formation, roughly 18% issue from the St. Louis residuum or the contact between the Warsaw and St. Louis formations. The remaining 1% issue from the Warsaw/Fort Payne contact. ***This distribution of springs supports the notion that the Fort Payne Formation is not a major groundwater flow unit as reported in Bradley (1985). Therefore, based on regional reports and data collected as part of the RFI process, deeper groundwater flow cells in the Fort Payne are not likely to occur.***

## FIGURE 9
# SPRING LOCATION MAP FROM KARST SURVEY

SOURCE: DICKSON AND BURNS, TENNESSEE QUADRANGLES

LEGEND:
O SPRING LOCATION

SCALE 0 3000 6000 FEET

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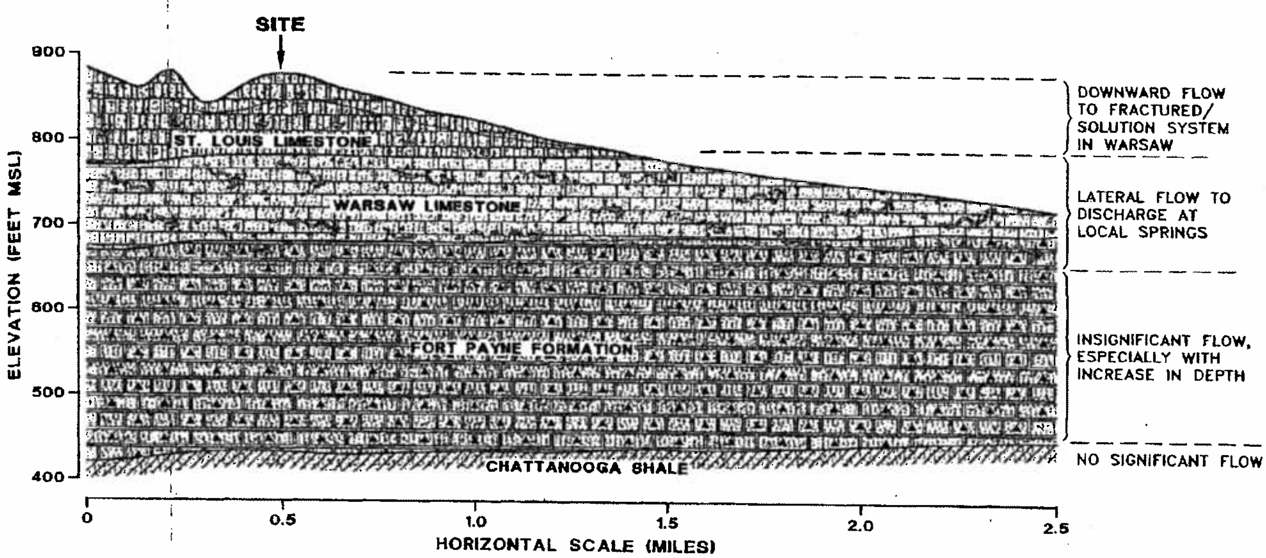
*__Figure 10. Conceptual Cross Section Showing Large-Scale GW Flow System.__*

This figure illustrates the groundwater flow system in the vicinity of the site. The residuum unit (chemically weathered St. Louis Formation) collects and stores precipitation, then ***slowly releases*** groundwater to the fracture/solution channels of the Warsaw Formation below. ***Groundwater in the Warsaw migrates laterally*** to discharge points in local streams within the solution network. The ***Fort Payne Formation, due to abundance of bedded chert, does not contribute significantly to the groundwater flow system,*** although flow along the contact between the Warsaw and Fort Payne is suggested by Bradley (1985).

FIGURE 10

# CONCEPTUAL GEOLOGICAL CROSS SECTION NW-SE ALONG BEAVERDAM CREEK SHOWING LARGE-SCALE GROUNDWATER FLOW SYSTEM




*NOTE:*
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*Figure 11. Conceptual Cross Section Showing Site-Wide Contaminants.*

Groundwater monitoring data show that the ***highest concentrations of VOCs are hung up in the saturated zone beneath source areas*** at the site. ***The low-permeability, high natural organic content of the residuum has trapped the source area constituents within the upper saturated zone.*** Constant flushing of rainwater through the source area serves to "slowly bleed" the VOCs into lower units, i.e., the rubble zone at the base of the residuum and the Warsaw Formation below.

# FIGURE 11
# CONCEPTUAL CROSS SECTION SHOWING SITE-WIDE CONTAMINANTS

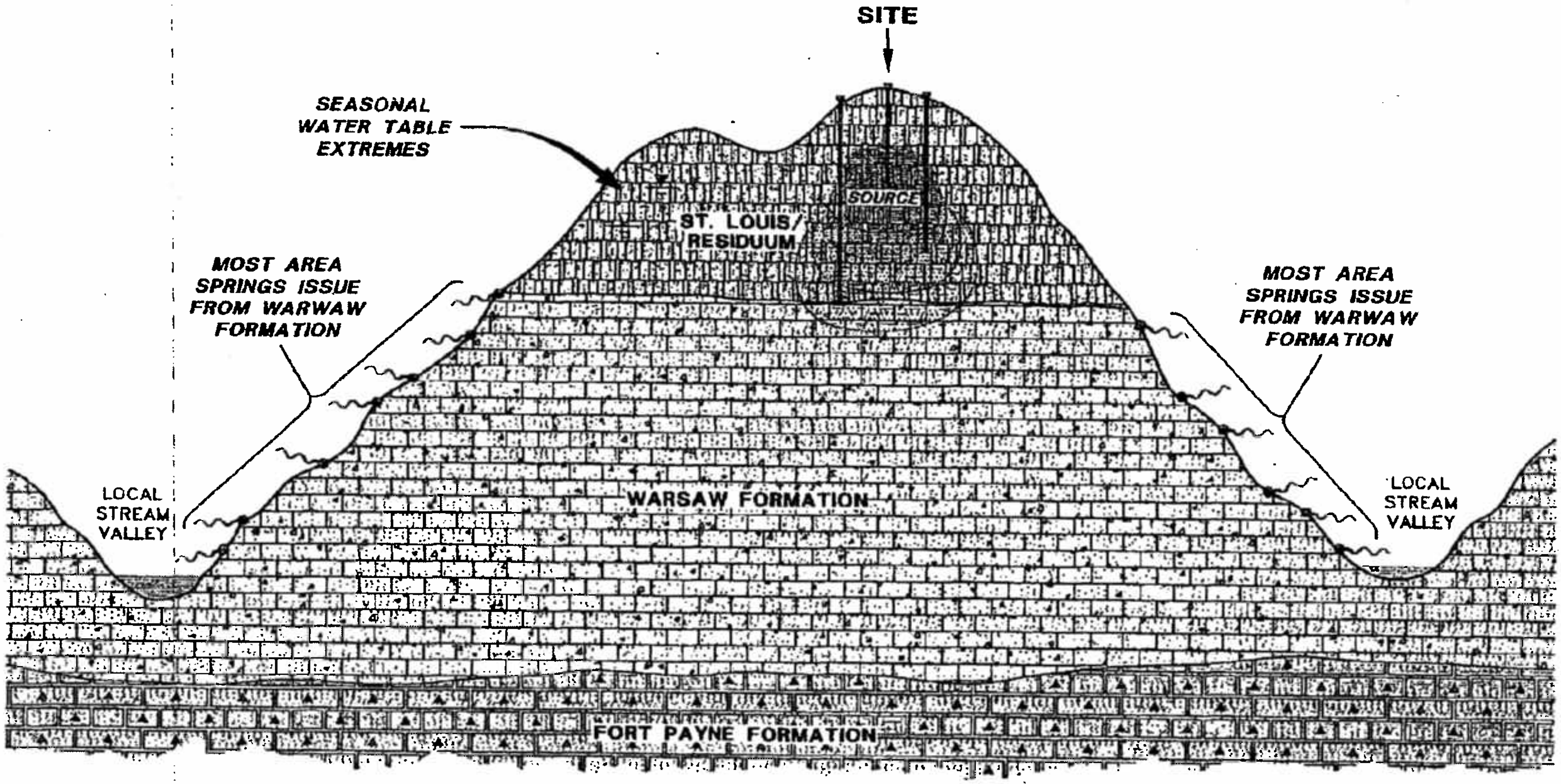


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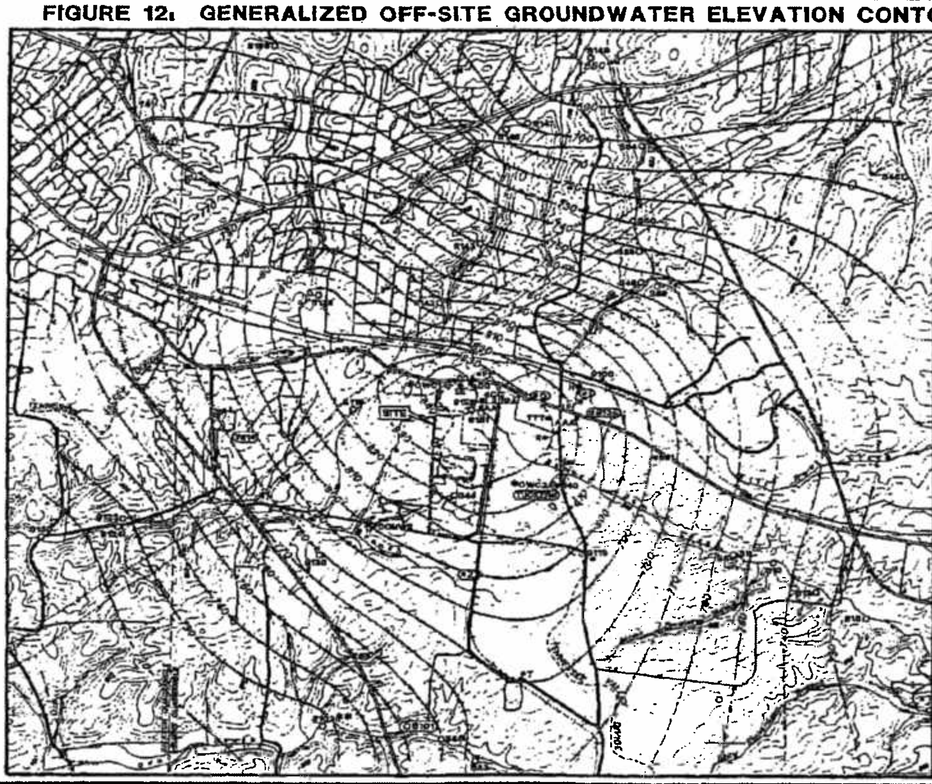
*Figure 12. Offsite Groundwater Level Map.*

Generalized groundwater levels in vicinity of site are drawn from area wells and spring elevations. While contours are not corrected for surface streams, this figure shows ***generalized radial flow pattern away from the site. Preferential flow toward Beaverdam Creek drainage is suggested by more shallow gradient in that direction*** (i.e., shallower gradient suggests higher effective K in fractured rock whereas steeper gradient suggests lower effective K).

**FIGURE 12: GENERALIZED OFF-SITE GROUNDWATER ELEVATION CONTOUR MAP, JUNE 1999**



**LEGEND:**

- o SPRING LOCATION SAMPLED
- • PRIVATE WELLS SAMPLED
- LOCATION OF OFF-SITE BEDROCK MONITORING WELL OOMW2
- LOCATION OF OFF-SITE WELL CLUSTER
- ACCESS DENIED BY PROPERTY OWNER FOR SPRING/RESIDENTIAL WELL SAMPLING (NOVEMBER 1997, JUNE 1998, DECEMBER 1998, AND/OR JUNE 1999)
- —820— GROUNDWATER ELEVATION CONTOUR
- – –820– – INFERRED GROUNDWATER ELEVATION CONTOUR
- * AT OFF-SITE WELL CLUSTERS, ONLY THE GROUNDWATER ELEVATIONS FOR RESIDUUM-BEDROCK WELL INCLUDED IN CONTOURING.
- ** SAMPLING LOCATION DESTROYED

**NOTES:**

1. SPRING AND WELL LOCATIONS WERE SURVEYED IN DECEMBER 1997.
2. GROUNDWATER ELEVATION CONTOURS ARE BASED ON WATER LEVEL SURVEY PERFORMED IN JUNE 1999.
3. GROUNDWATER ELEVATIONS OF SOME LOCATIONS WERE NOT INCLUDED IN CONTOURING. THOSE LOCATIONS ARE SHOWN IN GREY.

SOURCE: DICKSON AND BURNS, TENNESSEE QUADRANGLES

0 2250 4500
SCALE FEET

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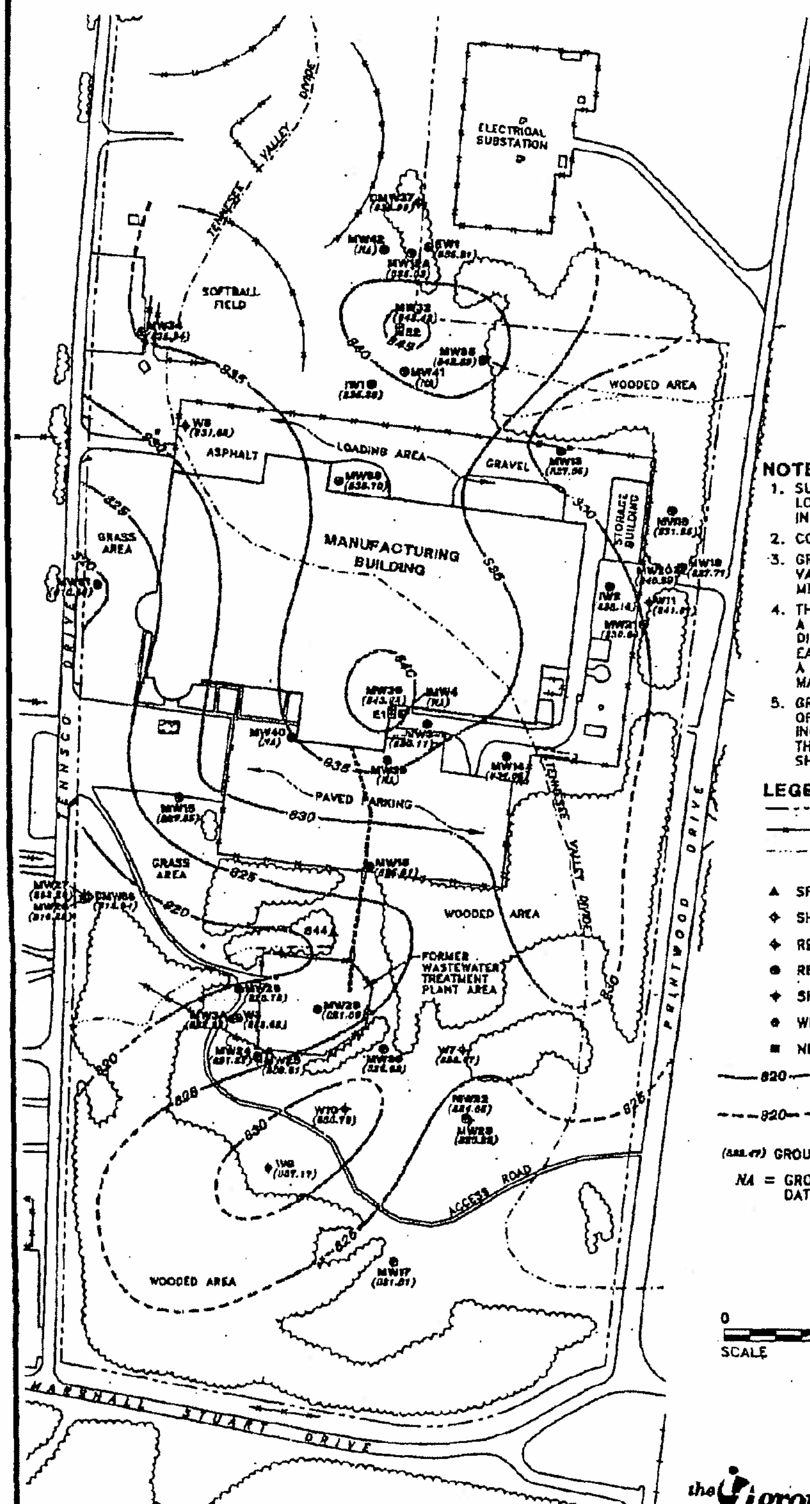
*Figure 13. Onsite GW Level Map.*

The ***groundwater level contour map at the site has remained roughly the same*** since water level measurements have been collected. Groundwater flows from higher areas of site (near building) toward offsite natural drains (i.e., springs and seeps) in the tributaries of Willow Branch and Beaverdam Creek. The seasonal range in water levels varies across the site between 3 and 38[3] feet. The average seasonal water level change is approximately 15 feet.

[3] Two wells (MW35 & MW31) exhibited a much greater seasonal range in water levels that the remaining site wells. When these two wells are eliminated from consideration, the range in water levels at the site is 3-24 feet and the average is approximately 14 feet.

**FIGURE 13**

## GENERALIZED ON-SITE GROUNDWATER ELEVATION CONTOUR MAP, JUNE 1999




**NOTES:**

1. SURVEY OF ALL WELL LOCATIONS WAS PERFORMED IN NOVEMBER 1997.
2. CONTOUR INTERVAL = 5 FT.
3. GROUNDWATER ELEVATION VALUES ARE IN FEET ABOVE MEAN SEA LEVEL.
4. THIS FIGURE IS BASED ON A SURFER MAP AND IS NOT DIRECTLY COMPARABLE TO EARLY MAPS. IT WILL PROVIDE A MORE COMPARABLE BASE MAP FOR GMP DATA.
5. GROUNDWATER ELEVATIONS OF SOME WELLS WERE NOT INCLUDED IN CONTOURING. THOSE ELEVATIONS ARE SHOWN IN GREY.

**LEGEND:**

- PROPERTY BOUNDARY
- FENCE
- INTERMITTENT STREAM OR DRAINAGE CHANNEL
- ▲ SPRING LOCATION
- SHALLOW RESIDUUM WELL
- RESIDUUM WELL
- ● RESIDUUM–BEDROCK WELL
- SHALLOW BEDROCK WELL
- WELL INSTALLED IN 1995
- ■ NEW EXTRACTION WELL
- 820 GROUNDWATER ELEVATION CONTOUR
- 820 INFERRED GROUNDWATER ELEVATION CONTOUR
- (833.47) GROUNDWATER ELEVATION
- NA = GROUNDWATER ELEVATION DATA NOT AVAILABLE

0 250 500
SCALE FEET

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*Centreville, VA 20120*

*Figure 14. Site TCE Plume Map.*

Highest concentrations of VOCs are centered near two main source areas: the Northern Disposal Area and the South Building area. ***Lateral spreading of plume is apparently limited to preferential flow pathways*** (e.g., between MW36 and MW15). Daughter products are present only within the most concentrated portion of the plume, and vinyl chloride is not accumulating.

Highlighted wells indicate locations where TCE daughter products are present.

# FIGURE 14
# TCE IN GROUNDWATER - DECEMBER 1998

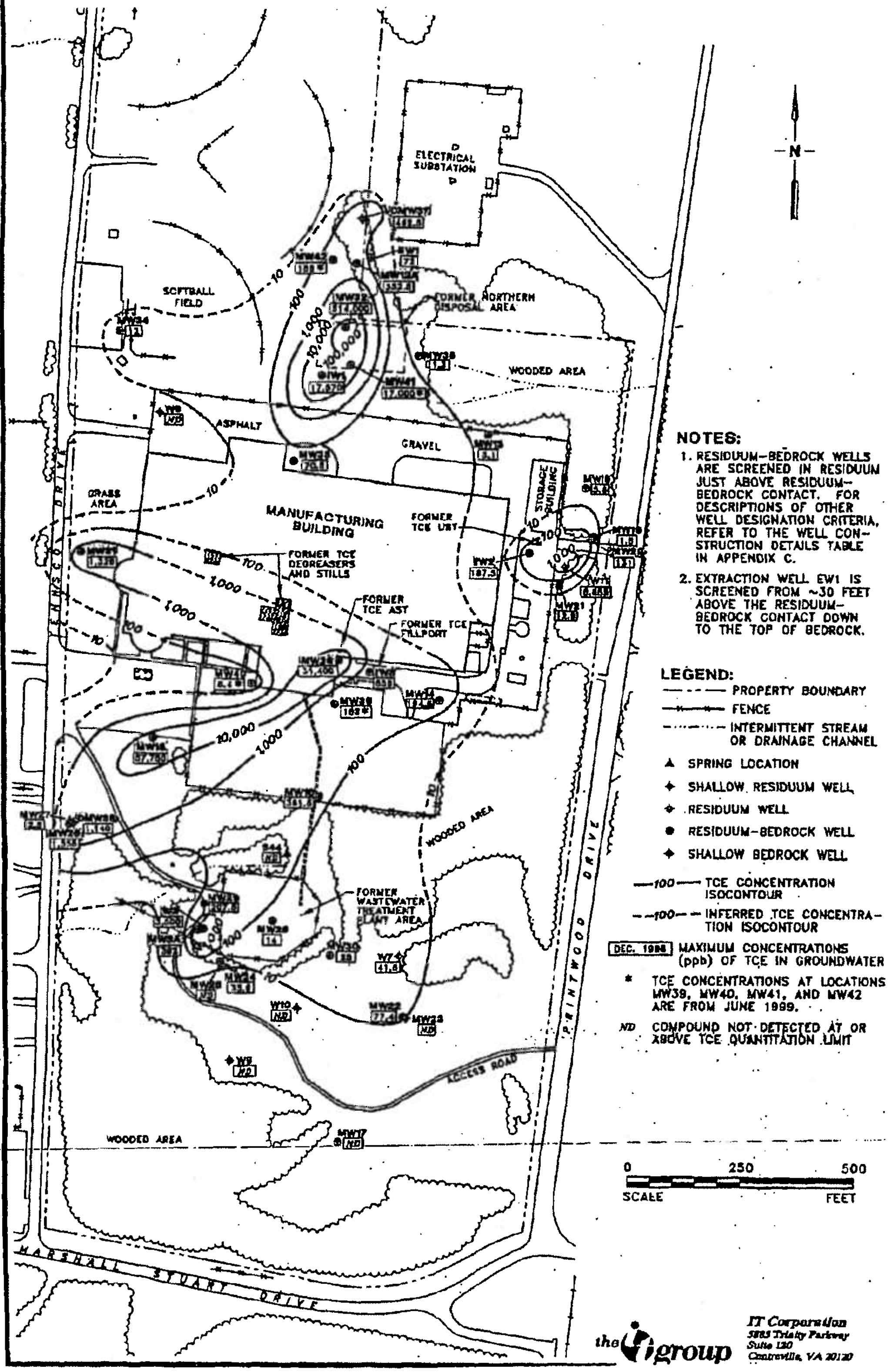


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*Figure 15. Plume Cross Section in Northern Disposal Source Area.*

***Highest VOC concentrations hung up in saturated residuum***, deeper portions of plume bleeding into bedrock. ***Concentrations relatively stable*** over 10 year monitoring period. Transport in bedrock unit is lateral, with dilution being predominant attenuation mechanism.

## FIGURE 15
# PLUME CROSS SECTION IN NORTHERN DISPOSAL AREA

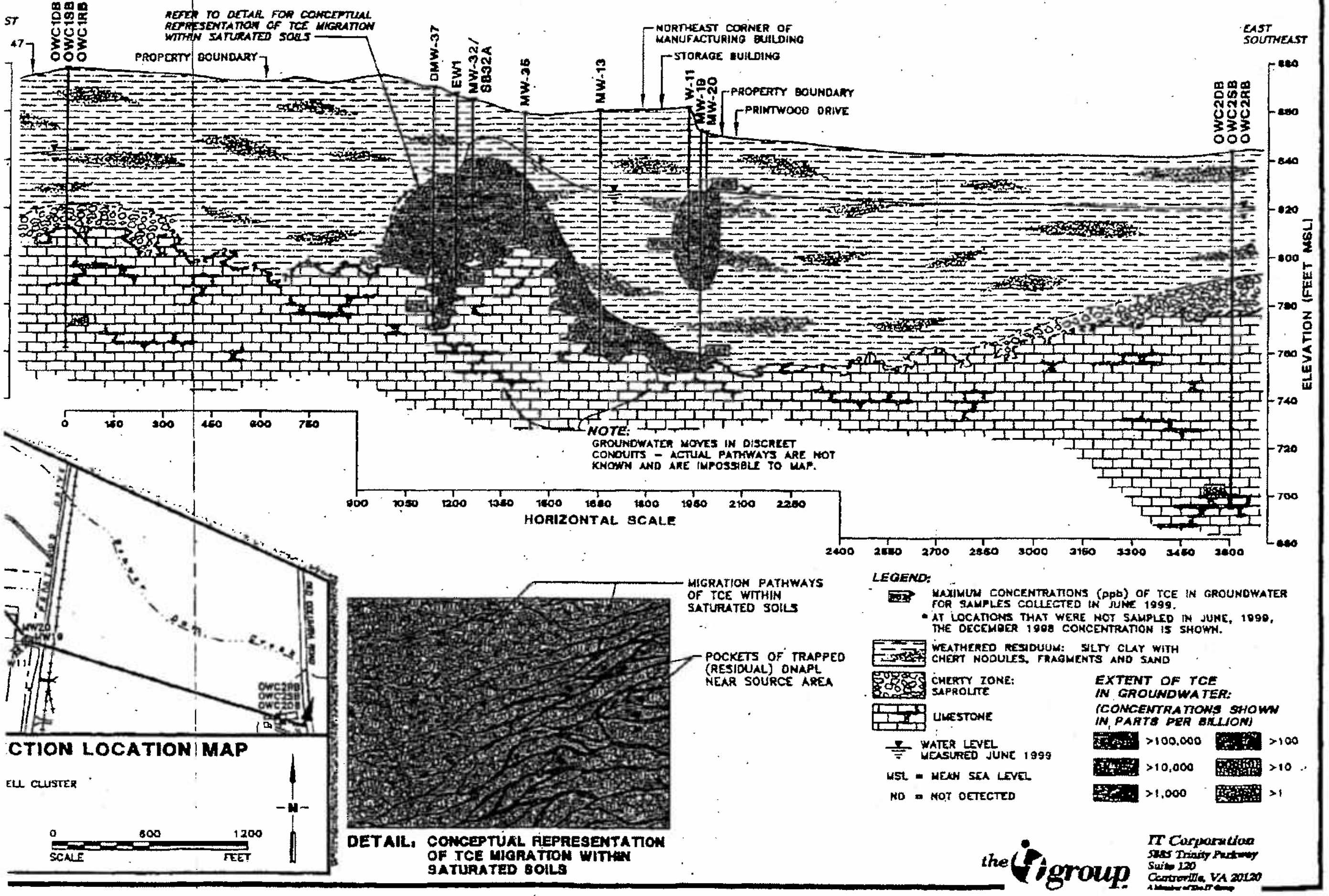
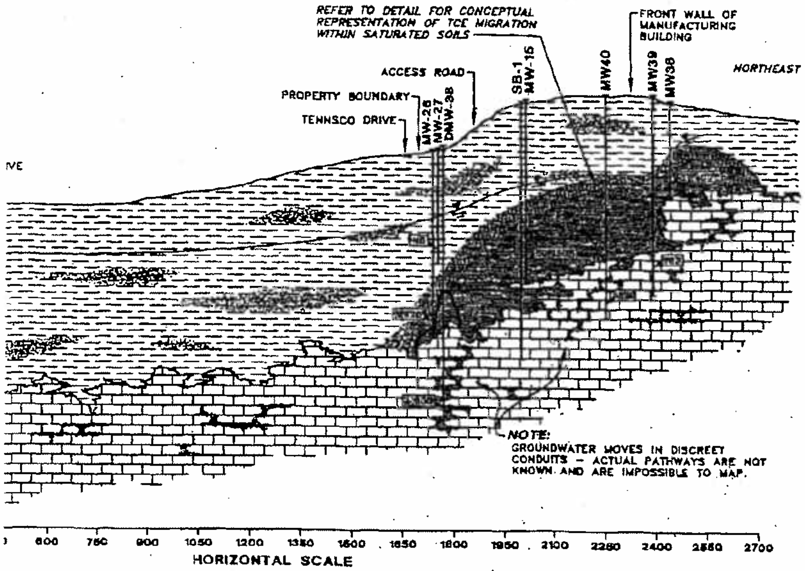
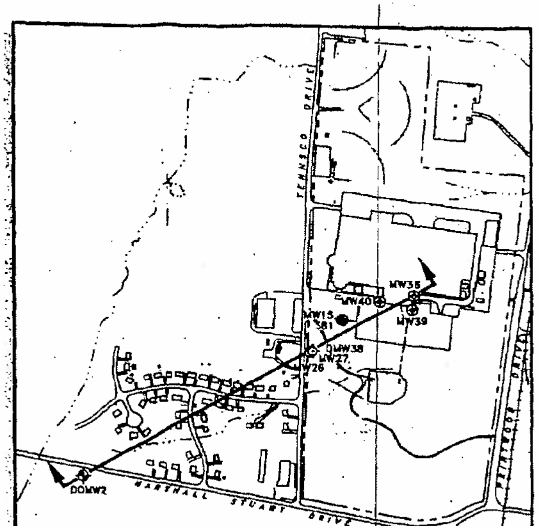


***Figure 16. Plume Cross Section in South Building Source Area.***

Highest VOC concentrations hung up in saturated residuum, deeper portions of plume bleeding into bedrock. Concentrations relatively stable over 10 year monitoring period. ***High concentration plume is no longer migrating laterally, rather, it is bleeding off into the deeper bedrock where lateral movement and dilution are occurring.***

## FIGURE 16
# PLUME CROSS SECTION IN SOUTH BUILDING SOURCE AREA




CROSS SECTION LOCATION MAP

*LEGEND:*

- LOCATION OF OFF-SITE BEDROCK MONITORING WELL DDMW2
- RESIDUUM–BEDROCK WELL
- SHALLOW BEDROCK WELL
- RESIDUUM WELL
- SOIL BORING LOCATION

0 600 1200
SCALE FEET

N

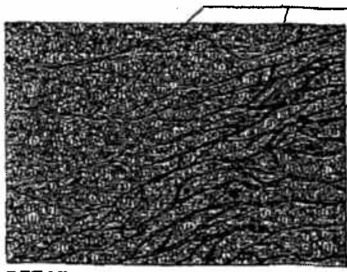
IS (ppb) OF
OR SAMPLES
S.

E NOT SAMPLED
EMBER 1998
IN.

SILTY CLAY WITH
ENTS AND SAND

***EXTENT OF TCE IN GROUNDWATER: (CONCENTRATIONS SHOWN IN PARTS PER BILLION)***

| | |
|---|---|
| >100,000 | >100 |
| >10,000 | >10 |
| >1,000 | >1 |




**DETAIL: CONCEPTUAL REPRESENTATION OF TCE MIGRATION WITHIN SATURATED SOILS**

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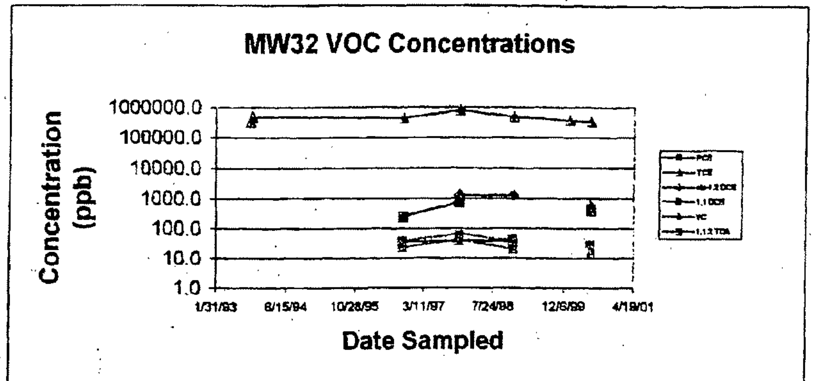
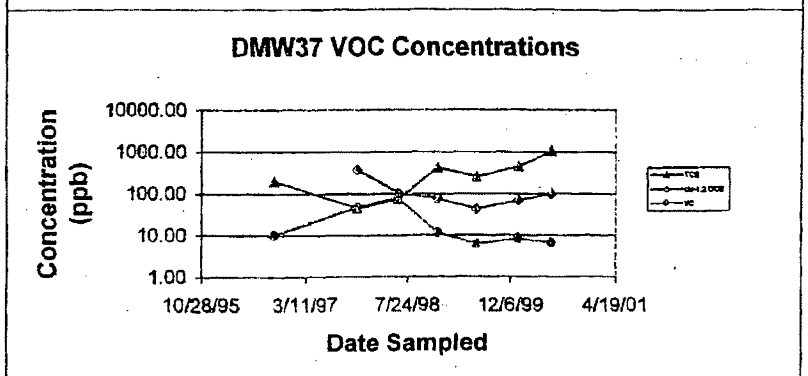
Figure 17. Multiple Graphs, VOCs through Time at Onsite Locations.

***VOC concentrations have been relatively stable through 10 year monitoring period. Daughter products are present only near source areas and VC is not accumulating.*** VOCs are trapped in saturated portion of the residuum, slowly bleeding off into lower bedrock system. Dilution in bedrock solution system increases with distance from site. Concentrations believed be entering bedrock at site are on the order of 100-1000ppb, whereas S5 and S6 total VOC concentrations are on the order of <10ppb. ***This suggests attenuation factors between 10 and 100 over a lateral distance of approximately 1.3 miles.***

(Please refer to Figure 10 depicting the groundwater flow system, the site, and springs S5 and S6).

Figure 17. VOC Graphs in Select Areas.



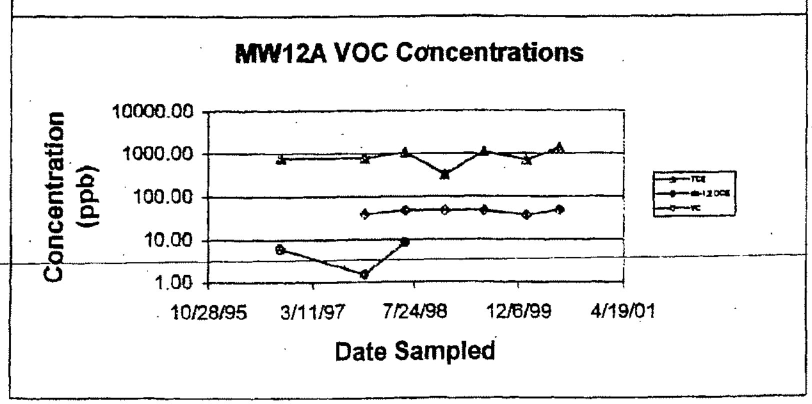
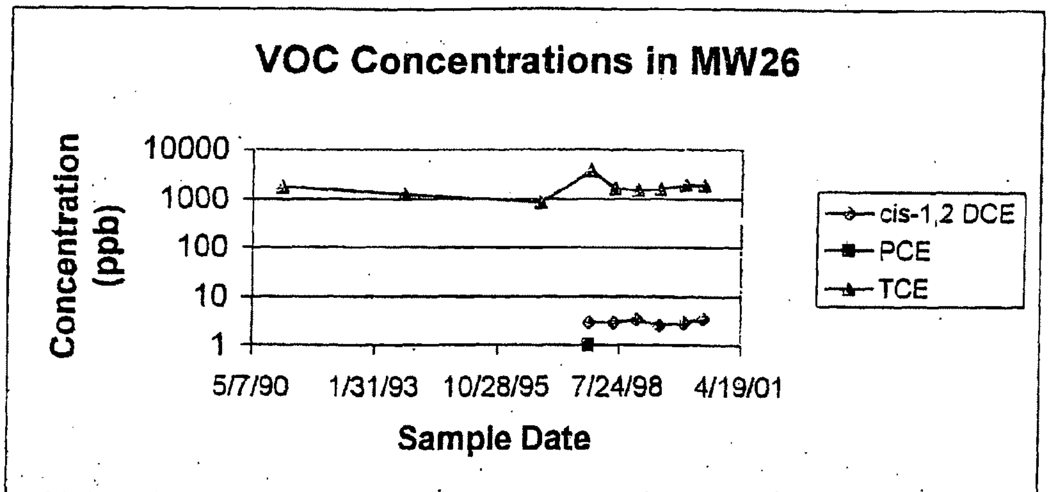
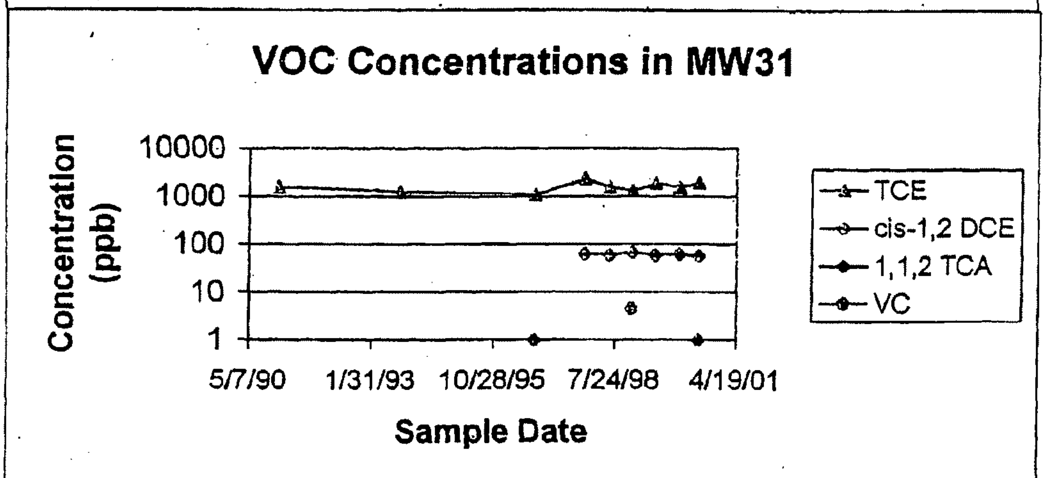
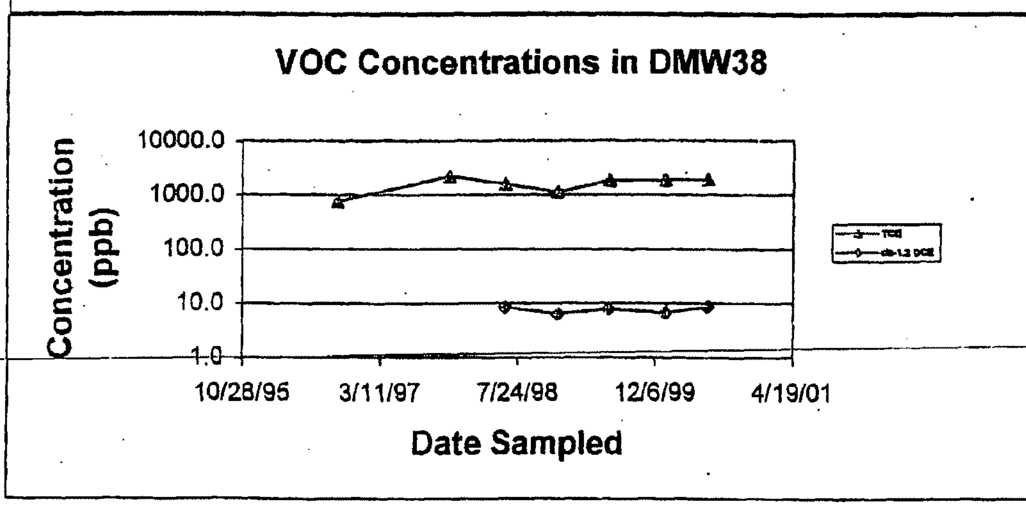



Figure 17. (con't)

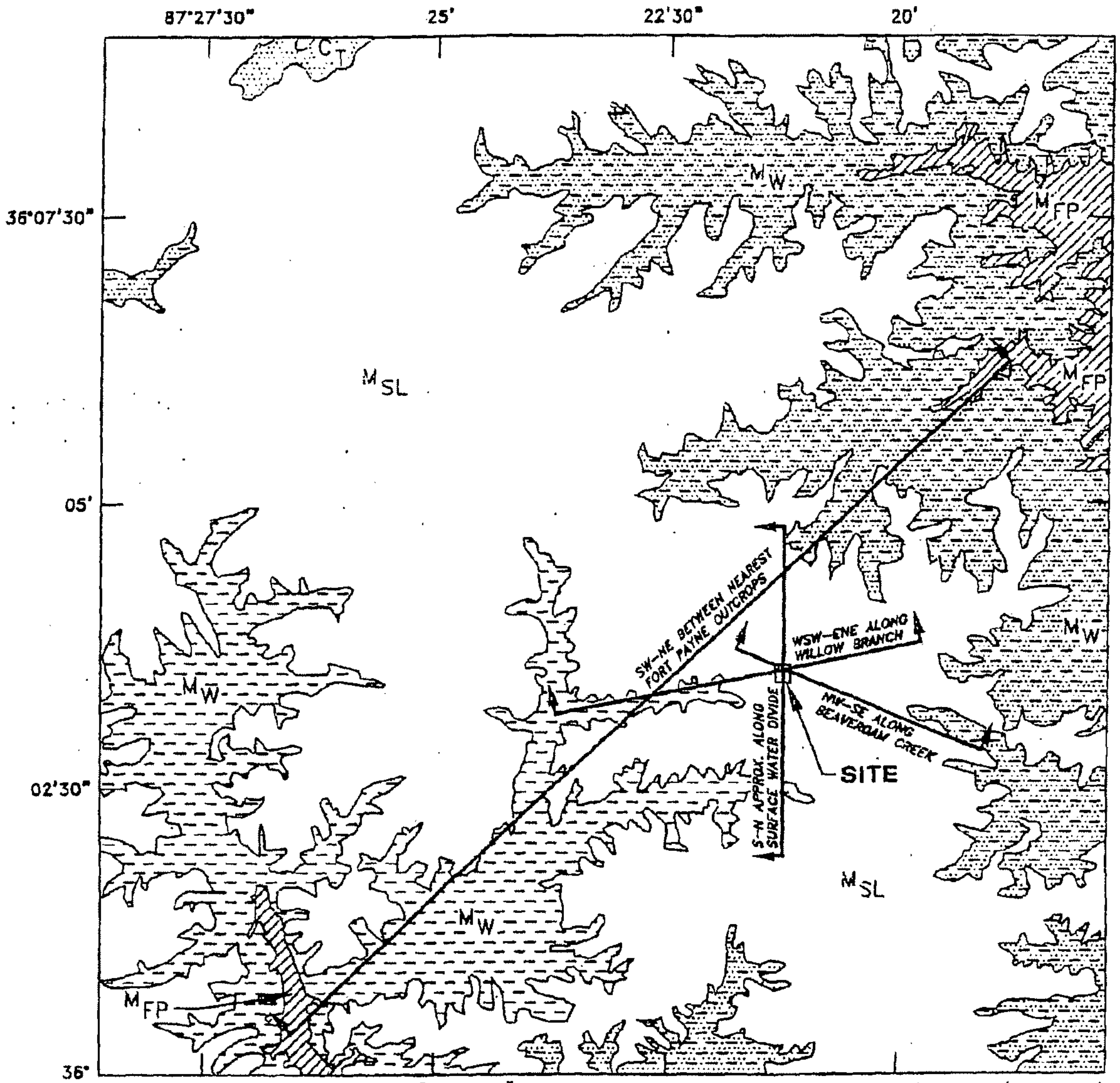


# ATTACHMENT A

# CROSS SECTION LOCATION MAP




Source: "Ground-Water Geology of the Dickson, Lawrenceburg, and Waverly Areas in the Western Highland Rim, Tennessee," Plate 3, USGS, 1964.

***LEGEND:***

**CRETACEOUS**

$C_T$ TUSCALOOSA GRAVEL

**MISSISSIPPIAN**

$M_{SL}$ ST. LOUIS LIMESTONE

$M_W$ WARSAW LIMESTONE

$M_{FP}$ FORT PAYNE FORMATION

0 8,000 16,000
SCALE FEET

N

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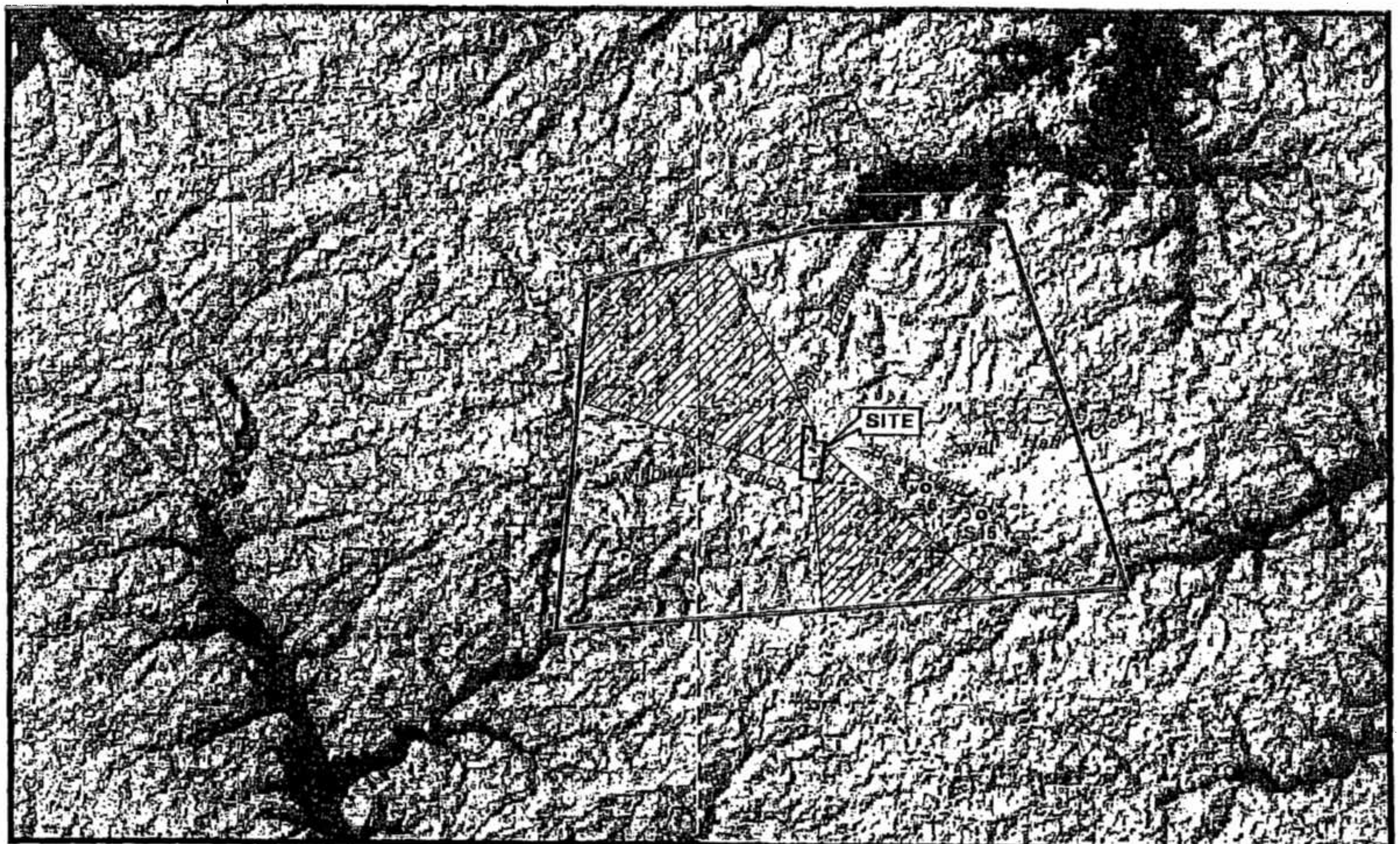
## FIGURE 18
# POTENTIAL GROUNDWATER DISCHARGE AREAS FOR THE SITE




*LEGEND:*

- APPROXIMATE OUTCROP OF BOTTOM OF WARSAW AND TOP OF FORT PAYNE FORMATIONS
- APPROXIMATE ZONE OF NO OFFSITE GROUNDWATER MIGRATION DUE TO PRESENCE OF REGIONAL SURFACE WATER DIVIDE
- APPROXIMATE AREA WITHIN DOWNGRADIENT AREA OF SITE LIKELY TO RECEIVE FLOW FROM SITE

0 8000 16000
SCALE FEET

N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## *HYDROGEOLOGIC CONCEPTUAL MODEL SUMMARY*

- ❑ The geologic framework in the Dickson area is characterized by muddy Mississippian-aged limestones which form a much different karst system (in terms of dissolution features) than middle-Ordovician limestone units elsewhere in Tennessee.
- ❑ Karst features in the Dickson area are characterized by: (1) a significant residuum overburden unit derived from the chemical weathering of the St. Louis Formation, (2) small-scale dissolution features, (3) rare, large-scale dissolution features such as caves and active sinks, and (3) an aquifer system that is drained by springs feeding local and main stem tributaries. These features are described in regional geology reports for the Dickson area and were verified by the extensive field karst survey completed as part of the Phase II RFI.
- ❑ The Warsaw Formation is the primary aquifer unit in the area. Most lateral groundwater flow occurs within the Warsaw.
- ❑ The top Fort Payne Formation effectively represents the bottom of the aquifer system due to the abundance of bedded and scraggy chert in this formation preventing the development of significant dissolution pathways for groundwater flow. This is further supported by the fact that the vast majority of springs identified in the area issue from the Warsaw Formation. Another important feature is the presence of effective drains for the aquifer system stratigraphically above the Fort Payne Formation in the form of springs, seeps, and gaining reaches of streams.
- ❑ The residuum overburden unit developed from chemical weathering of the St. Louis Formation. Due to the depth of the weathering front, the St. Louis is difficult to identify at the ground surface. Residuum thickness ranges from a few feet to over 80 feet in the site vicinity.
- ❑ The residuum overburden unit serves to stabilize groundwater flow by (1) providing a storage reservoir for infiltrating rainwater, and (2) slowly and steadily releasing groundwater to the underlying Warsaw Formation.
- ❑ Based on data collected from site well clusters, VOCs are trapped within the saturated residuum in each of the site source areas.
- ❑ VOC migration from the source areas is similar to that of groundwater—slowly migrating downward to the Warsaw Formation, where lateral flow to local springs and streams predominates.
- ❑ The discharge area for the site is limited to the areas perpendicular to the regional surface water divide, within the outcrop area of the Warsaw/Ft. Payne contact.
- ❑ Given the differences in VOC concentrations between the site and offsite springs, it appears that some attenuation is naturally taking place in the aquifer system. Therefore, monitored natural attenuation will be carefully evaluated as part of the upcoming CMS.