Appendix A

for the

Engineering Evaluation/Cost Analysis

Revised and Updated 2010

for the

Twins Inn Site

Arvada, Colorado

U.S EPA, Region 8

Appendix A

Groundwater Modeling

to Support EE/CA

Twins Inn Site

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1.0 Introduction

Groundwater modeling for the Twins Inn Site was conducted in 2001 as part of the Remedial Investigation (RI) effort (URS 2001, Appendix N). The RI model includes both flow and fate and transport using MODFLOW (McDonald and Harbaugh 1988) and MT3DMS (Zheng and Wang 1998). The RI model was calibrated to both groundwater flow and fate and transport conditions observed at the site in 2001. To support the Feasibility Study (FS), additional evaluation of the site conditions and modeling were conducted in 2005-2006 and are reported in this appendix.

2.0 Evaluation of Groundwater Contaminant Conditions

Several rounds of groundwater sampling have been conducted since the original site investigation in 1995 and the RI in 2001, including annual sampling in 2002, 2003, and 2005, and quarterly sampling in 2006. Based on the groundwater data, the site conditions were re-examined during preparation of the FS in three key areas:

- Overall plume conditions from 2001 to 2006
- The North Tank area source conditions
- The rate of natural attenuation

2.1 Plume Conditions, 2001 to 2006

Figures A-1 to A-5 present the interpreted TCE plumes for 2001, 2002, 2003, 2005, and 2006 (note that no groundwater samples were collected in 2004). Plume-wide groundwater concentrations of PCE, TCE, and 1, 1, 1-TCA during this period are included in Table A-1. During the last six years, the plume extent has remained almost the same, while the concentrations near the source (e.g., MW028) have fluctuated substantially. Specifically, the concentrations of TCE near the source area (MW028) increased from 1,200 micrograms per liter (µg/L) in 2001 to 26,000 µg/L in 2003, and then decreased to 500 µg/L in 2006. The variations of PCE and 1,1,1-TCA concentrations exhibit similar patterns as TCE (Table A-1). Further discussion of source conditions is provided in Section 2.2 below.

2.2 North Tank Source Characterization

To better understand the source conditions, the data in the vicinity of the North Tank source area were reviewed. The North Tank source area was extensively investigated in a series of sampling efforts from 1995 to 2002. It is believed that pure products of PCE, TCE, and 1,1,1-TCA were released to the ground surface and then migrated to the subsurface at this Site during the late 1960s to early 1970s when the Thoro Products Company conducted chlorinated solvent transfer, reclamation, and drum recycling activities. In the North Tank source area, TCE, PCE, and 1,1,1-TCA were routinely delivered to three aboveground storage tanks (Figure A-6) via railcar and then transferred to trucks for distribution throughout the Denver area. Drum washing also allegedly occurred in this area.

Sampling results from groundwater and subsurface soils collected during 1995 to 2006 within and immediately downgradient of the North Tank source area are presented in Tables A-2 and A-3. Groundwater concentrations of PCE, TCE, and 1,1,1-TCA are posted on Figures A-6 to

A-8, respectively. Subsurface soil concentrations of PCE, TCE, and 1,1,1-TCA are presented on Figure A-9 and in the cross sections on Figures A-10 to A-12. Groundwater concentrations of PCE, TCE, and 1,1,1-TCA as high as 56 milligrams per liter (mg/L), 220 mg/L, and 140 mg/L, respectively, were measured in groundwater samples from HA003 (Table A-2) during the RI. These concentrations are 37%, 20%, and 9% of their respective aqueous solubilities (URS 2001). Such high concentrations suggest that dense non-aqueous phase liquid (DNAPL) may exist in the subsurface in the vicinity of the tanks. However, the depth and distribution of DNAPL are unknown.

According to the subsurface lithology (Figures 5-2 through 5-5, URS 2001), the vadose zone soils are primarily composed of silty clay, while the saturated aquifer material is primarily composed of sand and gravel. The highest concentrations of PCE, TCE, and 1,1,1-TCA in the North Tank source area soil and groundwater were found in the silty clay soils just above the water table (i.e., capillary fringe) (e.g., HA003 groundwater TCE: 220 mg/L at 13.5 ft below ground surface (bgs), see Table A-2). These constituents were also detected in deeper samples collected near the bottom of the saturated alluvium (e.g., TWI-12 groundwater TCE: 1.8 mg/L at 25 ft bgs, or at bottom of the aquifer, see Table A-2) where the concentrations were generally lower. These data suggest that residual DNAPL may primarily exist in the silty clay, particularly near the interface of the silty clay and the sand and gravel (i.e., at or just above the water table). At direct push sampling location TWI-12, groundwater samples were collected from near the water table and from the base of the aquifer in 1997. The sample near the water table had a TCE concentration of 1,130 µg/L and the sample collected at the base of the aquifer had a TCE concentration of 1,820 µg/L. It is uncertain whether the higher concentration at the base of the aquifer is indicative of a local DNAPL source in the sand and gravel portion of the aquifer. Whether residual DNAPL exists at the bottom of the alluvium cannot be confirmed based on the available data.

2.2.1 Cycling of Groundwater Contaminant Concentrations Near Source

Figure A-13 shows time-series plots of groundwater concentrations and water levels from 1995 to 2006 at MW028, which is located about 100 ft downgradient of the tank formerly containing TCE (Figures A-6, A-7, A-8). Well MW028 is the closest well to the source area for which there is time-series data available through 2006. During the period from 1995 to 2006, the groundwater concentrations of TCE at this location varied as much as two orders of magnitude, as shown on Figure A-13. PCE and 1,1,1-TCA also had a similar variation in concentrations during this time. The highest concentration of TCE was detected in August 2003, which was the first sampling event following the 100-year snowfall that occurred in March 2003, when the

Arvada area had about 3 feet of snow during a single storm. The water table elevation also increased in 2003 relative to the previous sampling event in 2002, and this is likely related, at least in part, to the groundwater recharge resulting from the 2003 blizzard. The short-term slug of infiltration through the vadose zone that followed the 2003 storm, along with the elevated water table that followed, may have contributed to the increased concentrations of dissolved TCE and other contaminants in groundwater. The infiltration through the vadose zone may have caused dissolution of contaminants from residual DNAPL above the water table. Even more likely, the rise of the water table may have resulted in groundwater having direct contact with the residual DNAPL in the silty clay soils, resulting in a substantial increase in contaminant concentrations in groundwater.

No data are currently available for MW028 in the period between 1995 and 2001. Figure A-13 includes one data point from a nearby direct push borehole (TWI-12) from 1997. Assuming that the result from TWI-12 is reasonably representative of the order of magnitude concentration that would be expected at MW028 in 1997, one might conclude that there may a cycling of TCE concentrations near the source area. As shown on Figure A-13, the 1995 and 2003 TCE results for groundwater near the source area are similarly high, and they both appear to be followed by a period of much lower concentrations. While the available data does not have the temporal resolution needed to evaluate this apparent cycling in detail, it appears reasonable to interpret the available data as showing a cycling pattern.

2.2.2 Conceptual Model for North Tank Source Area

As noted above, the TCE concentrations at MW028 near the source decreased from 26,000 µg/L in 2003 to 870 µg/L in 2005 and then remained in the 300 to 540 µg/L range throughout 2005 and 2006. If the major source of the dissolved TCE plume is only in the saturated sand and gravel zone and the dissolved concentrations of TCE in groundwater are high (e.g., 26,000 µg/L) at the source area, then it is highly unlikely that the concentrations immediately downgradient of the source (MW028) would have decreased by two orders of magnitude from 2003 to 2005, as observed in the actual sampling data for MW028. It is more likely that there is a different source condition in 2003 than in 2005. The difference in source conditions may be related to the water table elevation. If the water table elevation is high enough to saturate the silty clay soils containing residual DNAPL, then a large amount of TCE dissolution may occur in addition to possible dissolution by infiltration through the vadose zone or minor dissolution in the sand and gravel layer. However, at other times, the water table may be lower, and less of the residual DNAPL in the vadose zone is in direct contact with groundwater. Results of groundwater

sampling conducted in 2007 after the large amount of snowfall at the Site in late 2006 to early 2007 may support this.

Two conceptual models representing these different source conditions are shown on Figure A-14. In Figure A-14, the version shown as Time 1 represents the source conditions when the silty clay is below the water table. The version shown as Time 2 represents source conditions when the water table is below the silty clay. In both models, it is assumed that the majority of residual DNAPL is present in the silty clay soils, with a minor amount of residual DNAPL in the sand and gravel. Both models also assume that there may be some minor dissolution of DNAPL via infiltration of precipitation through the vadose zone and there may be some dissolution from the assumed minor amount of residual DNAPL in the saturated sand and gravel.

In the Time 1 conceptual model, where part of the contaminated silty clay is saturated, there is greater dissolution of DNAPL, and presumably higher dissolved concentrations in groundwater. In this scenario, the groundwater contaminant source is a combination of dissolution of DNAPL from infiltration through the vadose zone and DNAPL dissolution through direct contact of groundwater with residual DNAPL in the silty clay layer and the sand and gravel layer. This conceptual model likely represents the conditions in 2003, when the TCE concentrations (e.g., 26,000 µg/L of TCE at MW028) were much higher than in previous years and the water table was elevated.

In the Time 2 conceptual model, where the water table is below the silty clay layer, the only potential sources of dissolved DNAPL to groundwater are infiltration through contaminated soils in the vadose zone and dissolution through direct contact of groundwater with the minor residual DNAPL source in the sand and gravel layer. Therefore, the dissolved TCE concentrations in groundwater are lower. This conceptual model likely represents the conditions near the source in 2005 to 2006, with the TCE concentration contributed by the saturated zone source on the order of 500 µg/L.

In summary, the review of the source characterization data and time-series groundwater data reveals the following:

- Groundwater concentrations of PCE, TCE, and 1,1,1-TCA in the North Tank source area suggest that residual DNAPL may exist in the subsurface soil in the vicinity of the aboveground tanks.
- The major source of residual DNAPL appears to exist in the variably saturated vadose zone silty clay soils.
- It is not known whether residual DNAPL exists in the saturated sand and gravel zone at the base of the aquifer. If present, the saturated zone residual DNAPL appears to be small in extent based on limited soil data, compared to the suspected DNAPL in the silty clay.
- Groundwater contaminant concentrations near the North Tank source area appear to cycle between low and high concentrations. This may be related to fluctuations of the water table resulting in changes in the amount of residual DNAPL in direct contact with groundwater. When the water level rises up into the silty clay where the major source of residual DNAPL is suspected to be, the concentrations of dissolved TCE in groundwater increased to over 20 mg/L and when the water table drops below the silty clay, the TCE concentrations decrease to around 0.5 mg/L.

2.3 Rate of Natural Attenuation

Based on the Site data, the rate of natural attenuation (based on changes in groundwater concentration) for the dissolved contaminant plume in groundwater (i.e., the plume) appears non-uniform over space and variable over time. In the North Tank source area, the attenuation rate is very high, as observed at MW028. This was confirmed by the bench-scale treatability study (Qiu, et al. 2004). However, near the leading edge (i.e., downgradient end) of the plume, the attenuation rate appears lower than observed in the past. From the well at Twins Inn Bar, which is located near Sheridan Blvd (Figures A-1 to A-5), the groundwater sampling results (Table A-4 and Figure A-15) show a decrease of concentrations from 1995 to 2000 and low but almost constant concentration in 2000 to 2006. The concentrations in the middle part of the plume (Figures A-1 to A-5) also have not changed much in the last few years.

The 2005-2006 data suggest that the biodegradation mechanisms are generally the same as understood in the RI report (URS 2001). At the time of the RI, concentrations of chlorinated solvents had decreased in the middle and downgradient portion of the plume while concentrations in the North Tank source area groundwater showed little variation. The recent groundwater constituent data indicate rapid degradation of TCE, PCE, and 1,1,1-TCA in the source area (MW028), but the concentrations of cis-1, 2-DCE, trans-1, 2-DCE, 1,1-DCE,

1,1-DCA, vinyl chloride, and ethane or ethane are either low or absent. This does not support such a rapid decrease of concentrations in the source zone as Type-1 anaerobic degradation. Type-1 degradation is defined by Wiedemeier et al (1999), as biodegradation that occurs in strongly reducing environments with anthropogenic carbon presence and follows the degradation sequence of PCE to TCE to dichloroethene to vinyl chloride to ethene to ethane. The degradation mechanism that caused the rapid decrease in concentrations of PCE, TCE, and 1,1,1-TCA in recent years is not known. In contrast, the degradation in the South Pit area at the Twins Inn Site and the area immediately downgradient from the South Pit appears to have followed a Type-1 degradation scheme, with degradation of chlorinated solvent compounds occurring the presence of petroleum hydrocarbon compounds, particularly toluene, and high concentrations of the biodegradation daughter products.

3.0 History Matching Simulation of Plume Migration

To evaluate the remedial alternatives for the Twins Inn Site FS, the RI model was revised based on the refined conceptual model for the source as discussed above (Section 2.2). The FS model was limited to (1) simulation of source of contamination and (2) simulation of biodegradation rate.

History matching of the plume migration was simulated from 2002 to 2006. The interpreted TCE plume extent in 2001 (Figure A-1) is assumed as the initial condition. The source of contamination is assumed as contaminated recharge flux with variable concentrations over time. The simulated contaminated recharge in the source zone is shown in Figure A-16. In the central source area (dark blue color), where the ground surface is not paved, the recharge rate is assumed as 0.001 ft/day (4.38 inches/yr), which is higher than the rest of area (0.000228 ft/day, or 1 inch/yr). During 2002 to 2004, the simulated TCE concentration is assumed as 700 mg/L in the dark blue area (5,000 ft^2), and 20 mg/L in the surrounding source (red color) area (55,000 ft^2). The equivalent mass of contamination entering into the saturated zone is 36 kg per year. During 2005 to 2006 the simulated TCE concentration associated with the contaminated recharge is assumed to decrease to 10 mg/L. The mass entering the saturated zone is equivalent to 0.5 kg per year. The rates and concentrations of the contaminated recharge are assumed and tested to simulate the source area concentrations as observed at MW028. The recharge rate in the rest of model domain remains the same as simulated in the RI model. It should be noted that assuming contaminated recharge to simulate a variable source is a numerical method used as an approximation of site conditions in the model, and does not necessarily reflect the actual condition of the contamination source.

The biodegradation rate is simulated as shown on Figure A-17 and does not vary with time during 2001 to 2006. The assumed biodegradation half-lives are: 10-year half-life for the downgradient plume area, 2-year half-life for the center of the plume, one-year half-life for the source area, and 180-days for the MW005 area (i.e., South Pit area, where Type-1 biodegradation was evidenced by diminishing PCE, TCE, and 1,1,1-TCA concentrations and by the high concentrations of daughter products and hydrocarbons). It should be noted that in the RI modeling, the biodegradation half-life was calibrated to one or two years based on the observation that the concentrations in the entire plume dropped by two orders of magnitude between 1995 and 2001. The assumed 10-year half-life is based on the concentration variation at Twins Inn Bar during 2000 to 2006. This assumption may be conservative for the entire downgradient portion of the plume.

The history matching simulation results are presented in Figures A-18 and A-19. The simulated plume extents in 2002 and 2003 remain approximately the same, while the concentrations at MW028 increased to 27,000 and 28,000 µg/L, respectively. For 2005 and 2006, the simulated concentrations at MW028 decreased to 1,000 and 500 µg/L, respectively. The simulated high concentration slug moves away from the source area downgradient to the vicinity of the Twins Inn Bar, although the simulated slug is not as large as the slug observed in the actual Site data. The simulated extent of the plume generally mimics the interpreted plume extent based on groundwater sampling data, but the middle portion of the simulated plume is narrower than the interpreted plume. Nevertheless, the simulated plumes roughly mimic the general features of the interpreted plumes, even though the exact concentrations were not simulated.

4.0 Simulations of Remedial Alternatives

Based on the results of the source area characterization, soil excavation is recommended to remove the residual DNAPL to the extent possible. However, due to the difficulty in obtaining property access to the property for this task, soil excavation may not be conducted or may be delayed. Thus, the groundwater remediation alternatives were designed based on two scenarios:

- **Scenario 1:** Soil excavation is conducted in the North Tank source area to remove the DNAPL in the silty clay soils.
- **Scenario 2:** No soil excavation is conducted in the source area.

The following remedial alternatives for groundwater were simulated based on the revised model:

- Monitored natural attenuation (MNA) with soil excavation
- PRB with soil excavation
- Bioremediation with soil excavation
- Bio-recirculation with soil excavation
- Chemical oxidation with soil excavation
- MNA without soil excavation
- PRB without soil excavation
- Bio-recirculation without soil excavation

4.1 Scenario 1: Simulation of Plume After Source Area Soil Excavation

With soil excavation, the major source of contamination is assumed to be removed. This may leave three possible situations at the source:

- Simulation 1: Source is completely removed, assuming the source is only present in the silty clay soils.
- Simulation 2: A minor source exists in the saturated zone, which contributes half of the current source concentration of 500 µg/L, i.e., 250 µg/L.
- Simulation 3: A minor source exists, which contributes entirely the current source concentration of 500 µg/L.

4.1.1 MNA with Soil Excavation

Figures A-20a, A-20b, and A-20c present the simulated plumes, assuming soil excavation followed by MNA for 20 years under three remaining source simulations. The simulation results are summarized below.

- MNA Simulation 1: If the source is completely removed, then by year 20 there is only a small distal plume remaining with concentrations ranging between 5 and 10 µg/L (Figure A-20a).
- MNA Simulation 2: If the remaining residual DNAPL in the saturated zone continuously contributes a source area concentration around 250 µg/L, the plume remains in the source area, but the downgradient portion is naturally attenuated by year 20 (Figure A-20b).
- MNA Simulation 3: If the remaining residual DNAPL source contributes continuously at the same concentration as observed in 2006, the plume remaining in the source area will be at a somewhat higher concentration than shown in Figure A-20b. The downgradient plume will be naturally attenuated by year 20 (Figure A-20c).

In these simulations, as a conservative assumption, the decay of the source, which may happen under natural conditions, is not included. Therefore, the TCE concentrations in groundwater may be overestimated.

4.1.2 PRB with Soil Excavation

Figure A-21 shows the simulated plume under the PRB with soil excavation scenario. The source area concentration after soil removal is assumed to be 500 µg/L. The PRB is simulated near MW030 along Lamar Street as shown in the figure. The biodegradation half-life of the PRB model cells is assumed as 0.5 day based on the conceptual design of the PRB. By year 20 the downgradient plume is completely gone, only the source area upgradient of the PRB remains. The simulated PRB effectively reduces concentrations to less than 5 µg/L. The concentrations in the source area are similar to those for MNA (Figure A-19c).

4.1.3 Bioremediation with Soil Excavation

Figure A-22 shows the simulated plume under bioremediation with soil excavation. The source area concentration after soil removal is assumed to be 500 µg/L. It is assumed that the biodegradation half-life is shortened to 110 days as a result of bioremediation in the proposed treatment area (Figure A-22). This effectively reduces the source concentrations to 300 µg/L. By year 20, the remaining extent of the simulated plume is similar to MNA (Figure A-20c), but the predicted concentrations in the source zone are less than those of MNA.

4.1.4 Bio-recirculation with Soil Excavation

For this scenario, the source area concentration after soil removal is assumed to be 500 µg/L. Bio-recirculation is assumed to be applied within the proposed treatment area (Figure A-23) for five years. Bio-recirculation wells include two for extraction and two for injection. The rate of injection and extraction is 0.75 gallons per minute (gpm) for each well. During the active bio-recirculation period, the simulated biodegradation half-life is assumed as 22 days based on the treatability study result (Qiu, et al. 2004). After the first five years of treatment, the biodegradation half-life is assumed as 110 days, the same as for bioremediation (4.1.3). The pattern of the simulated plumes (Figure A-23) is similar to the results for bioremediation, with slightly lower concentrations.

4.1.5 Chemical Oxidation with Soil Excavation

It is assumed that chemical oxidation effectively treats the dissolved phase concentrations in the proposed treatment area (Figure A-24) to 10 µg/L in a short time. However, contaminants sorbed on soil may continuously desorb into the dissolved phase after chemical oxidation, which results in an assumed concentration in the source zone after soil removal that is similar to the other scenarios. The simulation results predict that the source area remains with predicted concentrations of about 200 µg/L; however, the rest of the plume is attenuated by year 20.

4.2 Scenario 2: Simulation of Plume without Source Area Soil Excavation

If soil in the North Tank source area is not excavated, the major source of suspected DNAPL will remain. If the cycling described in Section 2.2.1 is correct, the history of the last decade will repeat. In the model, it is assumed that a water table rise will occur two years out of ten years. During the remaining eight years the water table is expected to be similar to what has typically been observed in 2005 to 2006. Thus, for years 0 to 10, the highly contaminated recharge is simulated for the first two years and the less contaminated recharge is simulated for the remaining eight years. This cycle is repeated for years 10 to 20. To be conservative, source decay is not included in these simulations.

4.2.1 MNA without Soil Excavation

If the suspected DNAPL source in the silty clay soils is not removed, the future simulated plume of TCE may occur as shown in Figure A-25. By year five, the simulated high concentration slug migrates away from the source area. Then the source concentrations will be at a lower concentration for a few years. In the second decade, it is assumed the source concentration will increase again as the result of a water level rise, and the second high concentration slug moves away from the source area as shown by year 15. Then the source area concentration decreases to

a lower level again. In this scenario, the downgradient plume almost disappears by year 20, but the concentrations above the MCL for TCE extend to the vicinity of MW011. It is expected that the high concentration slug may repeat in the following years.

4.2.2 PRB without Soil Excavation

If a PRB is installed and the DNAPL source remains in the silty clay soils, the future simulated plume of TCE may occur as shown in Figure A-26. The simulated plume in the downgradient portion is the same as for the PRB scenario with soil excavation (Figure A-21), while the concentrations in the source area fluctuate over time.

4.2.3 Bio-recirculation without Soil Excavation

Figure A-27 shows the simulation results for bio-recirculation without soil excavation. The assumptions are the same for the scenario of bio-recirculation with soil excavation, except the concentrations of contaminated recharge change over time. Comparing the result with the same scenario with soil excavation (Figure A-23), the downgradient portion of the plume may disappear slightly later, but the source concentrations are higher in year 15 and vary over time.

5.0 Conclusions and Limitations

5.1 Understanding of Source Conditions

Through the re-evaluation of the source area contaminant conditions and the modeling of the history matching process, the understanding of the source conditions has been improved:

- The repeated concentration variation cycle in the source area over the last decade suggests that (1) the main source of DNAPL is most likely located in the vadose zone silty clay in the source area, and (2) water level fluctuations periodically cause the dissolved DNAPL trapped in the silty clay to be released into the saturated zone, resulting in the concentration fluctuations.

- It is not known whether DNAPL residuals also exist in the saturated zone as a minor source of contaminants to groundwater. This needs to be verified after soil excavation by groundwater monitoring. It is noted that some soils with greater than 1 ppm concentrations of TCE, PCE, or 1,1,1-TCA occur at or near the bedrock interface. The observed concentrations in the source area groundwater in 2005 and 2006 could be the result of either dissolution via infiltration through the DNAPL in the silty clay or dissolution of DNAPL residuals in the saturated zone, or both.

5.2 Understanding of Biodegradation Conditions

The Twins Inn Site is predominantly under anaerobic biodegradation conditions based on available site data. Comparing the recent data with the historical data, it is found that the rate of degradation based on changes in groundwater concentrations varies in space and over time.

- In the source area, biodegradation is very fast. The mechanism for such fast biodegradation is not clear; whether the fast degradation in the source area will continue at a similar rate in the future is not known.
- The attenuation rate observed at the Twins Inn Bar indicates that the rate of attenuation after 2000 is much slower than the rate during 1995 to 2000.
- The natural attenuation rate over the majority of the plume from 2001 to 2006 appears to be slower than the attenuation rate inferred between 1995 and 2000. It is unknown whether the natural attenuation rate for the majority of the plume will continue to decrease.

5.3 Comparison of Remedial Alternatives

Comparing the model simulation results of various alternatives, it is found that:

- If contaminated soils in the vadose zone remain, no matter which remedial alternative is selected, the source area plume may persist with variable concentrations over time (Figures A-25, -26, -27).
- If soil excavation is conducted, the majority of the vadose zone source may be removed, while the saturated zone source may remain. If the observed concentration of 500 µg/L in the source area in 2006 is attributed completely or partially to the dissolution of residual DNAPL in the saturated zone, then the saturated source, if present, may remain after soil excavation and the source area plume may be as simulated in Figures A-20c, -20b, -21, -22, -23, and -24.
- If the concentrations in the source area in 2006 is completely attributed to the vadose zone and soil excavation can completely remove the source, then the source area plume may be naturally attenuated in five years as shown in Figure A-20a.
- No matter which remedial alternative is selected, the middle and downgradient portions of the plume attenuate at similar rates and may be naturally attenuated about 20 years after soil excavation.

5.4 Uncertainty of Model Results

The simulation results are subject to uncertainties. Even though the understanding of the source conditions and the natural degradation has been improved, quantification is still subject to uncertainty. The mass of contamination entering the saturated zone, the temporal and spatial variable biodegradation rates, and the effect of remedial alternatives are simulated based on assumptions.

6.0 Recommendations Based on Modeling Results

Based on the improved understanding of the source conditions, the most effective remedial action is soil excavation to remove the likely DNAPL source in the silty clay soils. Instead of immediately proceeding with active groundwater remediation following soil excavation, a phased approach is recommended. It is recommended that the plume concentrations be monitored for a few years after the soil excavation is completed to evaluate the effectiveness of soil removal. Monitoring after soil excavation will confirm or improve the understanding of the remaining source conditions, if a source does indeed remain. Based on the monitoring data, the remedial alternatives presented here can be further evaluated.

Periodic groundwater sampling for TCE, PCE, 1,1,1-TCA and daughter products, as well as geochemical indicator parameters should be considered. These data can be used to improve the understanding of the mechanisms of biodegradation, especially in the source area, and to evaluate the potential change in the natural attenuation rate in the future.

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TABLES

Table A-1
Twins Inn Site - Plume-Wide
Groundwater Concentrations (ug/L)
2001 - 2006

Site ID	Sample Date	1,1,1-Trichloroethane (1,1,1-TCA)	Tetrachloroethene (PCE)	Trichloroethene (TCE)
DP001	10/13/2000	22	230	82
DP002	10/11/2000	0.48	24	8.7
DP003	10/11/2000	2.7	38	100
DP004	10/12/2000	5.2	57	280
DP005	10/16/2000	0.56	19	12
DP006	11/29/2000	<1	<1	<1
DP007	10/16/2000	2300	2200	1100
DP008	10/12/2000	<1	<1	0.93
DP009	10/13/2000	<2	<2	1.4
DP009	1/16/2001	0.36	14	2.2
DP010	10/9/2000	5600	<5000	1300
DP011	11/6/2000	<1	<1	<1
DP012	11/8/2000	<1	<1	<1
DP013	1/16/2001	<1	<1	<1
DP014	10/10/2000	<1	<1	<1
DP015	11/8/2000	<1	<1	<1
DP016	11/29/2000	7.9	2.7	6.3
DP016	11/30/2000	180	49	11
DP017	11/5/2000	<1	<1	<1
DP017	11/6/2000	<1	<1	<1
DP018	11/6/2000	44	64	5.2
DP020	11/27/2000	1.8	6.5	44
DP021	11/27/2000	<1	<1	0.66
DP022	10/4/2000	180	56	42
DP024	12/4/2000	<1	<1	<1
DP024	12/5/2000	<1	<1	<1
DP025	10/4/2000	1.4	1.5	1.7
DP026	11/28/2000	30	30	38
DP027	11/29/2000	7.4	1.8	3.1
DP028	11/30/2000	8.5	0.47	3.4
DP029	10/5/2000	30	15	54
DP029	10/9/2000	<1	<1	2.1
DP030	10/3/2000	0.49	1	0.46
DP031	10/3/2000	<1	<1	<1
DP031	10/4/2000	<1	<1	<1
DP032	10/2/2000	<1	<1	<1
DP033	11/9/2000	0.65	1	0.44
DP034	11/10/2000	3.4	6.5	11
DP035	11/10/2000	11	15	21
DP036	12/1/2000	15	21	31
DP037	11/30/2000	40	37	63
DP037	12/4/2000	75	68	190
DP038	12/4/2000	<1	<1	0.24
DP039	11/7/2000	0.6	1.3	0.88
DP040	3/15/2001	1.7	0.93	2.4
EE-DW-001	5/18/1995	320	140	460
EE-DW-002	5/18/1995	330	140	460
EE-DW-002B	10/17/1995	120	<10	<10

Table A-1
Twins Inn Site - Plume-Wide
Groundwater Concentrations (ug/L)
2001 - 2006

Site ID	Sample Date	1,1,1-Trichloroethane (1,1,1-TCA)	Tetrachloroethene (PCE)	Trichloroethene (TCE)
EE-DW-002C	10/19/1995	270	120	340
EE-DW-002D	10/19/1995	360	140	440
EE-DW-003	5/18/1995	<0.5	<0.5	<0.5
EE-DW-004	5/18/1995	<0.5	<0.5	<0.5
EE-DW-005	5/30/1995	<10	--	--
EE-DW-007	5/30/1995	150	24	70
EE-DW-008	5/30/1995	210	100	230
EE-DW-009	5/31/1995	410	150	450
EE-DW-010	5/31/1995	390	120	460
EE-DW-011	5/31/1995	230	60	240
EE-DW-012	5/31/1995	330	88	340
EE-DW-013	5/31/1995	370	91	390
EE-DW-014	5/31/1995	510	170	620
EE-DW-015	5/31/1995	400	130	440
EE-DW-016	6/1/1995	390	160	460
EE-DW-017	6/1/1995	200	83	250
EE-DW-018	6/1/1995	280	110	310
EE-DW-019	6/1/1995	0.5	<0.5	<0.5
EE-DW-020	6/1/1995	110	<10	8
EE-DW-021	6/1/1995	<10	--	--
EE-DW-022	6/8/1995	1	<10	<10
EE-DW-023	6/8/1995	1.4	<0.5	<0.5
EE-DW-024	6/8/1995	<10	--	--
EE-DW-025	6/8/1995	1.6	1.8	0.8
EE-DW-026	6/8/1995	16	4.5	6.2
EE-DW-027A	6/14/1995	4	32	15
EE-DW-027BM	6/8/1995	11	4	5
EE-DW-027BT	10/17/1995	140	<10	<10
EE-DW-028	6/14/1995	<10	<10	<10
EE-DW-029	6/14/1995	<10	<10	<10
EE-DW-030	6/14/1995	<10	<10	<10
EE-DW-031	6/14/1995	310	160	460
EE-DW-032	6/15/1995	310	160	460
EE-DW-033	6/15/1995	580	160	740
EE-DW-034	6/15/1995	800	290	1100
EE-DW-035	7/6/1995	38	7.4	12
EE-DW-035A	6/20/1995	2	19	4
EE-DW-035B	7/6/1995	33	7	9
EE-DW-036	7/6/1995	90	18	32
EE-DW-037	7/6/1995	110	34	56
EE-DW-038	7/6/1995	<10	<10	<10
EE-DW-039	6/5/1995	<10	<10	<10
EE-DW-040	7/6/1995	<0.5	<0.5	<0.5
EE-DW-041	7/6/1995	<10	5	<10
EE-DW-042	7/7/1995	30	7	12
EE-DW-043	7/7/1995	240	43	180
EE-DW-044	7/7/1995	120	39	95
EE-DW-045	7/7/1995	650	160	660

Table A-1
Twins Inn Site - Plume-Wide
Groundwater Concentrations (ug/L)
2001 - 2006

Site ID	Sample Date	1,1,1-Trichloroethane (1,1,1-TCA)	Tetrachloroethene (PCE)	Trichloroethene (TCE)
EE-DW-046	7/7/1995	630	190	570
EE-DW-047	7/7/1995	1600	400	1600
EE-DW-048	7/7/1995	1800	560	1800
EE-DW-049	7/7/1995	500	210	490
EE-DW-050	7/7/1995	2	3	2
EE-DW-051	7/10/1995	260	60	280
EE-DW-052	7/10/1995	360	160	450
EE-DW-053	7/10/1995	37	26	68
EE-DW-054	7/10/1995	1	1	1
EE-DW-055	7/10/1995	80	47	100
EE-DW-056	7/10/1995	1.6	1.9	3.1
EE-DW-057	7/11/1995	140	17	48
EE-DW-058	7/11/1995	35	72	360
EE-DW-059	7/11/1995	2900	<0.5	2400
EE-DW-060	7/11/1995	2200	720	2100
EE-DW-061	7/11/1995	3	2	13
EE-DW-062	7/11/1995	1	2	22
EE-DW-063	7/11/1995	4	8	110
EE-DW-064	7/18/1995	2	8	100
EE-DW-065	7/18/1995	9	2	36
EE-DW-066	7/18/1995	23	8	11
EE-DW-067	7/18/1995	1	<0.5	<0.5
EE-DW-068	7/19/1995	2	<10	<10
EE-DW-069	7/19/1995	<10	7	2
EE-DW-070	7/19/1995	<10	<10	<10
EE-DW-071	7/19/1995	<10	--	--
EE-DW-072	7/19/1995	<0.5	<0.5	<0.5
EE-DW-073	7/20/1995	140	15	8
EE-DW-074	7/20/1995	1300	220	350
EE-DW-075	7/20/1995	350	82	46
EE-DW-076	7/20/1995	<10	<10	<10
EE-DW-077	7/20/1995	<0.5	<0.5	<0.5
EE-DW-078	7/26/1995	<10	<10	<10
EE-DW-079	7/26/1995	<10	<10	<10
EE-DW-080	7/27/1995	4	<10	<10
EE-DW-081	7/27/1995	<10	<10	<10
EE-DW-082	7/31/1995	<0.5	<0.5	<0.5
EE-DW-082a	7/27/1995	<10	<10	<10
EE-DW-082b	7/31/1995	<10	<10	<10
EE-DW-083	7/31/1995	<10	<10	<10
EE-DW-084	7/31/1995	3	35	4
EE-DW-085	7/31/1995	<10	<10	<10
EE-DW-086	9/6/1995	4	<10	<10
EE-DW-087	8/8/1995	<10	--	--
EE-DW-088	8/8/1995	4	<10	<10
EE-DW-089	8/10/1995	<0.5	<0.5	<0.5
EE-DW-090	8/11/1995	1.6	2.9	27
EE-DW-091	8/11/1995	16	86	140

Table A-1
Twins Inn Site - Plume-Wide
Groundwater Concentrations (ug/L)
2001 - 2006

Site ID	Sample Date	1,1,1-Trichloroethane (1,1,1-TCA)	Tetrachloroethene (PCE)	Trichloroethene (TCE)
EE-DW-092	8/11/1995	<10	<10	12
EE-DW-093	8/25/1995	41	4	18
EE-DW-094	8/25/1995	90	25	91
EE-DW-095	8/25/1995	4	<10	<10
EE-DW-096	9/6/1995	24	120	570
EE-DW-097	9/6/1995	79	45	280
EE-DW-098	9/6/1995	220	210	230
EE-DW-099	9/6/1995	0.9	8.9	1.3
EE-DW-100	9/6/1995	15000	1700	17000
EE-DW-101	10/16/1995	1.8	25	22
EE-DW-102	10/16/1995	<0.5	21	1.7
EE-DW-103	10/16/1995	<0.5	3.8	<0.5
EE-DW-104	10/16/1995	10	73	14
EE-DW-105	10/16/1995	<0.5	21	5.8
EE-DW-106	10/16/1995	<0.5	21	<0.5
EE-DW-107	10/30/1995	<0.5	1.1	<0.5
EE-DW-108	10/30/1995	<0.5	1.5	<0.5
EE-DW-109	10/30/1995	4700	1400	6900
EE-DW-110	10/30/1995	470	370	1500
EE-DW-111	10/30/1995	120	26	74
EE-DW-112	10/31/1995	130	33	38
EE-DW-113	10/31/1995	56	9.9	7.6
EE-DW-114	10/31/1995	<0.5	<0.5	<0.5
EE-DW-115	10/31/1995	<0.5	<0.5	<0.5
EE-DW-116	10/31/1995	16	2.9	10
EE-MW-01	6/8/1995	83	27	73
EE-MW-02	6/8/1995	460	120	510
EE-MW-03	6/19/1995	27	7	9
EE-MW-04	6/19/1995	190	42	150
EE-MW-05	6/19/1995	550	240	760
EE-MW-06	6/19/1995	380	120	380
EE-MW-07	6/19/1995	45	15	34
EE-MW-08	6/19/1995	120	40	170
EE-MW-09	6/19/1995	76	25	130
EE-MW-10	6/20/1995	120	64	170
EE-MW-10	8/10/1995	230	95	330
EE-MW-11	6/20/1995	0.68	<0.5	<0.5
EE-MW-12	6/20/1995	<100	<100	<100
EE-MW-13	6/20/1995	220	81	310
EE-MW-14	6/20/1995	310	140	390
EE-MW-15	7/11/1995	75	150	350
EE-MW-16	7/11/1995	70	97	190
EE-MW-17	7/17/1995	100	190	400
EE-MW-23	7/18/1995	<10	<10	6
EE-MW-24	8/14/1995	50	110	410
EE-MW-25	8/14/1995	910	280	580
EE-MW-26	8/25/1995	<0.5	<0.5	<0.5
EE-MW-27	8/25/1995	37	19	34

Table A-1
Twins Inn Site - Plume-Wide
Groundwater Concentrations (ug/L)
2001 - 2006

Site ID	Sample Date	1,1,1-Trichloroethane (1,1,1-TCA)	Tetrachloroethene (PCE)	Trichloroethene (TCE)
HA001	10/12/2000	3400	1900	26000
HA002	10/16/2000	12000	2800	4500
HA003	10/16/2000	140000	56000	220000
HA004	10/13/2000	13000	3000	3200
MW001	3/27/2001	<1	<1	<1
MW001	7/29/2002	<1	<1	<1
MW001	8/18/2003	<1	<1	<1
MW001	9/29/2005	<1	<1	<1
MW001	10/3/2006	<1	<1	<1
MW002	3/28/2001	<1	<1	<1
MW003	4/6/2001	100	240	30
MW003	7/29/2002	0.57	20	1.9
MW003	8/21/2003	6.3	100	8
MW004	4/4/2001	0.43	15	12
MW004	7/29/2002	1.1	22	12
MW004	8/21/2003	0.98	45	15
MW005	4/2/2001	<20	<20	32
MW005	7/25/2002	42	10	100
MW005	8/21/2003	1.3	1.4	15
MW005	9/29/2005	<33	<33	7.7
MW005	10/3/2006	<100	<100	24
MW006	3/30/2001	<1	<1	<1
MW006	7/25/2002	<1	<1	<1
MW006	8/19/2003	<1	<1	<1
MW006	9/29/2005	<1	<1	<1
MW006	10/4/2006	<1	<1	<1
MW007	3/30/2001	<1	<1	0.52
MW007	7/26/2002	<1	0.69	2.5
MW007	8/20/2003	<1	<1	1.4
MW007	9/29/2005	<1	<1	0.48
MW007	10/4/2006	<1	<1	0.26
MW008	3/29/2001	350	93	120
MW010	3/29/2001	11	13	13
MW010	7/29/2002	6.3	4.2	4.9
MW010	8/19/2003	47	15	15
MW010	10/3/2005	98	21	53
MW010	1/30/2006	180	62	94
MW010	4/27/2006	280	88	170
MW010	8/15/2006	24	11	13
MW010	10/2/2006	29	12	16
MW011D	3/30/2001	33	40	43
MW011D	7/8/2002	66	42	52
MW011D	8/20/2003	83	41	68
MW011D	10/3/2005	130	39	98
MW011D	10/2/2006	200	74	150
MW012	3/30/2001	12	8.4	21
MW012	7/26/2002	1.6	1.2	3.2
MW012	10/22/2003	10	3.3	17

Table A-1
Twins Inn Site - Plume-Wide
Groundwater Concentrations (ug/L)
2001 - 2006

Site ID	Sample Date	1,1,1-Trichloroethane (1,1,1-TCA)	Tetrachloroethene (PCE)	Trichloroethene (TCE)
MW012	9/30/2005	8.5	1.6	15
MW012	10/4/2006	20	5	23
MW013	3/29/2001	19	30	45
MW013	7/29/2002	12	23	38
MW013	8/20/2003	8.9	20	34
MW013	10/3/2005	26	16	29
MW013	1/30/2006	47	23	42
MW013	4/27/2006	58	25	51
MW013	8/15/2006	46	21	46
MW013	10/2/2006	56	21	50
MW014	3/28/2001	<1	<1	<1
MW014	7/26/2002	<1	<1	<1
MW014	10/22/2003	<1	<1	<1
MW014	9/30/2005	<1	<1	<1
MW014	10/2/2006	<1	<1	<1
MW015	3/28/2001	6.2	44	260
MW015	7/26/2002	<6.7	17	190
MW015	8/20/2003	6	24	160
MW015	9/30/2005	6.8	11	50
MW016	3/29/2001	37	57	100
MW016	8/20/2003	2.2	3.9	7.9
MW016	9/30/2005	2.2	4.2	9.7
MW016	10/2/2006	5.7	8	20
MW017	3/29/2001	140	97	250
MW017	7/26/2002	72	69	150
MW017	8/22/2003	23	42	69
MW017	9/30/2005	5.2	11	23
MW017	10/2/2006	6.6	15	29
MW018	3/28/2001	5.1	8.3	16
MW018	7/26/2002	1.1	2.3	2.2
MW018	8/19/2003	3.5	6.5	13
MW018	9/28/2005	4	9.5	19
MW018	1/30/2006	3.7	9.2	17
MW018	4/27/2006	2.5	6.7	11
MW018	8/15/2006	3.8	9	19
MW018	10/3/2006	3.6	8.8	19
MW019	3/28/2001	<1	<1	<1
MW019	7/24/2002	<1	<1	<1
MW019	8/19/2003	<1	<1	<1
MW019	9/30/2005	<1	<1	<1
MW020D	3/28/2001	<1.3	<1.3	1.1
MW020D	7/24/2002	<1	<1	0.41
MW020D	8/19/2003	<1	<1	0.25
MW020D	9/28/2005	<1	<1	0.2
MW020D	10/2/2006	<1	<1	0.18
MW024D	3/27/2001	<1	<1	<1
MW024D	7/24/2002	<1	<1	<1
MW024D	8/19/2003	<1	<1	<1

Table A-1
Twins Inn Site - Plume-Wide
Groundwater Concentrations (ug/L)
2001 - 2006

Site ID	Sample Date	1,1,1-Trichloroethane (1,1,1-TCA)	Tetrachloroethene (PCE)	Trichloroethene (TCE)
MW024D	9/28/2005	<1	<1	<1
MW024D	10/2/2006	<1	<1	<1
MW025	7/17/1995	220	230	260
MW025	3/30/2001	450	260	250
MW025	7/25/2002	1000	430	510
MW025	8/22/2003	240	140	190
MW025	10/3/2005	17	21	100
MW025	10/3/2006	<2	5.7	32
MW026	12/20/2000	<1	1.4	3.8
MW026	3/30/2001	<1	1	2.6
MW027	7/17/1995	<10	<10	<10
MW027	4/2/2001	<1	<1	0.42
MW027	7/25/2002	<1	<1	0.88
MW027	8/21/2003	<1	<1	0.83
MW027	9/29/2005	<1	<1	0.71
MW027	10/3/2006	<1	<1	0.87
MW028	7/17/1995	21000	3800	20000
MW028	4/2/2001	2100	570	1200
MW028	7/25/2002	42000	4200	15000
MW028	8/21/2003	70000	8800	26000
MW028	9/29/2005	1400	690	870
MW028	1/30/2006	580	340	400
MW028	4/27/2006	880	430	540
MW028	8/15/2006	460	260	300
MW028	10/3/2006	770	420	510
MW029	7/17/1995	64	67	76
MW029	8/10/1995	64	31	23
MW029	4/2/2001	21	32	93
MW029	7/25/2002	24	29	37
MW029	8/21/2003	8.9	24	71
MW029	9/29/2005	<20	12	34
MW029	10/3/2006	<10	5.2	11
MW030	7/17/1995	6100	1600	5200
MW030	4/2/2001	1600	480	720
MW030	7/25/2002	3300	500	1100
MW030	8/21/2003	6300	790	2200
MW030	9/29/2005	250	160	170
MW030	1/30/2006	100	110	120
MW030	4/27/2006	93	95	120
MW030	8/15/2006	76	79	120
MW030	10/3/2006	75	75	110
MW031	8/21/2003	1900	430	1000
MW031	10/3/2005	2600	630	1600
MW031	1/30/2006	1400	540	810
MW031	4/27/2006	800	350	560
MW031	8/15/2006	470	260	400
MW031	10/3/2006	350	190	320
MW032	8/22/2003	330	170	190

Table A-1
Twins Inn Site - Plume-Wide
Groundwater Concentrations (ug/L)
2001 - 2006

Site ID	Sample Date	1,1,1-Trichloroethane (1,1,1-TCA)	Tetrachloroethene (PCE)	Trichloroethene (TCE)
MW032	10/3/2005	78	85	170
MW032	10/3/2006	16	38	75
MW033	12/6/2005	2100	520	1200
MW033	1/30/2006	2000	510	1100
MW033	4/27/2006	1800	550	1100
MW033	8/15/2006	1700	560	1100
MW033	10/3/2006	1200	430	810
MW034	12/6/2005	0.21	<1	0.43
MW034	10/2/2006	0.29	<1	0.57
MW035	12/6/2005	0.52	0.3	1.5
MW035	10/2/2006	<1	<1	0.41
MW036	12/6/2005	0.24	0.71	1.1
MW036	10/2/2006	0.27	0.71	1
T2-GW-01	6/20/1996	<5	<5	<5
T2-GW-02	6/20/1996	<5	150	37
T2-GW-03	6/20/1996	70	270	16
T2-GW-04	6/25/1996	<5	<5	<5
T2-GW-05	6/25/1996	170000	8400	7100
T2-GW-06	6/25/1996	81	21	<5
T2-GW-07	6/26/1996	10	8	<5
T2-GW-08	6/26/1996	7	10	<5
T2-GW-09	6/26/1996	3100	180	140
T2-GW-11	7/1/1996	<5	<5	<5
T2-GW-12	7/1/1996	<5	<5	<5
T2-GW-13	7/1/1996	31	17	14
T2-GW-14	7/1/1996	35	24	14
T2-GW-15	7/1/1996	130000	3700	6800
T2-GW-16	7/2/1996	7500	1300	<500
TI-GW-103	7/23/1998	<0.5	0.89	5.15
TI-GW-105	6/27/1998	355	124	321
TI-GW-106	6/26/1998	<0.5	<0.5	<0.5
TI-GW-107	6/26/1998	<0.5	1.31	1.88
TI-GW-108	7/22/1998	9.35	4.83	5.85
TI-GW-109	7/21/1998	12.8	8.03	23.4
TI-GW-110A	7/22/1998	<0.5	<0.5	<0.5
TI-GW-110B	7/22/1998	<0.5	0.58	2.4
TI-GW-111	7/23/1998	<0.5	<0.5	<0.5
TI-GW-112	7/23/1998	2.03	<0.5	2.25
TS001	7/10/2002	5.6	110	11
TS002	7/11/2002	1100	750	97
TS003	7/11/2002	1200	440	85
TS004	7/15/2002	12	180	95
TS005	7/17/2002	2.8	8.4	5.7
TS006	7/17/2002	12	100	180
TS007	7/17/2002	11	230	42
TS008	7/18/2002	<1	<1	<1
TS009	7/9/2002	8.8	8.8	19
TS010	7/10/2002	12	19	32

Table A-1
Twins Inn Site - Plume-Wide
Groundwater Concentrations (ug/L)
2001 - 2006

Site ID	Sample Date	1,1,1-Trichloroethane (1,1,1-TCA)	Tetrachloroethene (PCE)	Trichloroethene (TCE)
TS012	7/15/2002	8.3	62	53
TWI-02	12/19/1997	51600	19500	45600
TWI-03	12/19/1997	179	389	283
TWI-04	12/19/1997	126	131	743
TWI-06	12/18/1997	36	85.9	304
TWI-09	12/18/1997	15.2	22.6	34.9
TWI-10	12/29/1997	1.01	0.434	<0.181
TWI-11	12/29/1997	0.195	8.41	0.292
TWI-12	12/30/1997	978	4680	1130
TWI-13	12/30/1997	87.9	22.6	20.5
TWI-14	12/10/1997	0.163	<0.092	0.228
TWI-15	12/10/1997	0.28	7.24	0.669
TWI-16	12/15/1997	1.04	8.81	6.92
TWI-17	12/19/1997	11.1	144	391
TWI-18	12/9/1997	0.363	0.372	4.77
TWI-19	12/8/1997	348	92.7	350
TWI-20	12/9/1997	727	150	335

Notes:
-- No data available
< Result is less than stated reporting limit
ug/L Micrograms per liter

*Site ID locations are identified on Figure 2-4 in the RI (URS 2001a), with exception of deep push locations. All DP locations are on figure 4-1 in the RI.

Table A-2
Twins Inn Site - North Tank Area
Groundwater Sampling Results
1995 - 2006

Sample Location	Sample Date	Depth (ft bgs)	Parameter	Concentration	Detection Limit	Units	Data Flag	
EE-DW-099	9/6/1995	WT*	1,1,1-Trichloroethane	0.9	--	µg/L	:	:
		WT*	1,1,1-Trichloroethane	ND	10	µg/L	:	:
		WT*	Tetrachloroethene	8	--	µg/L	:	:
		WT*	Tetrachloroethene	8.9	--	µg/L	:	:
		WT*	Trichloroethene	1.3	--	µg/L	:	:
		WT*	Trichloroethene	3	--	µg/L	:	:
EE-DW-100	9/6/1995	WT*	1,1,1-Trichloroethane	15000	--	µg/L	:	:
		WT*	1,1,1-Trichloroethane	22000	--	µg/L	:	:
		WT*	Tetrachloroethene	1700	--	µg/L	:	:
		WT*	Trichloroethene	17000	--	µg/L	:	:
		WT*	Trichloroethene	26000	--	µg/L	:	:
EE-DW-104	10/16/1995	WT*	1,1,1-Trichloroethane	8	--	µg/L	:	:
		WT*	1,1,1-Trichloroethane	10	--	µg/L	:	:
		WT*	Tetrachloroethene	73	--	µg/L	:	:
		WT*	Tetrachloroethene	74	--	µg/L	:	:
		WT*	Trichloroethene	11	--	µg/L	:	:
		WT*	Trichloroethene	14	--	µg/L	:	:
EE-DW-108	10/30/1995	WT*	1,1,1-Trichloroethane	ND	0.5	µg/L	:	:
		WT*	1,1,1-Trichloroethane	ND	10	µg/L	:	:
		WT*	Tetrachloroethene	1.5	--	µg/L	:	:
		WT*	Tetrachloroethene	ND	10	µg/L	:	:
		WT*	Trichloroethene	ND	0.5	µg/L	:	:
		WT*	Trichloroethene	ND	10	µg/L	:	:
EE-DW-109	10/30/1995	WT*	1,1,1-Trichloroethane	4,400	--	µg/L	:	:
		WT*	1,1,1-Trichloroethane	4,700	--	µg/L	:	:
		WT*	Tetrachloroethene	1,400	--	µg/L	:	:
		WT*	Trichloroethene	6,900	--	µg/L	:	:
		WT*	Trichloroethene	7,100	--	µg/L	:	:
T2-GW-01	6/20/1996	22	1,1,1-Trichloroethane	ND	5	µg/L	:	:
		22	Tetrachloroethene	4	5	µg/L	:	:
		22	Trichloroethene	ND	5	µg/L	:	:
T2-GW-02	6/20/1996	17	1,1,1-Trichloroethane	ND	5	µg/L	:	:
		17	1,1,1-Trichloroethane	2	5	µg/L	:	:
		17	Tetrachloroethene	150	5	µg/L	:	:
		17	Tetrachloroethene	190	5	µg/L	:	:
		17	Trichloroethene	37	5	µg/L	:	:
		17	Trichloroethene	44	5	µg/L	:	:
		17	1,1,1-Trichloroethane	70	5	µg/L	:	:
		17	Tetrachloroethene	270	10	µg/L	:	:
		17	Trichloroethene	16	5	µg/L	:	:
T2-GW-04	6/25/1996	23	1,1,1-Trichloroethane	4	5	µg/L	:	:
		23	Tetrachloroethene	ND	5	µg/L	:	:
		23	Trichloroethene	ND	5	µg/L	:	:
T2-GW-05	6/25/1996	26	1,1,1-Trichloroethane	170000	5000	µg/L	:	:
		26	Tetrachloroethene	8400	1000	µg/L	:	:
		26	Trichloroethene	7100	1000	µg/L	:	:
T2-GW-09	6/26/1996	22	1,1,1-Trichloroethane	3100	250	µg/L	:	:
		22	Tetrachloroethene	180	5	µg/L	:	:
		22	Trichloroethene	140	5	µg/L	:	:
T2-GW-11	7/1/1996	23.5	1,1,1-Trichloroethane	ND	5	µg/L	:	:
		23.5	Tetrachloroethene	ND	5	µg/L	:	:
		23.5	Trichloroethene	ND	5	µg/L	:	:
T2-GW-12	7/1/1996	23	1,1,1-Trichloroethane	ND	5	µg/L	:	:
		23	Tetrachloroethene	ND	5	µg/L	:	:
		23	Trichloroethene	ND	5	µg/L	:	:
T2-GW-13	7/1/1996	23	1,1,1-Trichloroethane	31	5	µg/L	:	:
		23	Tetrachloroethene	17	5	µg/L	:	:
		23	Trichloroethene	14	5	µg/L	:	:

Table A-2
Twins Inn Site - North Tank Area
Groundwater Sampling Results
1995 - 2006

Sample Location	Sample Date	Depth (ft bgs)	Parameter	Concentration	Detection Limit	Units	Data Flag	
T2-GW-14	7/1/1996	23.5	1,1,1-Trichloroethane	35	5	µg/L	:	:
		23.5	Tetrachloroethene	24	5	µg/L	:	:
		23.5	Trichloroethene	14	5	µg/L	:	:
T2-GW-15	7/1/1996	23.5	1,1,1-Trichloroethane	130000	5000	µg/L	:	:
		23.5	Tetrachloroethene	3700	500	µg/L	:	:
		23.5	Trichloroethene	6800	500	µg/L	:	:
T2-GW-16	7/2/1996	24	1,1,1-Trichloroethane	7500	500	µg/L	:	:
		24	Tetrachloroethene	1300	500	µg/L	:	:
		24	Trichloroethene	380	500	µg/L	:	:
TWI-02	12/19/1997	14.7	1,1,1-Trichloroethane	51600	84	µg/L	:	:
		14.7	Tetrachloroethene	19500	92	µg/L	:	:
		14.7	Trichloroethene	45600	90.5	µg/L	:	:
TWI-11	12/29/1997	22.8	1,1,1-Trichloroethane	0.195	0.168	µg/L	:	:
		22.8	1,1,1-Trichloroethane	0.192	0.168	µg/L	:	:
		22.8	Tetrachloroethene	8.41	0.184	µg/L	:	:
		22.8	Tetrachloroethene	7.87	0.184	µg/L	:	:
		22.8	Trichloroethene	0.292	0.181	µg/L	:	:
		22.8	Trichloroethene	0.206	0.181	µg/L	:	:
TWI-12	12/30/1997	17	1,1,1-Trichloroethane	978	8.4	µg/L	:	:
		25	1,1,1-Trichloroethane	41100	84	µg/L	:	:
		17	Tetrachloroethene	4680	9.2	µg/L	:	:
		25	Tetrachloroethene	3060	92	µg/L	:	:
		17	Trichloroethene	1130	9.05	µg/L	:	:
		25	Trichloroethene	1820	90.5	µg/L	:	:
DP007	10/16/2000	17	1,1,1-Trichloroethane	2300	100	µg/L	:	:
		17	1,1,1-Trichloroethane	2700	200	µg/L	:	:
		25	1,1,1-Trichloroethane	190	50	µg/L	:	:
		17	Tetrachloroethene	2200	100	µg/L	:	:
		17	Tetrachloroethene	2300	200	µg/L	:	:
		25	Tetrachloroethene	1200	50	µg/L	:	:
		17	Trichloroethene	1100	100	µg/L	:	:
		17	Trichloroethene	1300	200	µg/L	:	:
		25	Trichloroethene	31	50	µg/L	:	:
HA002	10/16/2000	14.5	1,1,1-Trichloroethane	12,000	290	µg/L	:	:
		14.5	Tetrachloroethene	2,800	290	µg/L	:	:
		14.5	Trichloroethene	4,500	290	µg/L	:	:
HA003	10/16/2000	13.5	1,1,1-Trichloroethane	140,000	4000	µg/L	:	:
		13.5	Tetrachloroethene	56,000	4000	µg/L	:	:
		13.5	Trichloroethene	220,000	4000	µg/L	:	:
HA004	10/13/2000	13	1,1,1-Trichloroethane	13,000	400	µg/L	:	:
		13	Tetrachloroethene	3,000	400	µg/L	:	:
		13	Trichloroethene	3,200	400	µg/L	:	:
TS001	7/10/2002	25	1,1,1-Trichloroethane	5.6	1	µg/L	:	:
		25	Tetrachloroethene	110	5	µg/L	:	:
		25	Trichloroethene	11	1	µg/L	:	:
TS002	7/11/2002	25	1,1,1-Trichloroethane	1100	20	µg/L	:	:
		25	Tetrachloroethene	750	20	µg/L	:	:
		25	Trichloroethene	97	20	µg/L	:	:
TS003	7/11/2002	24	1,1,1-Trichloroethane	1200	29	µg/L	:	:
		24	Tetrachloroethene	440	29	µg/L	:	:
		24	Trichloroethene	85	29	µg/L	:	:

Table A-2
Twins Inn Site - North Tank Area
Groundwater Sampling Results
1995 - 2006

Sample Location	Sample Date	Depth (ft bgs)	Parameter	Concentration	Detection Limit	Units	Data Flag	
MW003	4/6/2001	25	1,1,1-Trichloroethane	100	8	µg/L	J	P-L
		25	Tetrachloroethene	240	8	µg/L	J	P-L
		25	Trichloroethene	30	8	µg/L	J	P-L
	7/29/2002	25	1,1,1-Trichloroethane	0.57	1	µg/L	J	SQL-I
		25	Tetrachloroethene	20	1	µg/L	:	:
		25	Trichloroethene	1.9	1	µg/L	:	:
		25	1,1,1-Trichloroethane	0.52	1	µg/L	J	SQL-I
MW003	7/29/2002	25	Tetrachloroethene	21	1	µg/L	:	:
		25	Trichloroethene	1.9	1	µg/L	:	:
	8/21/2003	25	1,1,1-Trichloroethane	6.3	1	µg/L	:	:
		25	Tetrachloroethene	100	4	µg/L	:	:
		25	Trichloroethene	8	1	µg/L	:	:
MW028	7/17/1995	18	1,1,1-Trichloroethane	21,000	--	µg/L	:	:
		18	1,1,1-Trichloroethane	26,000	--	µg/L	:	:
		18	Tetrachloroethene	3,800	--	µg/L	:	:
		18	Tetrachloroethene	5,600	--	µg/L	:	:
		18	Trichloroethene	20,000	--	µg/L	:	:
		18	Trichloroethene	24,000	--	µg/L	:	:
	4/2/2001	18	1,1,1-Trichloroethane	2,100	40	µg/L	J	P-L
		18	Tetrachloroethene	570	40	µg/L	J	P-L
		18	Trichloroethene	1,200	40	µg/L	J	P-L
	7/25/2002	18	1,1,1-Trichloroethane	42,000	1000	µg/L	J	HT-L
		18	Tetrachloroethene	4,200	1000	µg/L	J	HT-L
		18	Trichloroethene	15,000	1000	µg/L	J	HT-L
	8/21/2003	18	1,1,1-Trichloroethane	65,000	2000	µg/L	:	:
		18	1,1,1-Trichloroethane	70,000	2000	µg/L	:	:
		18	Tetrachloroethene	8,100	2000	µg/L	:	:
		18	Tetrachloroethene	8,800	2000	µg/L	:	:
		18	Trichloroethene	25,000	2000	µg/L	:	:
		18	Trichloroethene	26,000	2000	µg/L	:	:
	9/29/2005	18	1,1,1-Trichloroethane	1,400	50	µg/L	:	:
		18	1,1,1-Trichloroethane	1,400	100	µg/L	:	:
		18	Tetrachloroethene	680	50	µg/L	:	:
		18	Tetrachloroethene	690	100	µg/L	:	:
		18	Trichloroethene	930	50	µg/L	:	:
		18	Trichloroethene	870	100	µg/L	:	:
	1/30/2006	18	1,1,1-Trichloroethane	580	10	µg/L	:	:
		18	Tetrachloroethene	340	10	µg/L	:	:
		18	Trichloroethene	400	10	µg/L	:	:
	4/27/2006	18	1,1,1-Trichloroethane	880	50	µg/L	:	:
		18	Tetrachloroethene	430	50	µg/L	:	:
		18	Trichloroethene	540	50	µg/L	:	:

Notes:

-- = Detection limit unknown
ND = Non detect
WT* = Samples were collected at the water level
µg/L = micrograms per liter

Table A-3
Twins Inn Site - North Tank Area
Soil Sampling Results
1995 - 2002

Sample Location	Sample Date	Depth (ft bgs)	Parameter	Concentration	Detection Limit	Units	Data Flag	
EE-DW-100	9/16/1995	2	1,1,1-Trichloroethane	3000	--	µg/kg	:	:
		2	Tetrachloroethene	310	--	µg/kg	:	:
		2	Trichloroethene	5200	--	µg/kg	:	:
	9/6/1995	3	1,1,1-Trichloroethane	12000	--	µg/kg	:	:
		3	Tetrachloroethene	2000	--	µg/kg	:	:
		3	Trichloroethene	21000	--	µg/kg	:	:
EE-DW-104	10/16/1995	7	1,1,1-Trichloroethane	35	--	µg/kg	:	:
		7	Tetrachloroethene	790	--	µg/kg	:	:
		7	Trichloroethene	210	--	µg/kg	:	:
		8	1,1,1-Trichloroethane	28	--	µg/kg	:	:
		8	Tetrachloroethene	1200	--	µg/kg	:	:
		8	Trichloroethene	210	--	µg/kg	:	:
		9	1,1,1-Trichloroethane	ND	5	µg/kg	:	:
		9	Tetrachloroethene	ND	5	µg/kg	:	:
		9	Trichloroethene	ND	5	µg/kg	:	:
EE-DW-108	10/30/1995	15	1,1,1-Trichloroethane	ND	5	µg/kg	:	:
		15	Tetrachloroethene	ND	5	µg/kg	:	:
		15	Trichloroethene	ND	5	µg/kg	:	:
EE-DW-109	10/30/1995	16	1,1,1-Trichloroethane	620	--	µg/kg	:	:
		16	Tetrachloroethene	260	--	µg/kg	:	:
		16	Trichloroethene	1400	--	µg/kg	:	:
		17	1,1,1-Trichloroethane	700	--	µg/kg	:	:
		17	Tetrachloroethene	140	--	µg/kg	:	:
		17	Trichloroethene	2000	--	µg/kg	:	:
		18	1,1,1-Trichloroethane	180	--	µg/kg	:	:
		18	Tetrachloroethene	86	--	µg/kg	:	:
		18	Trichloroethene	820	--	µg/kg	:	:
		19	1,1,1-Trichloroethane	250	--	µg/kg	:	:
		19	Tetrachloroethene	91	--	µg/kg	:	:
		19	Trichloroethene	1000	--	µg/kg	:	:
T2-SO-01	6/20/1996	1	1,1,1-Trichloroethane	ND	5	µg/kg	:	:
		1	Tetrachloroethene	59	10	µg/kg	:	:
		1	Trichloroethene	18	5	µg/kg	:	:
T2-SO-02	6/20/1996	2	1,1,1-Trichloroethane	ND	50	µg/kg	:	:
		2	Tetrachloroethene	1100	50	µg/kg	:	:
		2	Trichloroethene	20	50	µg/kg	:	:
T2-SO-03	6/20/1996	3	1,1,1-Trichloroethane	7200	630	µg/kg	:	:
		3	Tetrachloroethene	3700	630	µg/kg	:	:
		3	Trichloroethene	6900	630	µg/kg	:	:
T2-SO-04	6/25/1996	4	1,1,1-Trichloroethane	ND	5	µg/kg	:	:
		4	Tetrachloroethene	150	5	µg/kg	:	:
		4	Trichloroethene	14	5	µg/kg	:	:
T2-SO-05	6/25/1996	5	1,1,1-Trichloroethane	16	5	µg/kg	:	:
		5	Tetrachloroethene	94	5	µg/kg	:	:
		5	Trichloroethene	100	5	µg/kg	:	:
T2-SO-09	6/26/1996	3	1,1,1-Trichloroethane	150	25	µg/kg	:	:
		3	Tetrachloroethene	360	25	µg/kg	:	:
		3	Trichloroethene	570	25	µg/kg	:	:
		6	1,1,1-Trichloroethane	ND	630	µg/kg	:	:
		6	Tetrachloroethene	ND	630	µg/kg	:	:
		6	Trichloroethene	800	630	µg/kg	:	:
T2-SO-10	6/27/1996	10	1,1,1-Trichloroethane	130	50	µg/kg	:	:
		10	Tetrachloroethene	87	50	µg/kg	:	:
		10	Trichloroethene	460	50	µg/kg	:	:
T2-SO-11	7/1/1996	11	1,1,1-Trichloroethane	ND	5	µg/kg	:	:
		11	Tetrachloroethene	120	5	µg/kg	:	:
		11	Trichloroethene	4.8	5	µg/kg	:	:
T2-SO-12	7/1/1996	12	1,1,1-Trichloroethane	ND	5	µg/kg	:	:
		12	Tetrachloroethene	19	5	µg/kg	:	:
		12	Trichloroethene	3.2	5	µg/kg	:	:

January 31, 2007

Table A-3
Twins Inn Site - North Tank Area
Soil Sampling Results
1995 - 2002

Sample Location	Sample Date	Depth (ft bgs)	Parameter	Concentration	Detection Limit	Units	Data Flag	
T2-SO-13	7/1/1996	13	1,1,1-Trichloroethane	ND	5	µg/kg	:	:
		13	Tetrachloroethene	12	5	µg/kg	:	:
		13	Trichloroethene	4.4	5	µg/kg	:	:
T2-SO-14	7/1/1996	14	1,1,1-Trichloroethane	ND	50	µg/kg	:	:
		14	Tetrachloroethene	ND	50	µg/kg	:	:
		14	Trichloroethene	32	50	µg/kg	:	:
T2-SO-15	7/1/1996	15	1,1,1-Trichloroethane	ND	50	µg/kg	:	:
		15	Tetrachloroethene	210	50	µg/kg	:	:
		15	Trichloroethene	830	50	µg/kg	:	:
T2-SO-16	7/2/1996	16	1,1,1-Trichloroethane	ND	25	µg/kg	:	:
		16	Tetrachloroethene	60	25	µg/kg	:	:
		16	Trichloroethene	66	25	µg/kg	:	:
TWI-02	12/18/1997	0.5	1,1,1-Trichloroethane	220	48.3	µg/kg	:	:
		0.5	Tetrachloroethene	833	94.1	µg/kg	:	:
		0.5	Trichloroethene	1870	358	µg/kg	:	:
		14.5	1,1,1-Trichloroethane	672	19.1	µg/kg	:	:
		14.5	Tetrachloroethene	429	17.8	µg/kg	:	:
		14.5	Trichloroethene	351	11.5	µg/kg	:	:
		2	1,1,1-Trichloroethane	2.51	0.448	µg/kg	:	:
		2	Tetrachloroethene	9.05	0.873	µg/kg	:	:
		2	Trichloroethene	6.39	3.32	µg/kg	:	:
		8.5	1,1,1-Trichloroethane	67.6	3.86	µg/kg	:	:
		8.5	Tetrachloroethene	611	3.61	µg/kg	:	:
		8.5	Trichloroethene	368	2.31	µg/kg	:	:
TWI-11	12/29/1997	0.5	1,1,1-Trichloroethane	9.24	4.57	µg/kg	:	:
		0.5	Tetrachloroethene	7200	425	µg/kg	:	:
		0.5	Trichloroethene	110	2.74	µg/kg	:	:
		11.5	1,1,1-Trichloroethane	ND	3.67	µg/kg	:	:
		11.5	Tetrachloroethene	132	16.4	µg/kg	:	:
		11.5	Trichloroethene	10.9	2.2	µg/kg	:	:
		2	1,1,1-Trichloroethane	28.1	4.25	µg/kg	:	:
		2	Tetrachloroethene	4800	395	µg/kg	:	:
		2	Trichloroethene	275	254	µg/kg	:	:
TWI-11	12/29/1997	23	1,1,1-Trichloroethane	ND	3.43	µg/kg	:	:
		23	Tetrachloroethene	3.66	3.2	µg/kg	:	:
		23	Trichloroethene	ND	2.05	µg/kg	:	:
TWI-12	12/29/1997	0.5	1,1,1-Trichloroethane	680	365	µg/kg	:	:
		0.5	Tetrachloroethene	672	340	µg/kg	:	:
		0.5	Trichloroethene	15900	218	µg/kg	:	:
		10	1,1,1-Trichloroethane	2340	376	µg/kg	:	:
		10	Tetrachloroethene	457	351	µg/kg	:	:
		10	Trichloroethene	2820	225	µg/kg	:	:
		2	1,1,1-Trichloroethane	139	17.6	µg/kg	:	:
		2	Tetrachloroethene	132	3.43	µg/kg	:	:
		2	Trichloroethene	348	10.6	µg/kg	:	:
		23	1,1,1-Trichloroethane	15.6	3.53	µg/kg	:	:
		23	Tetrachloroethene	14.2	3.29	µg/kg	:	:
		23	Trichloroethene	ND	2.11	µg/kg	:	:
	12/29/1997	27	1,1,1-Trichloroethane	3350	380	µg/kg	:	:
		27	Tetrachloroethene	2480	355	µg/kg	:	:
		27	Trichloroethene	2750	228	µg/kg	:	:
DP007	10/16/2000	0.5	1,1,1-Trichloroethane	16000	15000	µg/kg	:	:
		0.5	Tetrachloroethene	300000	15000	µg/kg	:	:
		0.5	Trichloroethene	19000	15000	µg/kg	:	:
		2	1,1,1-Trichloroethane	9.4	5.7	µg/kg	:	:
		2	Tetrachloroethene	180	5.7	µg/kg	:	:
		2	Trichloroethene	13	5.7	µg/kg	:	:
		4	1,1,1-Trichloroethane	17	31	µg/kg	:	:
		4	Tetrachloroethene	570	31	µg/kg	:	:
		4	Trichloroethene	36	31	µg/kg	:	:

January 31, 2007

Table A-3
Twins Inn Site - North Tank Area
Soil Sampling Results
1995 - 2002

Sample Location	Sample Date	Depth (ft bgs)	Parameter	Concentration	Detection Limit	Units	Data Flag	
		6	1,1,1-Trichloroethane	28	31	µg/kg	:	:
DP007 continued	10/16/2000	6	Tetrachloroethene	560	31	µg/kg	:	:
		6	Trichloroethene	32	31	µg/kg	:	:
		8	1,1,1-Trichloroethane	52	310	µg/kg	:	:
		8	Tetrachloroethene	1700	310	µg/kg	:	:
		8	Trichloroethene	110	310	µg/kg	:	:
		10	1,1,1-Trichloroethane	44	32	µg/kg	:	:
		10	Tetrachloroethene	540	32	µg/kg	:	:
		10	Trichloroethene	34	32	µg/kg	:	:
		12	1,1,1-Trichloroethane	46	30	µg/kg	J	FD-F
		12	Tetrachloroethene	500	30	µg/kg	:	:
		12	Trichloroethene	19	30	µg/kg	:	:
		20	1,1,1-Trichloroethane	37	6.1	µg/kg	:	:
		20	Tetrachloroethene	36	6.1	µg/kg	:	:
		20	Trichloroethene	100	6.1	µg/kg	:	:
		12	1,1,1-Trichloroethane	81	31	µg/kg	J	FD-I
		12	Tetrachloroethene	480	31	µg/kg	:	:
		12	Trichloroethene	18	31	µg/kg	:	:
HA002	10/13/2000	0.5	1,1,1-Trichloroethane	ND	5.1	µg/kg	:	:
		0.5	Tetrachloroethene	2.4	5.1	µg/kg	J	Surr-H
		0.5	Trichloroethene	0.96	5.1	µg/kg	J	Surr-H
		4	1,1,1-Trichloroethane	250	30	µg/kg	:	:
		4	Tetrachloroethene	320	30	µg/kg	:	:
		4	Trichloroethene	350	30	µg/kg	:	:
		8	1,1,1-Trichloroethane	41	6.1	µg/kg	:	:
		8	Tetrachloroethene	120	6.1	µg/kg	:	:
		8	Trichloroethene	76	6.1	µg/kg	:	:
	10/16/2000	12	1,1,1-Trichloroethane	4700	330	µg/kg	:	:
		12	Tetrachloroethene	750	330	µg/kg	:	:
		12	Trichloroethene	1800	330	µg/kg	J	MS-L
HA003	10/16/2000	0.5	1,1,1-Trichloroethane	2.2	5.7	µg/kg	:	:
		0.5	Tetrachloroethene	10	5.7	µg/kg	:	:
		0.5	Trichloroethene	12	5.7	µg/kg	:	:
		2	1,1,1-Trichloroethane	ND	5.9	µg/kg	:	:
		2	Tetrachloroethene	2.1	5.9	µg/kg	:	:
		2	Trichloroethene	1.8	5.9	µg/kg	:	:
		4	1,1,1-Trichloroethane	2.5	5.9	µg/kg	:	:
		4	Tetrachloroethene	26	5.9	µg/kg	:	:
		4	Trichloroethene	18	5.9	µg/kg	:	:
		6	1,1,1-Trichloroethane	4.2	6.1	µg/kg	:	:
		6	Tetrachloroethene	54	6.1	µg/kg	:	:
		6	Trichloroethene	27	6.1	µg/kg	:	:
		8	1,1,1-Trichloroethane	2.9	6.2	µg/kg	:	:
		8	Tetrachloroethene	53	6.2	µg/kg	:	:
		8	Trichloroethene	34	6.2	µg/kg	:	:
		10	1,1,1-Trichloroethane	6.7	6.2	µg/kg	:	:
		10	Tetrachloroethene	97	6.2	µg/kg	:	:
		10	Trichloroethene	32	6.2	µg/kg	:	:
HA003	10/16/2000	12	1,1,1-Trichloroethane	ND	310	µg/kg	:	:
		12	Tetrachloroethene	800	310	µg/kg	:	:
		12	Trichloroethene	79	310	µg/kg	:	:
HA004	10/13/2000	0.5	1,1,1-Trichloroethane	830	33	µg/kg	:	:
		0.5	Tetrachloroethene	1100	33	µg/kg	:	:
		0.5	Trichloroethene	1100	33	µg/kg	:	:
		4	1,1,1-Trichloroethane	17	6	µg/kg	:	:
		4	Tetrachloroethene	210	6	µg/kg	:	:
		4	Trichloroethene	42	6	µg/kg	:	:
		8	1,1,1-Trichloroethane	2100	310	µg/kg	:	:
		8	Tetrachloroethene	1400	310	µg/kg	:	:
		8	Trichloroethene	1400	310	µg/kg	:	:

January 31, 2007

Table A-3
Twins Inn Site - North Tank Area
Soil Sampling Results
1995 - 2002

Sample Location	Sample Date	Depth (ft bgs)	Parameter	Concentration	Detection Limit	Units	Data Flag	
HA004 continued	10/13/2000	12	1,1,1-Trichloroethane	490	31	µg/kg	:	:
		12	Tetrachloroethene	320	31	µg/kg	:	:
		12	Trichloroethene	280	31	µg/kg	:	:
TS001	7/10/2002	11	1,1,1-Trichloroethane	7300	320	µg/kg	:	:
		11	Tetrachloroethene	6500	320	µg/kg	:	:
		11	Trichloroethene	2200	320	µg/kg	:	:
		24	1,1,1-Trichloroethane	ND	5.5	µg/kg	:	:
		24	Tetrachloroethene	5.7	5.5	µg/kg	:	:
		24	Trichloroethene	ND	5.5	µg/kg	:	:
TS002	7/11/2002	11	1,1,1-Trichloroethane	3000	310	µg/kg	:	:
		11	Tetrachloroethene	3000	310	µg/kg	:	:
		11	Trichloroethene	5100	310	µg/kg	:	:
		19	1,1,1-Trichloroethane	2.8	5.9	µg/kg	J	SQL-I
		19	Tetrachloroethene	4.3	5.9	µg/kg	J	SQL-I
		19	Trichloroethene	2.5	5.9	µg/kg	J	SQL-I
TS003	7/11/2002	11	1,1,1-Trichloroethane	1000	310	µg/kg	:	:
		11	Tetrachloroethene	690	310	µg/kg	:	:
		11	Trichloroethene	1600	310	µg/kg	:	:
		22	1,1,1-Trichloroethane	ND	5.5	µg/kg	:	:
		22	Tetrachloroethene	ND	5.5	µg/kg	:	:
		22	Trichloroethene	ND	5.5	µg/kg	:	:

Notes:

-- = Detection limit unknown
µg/kg = micrograms per kilogram
ft bgs = below ground surface
ND = non detect

January 31, 2007

Table A-4. Sample Results for Untreated Groundwater Near Twins Inn Bar

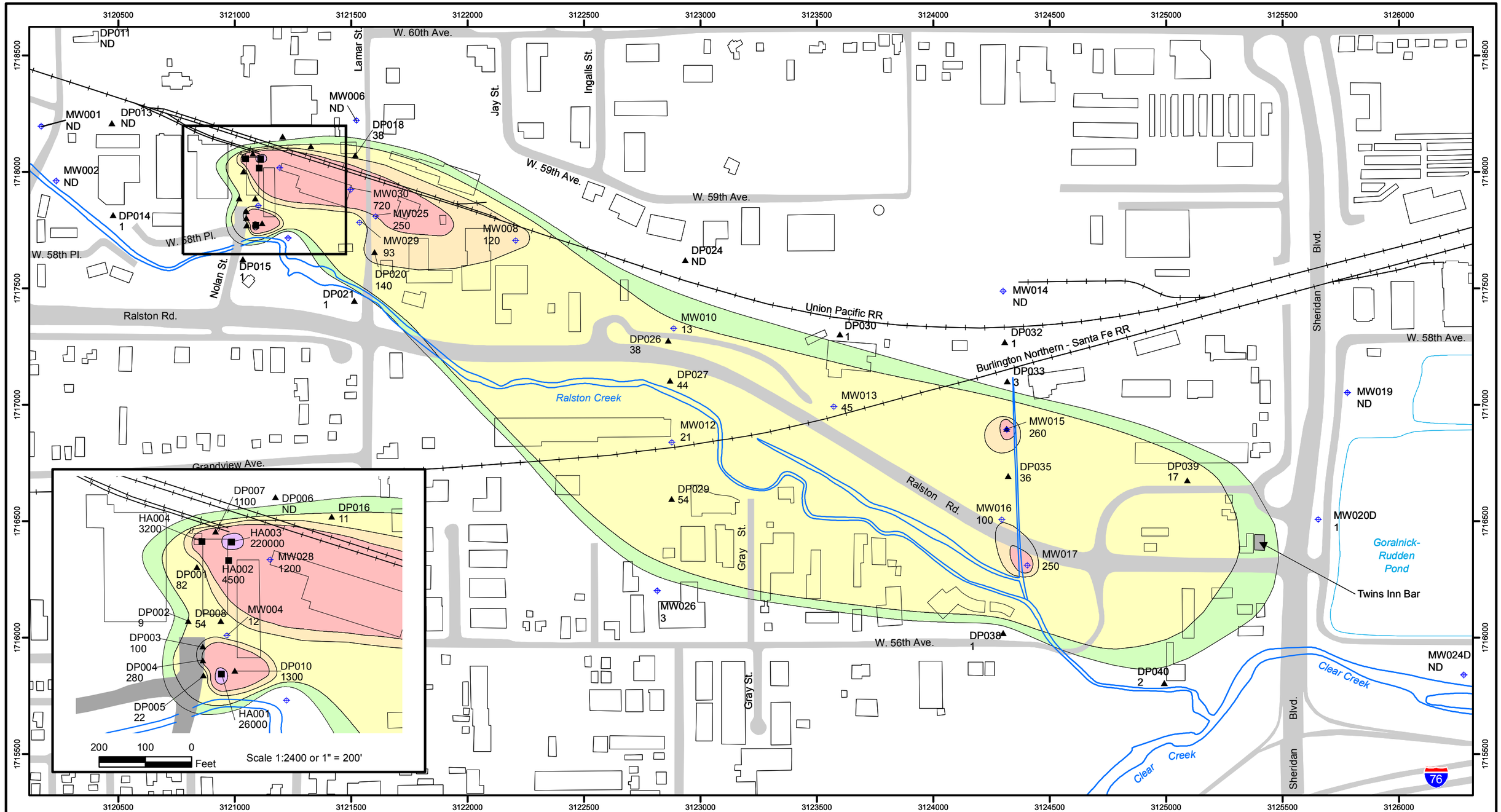
Sample Date	1,1,1-TCA	1,1-DCE	PCE	TCE	cis-1,2-DCE
5/18/1995	460	73	140	440	130
3/1/1996	220	44	99	270	ND
4/1/1996	310	62	120	450	ND
6/1/1996	290	25	120	390	110
9/1/1996	220	ND	110	330	82
12/1/1996	120	32	56	160	48
2/1/1997	89	21	45	130	38
8/1/1997	220	42	89	250	60
12/1/1997	110	36	59	150	37
6/1/1998	74	18	37	95	17
12/8/1998	69	8	23	29	no data
4/8/1999	21	4.6	15	30	no data
8/10/1999	17	4.1	15	26	no data
12/14/1999	10	2.3	12	19	no data
4/10/2000	7.7	1.9	8.7	13	no data
8/10/2000	7.2	2.2	9.7	16	no data
12/14/2000	4.4	1.3	6.9	11	no data
4/9/2001	3.2	1	5.4	9.7	no data
11/14/2001	3.3	1.1	6.1	9.3	no data
5/13/2002	1.6	0.97	4.1	6.5	no data
8/30/2002	2.2	1.4	4	7.4	no data
1/23/2003	1.6	0.71	4.4	5.6	no data
5/16/2003	1.9	0.88	4.6	7.4	no data
10/3/2003	2.3	1.3	5.9	9.2	no data
3/12/2004	2.3	1.1	5.6	8.4	no data
8/20/2004	4.6	1.7	10	17	no data
2/15/2005	3.5	1.6	7.9	12	no data
9/7/2005	6.3	2.1	9.9	16	no data

Notes:

Results are in micrograms per liter (ug/L)

ND = not detected

FIGURES



EXPLANATION

- Direct Push Location
- Hand Auger Location
- Monitoring Water Well
- Railroad
- Stream
- Pond
- Building
- Road

TCE Concentrations (µg/L)

- 5 - 9
- 10 - 99
- 100 - 199
- 200 - 24999
- ≥ 25000

500 0 500 Feet

Scale 1:4800 or 1" = 400'

NOTE:
TCE = Trichloroethene
Coordinates reference
State Plane Feet, Colorado Central Zone, NAD83
Vertical Datum: NAVD-88

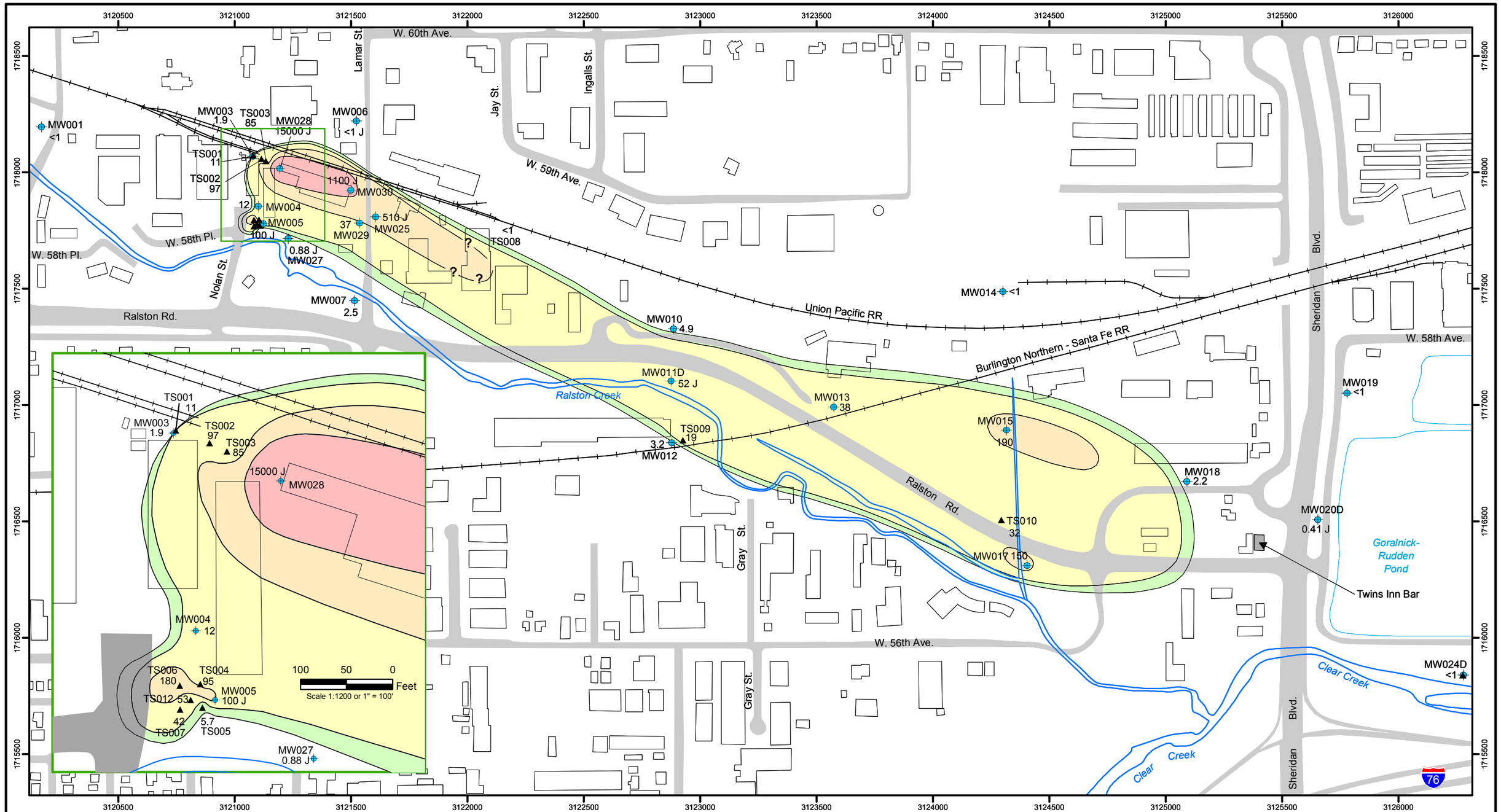
N W E S

URS

Figure A-1 Groundwater TCE Concentrations and Interpreted Plume April 2001

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	TCE Plume April 2001.mxd	1-2007



EXPLANATION

- Direct Push (TS) Location
- Monitor Well (MW) Location
- Railroad
- Stream
- Pond
- Building
- Road

TCE Concentrations (µg/L)

- 5 - 9
- 10 -99
- 100 - 999
- ≥1000

500 0 500 Feet

Scale 1:4800 or 1" = 400'

NOTE:
TCE = Trichloroethene
Coordinates reference
State Plane Feet, Colorado Central Zone, NAD83
Vertical Datum: NAVD-88

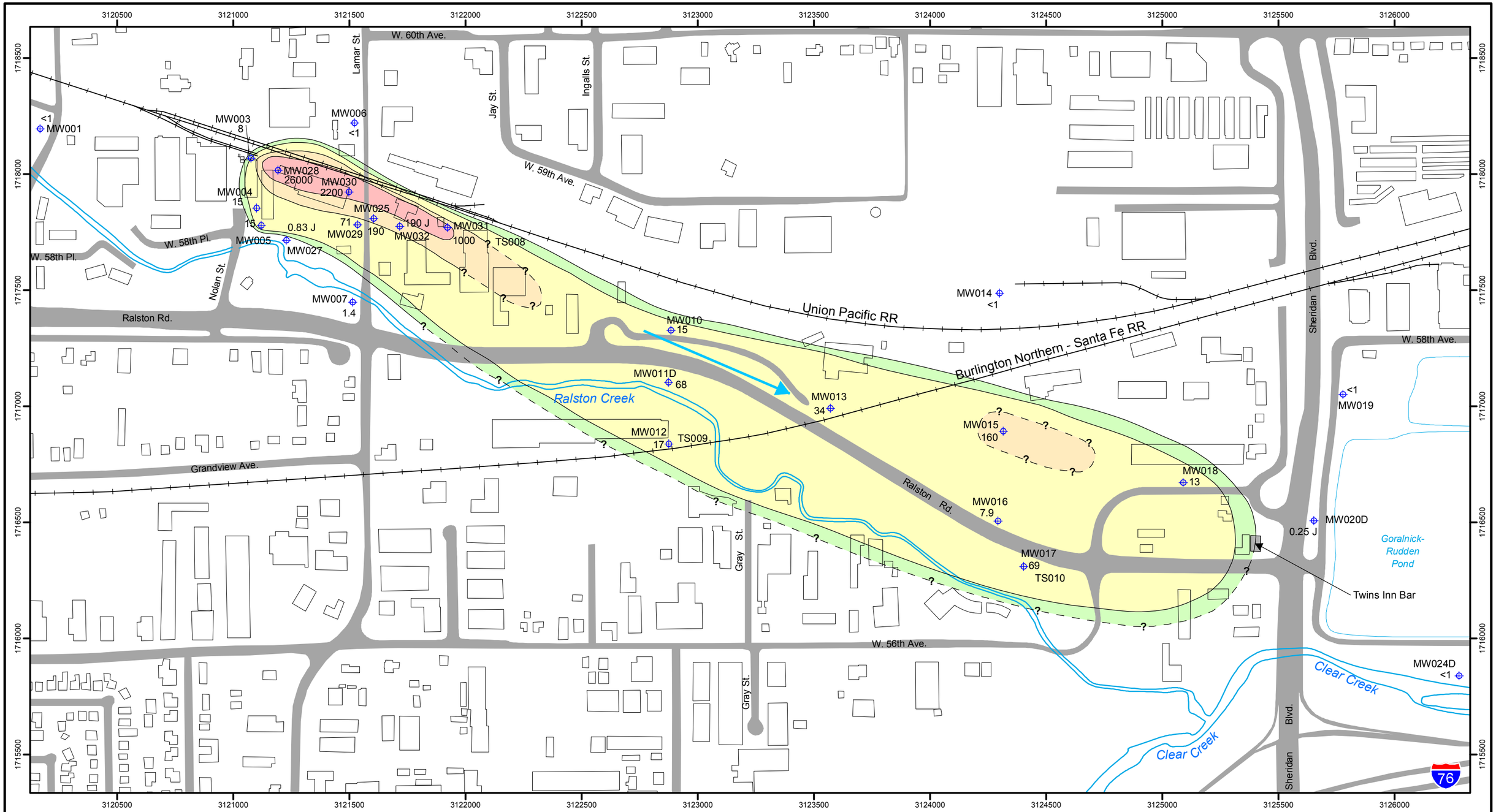
N W E S

URS

Figure A-2 Groundwater TCE Concentrations and Interpreted Plume July 2002

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	TCE Plume July 2002.mxd	1-2007



EXPLANATION

- Monitor Well (MW)
- Railroad
- Stream
- Pond
- Building
- Road
- Groundwater Flow Direction

August 2003 TCE Concentrations (µg/L)

- 5-9
- 10-99
- 100-999
- ≥ 1,000

400 0 400 Feet

Scale 1:4800 or 1" = 400'

NOTE:
TCE = Trichloroethene
Coordinates reference
State Plane Feet, Colorado Central Zone, NAD83
Vertical Datum: NAVD-88

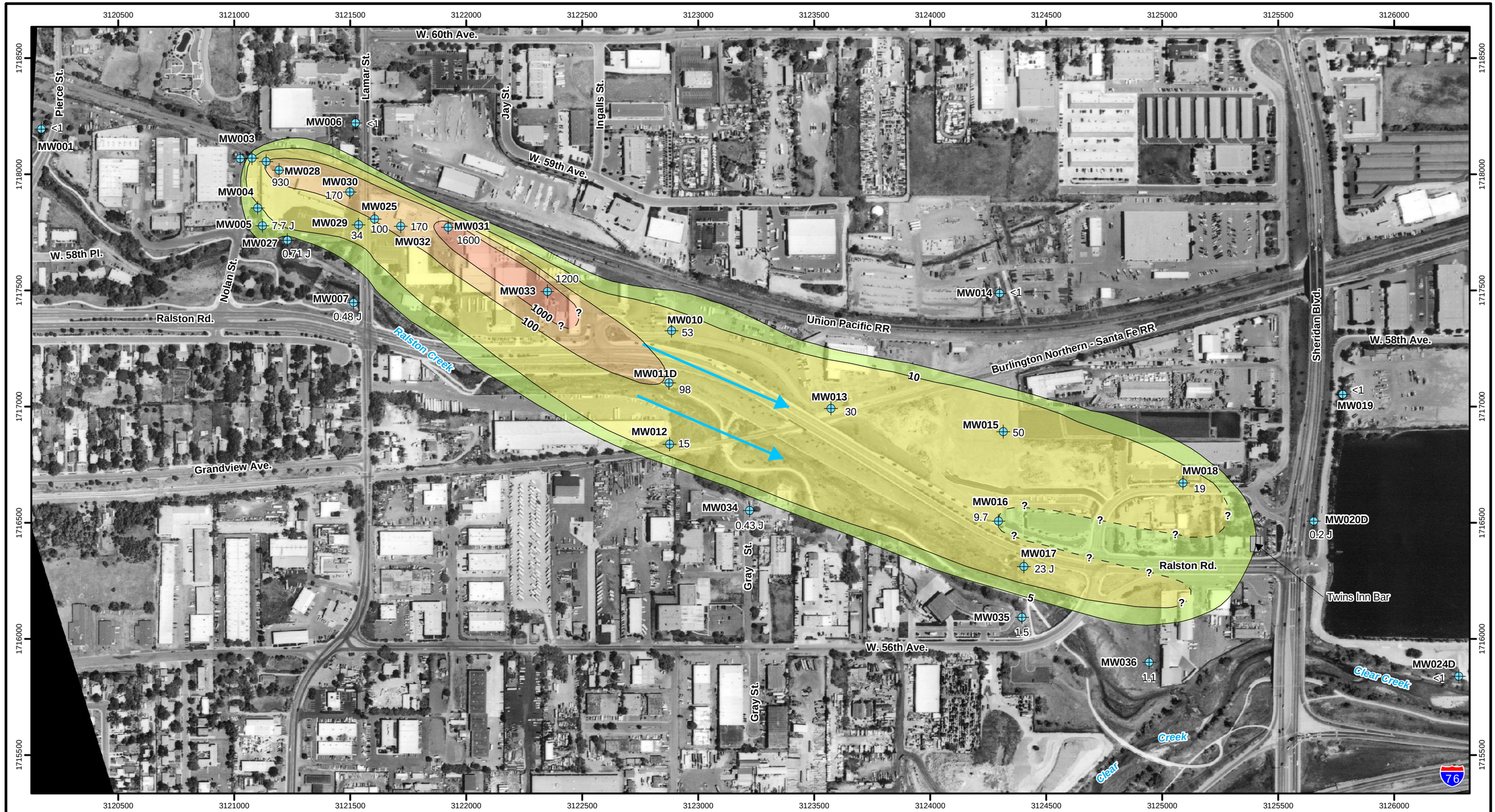
N W E S

URS

Figure A-3 Groundwater TCE Concentrations and Interpreted Plume August 2003

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	TCE Plume August 2003.mxd	1-2007



EXPLANATION

Monitoring Well (MW)

Groundwater Flow Direction

MCL/CBSG for TCE is 5 µg/L.

TCE Concentrations (µg/L)

- 5-9
- 10-99
- 100-999
- > 1,000

NOTES:
CBSG = Colorado Basic Standard for Groundwater
MCL = Maximum Contaminant Level
TCE = Trichloroethene
µg/L = Micrograms per liter
J = The associated value is an estimated quanitity
Coordinates reference State Plane Feet, Colorado Central Zone, NAD83 Vertical Datum: NAVD-88
The concentration values for MW033, MW034, MW035, and MW036 are preliminary data.

400 0 400 Feet

Scale 1:4800 or 1" = 400'

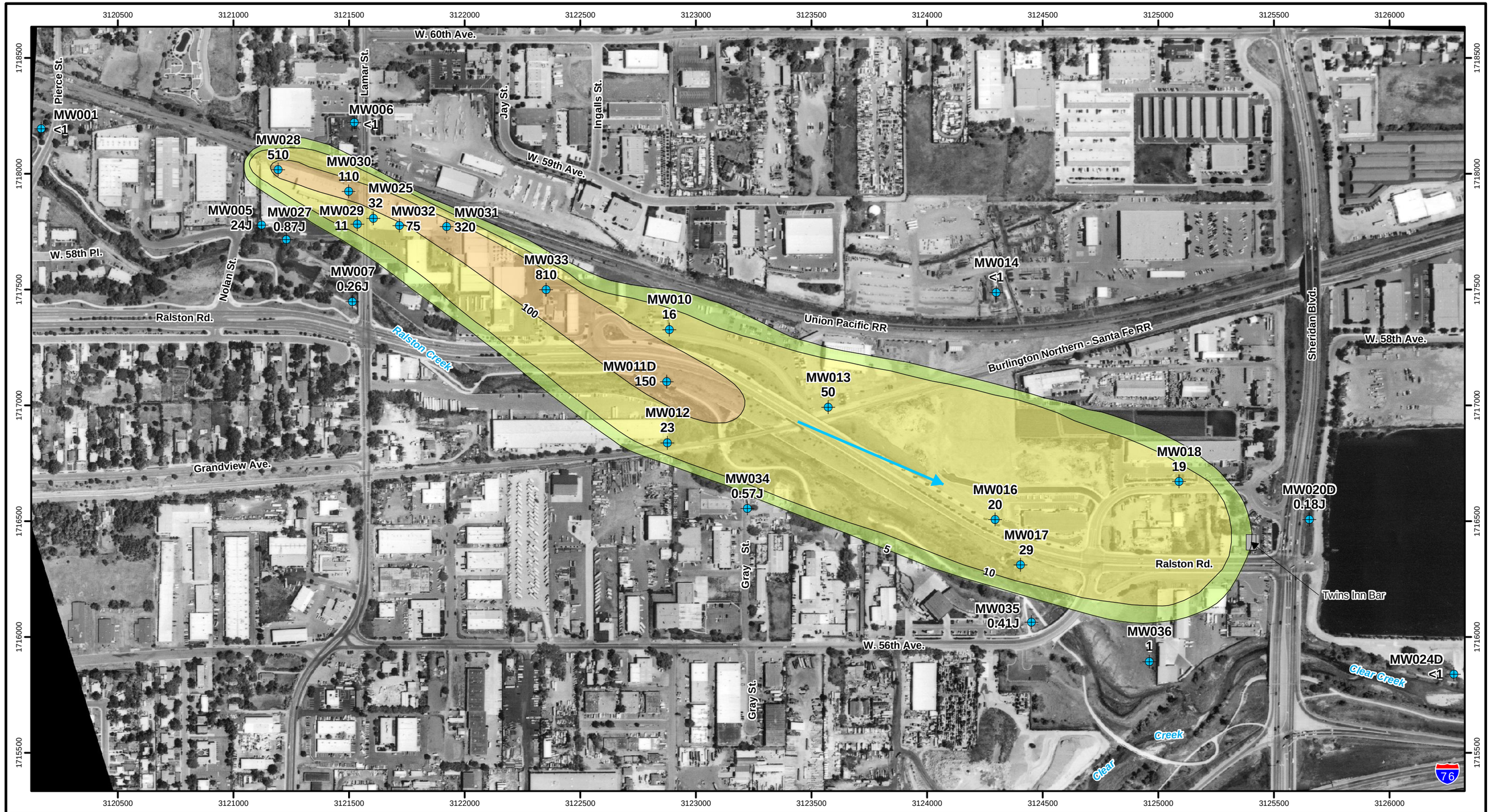
N W E S

URS

Figure A-4 Groundwater TCE Concentrations and Interpreted Plume September 2005

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	TCE Plume Fall 2005.mxd	1-2007



EXPLANATION

- Monitoring Well (MW)
- Groundwater Flow Direction

MCL/CBSG for TCE is 5 µg/L.

TCE Concentrations (µg/L)

- 5-9
- 10-99
- > 100

NOTES:
CBSG = Colorado Basic Standard for Groundwater
MCL = Maximum Contaminant Level
TCE = Trichloroethene
µg/L = Micrograms per liter
J = The associated value is an estimated quanitity
Coordinates reference State Plane Feet, Colorado Central Zone, NAD83 Vertical Datum: NAVD-88

400 0 400 Feet

Scale 1:4800 or 1" = 400'

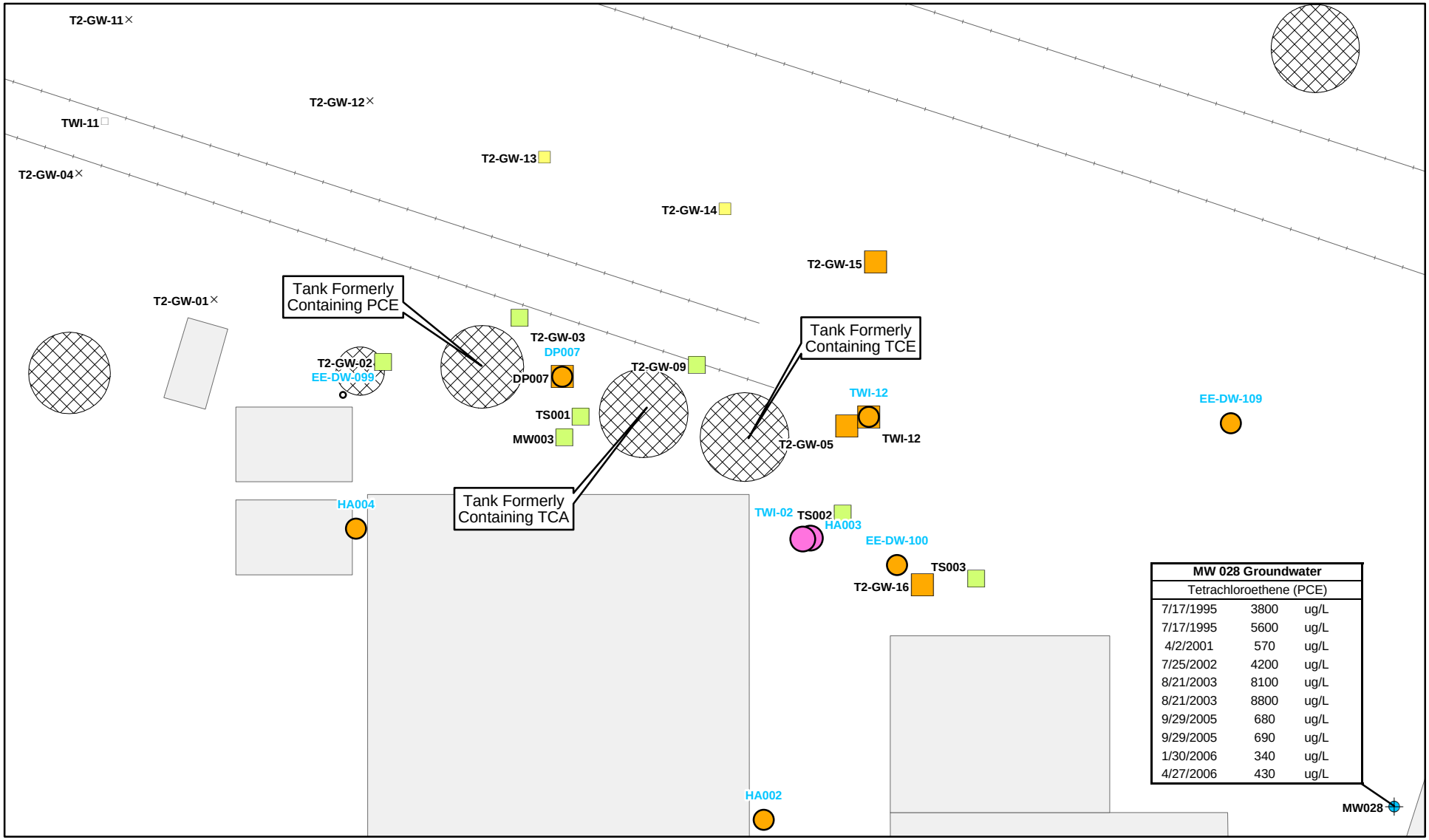
N W E S

URS

Figure A-5 Groundwater TCE Concentrations and Interpreted Plume October 2006

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	TCE Plume October 2006.mxd	1-2007



MW 028 Groundwater		
Tetrachloroethene (PCE)		
7/17/1995	3800	ug/L
7/17/1995	5600	ug/L
4/2/2001	570	ug/L
7/25/2002	4200	ug/L
8/21/2003	8100	ug/L
8/21/2003	8800	ug/L
9/29/2005	680	ug/L
9/29/2005	690	ug/L
1/30/2006	340	ug/L
4/27/2006	430	ug/L

PCE Concentration in Shallow Groundwater (µg/L)

- < 5
- 5 - 10
- 10 - 100
- 100 - 1000
- 1000 - 10000
- 10000 - 100000
- > 100000

PCE Concentration in Deep Groundwater (µg/L)

- < 5
- 5 - 10
- 10 - 100
- 100 - 1000
- 1000 - 10000
- 10000 - 100000
- >100000

- Monitoring Well
- Railroad
- Aboveground Tank
- Existing Building

N

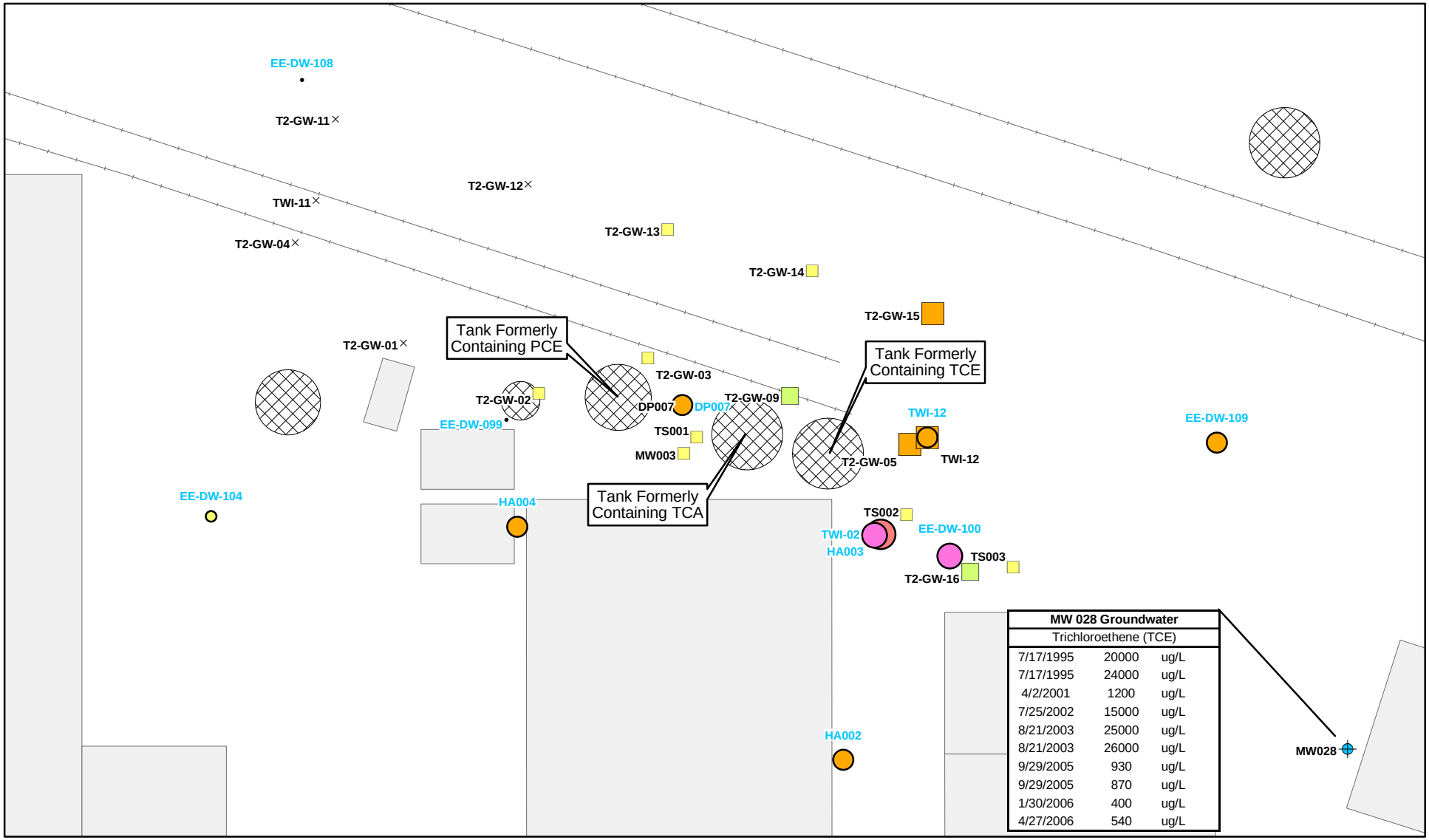
0 20 Feet

URS

Figure A-6 Source Area Groundwater PCE Concentrations 1995-2006

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	Source Area PCE 95-06.mxd	1-2007



MW 028 Groundwater		
Trichloroethene (TCE)		
7/17/1995	20000	ug/L
7/17/1995	24000	ug/L
4/2/2001	1200	ug/L
7/25/2002	15000	ug/L
8/21/2003	25000	ug/L
8/21/2003	26000	ug/L
9/29/2005	930	ug/L
9/29/2005	870	ug/L
1/30/2006	400	ug/L
4/27/2006	540	ug/L

TCE Concentration in Shallow Groundwater (µg/L)

- < 5
- 5 - 10
- 10 - 100
- 100 - 1000
- 1000 - 10000
- 10000 - 100000
- > 100000

TCE Concentration in Deep Groundwater (µg/L)

- < 5
- 5 - 10
- 10 - 100
- 100 - 1000
- 1000 - 10000
- 10000 - 100000
- >100000

- Monitoring Well
- Railroad
- Aboveground Tank
- Existing Building

N

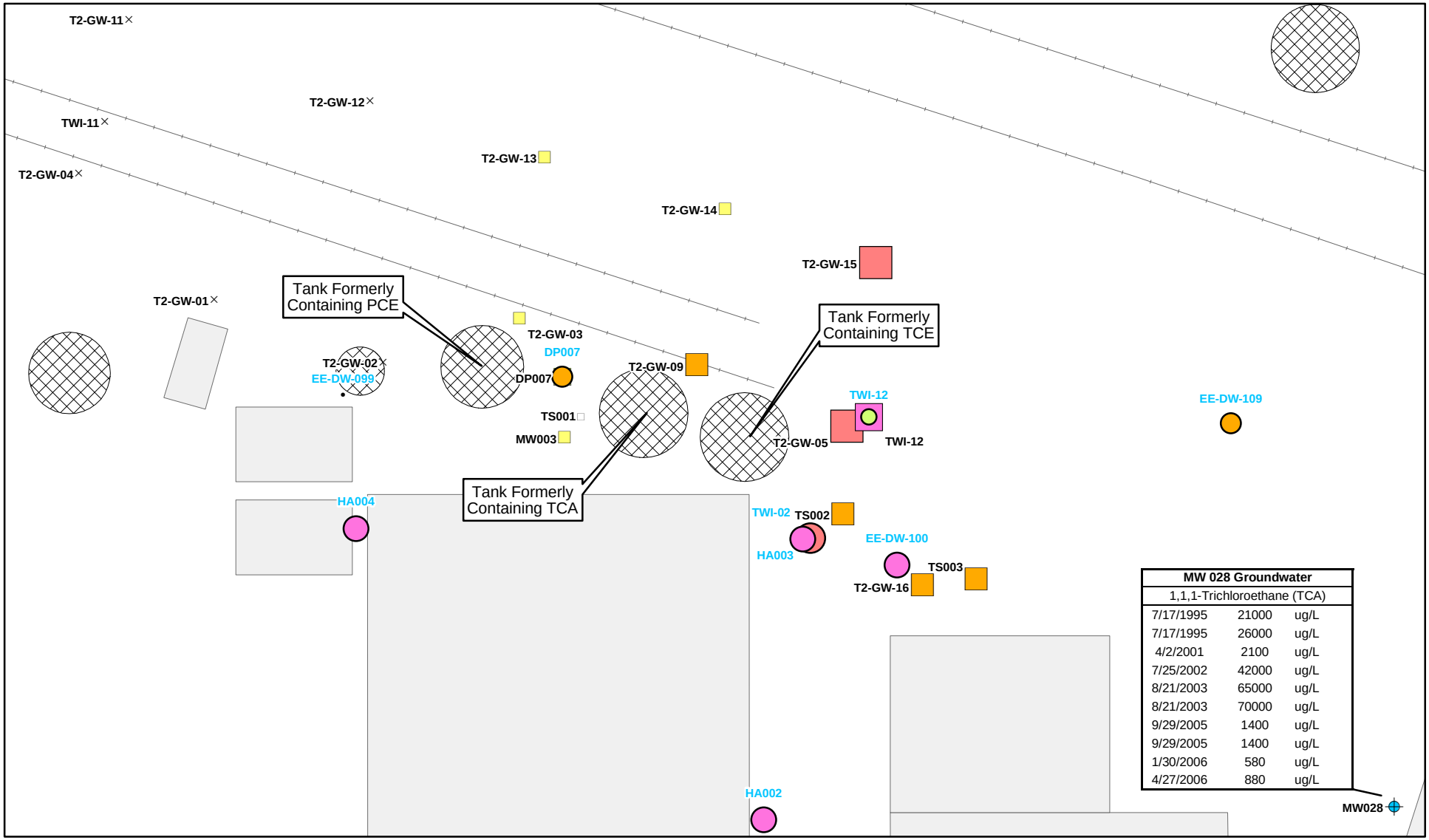
0 20 Feet

URS

Figure A-7 Source Area Groundwater TCE Concentrations 1995-2006

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	Source Area TCE 95-06.mxd	1-2007



MW 028 Groundwater		
1,1,1-Trichloroethane (TCA)		
7/17/1995	21000	ug/L
7/17/1995	26000	ug/L
4/2/2001	2100	ug/L
7/25/2002	42000	ug/L
8/21/2003	65000	ug/L
8/21/2003	70000	ug/L
9/29/2005	1400	ug/L
9/29/2005	1400	ug/L
1/30/2006	580	ug/L
4/27/2006	880	ug/L

TCA Concentration in Shallow Groundwater (µg/L)

- < 5
- 5 - 10
- 10 - 100
- 100 - 1000
- 1000 - 10000
- 10000 - 100000
- > 100000

TCA Concentration in RESULT

- < 5
- 5 - 10
- 10 - 100
- 100 - 1000
- 1000 - 10000
- 10000 - 100000
- >100000

- Monitoring Well
- Railroad
- Aboveground Tank
- Existing Building

N

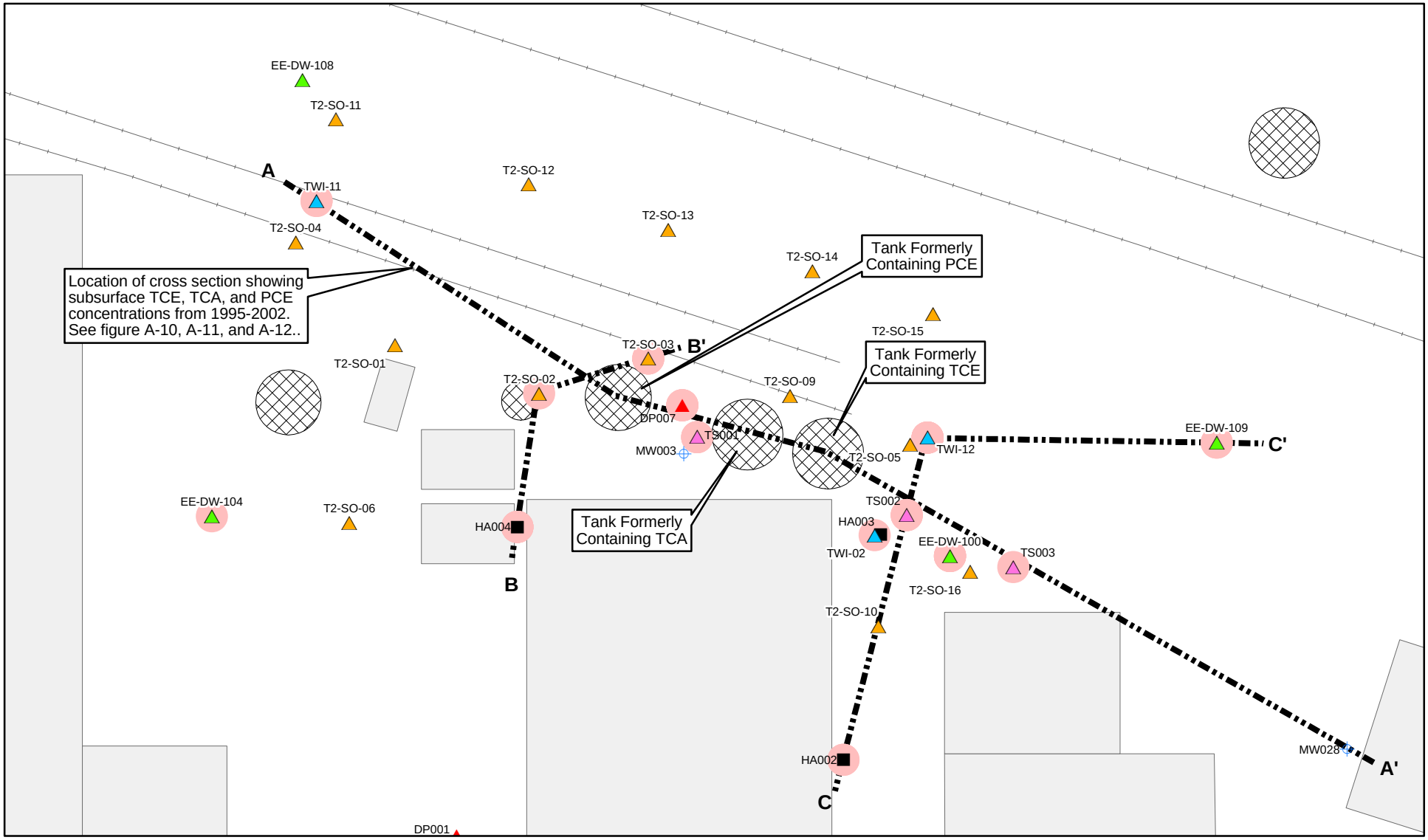
0 20 Feet

URS

Figure A-8 Source Area Groundwater TCA Concentrations 1995-2006

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	Source Area TCA 95-06.mxd	1-2007



1995 - 1997 Sampling Location

- 1995 Direct Push Borehole
- 1996 Direct Push Borehole
- 1997 Direct Push Borehole

2000 Sampling Location

- Direct Push Borehole
- Hand Auger Borehole

2002 Sampling Location

- Direct Push Borehole

- Concentrations greater than 1 ppm for TCE, 1,1,1-TCA, or PCE
- Monitoring Wells
- Railroad
- Aboveground Tank
- Existing Building

N

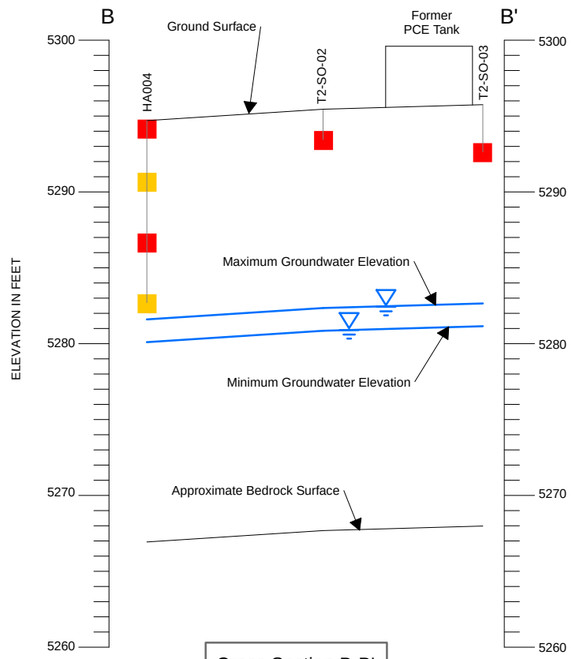
0 25 Feet

URS

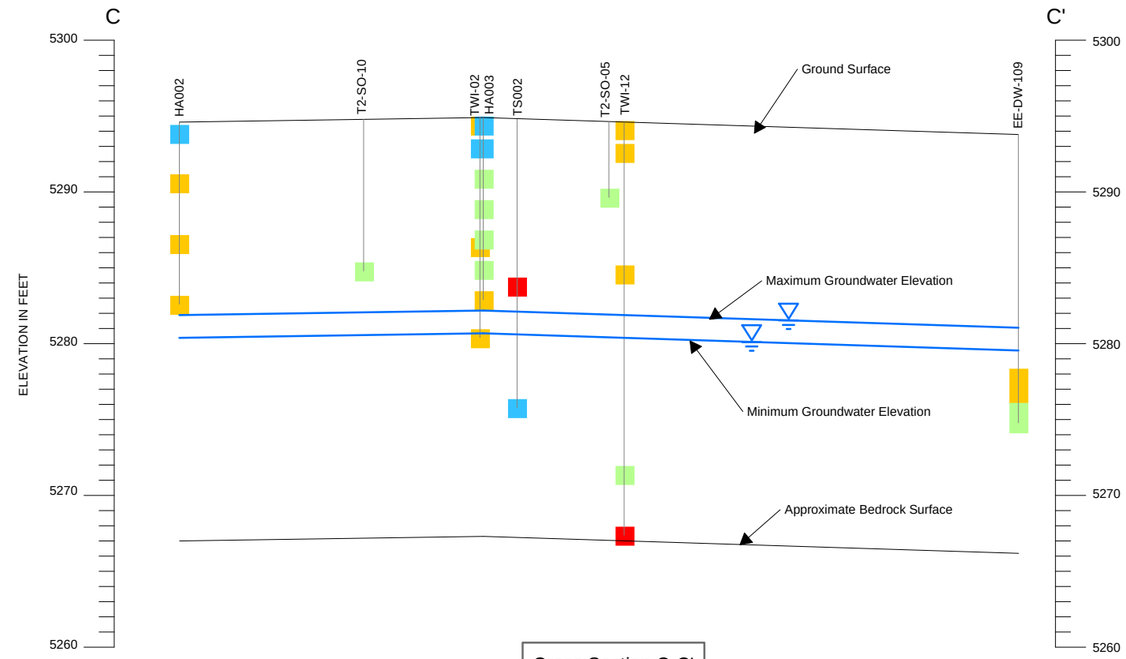
Figure A-9 Subsurface Soil Concentrations of PCE, TCE, and TCA 1995-2002 Plan View

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

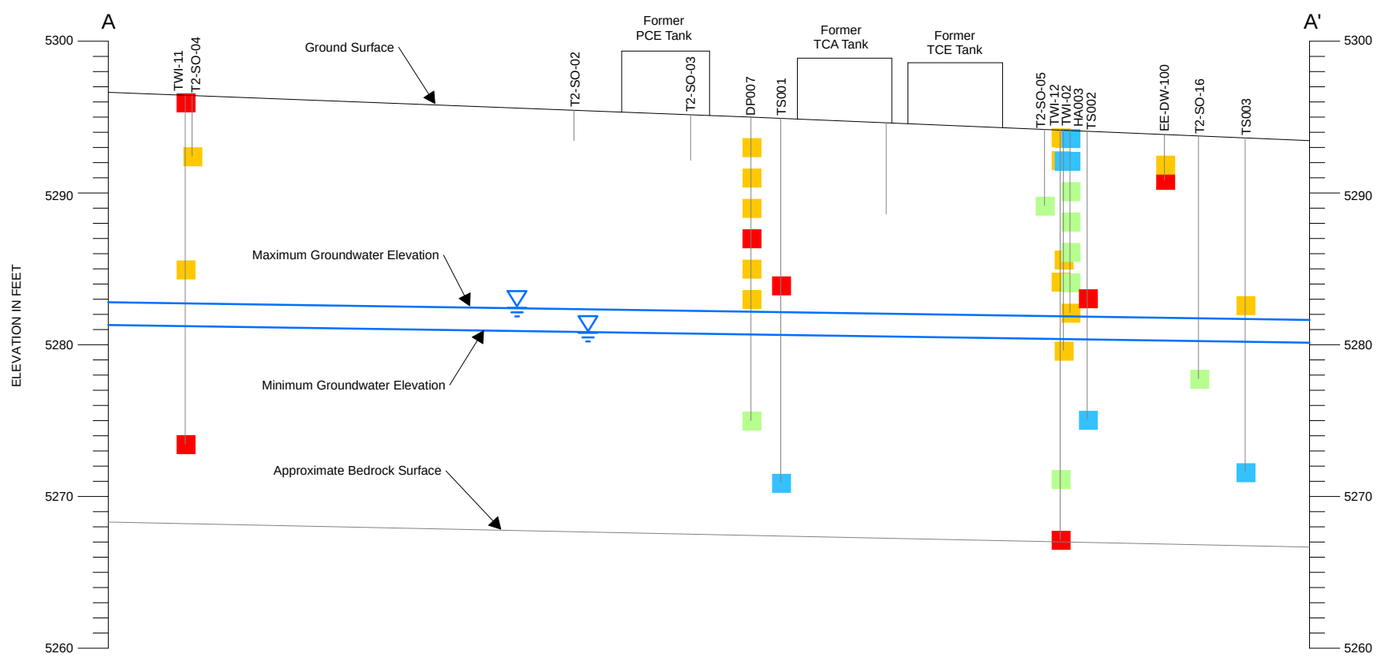
PROJECT NO.	DRAWING NO.	DATE
41567697	Subsurface Soil Plan View.mxd	12-2006



Cross Section B-B'
(looking northwest)



Cross Section C-C'
(looking northwest)



Cross Section A-A'
(looking north)

PCE Concentration in Soil (µg/kg)

- 0 - 10
- 11 - 100
- 101 - 1000
- > 1000

0 20 Feet

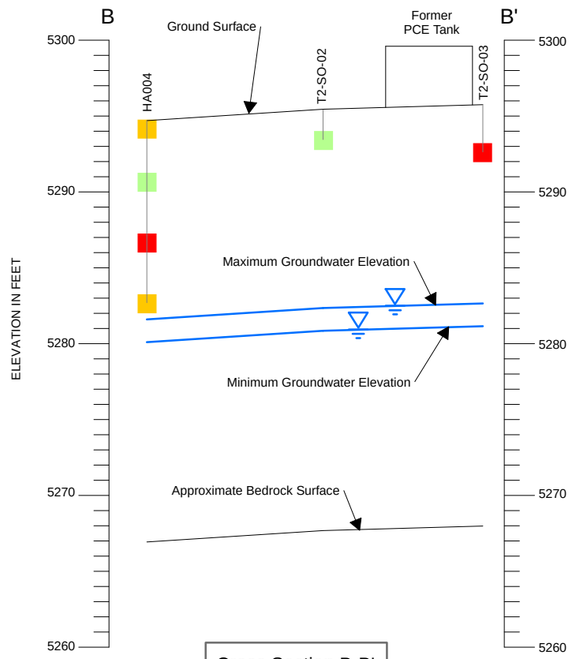
Horizontal Scale

URS

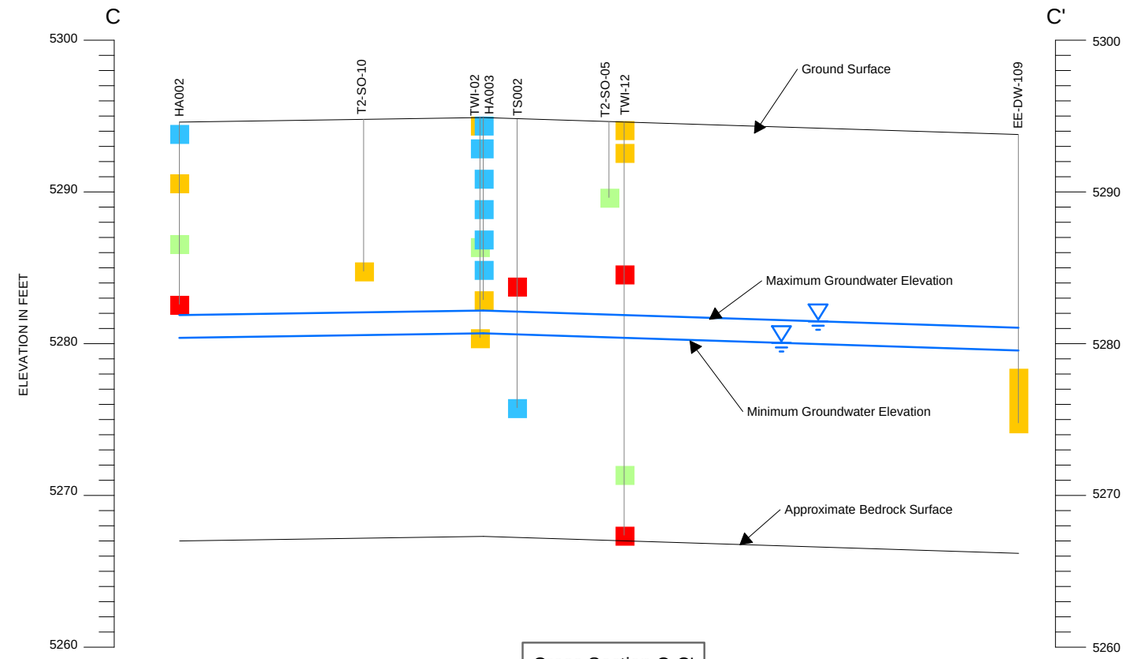
Figure A-10 Subsurface Soil PCE Concentrations 1995-2002 Cross Section

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

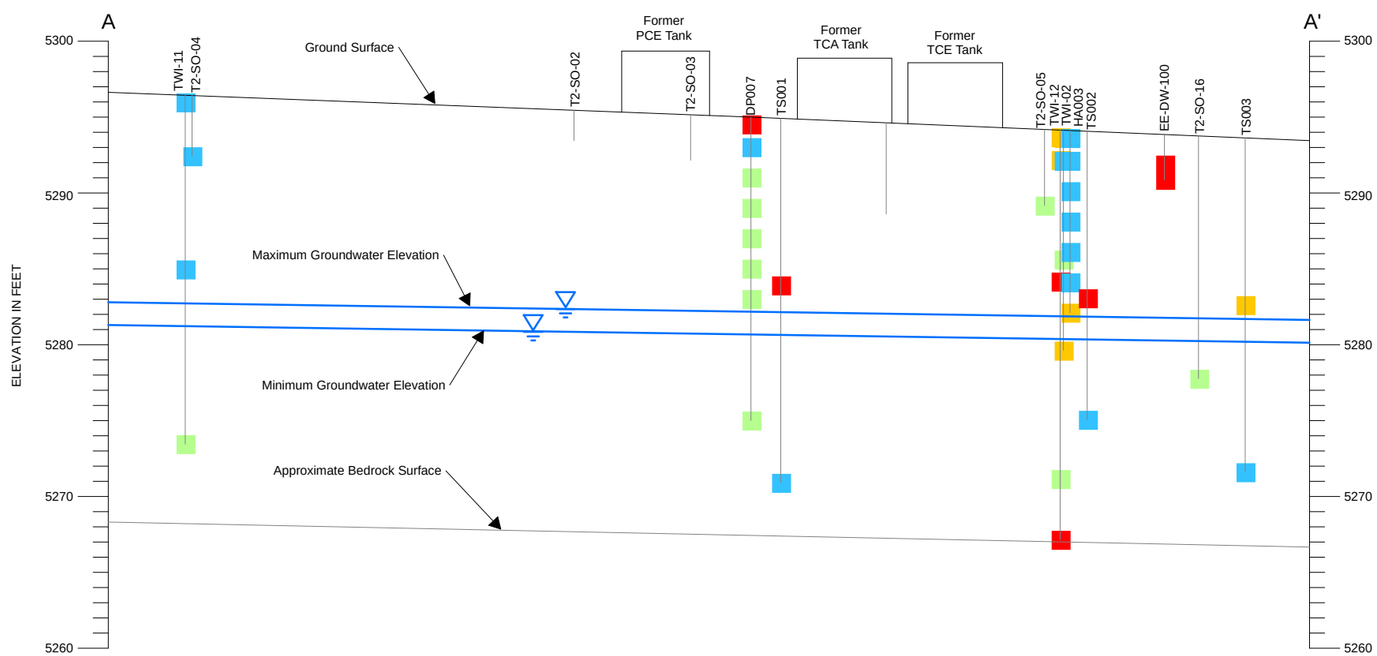
PROJECT NO.	DRAWING NO.	DATE
41567697	Subsurface Soil PCE.mxd	12-2006



Cross Section B-B'
(looking northwest)



Cross Section C-C'
(looking northwest)



Cross Section A-A'
(looking north)

TCA Concentration in Soil (µg/kg)

- 0 - 10
- 11 - 100
- 101 - 1000
- > 1000

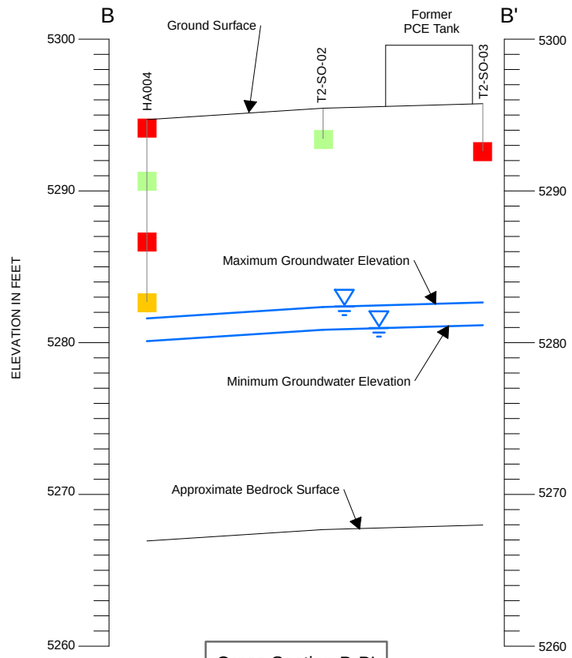
0 20 Feet
Horizontal Scale

URS

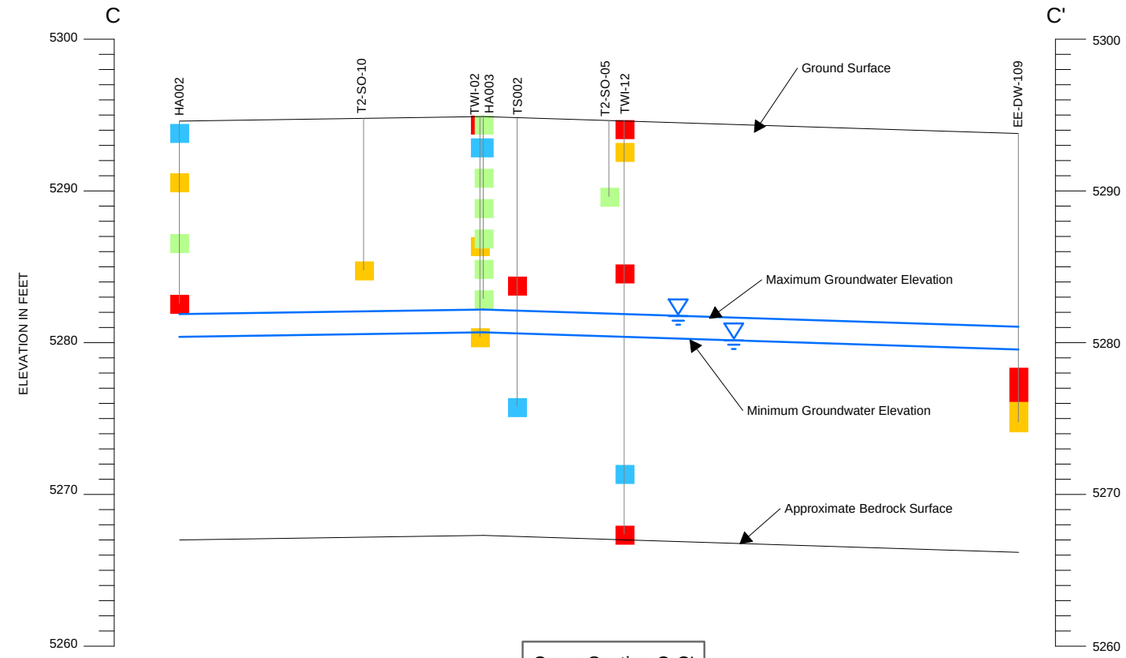
Figure A-11 Subsurface Soil TCA Concentrations 1995-2002 Cross Section

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

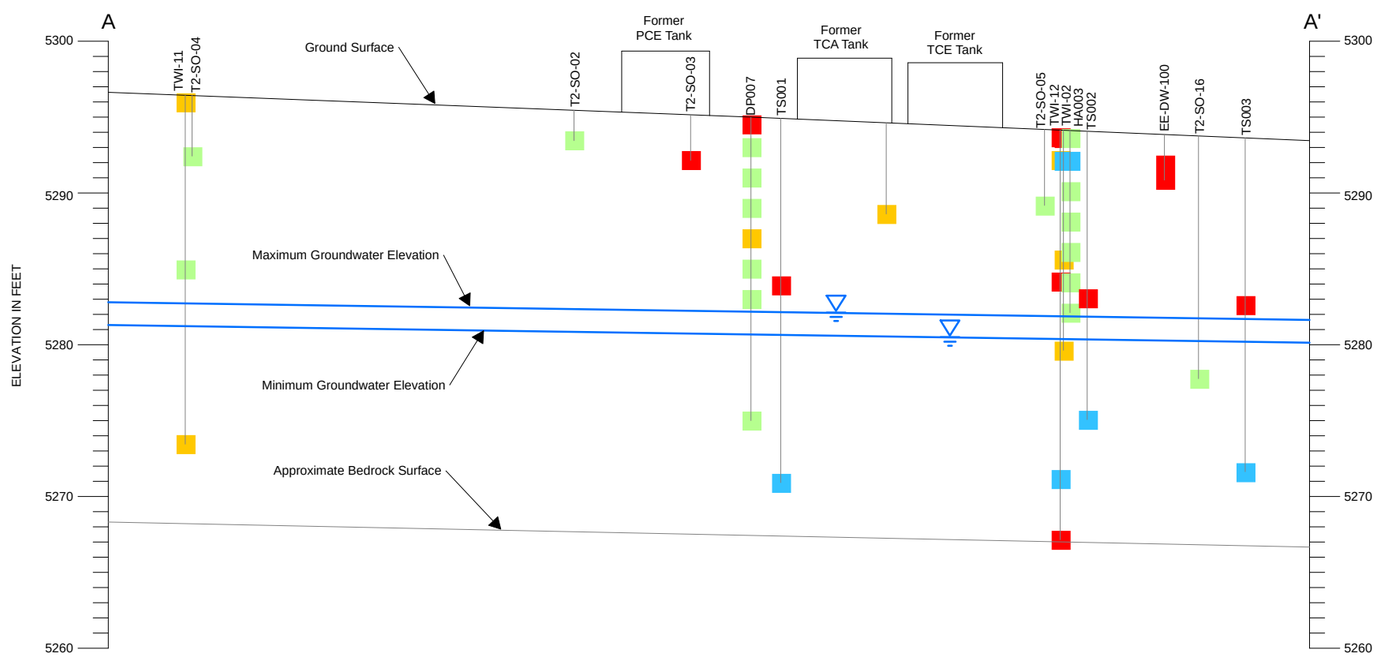
PROJECT NO.	DRAWING NO.	DATE
41567697	Subsurface Soil TCA.mxd	12-2006



Cross Section B-B'
(looking northwest)



Cross Section C-C'
(looking northwest)



Cross Section A-A'
(looking north)

TCE Concentration in Soil (µg/kg)

- 0 - 10
- 11 - 100
- 101 - 1000
- > 1000

0 20 Feet
Horizontal Scale

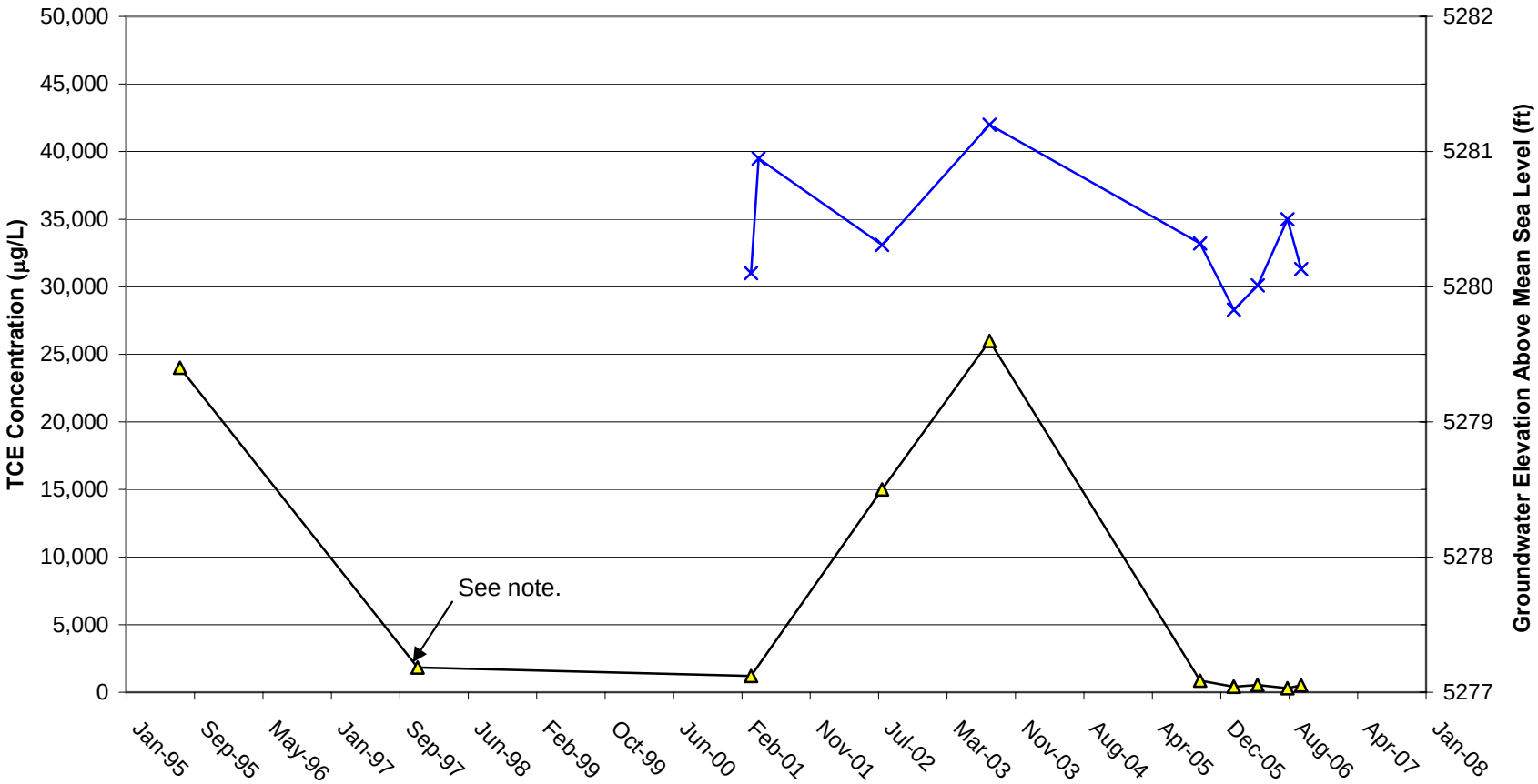
URS

Figure A-12 Subsurface Soil TCE Concentrations 1995-2002 Cross Section

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	Subsurface Soil TCE.mxd	12-2006

Figure A-13
Groundwater Elevations and TCE Concentrations at MW028
1995 - 2006



Note: No samples were collected at MW028 as part of the Twins Inn investigation from 1995 to 2000. The 1997 data point is from temporary direct push point TWI-12, which is closer to the source area and is about 90 ft upgradient of MW028.

Revised 30 April 2007

Figure A-14
Conceptual Site Model of North Tank Source Area
Twins Inn Site

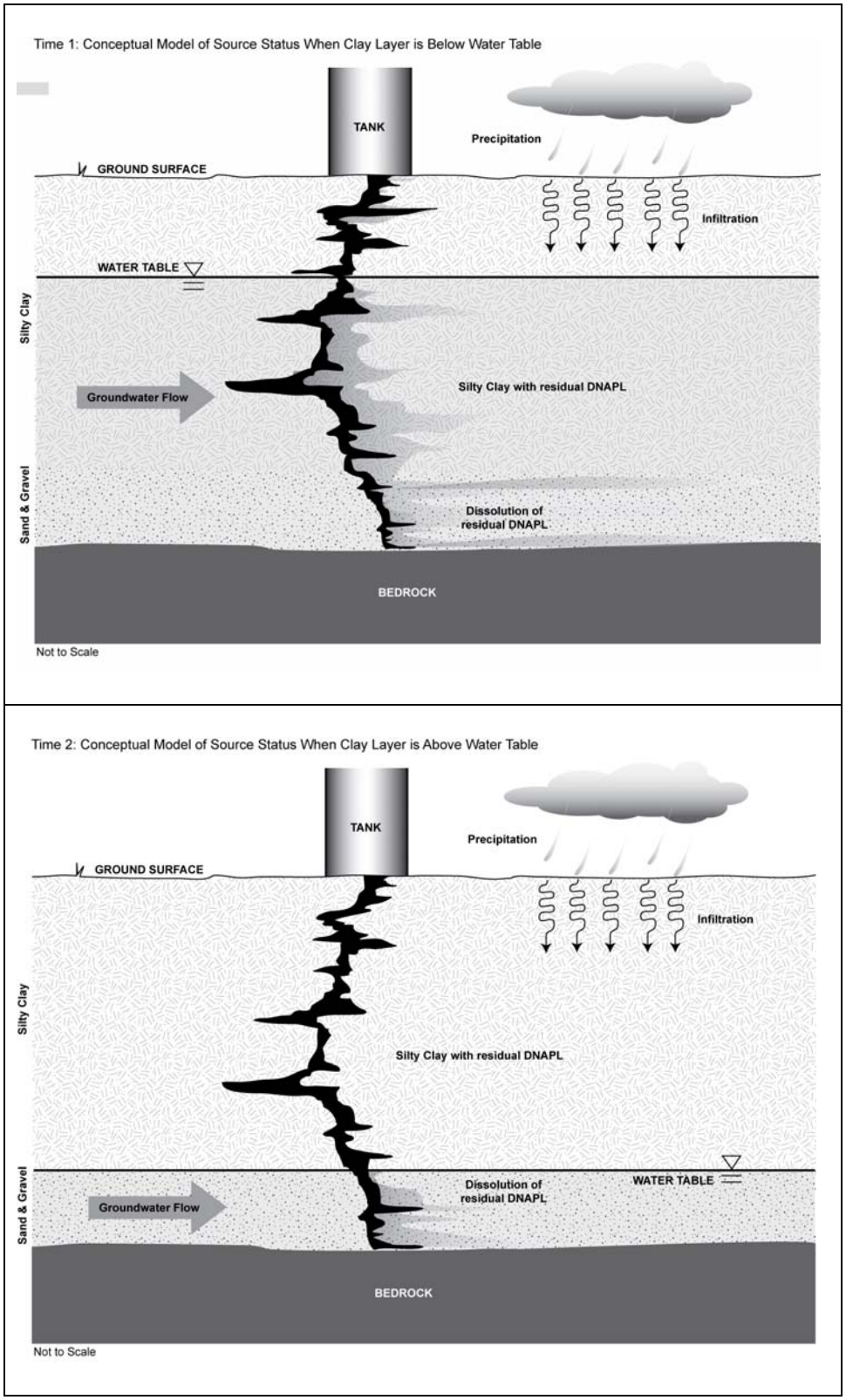
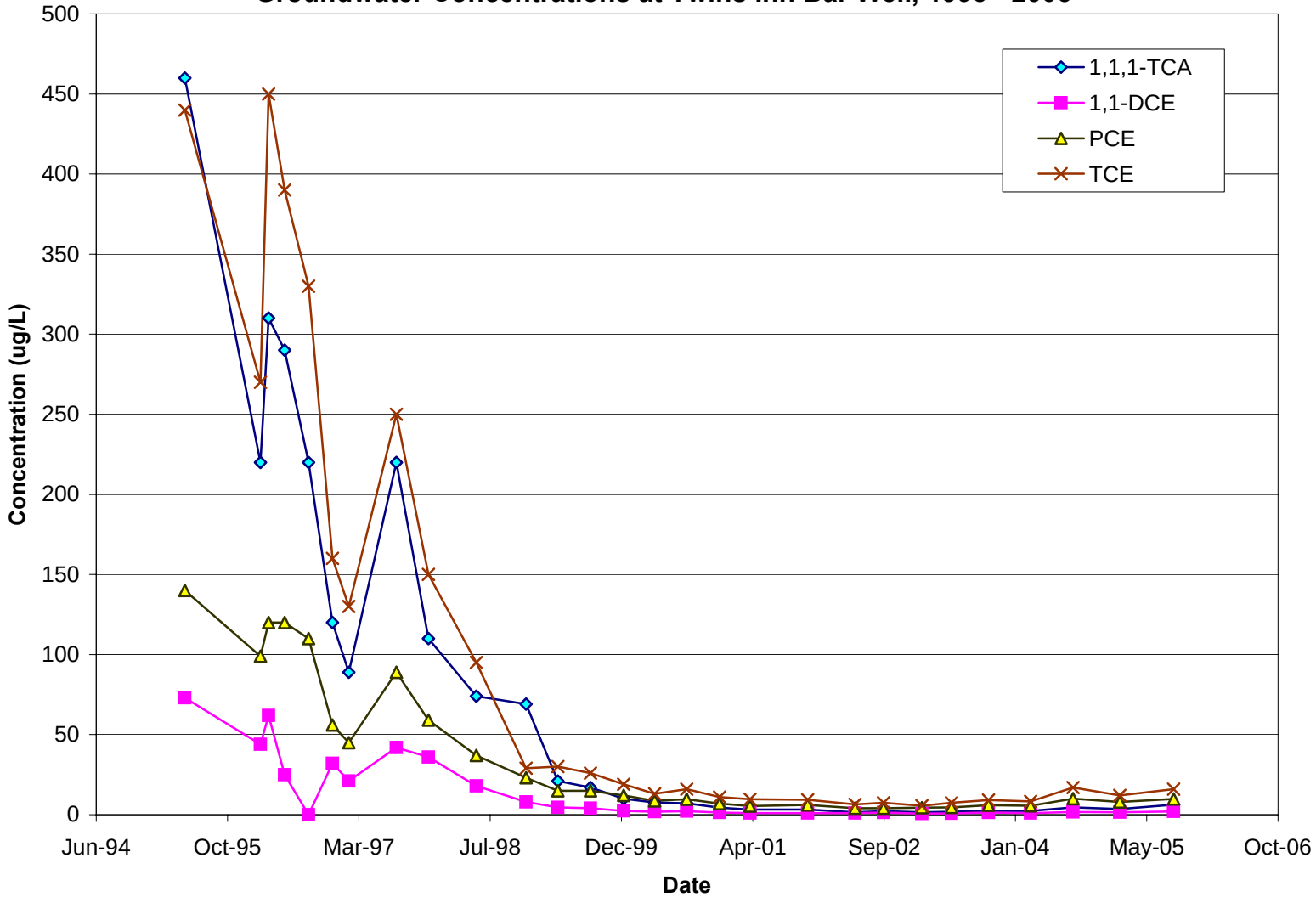
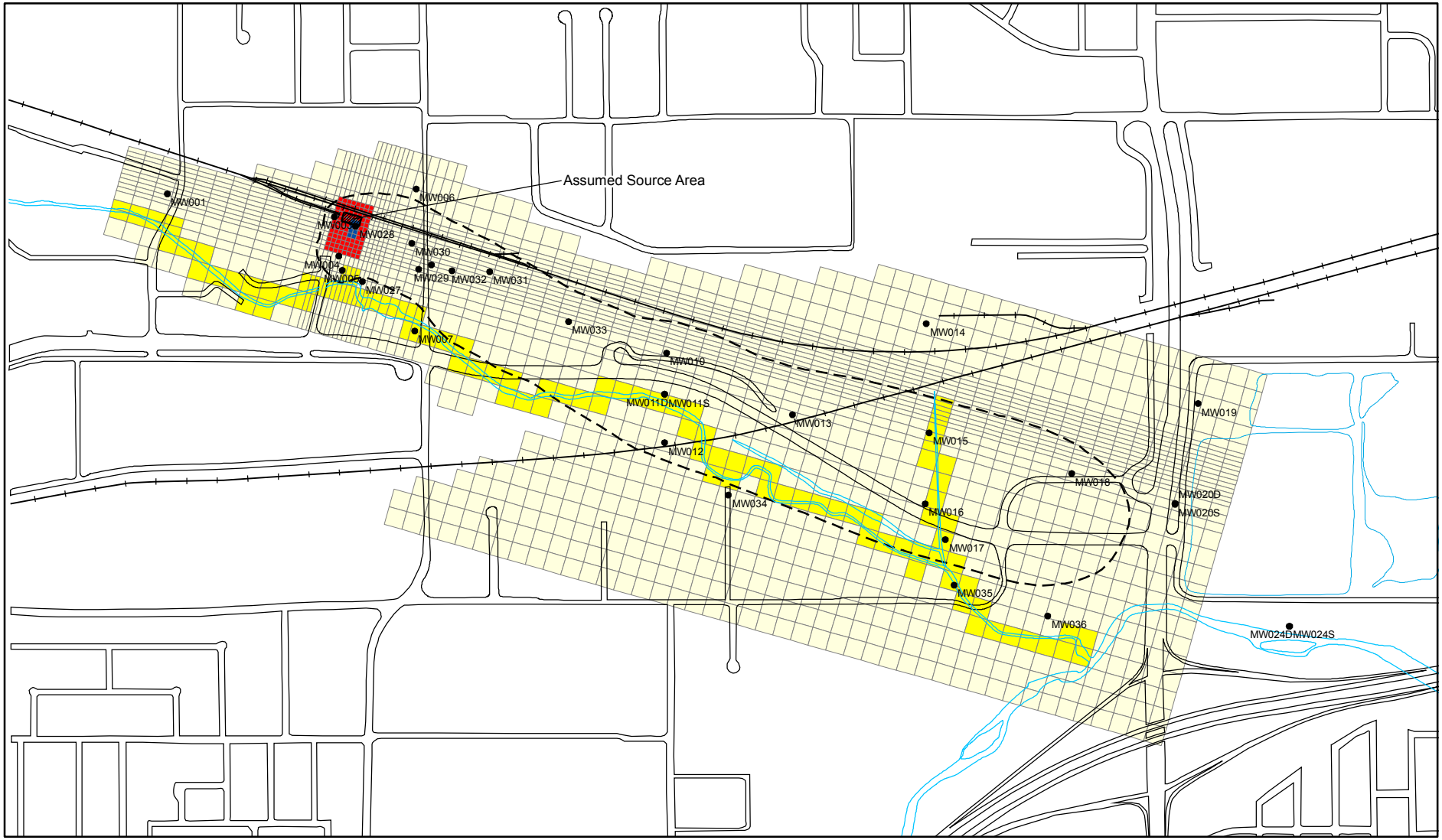


Figure A-15
Groundwater Concentrations at Twins Inn Bar Well, 1995 - 2005





Recharge rate (ft/day)	2002, 2003, 2004 Concentration (µg/L)	2005, 2006 Concentration (µg/L)
0.001	700000	10000
0.000228	20000	10000
0.000228	0	0
0.000456	0	0

- Groundwater Monitoring Well
- Assumed Source Area
- Plume Extent Oct. 2006

N

0 800 Feet

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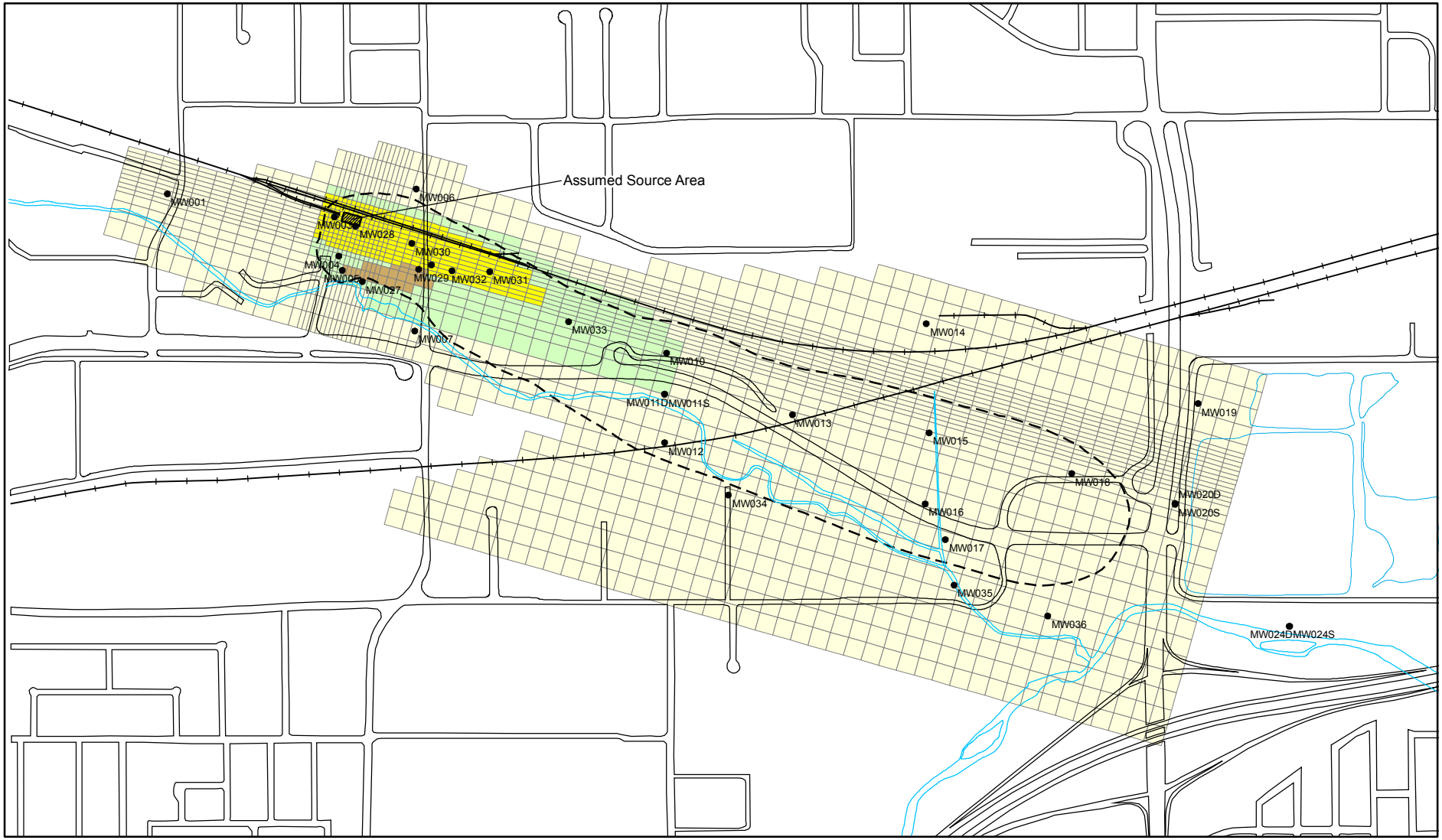
Figure A-16 Simulated Contaminated Groundwater Recharge as Contaminant Flux

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	Contaminant Recharge.mxd	1-2007



Biodegradation half-life (days)

- 180
- 365
- 730
- 3650

- Groundwater Monitoring Well
- Assumed Source Area
- Plume Extent Oct. 2006

N

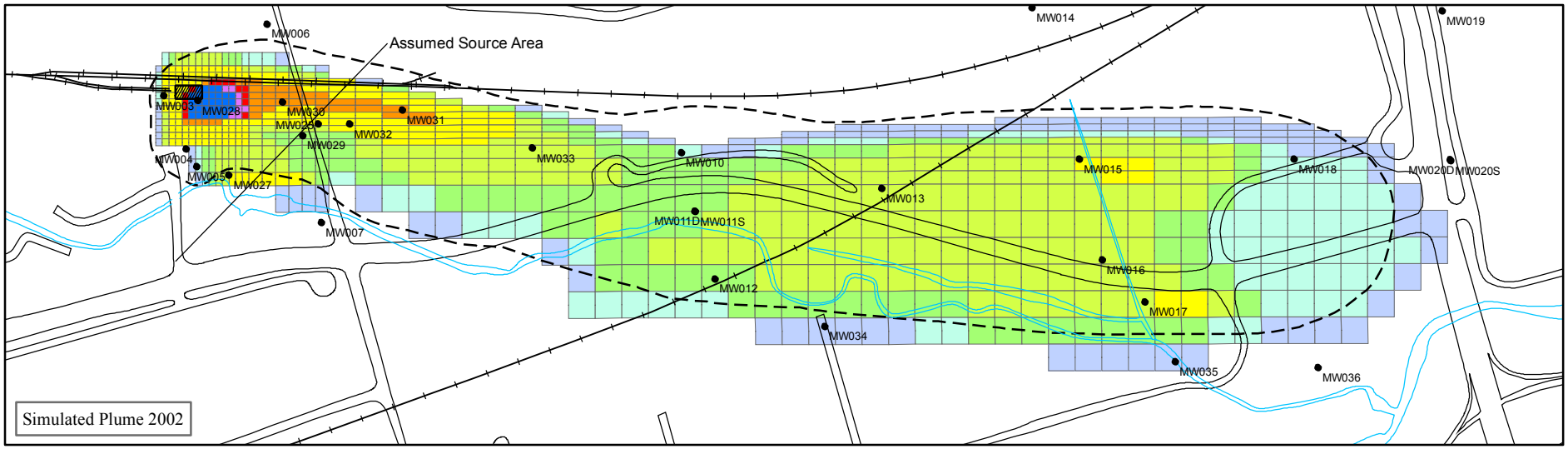
0 800 Feet

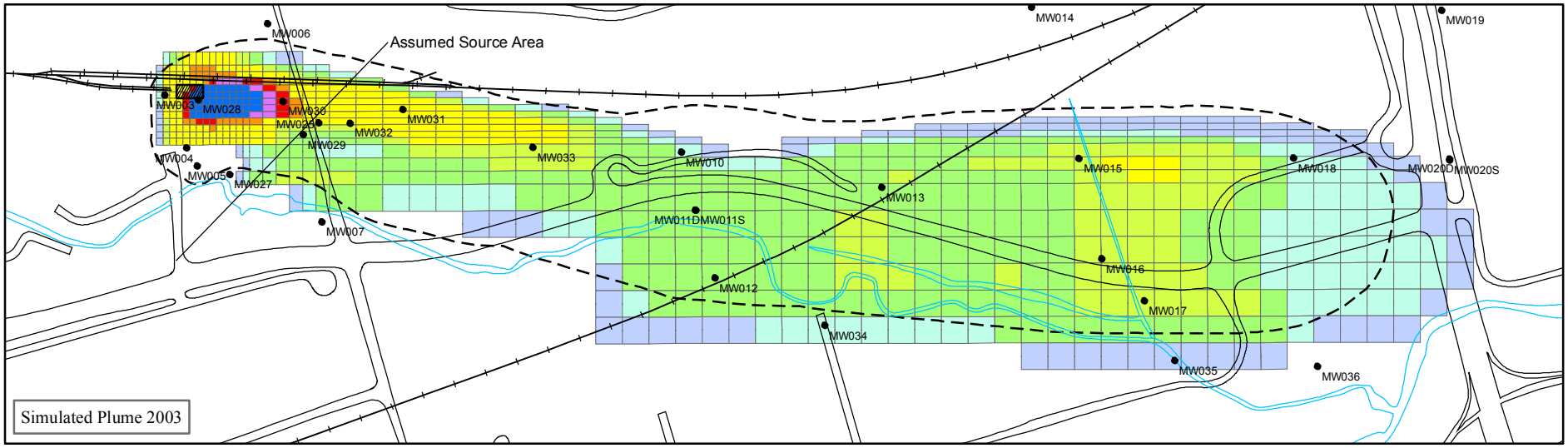
URS

Figure A-17 Simulated Distribution of Biodegradation Rates

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	Biodegradation Rate.mxd	1-2007





TCE Concentration (µg/L)

- 5 - 10
- 11 - 20
- 21 - 50
- 51 - 100
- 101 - 500
- 501 - 1000
- 1001 - 2000
- 2001 - 5000
- 5001 - 50000

- Groundwater Monitoring Well
- Assumed Source Area
- Plume Extent Oct. 2006

N

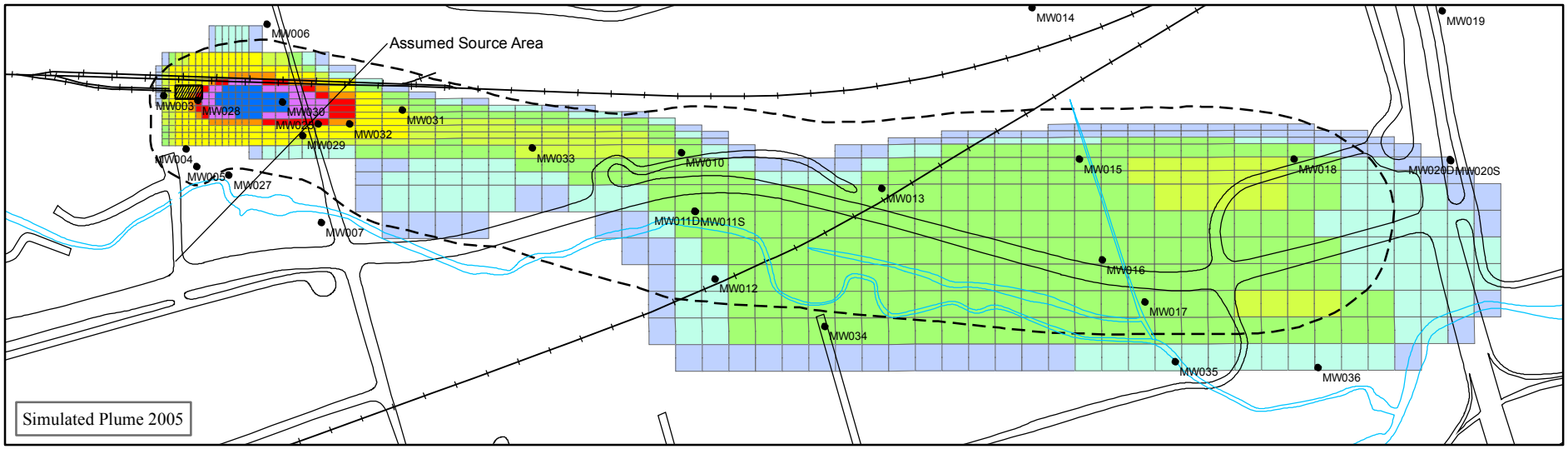
0 600 Feet

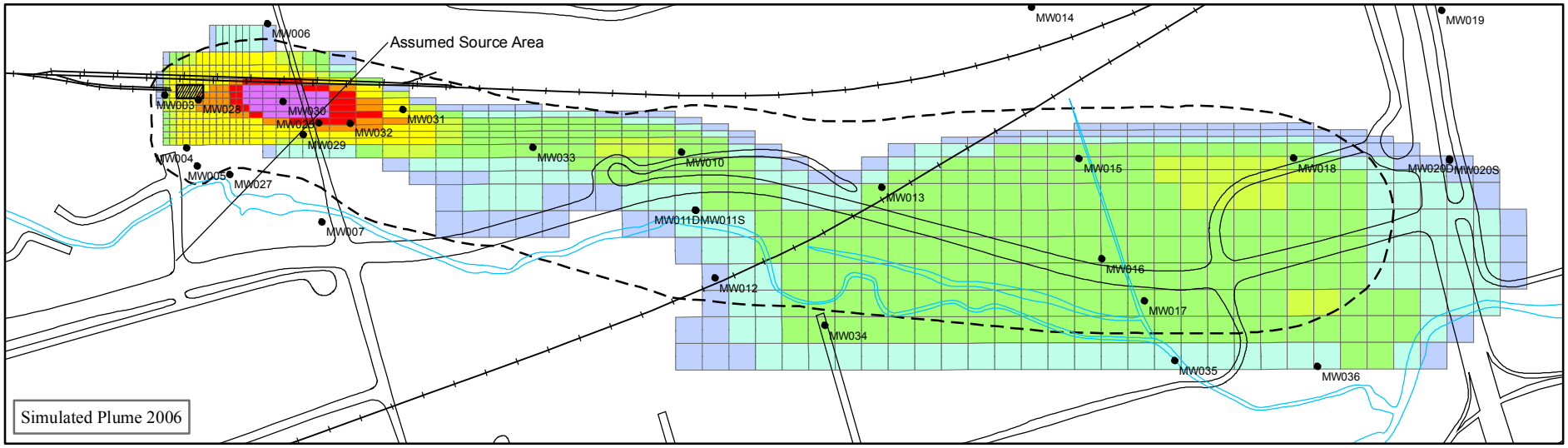
URS

Figure A-18 History Matching Simulation of TCE Plume 2002-2003

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	TCE History Sim 2002-03.mxd	1-2007





TCE Concentration (µg/L)

- 5 - 10
- 11 - 20
- 21 - 50
- 51 - 100
- 101 - 500
- 501 - 1000
- 1001 - 2000
- 2001 - 5000
- 5001 - 50000

- Groundwater Monitoring Well
- Assumed Source Area
- Plume Extent Oct. 2006

0 600 Feet

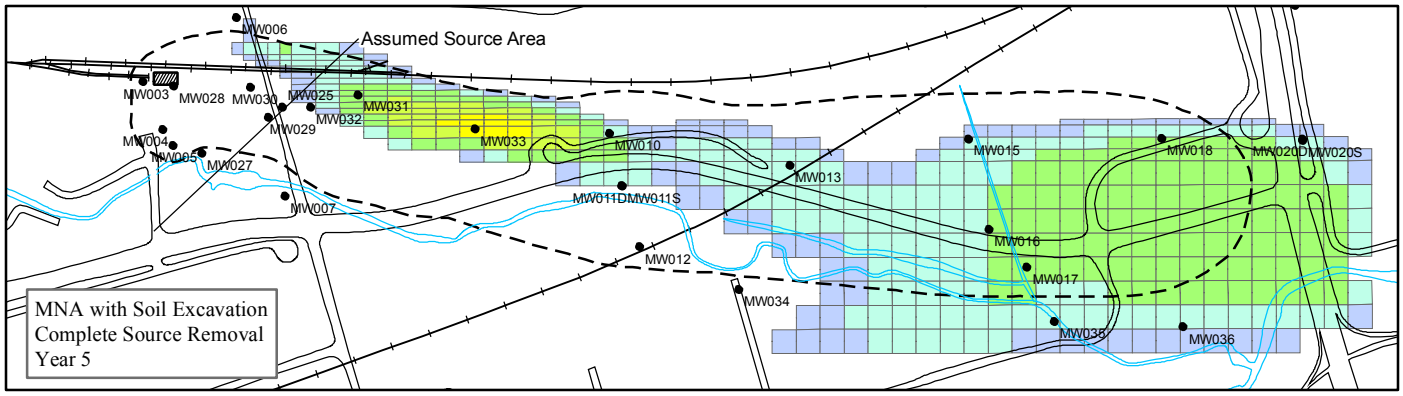
N

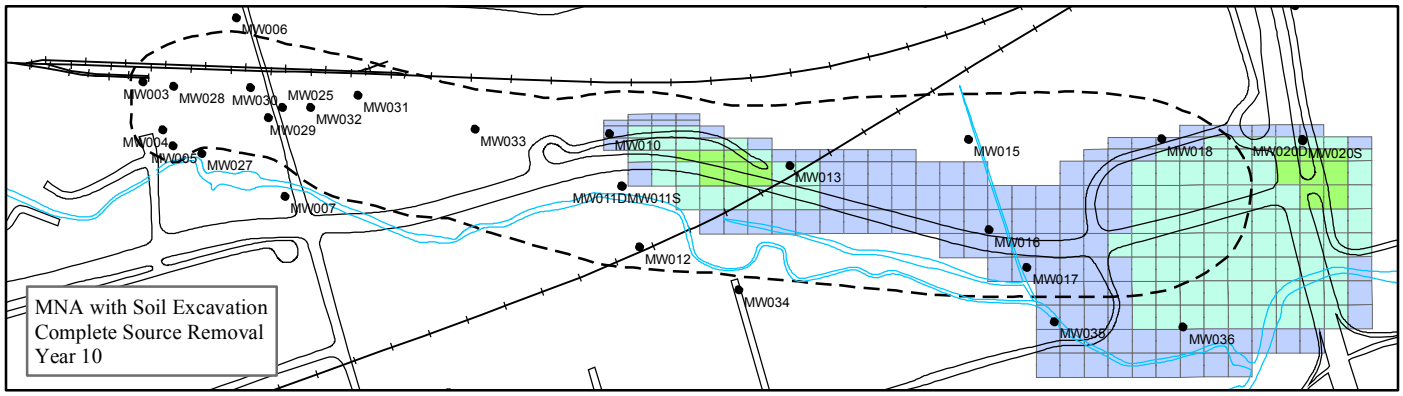
URS

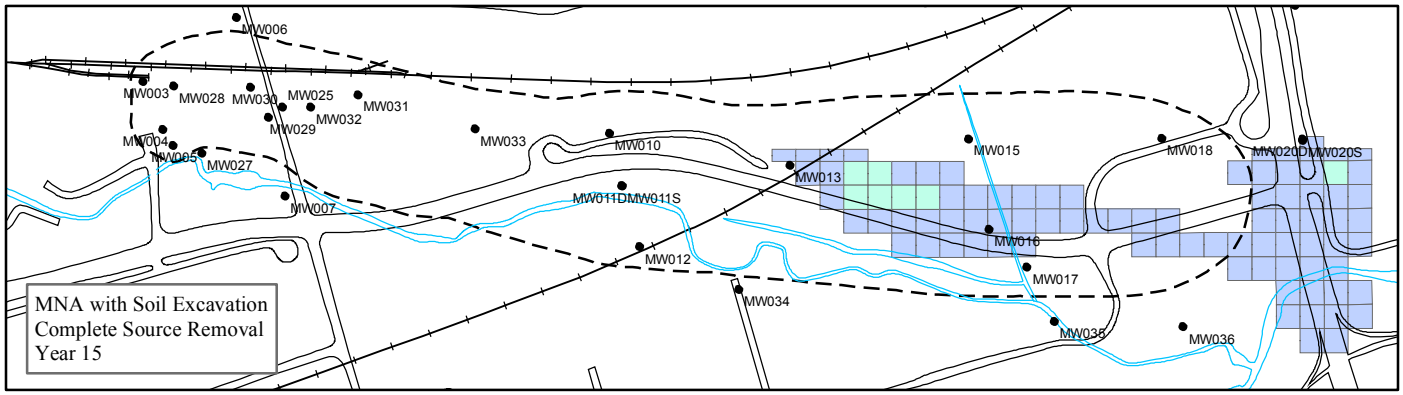
Figure A-19 History Matching Simulation of TCE Plume 2005-2006

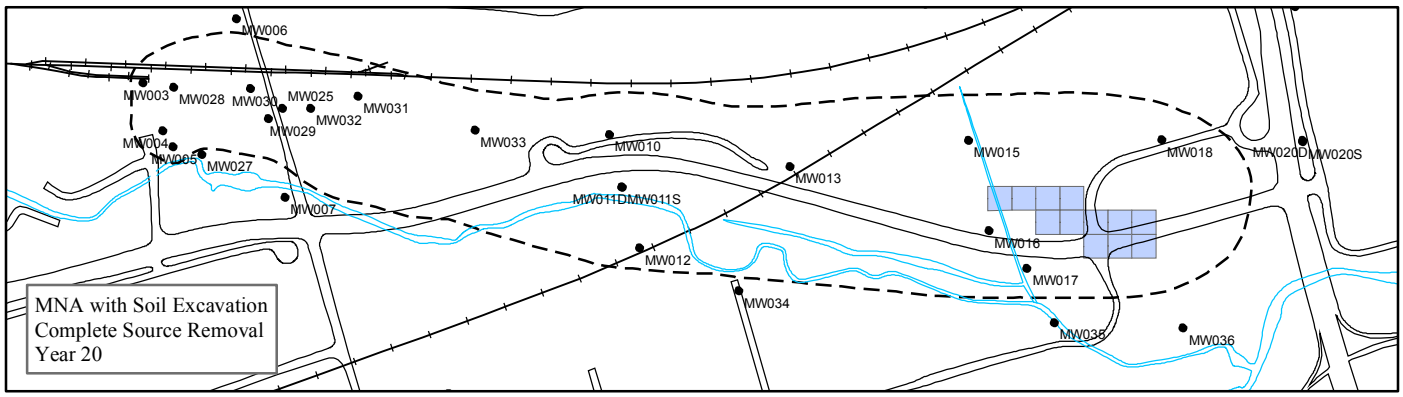
TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	TCE History Sim 2005-06.mxd	1-2007









TCE Concentration (µg/L)
- 5 - 10
- 11 - 20
- 21 - 50
- 51 - 100
- 101 - 500
- 501 - 1000
- 1001 - 2000
- 2001 - 5000
- 5001 - 50000

- Groundwater Monitoring Well
- Assumed Source Area
- Plume Extent Oct. 2006

N

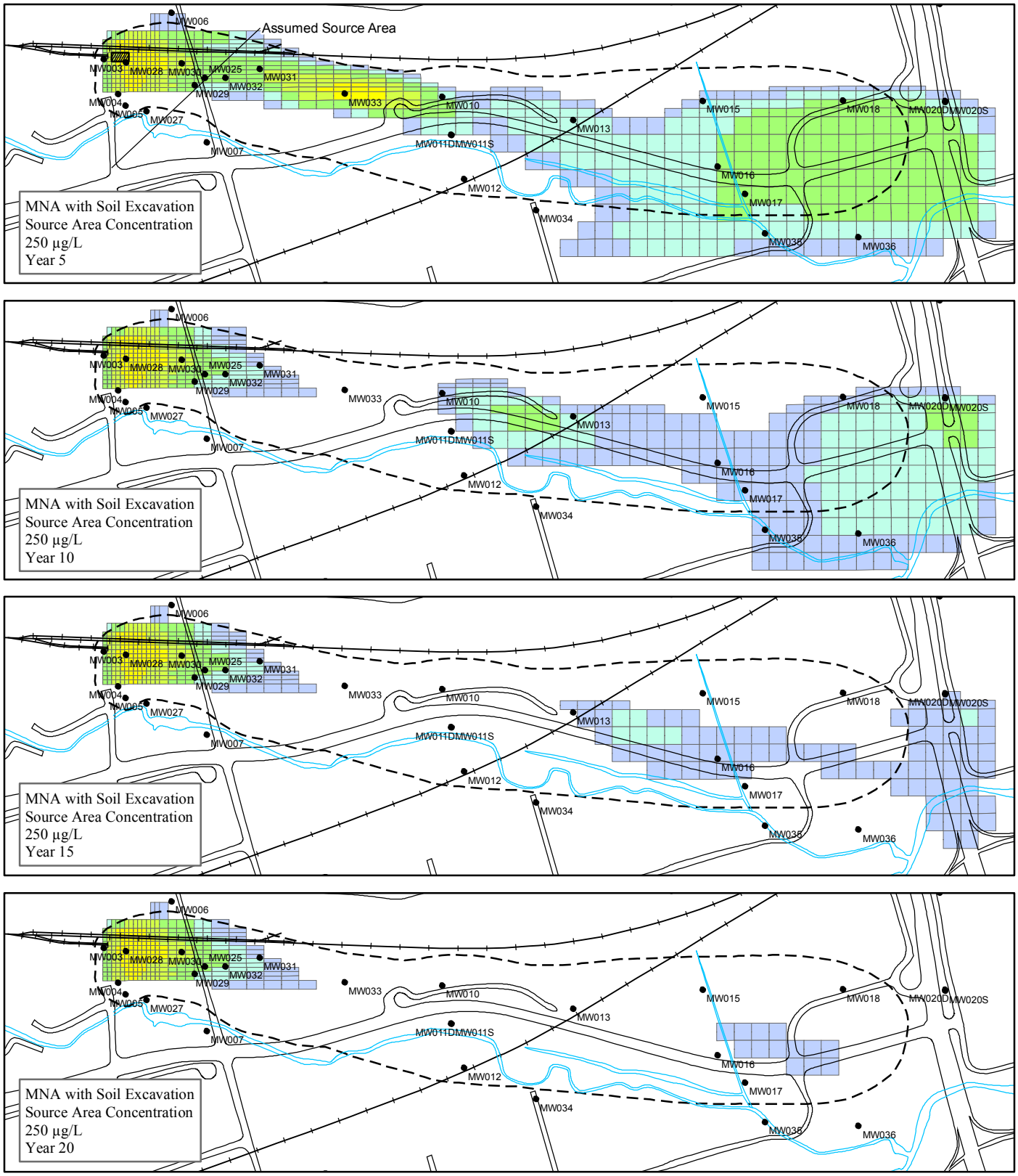
0 800 Feet

URS

Figure A-20a Predicted TCE Plume Migration
MNA with Soil Excavation
Complete Source Removal

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	Plume Excav MNA.mxd	1-2007



TCE Concentration (µg/L)

- 5 - 10
- 11 - 20
- 21 - 50
- 51 - 100
- 101 - 500
- 501 - 1000
- 1001 - 2000
- 2001 - 5000
- 5001 - 50000

- Groundwater Monitoring Well
- Assumed Source Area
- Plume Extent Oct. 2006

N

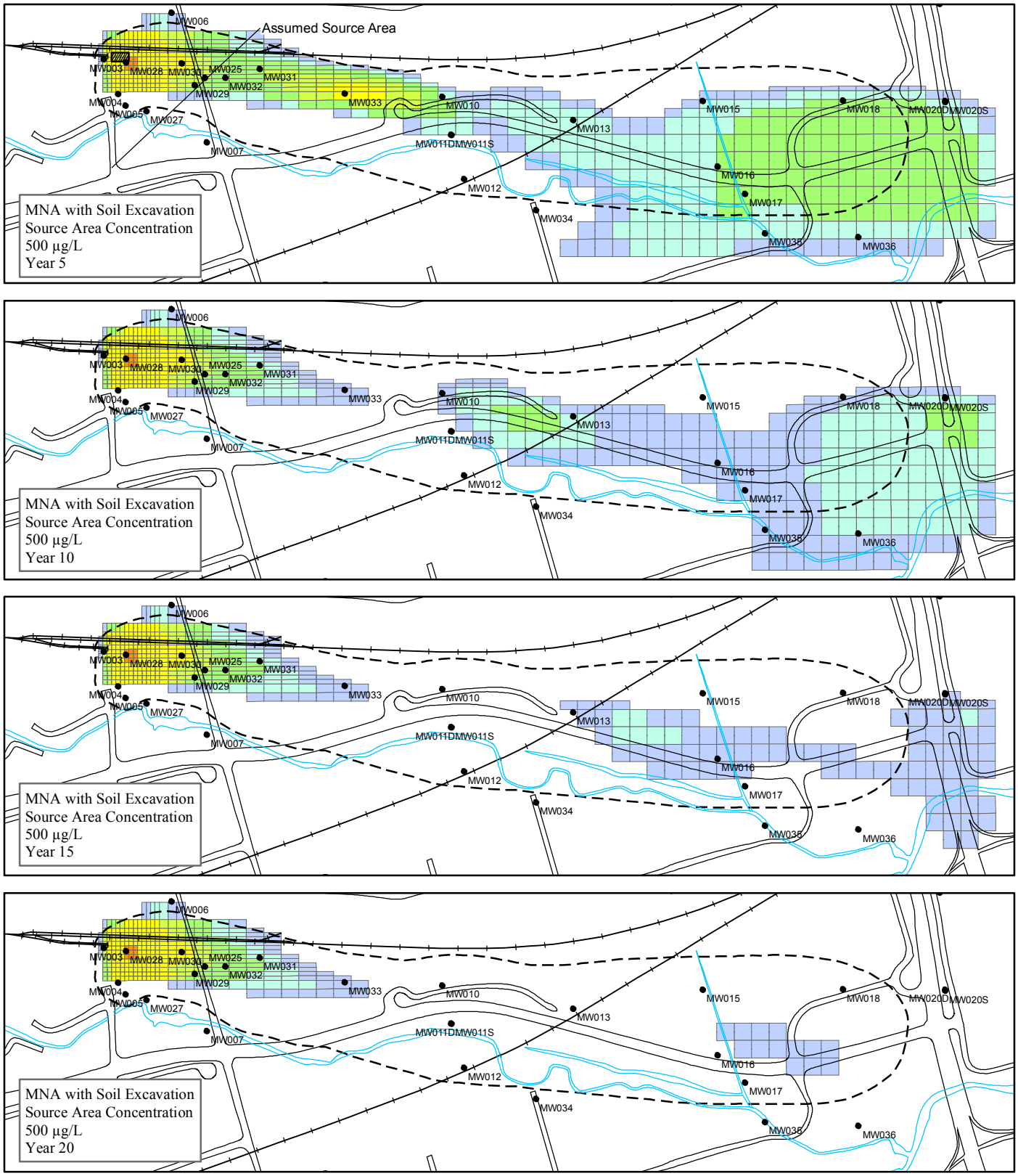
0 800 Feet

URS

Figure A-20b Predicted TCE Plume Migration MNA with Soil Excavation Source Area Concentration 250 µg/L

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	Plume Excav MNA250.mxd	1-2007



TCE Concentration (µg/L)

- 5 - 10
- 11 - 20
- 21 - 50
- 51 - 100
- 101 - 500
- 501 - 1000
- 1001 - 2000
- 2001 - 5000
- 5001 - 50000

- Groundwater Monitoring Well
- Assumed Source Area
- Plume Extent Oct. 2006

N

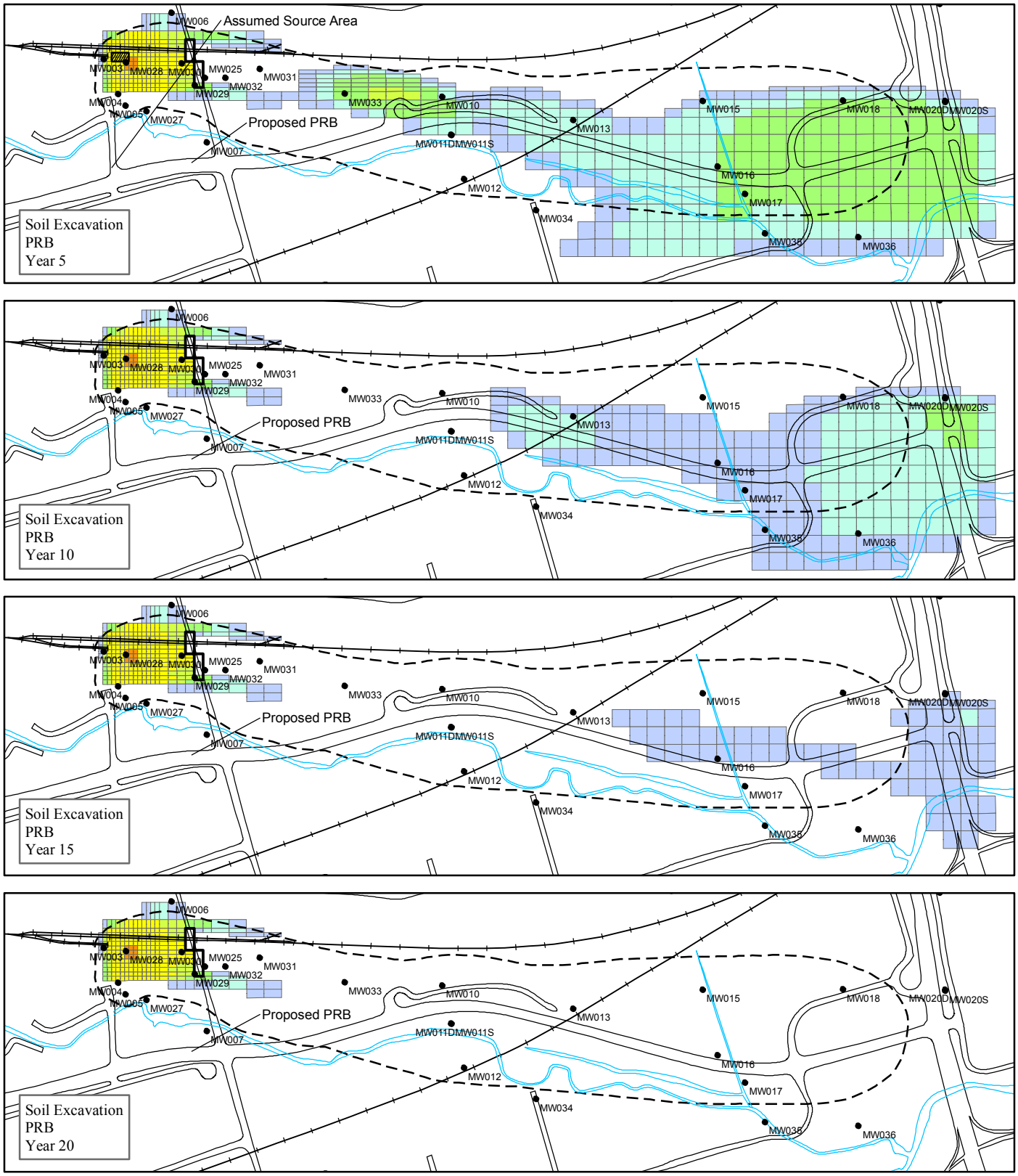
0 800 Feet

URS

Figure A-20c Predicted TCE Plume Migration
MNA with Soil Excavation
Source Area Concentration
500 µg/L

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	Plume Excav MNA500.mxd	1-2007



TCE Concentration (µg/L)

- 5 - 10
- 11 - 20
- 21 - 50
- 51 - 100
- 101 - 500
- 501 - 1000
- 1001 - 2000
- 2001 - 5000
- 5001 - 50000

- Proposed PRB
- Groundwater Monitoring Well
- Assumed Source Area
- Plume Extent Oct. 2006

0 800 Feet

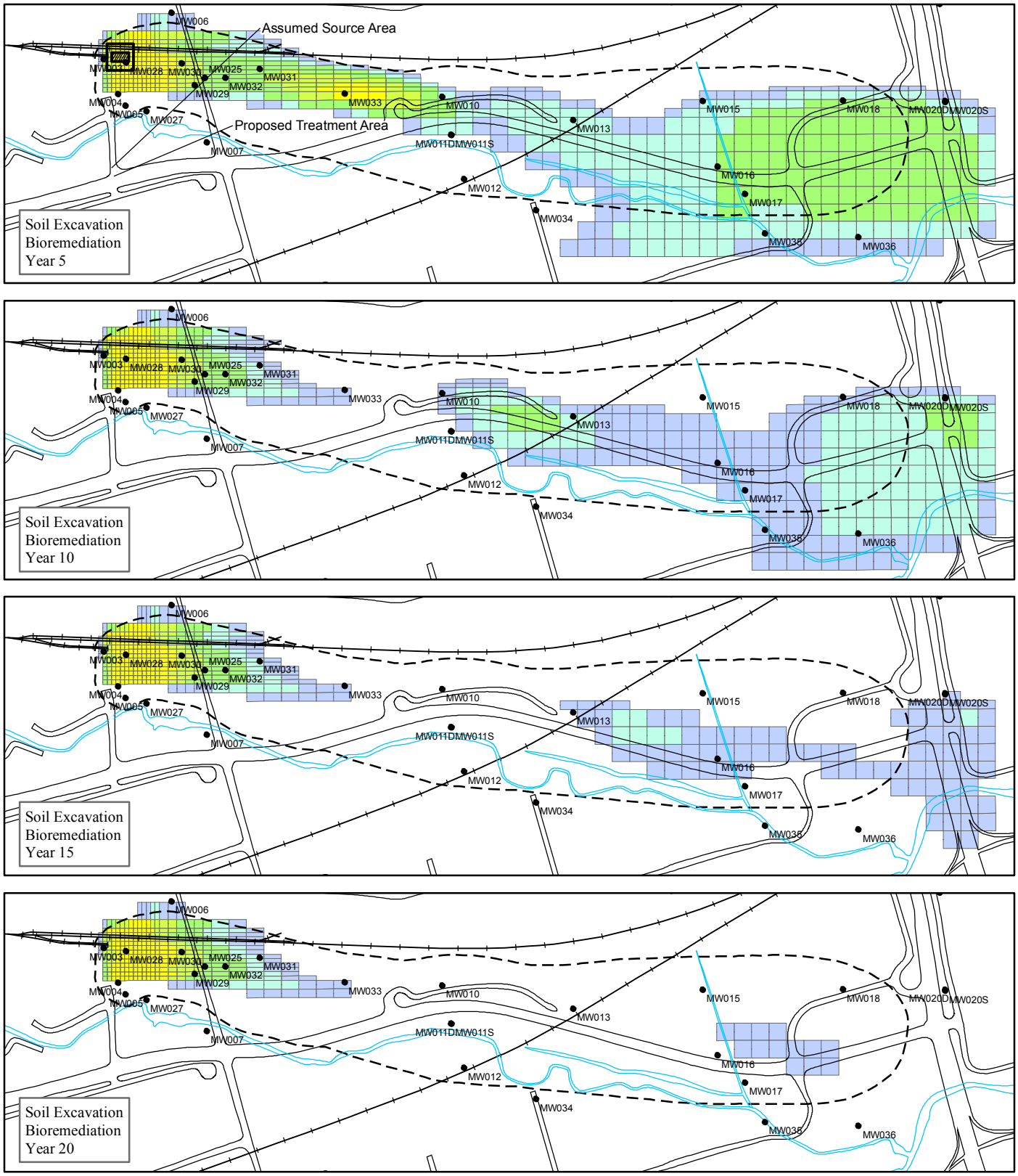
N

URS

Figure A-21 Predicted TCE Plume Migration PRB with Soil Excavation

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	Plume Excav PRB.mxd	1-2007



TCE Concentration (µg/L)

- 5 - 10
- 11 - 20
- 21 - 50
- 51 - 100
- 101 - 500
- 501 - 1000
- 1001 - 2000
- 2001 - 5000
- 5001 - 50000

- Groundwater Monitoring Well
- Assumed Source Area
- Proposed Treatment Area
- Plume Extent Oct. 2006

0 800 Feet

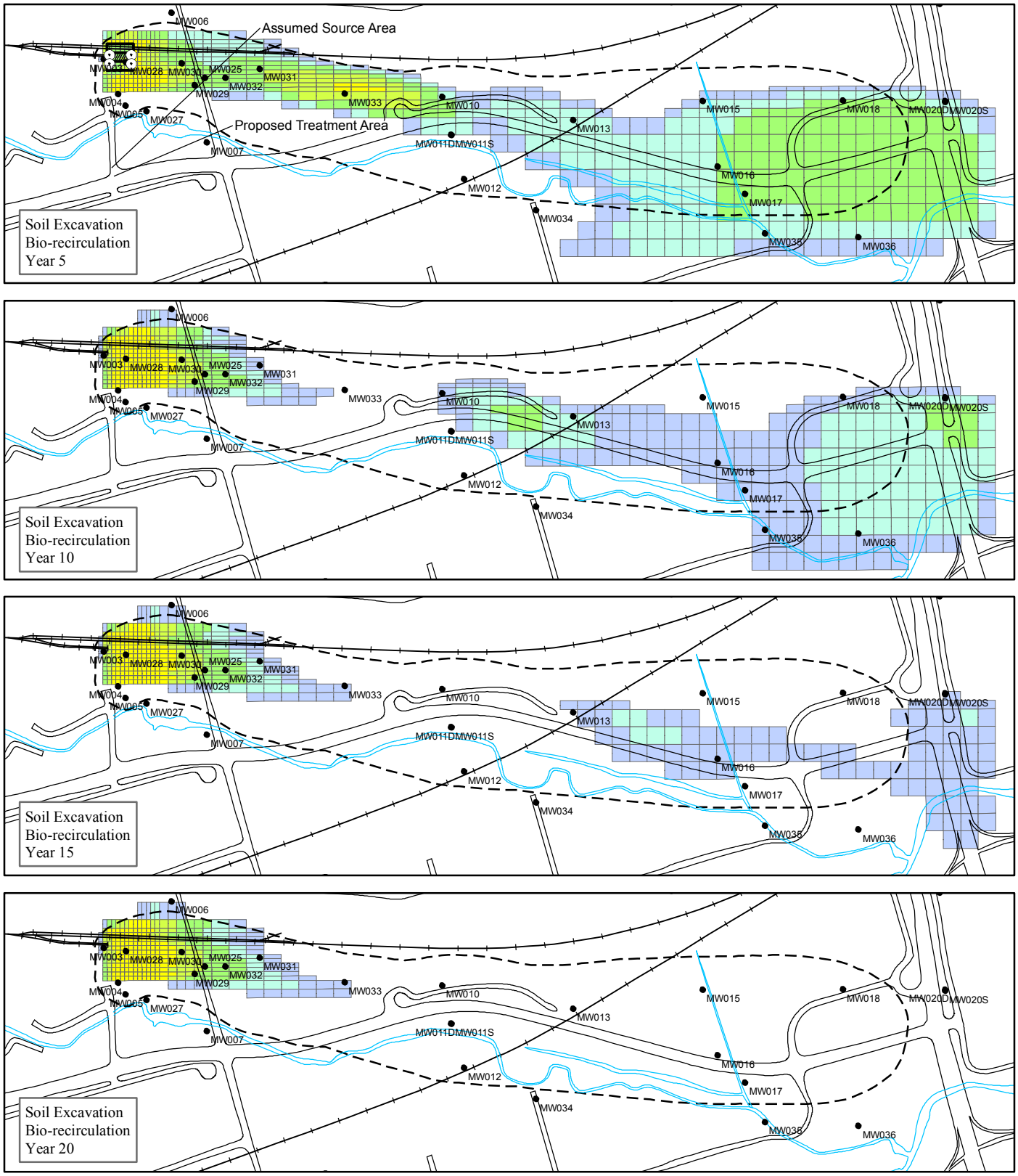
N

URS

Figure A-22 Predicted TCE Plume Migration Bioremediation with Soil Excavation

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	Plume Excav Biorem.mxd	1-2007



TCE Concentration (µg/L)

- 5 - 10
- 11 - 20
- 21 - 50
- 51 - 100
- 101 - 500
- 501 - 1000
- 1001 - 2000
- 2001 - 5000
- 5001 - 50000

- Groundwater Monitoring Well
- Bio-Circulation Well
- Assumed Source Area
- Proposed Treatment Area
- Plume Extent Oct. 2006

0 800 Feet

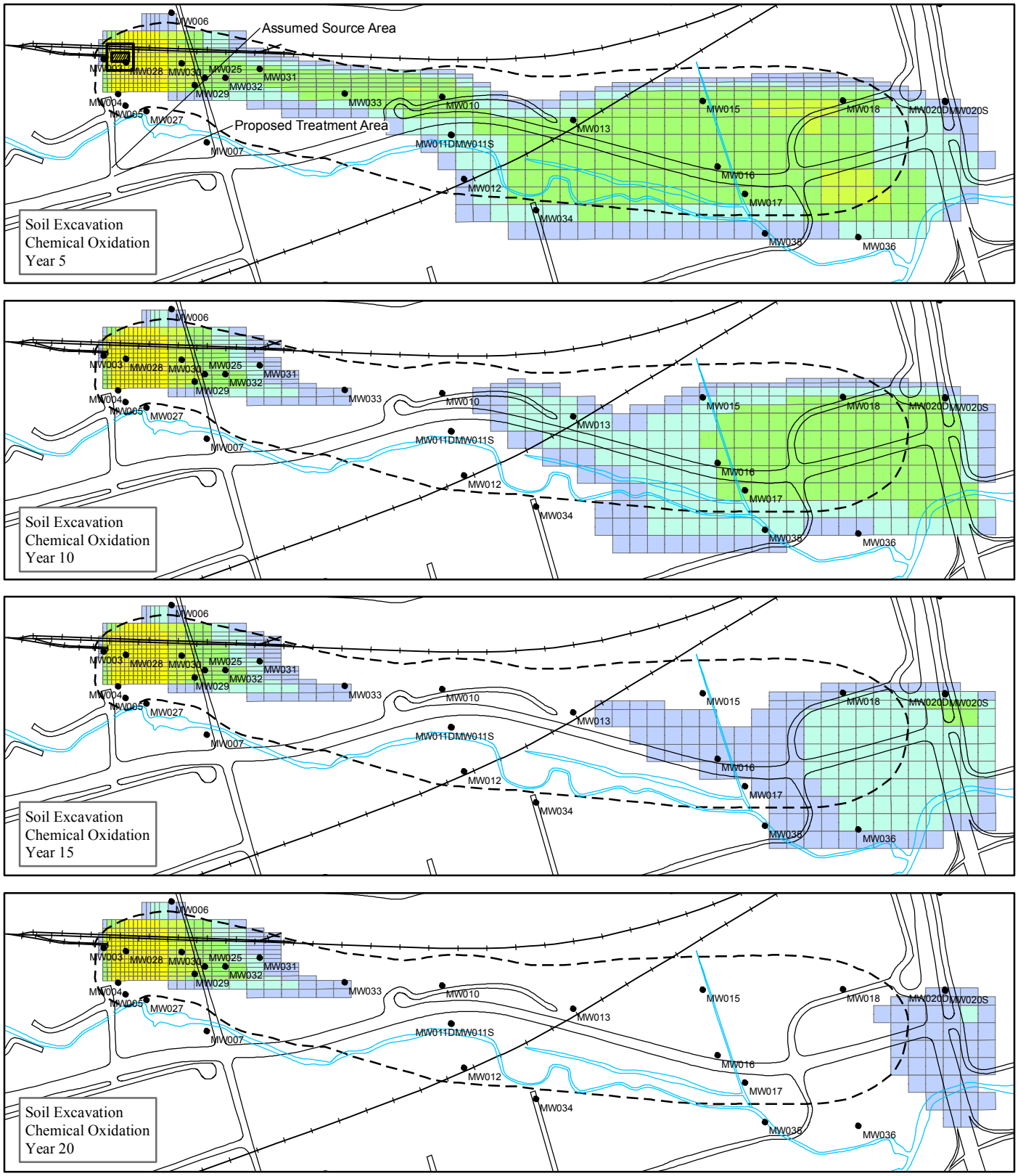
N

URS

Figure A-23 Predicted TCE Plume Migration Bio-recirculation with Soil Excavation

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	Plume Excav Biorecirc.mxd	1-2007



TCE Concentration (µg/L)

- 5 - 10
- 11 - 20
- 21 - 50
- 51 - 100
- 101 - 500
- 501 - 1000
- 1001 - 2000
- 2001 - 5000
- 5001 - 50000

- Groundwater Monitoring Well
- Assumed Source Area
- Proposed Treatment Area
- Plume Extent Oct. 2006

0 800 Feet

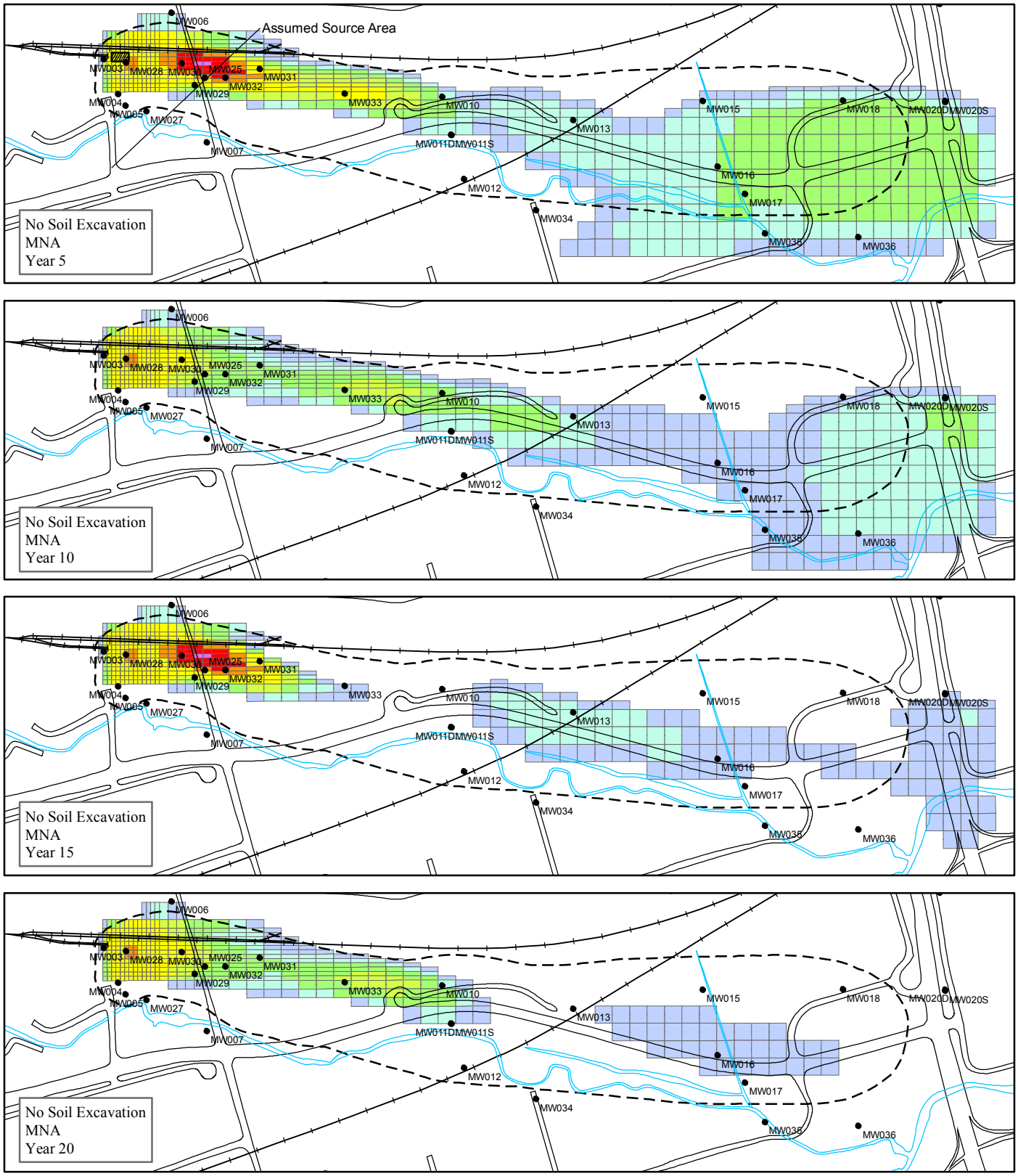
N

URS

Figure A-24 Predicted TCE Plume Migration Chemical Oxidation with Soil Excavation

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	Plume Excav Chemox.mxd	1-2007



TCE Concentration (µg/L)

- 5 - 10
- 11 - 20
- 21 - 50
- 51 - 100
- 101 - 500
- 501 - 1000
- 1001 - 2000
- 2001 - 5000
- 5001 - 50000

- Groundwater Monitoring Well
- Assumed Source Area
- Plume Extent Oct. 2006

0 800 Feet

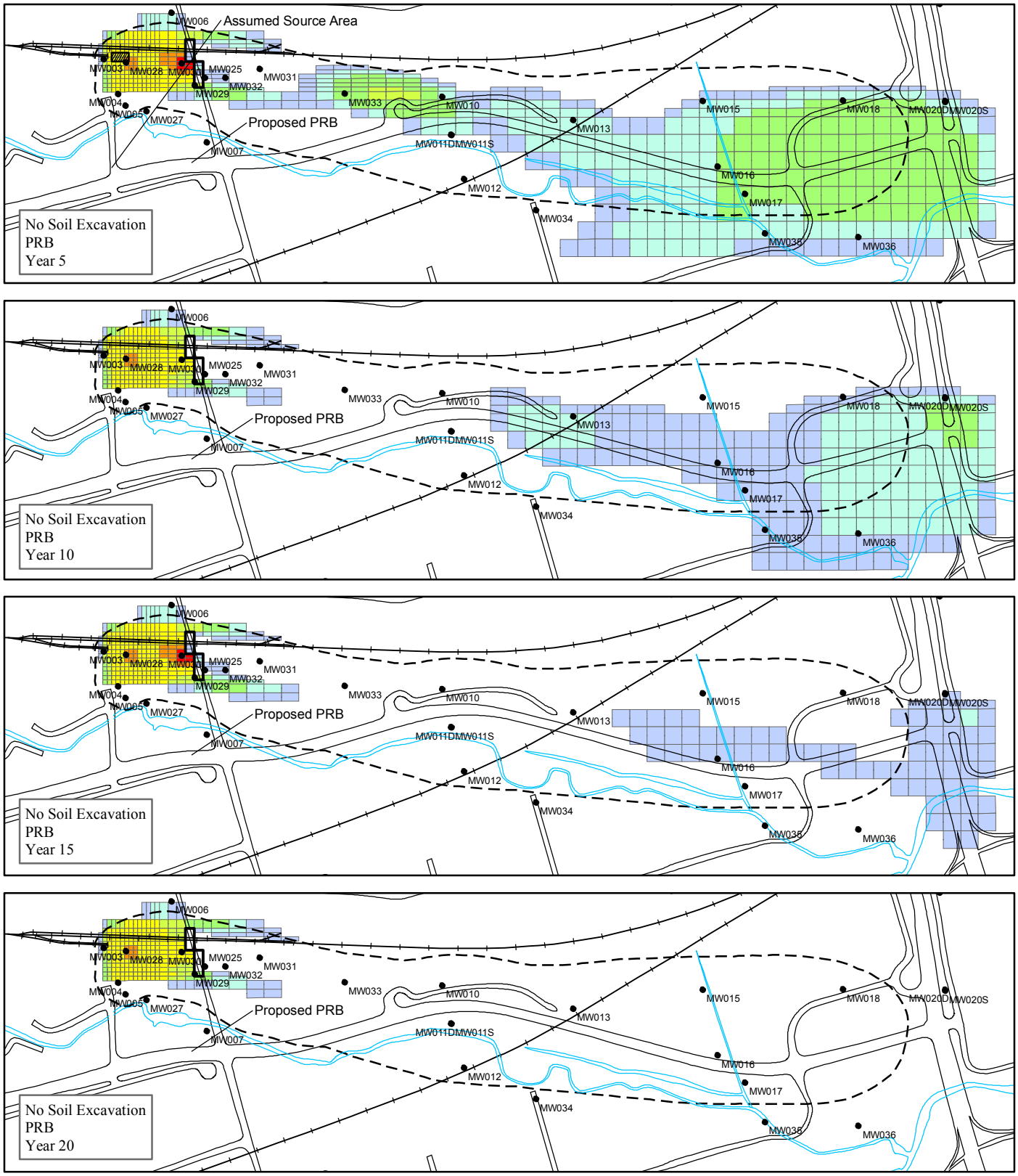
N

URS

Figure A-25 Predicted TCE Plume Migration
MNA
No Soil Excavation

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	Plume NoEx MNA.mxd	1-2007



TCE Concentration (µg/L)

- 5 - 10
- 11 - 20
- 21 - 50
- 51 - 100
- 101 - 500
- 501 - 1000
- 1001 - 2000
- 2001 - 5000
- 5001 - 50000

- Proposed PRB
- Groundwater Monitoring Well
- Assumed Source Area
- Plume Extent Oct. 2006

0 800 Feet

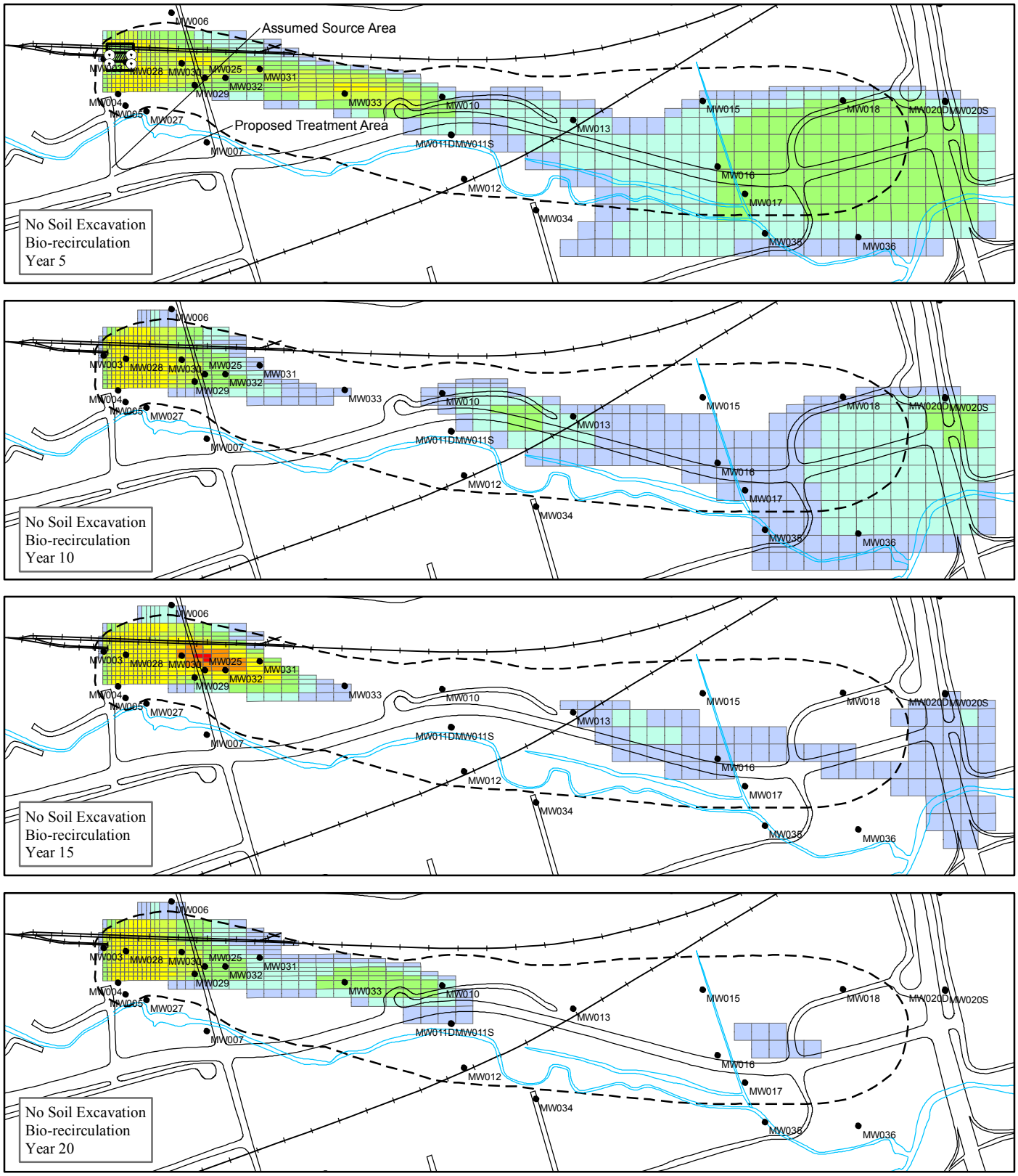
N

URS

Figure A-26 Predicted TCE Plume Migration
PRB
No Soil Excavation

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	Plume NoEx PRB.mxd	1-2007



TCE Concentration (µg/L)

- 5 - 10
- 11 - 20
- 21 - 50
- 51 - 100
- 101 - 500
- 501 - 1000
- 1001 - 2000
- 2001 - 5000
- 5001 - 50000

- Groundwater Monitoring Well
- Bio-Circulation Well
- Assumed Source Area
- Proposed Treatment Area
- Plume Extent Oct. 2006

0 800 Feet

N

URS

Figure A-27 Predicted TCE Plume Migration
Bio-recirculation
No Soil Excavation

TWINS INN FEASIBILITY STUDY
ARVADA, COLORADO

PROJECT NO.	DRAWING NO.	DATE
41567697	Plume NoEx Biorecirc.mxd	1-2007