0101-01-0081-700C

Michael L. House
Solutia Inc.
575 Maryville Centre Drive
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314-674-6717

March 11, 2013

Mr. Bill Wentworth
Waste and Chemicals Management Division (3WC23)
United States Environmental Protection
Region III
1650 Arch Street
Philadelphia, Pennsylvania 19103

Mr. Charlie Armstead
Environmental Resources Program Manager
Division of Land Resources
Office of Environmental Remediation
Office of Waste Management
601 57th Street, SE
Charleston, West Virginia 25304-2345

RE: Revised Interim Measures Effectiveness Monitoring Plan
Caps and Covers Project
Solutia Site; 1 Monsanto Road, Nitro, West Virginia
EPA ID. No. WVD039990965

Dear Bill and Charlie:

Attached is a revised *Interim Measures Effectiveness Monitoring Plan* (IM-EMP) for Solutia's RCRA Interim Measures Program being implemented at its site in Nitro, West Virginia. The IM-EMP is a multi-year monitoring, evaluation and control plan to be initiated upon completion of the last remedial element of the Interim Measures, the Caps and Covers project. The purpose of the IM-EMP is to assess the short-term and long-term effectiveness of the interim measures in achieving the Site Corrective Action Objectives.

The original Plan was submitted to the United States Environmental Protection Region III and the West Virginia Department of Environmental Protection (the Agencies) on May 30, 2012. Solutia received comments and direction from the Agencies in a meeting held in Charleston, West Virginia, on August 25, 2012. Based on the Agencies' comments on the initial plan, Solutia commissioned GSI Environmental Inc. (GSI) of Houston, Texas, to update the groundwater modeling results presented in its report titled, *Groundwater Model Development*

and Flow Simulations, Solutia Nitro Site, Nitro West Virginia, dated September 9, 2011, and submitted to the Agencies on October 24, 2011. The additional groundwater modeling evaluations were performed to specifically define optimal locations for IM-EMP pumping, gradient and groundwater quality monitoring wells as well as to address other Agency comments, questions, and recommendations. The detailed results of GSI's effectiveness monitoring evaluations are documented in a letter report titled, *Monitoring Well Evaluation for Remediation Effectiveness*, Solutia Nitro Site, Nitro, West Virginia, dated March 11 2013. This report is attached as an appendix to this IM-EMP.

Upon final approval of this revised IM-EMP Solutia will begin the installation of the wells defined in the plan such that caps and covers installation can resume following the winter construction break at the site.

If you have any questions, please call me at (314) 674-6717, or I can be reached via e-mail at mlhous1@solutia.com.

Sincerely,

Michael House

Michael L. House
Remediation Services Manager
Solutia Inc.

MLH/mh

Attachment

c: Ron Potesta, Mike Light – Potesta & Associates

FINAL
INTERIM MEASURES EFFECTIVENESS MONITORING PLAN

Solutia Inc. Nitro Site
Nitro, West Virginia

Prepared for:

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Project No. 0101-01-0081-700C

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POTESTA

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INTERIM MEASURES
EFFECTIVENESS MONITORING PLAN

Solutia Inc. Nitro Site
Nitro, West Virginia

1.0 PLAN OVERVIEW

The Site consists of two areas separated by Interstate 64 (I-64): the former Process Area (PA) south of I-64; and the former Wastewater Treatment Area (WTA) north of I-64. The PA also incorporates a 9-acre past disposal area (PDA). Completion of all planned Interim Measures is scheduled for year-end 2014.

This Interim Measure (IM) Effectiveness Monitoring Plan (IM-EMP) has been prepared pursuant to the Site Resource Conservation and Recovery Act (RCRA) Corrective Action Permit, I.D. WV039990965 (Permit), Section E.2, "Interim Measures." The IM-EMP objectives; sampling frequency and media analytes; IM inspection frequencies; and reporting requirements were included in the Final Interim Measures Work Plan, dated April 9, 2010 (WP), as approved by letter from Bill Wentworth, United States Environmental Protection Agency (USEPA) Project Manager to Michael House, Solutia Inc. (Solutia), dated June 29, 2010.

This IM-EMP identifies seven existing groundwater monitoring well pairs and proposes locations for four additional groundwater monitoring well pairs to support site wide groundwater monitoring. This IM-EMP also proposes five additional groundwater extraction wells and seven new piezometers to achieve and monitor an inward hydraulic across the four soil-bentonite barrier wall containment areas.

This proposed IM-EMP is based on the results of a site-specific groundwater flow model completed in September 2011. The detailed results of the 2011 groundwater model development were documented in a report titled, *Groundwater Model Development and Flow Simulations*, Solutia Nitro Site, Nitro, West Virginia, dated September 9, 2011 (*GSI GW Model Report*). The IM-EMP is also based on a site specific remediation effectiveness evaluation completed in March 2013. This evaluation utilized the 2011 groundwater flow model as well as historical groundwater concentration data for Site groundwater constituents. A letter report dated March 6, 2013 detailing the results of the March 2013 remediation effectiveness evaluation is enclosed as **Appendix A**. The groundwater flow model and the remediation effectiveness evaluation are summarized in Section 2.0 below.

The Quality Assurance Protection Plan (QAPP) applicable to this proposed IM-EMP is included as **Appendix B**.

2.0 INTERIM MEASURES FFECTIVENESS MONITORING PLAN DEVELOPMENT

A draft of the IM-EMP was submitted to the USEPA and West Virginia Department of Environmental Protection (WVDEP) (collectively, Agencies) on May 30, 2012. Solutia and the Agencies discussed the May 30, 2012 draft IM-EMP, along with Joel Hennessy's August 24, 2012 comments on the plan, in an August 25, 2012 meeting in the Charleston, West Virginia offices of Potesta & Associates, Inc. (POTESTA). As a result of this meeting, an agreement was reached on the following objective for a revised draft IM-EMP:

Procure Site groundwater and Site stormwater concentration data within 1 to -3 years of completion of installation of the Interim Measures that will be sufficient to develop a Statement of Basis for determination of final Remedial Measures by either:

1. *Acceptance of the existing Interim Measures as Final Remedial Measures, or;*
2. *Identification of required additional remedial measures to supplement the existing Interim Measures that are required to meet Site performance based requirements.*

It was further agreed that utilization of the March 2011 site specific groundwater flow model to perform an evaluation of the projected remedial effectiveness of the approved Interim Measures currently being installed would be beneficial in developing the revised IM-EMP to accomplish the newly defined objectives.

3.0 GROUNDWATER FLOW MODEL AND REMEDIATION EFFECTIVENESS EVALUATION

3.1 Site Groundwater Flow Model Development

In May 2010, Solutia commissioned GSI Environmental Inc. of Houston, Texas (GSI) to construct a model to simulate groundwater flow in the area of the Site, including measurement of the groundwater flow effects resulting from construction of planned Interim Measures (i.e. the soil-bentonite barrier walls and various soil caps and covers). The results of this modeling effort were documented in a report titled, *Groundwater Model Development and Flow Simulations*, Solutia Nitro Site, Nitro, West Virginia, dated September 9, 2011 (*GSI GW Model Report*). The report was sent to the Agencies by letter dated October 24, 2011.

3.1.1 Flow Model Conclusions

Key conclusions of the flow model were:

1. Groundwater elevations across the site outside of the barrier walls of the various containment areas will increase by less than 1 foot maximum, and in most areas, less than 0.5 feet. Construction of the walls is not expected to cause flooding anywhere on or off the site.

2. Altered groundwater flow patterns are unlikely to result in any impacts to groundwater that is not already impacted by past site activities. The altered groundwater flow patterns should not significantly affect the current groundwater quality monitoring well network outside of the immediate area of the barrier walls.

3. Groundwater flow simulations indicate that a total combined pumping rate of 2.4 gpm is needed to maintain an inward hydraulic gradient at the four source areas following installation of barrier walls that exhibit a hydraulic conductivity of $\leq 3 \times 10^{-8}$ cm/s.

4. The simulations indicate that the inward hydraulic gradient can be maintained with pumping only in Zone A[1].

5. A rise in the Kanawha River stage up to 2 feet is unlikely to have a significant impact on site groundwater flow patterns. A river stage increase of 5 feet would increase hydraulic heads in wells at the site and move the river/Armour Creek groundwater divide further west. A lowering of the Kanawha River stage would lower hydraulic heads across the site but would not impact groundwater flow patterns significantly. These scenarios were simulated using the site flow model and are discussed in detail in the *GSI GW Model Report.*

3.2 Remediation Effectiveness Evaluation

Based on the results of the August 25, 2012 Agencies' review of the May 30, 2012 draft IM-EMP at the Potesta Charleston office, Solutia commissioned GSI to perform additional groundwater evaluations utilizing the 2011 site specific groundwater flow model. Solutia requested that GSI evaluate the effectiveness of the completed Interim Measures by modeling decreases in groundwater constituent concentrations and documenting inward head gradients across the slurry walls. In addition, GSI was requested to develop an optimal array of groundwater constituent concentration wells and groundwater monitoring wells for collecting cross-gradient groundwater elevations. More specifically, GSI was tasked with determining and explaining:

- features of the site that affect groundwater flow patterns
- the rationale and optimal location of extraction wells inside the groundwater containment areas
- the number and location of gradient monitoring wells needed to demonstrate and monitor an inward hydraulic gradient across the slurry walls
- the number and location of proposed groundwater monitoring wells that are likely to show the most rapid groundwater COC concentration decreases and
- the projected overall effects of the remediation systems on groundwater concentrations

[1] To add a margin of safety vs. the model, all proposed containment area groundwater extraction wells be extended into the upper portion of the deeper groundwater Zone B.

3.2.1 Remediation Effectiveness Report Summary

Several features, including the location of the site adjacent to the Kanawha River, the higher transmissivity of the lower part of the alluvial aquifer, and the distribution of cross-wall gradients all have an effect on the locations of wells (for both pumping and monitoring). Hydraulically, cross-wall gradients are higher on the downgradient sides of the barrier walls because the natural groundwater gradient is from the center of the site to the Kanawha River. As a result of this distribution, crosswall gradient monitoring wells and pumping wells are best located along the downgradient side of the slurry walls. The final locations of the cross-gradient monitoring wells are shown in Drawings 1 and 2 located in **Appendix C**.

Mass transport modeling using MT3D with the existing MODFLOW groundwater flow model has identified locations where groundwater constituent concentrations are likely to show the largest change over a 3-year period. The trends in constituent concentrations are the more important factor in demonstrating the effectiveness of the remedial systems instead of the absolute magnitude of concentration changes. The final locations of the proposed constituent concentration monitoring wells are shown on Drawings 1 and 2 located in **Appendix C**.

The detailed results of GSI's effectiveness monitoring evaluations are documented in a letter report titled, *Monitoring Well Evaluation for Remediation Effectiveness*, Solutia Nitro Site, Nitro, West Virginia, dated March 11 2013 (*GSI GW Remediation Effectiveness Report*). The *GSI GW Remediation Effectiveness Report* is attached as **Appendix A**.

4.0 INTERIM MEASURES OBJECTIVES

Interim Measure Objectives (IMOs) have been developed for Site soils, wastes, stormwater and groundwater. The IMOs are premised on the Site remaining industrial or commercial. The IM-EMP is a multi-year monitoring, evaluation and control plan. The purpose of the IM-EMP is to assess the short-term and long-term effectiveness of the Interim Measures in achieving the Site Corrective Action Objectives. As described in detail in the April 9, 2010, Final Interim Measures Interim Measures Work Plan, the objectives of the IM-EMP can be defined in three timeframes:

1. Short-term: Confirm that the Interim Measures are functioning consistent with the design specifications. The key short-term performance standard is the maintenance of, or a trend toward, an inward hydraulic gradient on the downgradient side of all barrier walls.

2. Intermediate-term: Provide sufficient data to evaluate the rate of improvement of Site environmental media relative to the media objectives. The performance standard for this intermediate-term objective is an overall decrease in groundwater concentrations of the constituents of concern (COCs) at the monitoring locations.

3. Long-term: Collect Site media data to assess the adequacy of the Interim Measures toward achievement and maintenance of the long-term Site media objectives, including

long-term protection of human health and the environment. The long-term performance standard is the continued decrease in groundwater concentrations, and eventually, achievement of site media objectives. In the interim, assessment of progress toward achievement of these objectives will be accomplished by long-term monitoring of the condition and functionality of the Interim Measures and the quality of Site stormwater and groundwater. Short-Term and Intermediate/Long-Term IMOs are detailed in Table 1 (Tables are presented in **Appendix D**).

5.0 INTERIM MEASURES EFFECTIVENESS MONITORING PLAN

The IM-EMP is a multi-year monitoring, evaluation and control plan to be initiated upon completion of the Caps and Covers project. Completion of all planned Interim Measures is scheduled for year-end 2014.

5.1 Proposed Groundwater Monitoring and Source Containment

5.1.1 Site-wide Groundwater Monitoring

The Site currently contains seven existing down-gradient, perimeter well pairs that will be used as IM-EMP monitoring wells:

- GW-3(A/B) and GW-4(A/B) in the PA
- GW-13(A/B), GW-14(A/B), GW-17(A/B), GW-18(A/B) and GW-19(A/B) in the WTA

In addition to the seven existing, down-gradient, perimeter well pairs, this IM-EMP proposes to install the following four additional monitoring well pairs:

- CMW-11(A/B); CMW-59(A/B) and CMW-52R(A/B) in the PA
- CMW-41(A/B) in the WTA

The four new well pairs will be identical in construction to the existing perimeter monitoring wells. The seven existing perimeter groundwater monitoring well pairs and the four new well pairs are shown on the **Appendix C** Drawings 1, 2 and 3. Specific sampling procedures and protocols applicable to these samples are addressed in the QAPP (**Appendix B**).

5.1.2 Containment Areas Cross-Barrier Gradient Monitoring and Control

Groundwater from inside of the four soil-bentonite slurry wall containment areas will be extracted to maintain inward head gradients across the barrier walls. The *GSI GW Remediation Effectiveness Report* (**Appendix A**) concludes that this objective can be achieved by installation of five new groundwater extraction wells within the containment areas to supplement four existing monitoring wells, which will be converted to extraction wells. The total number and location of proposed extraction wells are:

- PA – 1 new pumping well in the PA (PA-New-1) in combination with existing well GW-1A; (see Appendix A, Figure 4)
- PDA - 1 new pumping well in the PDA (PDA-New-1) in combination with 3 existing wells: GW-9A, GW-10A and GW-11A (see Appendix A, Figure 4)
- WTA - 2 new pumping wells in WTA-West (WTA-New-1 and (WTA-New-2); 1 new pumping well in WTA-East (WTA-New-3) (see Appendix A, Figure 4)

Table 2 (**Appendix D**) contains well construction details for all new and existing IM-EMP wells. Note that the depth of each new well that will be used for groundwater extraction will be extended approximately 10 feet into the upper portion of the lower aquifer. Groundwater pumps will be set to run continuously at the design flow rates, with periodic adjustments as necessary to ensure an inward cross-barrier hydraulic gradient.

The *GSI GW Model Report* concluded and the *GSI GW Remediation Effectiveness Report* (**Appendix A**) confirmed, that at equilibrium, the nine total extraction wells, pumping at a combined flow rate of 2.4 gpm, will be sufficient to maintain cross-barrier inward hydraulic gradients within the four containment areas. The *GSI GW Remediation Effectiveness Report* also confirmed that the addition of seven new piezometers, in combination with one existing well, installed as four pairs across the downgradient barrier wall in each containment area will be sufficient to monitor and control the cross-barrier hydraulic gradients in each area.

5.1.3 Groundwater Treatment

The groundwater extracted from the containment areas (maximum of 2.4 GPM at equilibrium) to maintain an inward cross-barrier hydraulic gradient will be collected and pumped to a storage tank and fed through a single, centralized, granular activated carbon (GAC) treatment facility. The storage tank and central GAC treatment facility will be located near the existing gatehouse office area. Bench scale, pilot scale and full scale testing on site groundwater have demonstrated that GAC treated groundwater is sufficient to meet National Pollutant Discharge Elimination System (NPDES) Permit discharge limits. Design details for the storage and treatment facility will be submitted at a later date. The anticipated start-up of this facility will coincide with completion of Caps and Covers IMs, currently estimated to occur in late 2014.

6.0 SAMPLING, INSPECTIONS AND REPORTING

The proposed IM-EMP includes the following periodic inspection, sampling and reporting requirements:

6.1 Annual Inspection of All Caps and Covers

The annual inspection report will include documentation of all observations; all maintenance and repair actions taken; any additional actions that are in progress, needed or planned; and all quarterly hydraulic gradient measurement results.

6.2 IM-EMP Groundwater Monitoring Wells Sampling

Discreet groundwater samples will be collected quarterly for Year-1 following completion of Interim Measures Installation. Semi-annual sampling after Year-1 will be considered by the Agencies, based on Year-1 results. Summarizing proposed Site groundwater concentration monitoring wells:

- GW-3(A/B), GW-4(A/B), CMW-11(A/B), CMW-59(A/B) and CMW-52R(A/B) in the PA
- GW-13(A/B), GW-14(A/B), GW-17(A/B), GW-18(A/B), GW-19(A/B) and CMW-41(A/B) in the WTA

Each of the 22 total quarterly groundwater samples will be analyzed for VOCs, SVOC, metals, pesticides, and herbicides. TCDD will be analyzed on the first set of groundwater samples from all river boundary wells to confirm that results are consistent with the multi-year TCDD database collected pursuant to the RFI in 2005 through 2008. The first set of TCDD analytical results will be compared to those obtained during the RFI. If the current results for TCDD in groundwater are consistent with earlier results, Solutia will review the data with the Agencies, and reach a decision on the value of performing TCDD analysis (frequency, etc.) on subsequent groundwater IM monitoring samples.

The analytical results for each COC in groundwater and the calculated mass flow rate of groundwater will be used to determine an indicated mass flux to the river for each Site COC. The annual mass flux trend for each COC will be tracked and the results graphically displayed.

6.3 Cross-barrier Hydraulic Gradient Monitoring

Cross-barrier hydraulic gradient measurements will be performed quarterly at each of the cross-gradient well pairs in the four containment areas. Results will be documented in the IM-EMP annual report.

Monitoring needs for Site surface water, including the discharge from the central GAC groundwater treatment facility, will be developed and submitted to the Agencies with the NPDES application for the Site NPDES discharge Permit applicable to the Site following completion of installation of all Interim Measures, now targeted for late 2014.

6.4 Reporting

Annual IM-EMP reports will begin the first year following completion of the IM installation. The annual IM-EMP report will summarize the sampling and inspection results from the previous year and assess progress toward achievement of IM objectives. The annual IM-EMP report will be submitted to the Agencies by February 20th of the current year for the prior year report period.

7.0 CLOSING

This report has been prepared to assist Solutia in evaluating the current environmental conditions at the Site. POTESTA and Solutia mutually devised the scope of this study, which is limited to the specific project, location, and time-period described herein. The report represents POTESTA's understanding of the Site conditions as discernible from information provided by others and obtained by POTESTA using the methods specified. POTESTA assumes no responsibility for information provided or developed by others or for documenting conditions detectable with methods or techniques not specified in the scope of services. In addition, no activity, including sampling, assessment or evaluation of material or substance, may be assumed to be included in this study unless specifically considered in the scope of services and this report. Sketches and maps in this report are included only to aid the reader and should not be considered surveys or engineering studies. If additional data concerning this Site become available, POTESTA should be informed so that we may examine the information and, if necessary, modify this report accordingly.

APPENDIX A

GSI ENVIRONMENTAL

MEMORANDUM

TO: Michael L. House
Manager, Remedial Projects
Solutia Inc.

FROM: Phillip de Blanc, Ph.D., P.E.
Robert S. Lee, P.G.

SUBJECT: Monitoring Well Evaluation for Remediation Effectiveness Evaluation
Solutia Nitro Facility, Nitro, West Virginia

Via email: mlhous1@solutia.com

EXECUTIVE SUMMARY

Solutia Inc. (Solutia) currently monitors groundwater quality in two groundwater units at the former Flexsys America L.P. site in Nitro, West Virginia. Groundwater at the site is impacted by various organic compounds. Solutia installed slurry walls around the three source areas at the site to isolate the sources and high-concentration groundwater. Based on a request from the EPA, Solutia seeks to demonstrate the effectiveness of the remedial measures by documenting inward head gradients across the slurry walls and decreases in groundwater concentrations in its monitoring wells. Solutia requested that GSI Environmental Inc. (GSI) evaluate and/or explain:

- features of the site that affect groundwater flow patterns;
- the rationale behind the location of pumping wells inside the slurry walls;
- the number and location of gradient monitoring wells needed to demonstrate an inward hydraulic gradient across the slurry walls;
- the number and location of wells that are likely to show the most rapid concentration decreases so that they might be included in the remediation effectiveness evaluation; and,
- the overall effects of the remediation systems on groundwater concentrations.

Several features, including the location of the site adjacent to the Kanawha River, the higher transmissivity of the lower part of the alluvial aquifer, the distribution of cross-wall gradients, and the relative changes in concentration all have an effect on the locations of wells (for both pumping and monitoring). Hydraulically, cross-wall gradients are higher on the downgradient sides of the barrier walls because the natural groundwater gradient is from the center of the site to the Kanawha River. As a result of this distribution, cross-wall gradient monitoring wells and pumping wells are best located along the downgradient side of the slurry walls. The final locations of the cross-gradient monitoring wells are shown in Figure 4.

Mass transport modeling using MT3D with the existing MODFLOW groundwater flow model has identified locations where groundwater concentrations are likely to show the

largest change over a 3-year period. However, the maximum concentration change for any of the new or existing wells is modest, so that dramatic changes in concentrations over the relatively brief 3-year effectiveness monitoring period are not expected. Rather, the trends in these concentrations are the more important factor in demonstrating the effectiveness of the remedial systems instead of the absolute magnitude of concentration changes. The final locations of the concentration monitoring wells are shown in Figure 14 and are listed at the end of this memorandum.

SITE FEATURES AND CONCEPTUAL MODEL

Several features of the Nitro site have a large effect on groundwater flow patterns and the effect of the barrier walls on these patterns. Perhaps the most obvious of these features is that the Nitro site is located on the eastern bank of the Kanawha River. Along this bank, the ground surface slopes steeply downward from a height of approximately 20 to 30 feet to the water surface. The Past Disposal Area (PDA) and the West Waste Treatment Area (WTA-W) are both located nearly adjacent to this bank.

Gradients within the slurry walls are small, so that the groundwater elevation within the walls is nearly flat. Because a significant gradient is needed to force water into and out of the source areas through the walls, groundwater mounds on the outside of the upgradient side of the walls, while groundwater on the downgradient side of the walls is lower than the groundwater elevation inside the source areas.

Figure 1 illustrates this effect in the absence of pumping within the walls, while Figure 2 shows how cross-wall gradients are affected by pumping. These head gradients are in Zone A, but cross-wall gradients in Zone B are similar. Note that although the model predicts three areas of inward cross-wall gradients under pumping conditions (Figure 2), particle tracking analyses indicate that no water actually escapes from the source areas at the design pumping rates.

PUMPING WELLS

The fact that the upgradient sides of the source areas tend to naturally exhibit an inward hydraulic gradient while the downgradient sides exhibit an outward hydraulic gradient suggests that pumping within the slurry walls near the downgradient wall will be most effective in creating an inward gradient. Flow modeling confirms that pumping wells are most effective when installed on the inside of the downgradient walls. Although the head differences within the walls are fairly small, there is a small gradient across the interior of the slurry walls. Pumping near the downgradient slurry wall lowers the head along the inside of the downgradient wall more than pumping in the middle or upgradient side, so that pumping is more efficient (rates are lower) if the wells are located near the downgradient wall.

As seen by comparing Figures 1 and 2, pumping within the walls has a large effect on the cross-wall gradients, preventing any water within the slurry walls from discharging to the Kanawha River. Even without any pumping in the slurry walls, the barrier walls have a large effect on the amount of water flowing into the Kanawha River from the source areas. With no pumping, the flow from within the barrier walls into the river is reduced by 99.65%. As the pumping rate increases, groundwater flow rates (and therefore, chemical

mass) is similarly reduced, by 99.85% at 1 gpm and upwards of 99.95% at 1.8 gpm. At the design pumping rate, the mass discharge is theoretically reduced by 100% (no mass discharged into river from within the slurry walls).

Although the barrier walls will substantially reduce the long-term mass flux into the Kanawha River, some impacted groundwater will continue to flow into the river in the short term because some affected groundwater is located outside of the barrier walls. However, since the source areas are now isolated by the barrier walls, and the highest concentrations of COCs are within the source areas, the long-term mass of COCs discharging to the river will be greatly reduced.

CROSS-WALL GRADIENT MONITORING WELLS

The greatest outward gradient (with no pumping) and smallest inward gradient (when pumping inside the slurry walls) occurs on the downgradient side of the slurry walls. The cross-section provided in Figure 3 shows this effect at the PDA. Note that the head difference across the upgradient barrier wall is significantly greater than the head difference on the downgradient side.

This fact suggests that any failure to maintain an inward hydraulic gradient will be detected first across the downgradient side of all of the barrier walls, where the head difference is already the least. By contrast, the mounding of groundwater on the exterior of the upgradient side of the slurry walls suggests that an outward gradient is unlikely to develop at that location, or that it would manifest itself only after outward gradients had occurred on the downgradient side of the source area walls.

The smaller cross-wall gradients occurring on the downgradient side of the barrier walls suggest that cross-wall gradient wells located on the downgradient walls would be leading indicators of gradient changes across the walls at other locations. Therefore, as shown in Figure 4, cross-gradient monitoring wells have been located along the downgradient wall sections in all source areas.

It is possible that, at some times of the year, the gradient across the slurry walls could reverse from inward to outward. The head in the Kanawha River is maintained at a constant elevation of 566 ft msl. If heavy rainfall creates an increased head in the bedrock aquifer recharge areas, the gradient across the site could increase because of the constant river stage. This increased gradient could raise bedrock aquifer heads inside the slurry walls. The effect would likely be greatest in the PA and WTA-E, which are located further from the river than the other two units. Such a gradient reversal would be expected to be temporary as heads in the bedrock aquifer subside.

The gradient across the walls could also reverse if the Kanawha River stage were lowered for a substantial period of time. The reduced river level would lower the groundwater elevations on all sides of the barrier walls. However, water levels in the adjacent Kanawha River are maintained by the US Army Corps of Engineers to provide a navigable waterway for recreation and commerce. The Nitro site is situated along the lower portion of the Winfield Locks pool where fluctuation in river operating levels is minimized. The flow within the Kanawha River is regulated by controlling discharges from three storage reservoirs situated within the watershed. These include

Summersville Lake (on the Gauley River), Sutton Reservoir (on the Elk River), and Bluestone Dam. Discharge flows from these facilities are regulated to maintain a minimum pool level. As a result, only rarely would the river levels drop significantly below the normal pool level of 566 feet representative of the Winfield pool.

Outward hydraulic gradients could also occur if there is localized poor contact between the barrier walls and the underlying bedrock surface so that underflow occurs beneath the walls, or if localized tears or rips in the cap liner allow substantial recharge within the barrier walls. Solutia has taken measures during construction of the barrier walls and will take measures during caps and covers installation to minimize these items.

For instance, installation of the barrier walls was based on an extensive subsurface exploration program to determine not only the depth of the underlying bedrock surface along the perimeter of the barrier walls, but also analysis of core samples from these areas. Numerous core samples were obtained, visually observed, and tested to determine appropriate depth of the barrier wall key excavation. During the excavation of the barrier wall keys, cuttings were compared to the samples collected to ensure that the walls were keyed into the bedrock at the proper depth.

The synthetic capping materials will be installed under a stringent quality assurance program. The quality assurance program will include visual observations of the capped surface prior to backfill, checking for any tears or defects to the material, as well as both field and destructive testing of the completed field welded seams. This construction quality assurance program will serve to minimize the potential for rips, tears, and leakage through the finished cap.

If necessary, pumping rates inside the barrier walls could be temporarily increased to compensate and maintain or re-establish an inward hydraulic gradient if any of the scenarios above were to develop.

To understand how seasonal variations in groundwater elevations affect cross-wall gradients, it is suggested that water level elevations be measured monthly for the first year. Based on this data, either semi-annual or quarterly monitoring should provide sufficient data to ensure that inward hydraulic gradients are being maintained. Monitoring times for subsequent monitoring can be set to coincide to times when cross-wall gradients are greatest and least.

CONCENTRATION MONITORING WELLS FOR EFFECTIVENESS EVALUATION

GSI evaluated the rate of concentration changes in the wells by performing mass transport simulations of chemicals present in the groundwater, and observing locations with the greatest rate of concentration decrease. The existing groundwater flow model developed for the site was used as a basis for the mass transport model. Historical concentration contour maps and current groundwater concentration data were used to establish initial concentrations of a subset of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and pesticides/herbicides/PCBs (PEST).

GSI used the Nitro site MODFLOW (McDonald and Harbaugh, 1983) groundwater flow model developed by GSI (GSI, 2011) as the basis for the monitoring well evaluation.

Estimated current concentrations of VOCs, SVOCs and PEST were input into the model. An MT3D (Zheng, 1990) mass transport simulation was then performed to determine the monitoring wells in which groundwater concentrations changed most rapidly following slurry wall construction.

It is important to note that this modeling exercise is conducted only for the purpose of estimating the *relative rate of concentration change* in monitoring wells. The simulation results are not intended for predicting actual concentrations of individual chemicals or chemical classes at particular locations at particular times, nor is this mass transport model suitable for such a purpose. Depictions of concentration plumes are provided only for comparison of concentration changes over the life of the simulations, and do not show the actual current distribution of chemicals in groundwater at the site.

Estimation of Current Concentrations

Concentration contour maps for total VOCs, total SVOCs, and total PEST from the 2003 site investigation (Potesta, 2003) were used in conjunction with the individual well concentrations to establish initial total concentrations. Concentration observation points were placed along the contour lines of the figures and treated as concentration observations. These concentration observations from the contour maps were combined with the well concentrations and imported into GMS (Groundwater Monitoring System, Build June 9, 2006; managed by Environmental Modeling Systems, Inc.) for interpolation into a continuous distribution of total VOC, SVOC, and PEST groundwater concentrations.

Because the site investigation concentration contour maps do not indicate a contour for a zero (or non-detect) concentration, an outer contour representing a zero concentration was created for each chemical class. The zero concentration contour was necessary to prevent interpolation and/or extrapolation of concentrations beyond a reasonable distance from source areas. The zero concentration contour was created at an approximate distance of 50 to 100 feet outside of the minimum contour shown for each chemical class. Concentration observation points at which the concentration was assumed to be zero were placed along these estimated zero concentration contours in the same manner as the points placed along the other concentration contours.

Well data from Zone A was combined with the contour map observation data to create the concentration datasets for model layer 1. Well data from Zone B was combined with the contour map observation data to create the concentration datasets for model layers 2 and 3. Concentration observations in wells northeast of the wastewater treatment areas were not used in the interpolations, and other isolated concentrations were similarly excluded from the datasets. Some adjustments to the concentration contour data points created from the site investigation contour maps were also made to accommodate concentrations observed in wells nearby but outside of concentration contours.

The concentration datasets were imported into GMS and interpolated to a 50-ft square grid using natural neighbor interpolation with a constant nodal function. The interpolated concentrations were exported from GMS and converted to a format consistent with the

Groundwater Vistas (GWV; Version 6.14, Build 16; created by Environmental Modeling Systems, Inc) site model.

Mass Transport Simulation Parameters

Mass transport simulations were performed with MT3D through the GWV interface. The interpolated total VOC, SVOC and PEST concentrations were imported into GWV and specified as initial concentrations. These three total concentrations were also specified as three "chemical species" in the MT3D model.

When transported in groundwater, organic chemicals adsorb to organic matter in the subsurface so that the rate of chemical transport is less than the rate of groundwater flow. The retardation factor (R) represents the factor by which chemicals in groundwater move slower than the groundwater itself. Because the VOC, SVOC, and PEST "species" actually consist of the total concentration of a number of different compounds, each with a different value of R, it was necessary to determine a representative value of R for the three compound classes. The representative value for each class was taken as the arithmetic average of the computed retardation factors for compounds within the class. The retardation factor for each compound was computed as:

$$R = 1 + \frac{\rho_b K_d}{n} \quad where\ K_d = f_{oc} K_{oc}$$

and: R = retardation factor (dimensionless);
ρ_b = soil bulk density (M/L^3);
K_d = soil/water partitioning coefficient (L^3/M);
n = total porosity (dimensionless).
f_{oc} = fraction of organic carbon in the aquifer (dimensionless);
K_{oc} = organic carbon/water partitioning coefficient (L^3/M).

MT3D uses a single porosity value to calculate both seepage velocity and the retardation factor. In reality, seepage velocity is a function of effective porosity while retardation is a function of total porosity. To correct for this characteristic of MT3D, the calculated K_d values were multiplied by the ratio of (n_e/n) so that the combination of seepage velocities and retardation factors correctly predict chemical velocities. The calculated K_d and R values for each of the three species and layers were:

Species	Layer 1	Layer 2	Layer 3
Kd (L/mg)			
VOC	0.098	0.179	0.004
SVOC	0.121	0.222	0.005
PEST	0.053	0.097	0.002
R (dimensionless)			
VOC	1.78	1.96	2.28
SVOC	1.96	2.19	2.59
PEST	1.42	1.52	1.7

Values of the parameters on which these K_d and retardation factors are based, and other mass transport parameters used for the mass transport simulations, were as follows:

Parameter	Layer 1	Layer 2	Layer 3
Organic carbon fraction	0.002	0.002	0.00005
Total porosity	0.4	0.35	0.01
Effective porosity	0.2	0.32	0.009
Bulk density	1.59	1.72	2.62
Longitudinal dispersivity	12	12	12
Transverse dispersivity	2.4	2.4	2.4
Vertical dispersivity	0.24	0.24	0.24

Mass transport simulations were run for a period of 3 years. Advective transport was simulated using the modified method of characteristics (MMOC). A Courant number of 0.5 was specified for automatic time step control in the mass transport simulations. All degradation rates were assumed to be zero over the short period of the simulations.

Identification of Locations Exhibiting Maximum Rate of Concentration Decrease

The VOC "species" was used to determine the locations of most rapid concentration changes. To determine the locations that would exhibit the greatest concentration change over the 3-year period, concentration observation points were placed throughout the VOC plume in the model. Figures 5 through 8 show the locations of greatest concentration changes in terms of percent change over the next 3 years for Zones A and B in the southern and northern areas of the site. The green "0s" indicate that concentrations increased at that location, while red negative numbers indicate a concentration decrease, with the number indicating the percent decrease.

As seen in Figures 5 through 8, concentration observation points placed immediately outside of the downgradient barrier walls generally do not show the most rapid concentration decreases. The reason for the slow concentration changes at these locations is that groundwater along the sides of the source areas, while outside of the source areas, still exhibits relatively high concentrations. This groundwater flows down the sides of the exterior of the barrier walls and converges on the downgradient exterior side, transporting fairly high concentrations of constituents to these locations. In addition, groundwater flow rates immediately downgradient of the walls are relatively low, so that only slow changes in concentrations are expected at these locations.

As an example, the flowpaths around the PA are shown in Figure 9. The lines trace the path of groundwater around the source area. The small arrows on the pathlines mark 10-year travel distances. As seen in the figure, flow lines converge on the downgradient side of the PA barrier wall. The time markers are also closer together at the downgradient wall, indicating slower groundwater flow. The small concentration changes on the outside of the downgradient barrier walls is confirmed by the concentration changes provided in Figures 5 through 8.

An exception may be observation points downgradient of the WTA-E source area. Several observation points outside of the downgradient wall at this unit exhibit fairly large concentration changes. At this location, the initial high concentrations in the groundwater are displaced by lower concentrations flowing along the walls of the WTA units.

The greatest concentration changes are predicted to occur in observation points in which initial concentrations were high but where upgradient concentrations are lower. The largest concentration changes in high-concentration locations may be partially an artifact of the interpolation process, which tends to decrease concentrations as the distance from the high-concentration points increases. Generally, the simulations predict that concentrations in observation points on the upgradient edge of the plumes will decrease more rapidly than locations in the center of the plume.

Figures 10 through 13 show the names of the observation points that exhibit the concentration changes illustrated in Figures 5 through 8. Figure 14 shows the location of the observation points that are likely to be most useful for effectiveness monitoring, using both the modeling results and professional judgment. These wells are listed below:

Wells Exhibiting the Most Rapid Concentration Change (Based on VOC Concentrations)	Source Area	New or Existing
CMW-11-A/B	PDA	New
CMW-41-A/B	WTA-E	New
CMW-52R-A/B*	PDA	New
CMW-59-A/B	PA/PDA	New
GW-13A/B	WTA-W	Existing

* Location CMW-52R-A/B is slightly northwest of the CMW-52-A/B to accommodate site limitations.

These wells are supplemented by the existing concentration monitoring wells at the site. Although concentrations are expected to change only slowly at the site, sufficient data must be collected over the 3-year period to detect concentration trends. Quarterly monitoring of the monitoring wells is suggested to ensure that enough data is collected to provide a statistically significant measure of concentration changes in the wells.

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GSI, 2011. Groundwater Model Development and Flow Simulations, Solutia Nitro Site Nitro, West Virginia, GSI Environmental Inc., September 9, 2011.

McDonald and Harbaugh, 1983. A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model, Michael G. McDonald and Arlen W. Harbaugh, USGS Open-File Report 83-875, 1983.

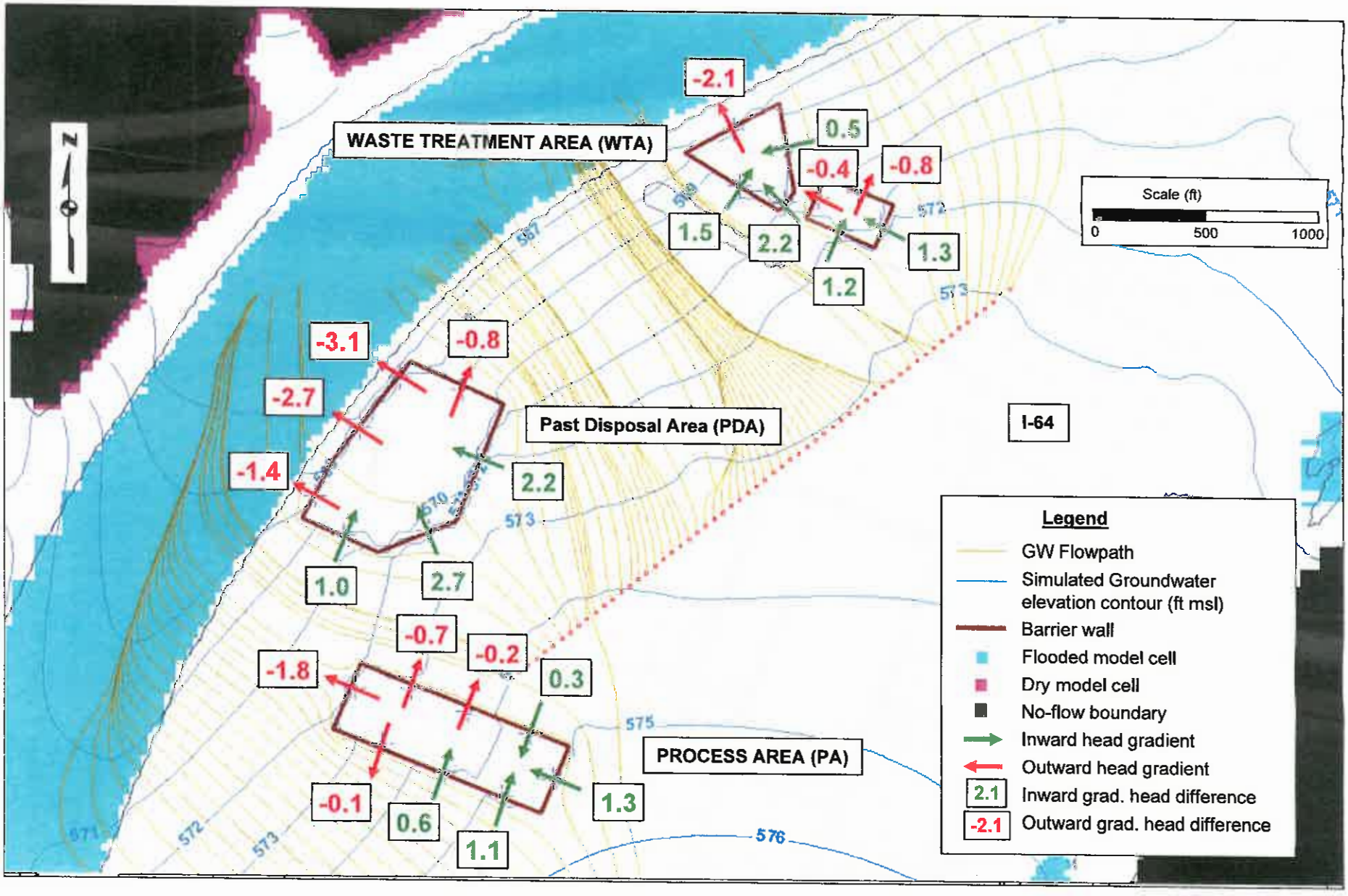
Potesta, 2003. Site Investigation of the Former Flexsys America I.P., Nitro, West Virgina Facility, Potesta & Associates, Inc. December, 2003.

Zheng, C., 1990. MT3D, A modular three-dimensional transport model for simulation of advection, dispersion, and chemical reactions of contaminants in groundwater systems, Report to the Kerr Environmental Research Laboratory, US Environmental Protection Agency, Ada, OK.

GSI Job No. G-3559
6 March 2013

GSI ENVIRONMENTAL

Figure 1
Simulated Gradient Across Slurry Walls with Caps in Place; No Pumping



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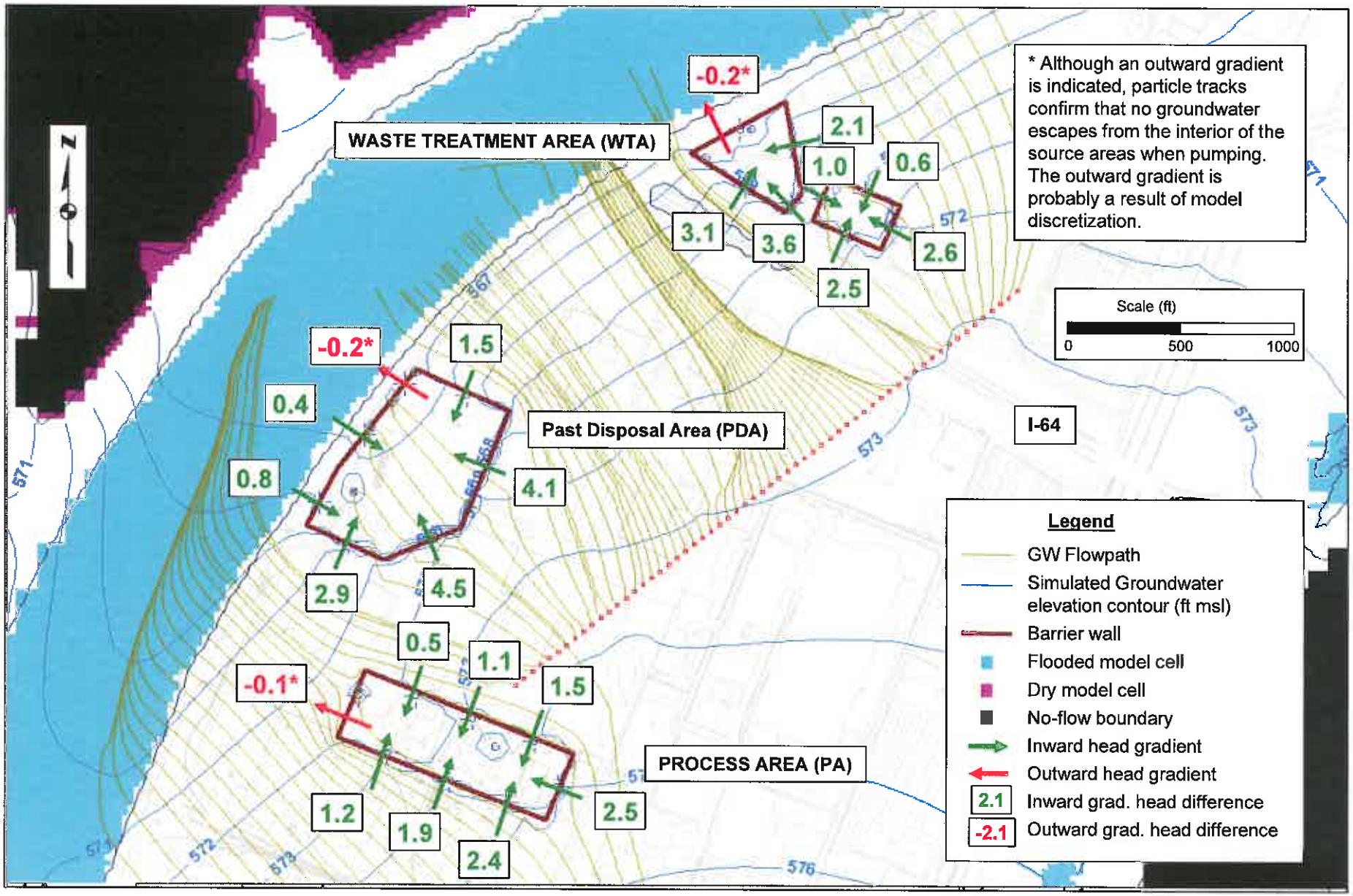
6 March 2013

GSI ENVIRONMENTAL

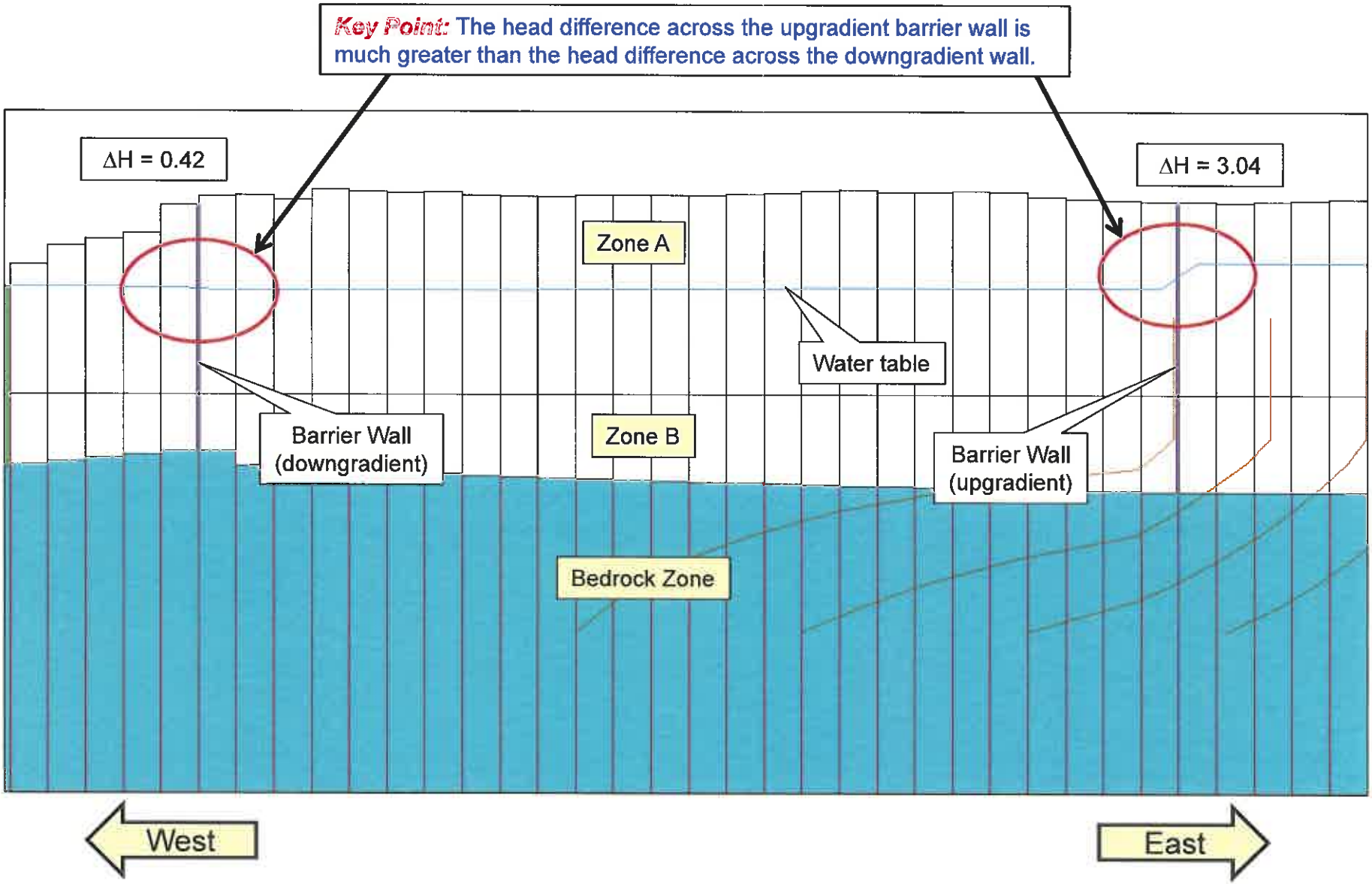
Figure 2
Simulated Gradient Across Slurry Walls with Caps in Place; with Pumping Inside Barrier Walls



GSI Job No. G-3559
6 March 2013

GSI ENVIRONMENTAL

Figure 3
Cross-Sectional View of Simulated Water Table Across PDA at Model Row 194



GSI Job No. G-3559
6 March 2013

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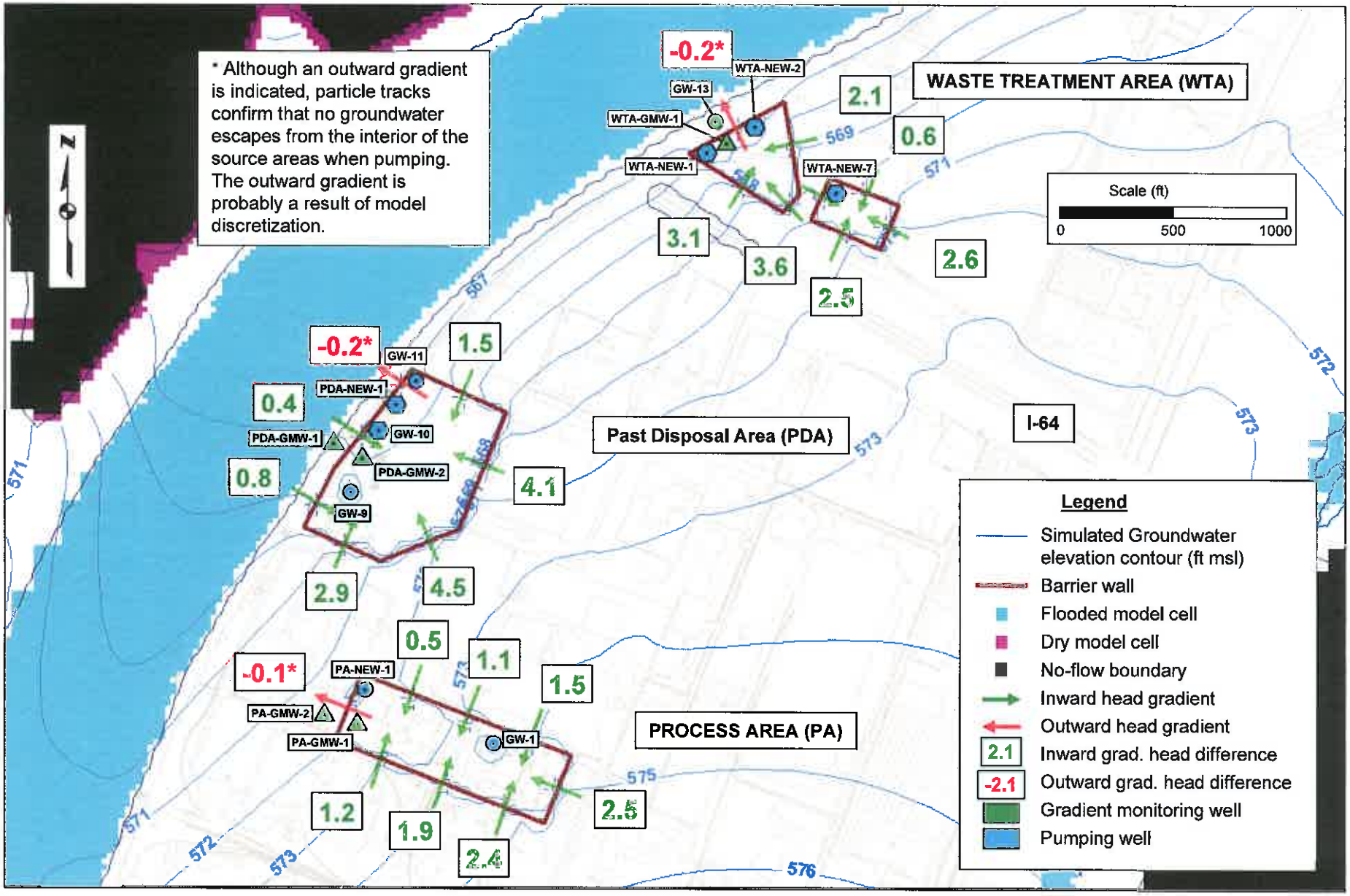
Figure 4
Current Proposed Cross-Barrier Gradient Monitoring Locations



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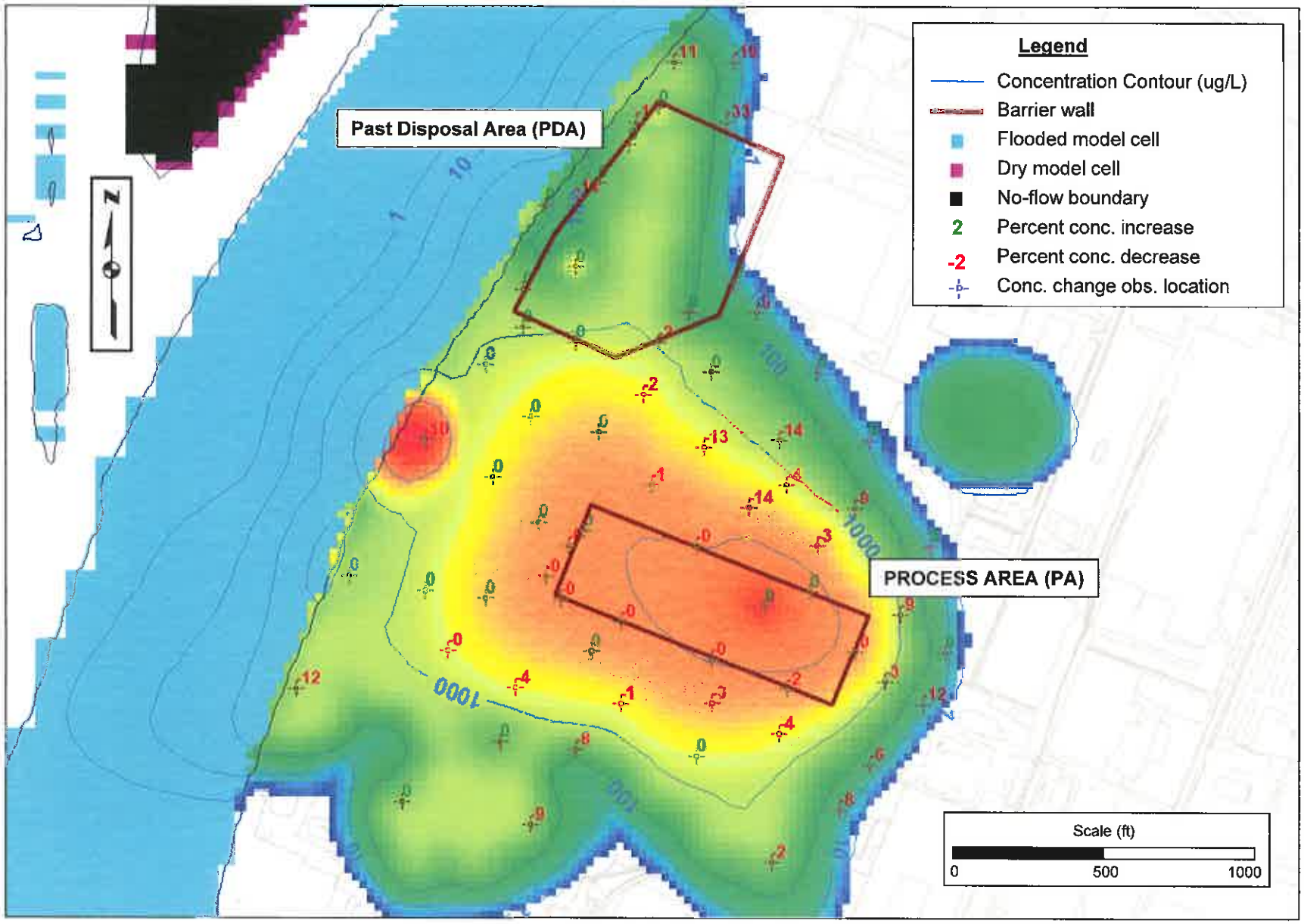
6 March 2013

GSI ENVIRONMENTAL

Figure 5
Simulated Percent VOC Concentration Change in Zone A Over 3 Years at the PDA and PA



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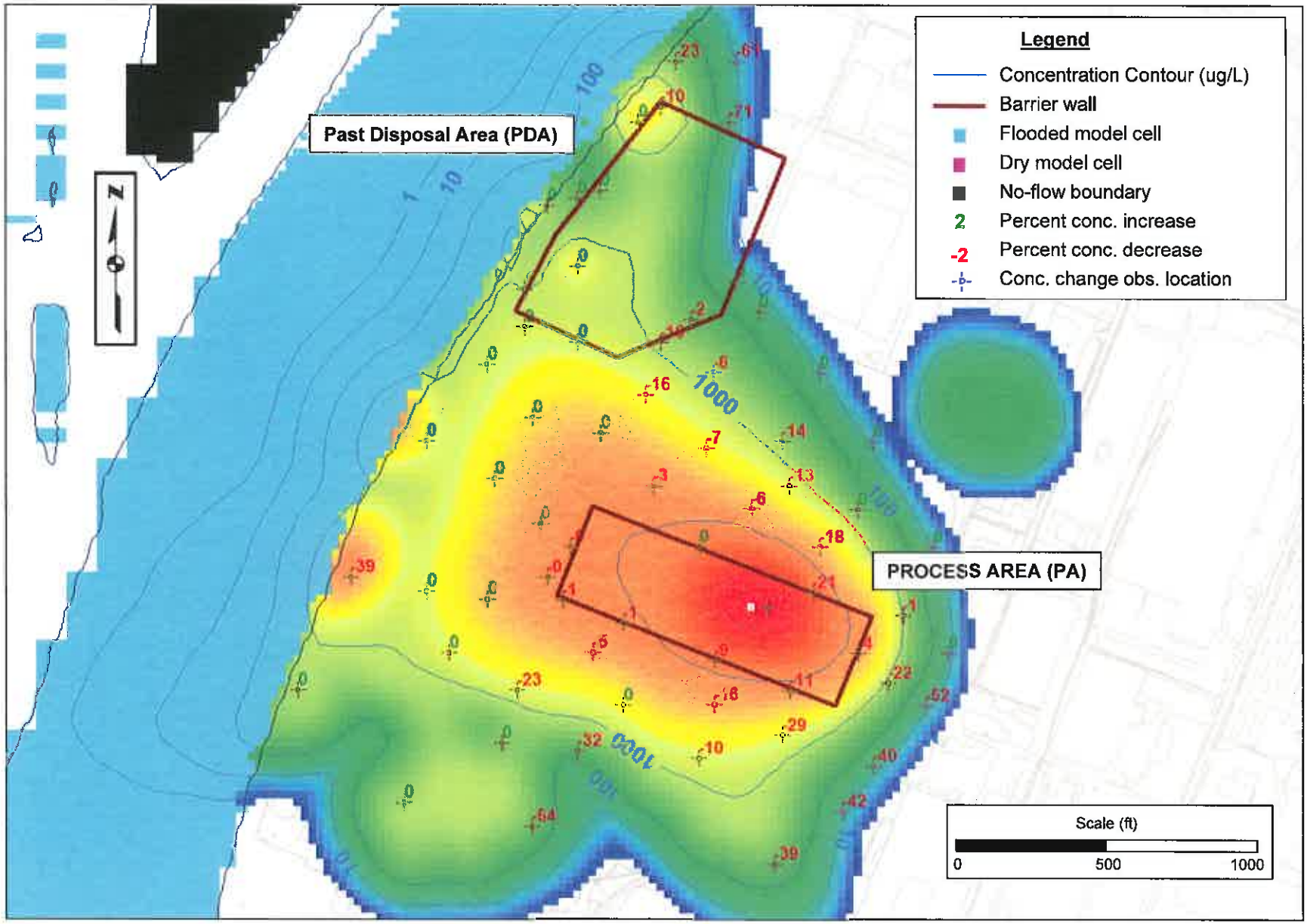
6 March 2013

GSI ENVIRONMENTAL

Figure 6
Simulated Percent VOC Concentration Change in Zone B Over 3 Years at the PA and PDA



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6 March 2013

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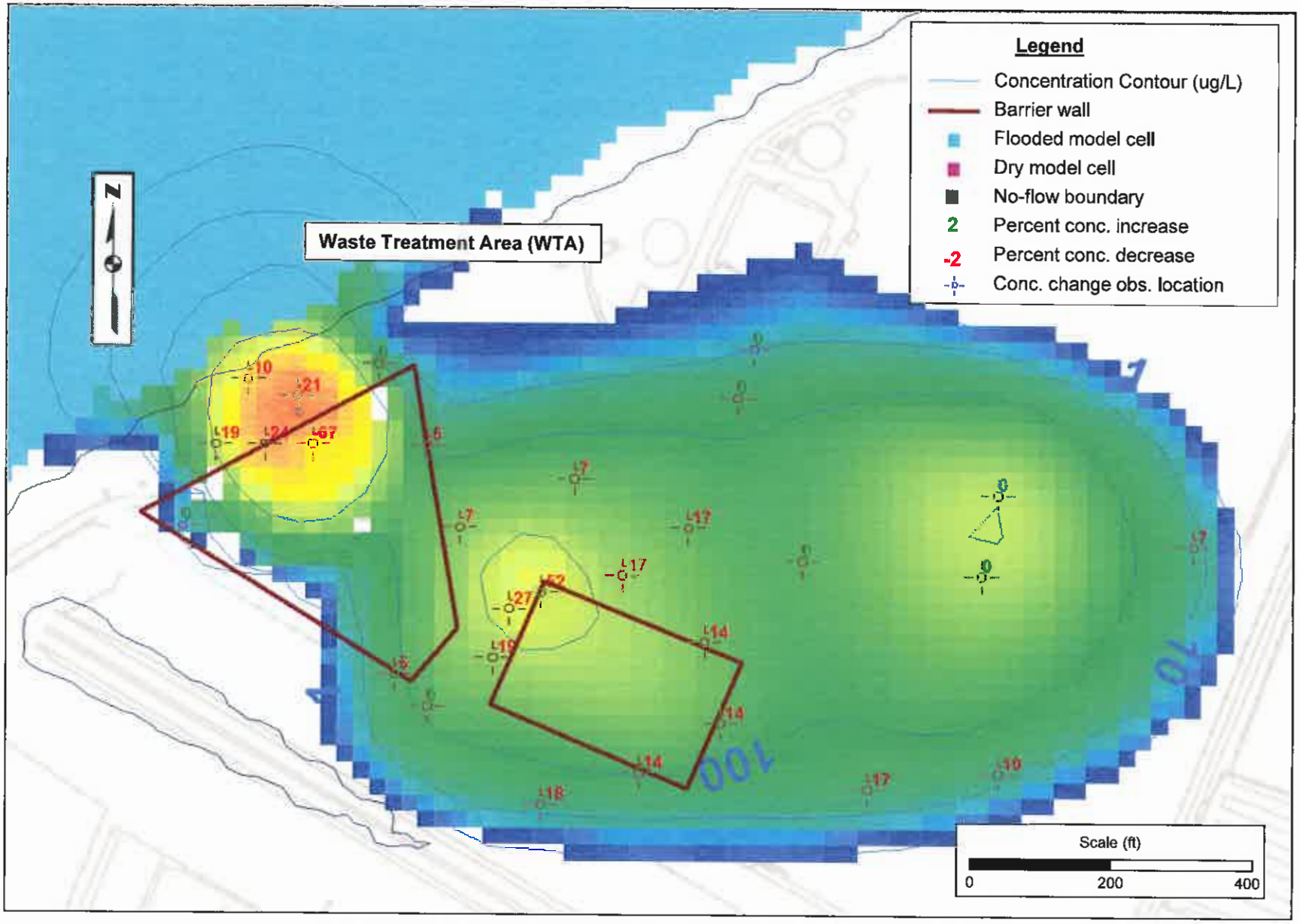
Figure 7
Simulated Percent VOC Concentration Change in Zone A Over 3 Years at the WTA



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6 March 2013

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Figure 8
Simulated Percent VOC Concentration Change in Zone B Over 3 Years a the WTA

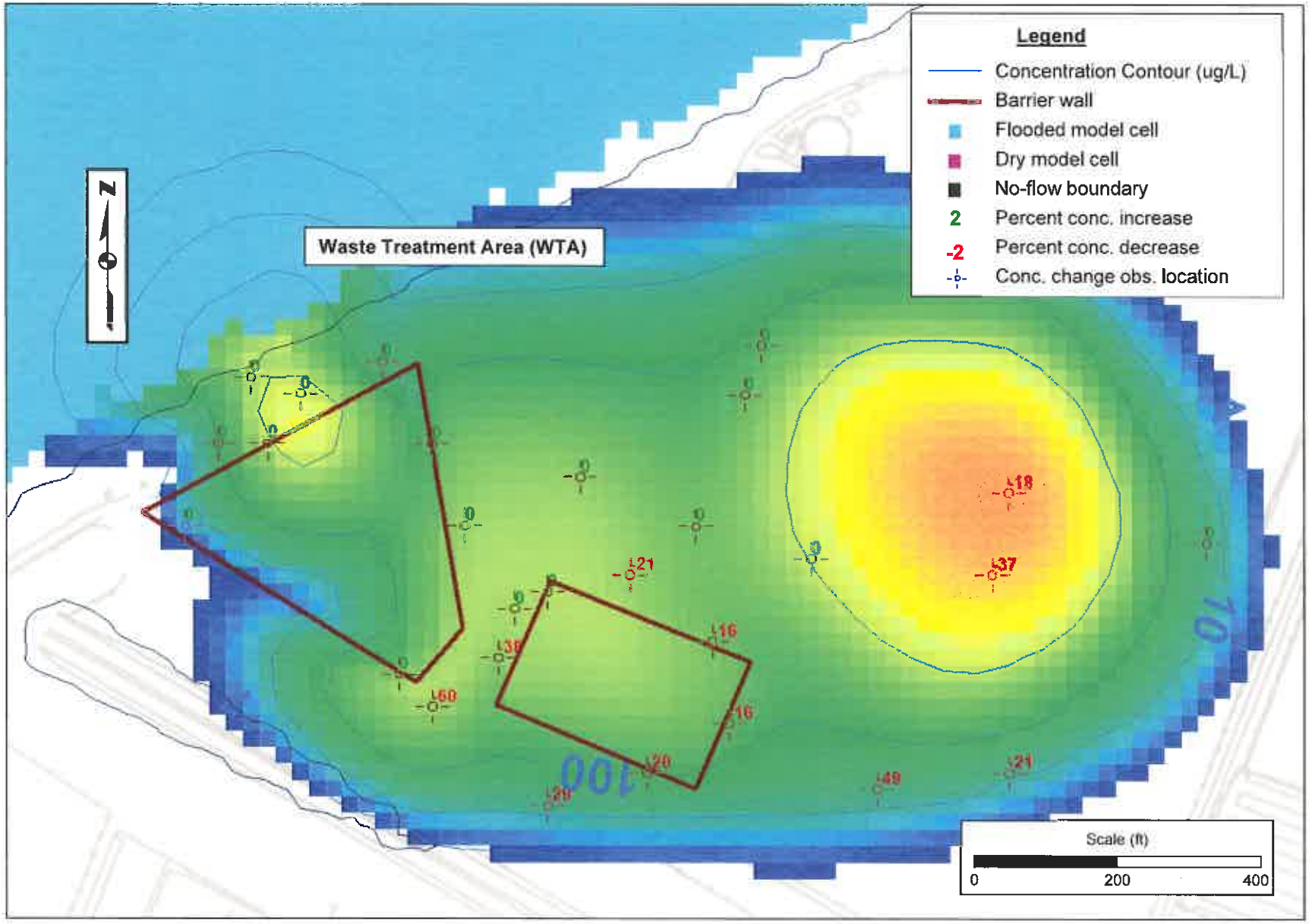

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Figure 9
Simulated Groundwater Flow Path Around Barrier Walls of the PA
With Time Markers at 10-Year Intervals

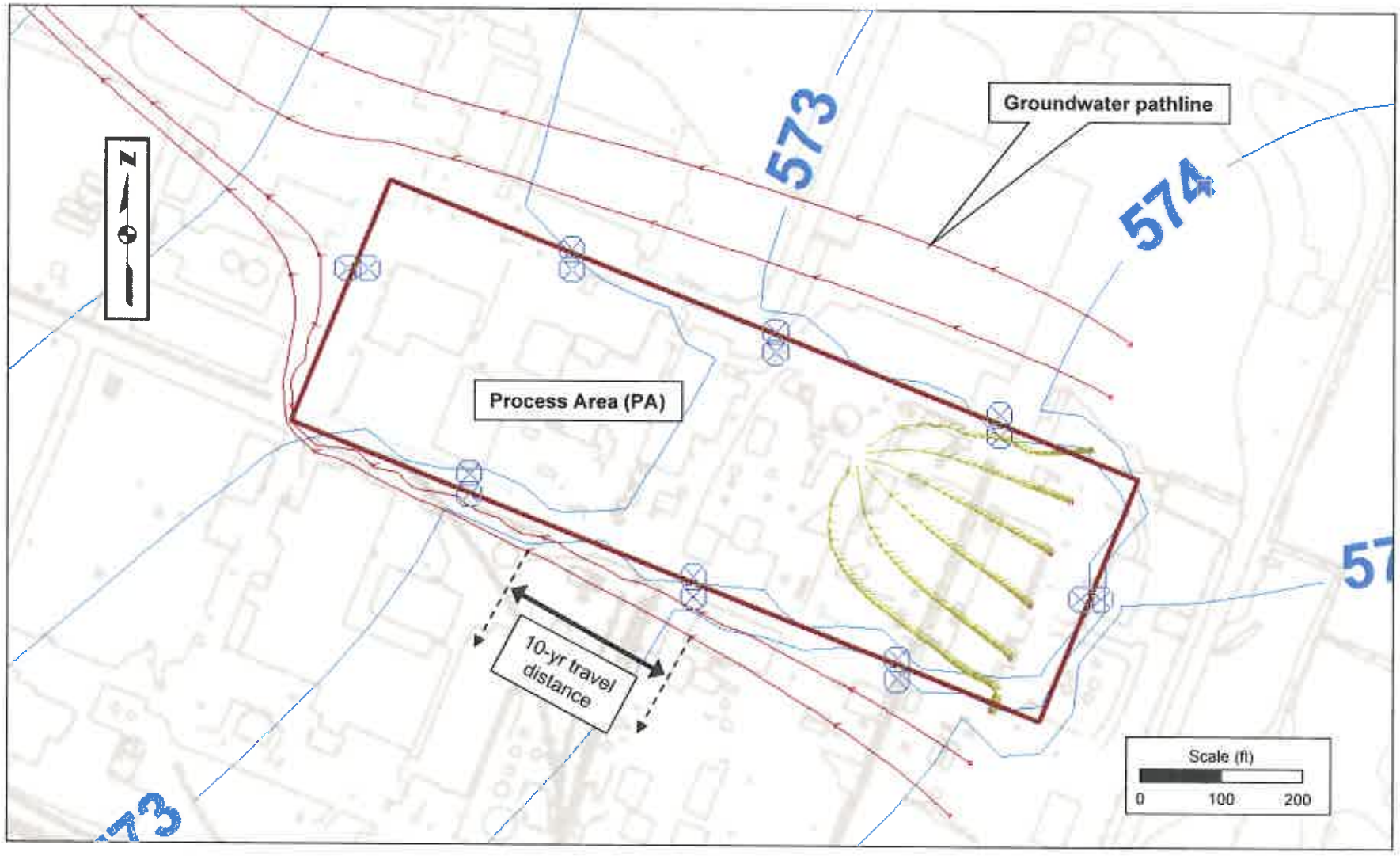

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Figure 10
Location of Wells Corresponding to VOC Concentration Changes in Zone A at the PDA

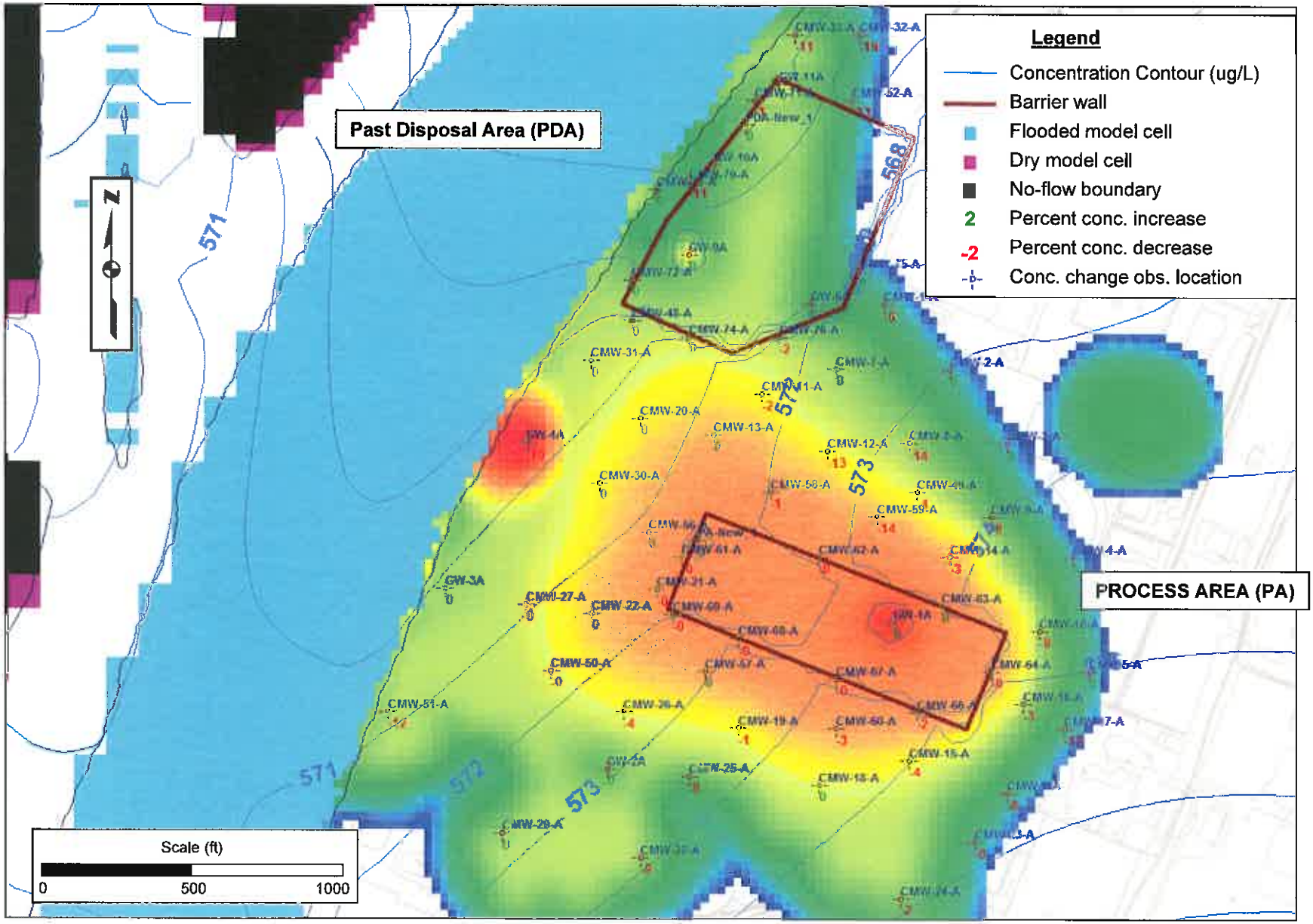

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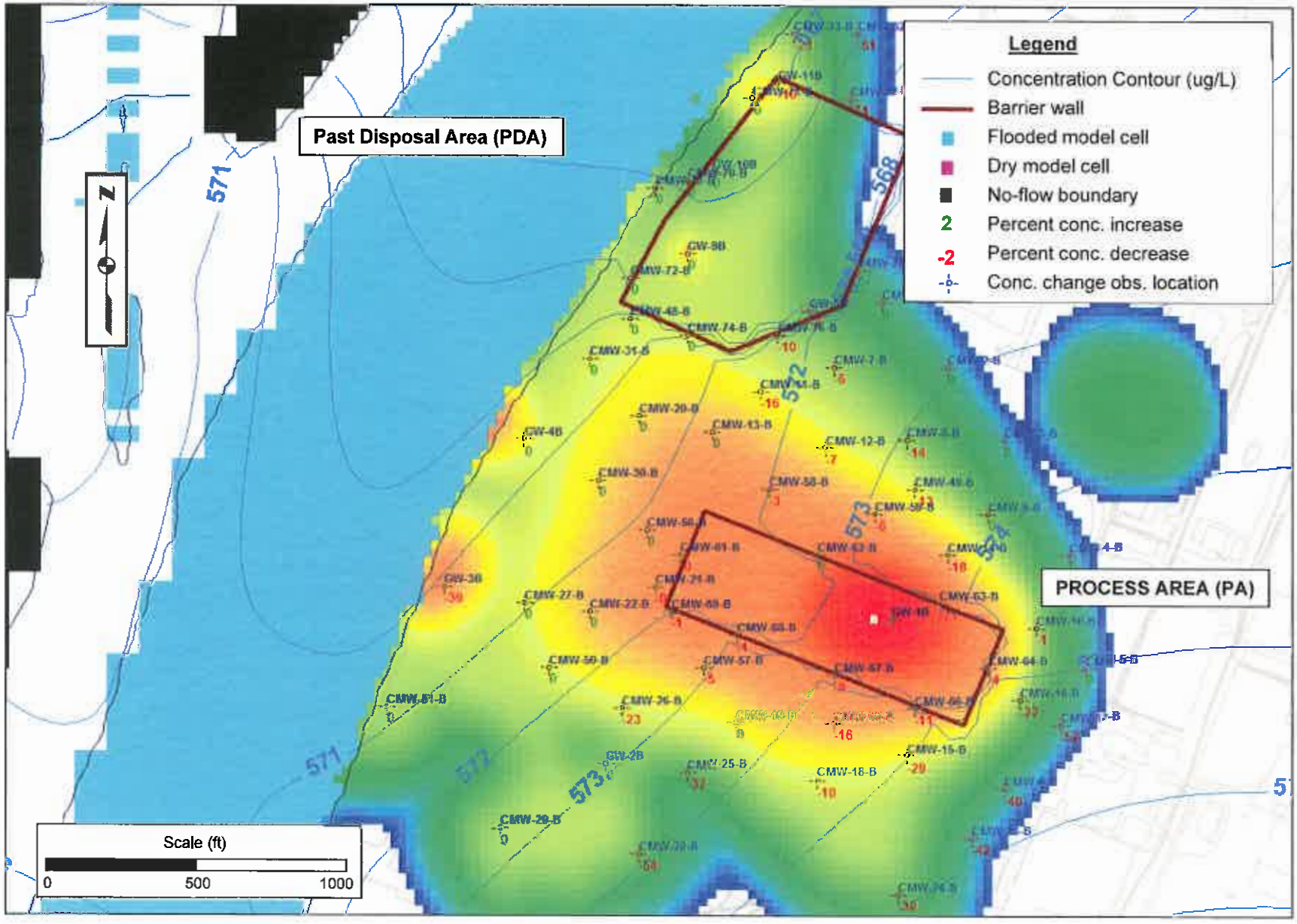
Figure 11
Location of Wells Corresponding to VOC Concentration Changes in Zone B at the PDA



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6 March 2013

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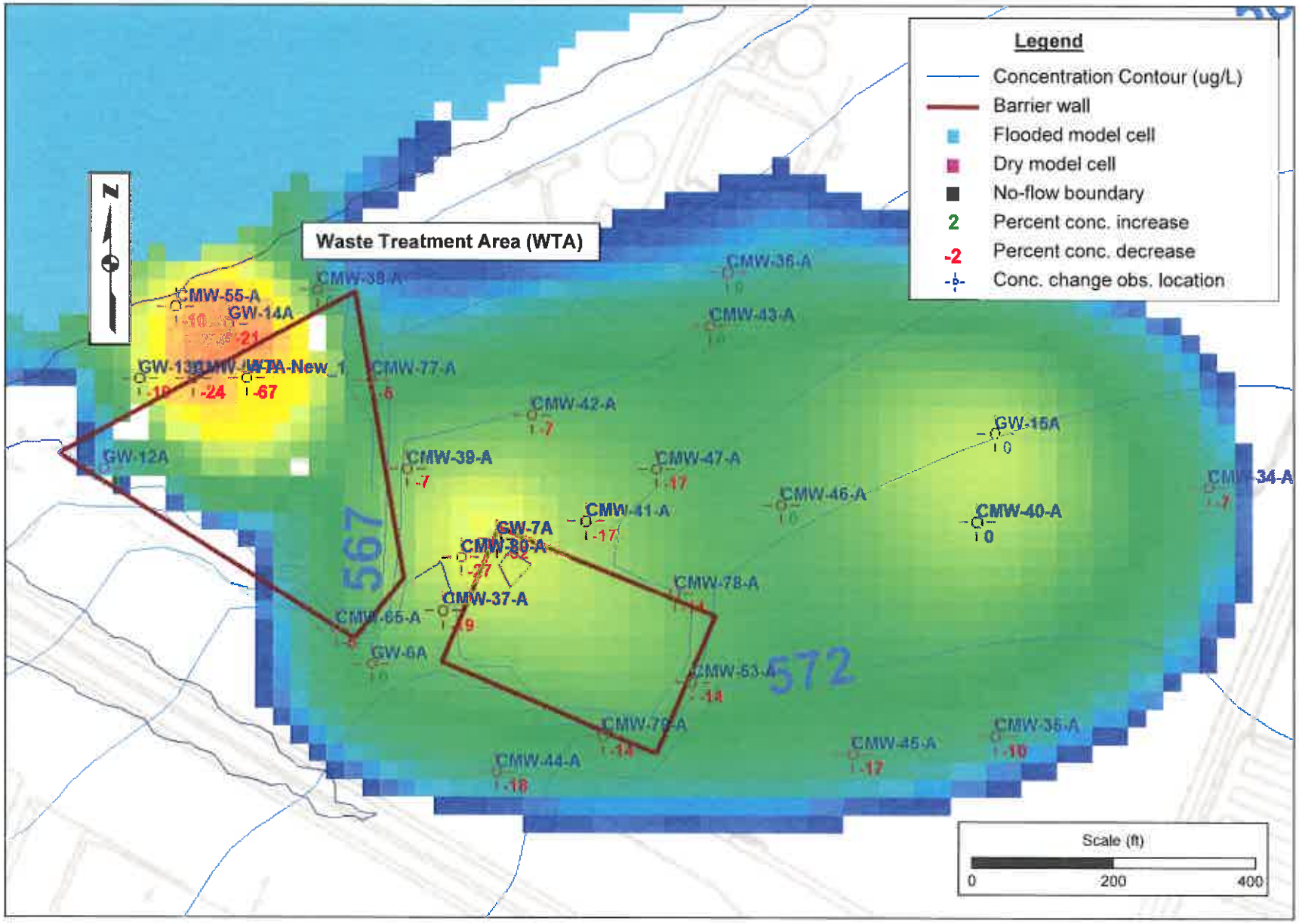
Figure 12
Simulated Percent VOC Concentration Change in Zone A Over 3 Years at the WTA



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6 March 2013

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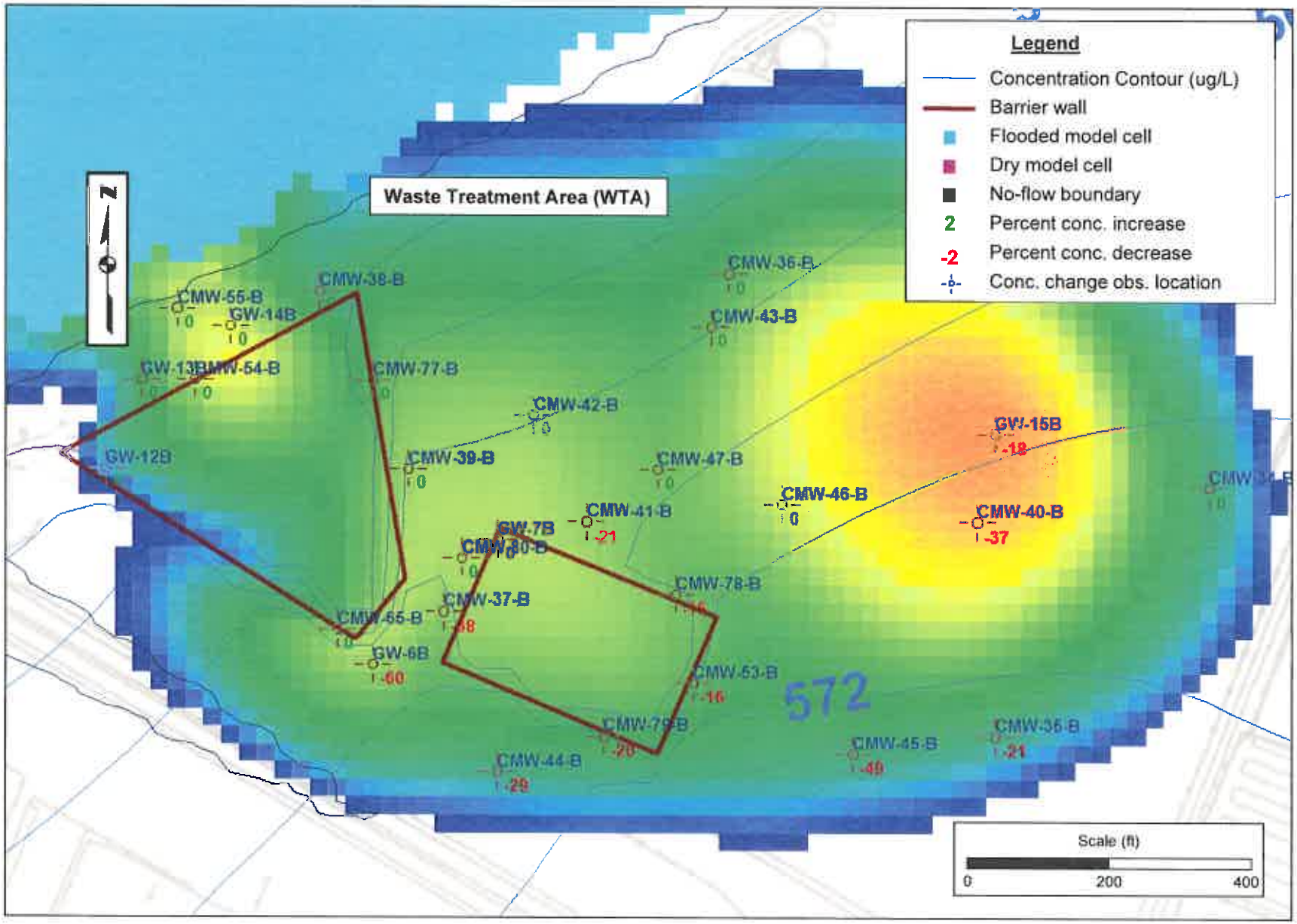
Figure 13
Simulated Percent VOC Concentration Change in Zone B Over 3 Years a the WTA



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6 March 2013

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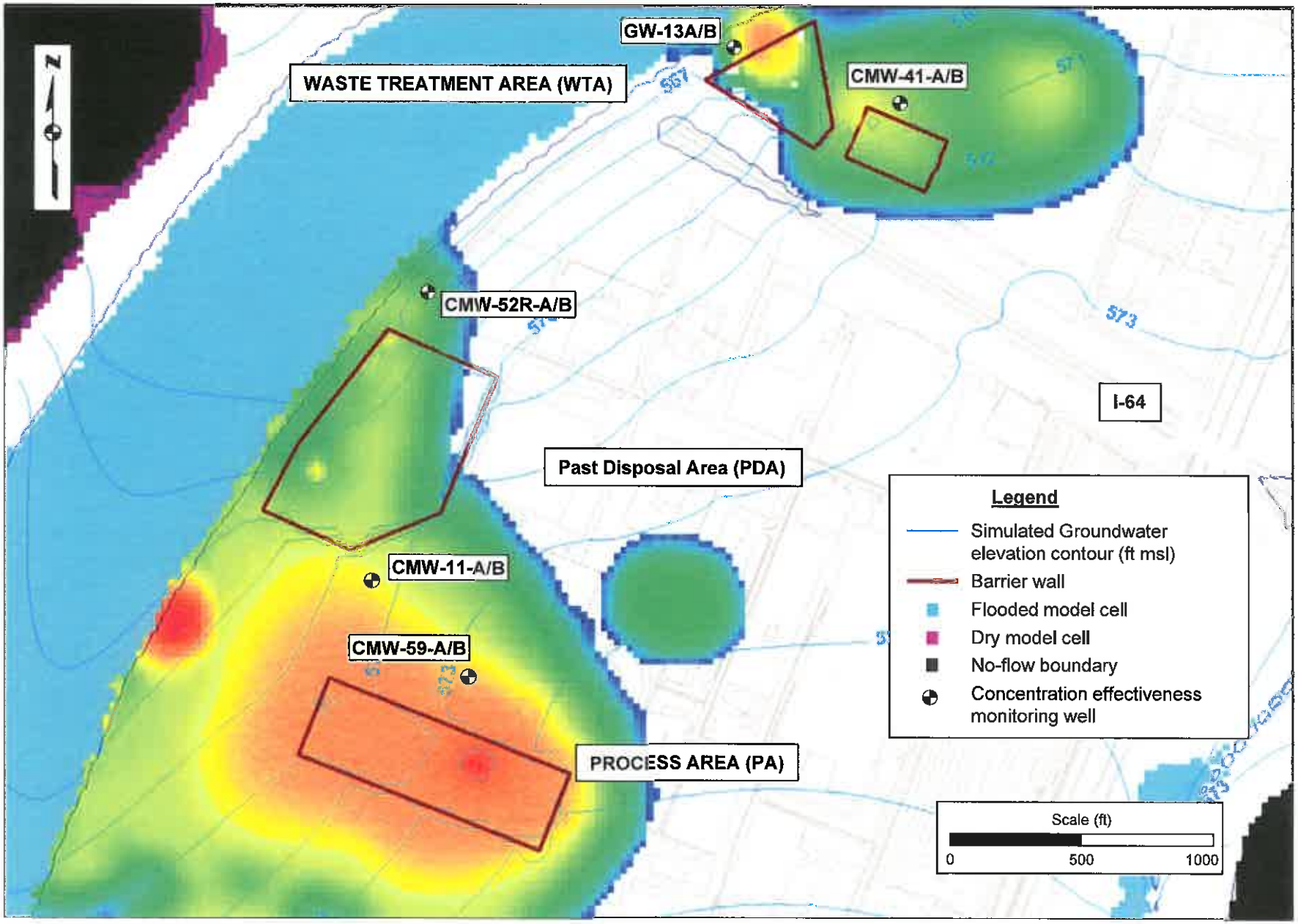
Figure 14
Proposed Locations of Concentration Wells for Effectiveness Monitoring



APPENDIX B

QUALITY ASSURANCE PROTECTION PLAN FOR EFFECTIVENESS MONITORING PLAN

Solutia Inc. Nitro Site
Nitro, West Virginia

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Project No. 0101-01-0081-700C

March 11, 2013

POTESTA

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QUALITY ASSURANCE PROTECTION PLAN
For
INTERIM MEASURES EFFECTIVENESS MONITORING PLAN

Solutia Inc. Nitro Site
Nitro, West Virginia

1.0 EXECUTIVE SUMMARY

The procedures for gathering and use of data is consistent with practices presented in the Quality Assurance Protection Plan (QAPP) document was submitted under separate cover and has been written as a reference document for the ongoing investigative work to be completed at the Site under the facility RCRA Corrective Action permit.

This QAPP integrates technical and quality aspects of the Interim Measure (IM) Effectiveness Monitoring Plan (EMP). The QAPP describes how quality assurance (QA) and quality control (QC) will be applied to the collection and evaluation of environmental data so that the results are of the type and quality needed. The QAPP addresses the procedures and practices developed so that information, data, and decisions derived from, or based on, data acquired during the IM-EMP for the Solutia Inc. (Solutia) site located in Nitro, West Virginia (Site) are technically sound, valid, and properly documented.

The QAPP was developed from guidance provided in *EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5* (March 2001), prepared by the United States Environmental Protection Agency (USEPA), and addresses project management and Measurement/Data Acquisition.

The QAPP provides a mechanism for collecting the samples and evaluating the quality of data acquired. Data collected during the project will form the basis for evaluating improvement in groundwater quality as a result of the Interim Measures. The appropriate control of field and analytical procedures and the assurance that data are representative and valid are important for successful evaluation of the Interim Measures.

2.0 PROJECT MANAGEMENT

2.1 Project Contacts

The key contacts for the monitoring plan and regulatory agencies responsible for oversight of the Interim Measures evaluation are listed below. The project contact list is the same as the distribution list for the project.

Solutia Project Manager/ Owner Contact:	Mr. Michael House Manager, Remedial Projects Solutia, Inc. 675 Marysville Centre Drive St. Louis, Missouri 63141 Telephone: (314) 674-6717 Email: Mlhous1@solutia.com
POTESTA Project Manager:	Mr. Michael Light Chief Engineer Potesta & Associates, Inc. 7012 MacCorkle Avenue, SE Charleston, West Virginia 25304 Telephone: (304) 342-1400 Fax: (304) 343-9031 Email: mlight@Potesta.com
USEPA Contact:	Mr. Bill Wentworth Waste and Chemicals Management Division (3WC23) USEPA Region III 1650 Arch Street Philadelphia, Pennsylvania 19103 Telephone: (215) 814-3184 Email: Wentworth.William@epamail.epa.gov
WVDEP Contact:	Mr. Thomas L. Bass West Virginia Department of Environmental Protection Office of Environmental Remediation 601 57th Street, SE Charleston, West Virginia 25304-2345 Telephone: (304) 926-0499 ext. 1274 Fax: (304) 926-0457 Email: Thomas.L.Bass@wv.gov

3.0 PROJECT OVERVIEW

The IM-EMP was prepared pursuant to the Site Resource Conservation and Recovery Act (RCRA) Corrective Action Permit, I.D. WV039990965 (Permit), Section E.2, "Interim Measures." The IMs presented in the Interim Measures Work Plan were installed as part of the continuing RCRA Corrective Action program to address Site soils and groundwater. The IM-EMP was developed to be initiated following implementation of the IMs, to assess the effectiveness of the IMs toward achievement of the objectives for Site environmental media.

3.1 Site Description

The Site, formerly known as Flexsys America L.P. (Flexsys) Nitro, West Virginia, is located along the eastern (right-descending) bank of the Great Kanawha River (Kanawha River), approximately one-half mile north of the City of Nitro in Putnam County, West Virginia (Figure 1, **Appendix A**). The Site is a former chemical manufacturing plant, which began production of various chemical compounds in the early 1910s and continued until mid-2004. From mid-2004 through December 2005, all operating facilities were shut down, decommissioned and dismantled to grade.

The Site encompasses approximately 122 acres and is divided into two separate areas by Interstate 64: 1) a southern area encompassing approximately 76 acres, which was the former Process Area (PA) and; 2) a northern area, encompassing approximately 46 acres, which was the former Wastewater Treatment Area (WTA) and included the wastewater treatment plant and several wastewater impoundments.

Characterization information on soils, groundwater, sediments and surface water obtained during performance of RCRA Facility Investigation at the Site has been used to divide the Site into the following four areas to facilitate development of the Conceptual Site Model.

- Area 1 - Source Areas
- Area 2 - Former Manufacturing Areas
- Area 3 - Non-Manufacturing Areas (Parking, Administration, Warehousing and Undeveloped Land
- Area 4 - Riverbank

Interim Measures were designed based on the Site characterization information and approved by the Agencies as appropriate to achieve Site environmental media objectives.

3.1.2 Historical Site Use

Chemical production began at the Site in 1918 when the United States Government started producing smokeless powder (nitrocellulose) for use in World War I. Nitrocellulose production ended in 1921 when the Site was purchased by the Rubber Services Company and used for the manufacturing of chloride, phosphate and phenol compounds. Monsanto Company (Old Monsanto) purchased the facility in 1929 from Rubber Services Company and added the manufacture of flotation agents, pickling inhibitors, anti-oxidants, anti-skinning, wetting agents, and oils to the existing production operations in the 1930s.

Old Monsanto continued to expand operations at the Site and accelerated its growth in the 1940s, including the production of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) and sodium trichlorophenoxyacetic acid. A byproduct of the production of 2,4,5-T is the creation of 2,3,7,8 tetrachlorodibenzo-para-dioxin (TCDD). TCDD has been detected in surface soils at the Nitro Site. Production of the herbicide 2,4,5-T was initiated at pilot scale during the summer of 1948; plant scale production began in October 1948 in Building 34. As the demand for the herbicide

increased during the Vietnam War, a new integrated facility in Building 92 was constructed and came online in August 1963. Production of the herbicide continued until demand for the product eased and production ceased at the Site in 1969. Several of the units associated with the production of the herbicide were decontaminated, demolished and buried on site during the early 1970s.

The manufacturing of rubber chemicals initially comprised about 65 percent of the Site's operations. The product line was diversified with new additions over the years, including the aforementioned herbicide production and an animal feed nutritional additive in addition to rubber chemicals including vulcanization accelerators, vulcanization inhibitors and anti-oxidants for miscellaneous rubber products. A variety of raw materials were used in the multiple chemical production processes carried out at the Site over the years, including inorganic compounds, organic solvents, and other organic compounds.

All production operations, maintenance and facility management of the Nitro plant were transferred to Flexsys in 1995. This transfer agreement included the entire Site and substantially all of the assets except the improved real estate and certain limited manufacturing assets. The RCRA Permit was modified (Class I modification) to reflect the change in permittee status from Old Monsanto to both Old Monsanto and Flexsys. In 1997, Old Monsanto spun off its chemical businesses to a newly created company called Solutia Inc. (Solutia). The equity acquired by Solutia included Old Monsanto's interest in Flexsys, including the Nitro facility, as well as Old Monsanto's solely owned assets and liabilities at the Nitro Site. Assets included the real Site property while liabilities included responsibility for RCRA Corrective Action. In 2000, Old Monsanto entered into a merger and changed its name to Pharmacia Corporation (Pharmacia). Also in 2000, New Monsanto, based on the previous agricultural division of Pharmacia was incorporated as a standalone subsidiary of Pharmacia. In 2002, New Monsanto was spun from Pharmacia as a separate company. Pharmacia became a subsidiary of Pfizer in 2003.

In October 2003 Flexsys made a business decision to cease all chemical production at the Nitro facility. Activities began during the second quarter of 2004 to dismantle, decontaminate, and remove all surface structures including the wastewater treatment plant facility. Demolition was completed in December 2005. Interim Measures implementation is in progress and is scheduled to be completed in 2015. The IM-EMP will begin upon completion of the IM installation.

3.2 Groundwater Monitoring

Periodic, representative groundwater samples will be collected from each EMP well location after appropriate purging. Temperature, pH, and specific conductivity will be measured in the field during the work to determine purge water stability before groundwater sampling.

INTERIM MEASURES GROUNDWATER SAMPLING
ANALYTICAL PARAMETERS AND METHODS

Target Compound List	Method
TCL Volatile Organic Compounds	5035/8260B

Target Compound List	Method
TCL Semi-Volatile Organic Compounds Plus Aniline and N-Nitrosodiphenylamine	8270C
TCL Inorganics	6010-7470-9012
2,4-D Herbicide	8151

All groundwater samples will be collected in containers provided by Test America (TA), a West Virginia certified laboratory. The provided containers will be pre-cleaned and appropriately preserved for shipment at the laboratory. Industry approved and accepted collection methods will be strictly adhered to during all sampling events. Samples from each well, using dedicated downhole pumps, will be collected directly from the in-well pump discharge following water purging.

A 250-milliliter (ml) plastic container with HNO_3 will be used for the collection of TCL inorganic samples analyzed as dissolved metals. The dissolved metals sample will be field filtered using a 0.45-micron inline filter during collection of the sample. A 250-ml plastic container with NaOH will be used for the collection of cyanide samples. One 1-liter amber glass jar will be collected for the 2,4-D herbicide extraction. Two 1-liter amber glass jars will be used for the collection of the TCL SVOCs, aniline and N-Nitrosodiphenylamine samples. Three 40-ml glass vials with HCL as a chemical preservative will be used for the collection of TCL-VOCs. Groundwater samples will be shipped to TA in a cooler (maintained @ 4°C), with proper chain-of-custody documentation. All samples will be transferred to TA for analysis at their Savannah, Georgia facility.

4.0 MEASUREMENT/DATA ACQUISTION

The groundwater samples will be collected on the frequency and analyzed for the parameters which were identified and discussed in Section 3.2 of the Interim Measures Effectiveness Monitoring Plan.

Field equipment to be used includes:

- Sample containers (laboratory provided)
- Before collecting samples the sampler will don a new pair of disposable nitrile gloves.
- Field replicate and laboratory QC samples will be collected.

4.1 Decontamination Procedures

Decontamination procedures will be followed prior to and during site sampling activities. Sampling procedures will utilize new, and laboratory supplied sampling bottles. In the event that reusable sampling equipment is utilized at the site, such as sampling pumps, field testing equipment, etc. The equipment will be decontaminated between individual sample collection events as follows:

- Wash with a non-phosphate biodegradable detergent and water solution,
- Rinse with distilled water,
- Rinse with methanol or hexane,
- Final rinse with distilled water, and
- Air dry.

4.2 Sample Handling and Custody Requirements

The laboratory will provide appropriate sample containers and the shipping containers (shuttles). Sample containers and preservatives used will conform to EPA SW-846 protocol. Samples requiring refrigeration will be shipped at approximately 4° C.

POTESTA will securely affix sample labels to the sample containers. Sample labels will identify the particular sample, and include the following additional information:

- Site name and designated project number,
- Sample identification number,
- Date and time the sample was collected,
- Sample preservation method,
- Analysis requested, and
- Sampling location.

POTESTA will maintain samples in accordance with the following chain-of-custody guidelines. A sample is under custody when it is:

- In a person's physical possession,
- In view of that person after he/she has taken possession,
- Secured by that person so that no one can tamper with the sample, or
- Secured by that person in an area that is restricted to authorized personnel.

A chain-of-custody record will be maintained from the time of sample collection until final deposition. Custody transfers will be noted and signed with a copy of the record being kept by the individual who endorsed it. At a minimum, the chain-of-custody will include the following information:

- POTESTA's name and address,
- Sample identification number,
- Sample location,
- Sample collection date and time,
- Sample information (i.e., matrix, number of sample containers, container type, etc.),
- Names and signatures of samplers, and
- Signatures of individuals who have had custody of the samples.

POTESTA will securely seal shuttles for shipment using custody seals. The custody seals will be used to demonstrate that a sample shuttle has not been tampered with or opened during shipment. The individual who has sample custody shall sign, date and affix the custody seal to the sample shuttle in such a manner that it cannot be opened unless it is broken. When samples are not under direct control of the individual responsible for them, they will be stored in a shuttle, which will be affixed with a custody seal.

POTESTA will place samples in an appropriate, dedicated transport shuttle. The shuttles shall be dedicated to transport samples associated with the project during transport of project samples. Sample containers will be packed with ice to maintain a temperature of 4° C. Temperature blanks will be added to shuttles prior to shipment. Once sample collection is complete, sample documentation will be placed in a resealable plastic bag, which will then be placed inside the shuttle. POTESTA will then affix a custody seal to the shuttle. The samples will be transported directly to the laboratory by the sampler or laboratory service within 24 hours of sample collection, or an overnight delivery service will by utilized within 24 hours of sample collection. When the shuttle is received in the laboratory, the laboratory sample custodian will use the temperature blanks to measure and document the temperature within the shuttles.

4.3 Analytical Method Requirements

The key laboratory personnel for this project will be the laboratory project manager. The laboratory project manager will be responsible for execution of the analytical testing program and data processing. The laboratory project manager will be the primary point of contact for the laboratory services coordinator. The laboratory QA Director is responsible for processing QA data and seeing that laboratory internal QA procedures are followed.

The laboratory will dispose of samples following analysis in accordance with pertinent federal, state, and local laws and ordinances.

TA will analyze the samples collected during the project. POTESTA has obtained copies of TA's Laboratory Quality Manuals and incorporates these manuals by reference into this QAPP. Standard laboratory turnaround time is 14 working days.

4.4 Quality Control Requirements

POTESTA will verify QA/QC by maintaining site logs, documenting field activities, and by analysis of QA/QC samples. POTESTA will collect and analyze QA/QC samples to assess laboratory performance and gauge the likelihood of cross-contamination associated with both field and laboratory activities. QA/QC samples include replicate samples (co-located soil, split soil, and duplicate water), field rinsate blanks, matrix spike/matrix spike duplicates, and trip blanks.

TA will provide its Level III QA/QC report for the laboratory analytical data in a CLP Type Format. The CLP format will follow EPA guidelines for reporting the following where applicable:

- Case Narrative

- QC Summaries
  - Method/Reagent Blanks
  - Calibration (Initial and Continuing)
  - Matrix Spikes and Spike Duplicates
  - Sample and Sample Duplicates
  - Surrogate Percent Recoveries
  - Internal Standards and Retention Time Summaries
  - GC/MS System Performance Checks
  - GC Confirmations
  - Tentatively Identified and Identified Compound Summaries
  - Raw Data (e.g., bench sheets, sample printouts, chromatograms, tracking reports, and shipping bills.)

4.5 Replicate Samples

The collection of replicate samples allows for the evaluation of the laboratory's performance by comparing the analytical results of two samples derived from the same source. Sample locations for replicate samples will be selected to ensure collection of representative samples and sufficient sample volume to fulfill QA/QC protocols. One replicate sample will be collected for each 20 samples obtained, or one per sampling event, if the event is less than 20 samples. Co-located (field replicates) samples for VOC analyses will be collected at the same time and location as the true sample. POTESTA will label replicate and co-located samples as independent samples so that they will not be identifiable by the laboratory.

Replicates of water samples will be obtained by alternately filling sample containers from the sampling device for each parameter to be evaluated. If sample bottles are filled directly, then the sample container for each set of parameters will be alternately filled.

4.6 Trip Blanks

A trip blank will be included with the sample shuttle received from the laboratory. The purpose of the trip blank is to evaluate the potential for cross-contamination between samples in the sample shuttle during sample collection and shipment. Trip blanks will be kept in the sample shuttles throughout the sample collection process. Upon return to the laboratory, the trip blanks will be analyzed for the VOCs associated with the sampling event.

4.7 Matrix Spike/Matrix Spike Duplicate

Field personnel will collect one MS/MSD per 20 samples collected, or one per sampling event, if the event is less than 20 samples. MS/MSD samples will be submitted at a frequency of one per 20 field samples collected. MS/MSD samples are used to assess analytical accuracy in terms of recovery. This type of sample is also used to measure the effects that the sample matrix may have on analytical methods (usually recovery). The laboratory will add predetermined quantities

(*i.e.*, known concentration) of certain analytes prior to analysis. The laboratory will split the sample into duplicates, spike the samples, and then analyze the samples. The relative percent difference between the samples is calculated and used to assess recovery accuracy.

4.8 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

Field instruments will be calibrated daily prior to use. Field technicians will record the calibration results on log forms. Equipment that fails to calibrate properly will not be used until the problem has been corrected. Leased equipment will be returned to the supplier for repair.

4.9 Instrument Calibration and Frequency

POTESTA will implement a calibration program so that routine calibration and maintenance is performed on field instruments. Field team members familiar with field calibration and equipment operation will maintain instruments by performing the calibration procedures outlined in the appropriate operation and field manuals.

4.10 Inspection/Acceptance Requirement for Supplies and Consumables

Site workers are responsible to examine supplies and consumables for potential contamination prior to use. Contaminated supplies and consumables shall not be used and will be discarded in designated waste containers.

4.11 Data Management

Personnel involved in the chain-of-custody and transfer of samples will be trained on the procedures and their importance and purpose prior to sampling initiation. Corrections or revisions to sample documentation shall be made by lining or striking through the original entry and initialing changes. The following subsections outline sample documentation procedures that will be used by POTESTA during this project.

A field logbook will be assigned to this project and will be maintained throughout the project. The field logbook is a descriptive notebook detailing site activities and observations so that an accurate and factual account of field procedures may be reconstructed. Field logbook entries will document the following:

- Site name and project number;
- POTESTA name and address;
- Names of personnel on-site;
- Dates and times of entry;
- Descriptions of relevant site activities, including site entry and exit times;
- Noteworthy events and discussions;
- Weather conditions;
- Site observations;
- Identification and description of samples and locations;

- Subcontractor information and names of on-site personnel;
- Dates and times of sample collections and chain-of-custody information;
- Site sketches (if needed); and
- Relevant and appropriate information delineated in field data sheets and sample labels.

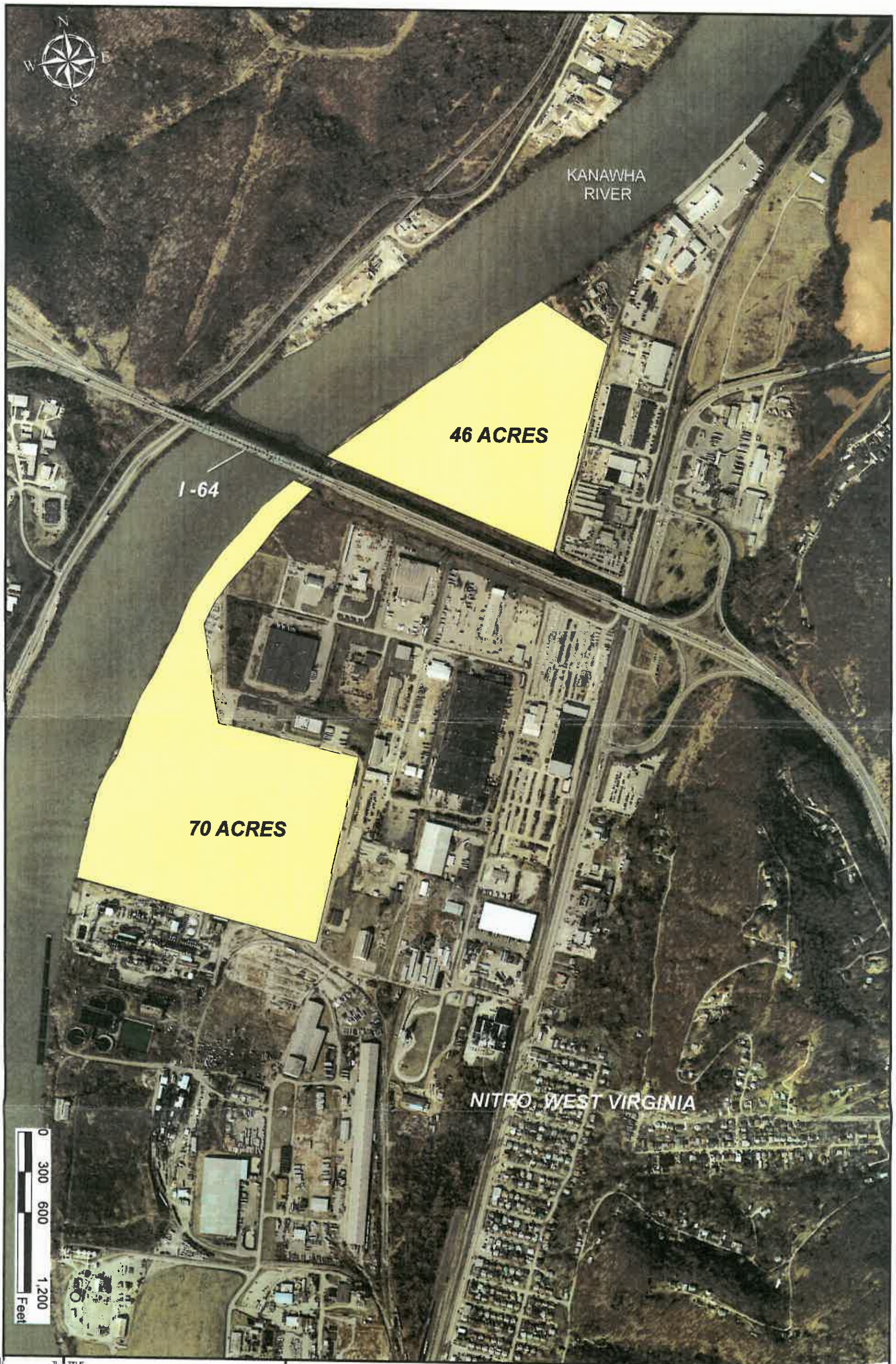
Field measurements and observations will be recorded in the project logbook.

Data collected during the sampling activities, including field and laboratory activities, will be recorded, reduced, reviewed, and reported. POTESTA will perform these functions for field sample data. The laboratory is responsible for recording, reducing, reviewing, and reporting the corresponding analytical results.

5.0 PROJECT REPORT

As required by the EMP Work Plan, annual IM-EMP reports will begin the first year following completion of the IM installation. The annual IM-EMP report will summarize the groundwater sampling results from the previous year and assess progress toward achievement of IM objectives. The report will include a summary of the laboratory analytical data results compared to their respective Region III Residential RBCs, including a trend of those results from previous years' results.

APPENDIX A



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				PROJECT NO.: 01-0081	APPROVED: RRP
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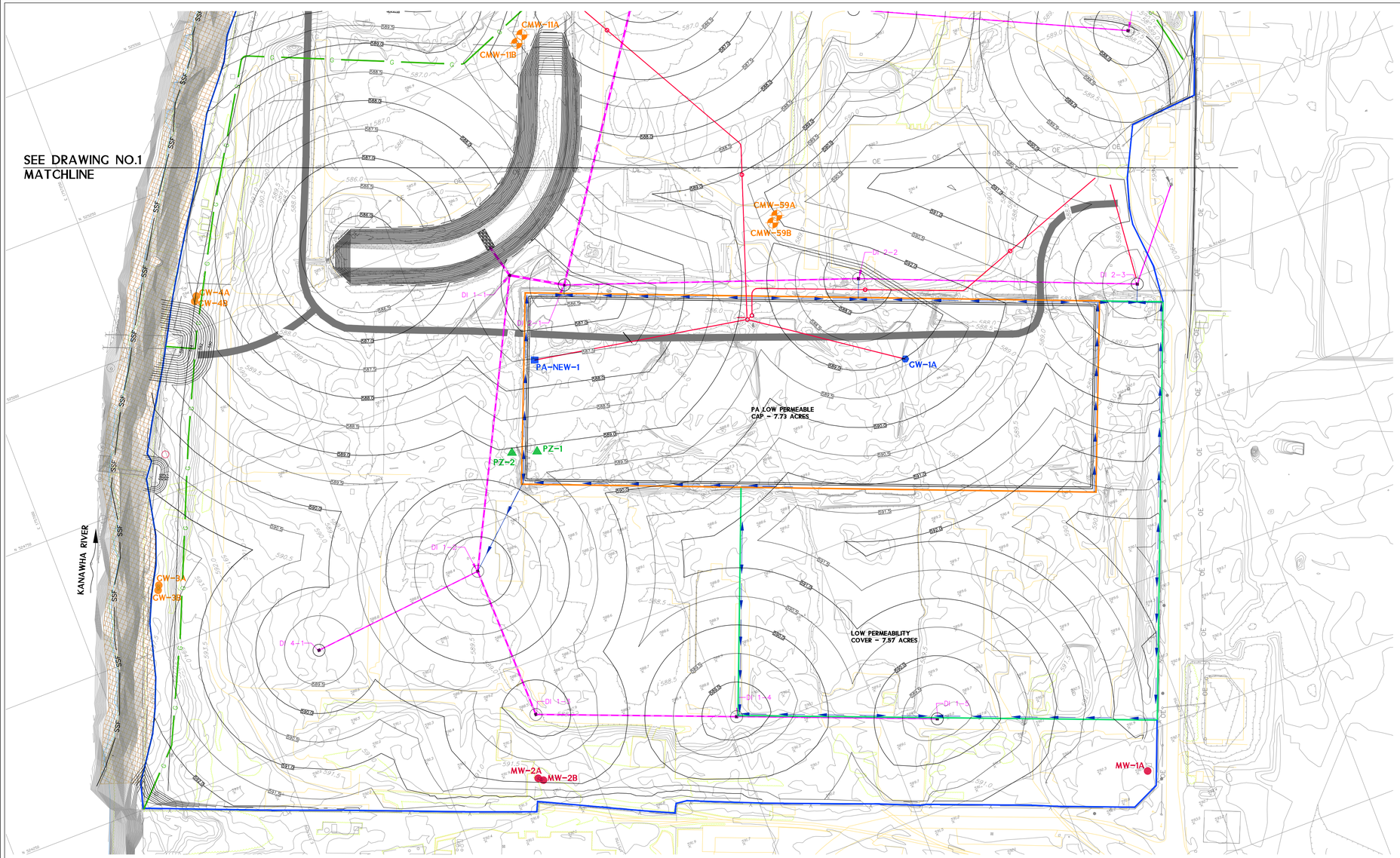
APPENDIX C



No.	Date	Revision

LEGEND

- PROPOSED DROP INLET
- PROPOSED STORM DRAIN LINE (CPP)
- PROPOSED LIMIT OF PERMANENT PERMEABLE COVER
- PROPOSED LIMIT OF LOW PERMEABILITY COVER
- PROPOSED LIMIT OF LOW PERMEABILITY CAP
- PROPOSED CAP SYSTEM UNDERDRAIN
- PROPOSED GENERAL FILL SURFACE GRADE OR SUBGRADE
- EXISTING FENCE
- EXISTING GAS PIPELINE
- SF — PROPOSED SILT FENCE
- SSF — PROPOSED SUPER SILT FENCE
- G — RELOCATED GAS PIPELINE
- STONE SURFACED ACCESS ROAD
- VEGETATION
- CMW-41A,B — PROPOSED/NEW CONCENTRATION EFFECTIVENESS MONITORING WELL
- GW-4A,4B — PROPOSED/EXISTING CONCENTRATION EFFECTIVENESS MONITORING WELL
- PZ-1 — PROPOSED PIEZOMETERS
- MW-2A,B — EXISTING GROUNDWATER MONITORING WELL
- GW-9A — PROPOSED/EXISTING GROUNDWATER EXTRACTION WELL
- PDA-NEW-1 — PROPOSED/NEW GROUNDWATER EXTRACTION WELL

GRAPHIC SCALE

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MAPPING REFERENCE:
BASE MAPPING SHOWN ON THIS DRAWING WAS PREPARED BY KEDDAL AERIAL MAPPING BASED ON AERIAL PHOTOGRAPHY DATED FEBRUARY 22, 2012.

PRELIMINARY

ISSUE DATE 3/25/13

-WELLS
CAD File No.
MBS
Drawn
CAG
Checked
CAG
Approved
NOTED
Scale:
MARCH 2013
Date:
01-0081-700C
Project No.

POTESTA & ASSOCIATES, INC.
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POTESTA

Client
SOLUTIA, INC.
ST. LOUIS, MISSOURI

Title
LOCATION PLAN-PA AREA
RCRA INTERIM MEASURES
EFFECTIVENESS MONITORING PLAN

1
Drawing No.

XREF Files: 01-0081-700C-BASE
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Date/Time: Fri Aug 03, 2018 - 8:57am
Plot Date/Time: Aug 23, 2018 - 8:57am
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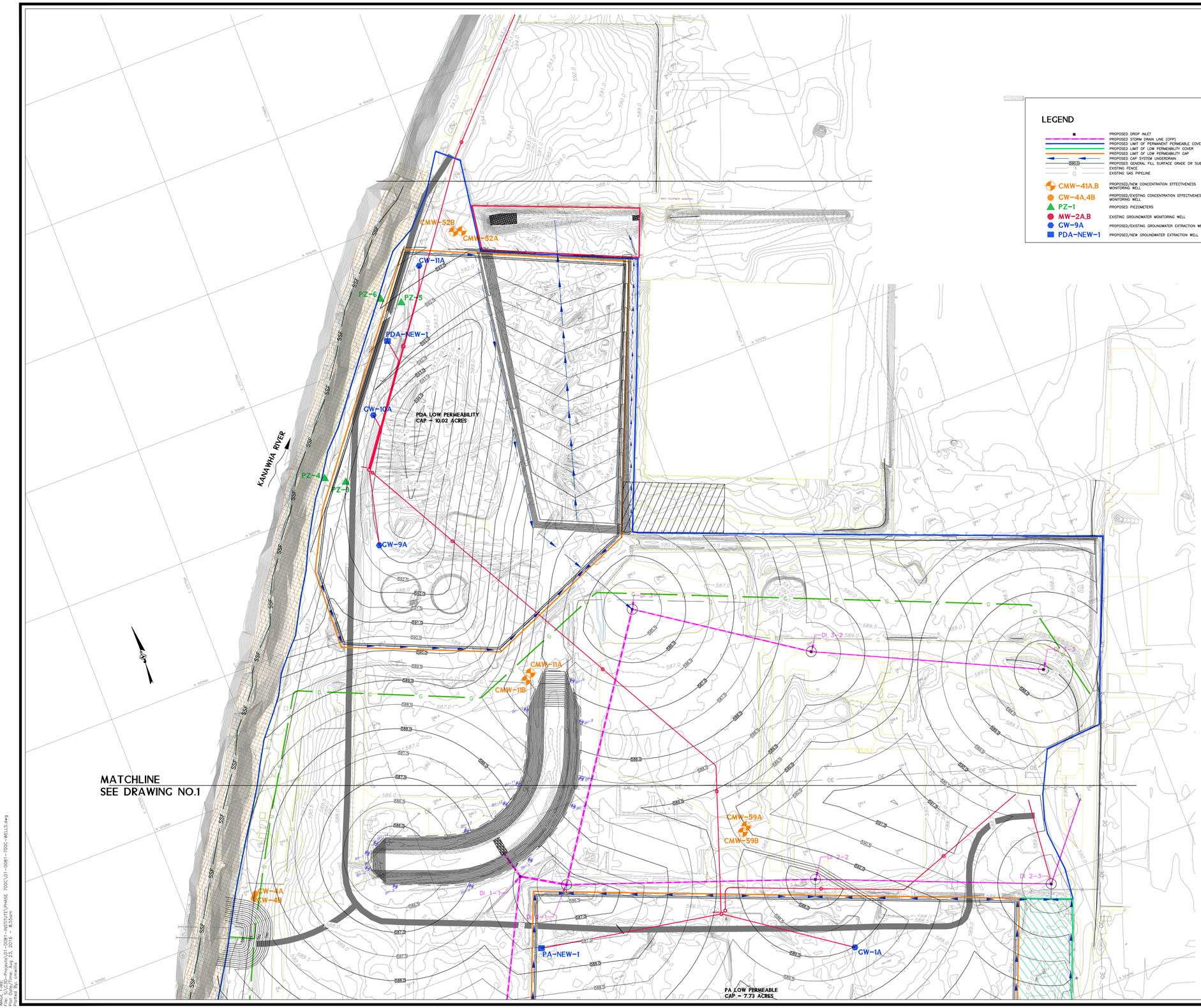
No.	Date	Revision



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- CMW-41A,B — PROPOSED/NEW CONCENTRATION EFFECTIVENESS MONITORING WELL
- CW-4A,4B — PROPOSED/EXISTING CONCENTRATION EFFECTIVENESS MONITORING WELL
- PZ-1 — PROPOSED PIEZOMETERS
- MW-2A,B — EXISTING GROUNDWATER MONITORING WELL
- CW-9A — PROPOSED/EXISTING GROUNDWATER EXTRACTION WELL
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GRAPHIC SCALE

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POTESTA

Client
SOLUTIA, INC.
ST. LOUIS, MISSOURI

Title
LOCATION PLAN-PDA AREA
RCRA INTERIM MEASURES
EFFECTIVENESS MONITORING PLAN

2
Drawing No.

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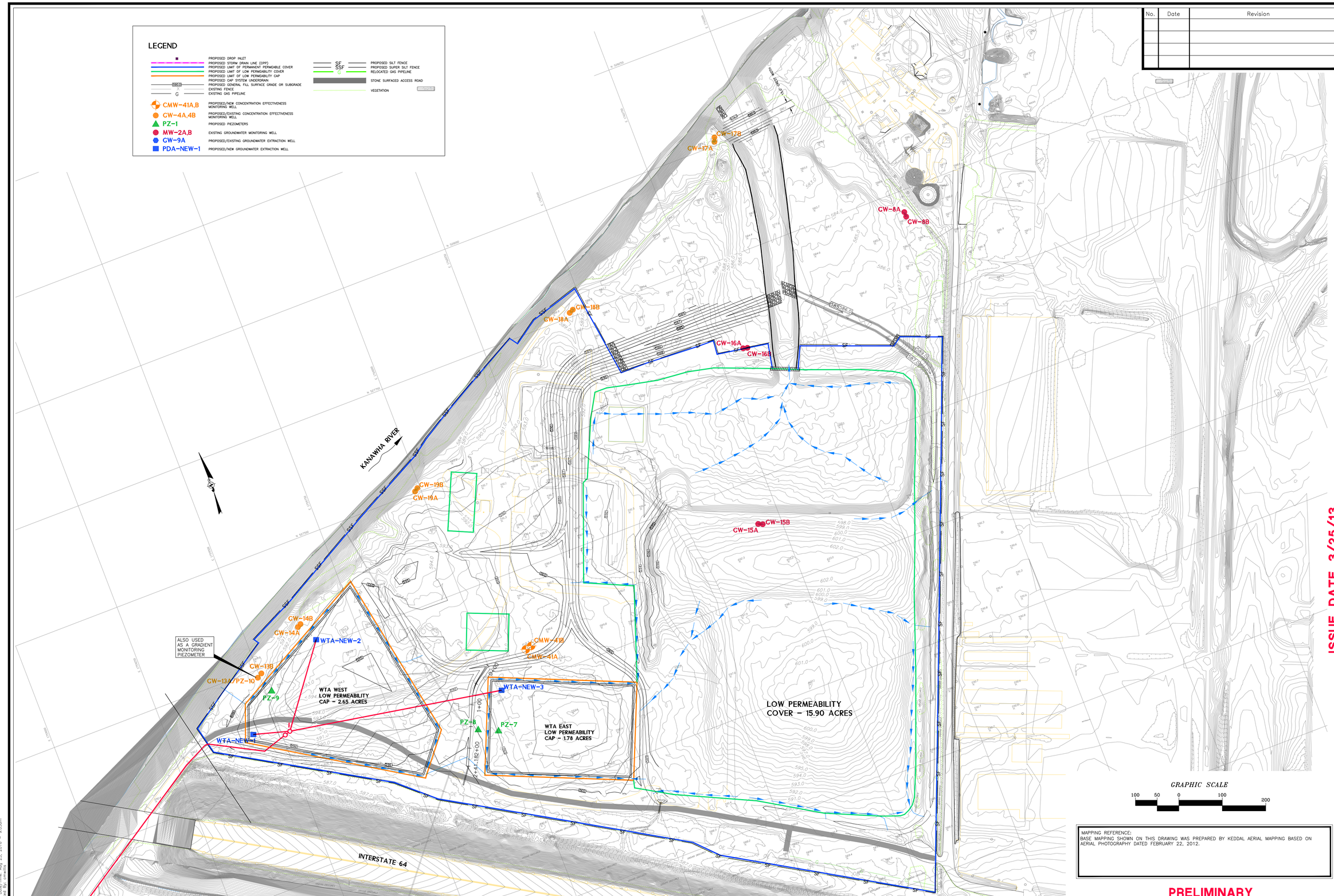

No.	Date	Revision

ISSUE DATE 3/25/13

-WELLS-WTA
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Drawn
CAG
Checked
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Approved
NOTED
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MARCH 2013
Date:
01-0081-700C
Project No.

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Title
LOCATION PLAN-WTA AREA
RCRA INTERIM MEASURES
EFFECTIVENESS MONITORING PLAN

3
Drawing No.

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APPENDIX D

TABLE 1

INTERIM MEASURES OBJECTIVE

Environmental Media	Interim Measures Objectives	
	Short-Term	***Intermediate / Long-Term***
Soil/wastes	**1)** Implement Site Health and Safety Plan and Site security procedures to prevent exposure of any future industrial and construction workers and trespassers to source area soils and wastes.	**1)** Prevent exposures of future Site users and trespassers to soils and wastes
Groundwater	**2)** Control Site sources and monitor TCDD, PCE, TCE, DCE and VC concentrations in groundwater to confirm improvement over time following Interim Measures implementation.. **3)** Control Site groundwater use until long-term CMOs are achieved. **4)** Monitor groundwater downgradient of the Former Rubber Chemicals Manufacturing Area and the Wastewater Treatment Area	**2)** Control migration of TCDD to the Kanawha River via the groundwater pathway such that the sum from all Site sources is below the "safe loading level"[(1)] for the Site. **3)** Control migration of PCE and its breakdown products to the Kanawha River via the groundwater pathway to a level that is protective of surface water quality. **4)** Determine if the Interim Measures are capable of achieving State and Federal groundwater cleanup criteria[(2)] and if not, what additional actions are required for final RCRA Corrective Measures.
Stormwater	**5)** Maintain compliance with the NPDES Permit	**5)** Control migration of TCDD to the Kanawha River via the stormwater pathway such that the sum from all Site sources is below the "safe loading level"[(1)] for the Site.

[(1)] "Safe Load Level" for the Site established in the TMDL Report: "Dioxin TMDL Development for Kanawha River, Pocatalico River and Armour Creek, West Virginia", dated September 14, 2000, prepared for U.S EPA Region III by Tetra-Tech, Inc.

[(2)] Achievement of groundwater cleanup criteria will require reasonable efforts to eliminate or mitigate further releases of contaminants from SWMUs, impoundments and affected soils and reduction of contaminant levels, as practicable, over time, to support reasonably expected use. These criteria may include the implementation of institutional and/or engineering controls.

TABLE 2

INTERIM MEASURES EFFECTIVENESS MONITORING PLAN WELLS

Extraction Well Information

Well ID	A (Final Cap Surf. Elev.)	B (General Fill Surf. Elev.)	C (Top of Casing Elev.)	D (Bottom of 12" Surf. Casing)	E (Bottom of Bentonite Seal)	F (Top of Screen Elevation)	G (Static Water Level Elev.)	H (High Level Sensor Elev.)	I (Low Level Sensor Elev.)	J (Bottom of Pump Intake)	K Bottom of Screen Elev.)	L (Bottom of Boring)
WTA - East												
WTA-NEW-3	593.8	592.3	590.6	590.3	587.3	570	569	568	558	548	550	549.5
WTA - West												
WTA-NEW-1	592.9	591.4	589.7	589.4	586.4	570	565.1	564	554	548	550	549.5
WTA-NEW-2	595	593.5	592.3	592	589	570	566	565	555	548	550	549.5
PDA												
PDA-NEW-1	593.9	592.4	590.7	590.4	587.4	570	567.5	566	556	548	550	549.5
GW-9A	594.5	593	588.6	588.3	574	567	569.3	568	558	550	552	552
GW-10A	594.2	592.7	590	589.7	577.8	566.8	568.2	567	557	549.8	551.8	551.8
GW-11A	594.8	593.3	591.6	591.3	572.5	569.5	567.6	566	556	552.5	554.5	554.5
PA												
PA-NEW-1	589	587.5	585.6	585.3	582.3	570	563.2	2562	552	548	550	549.5
GW-1A	590.5	589	587.5	587.2	588.5	565.5	573.7	572	562	548.5	550.5	550.5

Containment Areas Cross-Barrier Gradient Monitoring & Control Piezometers

Well ID	Location	A (Final Cap Surf. Elev.)	B (General Fill Surf. Elev.)	C (Bottom of 6" Surf. Casing)	D (Bottom of Bentonite Seal)	E (Top of Screen Elevation)	F (Static Water Level Elev.)	G Bottom of Screen Elev.)	H (Bottom of Boring)
WTA - East									
WTA-GMW-5	Inside	593.9	592.4	586.4	583.4	570	571.1	550	550
WTA-GMW-6	Outside	592	590.5	584.5	581.5	570	571.3	550	550
WTA - West									
WTA-GMW-1	Inside	593.1	591.6	586.5	583.5	570	568.1	550	550
GW-13A	Outside	591.7	590.2	n/a	573	570	567.2	555	555
PDA									
PDA-GMW-4	Inside	593.1	591.6	585.5	582.5	570	568.6	550	549.5
PDA-GMW-5	Outside	593.3	591.8	585.8	582.8	570	568	550	549.5
PA									
PA-GMW-1	Inside	590.6	589.1	583.1	580.1	570	572	550	549.5
PA-GMW-2	Outside	590.6	589.1	583.1	580.1	570	571.8	550	549.5

Concentration Effectiveness Monitoring Well Information

Well ID	A (Final Cap Surf. Elev.)	B (General Fill Surf. Elev.)	C (Bottom of 6" Surf. Casing)	D (Bottom of Bentonite Seal)	E (Top of Screen Elevation)	F (Static Water Level Elev.)	G Bottom of Screen Elev.)	H (Bottom of Boring)
WTA - East								
GW-13A	591.7	590.2	n/a	573	570	567.2	555	555
WTA - West								
CMW-41-A	592.5	591	585	582	570	570.3	550	550
CMW-41-B	592.5	591	585	558	555	570.3	535	535
PDA								
CMW-52-A	593.5	592	589.2	586.2	570	568.5	550	550
CMW-52-B	593.5	592	589.2	558	555	568.5	535	535
PA								
CMW-11A	588.9	587.4	581.4	578.4	570	571	550	550
CMW-11B	588.9	587.4	581.4	553	550	571	530	530
CMW-59A	593.8	592.3	584	581	570	573	550	550
CMW-59B	593.8	592.3	584	558	555	573	535	535