WATER MANAGEMENT WHITE PAPER
WOODBURY AND COTTAGE GROVE SITES

In accordance with the 2007 Settlement Agreement and Consent Order (Agreement) between 3M and Minnesota Pollution Control Agency (MPCA), 3M has been conducting remedial investigations and response actions to address PFCs present at three (3) sites in Minnesota, namely Oakdale, Cottage Grove and Woodbury. As part of this work under the Agreement, 3M prepared Remedial Design/Response Action (RD/RA) Plans for addressing the PFCs present at the Woodbury and Cottage Grove sites. A comprehensive review of the combined water management aspects of these individual RD/RAs is warranted, to take advantage of scheduling efficiencies and assure best management of water resources.

1.0 BACKGROUND

1.1 Woodbury Site Remediation

In accordance with the Agreement, 3M submitted the *Remedial Design/Response Action Plan* (Woodbury RD/RA Plan) for the Woodbury Site to the MPCA on April 1, 2009. MPCA provided technical comments to 3M on the Woodbury RD/RA Plan; subsequently, a Response to Comments letter was submitted by 3M to the MPCA on May 28, 2009. The MPCA approved the RD/RA Plan in their letter to 3M dated June 1, 2009.

The Woodbury RD/RA Plan includes a provision for treating the groundwater currently being extracted from the site. The current barrier well network at the 3M Woodbury Site consists of four wells (B-1, B-2, B-3, and B-4) that operate continuously, except during maintenance activities. The barrier well network was installed in the 1960's and operated since then to prevent potentially impacted groundwater beneath the former disposal areas from migrating off-site. Since 2005, the barrier well network has operated at an average combined flow rate of approximately 3,100 gallons per minute (gpm). The water is piped from Woodbury to the 3M Cottage Grove Plant for beneficial re-use and ultimately discharges through an NPDES outfall to the Mississippi River. The volume of groundwater pumped by the barrier wells fluctuates slightly, depending on the demand for water at the Cottage Grove facility.

The water produced by the barrier well network is being piped from Woodbury to the 3M Cottage Grove Plant, and ultimately discharges through an NPDES outfall to the East Cove and Mississippi River. The new treatment system will be constructed at the Cottage Grove Plant for treating this water to meet future NPDES permit conditions.

1.2 Cottage Grove Site Remediation

On March 13, 2008, 3M submitted the *Feasibility Study for the Cottage Grove Site, Cottage Grove, Minnesota* (Cottage Grove FS Report) to MPCA to address the presence of PFCs in soil, groundwater, and sediment at the Cottage Grove Site. The FS Report recommended enhanced groundwater recovery with granular activated carbon treatment prior to discharge as Groundwater Alternative GW-1. The intent of Groundwater Alternative GW-1 is to intercept and treat groundwater potentially migrating into the Mississippi River. Results from the river bed pore water samples (collected during the Phase 2 PFC Site Assessment conducted at the Cottage Grove Plant) provides a view of PFC concentrations in the pore water that are likely due to the discharge of groundwater into the river. By intercepting this groundwater, the quantity of PFCs potentially discharging into the river through groundwater seepage can be greatly reduced.

In accordance with the Agreement, 3M submitted the *Remedial Design/Response Action Plan* (Cottage Grove RD/RA Plan) for the Cottage Grove Site to the MPCA on December 1, 2009. The Cottage Grove RD/RA plan has been reviewed by MPCA and approved with comments on February 1, 2010.

The Cottage Grove RD/RA Plan includes the installation of new groundwater extraction wells located along the bluff on the southeastern side of the property to intercept groundwater currently discharging into the Mississippi River. By intercepting this groundwater, the quantity of PFCs discharging into the river through groundwater seepage can be greatly reduced. 3M is currently operating six production wells in the main plant area and two of these wells, PW-5 and PW-6 located along the southwestern boundary of the plant near the Mississippi River pump the majority of the water. These two wells pump approximately 1,215 gpm and the water is used for process purposes and as cooling water for the incinerator.

The new extraction wells will work in concert with existing wells PW-5 and PW-6 to intercept groundwater discharging into the river. Two of the new wells (EW-01 and EW-02) were

installed in October 2008 for a 48 hour pump test, however, they are not yet equipped with permanent pumps or collection piping. The RD/RA Plan includes a phased implementation of the groundwater extraction/interception system at the site starting with these two existing new wells. They would be operated during a Phase I period for up to a maximum of 18 months to obtain operating and performance data. These data are required so that the number of wells, pumping rates and design of any additional new extraction wells needed to complete the interception system could be determined based on field measurements rather than relying entirely on modeling predictions. The MPCA approved this concept of pumping EW-01 and EW-02 as part of a phased implementation to determine appropriate placement of additional wells, if needed.

The details for collection, use and discharge of this additional water produced during Phase I from the two extraction wells EW-01 and EW-02 would have to be determined. Total maximum pumped water from these two wells could be in the range of 1,500 to 2,000 gpm.

1.3 Cottage Grove Plant

The Cottage Grove Plant currently handles process water (which is supplied from the on-site extraction wells) through an on-site treatment plant and is discharged at outfall SD-0001. Stormwater and cooling water (which is primarily water from Woodbury extraction wells) is currently not treated and is discharged through outfall SD-0002. The NPDES permit for the plant has expired and is being reviewed by MPCA for renewal.

2.0 TECHNICAL EVALUATION

2.1 Woodbury Extraction Wells-Flow Reduction

A number of studies to evaluate the effectiveness of the site barrier well network have been completed by several different consultants (Bruce Liesch, Constoga-Rover & Associates, Barr Engineering, and Weston Solutions, Inc. (WESTON)). All of these studies have reached the same conclusion that the barrier well network provides an effective hydraulic barrier that prevents groundwater originating in the vicinity of the former Main and former Northeast Disposal Areas at the referenced site from migrating off-site.

WESTON performed hydraulic evaluations in May 2007 and May 2008 to assess the effectiveness of the barrier well network. Barrier wells B-1, B-2, B-3, and B-4 were operating at approximately 960, 150, 770, and 1,400 gallons per minute (gpm), respectively, during the May 2007 evaluation. In May 2008, the flow rates were slightly lower as B-1, B-2, B-3, and B-4 were pumping at 780, 135, 640, and 1,250 gpm, respectively. Details on the May 2007 study were presented in the Remedial Investigation/Feasibility Study (RI/FS) for the Woodbury Site that was submitted to the MPCA in February 2008, and details on the May 2008 study were presented in Addendum 2 to the Feasibility Study that was submitted to the MPCA in July 2008.

The results of these studies indicated that the capture zone of the barrier well network extends far beyond the delineated area of groundwater beneath the former disposal areas that have been impacted by perfluorochemicals (PFCs).

APRIL 2009 RESULTS

During a planned maintenance shutdown of barrier well B-2 in April 2009, WESTON collected depth-to-groundwater measurements from 42 monitoring wells at the Woodbury Site on April 16, 2009. At the time of the data collection, barrier wells B-1, B-3, and B-4 were measured to be pumping at 1,050, 700, and 1,420 gpm, respectively, which is comparable to the May 2007 pumping rates. Barrier well B-2 was shut down several days prior to April 16, 2009, for maintenance activities. The depth-to-groundwater and groundwater elevation data collected on April 16, 2009 for the 42 monitor wells are provided in Table 1, Appendix A.

Groundwater elevation contour maps using the April 16, 2009 water level data were constructed for the shallow groundwater flow system, the shallow Prairie du Chien aquifer, and the deeper Jordan Sandstone unit. Groundwater elevations and inferred capture zones are presented in Figures 1 through 3, Appendix A. The capture zones depicted in these figures confirm previous results that the area of groundwater capture induced by the three barrier wells operating at the time, extends far beyond the former disposal areas where groundwater has been impacted by PFCs. Therefore, the groundwater elevation data provided in these figures confirm that groundwater capture is being achieved without the operation of barrier well B-2.

OPTIMIZED PUMPING PLAN

The groundwater elevation data collected while barrier well B-2 was not operating in April 2009 shows that the capture zone with barrier wells B-1, B-3, and B-4 pumping, extends far beyond the area of groundwater impacted by PFCs and volatile organic compounds (VOCs). This indicates that even with barrier well B-2 off, additional modifications and optimization to the barrier well network is feasible while maintaining groundwater capture over the required area. A two-phased optimization approach is proposed:

- Phase 1: Continue pumping barrier wells B-1 and B-4 at flow rates comparable to those measured in April 2009 while turning off barrier wells B-2 and B-3.

- Phase 2: Reduce pumping at barrier wells B-1and B-4 with B-2 and B-3 off. The flow rates at each of the two barrier wells would be reduced up to 50 percent of current total flow rates, resulting in approximately 35 percent reduction in individual flow rates of B-1 and B-4.

The effect of implementing Phase 1 and Phase 2 on groundwater elevations across the area which defined the zone of capture, was calculated using the results of the May 2008 hydraulic evaluation. This is conservative since the flow rates for barrier wells B-1, B-3, and B-4 were lower in May 2008 than those measured in April 2009. Specifically, the change in water level (drawdown) measured under pumping and non-pumping conditions in May 2008 were used to estimate the water level response in each site monitor well for the barrier well network operating at lower flow rates. Since drawdown is directly proportional to flow rate, for the Phase 2 scenario, up to a 50 percent reduction in pumping rates equates to one-half the drawdown measured in site monitor wells during the May 2008 pump shut down tests. This assumes that groundwater is extracted from a single pumping center; therefore, while the barrier wells are in proximity to one another, this drawdown value represents an estimate and field data will be calculated to confirm the estimated value. The 50 percent drawdown value calculated for each well is subtracted from the non-pumping groundwater elevation for each well to predict a groundwater elevation for a monitor well. The same method can be used for the Phase 1 scenario to calculate a groundwater elevation for site monitor wells with barrier wells B-1 and B-4 operating at flow rates measured on April 16, 2009. On this date, barrier wells B-1 and B-4 were extracting 78 percent of the total groundwater being pumped at the site.

Phase 1: Pumping barrier wells B-1 and B-4 with B-2 and B-3 off.

Figures 4, 5 and 6, Appendix A show the calculated groundwater elevations and extent of predicted groundwater capture for the shallow, upper Prairie du Chien, and Jordan sandstone hydrostratigraphic units for the Phase 1 reduction with barrier wells B-1 and B-4 operating at the same flow rates as measured in April 2009 (1,050 and 1,420 gpm, respectively – total flow of 2,470 gpm), and barrier wells B-2 and B-3 off. The results presented in these figures also indicate that the capture zone for barrier wells B-1 and B-4 extends beyond the area of groundwater impacted by PFCs and VOCs.

The groundwater analytical data provided in Table 2, Appendix A indicate that PFCs are present in the groundwater samples collected from barrier well B-3. However, the concentration of PFCs present in groundwater samples collected from barrier well B-3 are below Minnesota Department of Health (MDH) Health Based Values (HBVs) for PFCs and are approximately one order of magnitude lower than the PFC results for barrier wells B-1 and B-4. In addition, the annual groundwater monitoring data for VOCs has shown non-detects in well B-3, which adds to the evidence that B-3 is not the primary source for capturing site constituents. As indicated in Figures 4 through 6, and from previous groundwater capture zone analyses performed during the shutdown tests, only a small portion of groundwater from beneath the former disposal areas is predicted to be captured by barrier well B-3.

Evidence that barrier wells B-1 and B-4 will capture groundwater in the vicinity of barrier well B-3 was collected during the May 2008 shut down test. During the May 2008 shut down test, the barrier wells were restarted at a rate of one per hour in order from the highest to the lowest pumping rates (B-4→B-1→B-3→B-2). Just prior to restarting barrier well B-3, a 22.2 foot decline in water level (drawdown) was measured in barrier well B-3 due to the operation of barrier wells B-1 and B-4. Clearly, this decline in water level will induce groundwater in the vicinity of barrier well B-3 to flow toward either barrier well B-1 or B-4.

Phase 2: Reduced Pumping at Barrier Wells B-1 and B-4 with B-2 and B-3 off.

Figures 7 through 9 Appendix A show the calculated groundwater elevations and extent of groundwater capture for the shallow, upper Prairie du Chien, and Jordan sandstone hydrostratigraphic units for pumping scenarios with the barrier wells operating at 50 percent of

the flow rates measured on April 16, 2009. The flow rates for barrier wells B-1 and B-4 for the 50 percent scenario are 675 and 910 gpm, respectively (total flow 1585 gpm). Extraction wells B-2 and B-3 would remain off.

As shown in Figures 7 through 9 groundwater capture is predicted to extend beyond the area of impacted groundwater beneath the former Main and Northeast Disposal Areas. A further reduction in pumping of the two barrier wells B-1 and B-4 while still maintaining capture is possible based on the results presented. Field data will be collected to verify these predictions.

In summary, the following conclusions are made from the groundwater elevation data collected in April 2009 and the plan for optimized pumping presented above:

- Groundwater capture in all three hydrostratigraphic units is achieved;
- Total pumping rates can be reduced by up to 25 percent for Phase 1 and up to 50 percent for Phase 2 of those measured in April 2009 thereby preserving approximately 368,000,000 – 833,000,000 total gallons of the groundwater resource per year.

2.2 Cottage Grove Interception Wells - FC Reduction

The new extraction/interception system will intercept groundwater moving to the Mississippi River and reduce the quantity of PFCs entering the river. The Phase 2 FC Site Assessment conducted at the Cottage Grove Plant included sampling of pore water in the river bed along the shore line. Water sampling locations included 25 equally spaced stations along a transect approximately 100 feet from and parallel to the shoreline. In addition, six locations at distances 25 ft, 200 ft, 300 ft, 400 ft, and 500 ft from the shoreline were established along each of three transects oriented perpendicular to the shoreline. Figure 1 in Appendix B presents these sampling locations. The pore water samples provide an indication of PFC concentrations in groundwater which may be discharging in to the river.

The groundwater model used for layout and predictive design of the Cottage Grove extraction/interception well system was used to estimate groundwater discharge and calculate a PFC flux to the river via the groundwater pathway. Based on the porewater sampling results as presented in the Site Assessment Report, the PFC concentrations were found in probe locations

extending 500 feet into the river with decreasing concentrations with increasing distance from the southern shoreline.

Using this information, it was assumed that the primary flux occurred in an approximate 700 foot wide zone along the shoreline with concentrations decreasing to the south (at increasing distance from the shoreline). Concentration isopleths were modeled along the shoreline as a basis for calculating flux and an example of the interpreted isopleths is shown in Appendix B, Figure 2. Several of the sampling locations did not report a PFC concentration since the results did not meet laboratory QC requirements and these are noted as NR (not reported). Appendix B, Table 1 presents the results of the flux calculation for the various PFCs as pounds per day. Data from the extended pilot test of the groundwater extraction/interception system will be useful in confirming the flux model predictions and demonstrating a reduction in PFC loading to the river.

3.0 RD/RA IMPLEMENTATION

3.1 Woodbury Site

Studies have predicted that pumping from the Woodbury extraction system can be reduced by 50% or more and still maintain capture of the groundwater plume. The basis for this prediction was discussed further in Section 2 of this report. In order to calibrate this prediction, the Woodbury system would be partially reduced during a Phase I period by approximately 25%. This would be accomplished by discontinuing pumping of barrier wells 2 and 3 during Phase I which would reduce total flow by about 800 gpm. Following approval, this could be implemented almost immediately since no equipment or hardware changes are needed. A monitoring program (as discussed in Section 4) would be implemented to track groundwater elevations, gradients and water quality to confirm capture and groundwater dynamics.

The Cottage Grove plant has determined that at this point, they could accommodate this type of flow reduction (approx 800 gpm) from the Woodbury extraction system and not adversely affect plant production operations. Additional flow reductions would require further evaluations by the plant to determine how that could be accomplished and not affect production.

3.2 Cottage Grove Site

MPCA has approved the Cottage Grove RD/RA Plan (with comments) including the concept of phased implementation of the extraction wells. This document presents a preliminary plan for Phase I operation of the 2 new existing extraction wells EW-01 and EW-02. This Phase I plan would include equipping the two wells with variable speed pumps, piping and electrical power for startup and operation. During operation, performance monitoring and operating data would be collected using the monitoring plan presented in Section 4.0 of this document. Extracted water could be used in the plant or treated and discharged through a temporary or existing outfall. Temporary piping and skid mounted treatment units could be considered for this Phase I water to expedite startup of operations and facilitate discharge. The system may be operated for up to 18 months to collect sufficient performance information.

The objectives of the Phase I test program for the new Cottage Grove extraction wells would be to:

- Collect design information for the final interception/extraction system.
- Collect water characterization data to help design the treatment system.
- Collect concentration data to evaluate reductions in PFC loading to the Mississippi River associated with the pumping of the extraction wells.
- Provide additional process water to the plant to off-set potential flow reductions from the Woodbury site.

4.0 PERFORMANCE MONITORING

4.1 Woodbury Site

Performance monitoring will be conducted as reduction in extraction pumping is implemented. A shutdown of barrier wells B-2 and B-3 will result in a reduction in total pumping of approximately 800 gpm or 25%. Total flow from wells B-1 and B-4 will be measured and tracked.

Prior to shutdown of wells, B-2 and B-3, a complete water sampling and level measurement campaign will be conducted at the 42 monitor wells at the site to establish the baseline conditions. Readings from these wells can also be compared to conditions in 2008 and 2009. Following shutdown of the two wells, monthly water level measurements will be obtained from

44 wells (including barrier wells B-2 and B-3) as listed in Table 3 and Figure 10, Appendix A. These wells will provide the data to document the capture zone for wells B-1 and B-4 and confirm the capture zone predictions as discussed in Section 2.1. One round of samples for PFC analysis will be obtained from each of the four extraction wells and those wells identified in Table 1 prior to shutdown of B-2 and B-3 and quarterly thereafter. A letter report will be prepared for submittal to MPCA at 6 months after shutdown to document the Phase 1 results. This report's findings and recommendations will be reviewed with the MPCA and if the data shows that further reductions in pumping are feasible, then permission will be sought from the MPCA to implement Phase 2.

4.2 Cottage Grove Site

Performance monitoring will be conducted for the operation of the Phase I (EW-01, EW-02) extraction wells. In addition to flow measurements from the two wells, groundwater elevations will be measured from these wells and wells listed in Attachment 2, Table 2 and shown in Figure 3.

Prior to startup of the two new wells, a complete round of water levels will be obtained from the 20 monitor wells listed in Table 2, Appendix B to establish baseline conditions and for comparison to historical data. Following startup of the two wells, water level measurements from the wells listed in Table 2 will be obtained daily for the first week, every other day for the second week and weekly for the next month. Thereafter, the frequency of groundwater elevation measurements will be reduced to monthly or at a frequency agreed with the MPCA.

Samples will be collected at startup and monthly from these two wells for PFC analysis to track removals. A letter report will be prepared at 6 months after startup to document results.

5.0 SCHEDULE

The proposed schedule for implementation of this plan is shown as follows:

ACTIVITY	SCHEDULE
1. Complete baseline performance monitoring event at Woodbury.	March 2010
2. Complete pilot design for Cottage Grove pilot test.	March – April 2010
3. Shutdown Woodbury barrier wells B-2 and B-3; begin Woodbury performance monitoring.	April 2010
4. Resolve discharge requirement with MPCA for extracted groundwater from EW-01 and EW-02	May – July 2010
5. Equip Cottage Grove extraction wells EW-01 and EW-02 with pumps, piping and power.	April – June 2010
6. Install temporary GAC treatment system (for extracted Woodbury groundwater) at the Cottage Grove facility. Prepare for winterizing system.	June 2010
7. Complete baseline performance monitoring event at Cottage Grove.	July - August 2010
8. Start-up wells EW-01 and EW-02; begin cottage Grove performance monitoring.	July – August 2010
9. Issue Woodbury Interim Performance Report.	October 2010
10. Initiate Woodbury evaluation of additional groundwater flow reduction.	October 2010
11. If feasible and approved, install Woodbury variable speed pumps and associated controls	November 2010
12. Implement additional flow reductions at Woodbury.	December 2010
13. Issue Cottage Grove Interim Performance Report	Dec 2010 - February 2011
14. Finalize Cottage Grove interception/extraction well network.	January 2011
15. Finalize Woodbury/Cottage Grove treatment facility design.	February 2011

APPENDIX A
WOODBURY SITE

Table 1

Depth-to-Groundwater and Groundwater Elevation Data
16 April 2009
Former Woodbury Disposal Site
Woodbury, Minnesota

Well ID	16-Apr-09		Well ID	16-Apr-09	
	Depth to Groundwater (ft btoc)	Groundwater Elevation (ft MSL)		Depth to Groundwater (ft btoc)	Groundwater Elevation (ft MSL)
MW-01	148.55	836.15	MW-K	96.87	828.13
MW-02	134.72	834.75	S-01JS	82.65	828.51
MW-03	136.08	834.69	S-01PC	82.71	828.13
MW-04L	105.66	827.14	S-02DR	42.85	835.54
MW-04	105.27	828.79	S-02JS	44.25	833.22
MW-05	139.87	795.18	S-02PC	44.51	833.27
MW-06	92.32	822.53	S-03JS	90.90	836.39
MW-06L	89.80	825.23	S-03PC	90.48	836.73
MW-07	136.11	836.70	S-04PC	135.78	835.63
MW-08	76.25	827.69	S-04SP	135.25	835.61
MW-09	71.80	828.53	S-05JS	106.18	839.44
MW-10	89.55	828.84	S-05PC	105.95	839.59
MW-11	88.99	828.91	S-05SP	105.86	839.76
MW-12	87.13	825.38	S-06JS	141.50	840.64
MW-B	dry	--	S-06PC	141.33	840.92
WR-03	106.72	828.22	S-07JS	79.85	836.57
WR-08	97.52	839.06	S-07PC	79.78	836.43
MW-F	108.75	819.59	S-07SP	78.33	836.98
MW-G	48.99	831.50	S-08JS	71.16	832.92
MW-H	95.85	826.67	S-08PC	68.92	834.64
MW-J	115.22	819.67	S-09JS	104.05	829.62

ft MSL - feet above mean sea level.

ft btoc - feet below top of casing.

Table 2

Summary of Groundwater Analytical Data
June, August, and October 2007, and March 2008 Sampling Events
Woodbury Site, Woodbury, MN

Well ID	DATE	PFBA (ppb, ug/L)	PFPeA (ppb, ug/L)	PFHxA (ppb, ug/L)	PFHpA (ppb, ug/L)	PFOA (ppb, ug/L)	PFBS (ppb, ug/L)	PFHS (ppb, ug/L)	PFOS (ppb, ug/L)
Barrier Wells									
B-1	Jun-07	1.59	0.487	0.974	0.143	1.44	1.73	1.52	ND
	Aug-07	1.66	0.486	0.828	0.108	1.37	1.94	1.54	0.039
	Oct-07	1.57	0.485	0.792	0.099	1.29	1.63	1.23	0.038
	Mar-08	1.79	0.509	0.847	0.128	1.20	1.75	1.39	0.041
B-2	Jun-07	0.471	ND	ND	ND	ND	ND	ND	ND
	Aug-07	0.434	ND	ND	ND	ND	ND	ND	ND
	Oct-07	0.461	ND	ND	ND	ND	ND	ND	ND
	Mar-08	0.536	ND	ND	ND	ND	ND	ND	ND
B-3	Jun-07	0.728	0.074	0.119	ND	0.207	0.362	1.29	0.171
	Aug-07	0.682	0.039	0.056	ND	0.15	0.407	1.36	0.138
	Oct-07	0.74	0.067	ND	ND	0.179	0.417	1.28	0.153
	Mar-08	0.769	0.067	0.095	ND	0.020	0.429	1.43	0.156
B-4	Jun-07	1.50	0.406	0.96	0.342	2.44	3.48	11.5	1.78
	Aug-07	1.38	0.332	0.546	0.243	1.98	3.78	11.6	1.68
	Oct-07	1.44	0.377	0.733	0.258	2.25	3.30	11.0	2.33
	Mar-08	1.69	0.447	0.837	0.388	2.94	3.84	13.9	3.06

ND - not detected at or above the limit of quantitation.

ppb - parts per billion

ug/L - micrograms per liter

Note: Results for PFNA, PFDA, PFUnA, and PFDoA were not reported or were not detected at all sample locations. Therefore, these data have been omitted from this table.

Table 3

Water Level Monitoring Locations
Woodbury Site Barrier Well Evaluation
Woodbury, MN

Well ID	Total Depth	Zone(s) Monitored	Well ID	Total Depth	Zone(s) Monitored
MW-01	170	St. Peter Sandstone	S-02PC	139.5	Upper PdC
MW-02[2]	155	St. Peter Sandstone	S-02JS	295	Jordan Sandstone
MW-03	161	St. Peter Sandstone	S-03PC	175	Upper PdC
MW-04L[2]	187	Middle PdC	S-03JS	335.5	Jordan Sandstone
MW-04	128	St. Peter Sandstone / Upper PdC	S-04SP	145	St. Peter Sandstone
MW-05	245	Middle PdC	S-04PC	200	Upper PdC
MW-06	178	St. Peter Sandstone	S-05SP	115	St. Peter Sandstone
MW-06L	232.7	PdC	S-05PC	170	Upper PdC
MW-07	161	St. Peter Sandstone	S-05JS	340	Jordan Sandstone
MW-08	163	Upper PdC	S-06PC	254	Middle PdC
MW-09	180	Upper PdC	S-06JS	400	Jordan Sandstone
MW-10	115.9	Upper PdC	S-07SP	90	St. Peter Sandstone
MW-11	160	Upper PdC	S-07PC	160	Upper PdC
MW-12	205	Glacial Drift / Upper PdC	S-07JS	325	Jordan Sandstone
MW-B	49[3]	Glacial Drift / St. Peter SS	S-08PC	140	Upper PdC
MW-F	128.7	Glacial Drift	S-08JS	320	Jordan Sandstone
MW-G	226.7	Jordan Sandstone	S-09JS[2]	360	Jordan Sandstone
MW-H[2]	310	Glacial Drift	WR-03[2]	390	Jordan Sandstone
MW-J	165	Upper PdC	WR-08	186.7	PdC
MW-K	116	St. Peter Sandstone	B-1[1,2]	320	PdC, Jordan SS
S-01PC[2]	140	Upper PdC	B-2[1,2]	315	Drift, St. Peter SS, PdC
S-01JS[2]	335	Jordan Sandstone	B-3[1,2]	310	Drift, PdC
S-02DR	60	Glacial Drift	B-4[1,2]	300	PdC

PdC = Prairie du Chien Group

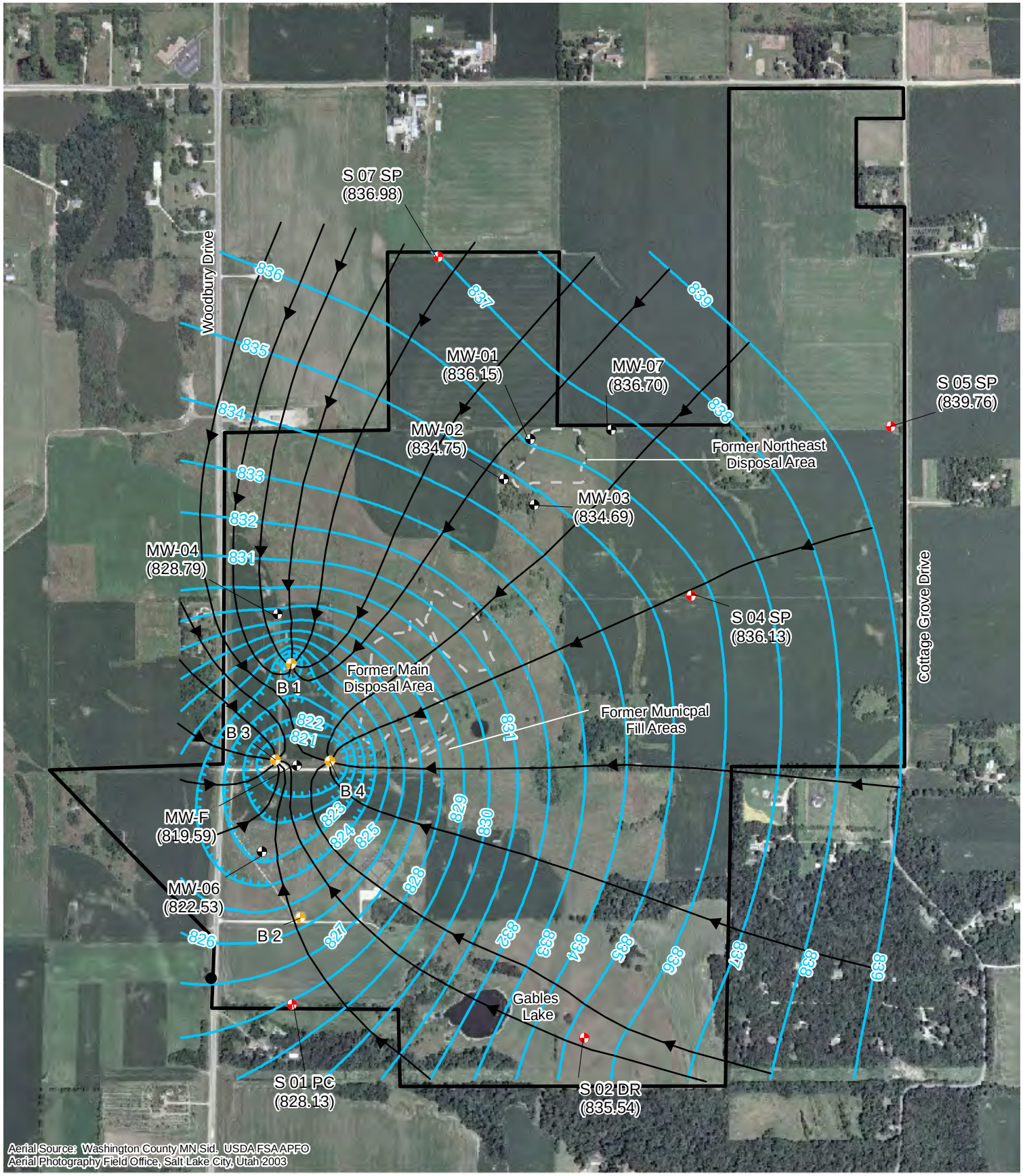
SS = Sandstone

NA = Not accessible.

[1] - Water levels in the barrier wells will be measured only during non-pumping periods. These water levels cannot be measured during pumping periods due to downhole obstructions (e.g. pump).

[2] - Groundwater samples for PFC analysis will be collected from these wells.

[3] - Obstruction in well at 49 ft bgs.



Legend:

- Monitoring Well Locations
- Sentinel Well Locations
- Barrier Well Locations
- Groundwater Elevation Contour (contour interval 1 foot)
- Area of Predicted Groundwater Capture
- (836.82) Groundwater Elevation (ft.msl)
- Site Boundary

N
W E
S

0 500 1,000 Feet

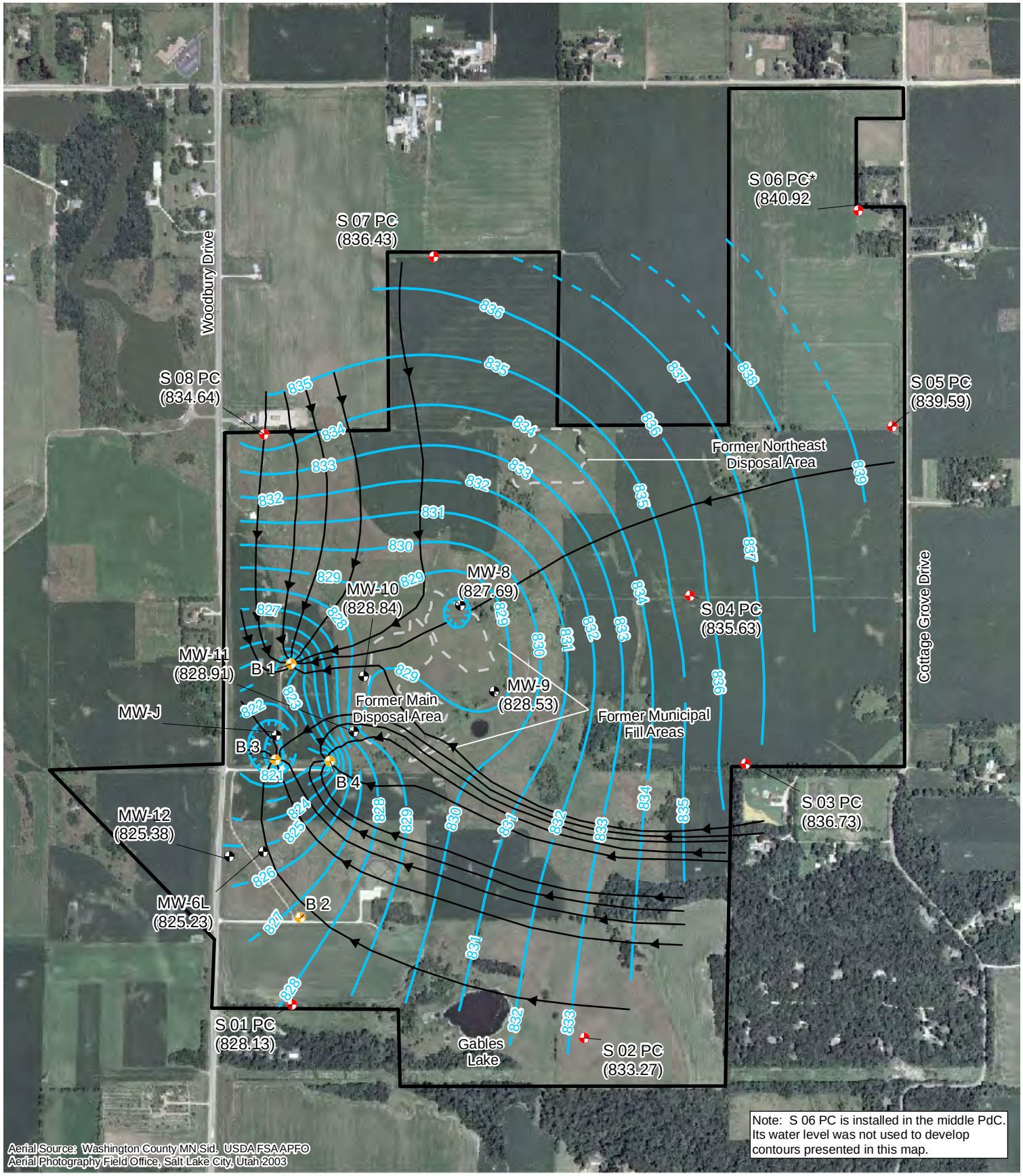
WESTON SOLUTIONS

FIGURE 1

GROUNDWATER ELEVATION CONTOUR MAP SHALLOW WELLS- PUMPING CONDITIONS 16 APRIL 2009

WOODBURY SITE
WOODBURY, MN

File: \\Fsfed01\TIG\3MWoodbury\MXD\shallow_gw_elev_jordan_16_april09.mxd, 09-Oct-09 09:40, ricksc



Legend:

- Monitoring Well Locations
- Sentinel Well Locations
- Barrier Well Locations
- Groundwater Elevation Contour (contour interval 1 foot)
- Groundwater Flowlines
- (828.53) Groundwater Elevation (ft.msl)
- Site Boundary

N
W E
S

0 500 1,000 Feet

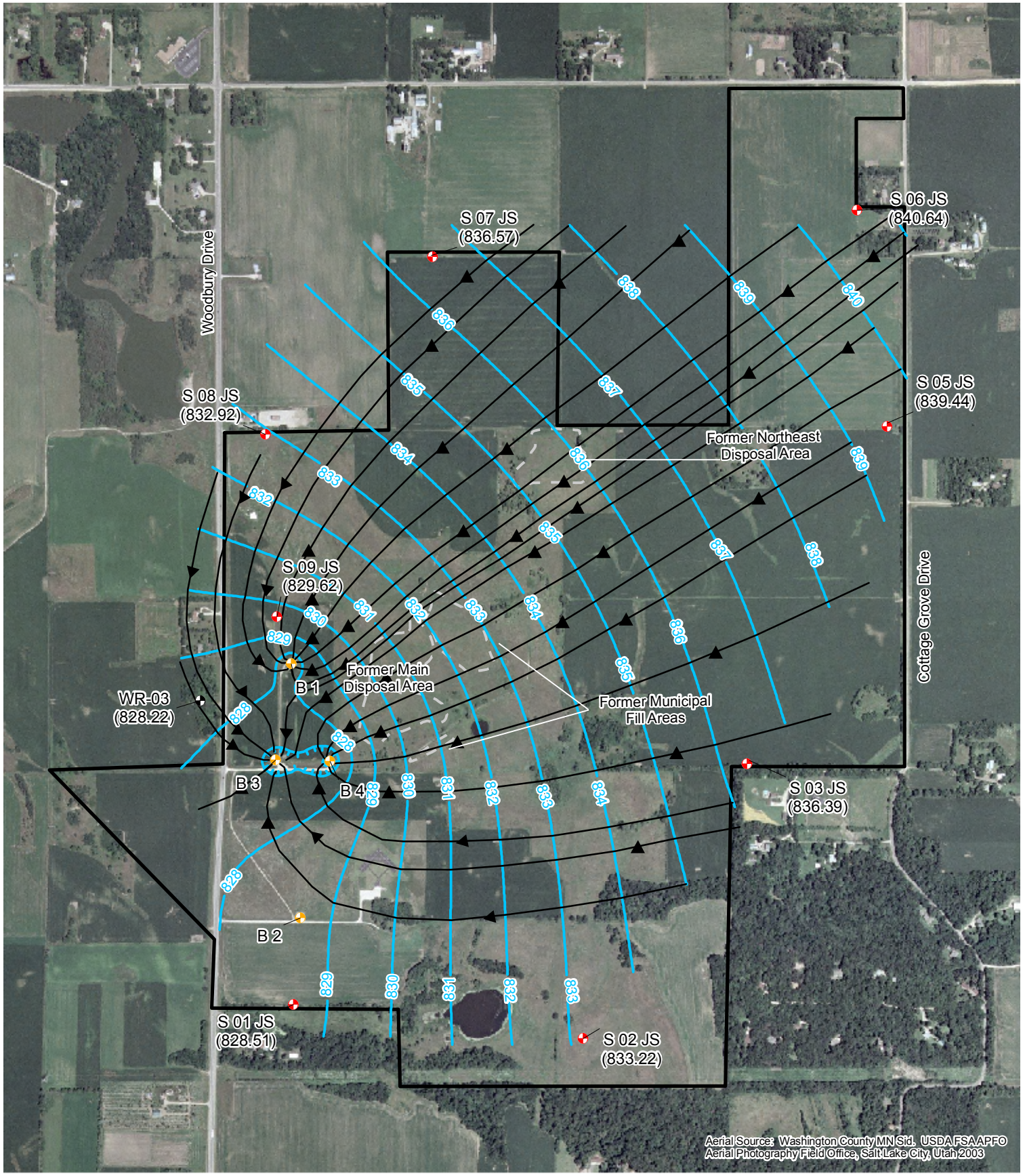
WESTON SOLUTIONS

FIGURE 2

GROUNDWATER ELEVATION CONTOUR MAP
SHALLOW PRAIRIE DU CHIEN WELLS
PUMPING CONDITIONS
16 APRIL 2009

3M WOODBURY SITE
WOODBURY, MN

File: \\Fsfed01\TIG\3MWoodbury\MXD\prairie_du_chien_gw_elev_April09.mxd, 09-Oct-09 09:41, ricksc



Legend:

- Monitoring Well Locations
- Sentinel Well Locations
- Barrier Well Locations
- Groundwater Elevation Contour (contour interval 1 foot)
- Groundwater Flowlines
- (833.22) Groundwater Elevation (ft.msl)
- Site Boundary

N
W E
S

0 500 1,000 Feet

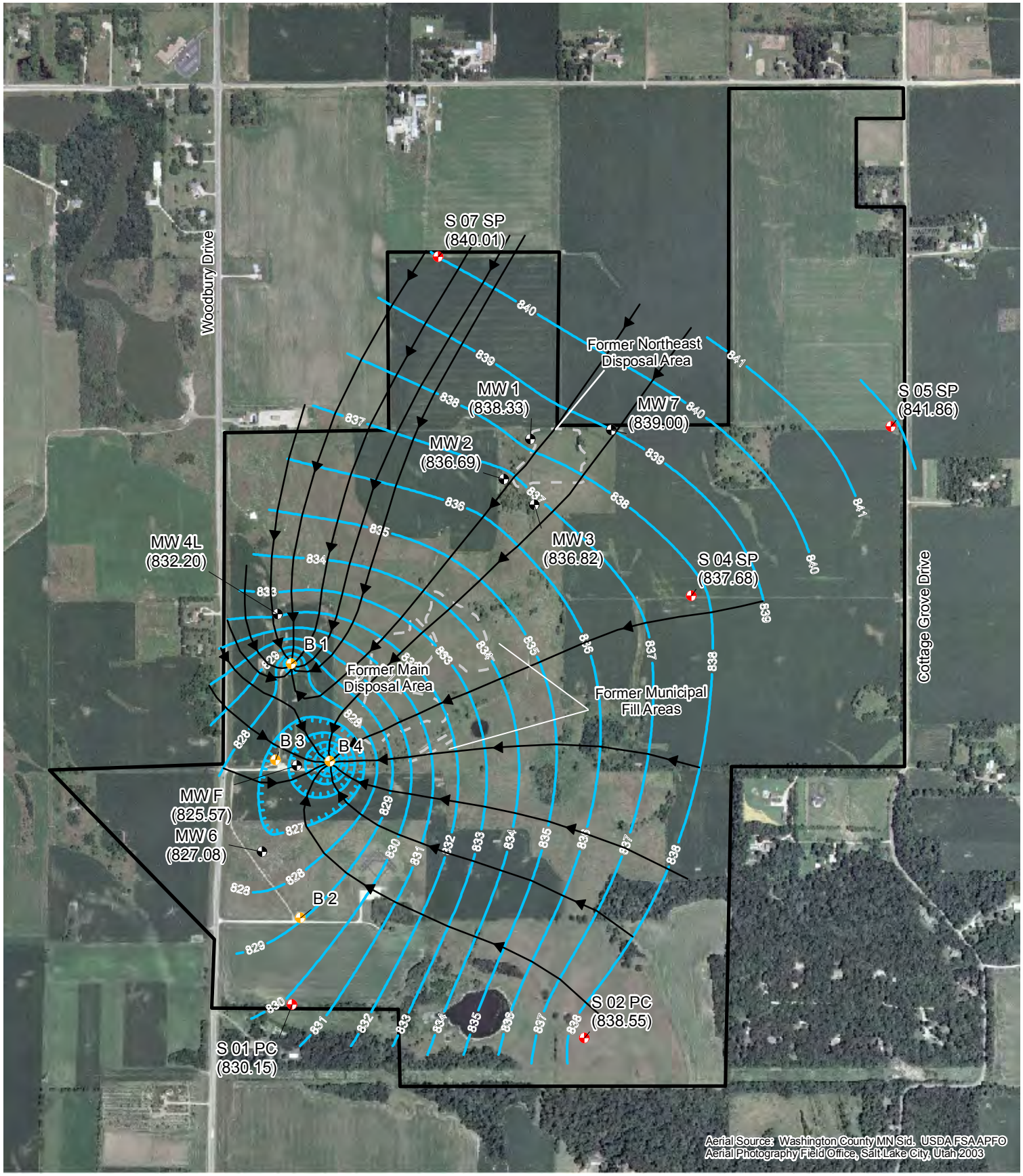
WESTON SOLUTIONS

FIGURE 3

GROUNDWATER ELEVATION CONTOUR MAP
JORDAN AQUIFER-
16 APRIL 2009

3M WOODBURY SITE
WOODBURY, MN

File: \\Fsfed01\TIG\3MWoodbury\MXD\gw_elev_jordan_16_april09.mxd, 16-Jun-09 14:40, ricksc



Legend:

- Monitoring Well Locations
- Sentinel Well Locations
- Barrier Well Locations
- Groundwater Elevation Contour (contour interval 1 foot)
- Groundwater Flowlines
- (833.22) Groundwater Elevation (ft.msl)
- Site Boundary

N
W E
S

0 500 1,000
Feet

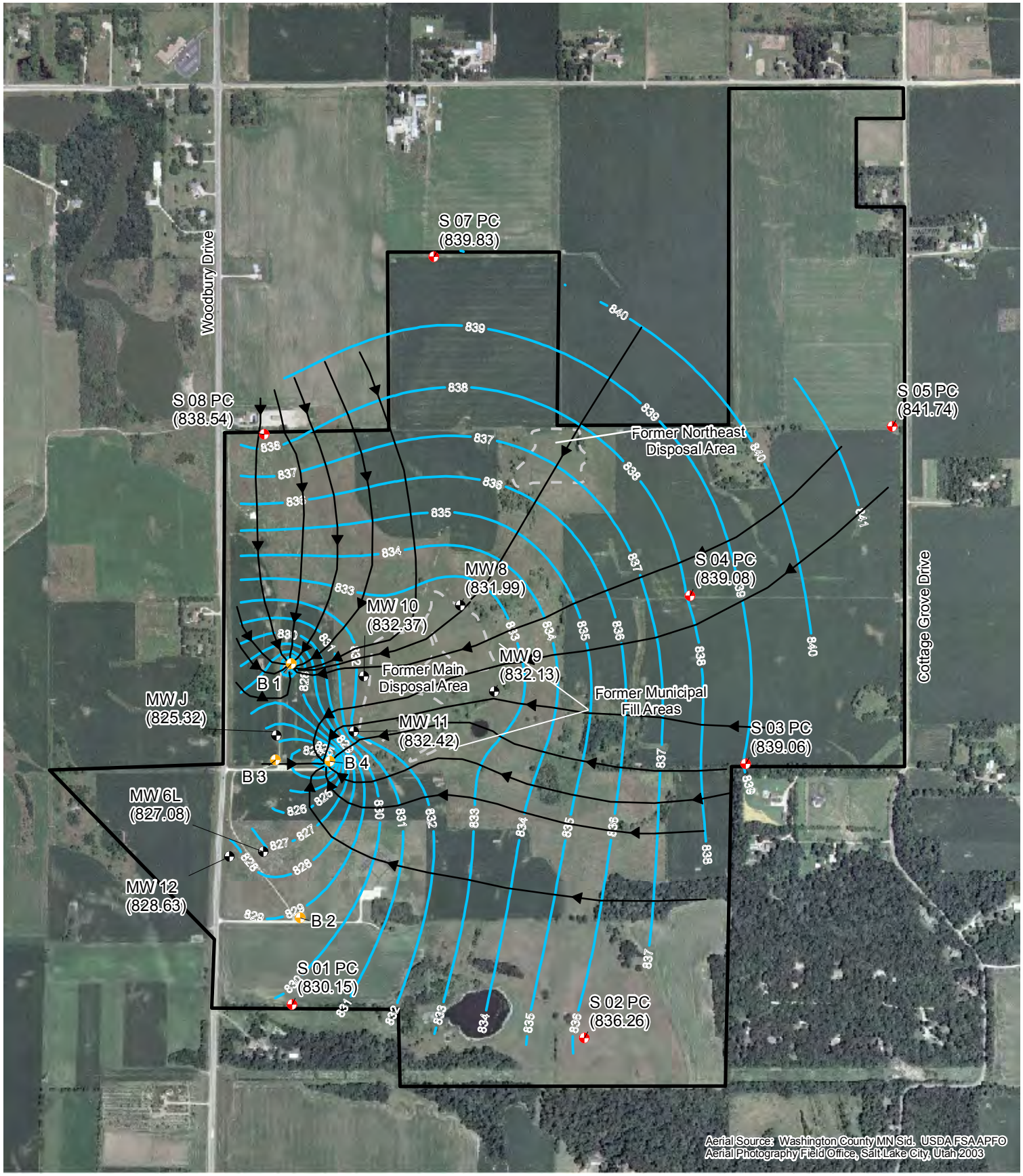
WESTON SOLUTIONS

FIGURE 4

PREDICTED GROUNDWATER ELEVATION CONTOUR MAP- SHALLOW WELLS PHASE 1

3M WOODBURY SITE
WOODBURY, MN

File: \\Fsfed01\TIG\3MWoodbury\MXD\gw_elev_shallow_scenario2.mxd, 08-Oct-09 11:26, ricksc



Legend:

- Monitoring Well Locations
- Sentinel Well Locations
- Barrier Well Locations
- Groundwater Elevation Contour (contour interval 1 foot)
- Groundwater Flowlines
- (833.22) Groundwater Elevation (ft.msl)
- Site Boundary

N
W E
S

0 500 1,000 Feet

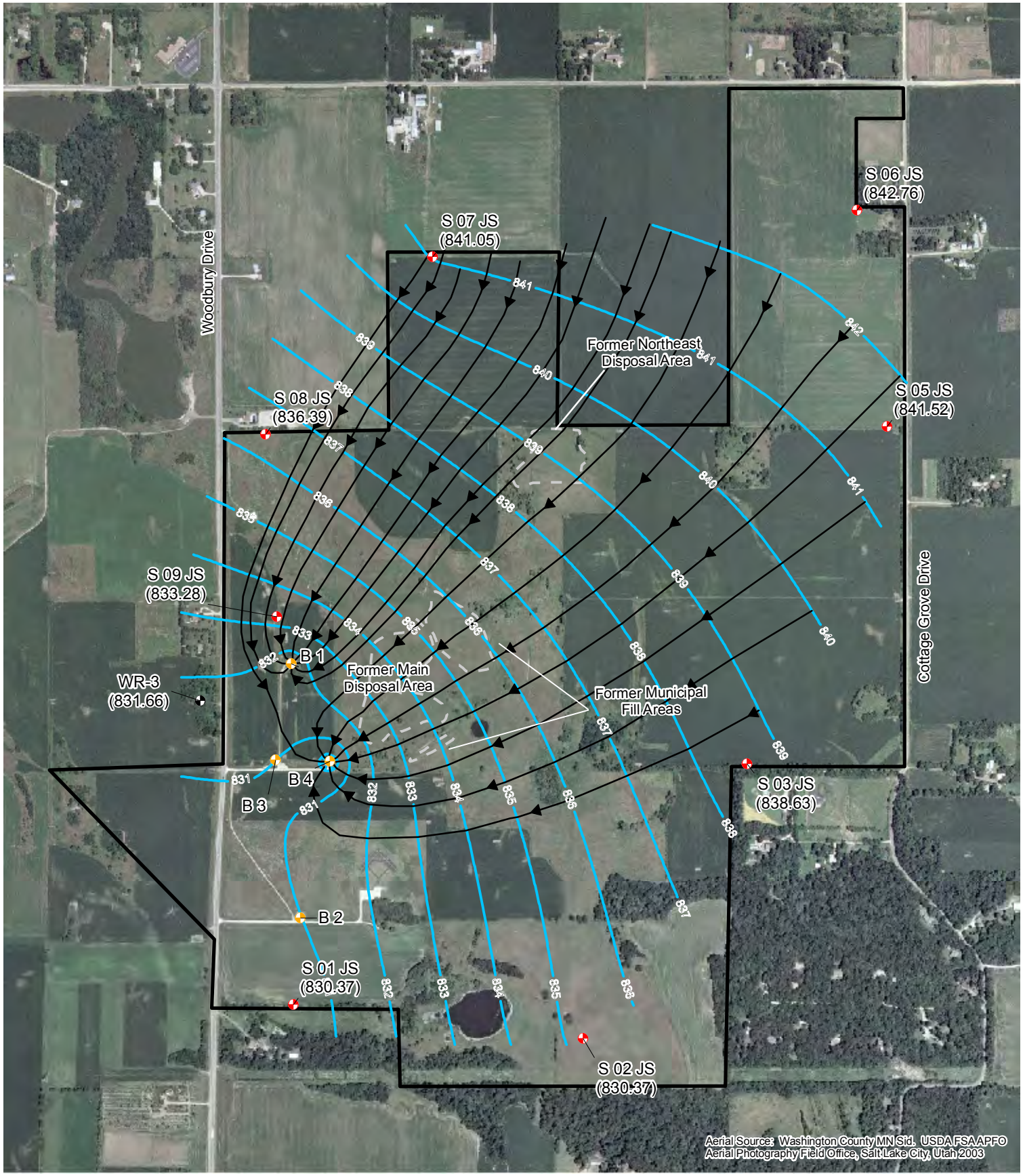
WESTON SOLUTIONS

FIGURE 5

PREDICTED GROUNDWATER ELEVATION CONTOUR MAP- SHALLOW PRAIRIE DU CHIEN PHASE 1

3M WOODBURY SITE WOODBURY, MN

File: \\Fsfed01\TIG\3MWoodbury\MXD\gw_elev_PDC_scenairo2mxd.mxd, 08-Oct-09 11:15, ricksc



Legend:

- Monitoring Well Locations
- Sentinel Well Locations
- Barrier Well Locations
- Groundwater Elevation Contour (contour interval 1 foot)
- Groundwater Flowlines
- (833.22) Groundwater Elevation (ft.msl)
- Site Boundary

N
W E
S

0 500 1,000 Feet

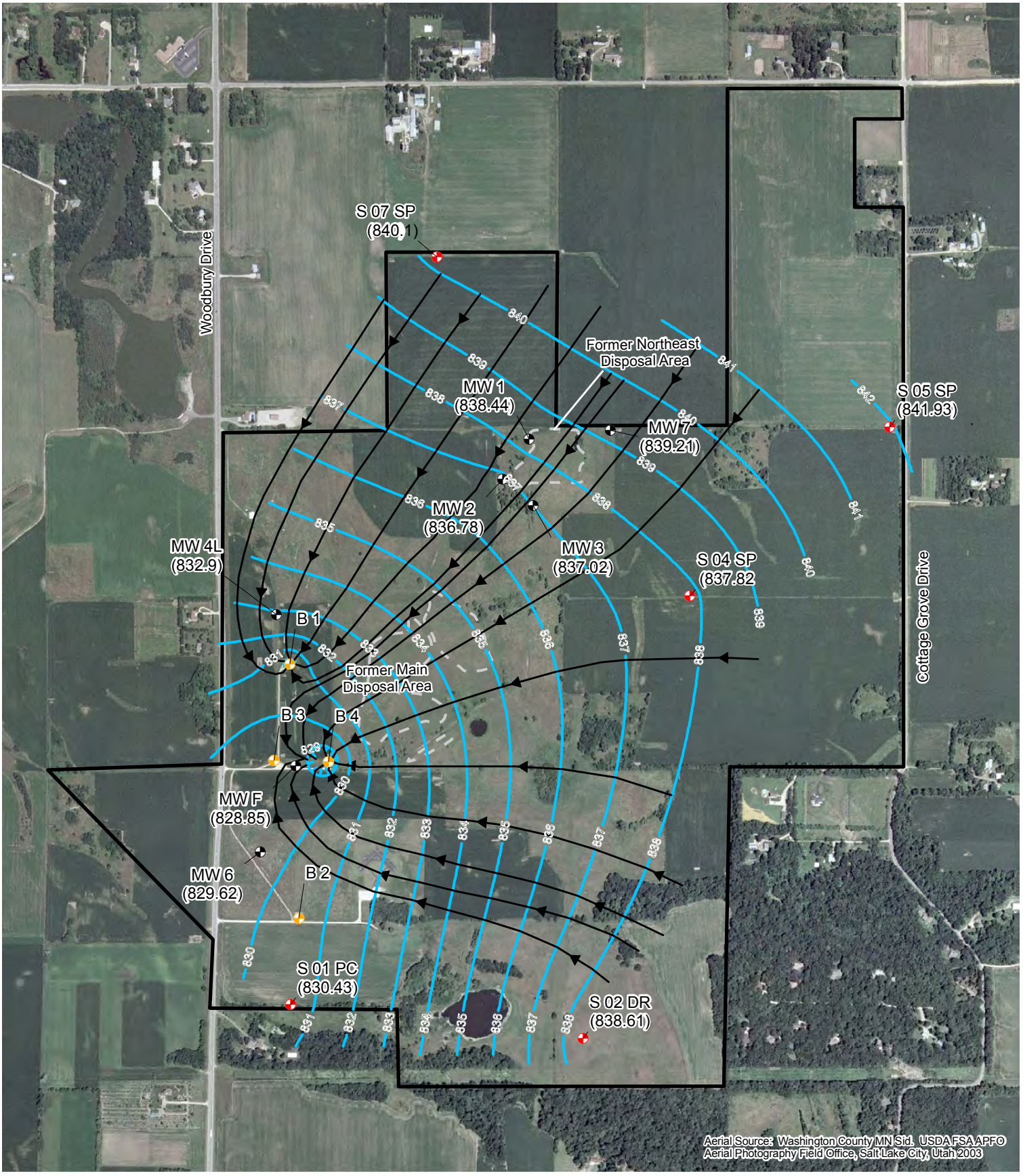
WESTON SOLUTIONS

FIGURE 6

PREDICTED GROUNDWATER ELEVATION CONTOUR MAP- JORDAN AQUIFER PHASE 1

3M WOODBURY SITE WOODBURY, MN

File: \\Fsfed01\TIG\3MWoodbury\MXD\gw_elev_jordan_scenario2.mxd, 08-Oct-09 11:48, ricksc



Legend:

- Monitoring Well Locations
- Sentinel Well Locations
- Barrier Well Locations
- Groundwater Elevation Contour (contour interval 1 foot)
- Groundwater Flowlines
- (833.22) Groundwater Elevation (ft.msl)
- Site Boundary

N
W E
S

0 500 1,000 Feet

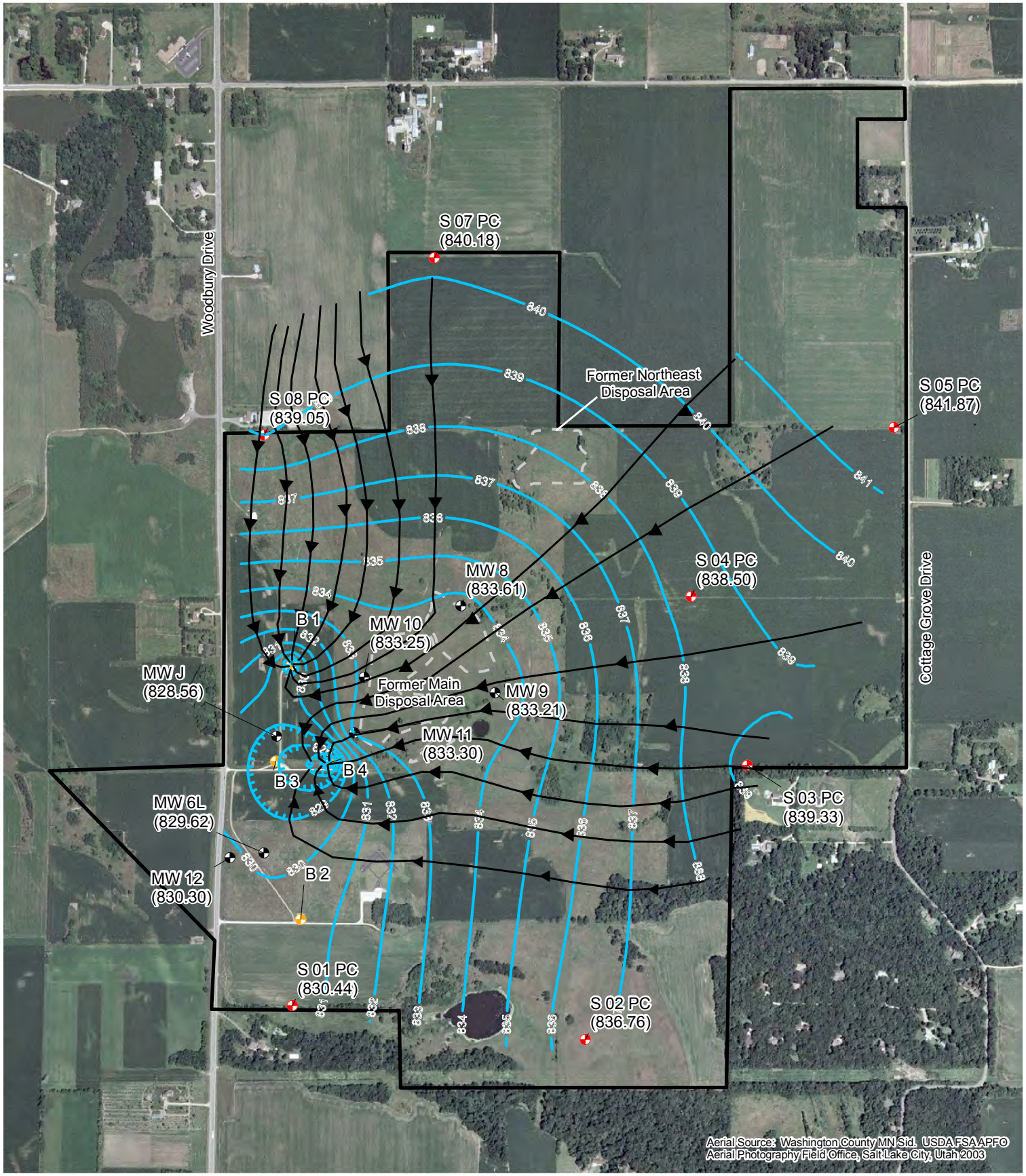
WESTON SOLUTIONS

FIGURE 7

PREDICTED GROUNDWATER ELEVATION CONTOURS AND CAPTURE ZONES- SHALLOW WELLS PHASE 2

3M WOODBURY SITE
WOODBURY, MN

File: \\fsfed01\tig\3MWoodbury\MXD\gw_elev_SHALLOW_option1.mxd, 05-Mar-10 09:40, ricksc



Legend:

- Monitoring Well Locations
- Sentinel Well Locations
- Barrier Well Locations
- Groundwater Elevation Contour (contour interval 1 foot)
- Groundwater Flowlines
- (833.22) Groundwater Elevation (ft.msl)
- Site Boundary

N
W E
S

0 500 1,000 Feet

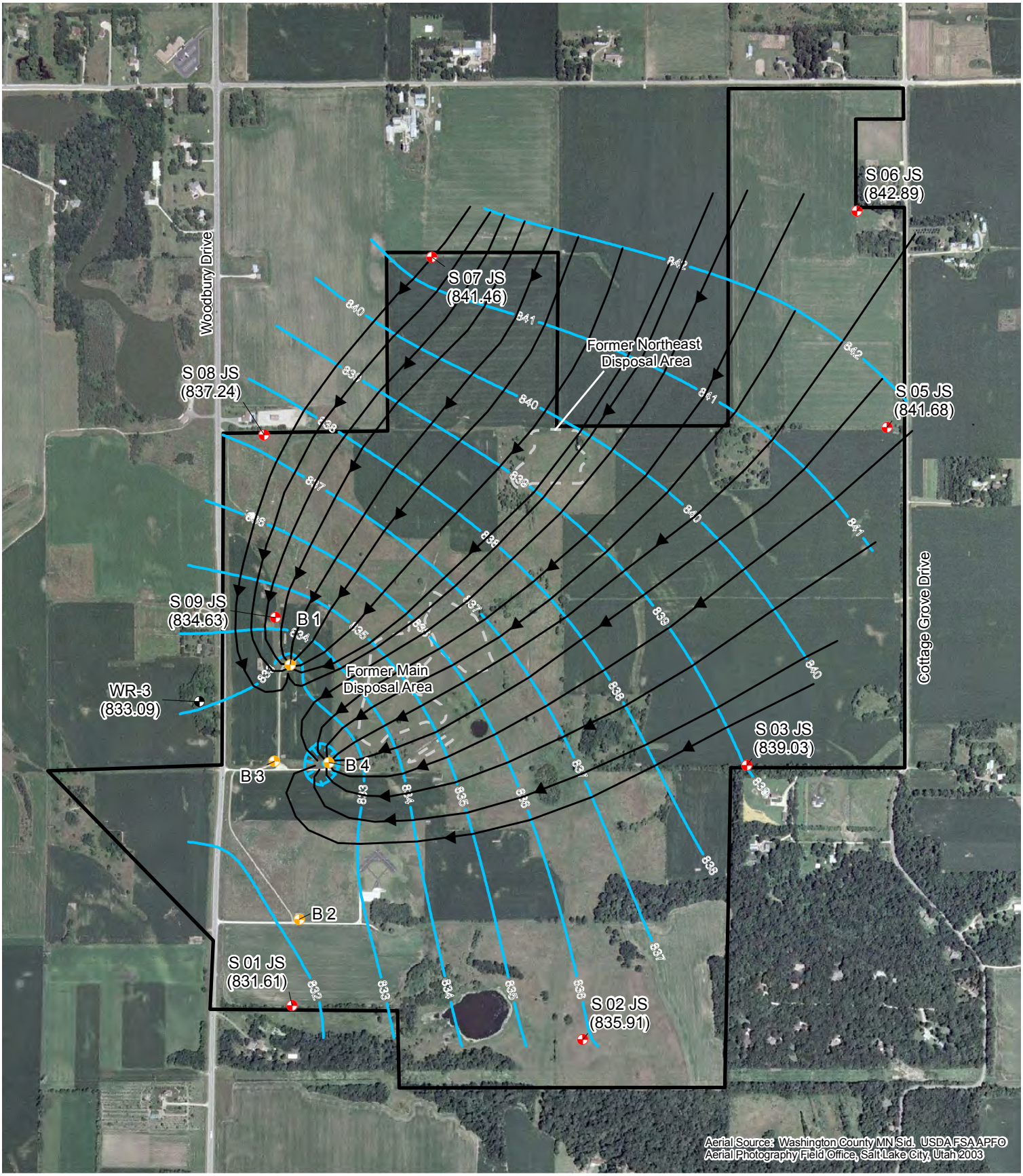
WESTON SOLUTIONS

FIGURE 8

PREDICTED GROUNDWATER ELEVATION CONTOURS AND CAPTURE ZONES- SHALLOW PRAIRIE DU CHIEN PHASE 2

3M WOODBURY SITE WOODBURY, MN

File: \\fsfed01\tig\3MWoodbury\MXD\gw_elev_PDC_option1.mxd, 05-Mar-10 10:22, ricksc



Legend:

- Monitoring Well Locations
- Sentinel Well Locations
- Barrier Well Locations
- Groundwater Elevation Contour (contour interval 1 foot)
- Groundwater Flowlines
- (833.22) Groundwater Elevation (ft.msl)
- Site Boundary

N
W E
S

0 500 1,000 Feet

WESTON SOLUTIONS

FIGURE 9

PREDICTED GROUNDWATER ELEVATION CONTOURS AND CAPTURE ZONES- JORDAN AQUIFER PHASE 2

3M WOODBURY SITE WOODBURY, MN

File: \\fsfed01\tig\3MWoodbury\MXD\gw_elev_jordan_option1.mxd, 05-Mar-10 09:48, ricksc

Legend:

- Monitoring Well Locations
- Sentinel Well Locations
- Barrier Well Locations
- Approximate Disposal Area Boundaries
- Site Boundary

N
W E
S

0 500 1,000 Feet

FIGURE 10

WOODBURY SITE AND WELL LOCATION MAP

3M WOODBURY SITE
WOODBURY, MN

File: \\Fsfed01\TIG\3MWoodbury\MXD\well_locations.mxd, 20-Jun-08 10:18, ricksc

APPENDIX B
COTTAGE GROVE SITE

Table 1

Estimated PFC Mass Flux to Mississippi River
Cottage Grove Facility, Cottage Grove, MN

Groundwater Flux Assumption	PFBA (lbs/day)	PFOS (lbs/day)	PFOA (lbs/day	Total PFCs (lbs/day)
Uniform Discharge	0.75	0.11	0.91	1.77

Total estimated groundwater discharge area = 2,942,000 ft^2

Table 2

Water Level Monitoring Locations
Extraction Well EW-01 and EW-02 Startup
Cottage Grove, MN Facility

Well ID	Well Depth (ft btoc)	Depth to Groundwater (ft btoc)	Well ID	Well Depth (ft btoc)	Depth to Groundwater (ft btoc)
EW-01	225	89	MW-16	141.1	94
EW-02	150	22	MW-101	101.9	95
ECPZ-01	112	70	MW-102	94.7	92
ECPZ-02	44.1	2.49	MW-103	86.0	80
ECPZ-03	42.3	0.65	MW-104	88.0	82
MW-10	241.5	94	MW-105	96.5	90
MW-11	186.6	103	MW-108	103.5	97
MW-12	141.0	94	MW-109	46.5	43
MW-13	134.0	92	MW-110	110.0	95
MW-15	186.5	96	PZ-14	187.7	65

Note: Monitor Wells MW-106 and MW-107 not included in water level monitoring network since they will be abandoned due to soil excavation activities performed in early 2010.

Legend:

- Phase 2 Porewater Sampling Location
- Production Well

N
W E
S

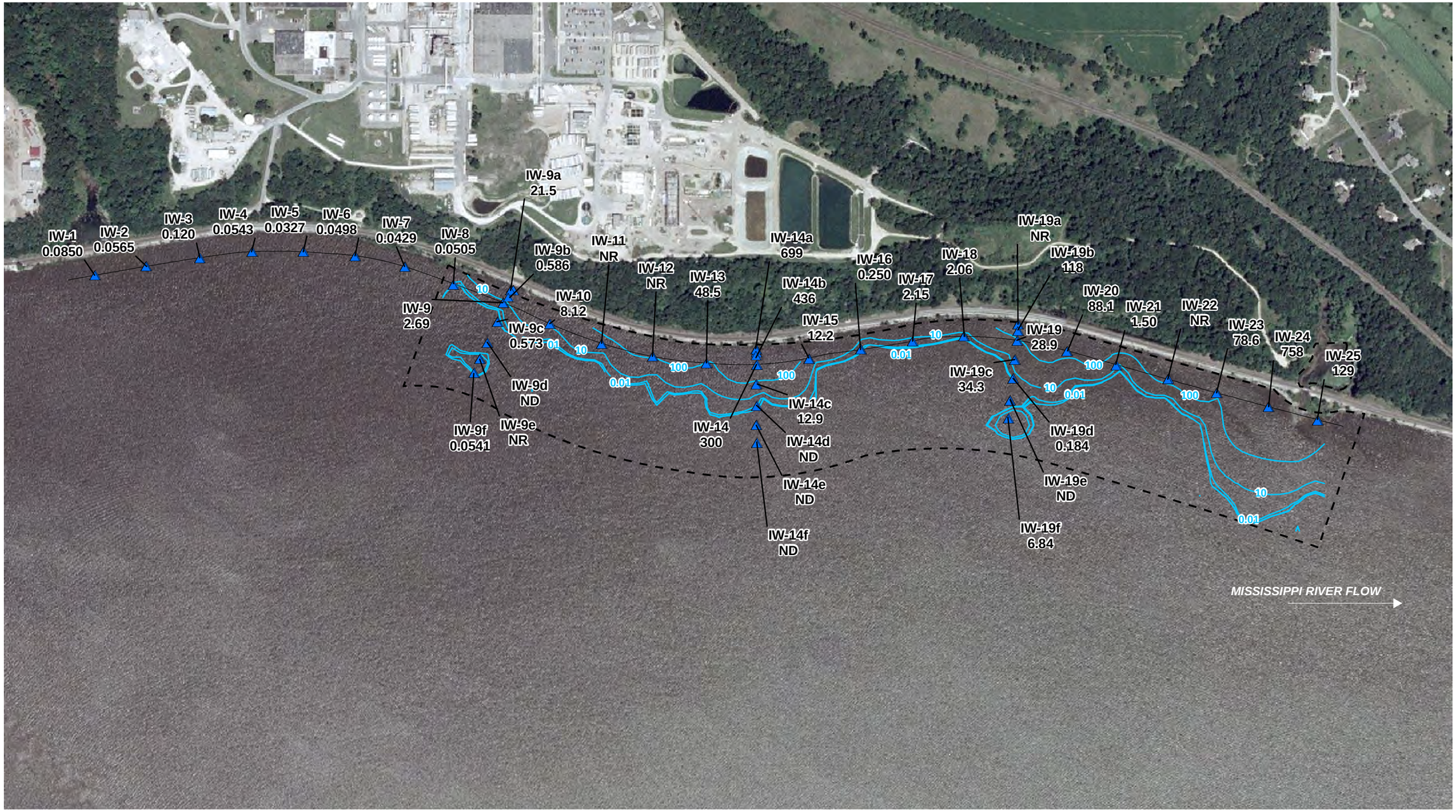
0 250 500
Feet

Map Source:
U.S. Department of Agriculture, Farm Services Agency, Aerial Photography Field Office;
National Agricultural Imagery Program (NAIP) Digital Orthorectified Images (DOQ), Minnesota, 2003

WESTON SOLUTIONS

FIGURE 1
POREWATER SAMPLING LOCATIONS
3M COTTAGE GROVE FACILITY

File: \\fsfed01\tig\Cottage_Grove\mxds\pore_water_dec_locs.mxd, 15-Feb-10 13:58, ricksc



Legend:

- ▲ Phase 2 Porewater Sampling Location
- ND Not Detected at or above Limit of Quantitation (LOQ)
- NR Not Reported due to quality control failures
- Interpreted PFOA Isoconcentration
- Estimated Groundwater Discharge Area

All concentrations in ppb (ng/mL)

N
W E
S

0 250 500
Feet

Map Source:
U.S. Department of Agriculture, Farm Services Agency, Aerial Photography Field Office;
National Agricultural Imagery Program (NAIP) Digital Orthorectified Images (DOQ), Minnesota, 2003

WESTON SOLUTIONS

FIGURE 2
PFOA CONCENTRATION ISOPLETHS
COTTAGE GROVE SITE

File: \\fsfed01\tig\Cottage_Grove\mxds\pore_water_PFOA_ISO_concentration.mxd, 15-Feb-10 13:44, ricksc

Legend:

- Monitoring Well
- Production Well
- Extraction Well

Note: Well Locations are Approximate

N
W E
S

0 500 1,000
Feet

Map Source:
U.S. Department of Agriculture, Farm Services Agency, Aerial Photography Field Office;
National Agricultural Imagery Program (NAIP) Digital Orthorectified Images (DOQ), Minnesota, 2003

FIGURE 3
WELL LOCATIONS
3M COTTAGE GROVE FACILITY

File: \\fsfed01\tig\Cottage_Grove\mxds\well_locations_0210.mxd, 15-Feb-10 13:59, ricksc