**RAI 02.04.12-48**

**QUESTION:**

To meet the requirements of 52.79(a) and assist staff in its analysis, additional information concerning the groundwater modeling is required. Describe the sensitivity cases used to evaluate post-construction infiltration rates within the powerblock of proposed STP Units 3&4, and the excavation backfill hydraulic properties, (e.g., saturated hydraulic conductivity). In addition, describe the potential influence of structures that will remain in the subsurface. For example, in addition to the slurry wall which is simulated and described, what is the potential influence of the two Crane Foundation Retaining Walls which are described as permanent structures (890 ft long, 80 ft deep, and 3 ft wide)? Also, describe the influence of the existing relief well system on the water table within the powerblock of proposed STP Units 3&4. For example, what would occur if the system or a portion of the system failed? Alternatively, describe the conservative or bounding assumptions made in the evaluation of the maximum water table within the powerblock and the plausible pathways from the proposed STP Units 3&4 to points of possible human exposure.

**RESPONSE:**

The response to RAI 02.04.12-48 is addressed in the following three parts as shown below:

- Part 1: Sensitivity to Post-Construction Infiltration Rates.
- Part 2: Potential Influence of Structures, Slurry Wall and Crane Foundation Retaining Walls on Groundwater Levels.
- Part 3: Failure of MCR Relief Wells and Impact on STP Units 3 & 4 Groundwater Levels.

**Part 1: Sensitivity to Post-Construction Infiltration Rates**

Sensitivity studies will be performed to further evaluate post-construction infiltration rates based on the power block area ground cover types and excavation backfill hydraulic properties. The sensitivity analyses will include varying the hydraulic properties of the excavation backfill and post-construction ground cover and evaluating groundwater response to these variations at STP Units 3 & 4. The results of these sensitivity studies will be provided in a supplement to this response to be submitted by December 15, 2010.

**Part 2: Potential Influence of Structures, Slurry Wall and Crane Foundation Retaining Walls on Groundwater Levels**

An evaluation of the potential influence of the permanent structures to be installed in the subsurface at STP Units 3 & 4 was conducted through a series of groundwater model sensitivity analyses. This evaluation confirmed that the results obtained using groundwater Run 201 as documented in the Groundwater Model Report (Reference 1) provide reasonable post-construction groundwater flow simulations for STP Units 3 & 4.

A series of sensitivity analyses were performed to evaluate model Run 201. As a result of the sensitivity analysis a revised pre-construction model (Run 301) was developed. Run 301 was verified using the February and March 2003 groundwater level measurement data sets for the STP site (MCR elevation level at 47 ft MSL). In addition, model simulation results of Run 301 with MCR level at 42 ft MSL was compared to that of the pre-construction Run 201 model, with MCR water level also at 42 ft MSL. The simulated heads and groundwater budget of Run 301 matched very closely with that of Run 201. In fact, in some cases, the residuals in Run 301 were better than that in Run 201. The results of the verification are discussed in the response to RAI 02.04.12-40

The pre-construction model (Run 301) was further modified to include updated post-construction structural design configurations for STP Units 3 & 4. The revised post-construction model (referred to as Run 301PC) is used to evaluate the Run 201 post-construction simulations. Run 301PC incorporated the following post-construction design updates:

- Refinements to the STP Units 3 & 4 structures and structural fill locations and elevations;
- Updated version of the power block finished grade design, including a backfill cover;
- Configuration refinements to the Slurry Wall design;
- Inclusion of two crane foundation retaining walls (CFRWs);
- Inclusion of a relocated portion of the Main Drainage Channel (MDC); and
- Incorporation of a conservative bounding MCR stage elevation (MCR spillway).

In addition, the development of model Run 301PC required the incorporation of three additional model layers (for a total of ten model layers) to accommodate the updated STP Units 3 & 4 structure foundation and excavation depths. Pre-construction model layer 2 (part of Stratum A/B), model layer 4 (Stratum D), and model layer 6 (Stratum F) were each split into two layers to support post-construction simulations.

Post-Construction Model 301PC

An approximately five-foot thick clay cap is planned as a ground cover at STP Units 3 & 4. The clay cover will serve as a low permeability cap over the structural fill material. This clay cap was incorporated into model layer 1 and was set to a top elevation of approximately 34 ft MSL, the approximated finished grade at STP Units 3 & 4, and a bottom elevation of 29 ft MSL, base of the clay cap. The hydraulic conductivity was set to 5E-06 centimeters per second (cm/s).

The slurry walls (composed of a proposed bentonite/clay slurry mix) and the CFRWs (composed of a proposed concrete mix) were modeled in Visual MODFLOW (Reference 2) using the Horizontal Flow Barrier (HFB) package (Reference 3). The slurry wall dimensions were modeled to be three feet thick with a hydraulic conductivity of 1E-06 cm/s (Reference 1). For modeling purposes, the design and construction of the CFRWs was assumed to be similar to that of a slurry wall and modeled as such.

The slurry wall in the vicinity of STP Units 3 & 4 was keyed three feet into Stratum J clay, which is the bottom layer of the groundwater model. The slurry wall around the circulating water pipes was keyed three feet into Stratum D clay (model layer 5). In Run 301PC, Stratum D is divided into two model layers (model layers 5 and 6). The top of the new model layer was set at an elevation of three feet below the top of model layer 5.

The CFRW base elevation was set at an elevation of approximately -74 ft MSL. Layer 6 (Stratum F clay in the pre-construction Run 301 model) was divided into two model layers (layers 8 and 9) in the post-construction model (Run 301PC). The top of the new layer was set at -74 ft MSL in the vicinity of the CFRWs. The HFBs representing the crane foundation retaining walls extend from ground surface to the top of this new model layer (model layer 8).

The location and dimensions of the proposed relocated MDC north and west of STP Units 3 & 4 were incorporated into the post-construction model (Run 301PC). The MDC is represented in the model with lines of drain cells in model layer 1. A conductance value of 200 ft/day per foot is used for these drain lines in the model. This is the same conductance value used in the calibrated groundwater model Run 201 for the portion of the existing MDC that was to be relocated prior to constructing STP Units 3 & 4.

Run 301PC incorporated a MCR stage of 49.5 ft MSL, which is the elevation of the MCR spillway. This elevation represents an upper bounding condition considering that the maximum operating stage for the MCR is 49 ft MSL and a stage greater than 49.5 ft MSL would cause water within the MCR to be diverted over the spillway to the Colorado River.

Post-Construction Sensitivity Analysis Results

Figure 2-1 shows the STP Units 3 & 4 plan-view layout of structures, retaining walls, and the clay cap material in model layer 1 of the post-construction model (Run 301PC). Table 2-1 provides the water balance for the post-construction run (Run 301PC) in comparison to the pre-construction model run (Run 301). This table shows increased discharge to groundwater from the MCR as expected with the relative MCR stage increase (i.e., pre-construction model Run 301 uses an MCR stage of 42 ft MSL whereas post-construction model Run 301PC uses the MCR spillway stage of 49.5 ft MSL).

Contours of simulated head values in Stratum C sands (model layer 4) from the post-construction model are displayed on Figures 2-2 and 2-3. Figure 2-2 shows the entire simulation domain, while Figure 2-3 displays the area immediately surrounding STP Units 3 & 4. Similar plots are provided in Figures 2-4 and 2-5 for Stratum E sands (model layer 7) and in Figures 2-6 and 2-7 for Stratum H sands (model layer 10). The hydraulic conductivity contrast created by the slurry walls and structural fill material causes refraction of the head contours as seen on Figures 2-3, 2-5, and 2-7. Figure 2-8 displays the depth to water obtained from the post-construction simulation.

Particle tracks were then used to predict post-construction groundwater flow paths from STP Units 3 & 4. The starting positions of particles used in forward particle tracking were placed in model layer 4 (Stratum C), model layer 7 (Stratum E), and model layer 10 (Stratum H).

Figure 2-9 displays the particle pathlines for Run 301PC as calculated by MODPATH within Visual MODFLOW (Reference 2). Particles were released in Stratum C, both within and outside of the slurry wall surrounding STP Units 3 & 4. All but two particles released in the vicinity of STP Units 3 & 4 travel towards the east or southeast. The two particles that travelled towards the southwest were released west of Units 3 & 4, outside of the slurry wall. These particles traveled southwesterly within the Upper Shallow Aquifer terminating at the relocated Little Robbins Slough. The cause of this southwesterly flow pattern is due to a groundwater flow divide in Stratum C immediately to the west of the power block, beyond the slurry wall. This flow divide is not evident in the Lower Shallow Aquifer strata as shown in Figure 2-10. Particles released in the vicinity of the STP Units 3 & 4 in model layer 7 (Stratum E) travel towards the east or southeast as shown in Figure 2-10.

Figures 2-11 to 2-13 display the particles released in Stratum C (model layer 4), Stratum E (model layer 7), and Stratum H (model layer 10) within the Unit 3 & 4 power block, adjacent to the radwaste buildings, the source of a postulated accidental release. The particles ultimately migrate to the east and southeast similar to the particle tracks documented by Run 201 (Reference 1).

The shortest travel time to the site boundary from a radwaste building (STP Unit 3) is about 104 years. The particles released in Stratum E (model layer 7), move eastward to the site boundary. Particles that start in model layer 4 (Stratum C) move downward through the fill material to Strata E before continuing eastward or southeastward to the site boundary. The shortest travel times for the particles released in Stratum C are similar to those released in Stratum E since movement downward through the fill material is short relative to the movement through Stratum E from STP Units 3 & 4 to the eastern site boundary.

Results of Run 301PC indicate that groundwater levels at STP Units 3 & 4 remained more than 10 feet below the post-construction plant grade elevation 34 ft MSL (Figure 2-8) and that groundwater flow originating within the slurry walls migrate to the east and southeast (Figures 2-11 to 2-13). The differences between the pre- and post-construction simulated groundwater heads are presented in Figure 2-14. The simulated groundwater levels in the post-construction model in the Upper Shallow Aquifer (Stratum C) are up to three feet lower within the power block of Units 3 & 4 and no more than one foot lower outside of the power block slurry wall compared to pre-construction simulated groundwater levels. This creates a depression in the potentiometric surface beneath Units 3 & 4 and is similar to Run 201 as explained in the response to RAI 02.04.12-42.

The groundwater heads obtained from Run 301PC are similar to the results obtained from the post-construction Run 201, and thus the results of the post-construction Run 201 are considered valid. The influence of the two CFRWs inside the slurry wall did not cause any appreciable impact to the groundwater levels at STP Units 3 & 4. In addition, the results indicate that particles released (representing groundwater flow paths) within the slurry wall at STP Units 3 & 4 will travel east and southeast as indicated by Run 201.

**Part 3: Failure of MCR Relief Wells and Impact on STP Units 3 & 4 Groundwater Level**

A complete failure of all or a significant number of the approximately 770 independent passive relief wells is not considered to be a credible event. However, to address this question, two groundwater modeling runs with relief well failure scenarios were developed as described below. Since relief well failure is unexpected, the scenarios examined can provide a bounding, worst-case scenario for a potential change to the predicted (simulated) maximum groundwater level beneath STP Units 3 & 4 .

Relief Well Failure Model Scenarios

The two relief well failure sensitivity analyses developed were built upon post-construction model Run 301PC. The first scenario (Run 301PC_RWFailN) simulated the hypothetical case of a failure of all relief wells and sand drains around the northern perimeter of the MCR adjacent to STP Units 1, 2, 3, and 4. The second scenario (Run 301PC_RWFailAll) simulated the hypothetical case of failure of all MCR relief wells and sand drains. The drain lines representing the relief wells and sand drains that were inactivated for the simulations are shown in Figure 3-1.

Relief Well Failure Model Results

Table 3-1 provides a comparison of the water balance among the two relief well failure scenarios to that of base case Run 301PC. Table 3-2 presents the groundwater discharge from the MCR shown on Table 3-1 as captured by each relief well drain line. As shown in Table 3-1, discharge from the MCR in the model water budget decreases with an increase in the number of inactive relief wells. Consequently, Run 301PC provides the largest discharge from the MCR because all relief well drain lines are active. Run 301PC_RWFailN provides the second largest discharge because less relief well drain lines are active. Run 301PC_RWFailAll gives the lowest discharge because no relief well drain lines are active. This is attributed to the active relief well drain lines ability to lower the simulated groundwater heads immediately outside the MCR perimeter creating a relatively large hydraulic gradient within the MCR embankment, which increases the MCR discharge. When relief well drain lines are inactivated in the model, higher water levels beyond the perimeter of the MCR occur, which decreases hydraulic gradients beyond the MCR and discharge from the MCR. As the amount of inactive relief wells increases, flow to surface drains, the Colorado River and Kelly Lake increases.

Table 3-3 gives the maximum simulated head value in each layer in the vicinity of STP Units 3 & 4 for each of the relief well failure scenarios. The area examined for the maximum head value corresponds to the Units 3 & 4 area polygon shown on the water level comparison figures discussed in the next paragraph. The maximum water level obtained from the relief well failure simulations is elevation 25.8 ft MSL that occurs when all relief wells fail (Run 301PC_RWFailAll). This elevation value is at the southern end of the slurry wall enclosure, south of the Units 3 & 4 power block area. The simulated groundwater elevation at the power block area is less than 25 feet MSL when all relief wells fail (Run 301PC_RWFailAll).

Figures 3-2 through 3-6 provide a comparison of simulated water levels in Strata C, E and F from the northern perimeter relief well failure scenario (Run 301PC_RWFailN) and the post-construction model (Run 301PC). These figures provide the head difference between the relief well failure scenario and the base case post-construction model. The differences in head were calculated using the "drawdown" format where the head from the relief well failure scenario (Run 301PC_RWFailN) is subtracted from the head for the post-construction base case model (Run 301PC). As a result, a negative difference denotes simulated head values from Run 301PC are less than those simulated for the relief well failure scenario. A positive difference corresponds to locations where the base case simulated head values are larger than relief well failure scenario values. As expected from relief well failure along the northern perimeter, Figures 3-2 through 3-6 show a relative increase in water levels around the northern portion of the MCR. This increase is largest along the northeastern portion of the perimeter where the hydraulic gradient is steepest (i.e., from the MCR to the Colorado River). In the vicinity of the STP Units 3 & 4 site (northern perimeter of the MCR), the water level increase is not as large due to the relatively shallow hydraulic gradient created by the groundwater flow divide located in this area. In this scenario, the water level change in model layer 10 (Stratum H) from relief well failure is negligible as shown on Figure 3-6.

Graphical comparisons of simulated water levels from the all relief well failure scenario (Run 301PC_RWFailAll) and the base case post-construction scenario (Run 301PC) are provided on Figures 3-7 through 3-12. A relative increase in water levels is evident across the simulation domain and in all three sand strata. The groundwater flow divide, which exists to the north of the MCR in the vicinity of STP Units 3 & 4, acts to limit the relative water level increase in this region, which is also the location of STP Units 3 & 4. The impact of the divide is evident in Figures 3-7 and 3-8.

<u>Relief Well Failure Model Conclusions</u>

Relief well failure will cause an increase in water levels in the vicinity of STP Units 3 & 4 and is dependent on the number of relief wells that fail. However the maximum water level simulated in the vicinity of STP Units 3 & 4 from the two relief well failure scenarios is elevation 25.8 ft MSL, which is south of the power block area. In addition, the groundwater flow divide that exists in the Upper Shallow Aquifer (Stratum C) to the north of the MCR in the vicinity of Units 3 & 4 mutes the water level increase in this area.

The relief well failure situations are unlikely because STP has a routine maintenance program for the relief wells to ensure they function properly. However, even though this is an unlikely event, the two hypothetical sensitivity analyses demonstrated that, even if the relief wells failed, the groundwater level would not exceed the maximum groundwater elevation of 28 ft MSL that was established for STP Units 3 & 4.

No COLA revision is required as a result of this RAI response

**References**

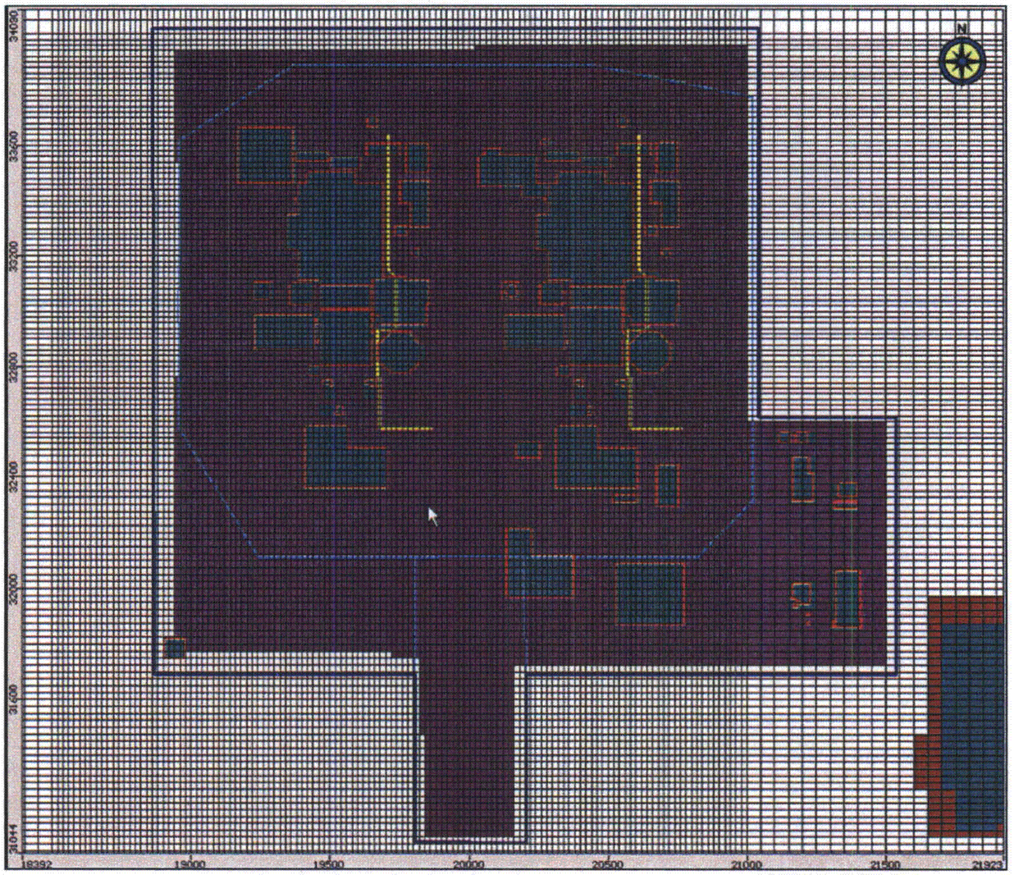
1) STPNOC Letter No. U7-C-STP-NRC-090206, "Supplemental Response to Requests for Additional Information," dated November 30, 2009, Attachment 2, "Groundwater Model Development and Analysis for STP Units 3&4".

2) Schlumberger Water Services, 2009. Visual MODFLOW Professional v.4.3, User's Manual.

3) Hsieh, Paul A. and Freckleton, John R., 1993. Documentation of a Computer Program to Simulate Horizontal-Flow Barriers using the U.S. Geological Survey's Modular Three-Dimensional Finite-Difference Ground-Water Flow Model, U.S. Geological Survey Open-File Report 92-477.

**Table 2-1. Water Balance Comparison Between Run 301 and Run 301PC**

| Description | Runs | | | |
|---|---|---|---|---|
| | 301 | | 301PC | |
| | Inflows (gpm) | Outflows (gpm) | Inflows (gpm) | Outflows (gpm) |
| MCR Discharge Total | 3574.9 | 0.0 | 5030.9 | 0.0 |
| Through Sand Pits | 2827.8 | 0.0 | 3498.5 | 0.0 |
| Through Remaining Portion of MCR | 747.1 | 0.0 | 1532.4 | 0.0 |
| Precipitation/Recharge | 2.0 | 0.0 | 2.0 | 0.0 |
| ECP | 0.8 | 0.0 | 1.5 | 0.0 |
| Stratum C GHB | 213.2 | 244.8 | 211.7 | 257.1 |
| Stratum E GHB | 216.4 | 100.0 | 209.1 | 103.4 |
| Stratum H GHB | 182.1 | 91.4 | 175.8 | 94.7 |
| Levee-Bound Irrigation Canals | 148.2 | 3.1 | 147.7 | 4.1 |
| Livestock Well | 0.0 | 0.4 | 0.0 | 0.4 |
| Colorado River | 0.2 | 675.5 | 0.2 | 715.6 |
| Canals and Ditches in Stratum A/B | 0.0 | 542.5 | 0.0 | 666.7 |
| Little Robbins Slough and Plant Area Drainage Ditches in Stratum C | 0.0 | 671.6 | 0.0 | 935.7 |
| Kelly Lake | 0.0 | 298.5 | 0.0 | 372.6 |
| MCR Relief Wells and Sand Drains from MCR | 0.0 | 1699.9 | 0.0 | 2606.1 |
| MCR Relief Wells and Sand Drains from other Sources | 0.0 | 10.3 | 0.0 | 23.0 |
| **TOTALS** | **4337.9** | **4338.1** | **5778.9** | **5779.4** |
| **PERCENT DISCREPANCY** | **-0.005** | | **-0.010** | |



Legend: Blue Line = extent of Units 3 and 4 area; Cyan Line = Slurry Walls; Green Cells = inactive to flow (structures); Red Lines = Structure footprints; Yellow Lines = Crane Foundation Retaining Walls; Red Cells = structural fill material (Units 1 and 2 only in this layer); Purple Cells = clay cap material; White Cells = Stratum A/B clay material.

Notes: Plot shown in dimensions of feet with Visual MODFLOW model coordinates.

**Figure 2-1. Representation of Clay Cap, Structures, and Retaining Walls in Post-Construction Model, Run 301PC.**

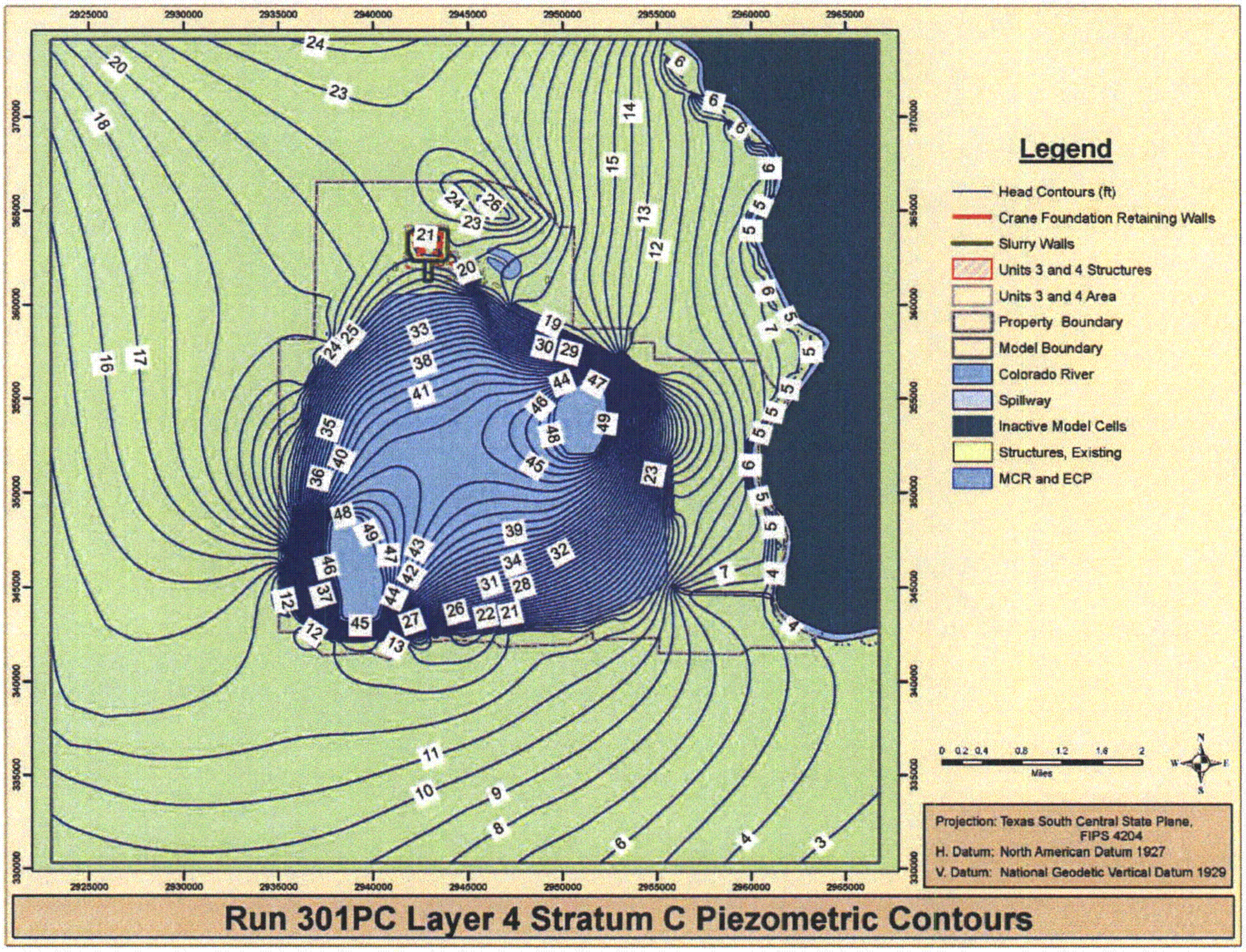



**Figure 2-2. Stratum C Head Contours from Post-Construction Model, Run 301PC.**

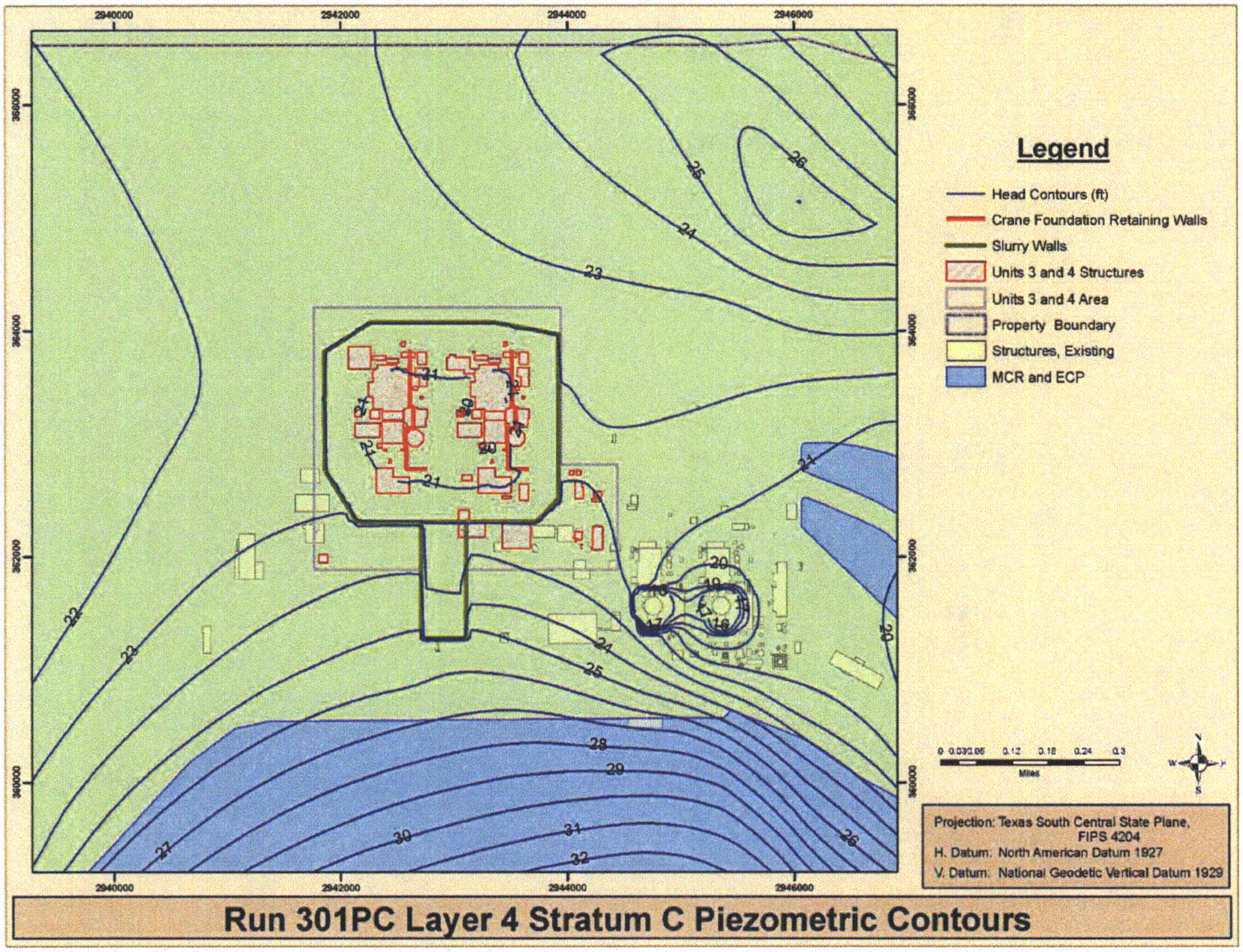



**Figure 2-3. Stratum C Head Contours in the Vicinity of the STP Units 3 & 4 Power Block from Post-Construction Model, Run 301PC.**

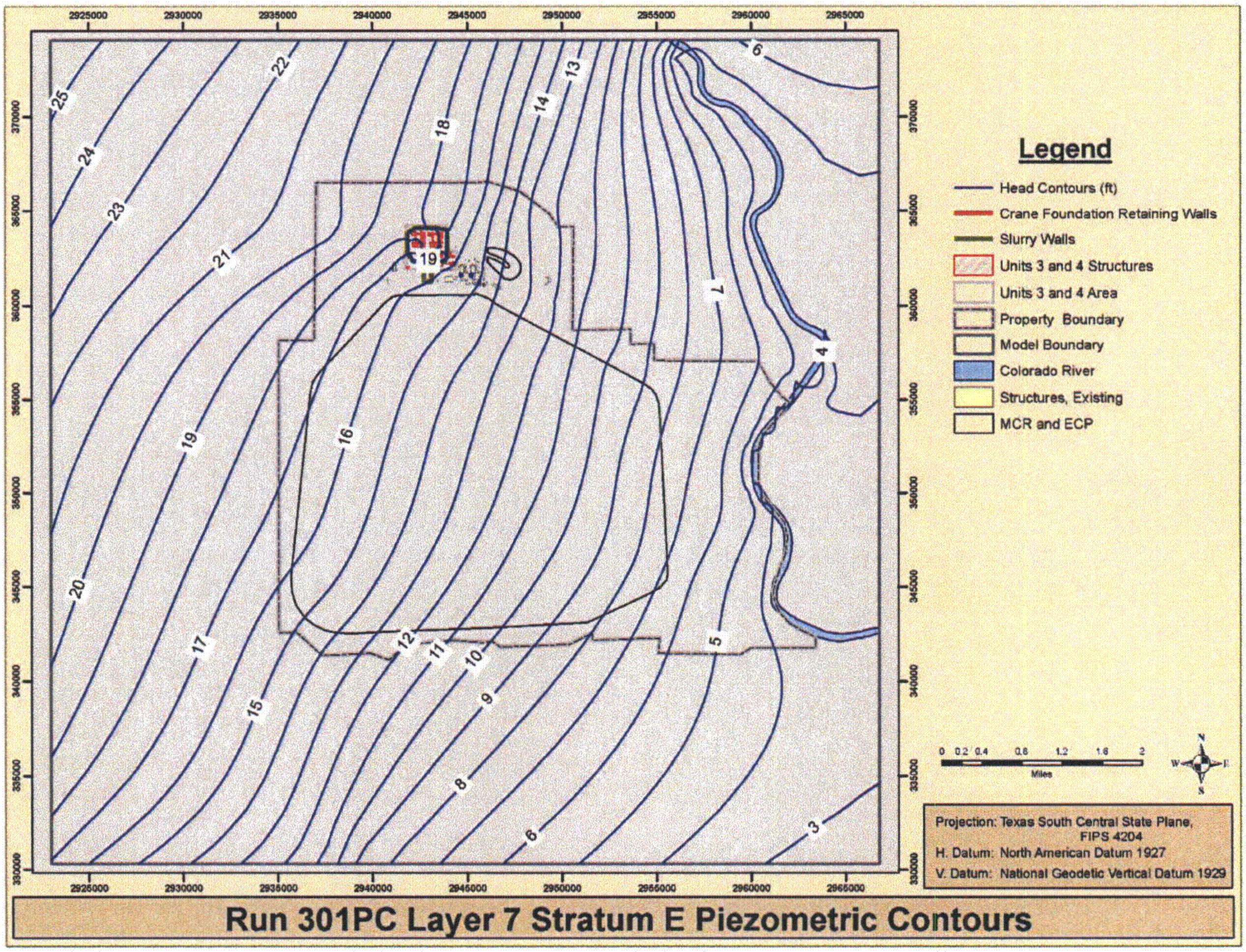



**Figure 2-4. Stratum E Head Contours from Post-Construction Model, Run 301PC.**

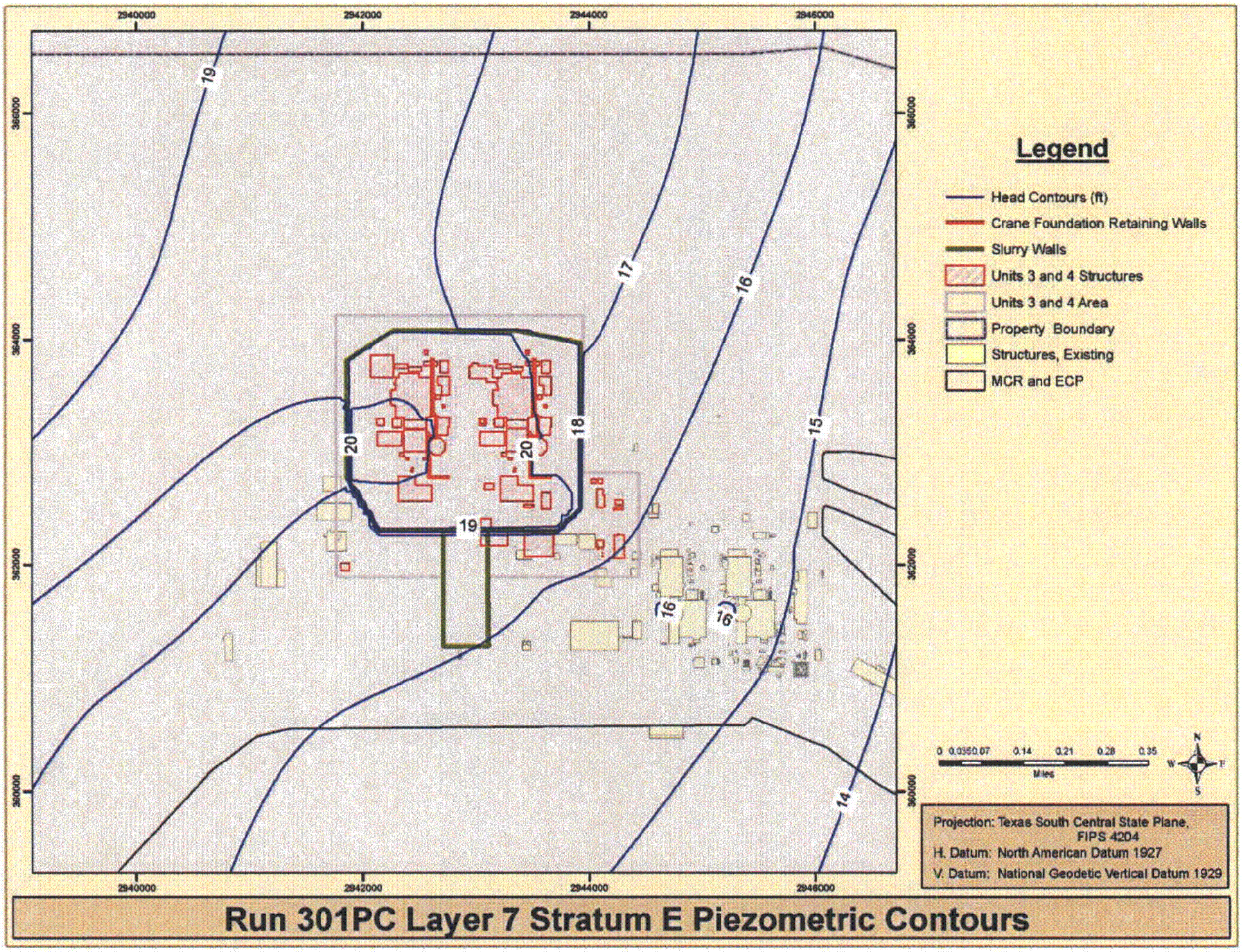



**Figure 2-5. Stratum E Head Contours in the Vicinity of the STP Units 3 & 4 Power Block from Post-Construction Model, Run 301PC.**

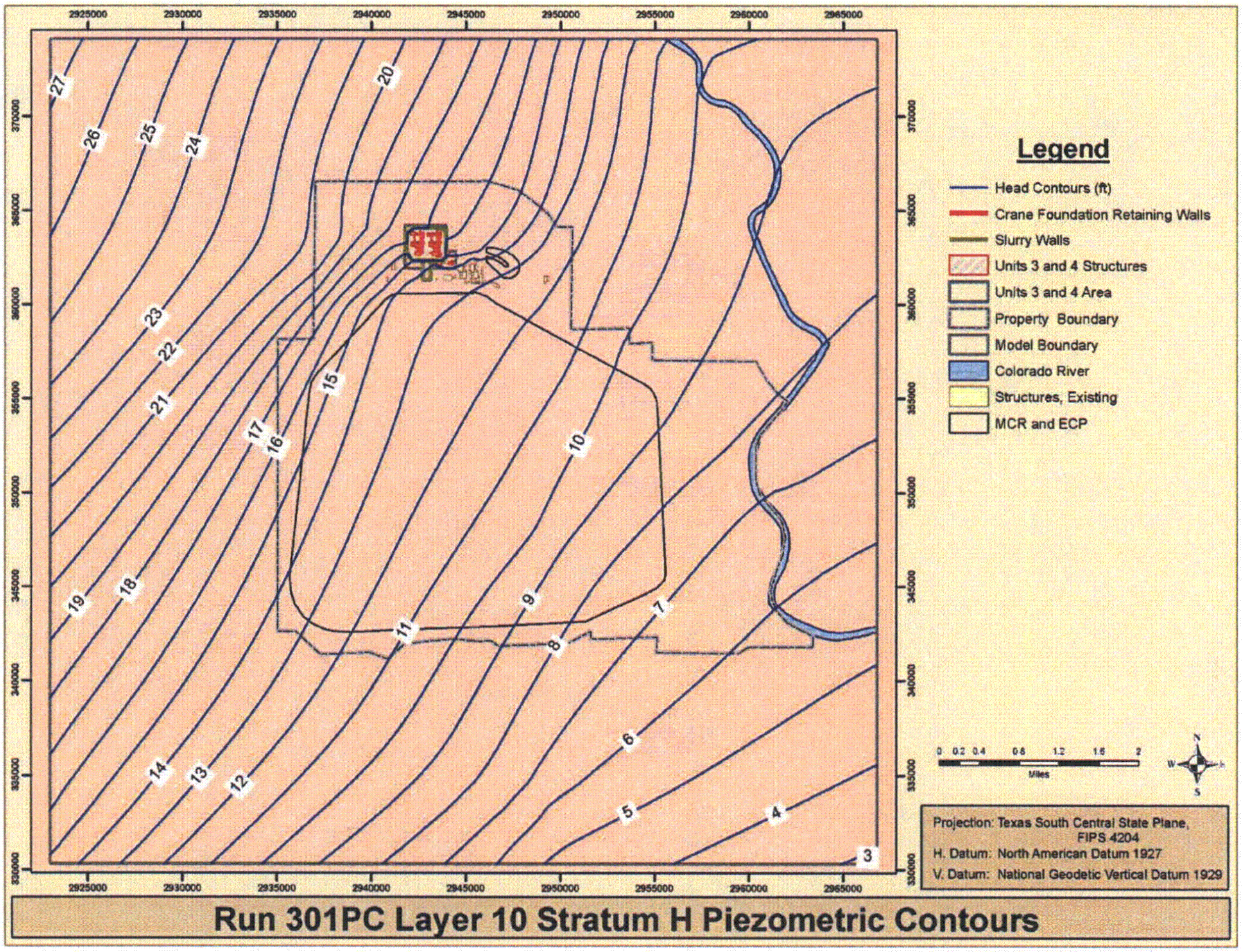



**Figure 2-6. Stratum H Head Contours from Post-Construction Model, Run 301PC.**

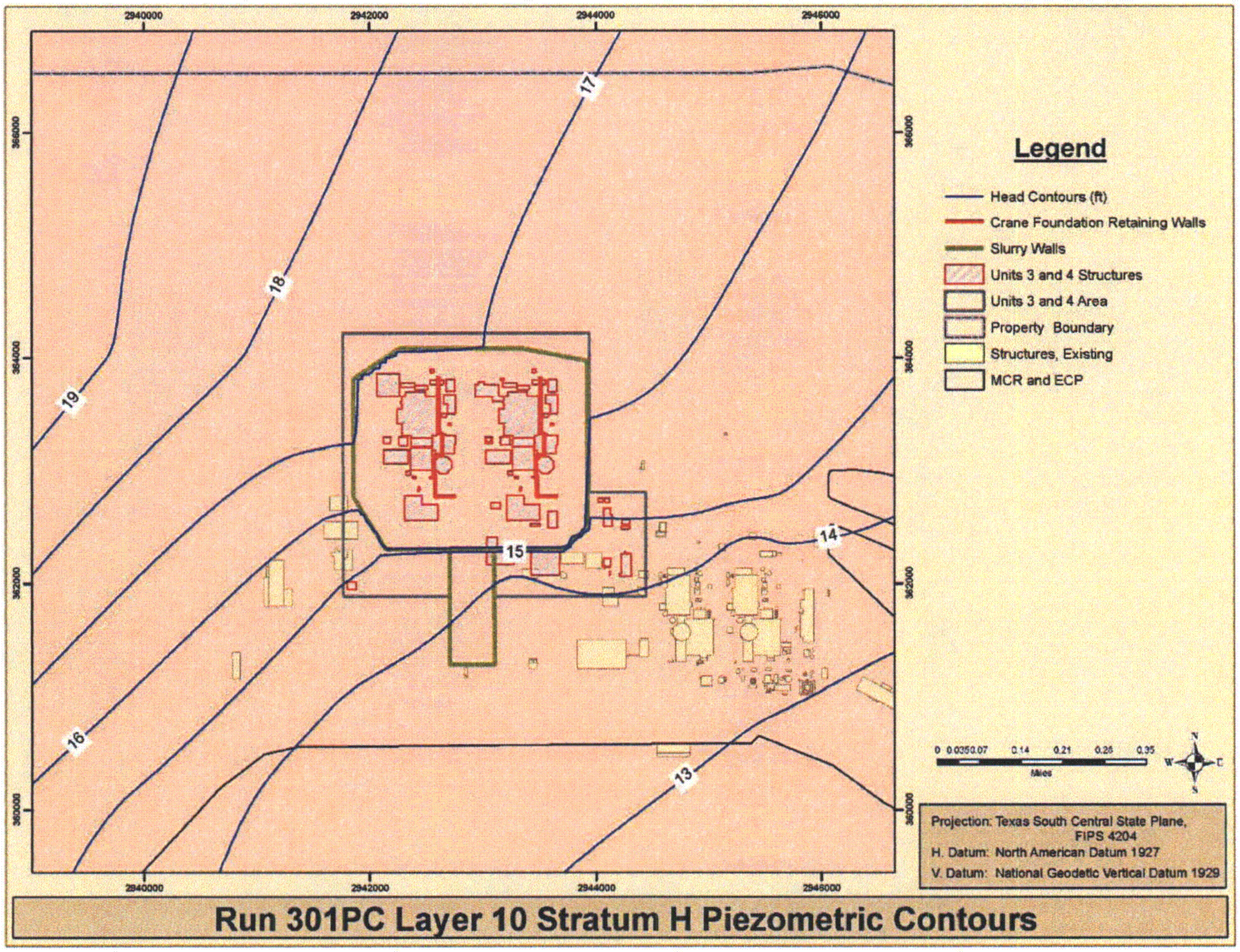



**Figure 2-7. Stratum H Head Contours in the Vicinity of the STP Units 3 & 4 Power Block from Post-Construction Model, Run 301PC.**

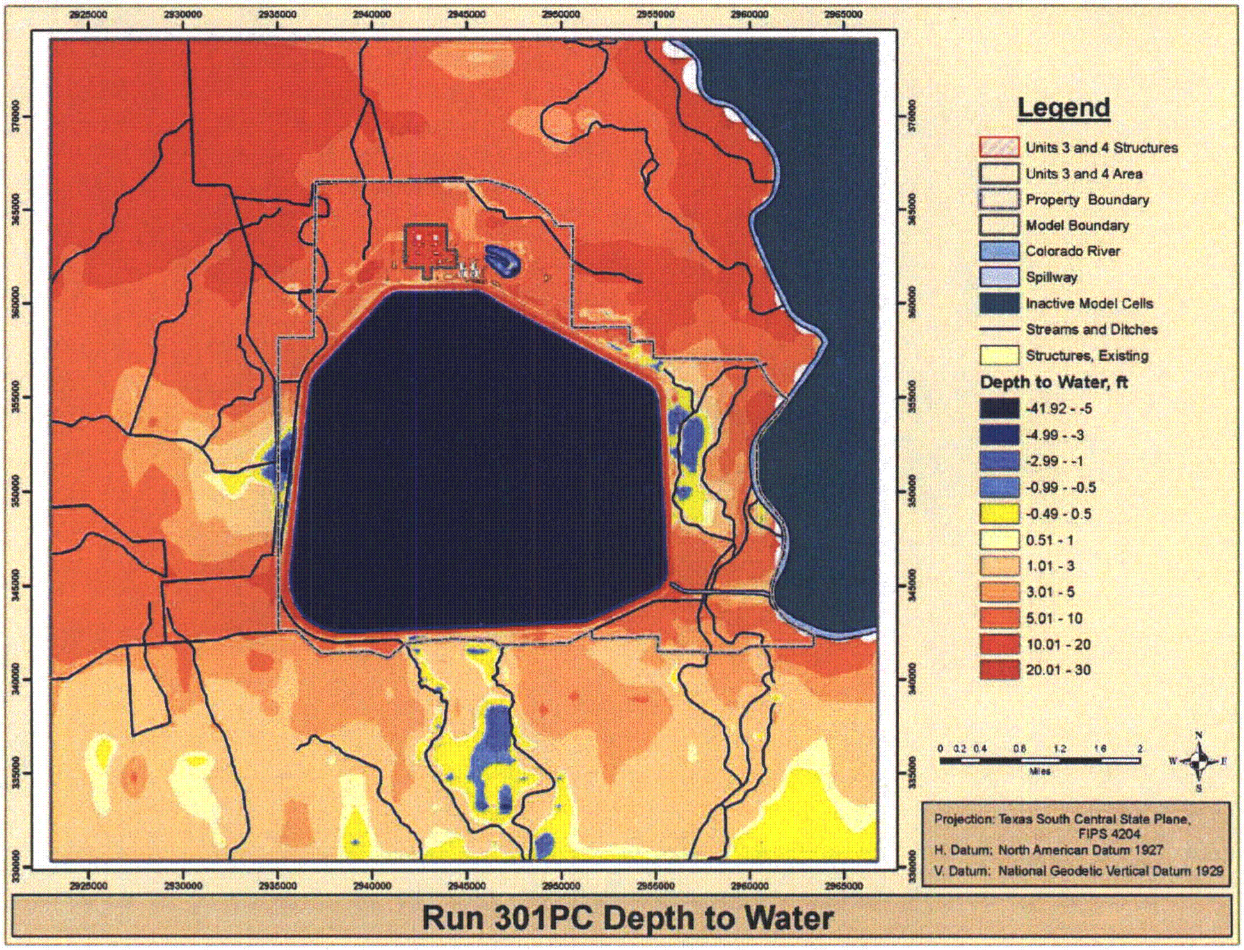
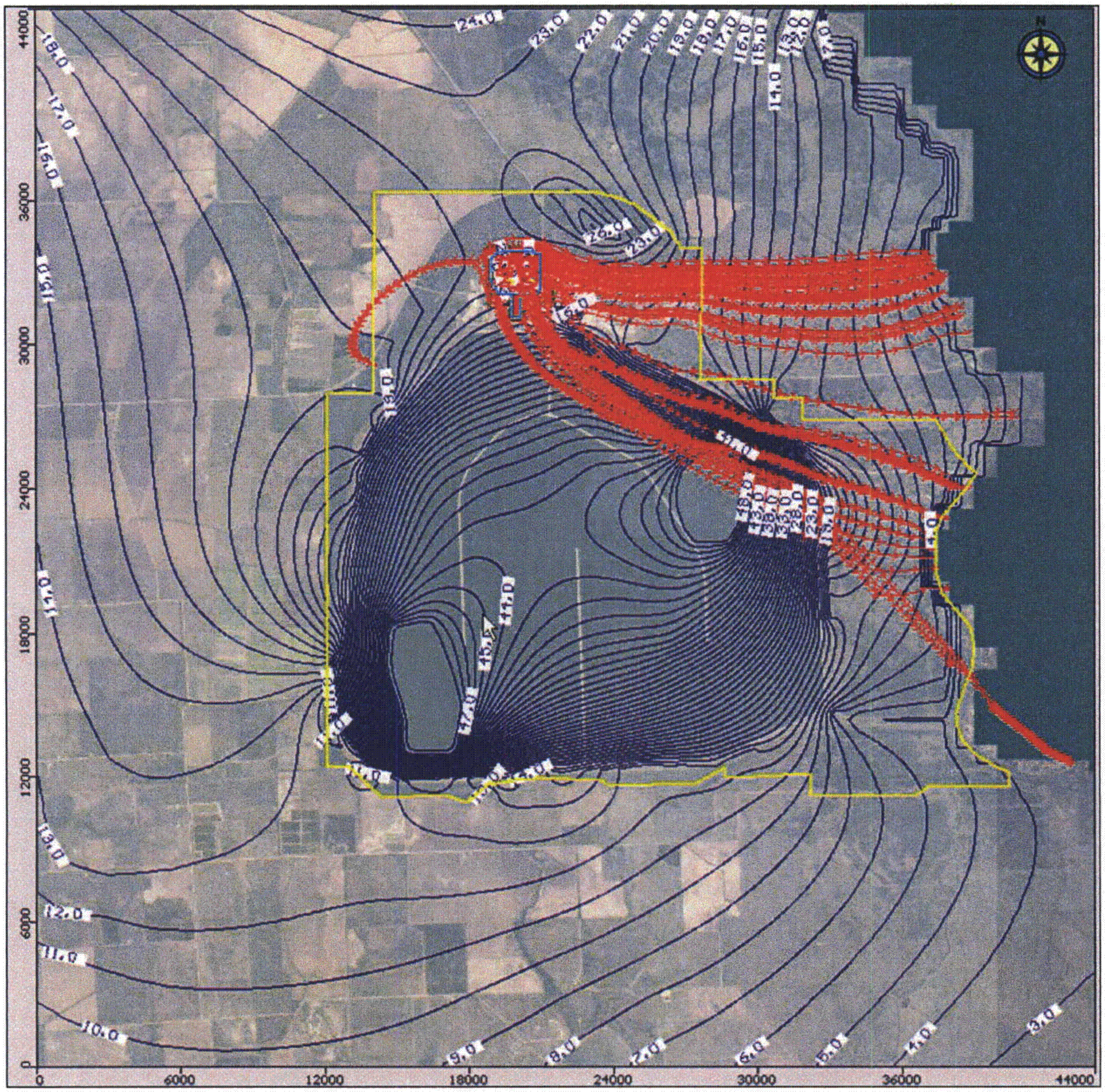



**Figure 2-8. Depth to Water from Post-Construction Model, Run 301PC.**



Legend: Red, arrowed lines = particle pathlines; yellow line = site boundary; blue lines = head contours; blue-green shaded area = inactive cells.

Note: Plot is shown with Visual MODFLOW model coordinates which have units of feet.

**Figure 2-9. Pathlines from Particles Released in Stratum C of Post-Construction Model, Run 301PC.**


Legend: Red, arrowed lines = particle pathlines; yellow line = site boundary; blue lines = head contours.

Note: Plot is shown with Visual MODFLOW model coordinates which have units of feet.

**Figure 2-10. Pathlines from Particles Released in Stratum E of Post-Construction Model, Run 301PC.**


Legend: Blue, arrowed lines = particle pathlines; yellow line = site boundary; dark blue lines = head contours; aqua lines = slurry walls.

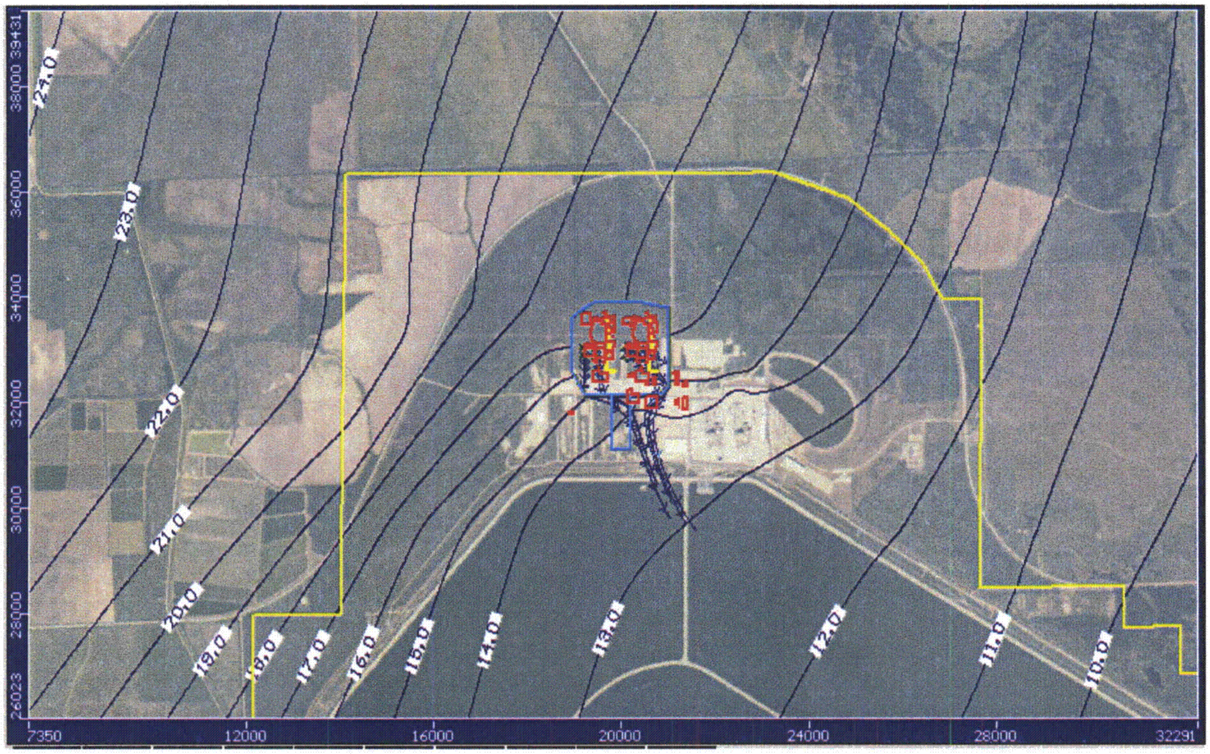
Note: Plot is shown with Visual MODFLOW model coordinates which have units of feet. Particle pathways terminated once a particle reached a site boundary.

**Figure 2-11. Pathlines from Particles Released Adjacent to STP Units 3 & 4 Radwaste Buildings in Stratum C, Post-Construction Model, Run 301PC.**


Legend: Blue, arrowed lines = particle pathlines; yellow line = site boundary; dark blue lines = head contours; aqua lines = slurry walls.

Note: Plot is shown with Visual MODFLOW model coordinates which have units of feet.
Particle pathways terminated once a particle reached a site boundary.

**Figure 2-12. Pathlines from Particles Released Adjacent to STP Units 3 & 4 Radwaste Buildings in Stratum E, Post-Construction Model, Run 301PC.**



Legend: Blue, arrowed lines = particle pathlines; yellow line = site boundary; dark blue lines = head contours; aqua lines = slurry walls

Note: Plot is shown with Visual MODFLOW model coordinates which have units of feet.
Particle pathways terminated once a directional trend was established.

**Figure 2-13. Pathlines from Particles Released Adjacent to STP Units 3 & 4 Radwaste Buildings in Stratum H, Post-Construction Model, Run 301PC.**

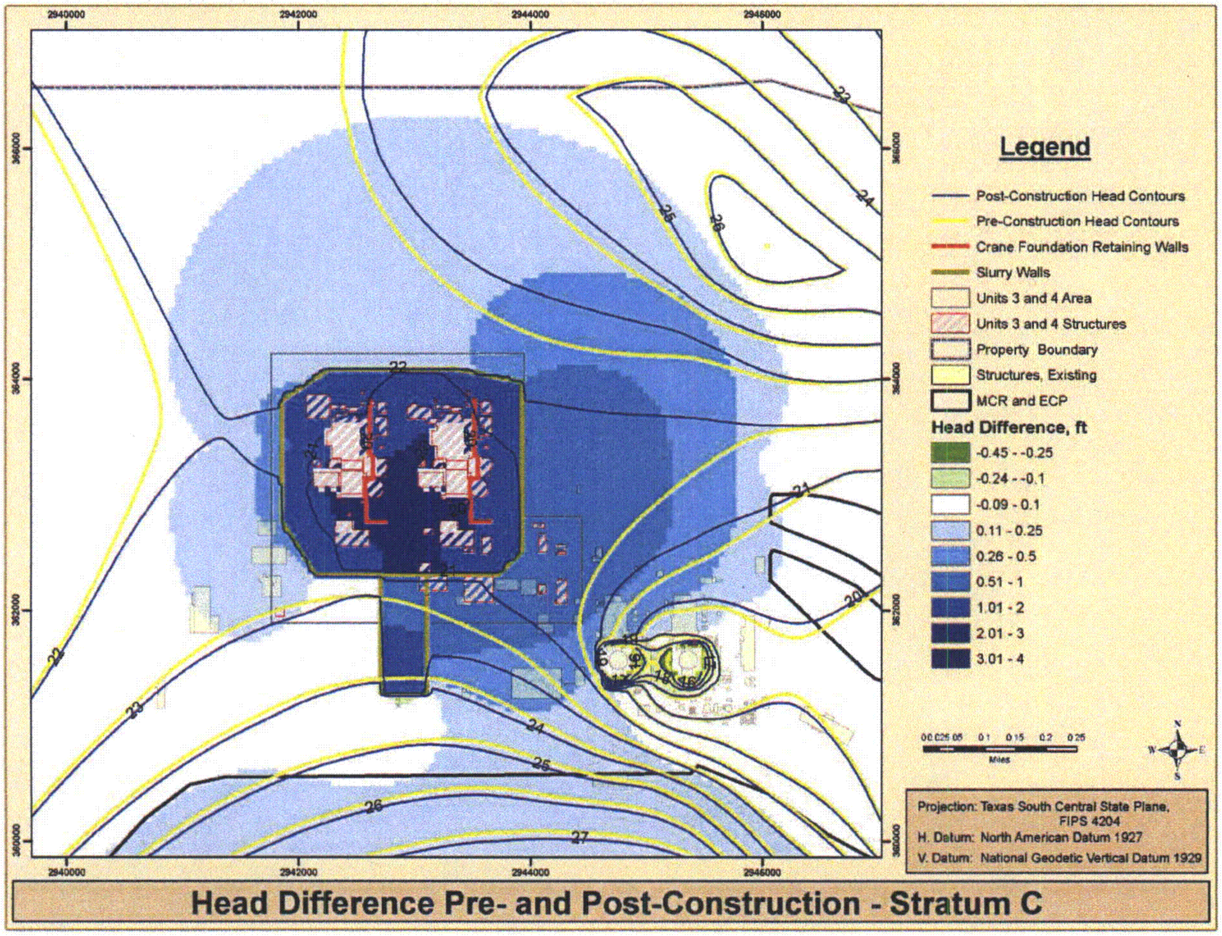



**Figure 2-14. Pre- and Post-Construction Simulated Head Differences in the Vicinity of STP Units 3 & 4 Power Block in Stratum C.**

**Table 3-1. Comparison of Water Balance for Boundary Conditions.**

| Description | Runs | | | | | | | | Post-Construction Summary | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 301 | | 301PC | | 301PC_RWFailN | | 301PC_RWFailALL | | Inflows (gpm) | | Outflows (gpm) | |
| | Inflows (gpm) | Outflows (gpm) | Inflows (gpm) | Outflows (gpm) | Inflows (gpm) | Outflows (gpm) | Inflows (gpm) | Outflows (gpm) | Max. | Min. | Max. | Min. |
| MCR Discharge Total | 3574.9 | 0.0 | 5030.9 | 0.0 | 4805.6 | 0.0 | 4046.0 | 0.0 | 5,030.9 | 4,046.0 | 0.0 | 0.0 |
| Through Sand Pits | 2827.8 | 0.0 | 3498.5 | 0.0 | 3340.6 | 0.0 | 2808.6 | 0.0 | 3,498.5 | 2,808.6 | 0.0 | 0.0 |
| Through Remaining Portion of MCR | 747.1 | 0.0 | 1532.4 | 0.0 | 1465.0 | 0.0 | 1237.4 | 0.0 | 1,532.4 | 747.1 | 0.0 | 0.0 |
| Precipitation/Recharge | 2.0 | 0.0 | 2.0 | 0.0 | 2.0 | 0.0 | 2.0 | 0.0 | 2.0 | 2.0 | 0.0 | 0.0 |
| ECP | 0.8 | 0.0 | 1.5 | 0.0 | 1.5 | 0.0 | 1.5 | 0.0 | 1.5 | 0.8 | 0.0 | 0.0 |
| Stratum C GHB | 213.2 | 244.8 | 211.7 | 257.1 | 209.7 | 257.6 | 208.1 | 294.8 | 213.2 | 208.1 | 294.8 | 244.8 |
| Stratum E GHB | 216.4 | 100.0 | 209.1 | 103.4 | 208.4 | 103.7 | 203.5 | 111.4 | 216.4 | 203.5 | 111.4 | 100.0 |
| Stratum H GHB | 182.1 | 91.4 | 175.8 | 94.7 | 175.0 | 95.2 | 172.5 | 98.4 | 182.1 | 172.5 | 98.4 | 91.4 |
| Levee-Bound Irrigation Canals | 148.2 | 3.1 | 147.7 | 4.1 | 139.8 | 4.4 | 138.6 | 4.5 | 148.2 | 138.6 | 4.5 | 3.1 |
| Livestock Well | 0.0 | 0.4 | 0.0 | 0.4 | 0.0 | 0.4 | 0.0 | 0.4 | 0.0 | 0.0 | 0.4 | 0.4 |
| Colorado River | 0.2 | 675.5 | 0.2 | 715.6 | 0.1 | 739.2 | 0.1 | 819.4 | 0.2 | 0.1 | 819.4 | 675.5 |
| Canals and Ditches in Stratum A/B | 0.0 | 542.5 | 0.0 | 666.7 | 0.0 | 666.5 | 0.0 | 982.1 | 0.0 | 0.0 | 982.1 | 542.5 |
| Little Robbins Slough and Plant Area Drainage Ditches in Stratum C | 0.0 | 671.6 | 0.0 | 935.7 | 0.0 | 1083.4 | 0.0 | 1921.8 | 0.0 | 0.0 | 1,921.8 | 671.6 |
| Kelly Lake | 0.0 | 298.5 | 0.0 | 372.6 | 0.0 | 515.6 | 0.0 | 539.6 | 0.0 | 0.0 | 539.6 | 298.5 |
| MCR Relief Wells and Sand Drains from MCR | 0.0 | 1699.9 | 0.0 | 2606.1 | 0.0 | 2053.3 | 0.0 | 0.0 | 0.0 | 0.0 | 2,606.1 | 0.0 |
| MCR Relief Wells and Sand Drains from other Sources | 0.0 | 10.3 | 0.0 | 23.0 | 0.0 | 22.8 | 0.0 | 0.0 | 0.0 | 0.0 | 23.0 | 0.0 |
| TOTALS | 4337.9 | 4338.1 | 5778.9 | 5779.4 | 5542.1 | 5542.1 | 4772.2 | 4772.4 | 5778.9 | 4337.9 | 5779.4 | 4338.1 |
| PERCENT DISCREPANCY | -0.005 | | -0.009 | | 0.000 | | -0.004 | | | | | |

Note: "Inflows" is a measure of water into the model domain from a listed boundary condition described in Column 1.
"Outflows" is a measure of water from the model domain to a listed boundary condition described in Column 1.

**Table 3-2. Comparison of MCR Discharge Captured by Relief Wells and Sand Drains.**

| Budget Zone | Run | 301 | | 301PC | | 301PC_RWFailN | | 301PC_RWFailAll | | Post-ConstructionSummary | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Description of Relief Well Location | Outflow to DRAINS (cf/day) | Percentage of Total Outflow | Outflow to DRAINS (cf/day) | Percentage of Total Outflow | Outflow to DRAINS (cf/day) | Percentage of Total Outflow | Outflow to DRAINS (cf/day) | Percentage of Total Outflow | Max % of Total Outflow | Min. % of Total Outflow |
| 29 | North 1 | 0.0 | 0.0 | 579.1 | 0.1 | 0.0 | 0.0 | 0.0 | — | 0.1 | 0.0 |
| 30 | North 2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — | 0.0 | 0.0 |
| 31 | Northeast 1 | 65,173.0 | 19.8 | 100,120.0 | 19.8 | 0.0 | 0.0 | 0.0 | — | 19.8 | 0.0 |
| 32 | East 1 | 14,426.0 | 4.4 | 27,311.0 | 5.4 | 27,516.0 | 6.9 | 0.0 | — | 6.9 | 5.4 |
| 33 | East 2 | 8,066.9 | 2.5 | 12,610.0 | 2.5 | 12,645.0 | 3.2 | 0.0 | — | 3.2 | 2.5 |
| 34 | East 3 | 523.7 | 0.2 | 1,771.6 | 0.4 | 1,781.3 | 0.4 | 0.0 | — | 0.4 | 0.4 |
| 35 | East 4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | — | 0.0 | 0.0 |
| 36 | Southeast 1 | 0.0 | 0.0 | 608.8 | 0.1 | 617.5 | 0.2 | 0.0 | — | 0.2 | 0.1 |
| 37 | Southeast 2 | 3,308.7 | 1.0 | 9,490.2 | 1.9 | 9,500.9 | 2.4 | 0.0 | — | 2.4 | 1.9 |
| 38 | South 1 | 9,154.9 | 2.8 | 17,279.0 | 3.4 | 17,309.0 | 4.3 | 0.0 | — | 4.3 | 3.4 |
| 39 | South 2 | 14,520.0 | 4.4 | 24,064.0 | 4.8 | 24,113.0 | 6.0 | 0.0 | — | 6.0 | 4.8 |
| 40 | South 3 | 18,501.0 | 5.6 | 27,409.0 | 5.4 | 27,441.0 | 6.9 | 0.0 | — | 6.9 | 5.4 |
| 41 | South 4 | 102,990.0 | 31.3 | 134,060.0 | 26.5 | 134,070.0 | 33.5 | 0.0 | — | 33.5 | 26.5 |
| 42 | Southwest | 54,780.0 | 16.6 | 80,994.0 | 16.0 | 81,000.0 | 20.3 | 0.0 | — | 20.3 | 16.0 |
| 43 | West 1 | 22,557.0 | 6.9 | 32,406.0 | 6.4 | 32,420.0 | 8.1 | 0.0 | — | 8.1 | 6.4 |
| 44 | West 2 | 6,329.0 | 1.9 | 10,851.0 | 2.1 | 10,910.0 | 2.7 | 0.0 | — | 2.7 | 2.1 |
| 45 | Northwest 1 | 8,886.8 | 2.7 | 19,597.0 | 3.9 | 20,328.0 | 5.1 | 0.0 | — | 5.1 | 3.9 |
| 46 | Northwest 2 | 0.0 | 0.0 | 6,945.0 | 1.4 | 0.0 | 0.0 | 0.0 | — | 1.4 | 0.0 |
| Totals (cf/day) | | **329,217.0** | 100.0 | **506,095.7** | 100.0 | **399,651.7** | 100.0 | **0.0** | — | 100.0 | 100.0 |
| Totals (gpm) | | **1,710.2** | | **2,629.1** | | **2,076.1** | | **0.0** | | 2,629.1 | 0.0 |

**Table 3-3. Comparison of Maximum Water Level in Each Model Layer in the Units 3 & 4 Area**

| Layer | Stratum | Description | Scenario | | |
|---|---|---|---|---|---|
| | | | 301PC | 301PC_RWFailN | 301PC_RWFailAll |
| | | | Max. Water Level (ft NGVD29) | Max. Water Level (ft NGVD29) | Max. Water Level (ft NGVD29) |
| 1 | A/B | clay - confining unit | 24.6 | 25.0 | 25.2 |
| 2 | | | 24.5 | 25.0 | 25.1 |
| 3 | | | 24.7 | 25.2 | 25.3 |
| 4 | C | sand | 25.2 | 25.7 | 25.8 |
| 5 | D | clay - confining unit | 24.4 | 24.9 | 25.0 |
| 6 | | | 20.7 | 20.9 | 21.0 |
| 7 | E | sand | 20.5 | 20.6 | 20.8 |
| 8 | F | clay - confining unit | 19.5 | 19.7 | 19.8 |
| 9 | | | 17.7 | 17.8 | 18.0 |
| 10 | H | sand | 17.5 | 17.6 | 17.8 |

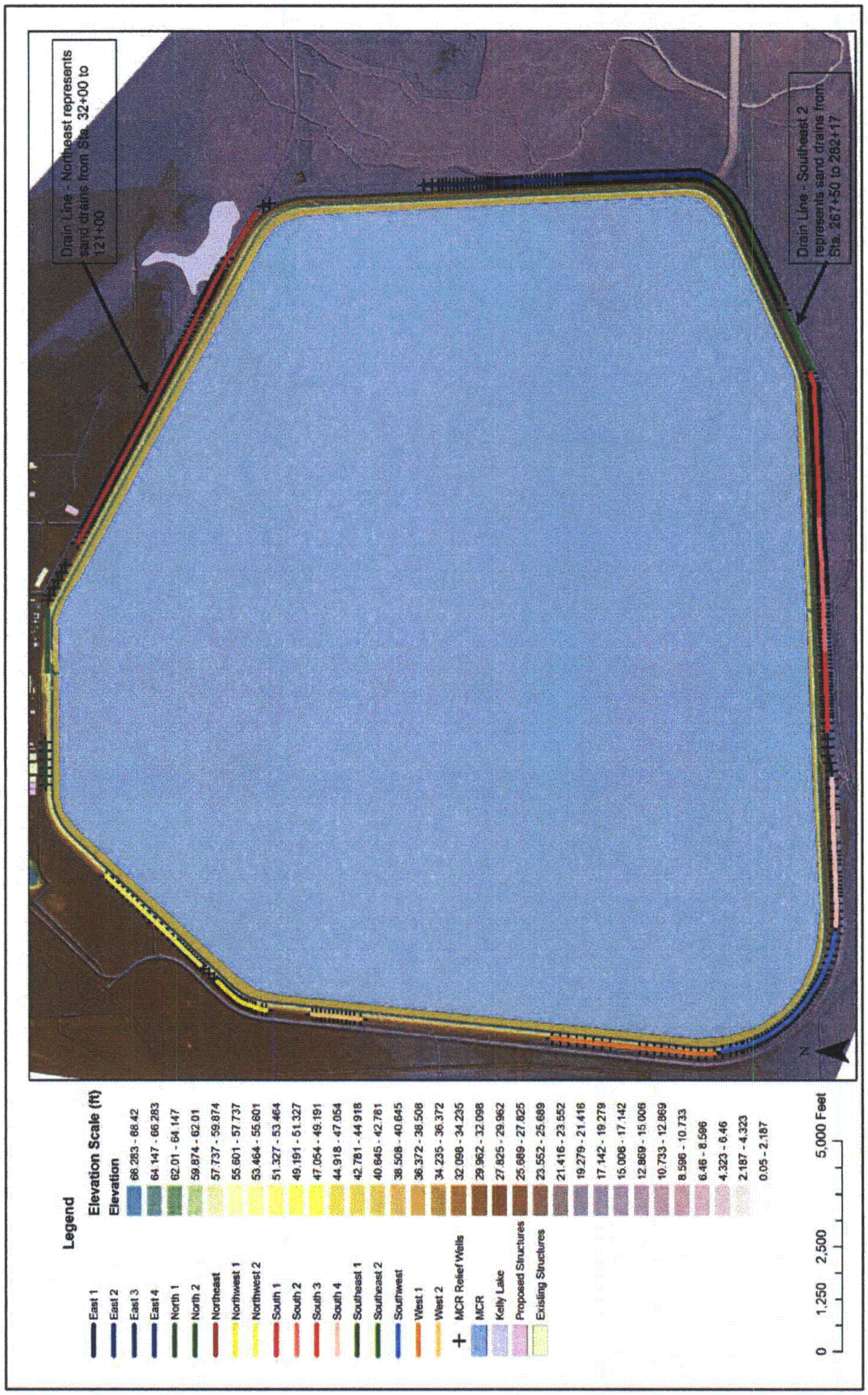



**Figure 3-1. Location of Drain Lines that Represent Relief Wells and Sand Drains in the Groundwater Model.**

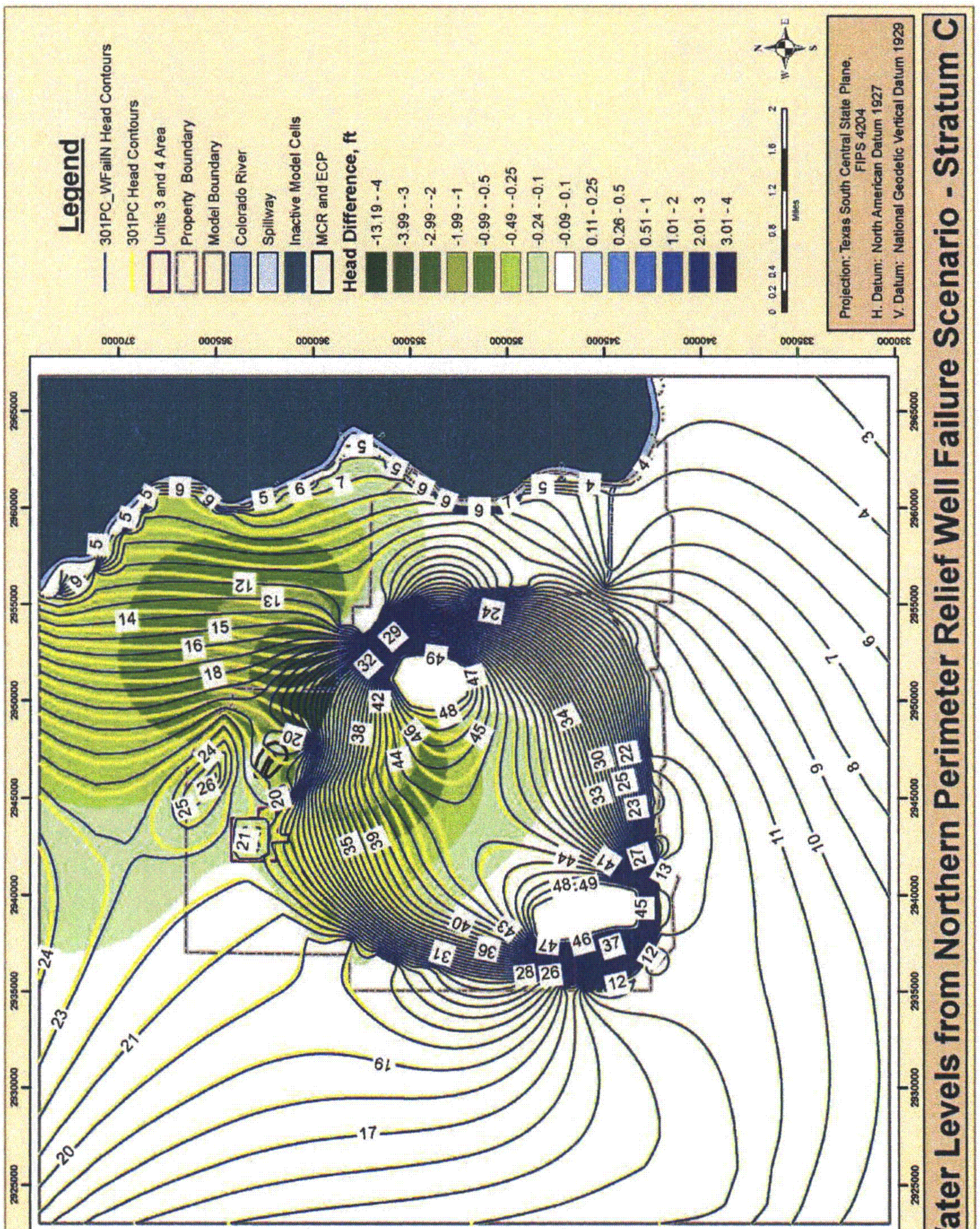



**Figure 3-2. Comparison of Water Levels in Stratum C from Northern Relief Well Failure Scenario to Post-Construction Model.**

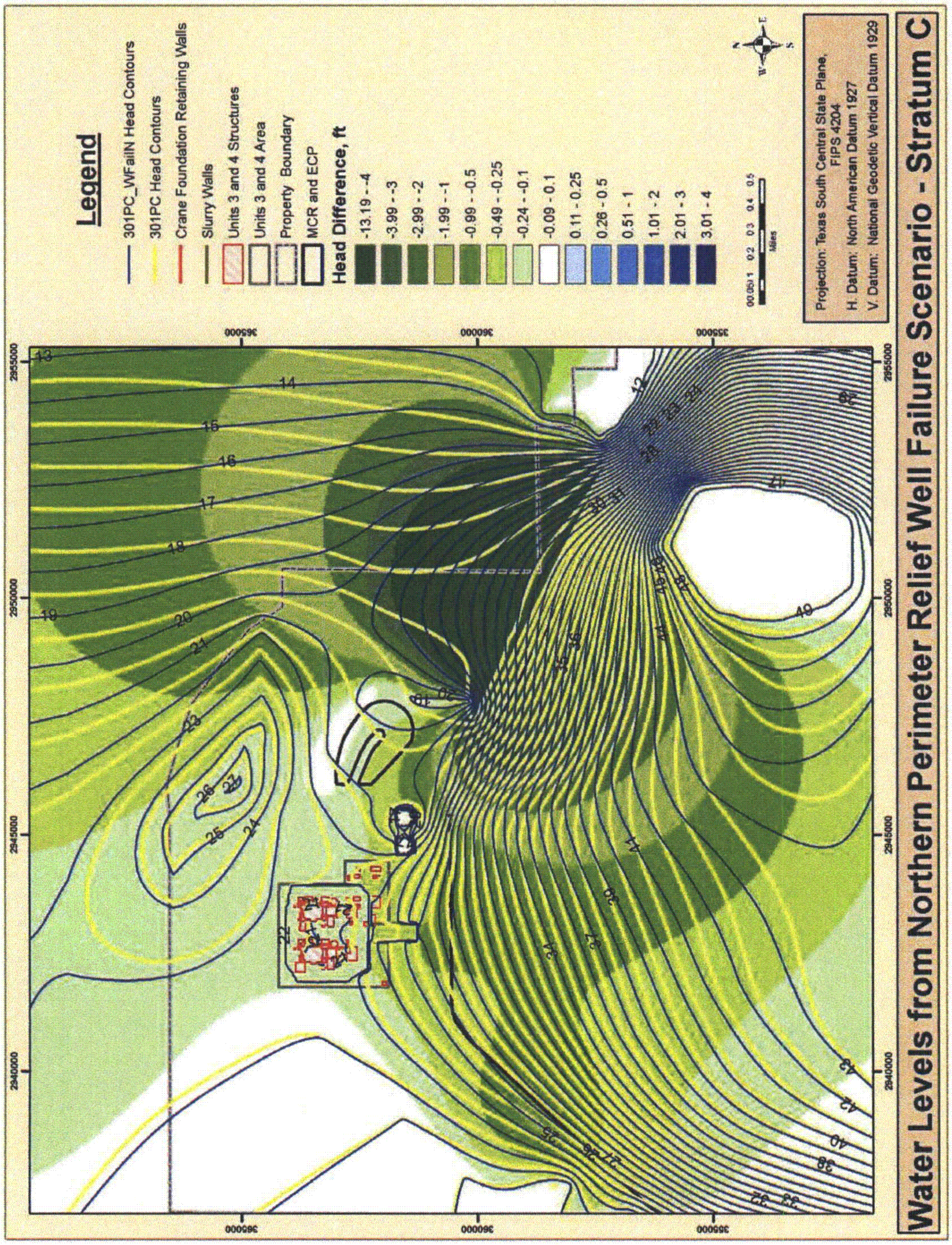



**Figure 3-3. Comparison of Water Levels in the STP Units 3 & 4 Area in Stratum C from Northern Relief Well Failure Scenario to Post-Construction Model.**

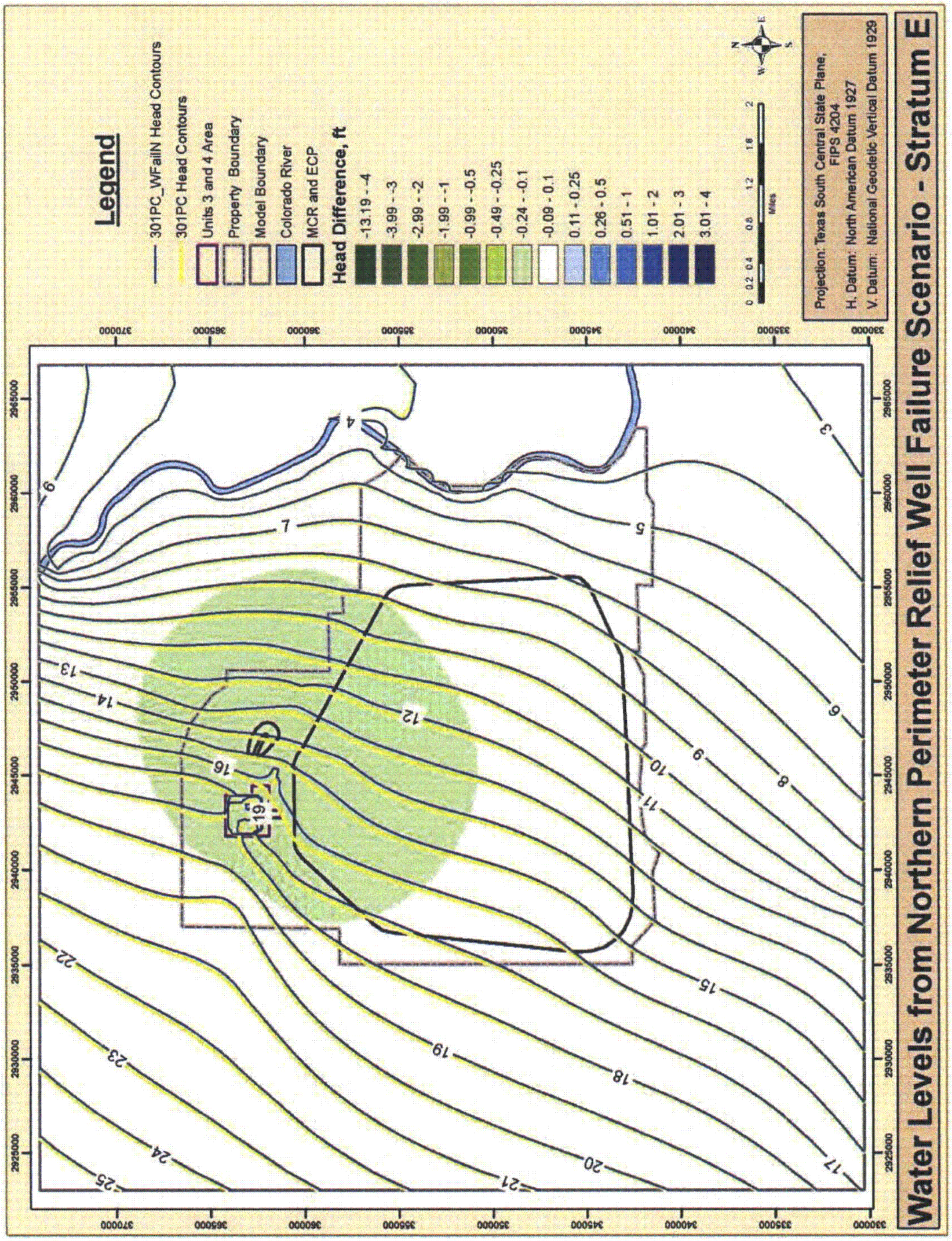



**Figure 3-4. Comparison of Water Levels in Stratum E from Northern Relief Well Failure Scenario to Post-Construction Model.**

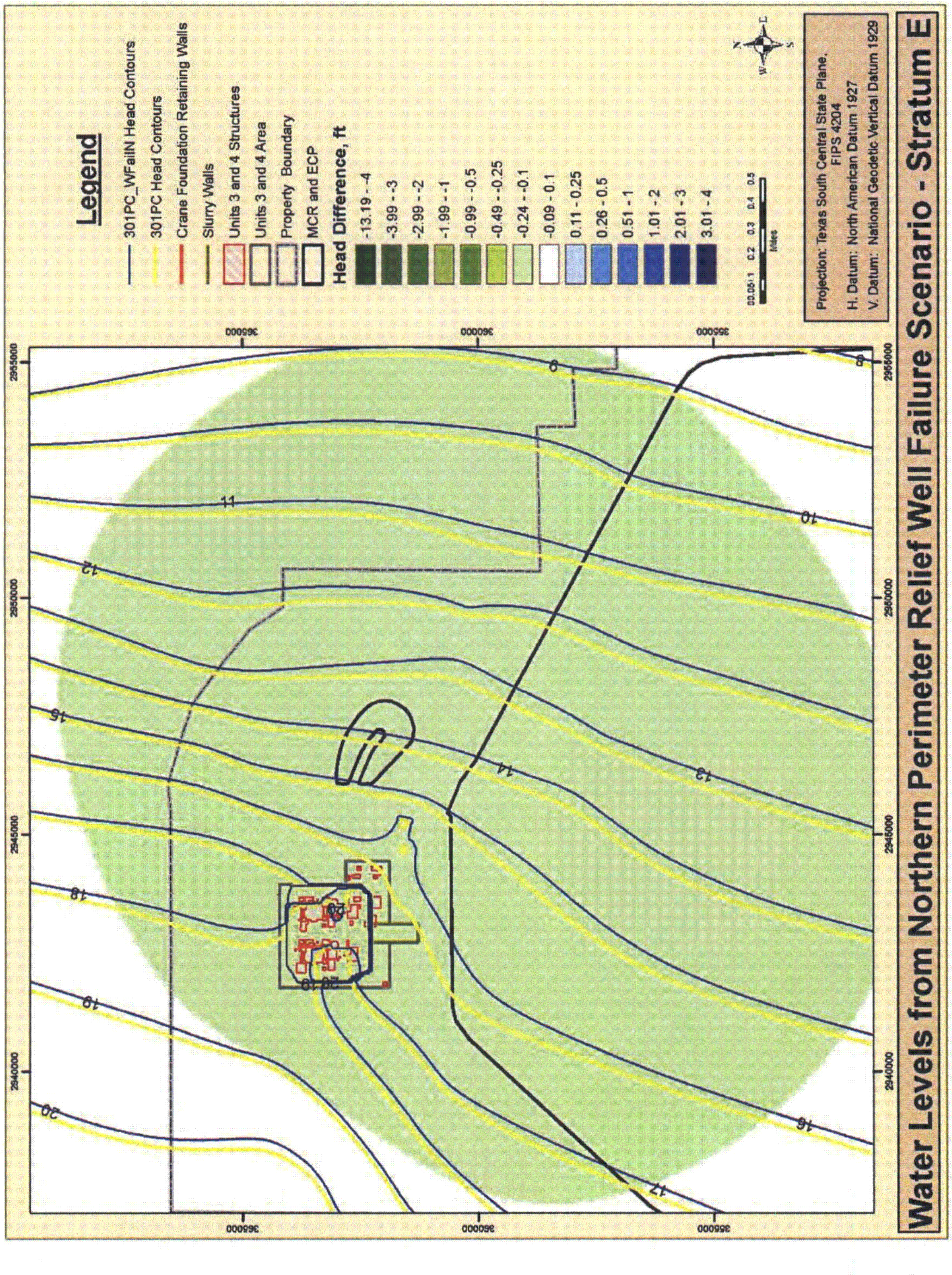



**Figure 3-5. Comparison of Water Levels in the Vicinity of STP Units 3 & 4 in Stratum E from Northern Relief Well Failure Scenario to Post-Construction Model.**

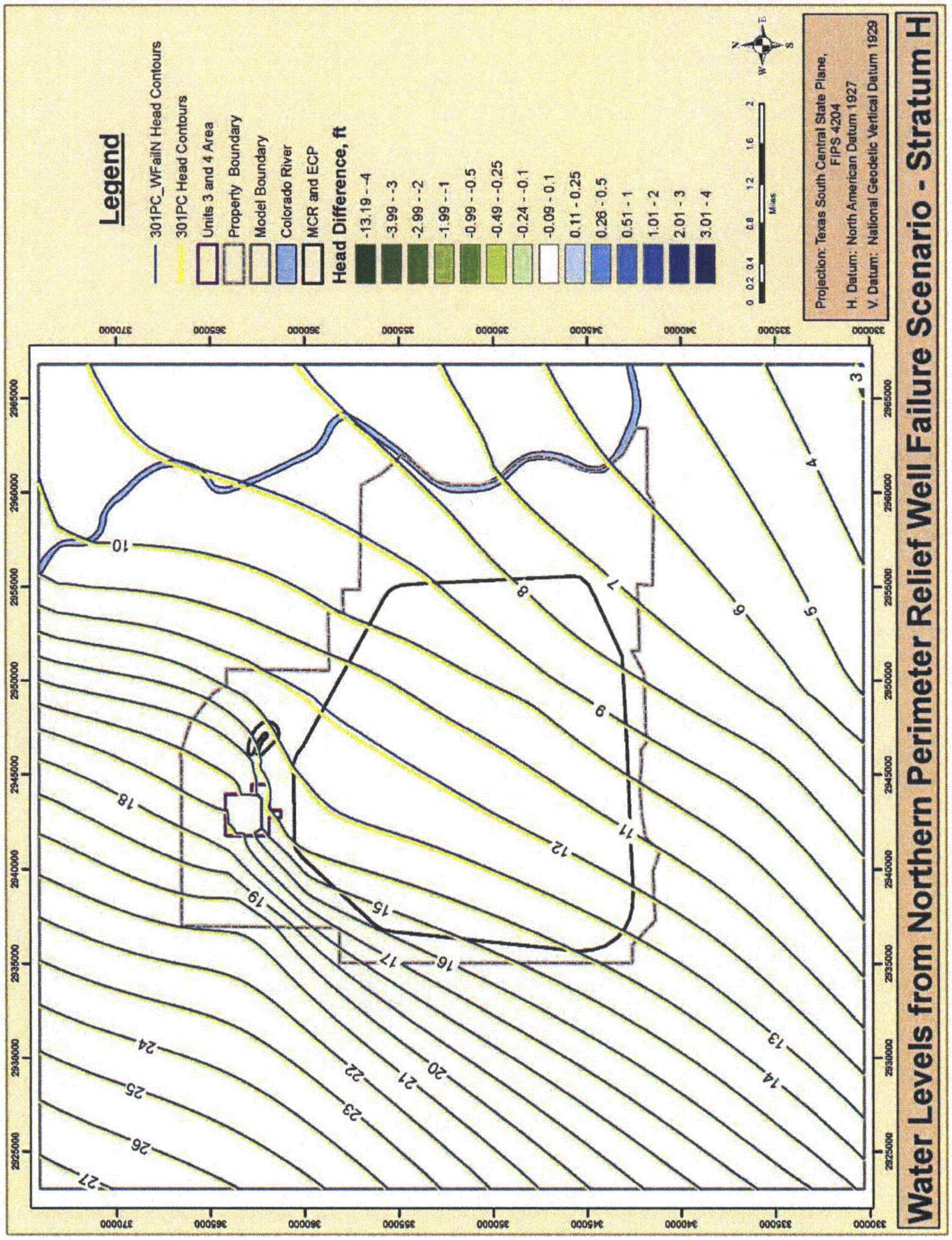



**Figure 3-6. Comparison of Water Levels in Stratum H from Northern Relief Well Failure Scenario to Post-Construction Model.**

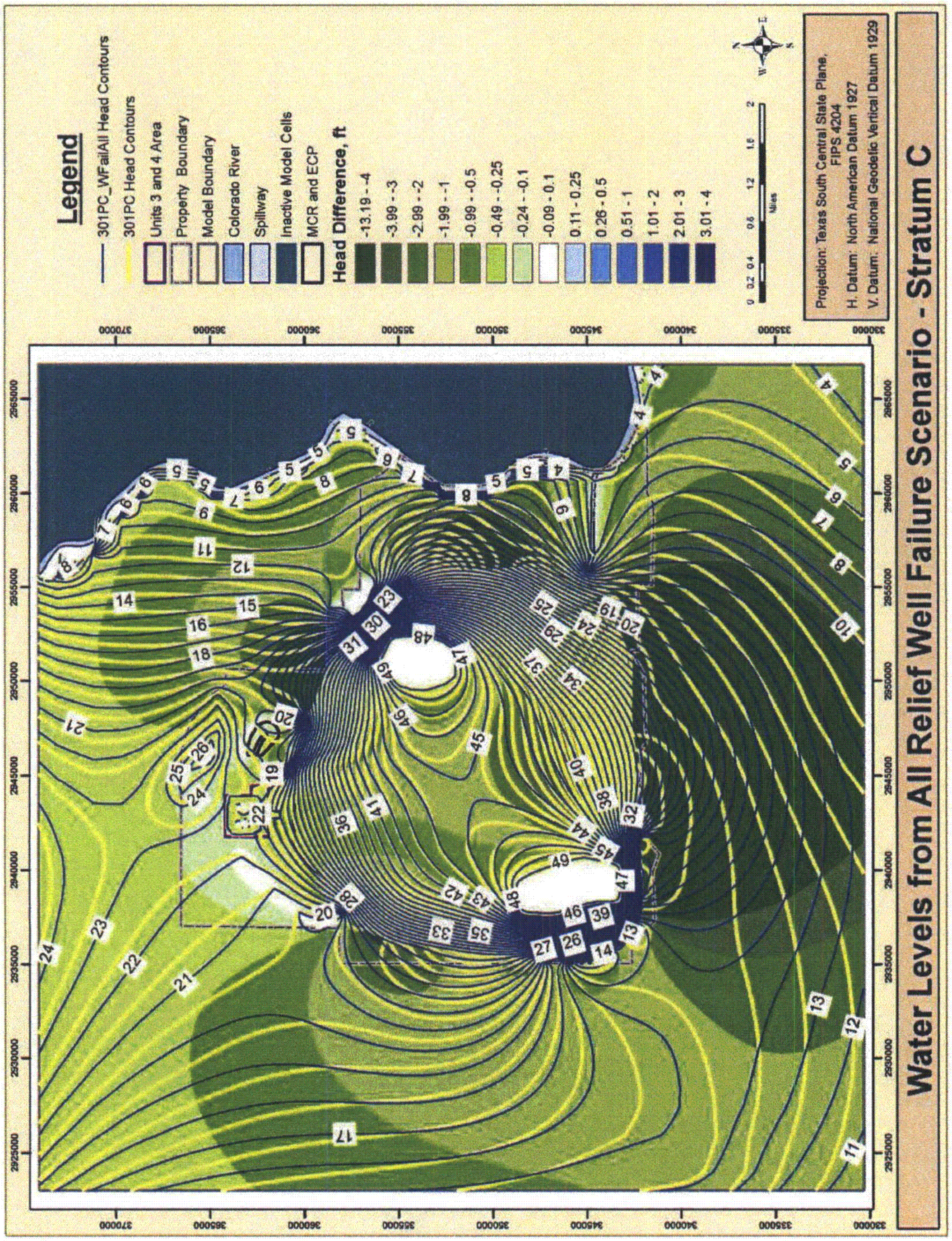



**Figure 3-7. Comparison of Water Levels in Stratum C from All Relief Well Failure Scenario to Post-Construction Model.**

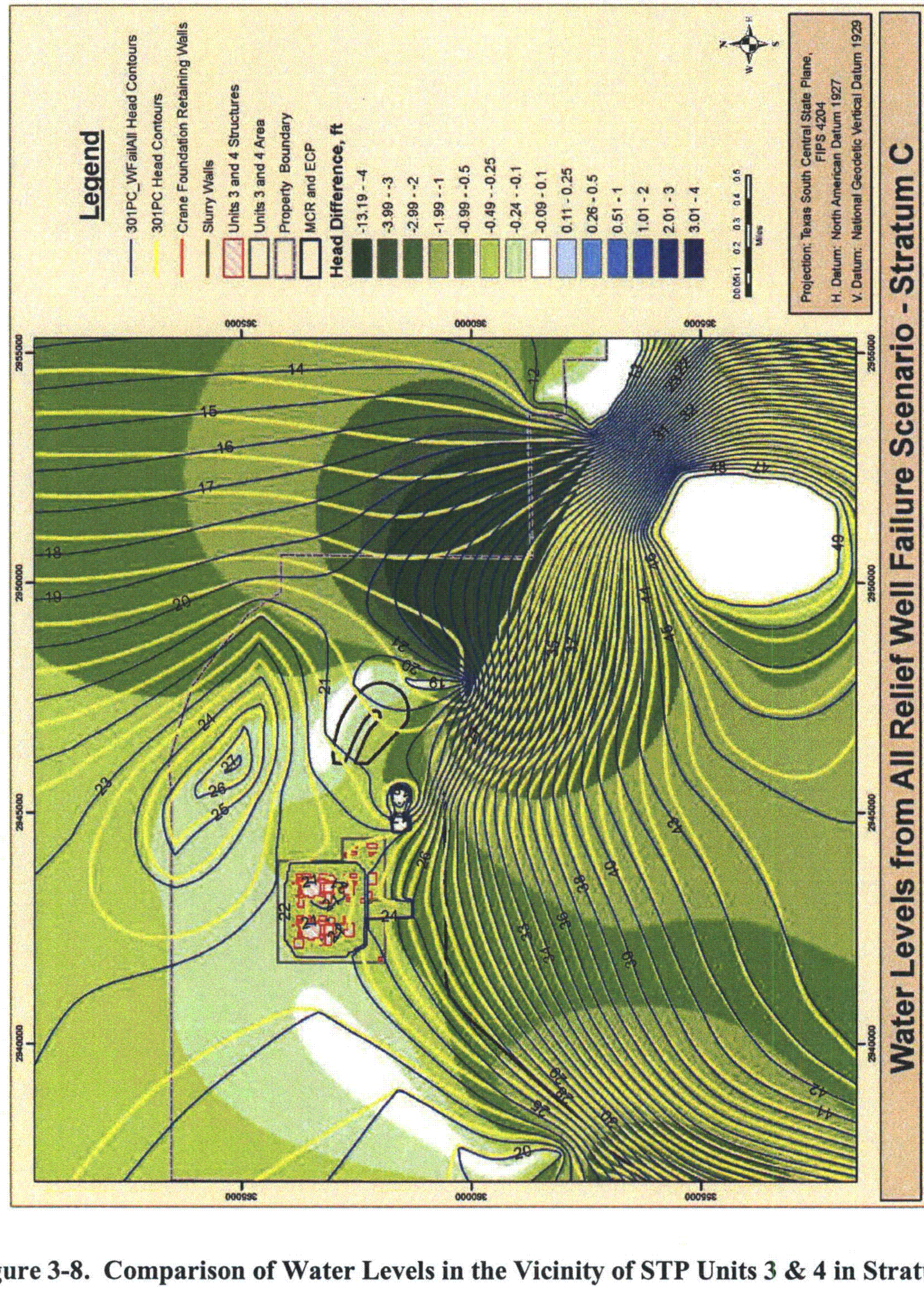



**Figure 3-8. Comparison of Water Levels in the Vicinity of STP Units 3 & 4 in Stratum C from All Relief Well Failure Scenario to Post-Construction Model.**

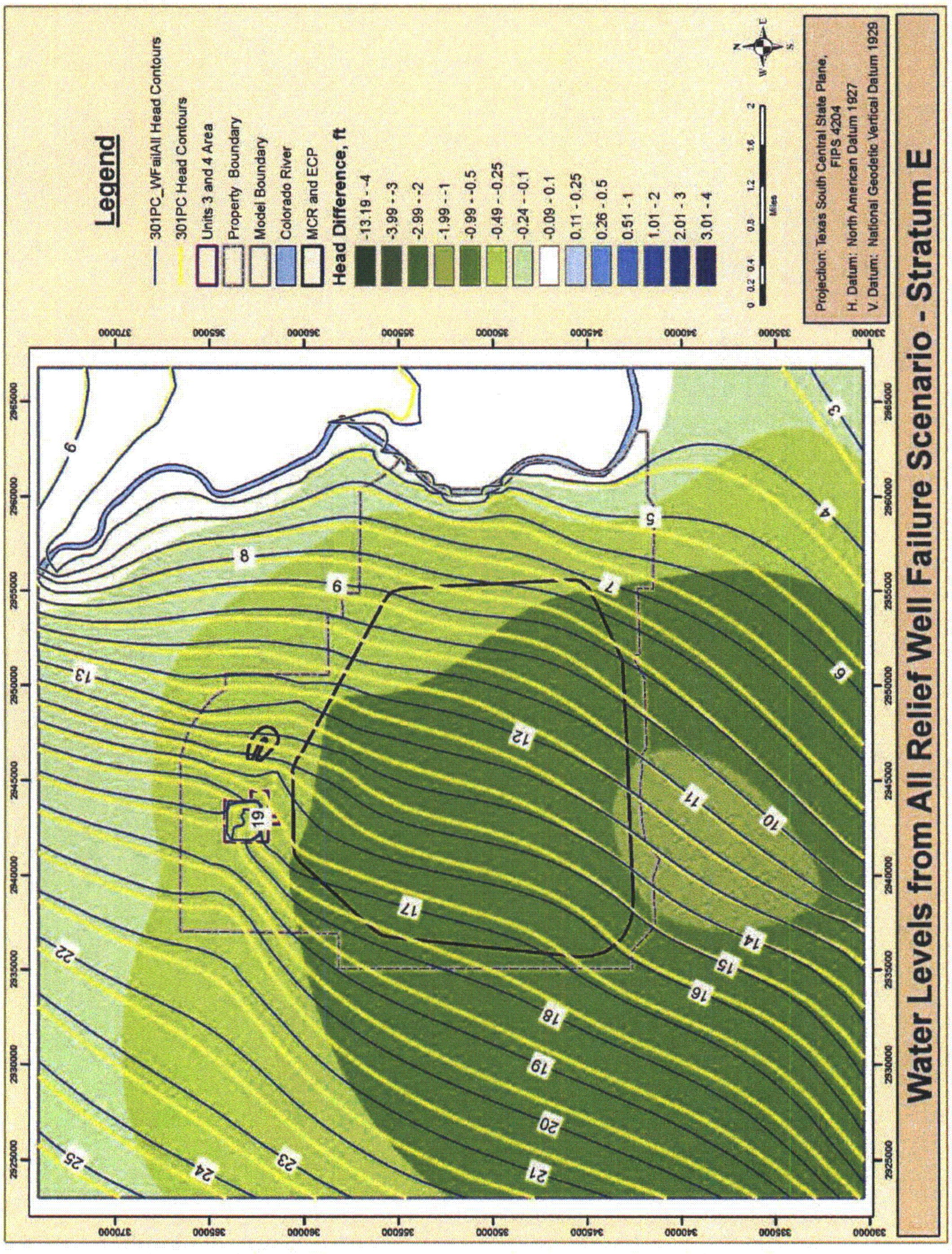



**Figure 3-9. Comparison of Water Levels in Stratum E from All Relief Well Failure Scenario to Post-Construction Model.**

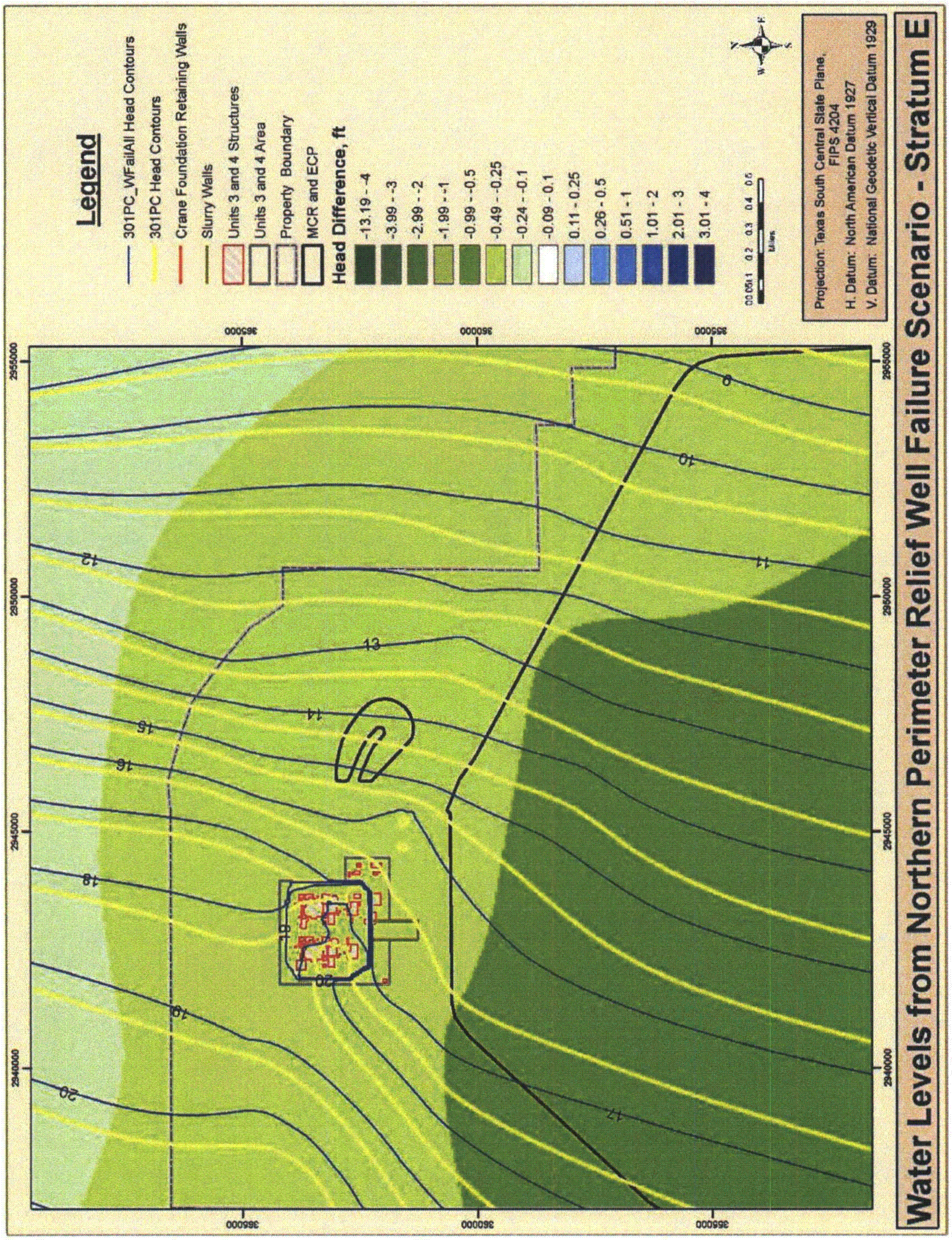



**Figure 3-10. Comparison of Water Levels in the Vicinity of STP Units 3 & 4 in Stratum E from All Relief Well Failure Scenario to Post-Construction Model.**

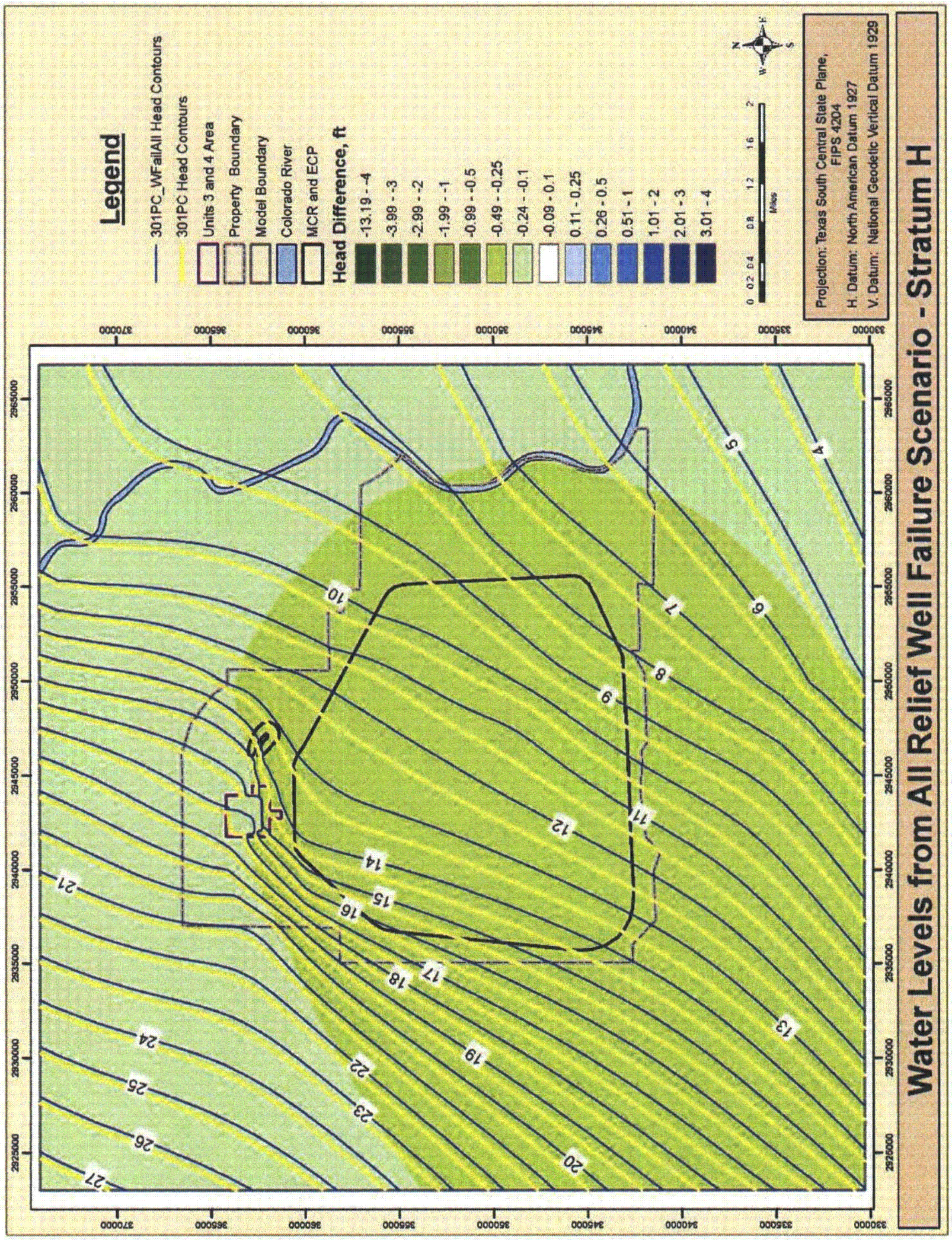



**Figure 3-11. Comparison of Water Levels in Stratum H from All Relief Well Failure Scenario to Post-Construction Model.**

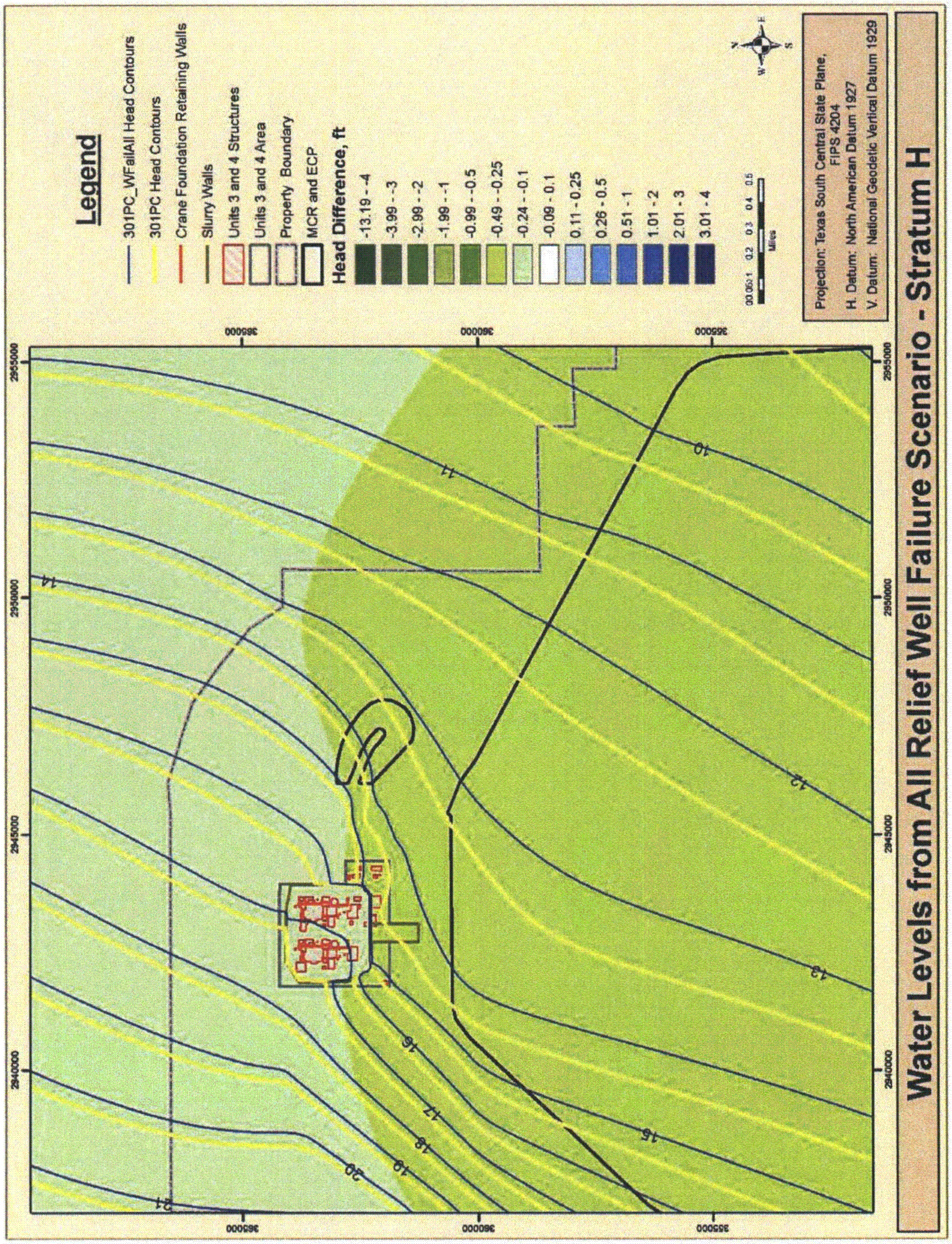



**Figure 3-12. Comparison of Water Levels in the Vicinity of STP Units 3 & 4 in Stratum H from All Relief Well Failure Scenario to Post-Construction Model.**

**RAI 02.04.12-49**

**QUESTION:**

To meet the requirements of 52.79(a) and assist staff in its analysis, additional information concerning the groundwater modeling is required. The NRC notes that revisions to FSAR, Rev. 3, Section 2.4S.12.5 Site Characteristics for Subsurface Hydrostatic Loading submitted on September 21, 2009 (U7-C-STP-NRC-090146), state that "In summary, based on measured groundwater levels in observations wells and modeled post-construction groundwater levels, the maximum post-construction groundwater elevation at the STP Units 3 and 4 site is estimated to be 28 ft MSL, ...". While the summary statement is made, the specifics are not provided in the section. Provide a list of the specific conclusions made regarding the measured pre-construction groundwater levels and a list of specific post-construction model results that support the maximum post-construction groundwater elevation of 28 ft MSL.

**RESPONSE:**

Conclusions embodied in the summary statement made in the response to RAI 02.04.12-35 (U7-C-STP-NRC-090146, September 21, 2009) are drawn from observed groundwater levels at the STP site and from groundwater model results of expected post-construction conditions. The maximum post-construction groundwater elevation of 28 ft MSL is supported by the following specific pre-construction groundwater level data:

1. During a 34-year monitoring period from 1973 to 2007, groundwater levels in the Upper Shallow Aquifer for the northern portion of the STP site, including the area of STP Units 3 & 4, were below an elevation of approximately 27.5 ft MSL as described in the responses to RAI 02.04.12-1 (Reference 1) and RAI 02.04.12-26 (Reference 2).
2. FSAR Figure 2.4S.12-23, which was submitted with the response to RAI 02.04.12-27 (U7-C-STP-NRC-090146, September 21, 2009), includes a hydrograph showing water levels in Piezometer 602A during the period 1995 through 2006. Water levels in this piezometer are below an elevation of approximately 26 ft MSL during this period. This Upper Shallow Aquifer piezometer is located just to the north of the STP Units 3 & 4 power block area.
3. Groundwater elevations measured within the footprint of STP Units 3 & 4 in 2007 and 2008 at the power block observation wells (OW-300 & OW-400 well series) are below 27.6 ft MSL as described in the response to RAI 02.04.12-34 (Reference 3).

Therefore, based on a review of observed groundwater levels measured in the northern portion of the STP site, the selected maximum post-construction groundwater level elevation of 28 ft MSL is not projected to be exceeded at STP Units 3 & 4.

The maximum post-construction groundwater elevation of 28 ft MSL is further supported by the results of a groundwater numerical model (Reference 4):

1. For both post-construction scenarios (with and without slurry wall) examined using the groundwater model, post-construction groundwater levels at STP Units 3 & 4 are approximately 1 to 3 ft lower in the Upper Shallow Aquifer than simulated pre-construction levels as interpreted from Figures 90, 91, 99, and 100 of Reference 4.

2. In the two post-construction scenarios examined using the groundwater model, simulated maximum groundwater levels within the STP Units 3 & 4 power block are below 24 ft MSL. These groundwater level results are presented in Figure 93 of Reference 4.

The conclusion that the maximum post-construction groundwater levels at STP Units 3 & 4 are expected to be lower than pre-construction groundwater levels is explained in Section 6 of the Groundwater Modeling Report (Reference 4):

> "Simulated water levels were also examined under post-construction conditions. In post-construction models, simulated water levels are lower in the Upper Shallow Aquifer at the Units 3 and 4 site relative to levels simulated in the calibrated model of existing conditions. Simulated water levels in the Lower Shallow Aquifer are higher at the Units 3 and 4 site relative to levels simulated in the calibrated model of existing conditions. These water level changes occur [in the model] because the excavation for Units 3 and 4 construction results in removal of a portion of the confining layer that separates the Upper and Lower Shallow Aquifers and replaces the confining material with structural fill which is relatively permeable. The fill material creates a greater degree of hydraulic connection between the Upper and Lower Shallow Aquifers that allows the Upper Shallow Aquifer to contribute water to the Lower Shallow Aquifer and generates the water level changes ...."

As stated in the response to RAI 02.04.12-42, the consistency between the historic STP Units 1 & 2 piezometer data and the model simulations of the Upper and the Lower Shallow Aquifers at STP Units 1 & 2 indicates that the model can be effectively used as a predictive tool for the two post-construction scenarios at STP Units 3 & 4. Figures 1 and 2 in the response to RAI 02.04.12-42 illustrate the STP Units 1 & 2 piezometer data as contoured groundwater elevations for the Upper Shallow Aquifer and the Lower Shallow Aquifer, respectively. Figure 1 of RAI 02.04.12-42 supports the model's simulation of the depression in the Upper Shallow Aquifer at STP 1 & 2, as illustrated by Figure 71 of Reference 4. The mounding in the Lower Shallow Aquifer predicted by the model (Figure 73 of Reference 4) is also supported by the piezometer data, as shown in Figure 2 of RAI 02.04.12-42. Conceptually, this is due to the highly permeable backfill at STP Units 1 & 2 that connects Strata A through E, creating a preferential pathway from the Upper Shallow Aquifer to the Lower Shallow Aquifer that causes an equilibration of the downward vertical head gradient from the Upper Shallow Aquifer to the Lower Shallow Aquifer through the permeable backfill.

Additional groundwater model sensitivity analyses were performed to support the conclusions made regarding the measured pre-construction groundwater levels and to provide further evidence for the post-construction model results. A summary of the sensitivity analyses performed is provided in the response to RAI 02.04.12-40.

One of the sensitivity analysis objectives was to evaluate a failure of the MCR relief well system and the impact on post-construction model results to maximum groundwater elevations at STP Units 3 & 4. Two simulations were performed as discussed in the response to RAI 02.04.12-48. One simulation portrays potential impacts to the groundwater level beneath STP Units 3 & 4 if the MCR relief wells and sand drains along the northern perimeter of the MCR failed simultaneously. The other simulation portrays potential impacts to the site if all the relief wells and sand drains failed simultaneously.

The maximum simulated water level in the vicinity of STP Units 3 & 4 occurs when all relief wells failed, resulting in a groundwater elevation of approximately 25.8 ft MSL at the south end of the slurry wall. However, simultaneous failure of all relief wells is not considered possible for several reasons. The wells are all independent, passive devices that STP routinely monitors and maintains to keep them functioning properly. If problems occur, STP repairs or replaces the wells to assure continued operation. Thus, the chance of simultaneous and permanent failure is considered improbable if not impossible. Even when the highly improbable event of simultaneous failure of all relief wells is simulated in the model, the maximum simulated water levels in the vicinity of STP Units 3 & 4 will not exceed the maximum post-construction groundwater elevation estimate of 28 ft MSL. A more detailed discussion of the sensitivity analysis for the MCR relief well failure is presented in the response to RAI 02.04.12-48.

In summary, both historical evidence and post-construction groundwater model results support the conclusion that the maximum post-construction groundwater level at STP Units 3 & 4 will not exceed an elevation of 28 ft MSL.

No COLA revision is required as a result of this RAI response.

References:

2. STPNOC Letter ABR-AE-08000047, "Response to Requests for Additional Information," Attachment 6 (RAI 02.04.12-1), July 2, 2008.

3. STPNOC Letter ABR-AE-08000055, "Response to Requests for Additional Information," Attachment 6 (RAI 02.04.12-26), July 24, 2008.

4. STPNOC Letter U7-C-STP-NRC-090146, "Response to Requests for Additional Information," Attachment 8 (RAI 02.04.12-34), September 21, 2009.

5. STPNOC Letter U7-C-STP-NRC-090206, "Supplemental Response to Requests for Additional Information", Attachment 2, "Groundwater Model Development and Analysis for STP Units 3 & 4," November 30, 2009.

**RAI 02.04.12-50**

**QUESTION:**

To meet the requirements of 52.79(a) and assist staff in its analysis, additional information concerning the groundwater modeling is required. The NRC notes that based on review of FSAR, Rev 3, Sections 2.4S.12 and 2.4S.13, revisions submitted to Section 2.4S.12 and 2.4S.13 on November 23, 2009 (U7-C-STP-NRC-090205), and the groundwater model results (Figures 91 and 100), the applicant may not have considered results of post-construction groundwater simulations on the southwest pathway analysis. The pathways analyzed in FSAR, Rev 3, Section 2.4S.12 and 2.4S.13 (with revisions of 11/23/2009) may not adequately consider a southwest pathway in the Lower Shallow Aquifer. The current groundwater model results indicate a 3 to 3.5 ft increase in piezometric surface at the filled excavation in the Lower Shallow Aquifer. Provide a discussion of this key simulation result with regard to the elimination of a plausible southwest directed groundwater pathway in the Lower Shallow Aquifer.

**RESPONSE:**

The groundwater model does account for the post-construction increase in the piezometric surface (mounding) in the excavated fill at the below grade elevations associated with the Lower Shallow Aquifer (Reference 1). The results of the modeling do not indicate that a southwest pathway from Units 3 & 4 in the Lower Shallow Aquifer would develop for either pre- or post-construction conditions.

The response to RAI 02.04.12-28, Supplement 1 (Reference 2) explains the physical subsurface conditions that would preclude a southwest flowpath in the Lower Shallow Aquifer. These conditions are summarized in the paragraph below.

> The westward flow component in the Shallow Aquifer may represent a pathway from the Unit 4 Radwaste Building in the Upper zone. However, in the Lower zone, a sedimentary facies change is present between Unit 4 and the west site boundary. This material is predominantly silt and clay instead of sand as indicated by soil boring logs B-420, B-932L, and B-951L (FSAR Subsection 2.5S.4). Corroborating the observed facies change are slug test results from observation wells OW-910L, OW-951L, and OW-950L, which indicate the hydraulic conductivity of the Lower Shallow Aquifer decreases by an order of magnitude from Unit 4 to the west and southwest site boundary (FSAR Figure 2.4S.12-26). In addition, potentiometric maps (FSAR Figure 2.4S.12-19) indicate the hydraulic gradient in this area is very small compared with the predominant southeast flowpaths.

A model sensitivity analysis has also been performed to assist in responding to this RAI. A description of the post-construction sensitivity analysis, including the results of groundwater flowpath particle tracking from STP Units 3 & 4 is provided in the response to RAI 02.04.12-48.

Based on the sensitivity analysis, particle tracks were used to determine groundwater flow paths from STP Units 3 & 4. Particles released in stratum C (model layer 4), stratum E (model layer 7), and stratum H (model layer 10) beneath the Units 3 & 4 power block, inside the slurry wall, ultimately migrate to the east and southeast similar to the particle tracks documented by Run 201 (Reference 1). The particles released adjacent to the Radwaste Building in layer 4, to simulate a postulated accidental release to groundwater, move downward through the Units 3 & 4 fill material to stratum E before continuing eastward or southeastward to the site boundary. Particles released west of Units 3 & 4, outside of the slurry wall, travel westward within the Upper Shallow Aquifer to the west site boundary. From the west site boundary, the particle pathline migrates to the southeast and terminates at the relocated Little Robbins Slough. The cause of this is that a flow divide exists in stratum C immediately to the west of the power block beyond the slurry wall. This flow divide is not evident in the Lower Shallow Aquifer.

Additional model sensitivity analyses will be conducted by varying the hydraulic conductivity of the filled excavation material and its impact on potentiometric heads, which will be discussed in a supplemental response to RAI 02.04.12-48, which is scheduled to be submitted by December 15, 2010. Additionally, an analytical radionuclide transport analysis will be performed to estimate the radionuclide concentrations at the site boundary if a southwest flowpath did exist. The analysis will be performed by selecting the postulated post-construction potentiometric head in the Lower Shallow Aquifer beneath Units 3 & 4 and evaluating theoretical groundwater gradients and travel times to the southwestern site boundary. The results of these evaluations will be provided in a supplement to this RAI response by December 15, 2010.

No COLA revision is required as a result of this RAI response.

References:

2. STPNOC Letter No. U7-C-STP-NRC-090206, "Supplemental Response to Requests for Additional Information," dated November 30, 2009, Attachment 2, "Groundwater Model Development and Analysis for STP Units 3&4".

3. STPNOC Letter No. U7-C-STP-NRC-090205, "Supplemental Response to Request for Additional Information," dated November 23, 2009.