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# ADDENDUM TO ANALYSIS REPORT TASK 2 OF AP-088 ESTIMATING BASE TRANSMISSIVITY FIELDS

**(AP-088: Analysis Plan for Evaluation of the Effects of Head Changes on Calibration of Culebra Transmissivity Fields)**

**Task Number 1.3.5.3.1.2**

**Report Date: February 13, 2003**


Authors: R.L. Beauheim for R.M. Holt Date: 4/7/03
Robert M. Holt
Consulting Hydrogeologist

R.L. Beauheim for L. Yarbrough Date: 4/7/03
Lance Yarbrough
GIS Specialist

Technical Review: R.L. Beauheim for J. Kuszmaul Date: 4/7/03
Joel Kuszmaul
Consulting Geological Engineer

QA Review: Mario Chavez Date: 4/7/03
Mario J. Chavez, 6820
Carlsbad Programs Group

Management Review: David Kessel Date: 4/7/03
Dave Kessel
Manager, Performance Assessment and
Decision Analysis


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WIPP:1.3.5.3.1.2:TD:QA-L:522085 DRRP Orig 4/15/03

# Table of Contents

## Discussion

This addendum applies to activities from Task 2 of AP-088, "Analysis Plan for Evaluation of the Effects of Head Changes on Calibration of Culebra Transmissivity Fields." The purpose of this task is to develop a geologically-based predictor of mean Culebra transmissivity using a standard linear-regression approach and use this predictor to generate 100 equally probable realizations of the Culebra mean transmissivity field. This task is subdivided into six subtasks:

1) Conceptual Model Development – Formalize a conceptual model for geologic controls on Culebra Transmissivity.
2) Linear Regression Analysis – Regress geologic controls against Culebra transmissivity data to determine regression coefficients for geological controls on transmissivity.
3) Reduction of Geological Map Data – Import geological map data from Task 1 into a GIS environment and create data files of geological and "soft" data for the Culebra model domain.
4) Indicator Variography – Analyze variograms of an indicator function of high Culebra transmissivity to define a variogram model and variogram model parameters.
5) Conditional Indicator Simulation – Use variogram-model parameters for the high-transmissivity indicator to generate 100 conditional realizations of the spatial locations of high-transmissivity zones in the Culebra.
6) Construction of Transmissivity Fields – Use the regression coefficients, the 100 realizations of high-transmissivity indicators, and the other geologic data to generate 100 realizations of the mean transmissivity in the Culebra model domain.

The activities associated with each of these subtasks are described in Holt and Yarbrough (2002). This addendum is necessary because Task 2 has been revised to reflect new geologic map data from Powers (2003). Powers (2003) updated two maps that are used in subtask 3, specifically 1) a map showing the margin of Salado dissolution (Figure 1) and 2) a structure contour map on the top of the Culebra Dolomite Member of the Rustler Formation (Figure 2). These maps are used in Subtask 3, and Subtasks 3 through 6 have been repeated. Subtasks 1 (Conceptual Model Development) and 2 (Linear Regression

Analysis) are unaffected by these map changes. Because the new maps result in no procedural changes in any of Task 2 Subtasks, this addendum only contains supplements to the appendices contained within Holt and Yarbrough (2002) that require modification due to the new data. Appendix supplements include:

- Appendix B- Routine Calculation: Adobe Acrobat File Import for AP-088,
- Appendix D - Routine Calculation: Creation of Culebra Structure Surface for AP-088,
- Appendix E - Routine Calculation: Creating Surface Elevation Data for AP-088,
- Appendix F - Routine Calculation: Creating an Isopach of Culebra Overburden for AP-088
- Appendix H - Routine Calculation: Creation of the Indicator Grids for AP-088.

## References Cited

Holt, R. M., and L. Yarbrough, Analysis Report Task 2 of AP-088 – Estimating base transmissivity fields, ERMS#523889.

Powers, D. W., 2003, Analysis Report for Task 1 of Ap-088 – Construction of geologic contour maps – Addendum , ERMS#522086.

# Figures

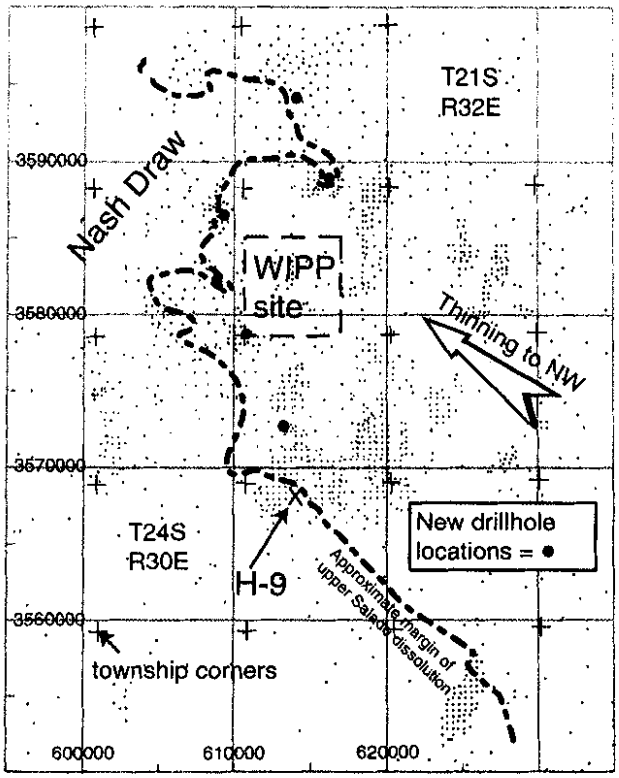



Figure 1. Salado dissolution margin modified from Powers (2003) (replaces Figure 3 in Holt and Yarbrough, 2002).

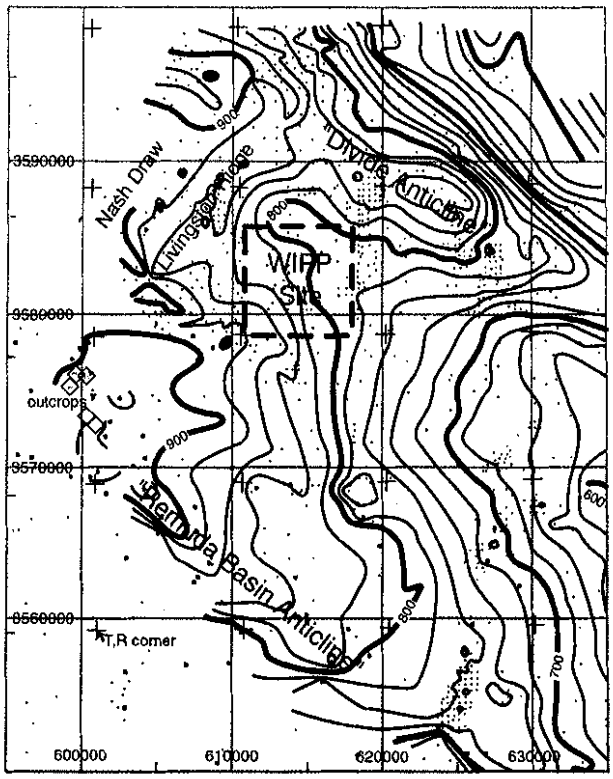



Figure 2. Structure contour map on the top of the Culebra Dolomite modified from Powers (2003).

# Appendix Supplements

## Appendix B Supplement - Routine Calculation: Adobe Acrobat File Import for AP-088

**Software Used:**

ERDAS Imagine

ArcMap 8.1

**Description:**

Two revised geologic maps were imported into a GIS format. These maps were Adobe Acrobat portable document files (PDFs). Each of these PDFs was converted to a high-resolution (600dpi) Tagged Image Format File (TIFF). Using ERDAS Imagine, the image files were then georectified (assigned coordinates) to the coordinate system supplied on the maps. In each case, the Universe Transverse Mercator (UTM) Projection, Zone 13 North was used. All maps were assigned the North American Datum 1927 (NAD27). These rectified images were then opened in ESRI ArcMap 8.1 to begin heads-up digitizing (HUD). HUD is an interpretive procedure that allows the analyst to trace on-screen features from a rectified image. The HUD resulted in the following spatial arc data.

**Input:**

- "Culebra_Elev_rev_1-3-03_B.pdf" from ERMS# 522086
- "Salado_Dissolution_Line_revised_1-3-03.pdf" from ERMS# 522086

**Output:**

- ArcView Shapefiles:
- "dissolution_line.shp"
- "culebra_contours.shp"

**Data Sources:**

Spatial data digitized from geologic maps prepared by Dennis Powers for Task 1 of AP-088. ERMS# 522086

**Platform:**

1.8-GHz Pentium 4 - Windows 2000

## Appendix D Supplement - Routine Calculation: Creation of Culebra Structure Surface for AP-088

**Software Used:**

Arc/Info

**Description:**

Using the "culebra_contours.shp" spatial data created from the HUD (Appendix B Supplement), a hydrologically correct surface was calculated for the top of the Culebra Dolomite. The same technique explained in Appendix D was employed to create a structure surface. The TOPOGRID command was executed using a 50-meter grid spacing based on the grid locations derived in Appendix C. The resulting revised Culebra structure surface was saved as an Arc/Info GRID format.

**Input:**

- Arc/Info coverage format "culebra_contours.shp" from Appendix B Supplement.

**Output:**

- Arc/Info GRID format directory file named "culebra"

**Data Sources:**

Spatial data digitized from geologic maps prepared by Dennis Powers for Task 1 of AP-088. ERMS# 522086. (see Input listed in Appendix B Supplement)

**Platform:**

1.8-GHz Pentium 4 - Windows 2000

## Appendix E Supplement - Routine Calculation: Creating Surface Elevation Data for AP-088

**Software Used:**

ArcView

**Description:**

During the first execution of this subtask, elevation data obtained from the USGS National Elevation Dataset (NED) (http://edcnts12.cr.usgs.gov/ned/) was assumed to posses a geographic datum of North American Datum 1927 (NAD27). This assumption was incorrect and the correct datum was NAD83. To correct this datum-shift, the elevation data was then reprojected to NAD27 prior to resampling the 30 meter data to conform to the study area's 50 meter grid spacing.

**Input:**

- Arc/Info GRID format file of the USGS National Elevation Dataset (NED)

**Output:**

- Arc/Info GRID format directory file named "dem_utm_nad27"

**Data Sources:**

USGS National Elevation Dataset (NED) (http://edcnts12.cr.usgs.gov/ned/)

**Platform:**

1.8-GHz Pentium 4 - Windows 2000

## Appendix F Supplement - Routine Calculation: Creating an Isopach of Culebra Overburden for AP-088

**Software Used:**

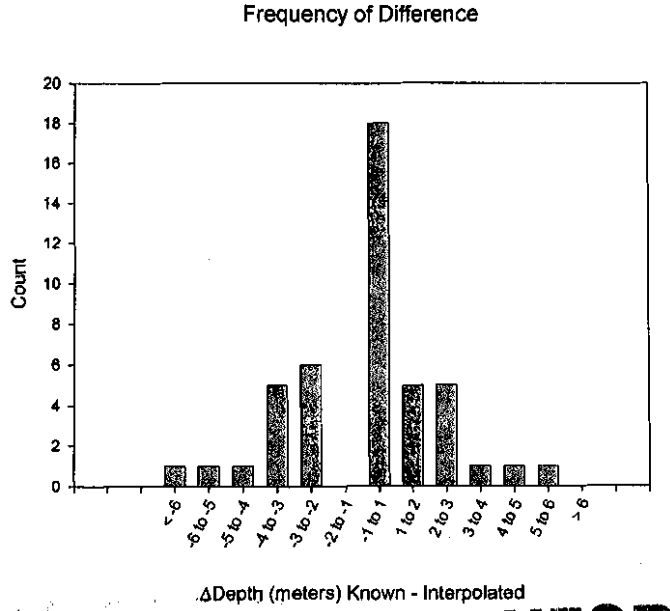
ArcView

**Description:**

Using the digital elevation data from the NED and the Culebra structure surface, an isopach grid was created. The revised isopach was created in ArcView using the map calculator function. The Culebra structure data were subtracted from the elevation data. The resulting grid is a revised isopach of Culebra overburden on 50-meter spacing.

As before, the GRIDPOINT function in Arc/Info was used to generate a point spatial data set. The data was queried using the same 50-meter grid spacing developed in Appendix C. This resulting isopach data file was exported into a TAB delimited text format.

To verify the interpolation method, 45 wells with know data were compared to interpolated data queried from the GIS. Assuming the average thickness of the Culebra was seven meters, the depth to the center of the Culebra unit was calculated and compared to known data. The average difference was 0.05 meters with a standard deviation of 2.27 meters. This comparison is summarized in an EXCEL spreadsheet.



**Input:**

- Arc/Info GRID format directory file named "culebra" from Appendix D Supplement
- Arc/Info GRID format directory file named "dem_utm_nad27" from Appendix E Supplement

**Output:**

- Arc/Info GRID format directory file named "isopach"
- EXCEL format file "qa_isopach_supplement.xls"
- TAB delimitated file "isopach.txt"

**Data Sources:**

Geologic maps prepared by Dennis Powers for Task 1 of AP-088. ERMS# 522086. (see Input listed in Appedix B Supplement)

USGS National Elevation Dataset (NED) (http://edcnts12.cr.usgs.gov/ned/)

**Platform:**

1.8-GHz Pentium 4 - Windows 2000

## Appendix H Supplement - Routine Calculation: Creation of the Indicator Grids for AP-088

### Software Used:

Arc/Info

### Description:

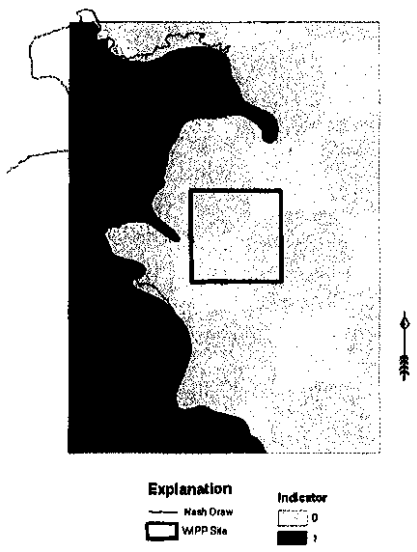
The indicator grids described in Appendix H, required recreating using the newly revised data files. The halite margin m2/h2, and halite margin m3/h3 spatial data did not change so a revised M2/H2 Indicator was not need. Only the Dissolution and Middlezone Indicators required revision.

As in Appendix H, the resulting polygons were attributed then populated with the appropriate indicator in the database, as follows:

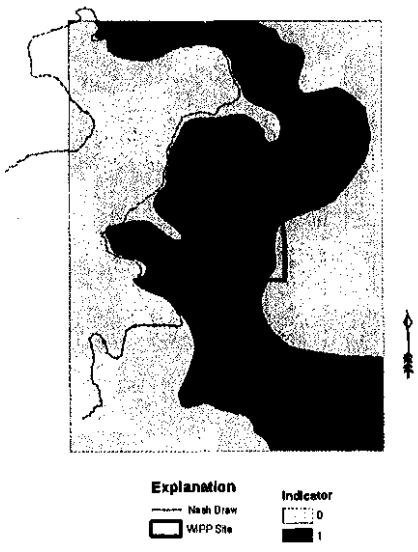
- Middle Zone Indicator – (0 where dissolution occurs and m2/h2 overlies and underlies the Culebra, 1 elsewhere)
- Salado Dissolution Indicator – (1 where Salado dissolution has occurred, 0 elsewhere)

The figures below show the indicator polygons within the model domain.

**Salado Dissolution Indicator**




**Middlezone Indicator**



Next the 50-meter points created in a previous subtask (Appendix C) were overlain on each of the newly revised indicator polygons. The attributes of the polygons were then spatially joined to the points, thereby creating a new attribute in the point data representing the associated indicator value. Two indicator point data files were created using this technique:

- Middle Zone Indicator Grid
- Salado Dissolution Indicator Grid

Numerous points within the indicator regions and along the indicator boundaries were checked to assure proper indicator value assignment to each point. Large scale PDFs were produced for each grid file. The indicator was color coded and plotted with the spatial data used to create the indicator girds. Each indicator grid was then exported into a TAB delimited text format.

**Input:**

- Shapefile "final_points.shp" from Appendix C
- Shapefile "dissolution_line.shp" from Appendix B Supplement
- Shapefile "salt_margin_m2_h2.shp" from Appendix B
- Shapefile "salt_margin_m3_h3.shp" from Appendix B

**Output:**

- TAB delimited file: p_middlezone.txt
- TAB delimited file: p_dissolution.txt
- PDF file: "middlezone_revised_qa.PDF"
- PDF file: "salado_dissolution_revised_qa.PDF"

**Data Sources:**

Spatial data digitized from geologic maps prepared by Dennis Powers for Task 1 of AP-088. ERMS# 522086. (see Input listed in Appendix B Supplement)

**Platform:**

1.8-GHz Pentium 4 - Windows 2000

## Chavez, Mario Joseph

**From:** Joel Kuszmaul [kuszmaul@olemiss.edu]
**Sent:** Monday, April 07, 2003 9:45 AM
**To:** Chavez, Mario Joseph
**Cc:** rlbeauh@sandia.gov; rmholt@olemiss.edu
**Subject:** RE: DRC FORM COMPLETE

Mario, either you or Rick Beauheim are welcome to sign the DRC for my review of the addendum to Holt's analysis report.

Thanks,

Joel

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## Chavez, Mario Joseph

**From:** Robert M. Holt [rmholt@olemiss.edu]
**Sent:** Monday, April 07, 2003 11:53 AM
**To:** 'Chavez, Mario Joseph'
**Subject:** RE: DRC FORM COMPLETE

Mario,
You may have signature athourity for me with respect to my part of AP-088.
Thanks,
Bob

## Chavez, Mario Joseph

**From:** Lance Yarbrough [Lance@Yarbrough.com]
**Sent:** Monday, April 07, 2003 12:33 PM
**To:** 'Chavez, Mario Joseph'
**Cc:** Richard Beauheim
**Subject:** RE: DRC FORM COMPLETE

To Whom It May Concern:

I give Mario Chavez and Rick Beauheim signature authority for the DRC's and Title Page for Task 2 of AP-088.

Respectfully,
Lance Yarbrough, EIT
*Consulting Engineer*

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Lance D. Yarbrough, EIT
Graduate Researcher/Instructor
Geology and Geological Engineering
118 Carrier Hall
University, MS 38677
V- (662) 915-7651
F- (662) 915-5995