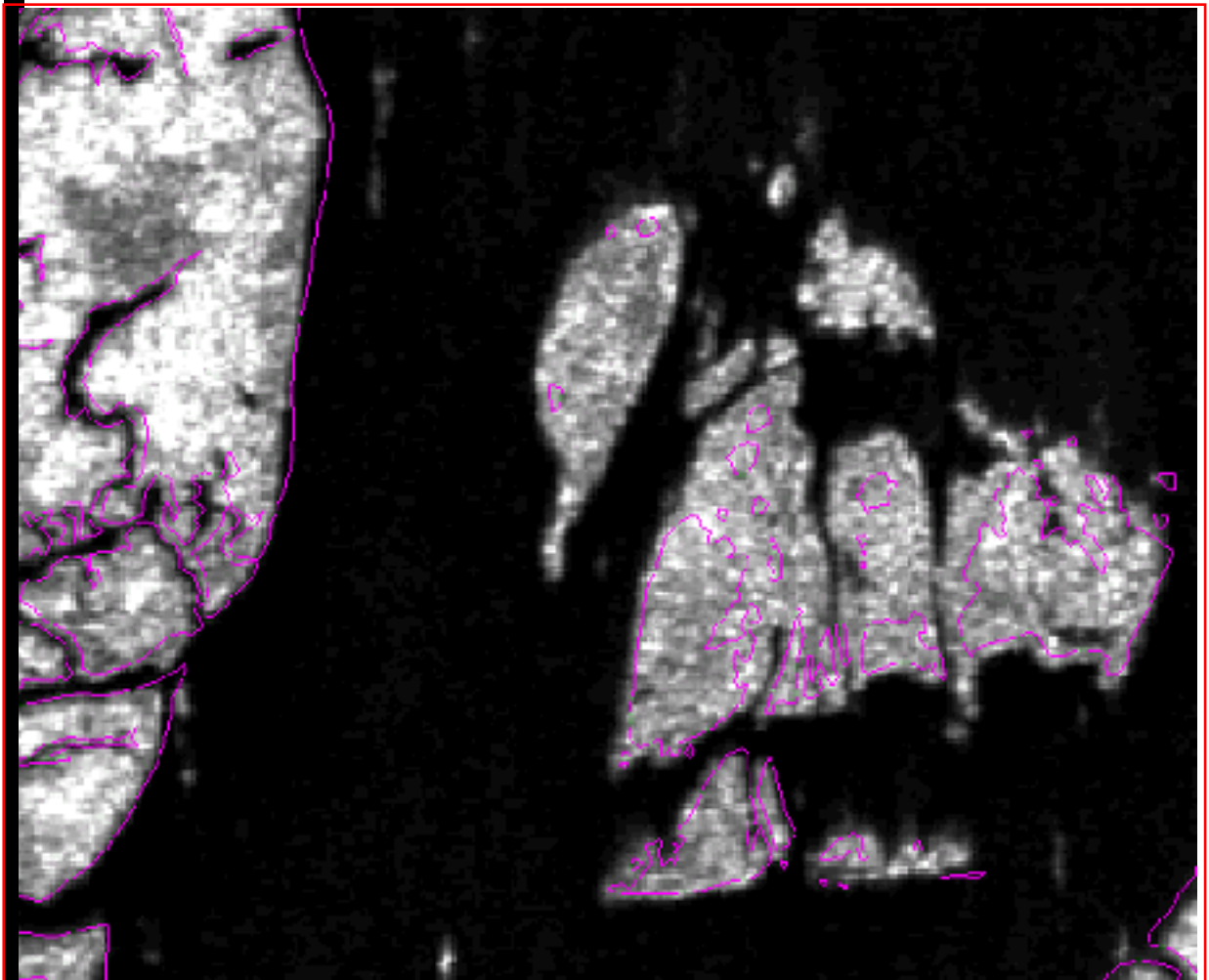


**US Army Corps  
of Engineers®**  
Engineer Research and  
Development Center

# **Comparing Digital Flood Insurance Rate Maps (DFIRMs) to Interferometric Synthetic Aperture Radar (IFSAR) Products**

September 2000

James J. Damron



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## **PREFACE**

This study was sponsored by the Federal Emergency Management Agency (FEMA) and managed by the U.S. Army Engineer Research and Development Center's (ERDC) Topographic Engineering Center (TEC).

The study was conducted during the period December 1999 to July 2000. Mr. Anthony R. Niles was Chief, Geospatial Engineering Branch, and Mr. William Z. Clark was Director, Topographic Research Division, during this period.

Colonel James A. Walter was the Director of ERDC's TEC at the time of publication of this report.

## **ACKNOWLEDGMENTS**

Appreciation is hereby given to the following TEC employees: Dr. Alta Walker, Terrain Analysis Branch; Jamie Richardson, Products & Services Branch; and John Nedza, Terrain Data Generation Branch, who assisted in the review of the applied methodologies used within the study.

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# **COMPARING DIGITAL FLOOD INSURANCE RATE MAPS (DFIRMS) TO IFSAR PRODUCTS**

## **INTRODUCTION**

The evolution of digital data has opened the door for exploration and for unlimited possibilities for the future. The Federal Emergency Management Agency (FEMA) is in a digital revolution. FEMA will convert Flood Insurance Rate Maps (FIRMs) to Digital Flood Insurance Rate Maps (DFIRMs) under the Map Modernization Flood Hazard Mapping Program. The first phase will convert hardcopy FIRMs to DFIRMs. Future FIRM studies will be based upon softcopy mapping technologies. The main goal of FEMA is to be able to update DFIRMs using Geographic Information System (GIS). Information on the current program is provided at [http://www.fema.gov/mit/tsd/MM\\_DFHM.htm](http://www.fema.gov/mit/tsd/MM_DFHM.htm).

### **Background**

The evolution of digital mapping technologies in the field of Digital Elevation Model (DEM) production with the advent of digital photogrammetry parallels the development of the Interferometric Synthetic Aperture Radar (IFSAR) collection systems. The IFSAR collection system uses dual Synthetic Aperture Radar (SAR) to actively illuminate the ground at a slant angle on a fixed wing aircraft in forward flight.

The aircraft's Differential Global Positioning System (DGPS) and Inertial Navigation System (INS) devices also collect information used for post processing the radar data on the ground. General information on GPS is located at the Global Positioning System Data & Information web site [http://192.5.41.239/gps\\_datafiles.html](http://192.5.41.239/gps_datafiles.html) maintained by the United States Naval Observatory. INS devices collect information on the aircraft's three axes — pitch, yaw, and roll — as well as the aircraft's airspeed and heading while in forward flight. Without these devices, data collected from IFSAR systems could not be geo-referenced to a location on the earth. The elevation of the ground is derived by processing the reflective radar data using the DGPS and INS information from the aircraft and IFSAR collection system.

Currently, there is only one commercial IFSAR collection device and it is owned and operated by Intermap Technologies Inc. Information on Intermap's IFSAR collection capabilities and products can be found at the following Web site: <http://www.intermaptechnologies.com>. Intermap Technologies Inc. will be further referred to as Intermap. This study will focus on the comparison of IFSAR products to DFIRMs, in terms of data accuracy and content.

The IFSAR data were collected over the Virginia Beach, Virginia, area as part of NASA's Commercial Remote Sensing Program involving the Scientific Data Purchase Program at the Stennis Space Center, Mississippi. The Topographic Engineering Center (TEC) requested IFSAR products from the Scientific Data Purchase Program. DFIRMs were requested from Dewberry & Davis through its Fairfax, Virginia, office.

## **Purpose**

There were two main objectives for this study. First, to see how IFSAR-derived products can be used to enhance DFIRMs. Second, to determine which vector categories in the DFIRMs could best benefit from IFSAR-derived products. The comparative analysis was accomplished by using GIS software ArcInfo 8.0.1 on a UNIX workstation and Quattro Pro 9. Data formats were evaluated to provide information about these products. Understanding the different data formats of the IFSAR and DFIRM products is sometimes difficult and describing the two different products was an important component in understanding the data. Information on IFSAR and DFIRM products are placed throughout the study for further reading as Web or document references.

## **Scope of Study**

The short-term benefit to FEMA will be information on the current state of horizontal accuracy of DFIRMs used during the early production years prior to the DFIRM 2.0 and 2.1 specifications. The long-term benefit to FEMA is to provide a better understanding of IFSAR product accuracies and how these products might help to update and improve DFIRMs when other products are not available for the task. This study was conducted from December 1999 to February 2000 with a three-month break while waiting for a new DFIRM data set, and from May 2000 to July 2000.

## IFSAR DATA

The IFSAR DEM and Ortho-Rectified Image (ORI) products covered an approximate area of 691 mi<sup>2</sup> or 1789 km<sup>2</sup>. The IFSAR collection, shown in Figure 1 on the next page, is within the southeast corner of Virginia. The IFSAR collection encompassed all or portions of six counties: Chesapeake, Newport News, Norfolk, Portsmouth, Suffolk, and Virginia Beach. The IFSAR DEMs and ORIs were delivered in a UTM projection, Zone 18, WGS84 horizontal datum, and units in meters.

The IFSAR DEM was converted from the WGS84 ellipsoid heights to orthometric heights (mean sea level) using a worldwide geoid model similar to the NGS GEOID96 model prior to the delivery, which Intermap refers to as the EGM96 vertical datum. Information on the global geopotential model EGM96 used by Intermap to obtain orthometric heights for DEMs can be found at <http://cddisa.gsfc.nasa.gov/926/egm96/egm96.html> (NASA). Intermap used the GEOID96 model as part of this delivery. The accepted geoid model used in the United States is the GEOID99 model, which replaces the older GEOID96 model (NGS). The geoid model is added to the ellipsoid heights, thereby producing the normal curvature of the earth. This normal curvature is important because it provides the correct elevation of the earth's surface for water to flow downhill and for line-of-sight investigations involved within the telecommunication industry.

### Data Formats

The IFSAR DEM data included 15 DEM files with associated header files in a .txt extension. The format of the IFSAR DEM data was an IEEE floating point, 32-bit signed binary file format with a .bil extension and a 5-m post space. The IFSAR DEM delivered was the Global Terrain one (GT1) product with a horizontal accuracy of 2.5-m Root-mean-square Error (RMSE) and a vertical accuracy of 1-m RMSE. Information on the IFSAR DEM product line can be found at <http://www.globalterrain.com/products.html>. The sample header file, seen in Appendix A, was used to write new header files and allowed the IFSAR DEM data to be imported into ArcInfo. A sample header file with a .hdr extension is shown in Figure 2. The .bil extension of the IFSAR DEMs was changed to a .dem so the data could be imported into ArcInfo using the *ifsargrid.aml* seen in Appendix B. The IFSAR DEM data were imported into ArcInfo using the *FLOATGRID* command. The IFSAR DEM file names are shown in Table 1. The *PROJECTDEFINE* command was used to add coordinate system information to each DEM file.

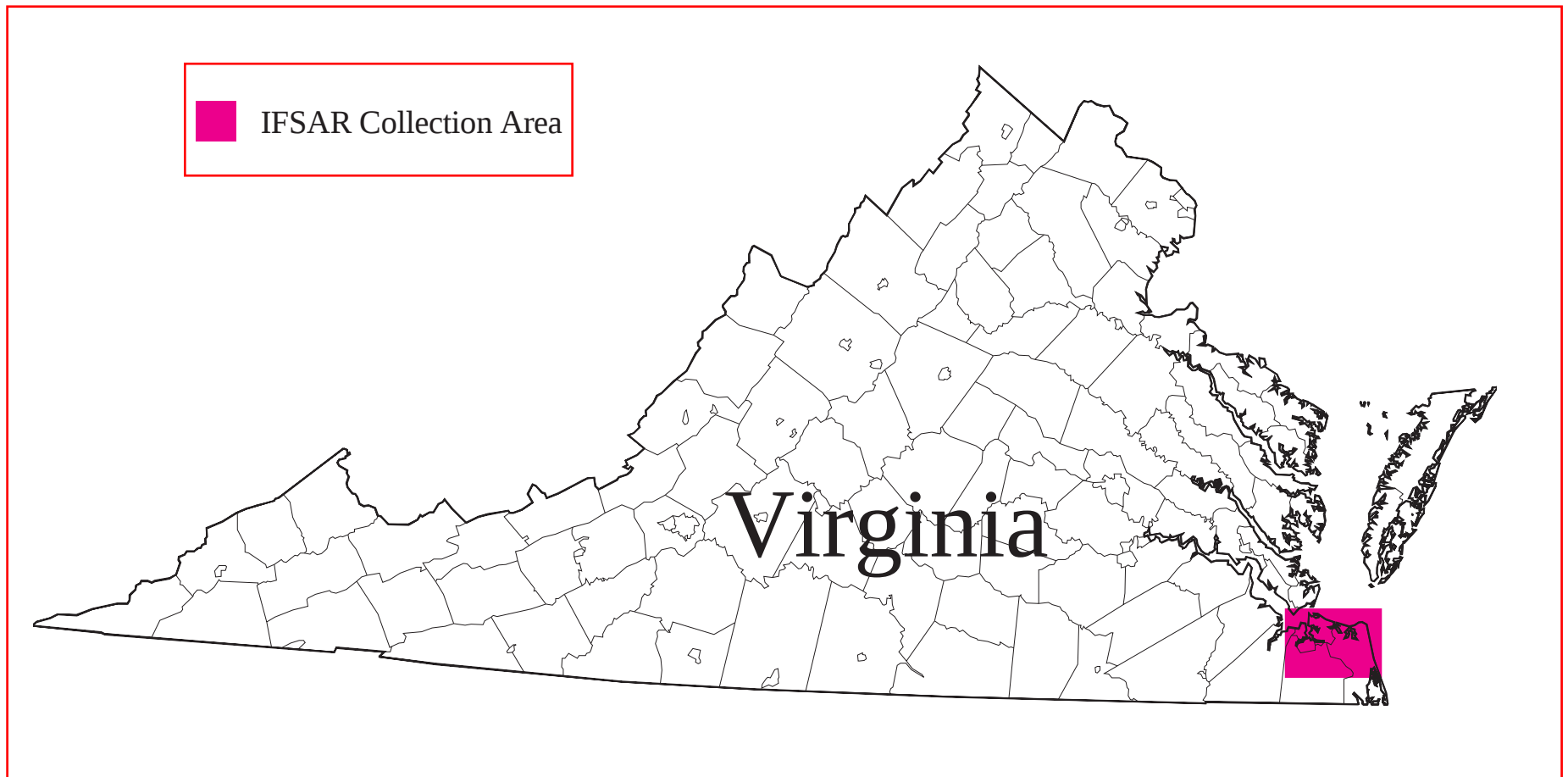


Figure 1. IFSAR Collection Area

```

nrows 2901
ncols 1807
xll 410167.5
yll 4067232.5
cellsize 5
NODATA_value -9999
byteorder MSBFIRST

```

Figure 2. Sample New Header file

Table 1. IFSAR DEMs

|                |                |                |
|----------------|----------------|----------------|
| gt1n36w075f8v1 | gt1n36w076f3v1 | gt1n36w076g4v1 |
| gt1n36w075g8v1 | gt1n36w076f4v1 | gt1n36w076h1v1 |
| gt1n36w075h8v1 | gt1n36w076g1v1 | gt1n36w076h2v1 |
| gt1n36w076f1v1 | gt1n36w076g2v1 | gt1n36w076h3v1 |
| gt1n36w076f2v1 | gt1n36w076g3v1 | gt1n36w076h4v1 |

The IFSAR ORI products, referred to as a magnitude image, were collected and delivered with west and south orientation, referred to as a look. The west and south look ORIs consisted of 15 GEOTIFF, 8-bit format images with embedded coordinates to reference each image with a 2.5-m pixel size and a horizontal accuracy of 2.5-m RMSE. All ORI files were accompanied by an ASCII metadata file with a .txt extension. Information on the ORI products can be found at <http://www.globalterrain.com/products.html>. One example of these files is shown in Appendix C. The ORI data were imported into ArcInfo using the *IMAGEGRID* command with a sample ORI seen in Figure 3. The ORI south and west look file names are shown in Table 2. Finally, the *PROJECTDEFINE* command was used to add coordinate system information to each file.

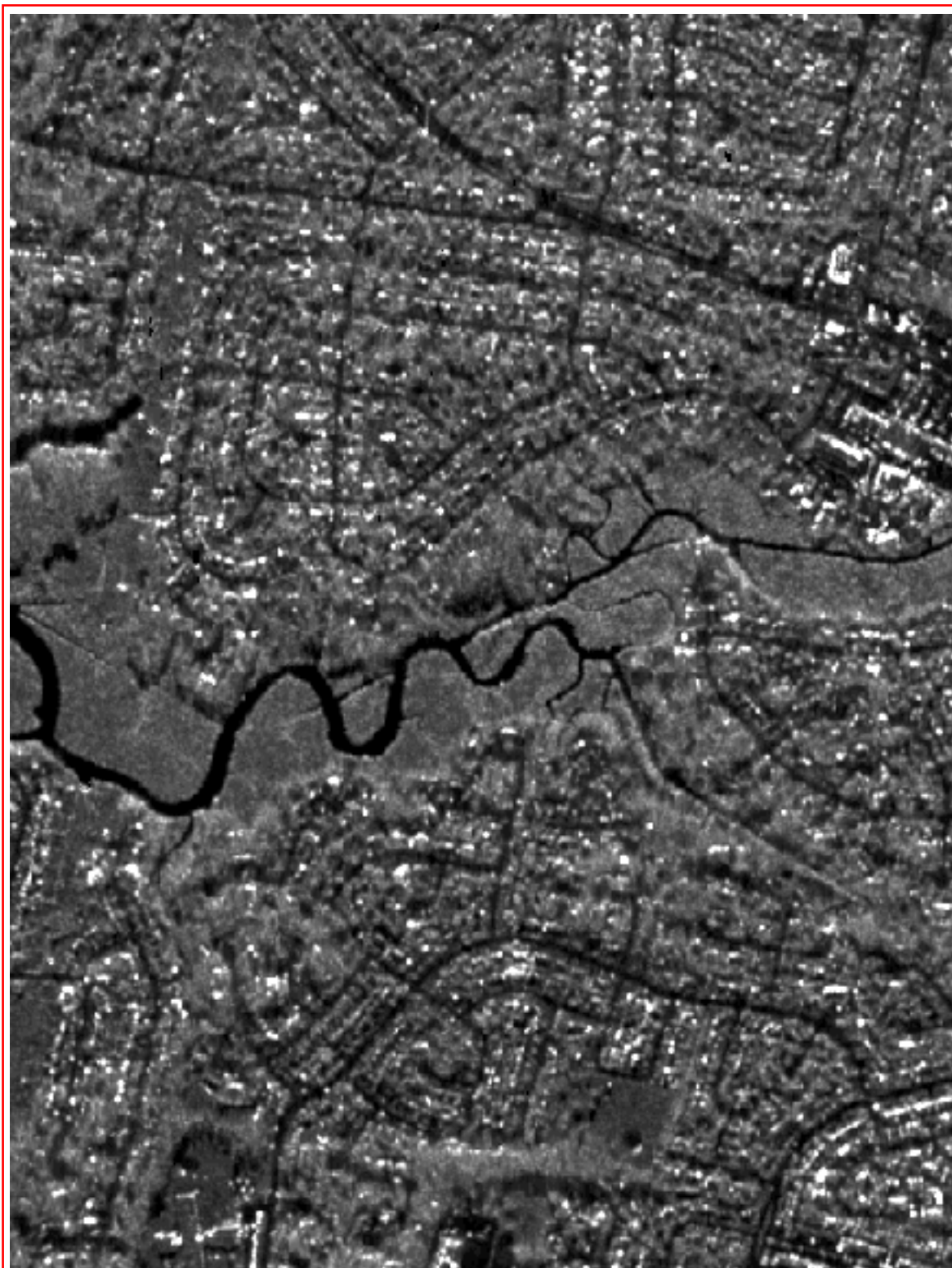


Figure 3. Sample ORI

Table 2. ORIs

|                |                |                |
|----------------|----------------|----------------|
| im2n36w075f8v1 | im2n36w076f3v1 | im2n36w076g4v1 |
| im2n36w075g8v1 | im2n36w076f4v1 | im2n36w076h1v1 |
| im2n36w075h8v1 | im2n36w076g1v1 | im2n36w076h2v1 |
| im2n36w076f1v1 | im2n36w076g2v1 | im2n36w076h3v1 |
| im2n36w076f2v1 | im2n36w076g3v1 | im2n36w076h4v1 |

## IFSAR Anomalies

The IFSAR DEMs had one noticeable anomaly in the delivered data set. This anomaly was discovered when a hill shading technique was applied to the merged IFSAR DEMs. One DEM sheet, gt1n36w076h3v1, had a visible line along three adjoining sheets (Figure 4). Further investigation using the *CELLVALUE* command at the GRID prompt showed the sheet to be 0.24 m lower than three adjoining sheets. Intermap concurred with the findings and agreed to correct the problem. A new DEM data set was delivered. The IFSAR DEMs were merged and checked for the same problem. No problems were found in the new delivery of the IFSAR DEMs.

Dropouts, normal occurrences with IFSAR collections, are visible in the ORIs as black areas with no data. Most are created from shadowing effects of the physical terrain or large objects. In Figure 5, data dropouts are visible as black areas in the clipped image from the west look data set. It was not clear why the dropouts occurred in these areas. Data distortions are another type of anomaly associated with collections. In Figure 6, the distorted data near the water body are caused by the reflection of roofs of nearby buildings in that area. The distortion in Figure 7 is caused by the combined reflection of several roofs.

This collection was different from prior IFSAR collections due to the delivery of a west and south look. Intermap explained to TEC that the west look is the primary data set and the south look is the secondary data set. Both data sets were accidentally merged together and displayed a minor anomaly that appeared interesting and could warrant further investigation at a later time. In Figure 8, a clipped image of the merged west and south looks shows a visible offset of several meters. It is unknown at this time what the cause could be. The offset was reported to Intermap and its technical support recommended that the west and south looks not be merged.

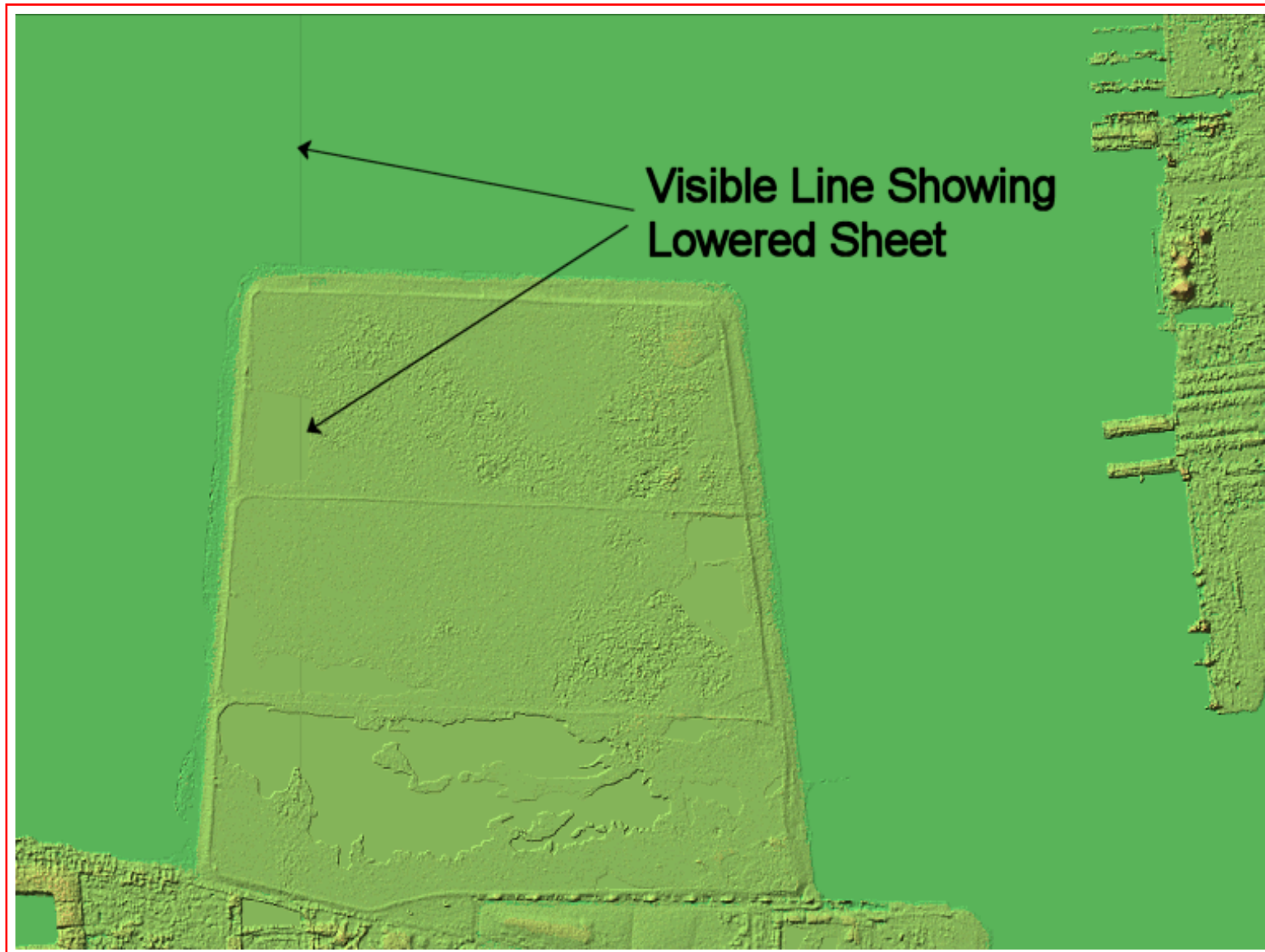


Figure 4. Visible Line Indicating Lower DEM

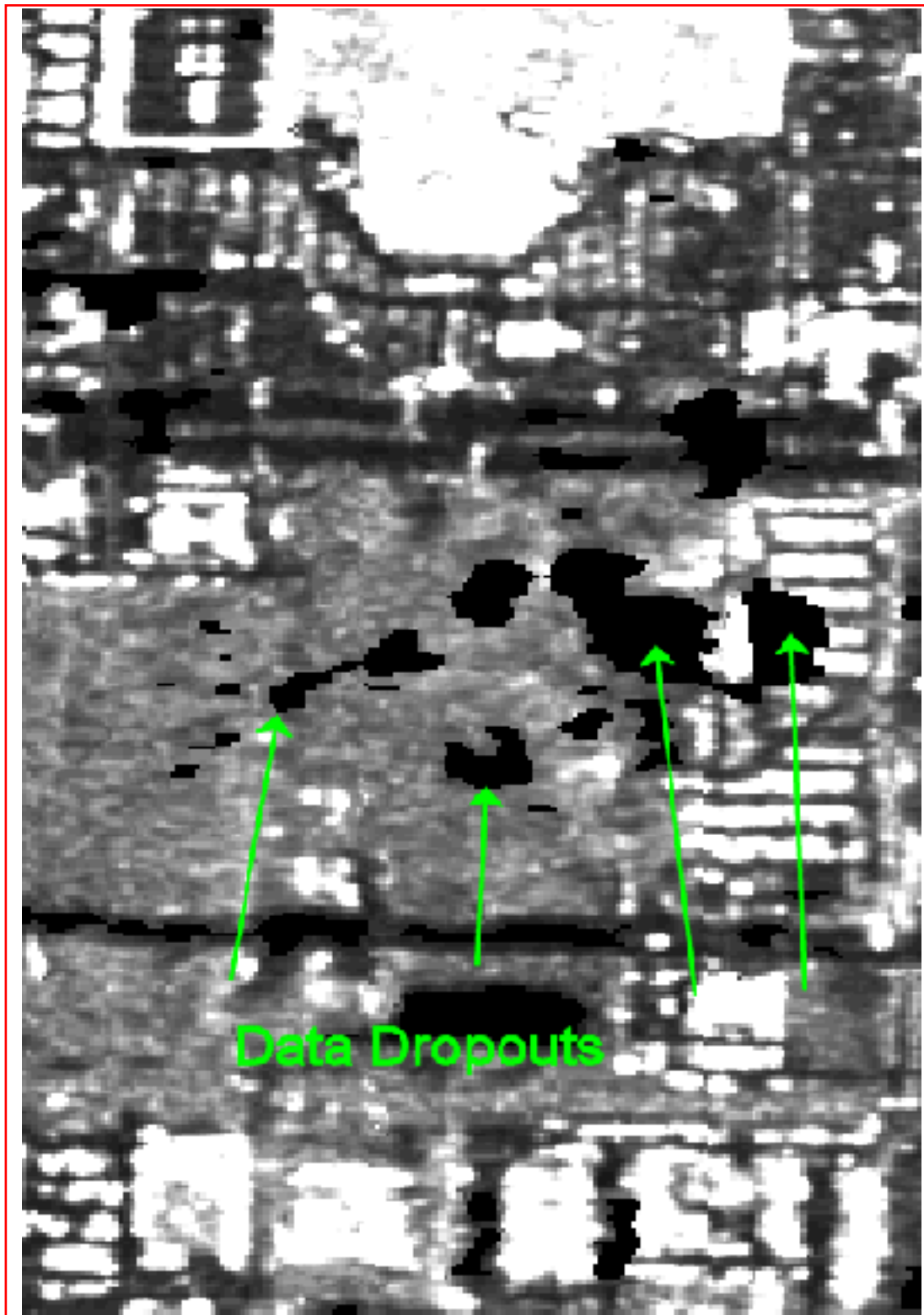


Figure 5. Black Areas Indicate Data Drop outs

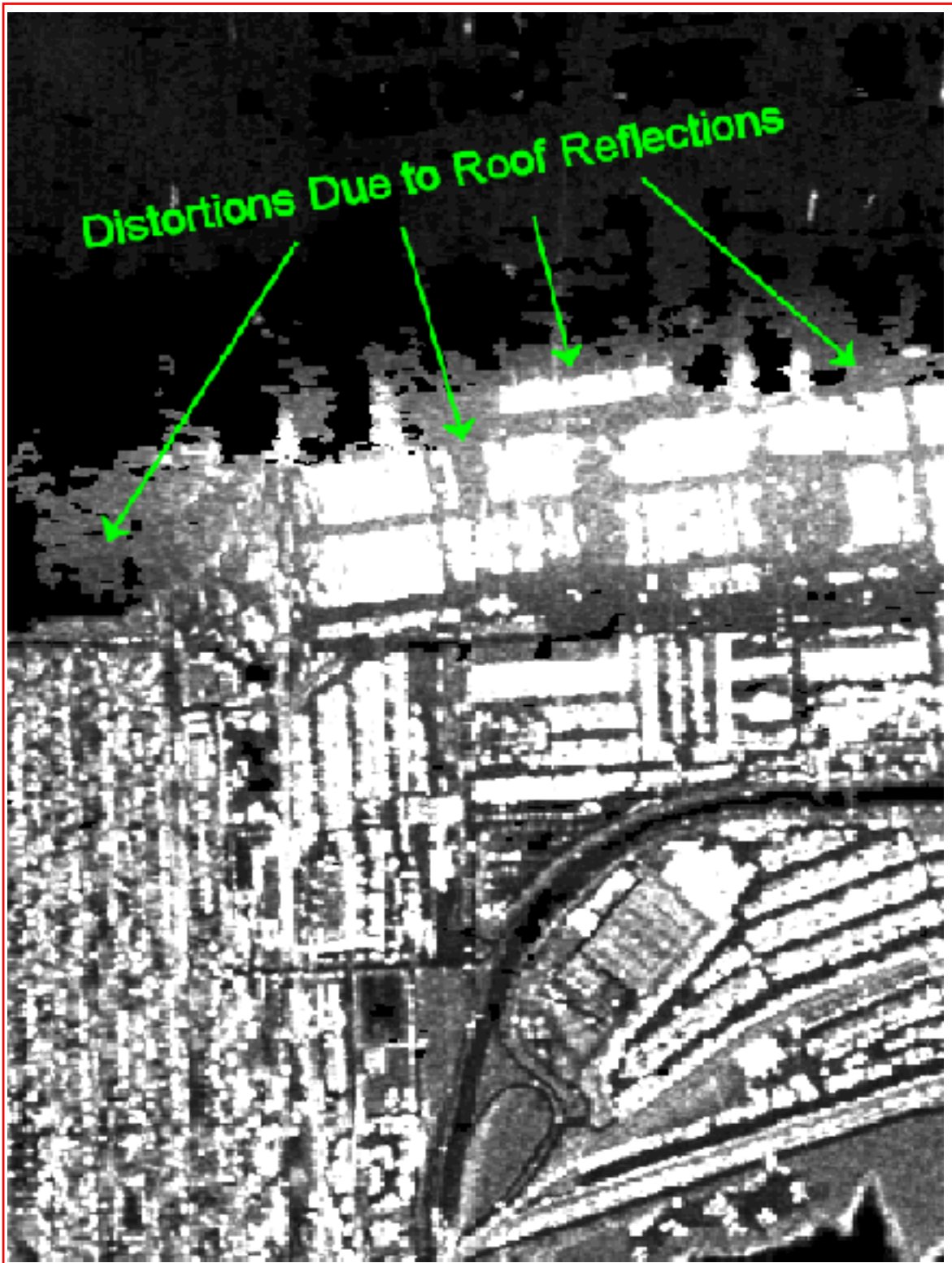


Figure 6. Distortions in Water Bodies Due to Roof Reflections

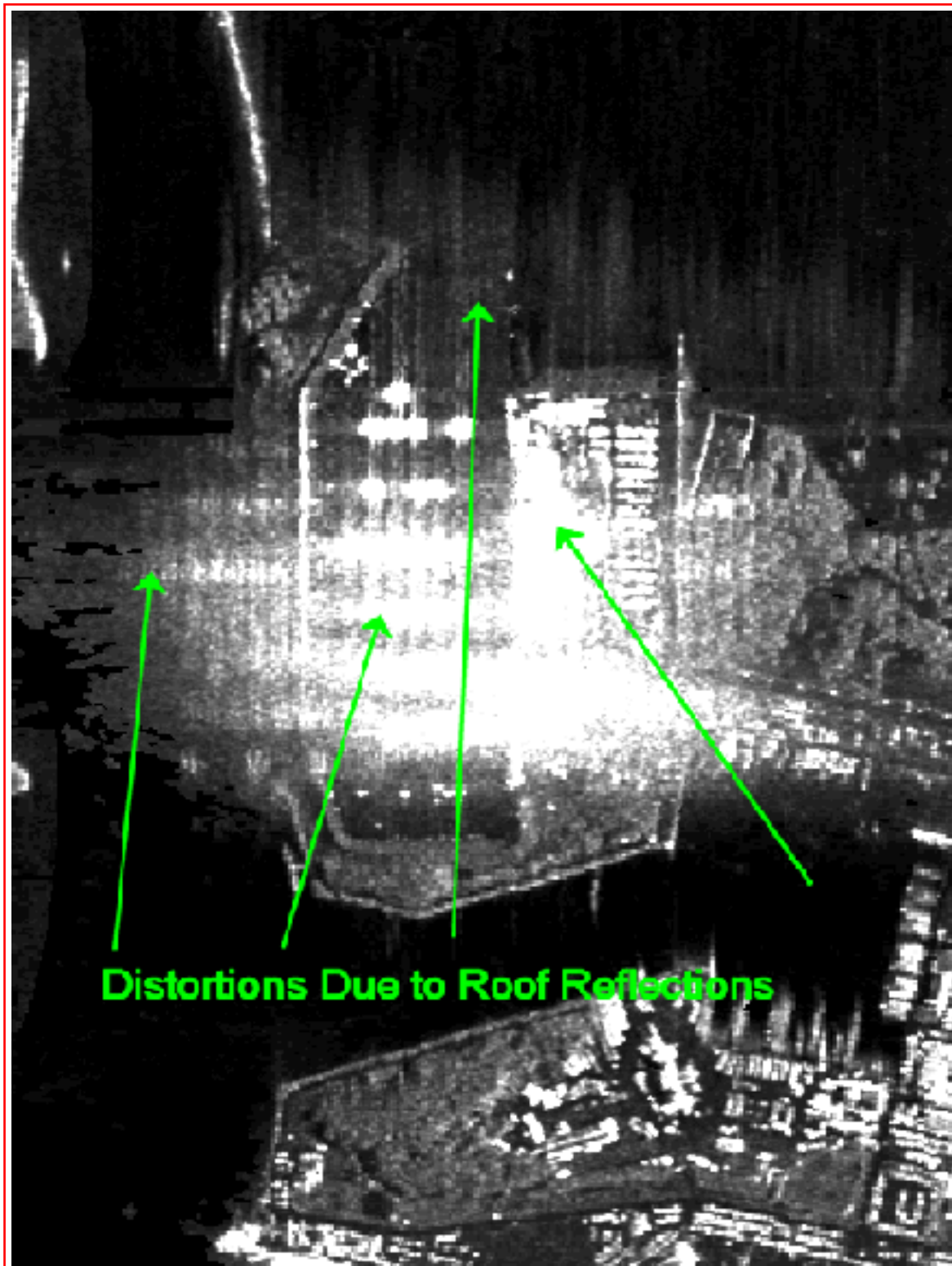


Figure 7. Distortions Due to Several Roof Reflections



Figure 8. Offset from Merging West and South Looks

## DFIRM DATA

DFIRM sheets are designed around the bounding box of a standard USGS 7.5-minute 1:24,000-scale map sheet, referred to as a quad. The DFIRM data set delivered to TEC was in a UTM projection, zone 18, North American Datum of 1927 (NAD 27), National Geodetic Vertical Datum of 1929 (NGVD 29), and units in meters. The DFIRMs covered all of Virginia Beach County and encompassed more than half of the IFSAR collection area shown in Figure 9. DFIRMs are based on the USGS Digital Line Graphs three (DLG-3) format, which provides a full range of attribute codes and are fully topologically structured (USGS).

### Data Format

The first DFIRM data set was delivered by Dewberry & Davis in a DLG format with a .dlg extension. The DLGs were delivered on CD-ROM in four categories: flood hazard zones (f), hydrography (h), map panel (m), and political areas (p). They include 12 sheets per category, shown in Table 3. The file naming convention for the DFIRMs is that the first five characters indicate the state/county fips code, the sixth character is the file category, and the last two characters are the sheet identifiers. Four ARC Macro Language (AML) scripts were written to import the DLGs into ArcInfo seen in Appendixes D, E, F, and G, which assigned character attributes to the numerical values of the DLGs for easy interpretation.

Table 3. DLGs

| Flood Hazard | Hydrography | Map Panel | Political Areas |
|--------------|-------------|-----------|-----------------|
| 51810faa     | 51810haa    | 51810maa  | 51810paa        |
| 51810fab     | 51810hab    | 51810mab  | 51810pab        |
| 51810fac     | 51810hac    | 51810mac  | 51810pac        |
| 51810fba     | 51810hba    | 51810mba  | 51810pba        |
| 51810fbb     | 51810hbb    | 51810mbb  | 51810pbb        |
| 51810fbc     | 51810hbc    | 51810mbc  | 51810pbc        |
| 51810fca     | 51810hca    | 51810mca  | 51810pca        |
| 51810fcb     | 51810hcb    | 51810mcb  | 51810pcb        |
| 51810fcc     | 51810hcc    | 51810mcc  | 51810pcc        |
| 51810fdb     | 51810hdb    | 51810mdb  | 51810pdb        |
| 51810fdc     | 51810hdc    | 51810mdc  | 51810pdc        |
| 51810fdd     | 51810hdd    | 51810mdd  | 51810pdd        |

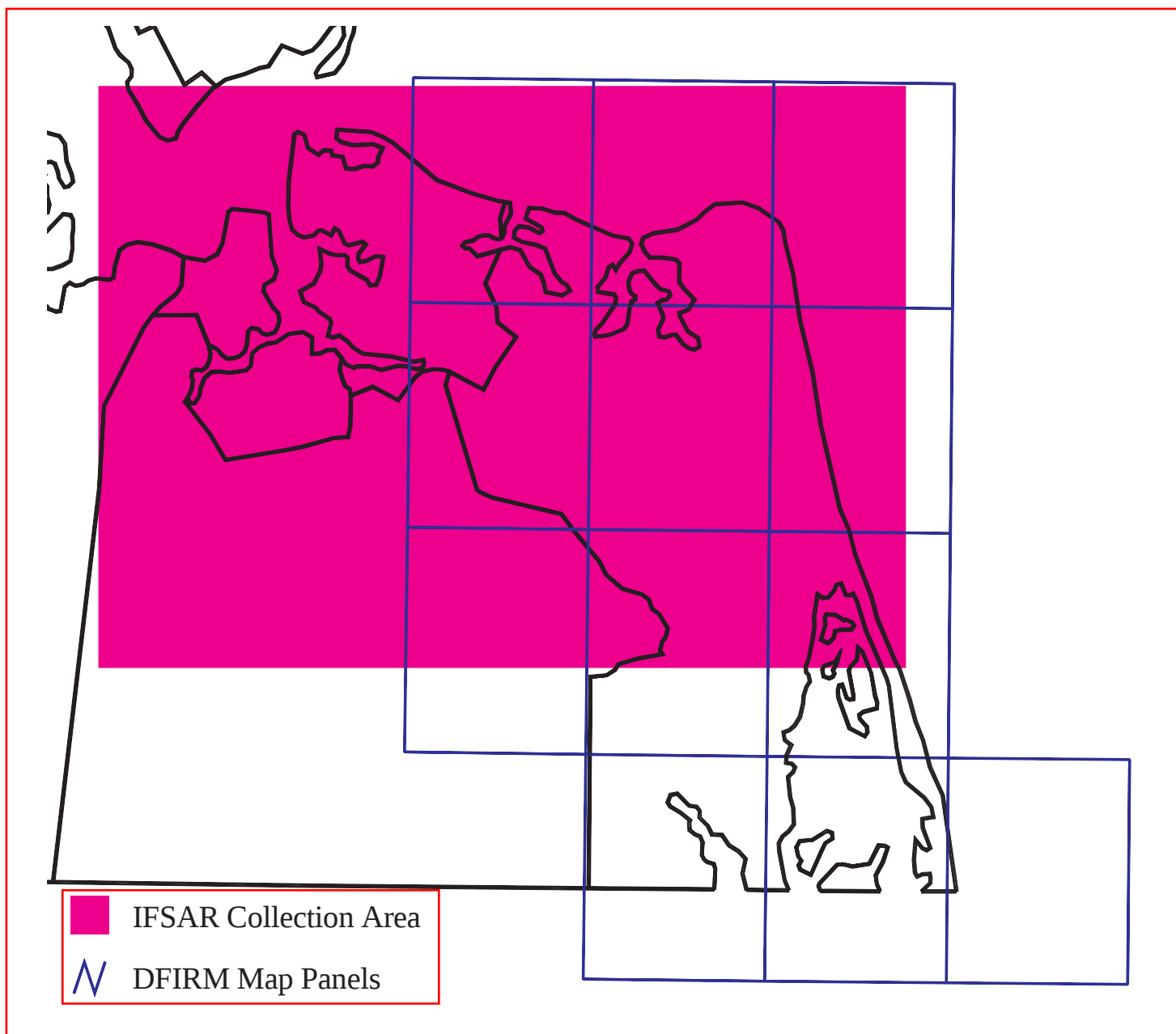


Figure 9. IFSAR Collection Area Overlaid with DFIRM Map Panels

## DFIRM Anomalies

Figure 10 is an example of one of the many errors found in the DLG DFIRMs. Adjoining quad vertices were offset by as much as 1 m, and some quads overlapped each other. The DLG DFIRMs were an intermediate version that required many hours of *EDGEMATCHING* in ArcEdit to correct problems found in the DFIRM vectors. TEC asked Dewberry & Davis to deliver a finalized seamless version of the Virginia Beach DFIRMs when available.

## Second DFIRM Data Set

The second DFIRM data set was delivered to TEC on May 8, 2000. The Arc Interchange format with a .e00 extension was the chosen format for the second delivery. The Arc Interchange format had the same attribution scheme as the previous DLG format. The DFIRMs were delivered on CD-ROM with five different categories: elevation reference marks (e), flood (f), hydrography (h), map panels (m), and political areas (p), listed in Table 4. Additional files included the entire data set for each category listed in Table 4 with a prefix of vb signifying the difference. The Arc Interchange naming conventions were as follows: the first five characters are the county name, the next two characters are the sheet number, and the last character is the file category. The readme statement shown in Appendix H provides more detail about the DFIRM sheets.

Table 4. Arc Interchange (e00)

|          |          |          |          |          |
|----------|----------|----------|----------|----------|
| vabch01e | vabch04e | vabch06p | vabch09p | vabch12p |
| vabch01f | vabch04f | vabch07f | vabch10e | vb_24k   |
| vabch01h | vabch04h | vabch07h | vabch10f | vb_erm   |
| vabch01m | vabch04m | vabch07m | vabch10h | vb_fall  |
| vabch01p | vabch04p | vabch07p | vabch10m | vb_hall  |
| vabch02e | vabch05e | vabch08e | vabch10p | vb_mall  |
| vabch02f | vabch05f | vabch08f | vabch11e | vb_pall  |
| vabch02h | vabch05h | vabch08h | vabch11f |          |
| vabch02m | vabch05m | vabch08m | vabch11h |          |
| vabch02p | vabch05p | vabch08p | vabch11m |          |
| vabch03f | vabch06e | vabch09e | vabch11p |          |
| vabch03h | vabch06f | vabch09f | vabch12f |          |
| vabch03m | vabch06h | vabch09h | vabch12h |          |
| vabch03p | vabch06m | vabch09m | vabch12m |          |

**Vertices Not Connecting  
Along Adjoining Sheets**

Figure 10. Vector Problem with DLG DFIRMs

The DLG DFIRM AMLs were edited to import the Arc Interchange files into ArcInfo. The AMLs were changed to accept the new naming convention, seen in Appendixes I, J, K, and L. The one major change to the AMLs was the replacement of the *DLGARC* with the *IMPORT* command to accept the Arc Interchange files. A new AML was written to import Elevation Reference Marks (ERM), seen in Appendix M. The vector sheets were viewed in ArcEdit with adjoining sheets to search for errors found in the first DLG DFIRM s. No anomalies were present in the second DFIRM delivery.

## ANALYSIS

The analysis included mapping specific items of the DFIRMs to IFSAR products. Elevation data and feature comparisons were the two main categories of the analysis. The elevation comparison was focused on the ERM's and the IFSAR DEM. The feature comparison looked into how closely the hydrography category appeared to converge with features seen in the ORI. Quattro Pro 9, ArcInfo 8.0.1, and Corpscon 5.11.08 for Windows were used for the analysis.

### Processing ERM and IFSAR DEM

The ERM AML was used to import the Arc Interchange files and assign character attributes to the data set. There were 70 ERM's for the 12 DFIRM's, with only 48 ERM's covering the IFSAR collection area, shown in Figure 11. The 48 ERM's were clipped to the IFSAR collection area. The *ADDXY* command was used to add x,y coordinates to the 48 points for further processing. In TABLES, the clipped ERM coverage was selected and the *UNLOAD* command was used to dump the xyz data to an ASCII file for analysis using the string *unload ermngvd29.txt x-coord y-coord elev delimited*. The 48 ERM's were in the NAD 27 and NGVD 29 datums, shown in Appendix N. The ERM's were projected to the North American Datum of 1983 (NAD 83), and North American Vertical Datum of 1988 (NAVD 88) to match the datum of the IFSAR DEM using Corpscon software available on the TEC Web site at <http://crunch.tec.army.mil/software/corpscon/corpscon.html>. ERM height values are shown in Table 5 under columns DFIRM NGVD29 and DFIRM NAVD88.

The x,y coordinates from the projected ERM's were used with an AML, shown in Appendix O, to extract elevation values from the IFSAR DEM. The IFSAR coordinates and elevation values were dumped into an ASCII file for analysis. The IFSAR elevation values were in meters and the ERM's elevation values were in feet. The IFSAR elevation values were converted to feet using Corpscon software. Quattro Pro was used to check the Corpscon conversion using the formula  $m * 3937/1200$  to obtain exact values for the IFSAR elevation values. In Table 5, the old and new IFSAR elevation values can be seen in columns IFSAR Meters and IFSAR Feet.

### Preliminary Datum Comparison

The first analysis looked at the differences between datum elevations, seen in Table 5 under columns DFIRM NGVD29 and DFIRM NAVD88. The basic statistics for the datum differences, seen in Table 6 under column NGVD29-NAVD88, were a mean value of 0.94 ft, maximum value of 1.12 ft, minimum value of 0.81 ft, and standard deviation of 0.11 ft. In Figures 12 and 13, the datum differences between NAVD29 and NAVD88 can be seen and are fairly homogeneous depending on general location of the points. The main problem with converting from NGVD29 to NAVD88 is the establishment of orthometric heights in the area. The National Geodetic Survey (NGS) has not supported the NGVD29 vertical datum for the last

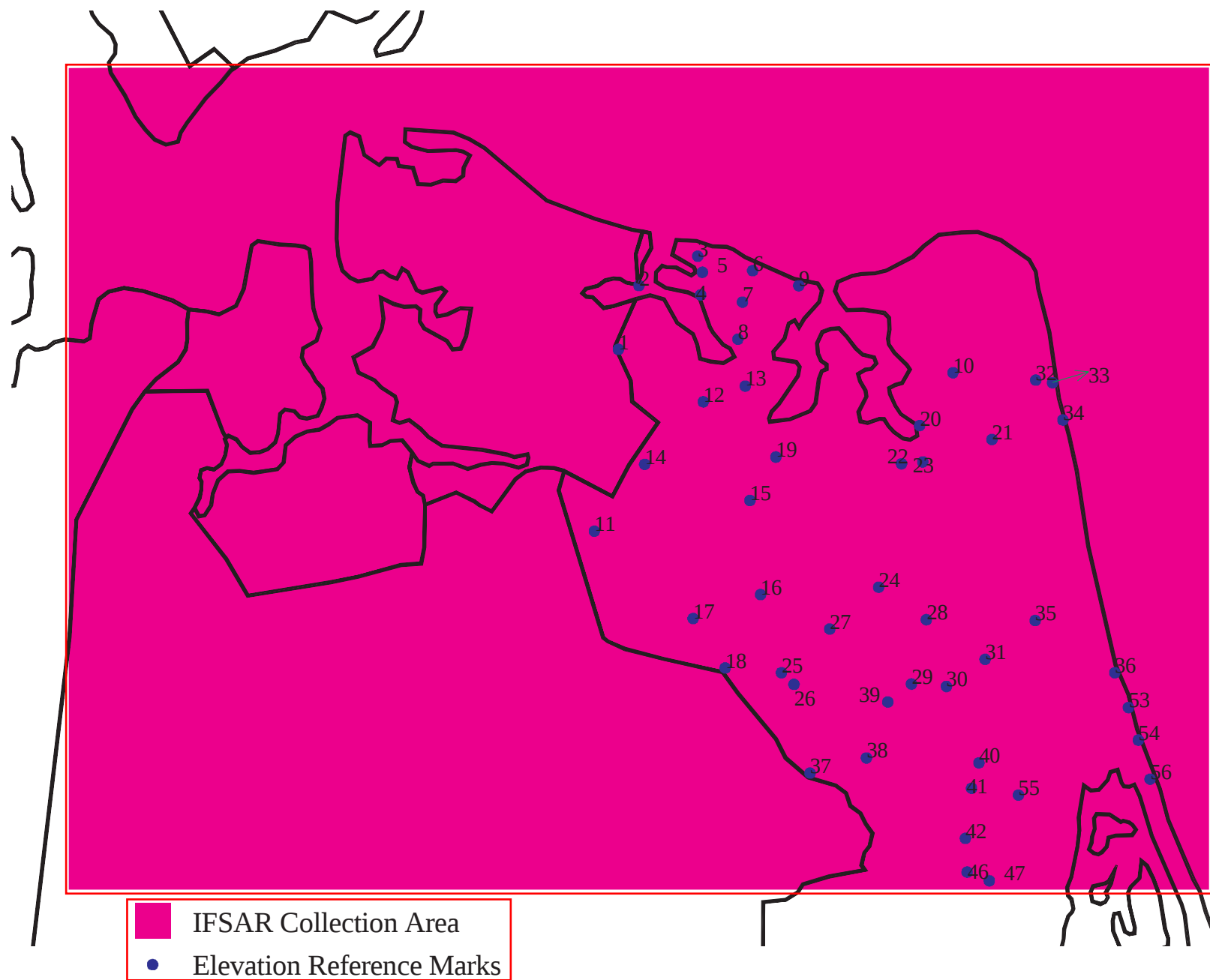


Figure 11. ERMs Within the IFSAR Collection Area

10 years. Benchmarks may be suspect as to the actual horizontal and vertical accuracy. A High Accuracy Reference Network (HARN) is needed to tie into to help update older benchmarks using the *NOAA Technical Memorandum NOS NGS-58: Guidelines for Establishing GPS-Derived Ellipsoid Heights (Standards: 2 cm AND 5 cm) Version 4.3*.

## **Elevation Analysis**

The next analysis addresses the differences between the IFSAR DEM and the newly converted ERM NAVD88 elevations. The differences between columns GEOID96 Feet and DFIRM NAVD88 are shown in Table 6. In Figures 14 and 15, the extremely variable differences are seen with nine values less than 1 ft; the remaining 39 values are more than 1 ft. Further investigation was needed to determine why the IFSAR DEM differed from the ERM NAVD88 elevations. The height differences were from buildings and forest canopies in highly urbanized areas. The IFSAR system collects data at a resolution of 2.5 m and the IFSAR DEM was produced and delivered at 5 m. The Observations column in Table 6 lists the possible causes of the height differences observed in the analysis. The main categories listed are forest (For), structure (Stru), voids, and water, with abbreviated combinations of each. The three best and worst differences will be shown to illustrate what the investigation found. Buildings will appear in the ORI as bright white, forested areas as lighter tones of gray, water and roads as black. The IFSAR DEM was converted to a color-shaded-relief to represent different changes in elevation. ArcEdit was used to plot each ERM over the magnitude and color-shaded-relief images to show what the investigation found.

## **Summary Analysis**

The three best ERM s were found to be ERM 55 with 0.09 ft or approximately 1 inch, ERM 15 with 0.15 ft or approximately 1.8 inches, and ERM 41 with 0.46 ft or approximately 5.5 inches. In Figure 16, ERM 55 is shown as a magenta color with the magnitude and color-shaded-relief side-by-side images. ERM 55 is close to a forested section seen in the ORI with a road running between forested sections. The color-shaded-relief image shows the road has disappeared from view because of the processing of the IFSAR DEM to 5 m. ERM 55 had the lowest height difference of any point and is attributed to its location near an agricultural and rural area. ERM 15 seen in Figure 17 was the best point found in an urban area due to its location near a transportation feature. The buildings and forest canopy near ERM 15 could possibly be affecting the IFSAR DEM. In Figure 18, ERM 41 was located in an agricultural and rural area with minor residential development seen in the ORI. The forest canopy was a possible cause of the elevation difference with ERM 41.

The three worst ERM s were ERM 29 with 43.64 ft, ERM 21 with 28.65 ft, and ERM 5 with 27.23 ft. ERM 29 in Figure 19 was the worst point of the comparison. This was mainly due to the forest canopy and possibly data dropouts seen in the ORI as black areas. The forest canopy is clearly affecting the IFSAR DEM in this location seen in the color-shaded-relief. In Figure 20, the IFSAR DEM was affected by the forest canopy in the area of ERM 21. The IFSAR DEM

Table 5. IFSAR DEM and ERM Heights

| <b>NAD83 x-coord</b> | <b>NAD83 y-coord</b> | <b>ERM Identifier</b> | <b>IFSAR Meters</b> | <b>IFSAR Feet</b> | <b>DFIRM NGVD29</b> | <b>DFIRM NAVD88</b> |
|----------------------|----------------------|-----------------------|---------------------|-------------------|---------------------|---------------------|
| 393409.37973         | 4082805.83270        | 1                     | 6.3080              | 20.6955           | 20.71               | 19.87               |
| 394307.49802         | 4085591.52714        | 2                     | -0.3670             | -1.2041           | 12.79               | 11.95               |
| 396874.85194         | 4086875.05312        | 3                     | 7.3780              | 24.2060           | 18.52               | 17.67               |
| 397001.98449         | 4085186.53175        | 4                     | 1.8210              | 5.9744            | 9.76                | 8.90                |
| 397079.77849         | 4086175.81475        | 5                     | 11.0440             | 36.2335           | 9.85                | 9.00                |
| 399273.22748         | 4086245.00284        | 6                     | 1.5430              | 5.0623            | 9.91                | 9.06                |
| 398829.63262         | 4084872.41502        | 7                     | -1.6050             | -5.2657           | 11.88               | 11.02               |
| 398627.37158         | 4083252.71472        | 8                     | 9.5640              | 31.3779           | 20.23               | 19.38               |
| 401287.72958         | 4085586.81242        | 9                     | 4.9430              | 16.2172           | 6.35                | 5.51                |
| 408019.98137         | 4081786.76947        | 10                    | 10.5420             | 34.5865           | 23.76               | 22.94               |
| 392357.14375         | 4074861.96580        | 11                    | 4.9590              | 16.2697           | 18.04               | 17.19               |
| 397118.37701         | 4080516.77227        | 12                    | 4.8790              | 16.0072           | 17.58               | 16.73               |
| 398949.86789         | 4081203.06194        | 13                    | 8.1300              | 26.6732           | 26.47               | 25.63               |
| 394556.65444         | 4077783.89734        | 14                    | 3.4070              | 11.1778           | 15.34               | 14.49               |
| 399152.98245         | 4076206.39426        | 15                    | 3.0580              | 10.0328           | 10.80               | 9.88                |
| 399617.99304         | 4072093.28068        | 16                    | 2.5520              | 8.3727            | 11.04               | 10.01               |
| 396673.00733         | 4071045.96544        | 17                    | 6.7730              | 22.2211           | 9.86                | 8.89                |
| 398074.27240         | 4068885.38444        | 18                    | 10.8850             | 35.7119           | 10.57               | 9.54                |
| 400288.59432         | 4078104.08520        | 19                    | 4.8170              | 15.8038           | 15.97               | 15.12               |
| 406568.20028         | 4079479.14320        | 20                    | 9.0920              | 29.8293           | 16.69               | 15.88               |
| 409722.94886         | 4078870.16070        | 21                    | 12.0520             | 39.5406           | 11.71               | 10.89               |
| 405774.51625         | 4077808.12393        | 22                    | 1.7630              | 5.7841            | 18.87               | 18.04               |
| 406701.86713         | 4077889.88166        | 23                    | 6.8410              | 22.4442           | 18.87               | 18.04               |
| 404774.97851         | 4072417.56854        | 24                    | 2.8970              | 9.5046            | 14.28               | 13.28               |
| 400529.37587         | 4068676.73248        | 25                    | 4.0610              | 13.3235           | 11.47               | 10.39               |
| 401075.66444         | 4068170.23380        | 26                    | 8.5400              | 28.0183           | 11.56               | 10.47               |
| 402640.16089         | 4070589.02789        | 27                    | 4.0810              | 13.3891           | 13.95               | 12.88               |

| NAD83 x-coord | NAD83 y-coord | ERM Identifier | IFSAR Meters | IFSAR Feet | DFIRM NGVD29 | DFIRM NAVD88 |
|---------------|---------------|----------------|--------------|------------|--------------|--------------|
| 406859.65941  | 4070996.82929 | 28             | 6.7080       | 22.0078    | 10.99        | 10.00        |
| 406207.35873  | 4068186.04911 | 29             | 15.5130      | 50.8956    | 8.35         | 7.26         |
| 407734.68321  | 4068081.06769 | 30             | 4.5920       | 15.0656    | 7.18         | 6.09         |
| 409422.06397  | 4069264.09679 | 31             | 7.3230       | 24.0255    | 17.01        | 15.98        |
| 411635.80979  | 4081461.68222 | 32             | 5.2520       | 17.2309    | 11.46        | 10.64        |
| 412368.52244  | 4081349.25025 | 33             | 7.2450       | 23.7696    | 8.05         | 7.23         |
| 412822.09919  | 4079719.53672 | 34             | 5.1480       | 16.8897    | 13.83        | 13.00        |
| 411610.92939  | 4070959.94322 | 35             | 2.3230       | 7.6214     | 6.20         | 5.27         |
| 415086.47948  | 4068678.72381 | 36             | 4.1170       | 13.5072    | 7.56         | 6.64         |
| 401777.63693  | 4064291.03898 | 37             | -0.8530      | -2.7986    | 2.43         | 1.31         |
| 404243.68979  | 4064954.78910 | 38             | 10.2750      | 33.7106    | 9.85         | 8.73         |
| 405176.58641  | 4067402.24954 | 39             | 4.2090       | 13.8090    | 15.86        | 14.75        |
| 409153.94202  | 4064742.51957 | 40             | 6.7250       | 22.0636    | 19.47        | 18.37        |
| 408832.70449  | 4063631.87659 | 41             | 3.7490       | 12.2998    | 12.94        | 11.84        |
| 408561.88182  | 4061441.06560 | 42             | 5.3780       | 17.6443    | 15.87        | 14.78        |
| 408642.63246  | 4059968.87470 | 46             | 4.3330       | 14.2159    | 14.26        | 13.19        |
| 409608.90667  | 4059588.08334 | 47             | 3.0610       | 10.0426    | 6.19         | 5.13         |
| 415684.41136  | 4067157.35210 | 53             | 3.7290       | 12.2342    | 12.04        | 11.10        |
| 416118.20805  | 4065734.66688 | 54             | 4.3000       | 14.1076    | 10.56        | 9.61         |
| 410880.84844  | 4063334.19477 | 55             | 1.2700       | 4.1667     | 5.16         | 4.08         |
| 416631.30942  | 4064029.86330 | 56             | 0.2400       | 0.7874     | 10.33        | 9.37         |
|               |               | Mean           | 5.3041       | 17.4017    | 12.9671      | 12.0213      |
|               |               | Max            | 15.5130      | 50.8956    | 26.4700      | 25.6300      |
|               |               | Min            | -1.6050      | -5.2657    | 2.4300       | 1.3100       |
|               |               | STD            | 3.4964       | 11.4711    | 4.9445       | 4.9851       |

Table 6. IFSAR DEM and ERM Differences

| NAD83 x-coord | NAD83 y-coord | ERM Identifier | NGVD29 - NAVD88 | IFSAR - NAVD88 | Observations |
|---------------|---------------|----------------|-----------------|----------------|--------------|
| 393409.37973  | 4082805.83270 | 1              | 0.84            | 0.8255         | Forest       |
| 394307.49802  | 4085591.52714 | 2              | 0.84            | -13.1541       | Structure    |
| 396874.85194  | 4086875.05312 | 3              | 0.85            | 6.5360         | Forest       |
| 397001.98449  | 4085186.53175 | 4              | 0.86            | -2.9256        | Structure    |
| 397079.77849  | 4086175.81475 | 5              | 0.85            | 27.2335        | Forest       |
| 399273.22748  | 4086245.00284 | 6              | 0.85            | -3.9977        | Structure    |
| 398829.63262  | 4084872.41502 | 7              | 0.86            | -16.2857       | For/Stru     |
| 398627.37158  | 4083252.71472 | 8              | 0.85            | 11.9979        | Forest       |
| 401287.72958  | 4085586.81242 | 9              | 0.84            | 10.7072        | Forest       |
| 408019.98137  | 4081786.76947 | 10             | 0.82            | 11.6465        | Forest       |
| 392357.14375  | 4074861.96580 | 11             | 0.85            | -0.9203        | For/Stru     |
| 397118.37701  | 4080516.77227 | 12             | 0.85            | -0.7228        | Forest       |
| 398949.86789  | 4081203.06194 | 13             | 0.84            | 1.0432         | Forest       |
| 394556.65444  | 4077783.89734 | 14             | 0.85            | -3.3122        | Structure    |
| 399152.98245  | 4076206.39426 | 15             | 0.92            | 0.1528         | Structure    |
| 399617.99304  | 4072093.28068 | 16             | 1.03            | -1.6373        | Structure    |
| 396673.00733  | 4071045.96544 | 17             | 0.97            | 13.3311        | Forest       |
| 398074.27240  | 4068885.38444 | 18             | 1.03            | 26.1719        | Forest       |
| 400288.59432  | 4078104.08520 | 19             | 0.85            | 0.6838         | Structure    |
| 406568.20028  | 4079479.14320 | 20             | 0.81            | 13.9493        | Forest       |
| 409722.94886  | 4078870.16070 | 21             | 0.82            | 28.6506        | Forest       |
| 405774.51625  | 4077808.12393 | 22             | 0.83            | -12.2559       | Structure    |
| 406701.86713  | 4077889.88166 | 23             | 0.83            | 4.4042         | For/Stru     |
| 404774.97851  | 4072417.56854 | 24             | 1.00            | -3.7754        | For/Stru     |
| 400529.37587  | 4068676.73248 | 25             | 1.08            | 2.9335         | For/Stru     |
| 401075.66444  | 4068170.23380 | 26             | 1.09            | 17.5483        | Forest       |
| 402640.16089  | 4070589.02789 | 27             | 1.07            | 0.5091         | Structure    |

| NAD83 x-coord | NAD83 y-coord | ERM Identifier | NGVD29-NAVD88 | IFSAR - NAVD88 | Observations |
|---------------|---------------|----------------|---------------|----------------|--------------|
| 406859.65941  | 4070996.82929 | 28             | 0.99          | 12.0078        | Forest       |
| 406207.35873  | 4068186.04911 | 29             | 1.09          | 43.6356        | For/Voids    |
| 407734.68321  | 4068081.06769 | 30             | 1.09          | 8.9756         | For/Stru     |
| 409422.06397  | 4069264.09679 | 31             | 1.03          | 8.0455         | Forest       |
| 411635.80979  | 4081461.68222 | 32             | 0.82          | 6.5909         | For/Stru     |
| 412368.52244  | 4081349.25025 | 33             | 0.82          | 16.5396        | Forest       |
| 412822.09919  | 4079719.53672 | 34             | 0.83          | 3.8897         | Structure    |
| 411610.92939  | 4070959.94322 | 35             | 0.93          | 2.3514         | Structure    |
| 415086.47948  | 4068678.72381 | 36             | 0.92          | 6.8672         | For/Stru     |
| 401777.63693  | 4064291.03898 | 37             | 1.12          | -4.1086        | Forest       |
| 404243.68979  | 4064954.78910 | 38             | 1.12          | 24.9806        | For/Voids    |
| 405176.58641  | 4067402.24954 | 39             | 1.11          | -0.9410        | For/Stru     |
| 409153.94202  | 4064742.51957 | 40             | 1.10          | 3.6936         | Structure    |
| 408832.70449  | 4063631.87659 | 41             | 1.10          | 0.4598         | Structure    |
| 408561.88182  | 4061441.06560 | 42             | 1.09          | 2.8643         | Structure    |
| 408642.63246  | 4059968.87470 | 46             | 1.07          | 1.0259         | Forest       |
| 409608.90667  | 4059588.08334 | 47             | 1.06          | 4.9126         | Forest       |
| 415684.41136  | 4067157.35210 | 53             | 0.94          | 1.1342         | Structure    |
| 416118.20805  | 4065734.66688 | 54             | 0.95          | 4.4976         | Structure    |
| 410880.84844  | 4063334.19477 | 55             | 1.08          | 0.0867         | Forest       |
| 416631.30942  | 4064029.86330 | 56             | 0.96          | -8.5826        | Stru/Water   |
|               |               | Mean           | 0.9458        | 5.3805         |              |
|               |               | Max            | 1.1200        | 43.6356        |              |
|               |               | Min            | 0.8100        | -16.2857       |              |
|               |               | STD            | 0.1101        | 11.1901        |              |

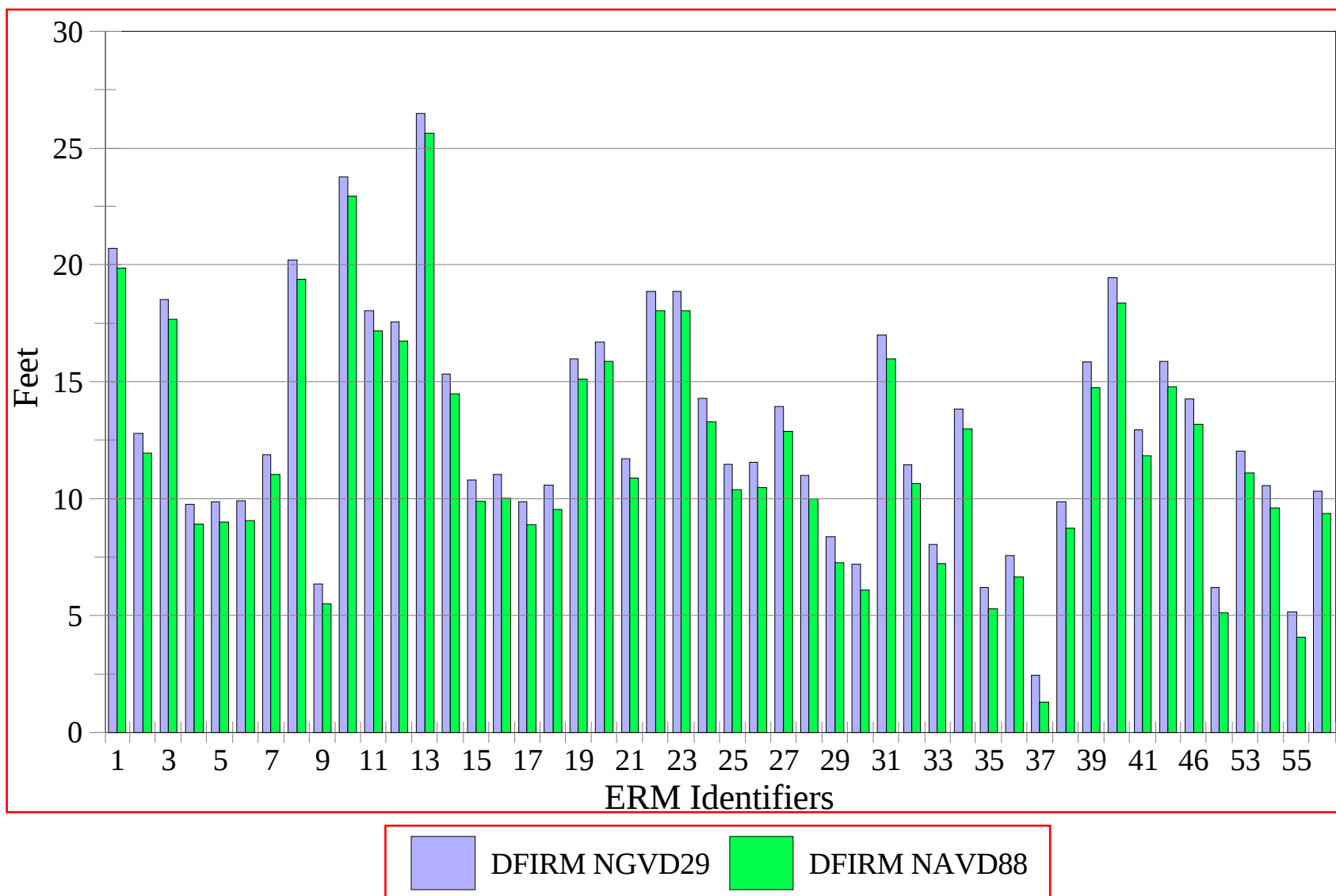


Figure 12. Vertical Datum Comparison NGVD29 AND NAVD88

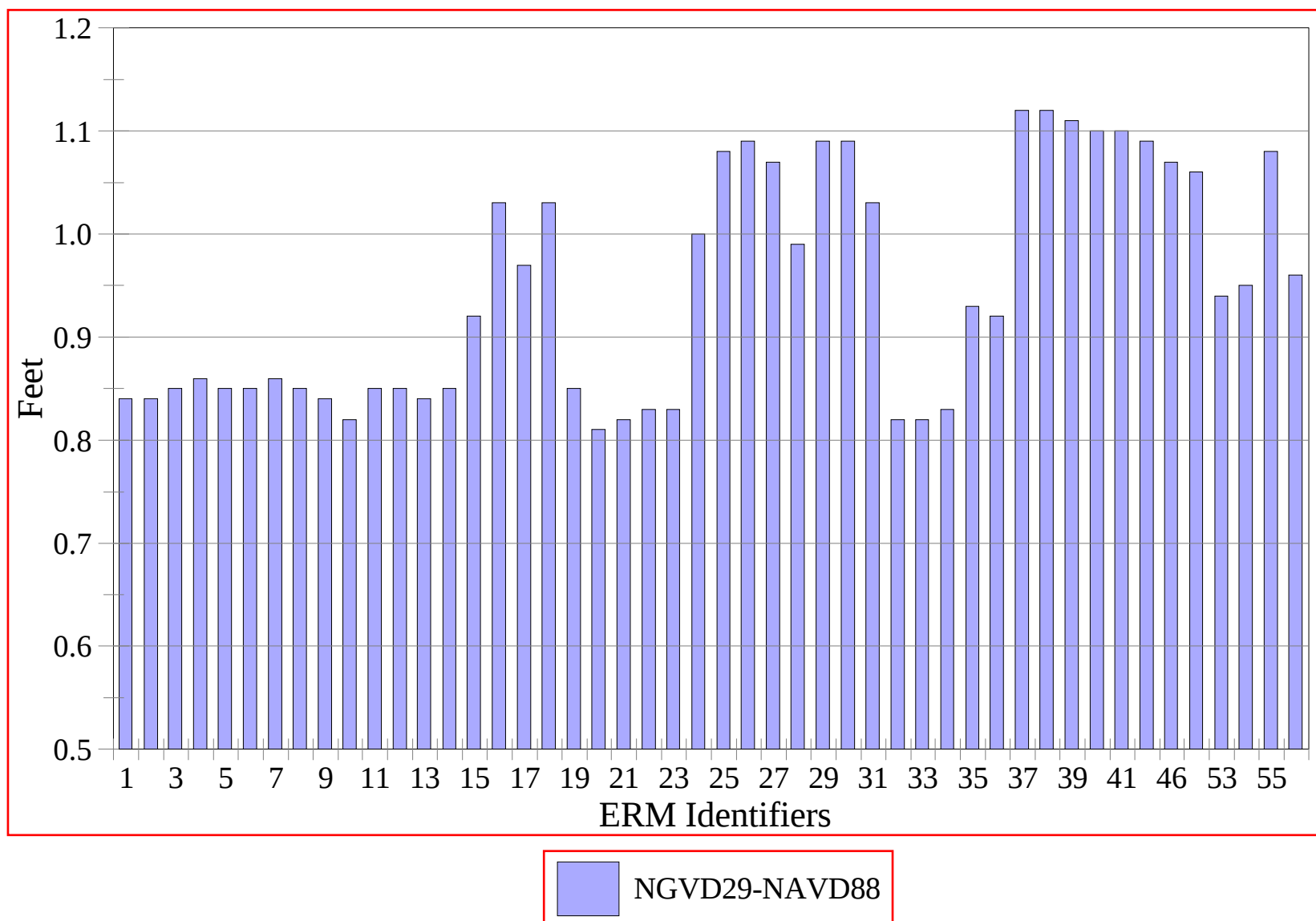


Figure 13. Difference Between DFIRM NGVD29 and NAVD88

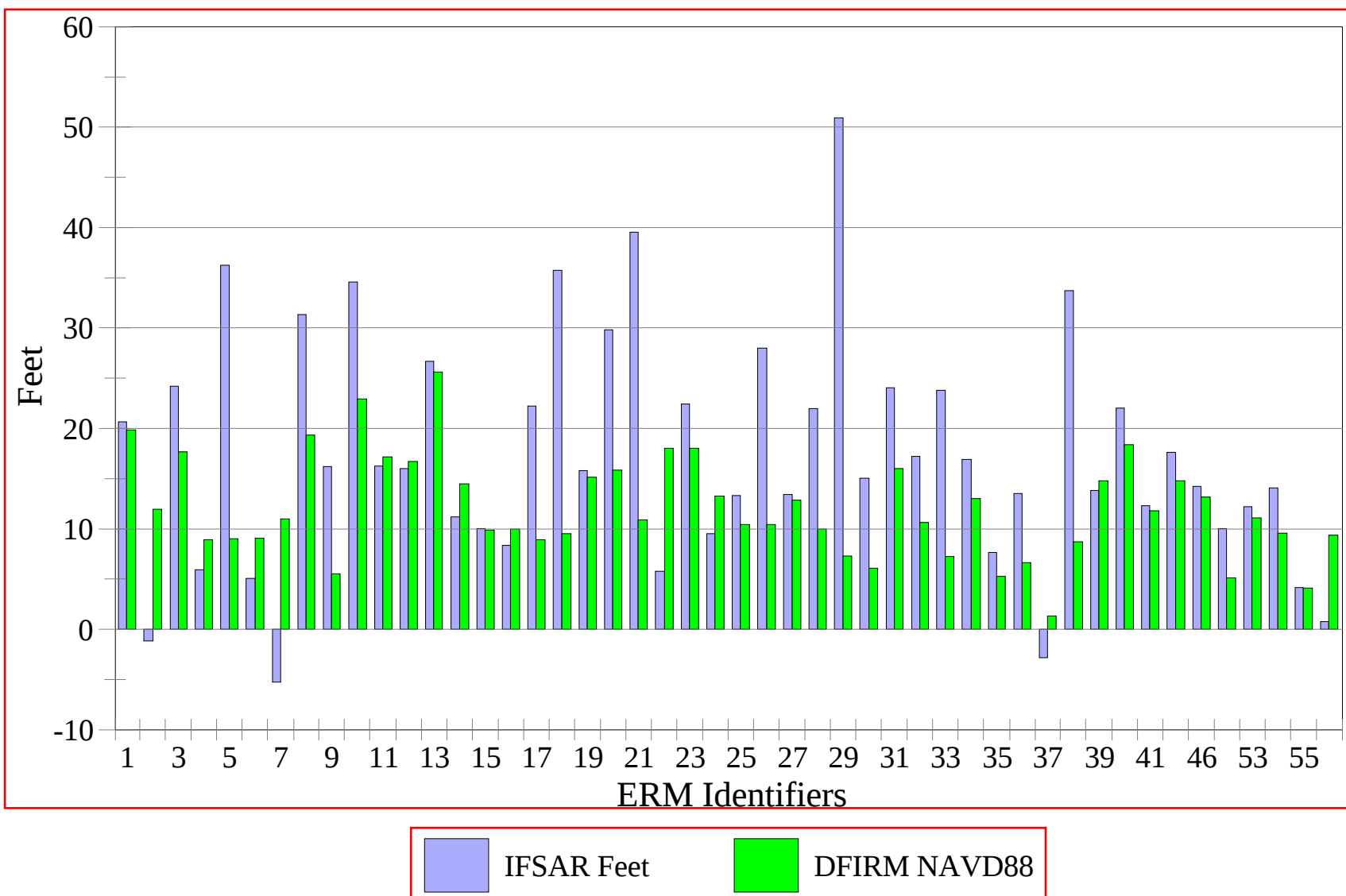


Figure 14. Orthometric Height Comparison

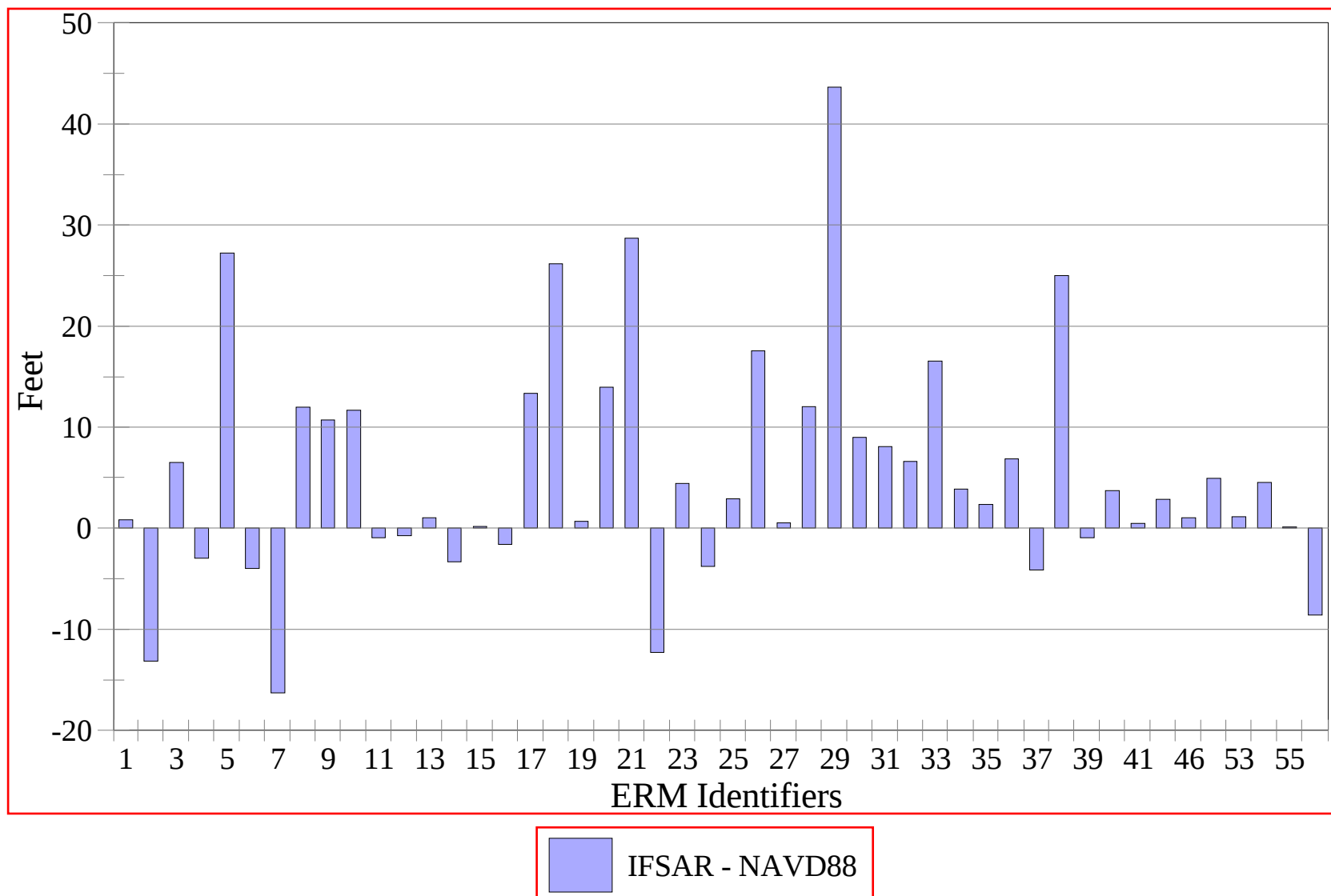


Figure 15. Difference Between IFSAR Feet and DFIRM NAVD88

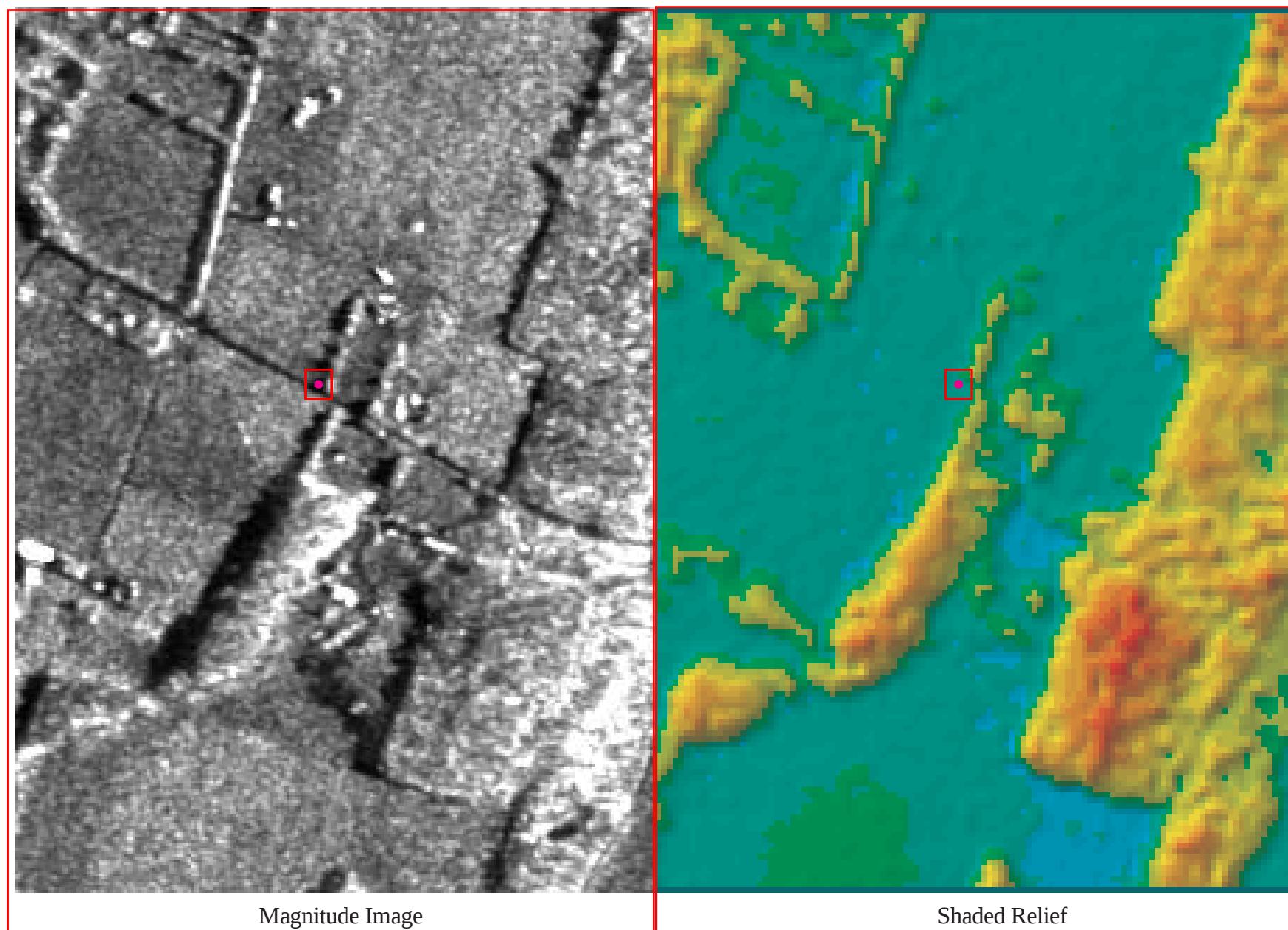


Figure 16. ERM 55 with a 1-Inch Elevation Difference

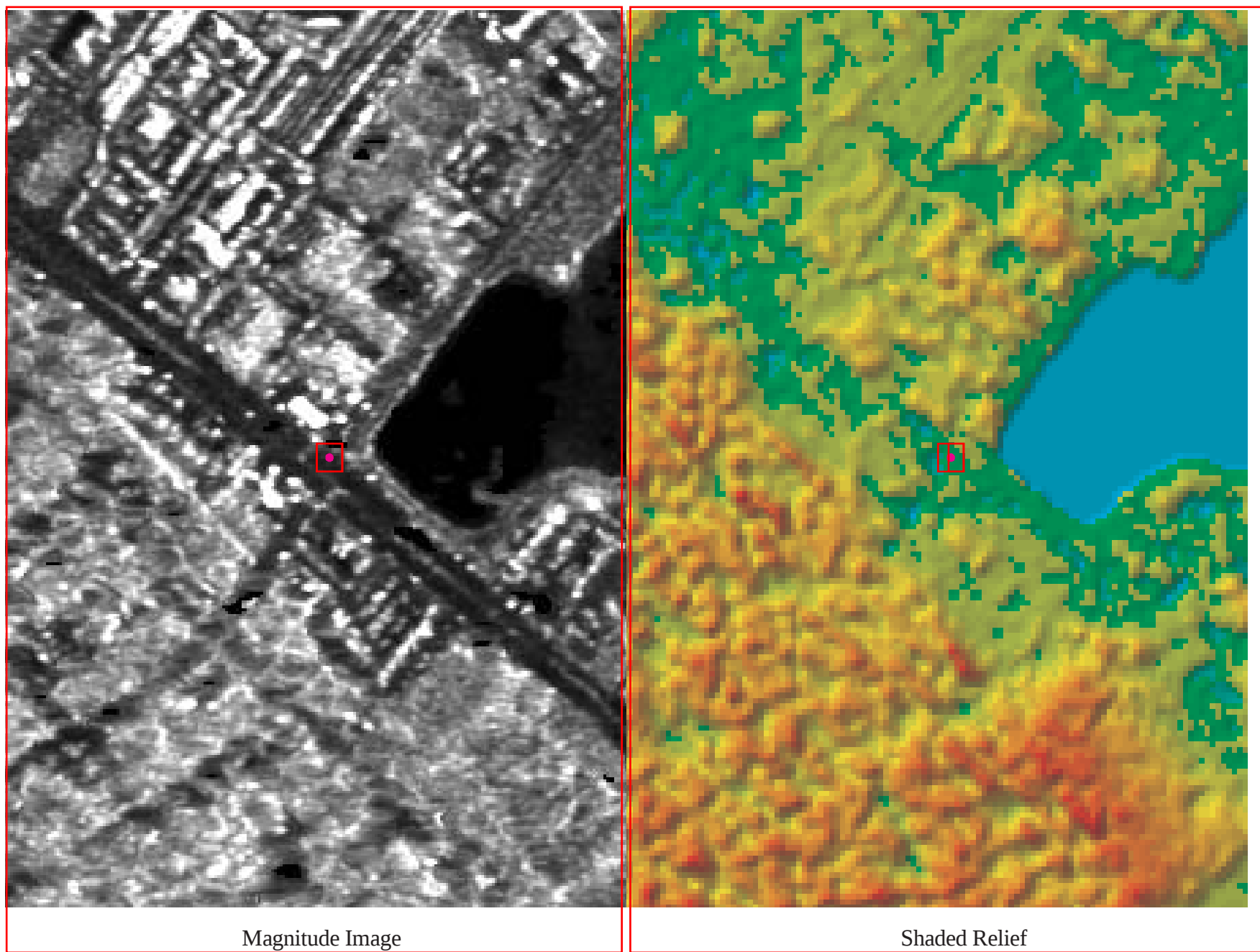


Figure 17. ERM 15 with a 1.8-Inch Elevation Difference

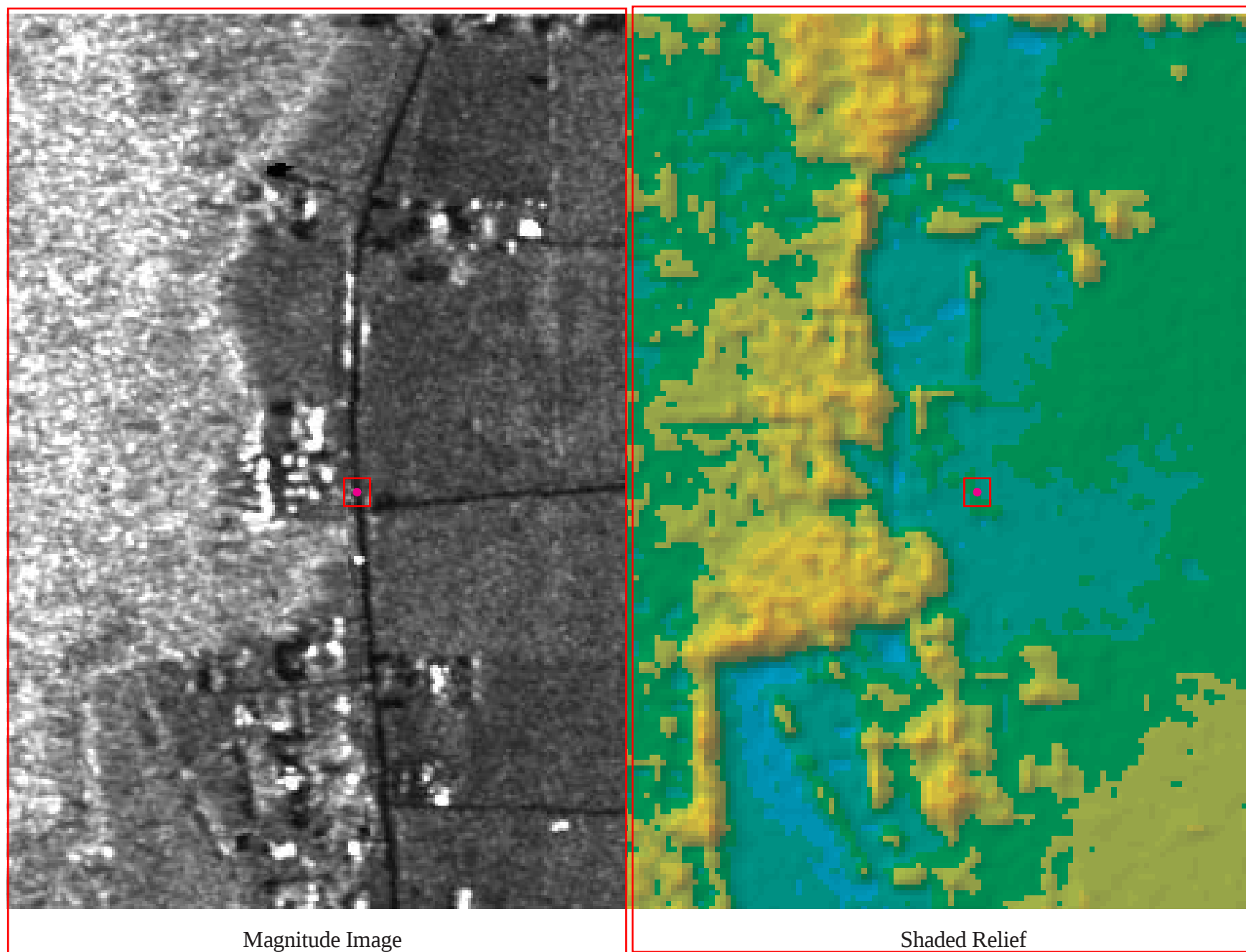


Figure 18. ERM 41 with a 5.5-Inch Elevation Difference

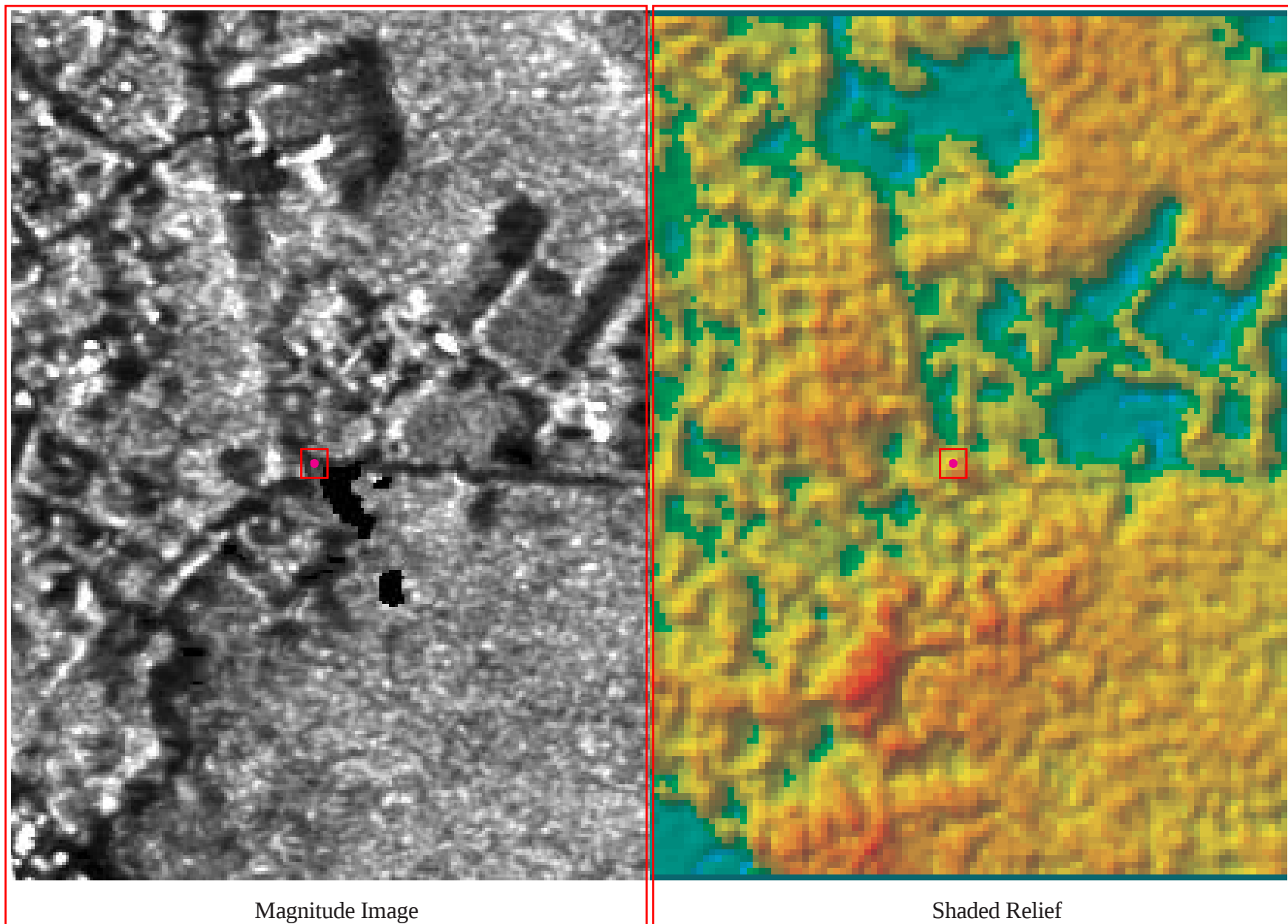


Figure 19. ERM 29 with a 43.64-Foot Elevation Difference

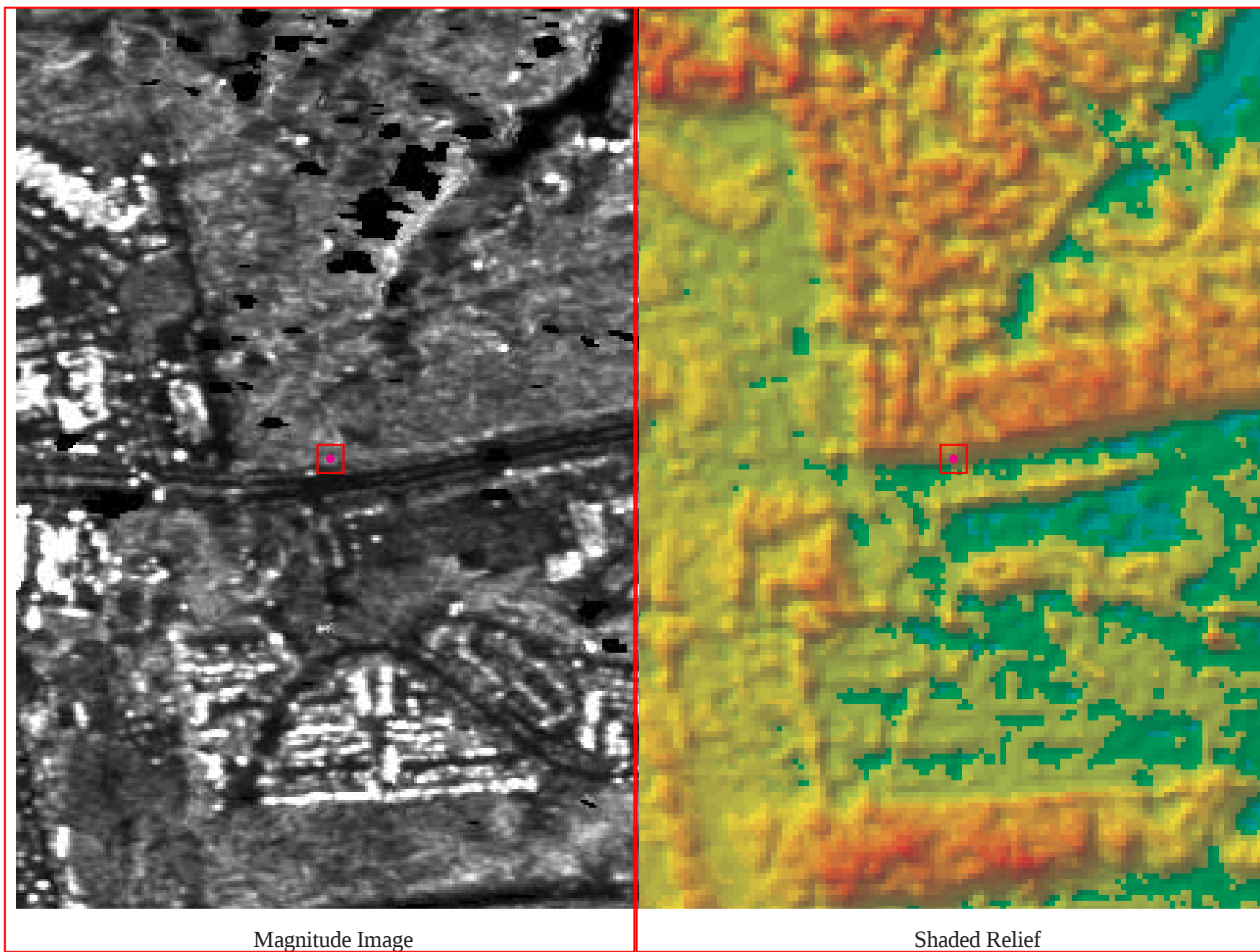


Figure 20. ERM 21 with a 28.65-Foot Elevation Difference

located around ERM 5 was affected by the forest canopy shown in Figure 21. The forest canopy was the main cause of height difference in the three locations shown in Figures 19, 20, and 21. These large height differences seen in Table 6 were mainly due to the highly forested urban areas of Virginia Beach and possibly the DEM being processed to 5 m. Intermap is developing techniques to produce a bald earth DEM, which might improve the height differences seen in the IFSAR DEM and NAVD88 ERM comparison.

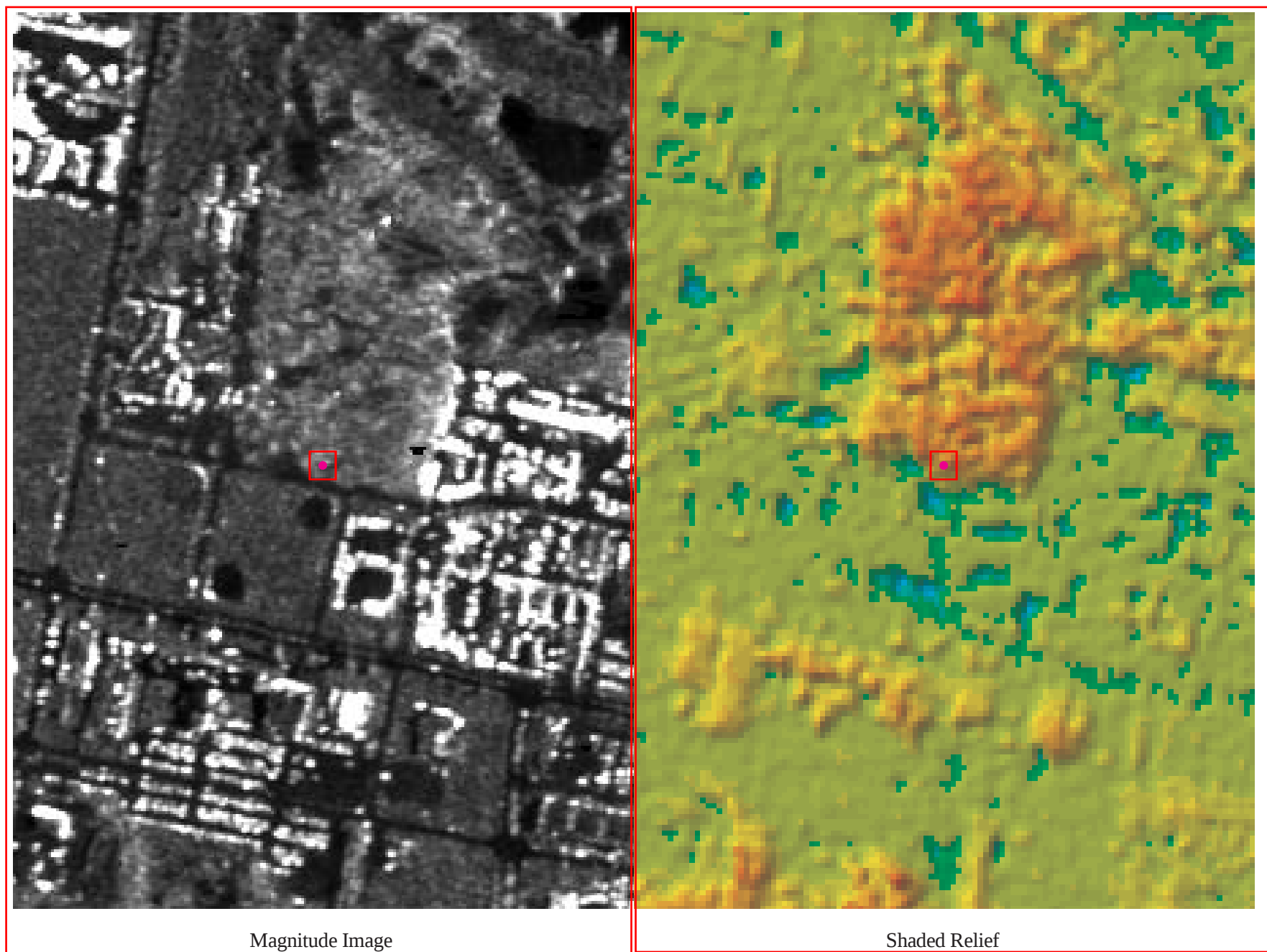


Figure 21. ERM 5 with a 27.23-Foot Elevation Difference

## DFIRM Verification

The main DFIRM vector categories — flood hazard, hydrography, political areas, and map panels — are based on the DLG-3 format and the standard USGS 7.5-minute 1:24,000-scale quad. The first step was to determine how accurate the panels were by generating USGS 7.5-minute quad corner points. The four corner coordinates of eleven USGS 7.5-minute quads were manually generated for the analysis seen in Table 7. These generate corner points were used as the known control for this analysis. The x,y geographic coordinates of each quad corner were typed into a text file and given a reference number. The precision of the data was set to double double by using the *PRECISION* command. The *GENERATE* command with the input and point option was used to import the coordinates of each quad into ArcInfo. The USGS-generated corner points were combined into one coverage and projected to the UTM, Zone 6, and NAD83 coordinate system used for the study, thus providing a better way to measure distances.

Table 7. Generated USGS 7.5-minute Quads

|               |                      |
|---------------|----------------------|
| Cape Henry    | North Bay            |
| Creeds        | North Virginia Beach |
| Fentress      | Pleasant Ridge       |
| Kempsville    | Princess Anne        |
| Knotts Island | Virginia Beach       |
| Little Creek  |                      |

The DFIRM vb\_24k vectors were chosen to represent the DFIRM corner coordinates and should be the same for all DFIRM categories. The *ARCPOINT* command was used to convert the boundary lines to four corner points needed for the comparison. The DFIRM corner points were projected to the UTM, Zone 6, and NAD83 coordinate system used for the study. The analysis used the *POINTDISTANCE* command to measure and compare the DFRIM vb\_24k points to the USGS-generated corner points.

The results of the analysis seen in Appendix P were converted from meters to feet and inches with an average distance of 4.5 in., minimum distance of 4.17 in., and maximum distance of 4.84 in. between the two sets of corner points. The other DFIRM categories were found to be consistent with these findings. The corner points are within the 40-ft specification outlined in *Digital Line Graphs 1:24,000-Scale Maps* (USGS) and *Standards for Digital Flood Insurance Rate Maps* (FEMA). It was not required to calculate a root-mean-square value (RMS) with each point fallen within inches of another.

## Hydrography and ORI

This part of the analysis looked into the relative horizontal and positional accuracy of the DFIRM hydrography category compared to the IFSAR ORI. ArcEdit was used for the analysis to overlay the hydrography vectors onto the west look ORI. Coastlines, river boundaries, and structures were investigated to determine relative accuracy.

In Figure 22, the hydrography vectors do not match the river boundary. At the top center of Figure 22, the green arrows are displaying a distance of more than 45 m from the left river boundary line shown in magenta and the river seen in the ORI. The green circle is displaying what looks like an island splitting the river. The hydrography vectors in Figure 23 do not match the ORI very well. The green circle shows the river edge curving while the hydrography line is fairly straight. Other hydrography lines are as much as 25 m from the river boundary. In Figure 24, the large island is clearly not represented by the hydrography line and other smaller islands are omitted. The hydrography line representing the bend in the river boundary does not depict what is seen in the ORI. The hydrography lines, shown in Figure 25, are offset horizontally by as much as 20 m. The orange line indicates where the center line is located in the ORI.

The hydrography vectors representing the shoreline do not match what is seen in the ORI in Figure 26. The hydrography line is more than 45 m from the visible edge of the coast in some places seen in the ORI. In Figure 27, the hydrography coastlines do not visibly match many of the islands seen in the ORI. These inaccuracies may be due to tidal differences, different generation of the DLG lines used in this DFIRM, generalization of the hydrography lines, or environmental factors such as vegetation and temporal changes within the islands.

Structures are an important element in the hydrography vectors. Coastal hard points, which can be piers, ripraps, and other structures, are some of the other elements of the hydrography vectors. In Figure 28, the piers seen in magenta have been mapped in the hydrography vectors, but many of the pier structures remain unmapped as seen in the ORI. The horizontal position of the mapped pier structures is offset as much as 8 to 15 m. The channel is not accurately mapped to the boundary, clearly seen in the ORI. The pier structures show a positional offset and some structures are unmapped as well in Figure 29. The mapped shoreline is also not as accurate as it appears in the ORI.

What can be done? It is clear that the ORIs from the IFSAR collection could be used to manually update the hydrography vectors using GIS software. The coastal hard points, stream and river boundaries, and shoreline features can be mapped accurately using the ORI, which portray current features. While most of the hydrography vectors are within the DLG-3 standards, some vectors do appear outside the standard using the prior figures as examples. The horizontal accuracy and alignment of features could increase from the DLG-3 standard of 40 ft per 1/50th of an inch on hard copy (FEMA) to 2.5 m or 8.2 ft using ORIs as a guide. Other important considerations are the length of time and cost that would be involved to update the current inventory of hydrography vectors using the DLG-3 standard if the ORIs were available.



Figure 22. Hydrography Offset Along River Channel

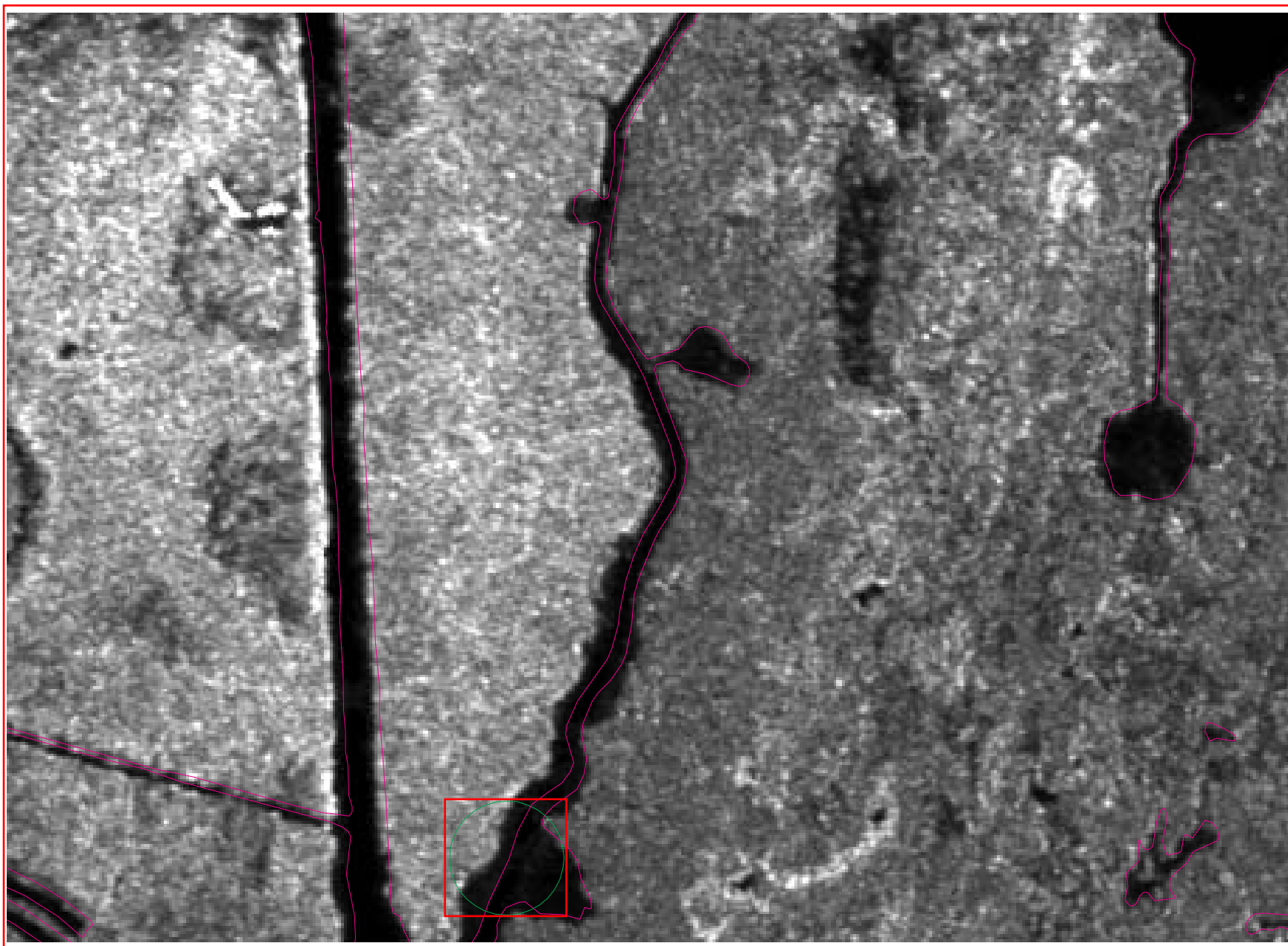


Figure 23. Hydrography Offset Along Channel Boundaries

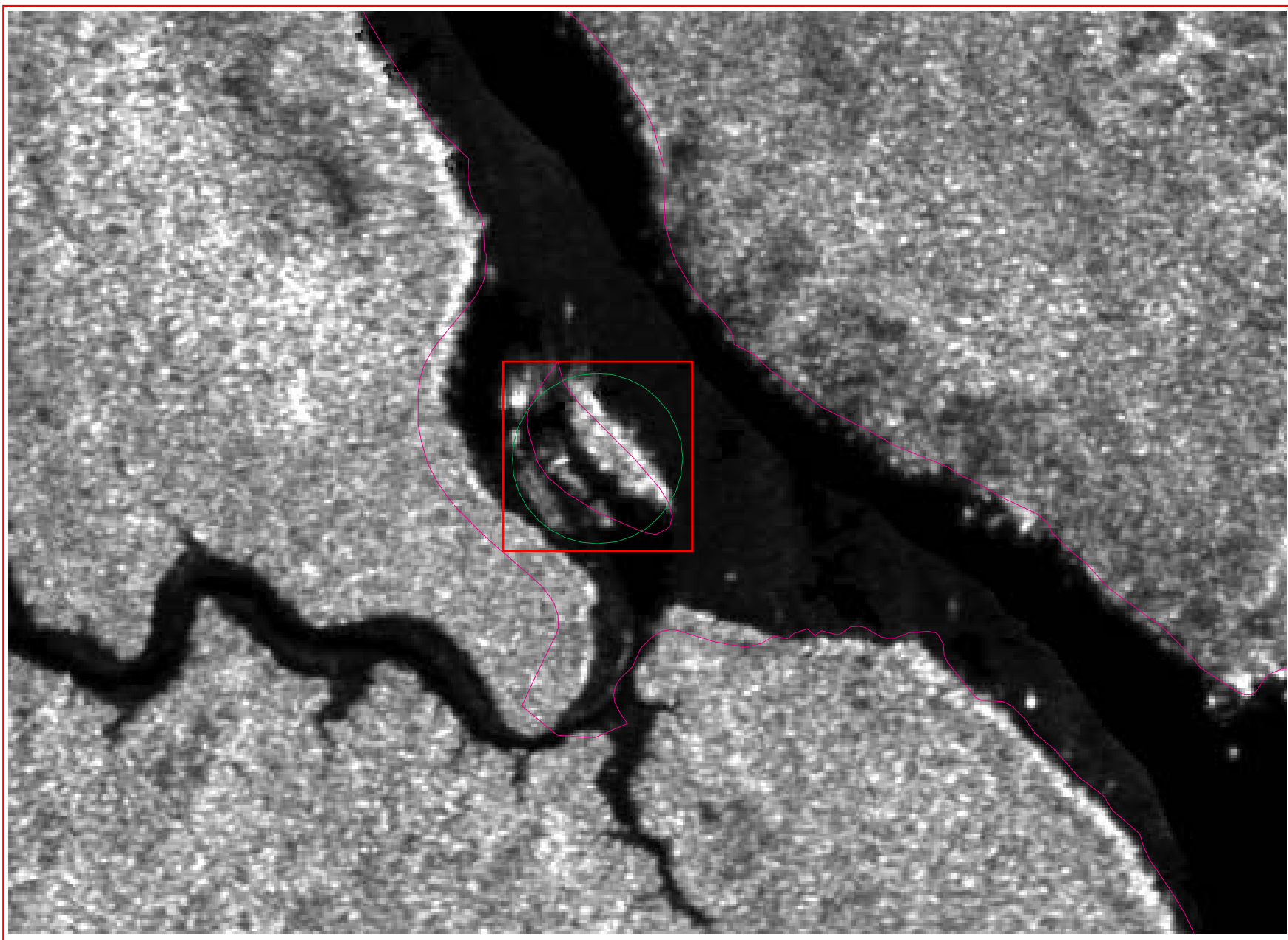


Figure 24. Hydrography Offset and Single Island Boundary

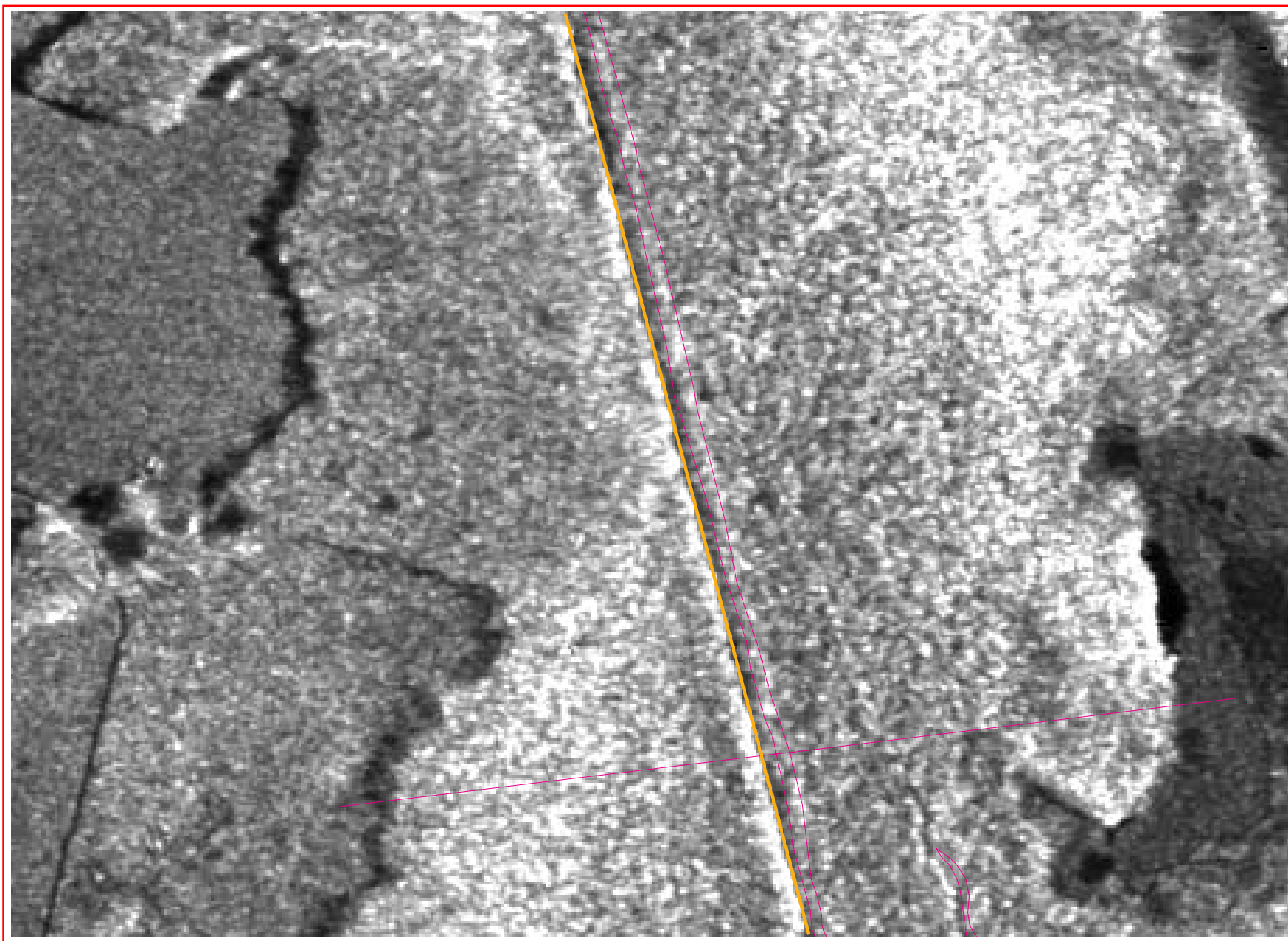


Figure 25. Hydrography Offset Along Channel Boundary

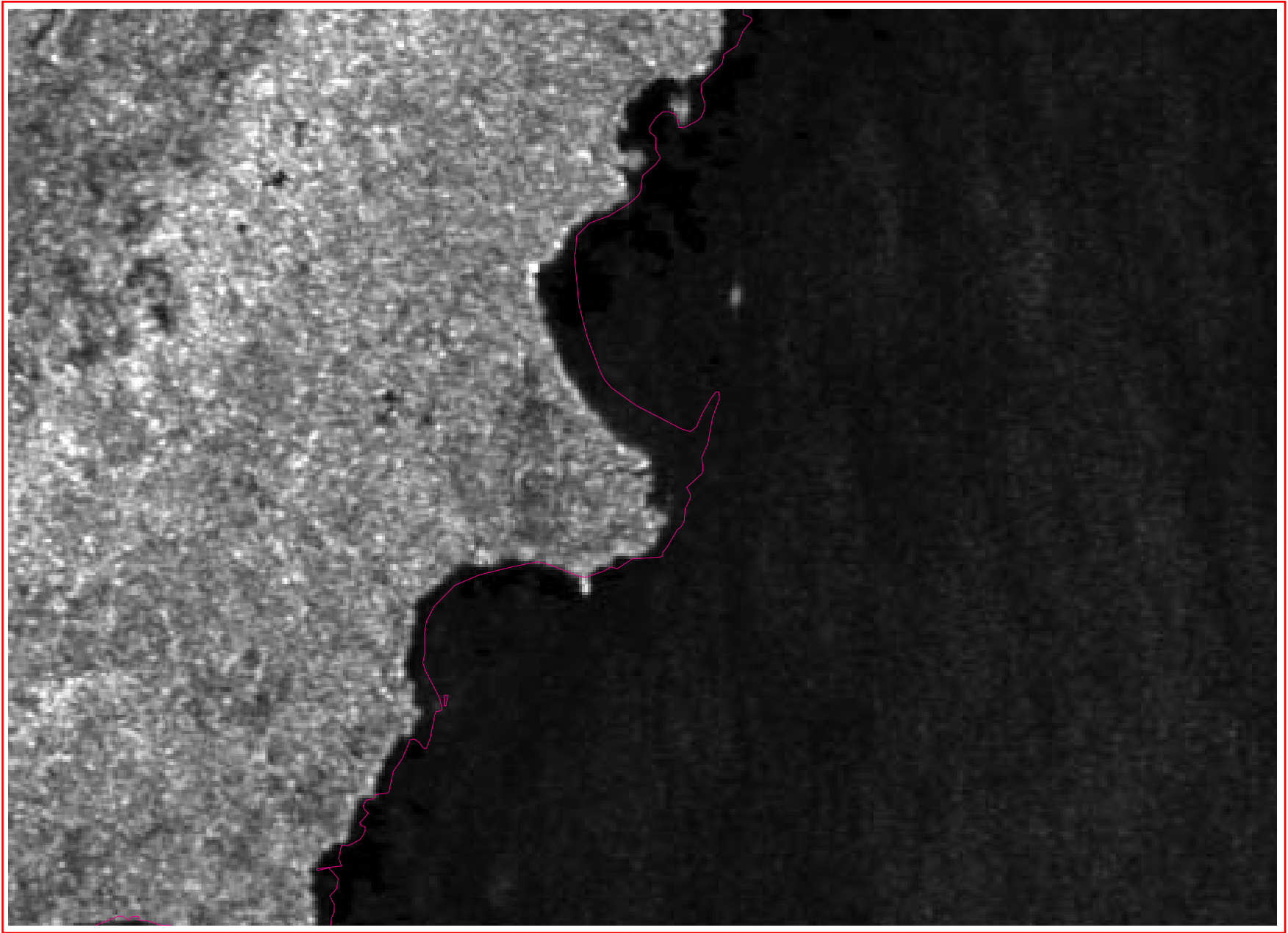


Figure 26. Hydrography Offset Along Shoreline



Figure 27. Hydrography Offset Along Multiple Shorelines

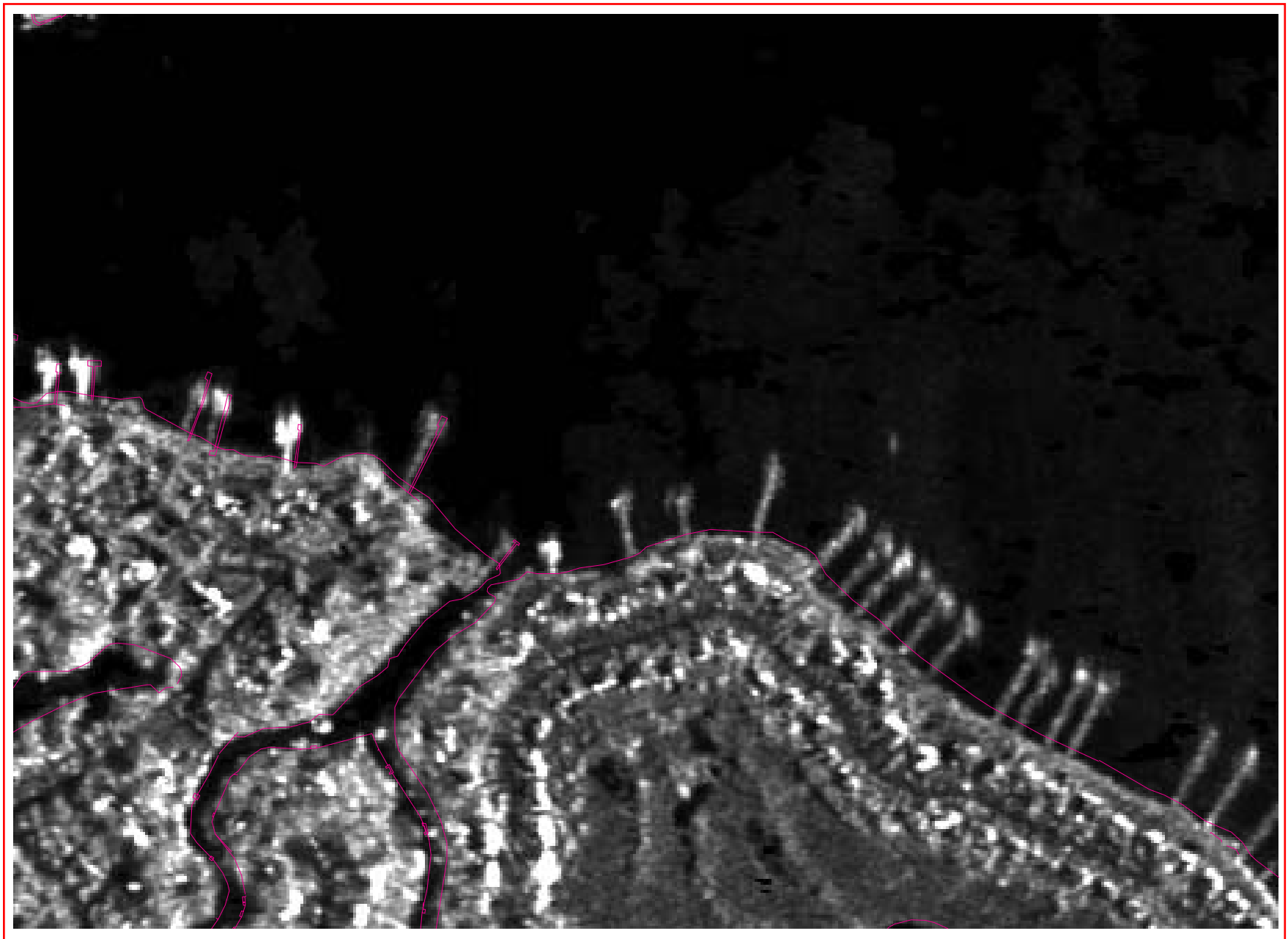


Figure 28. Hydrography - Offset and Missing Pier Vectors

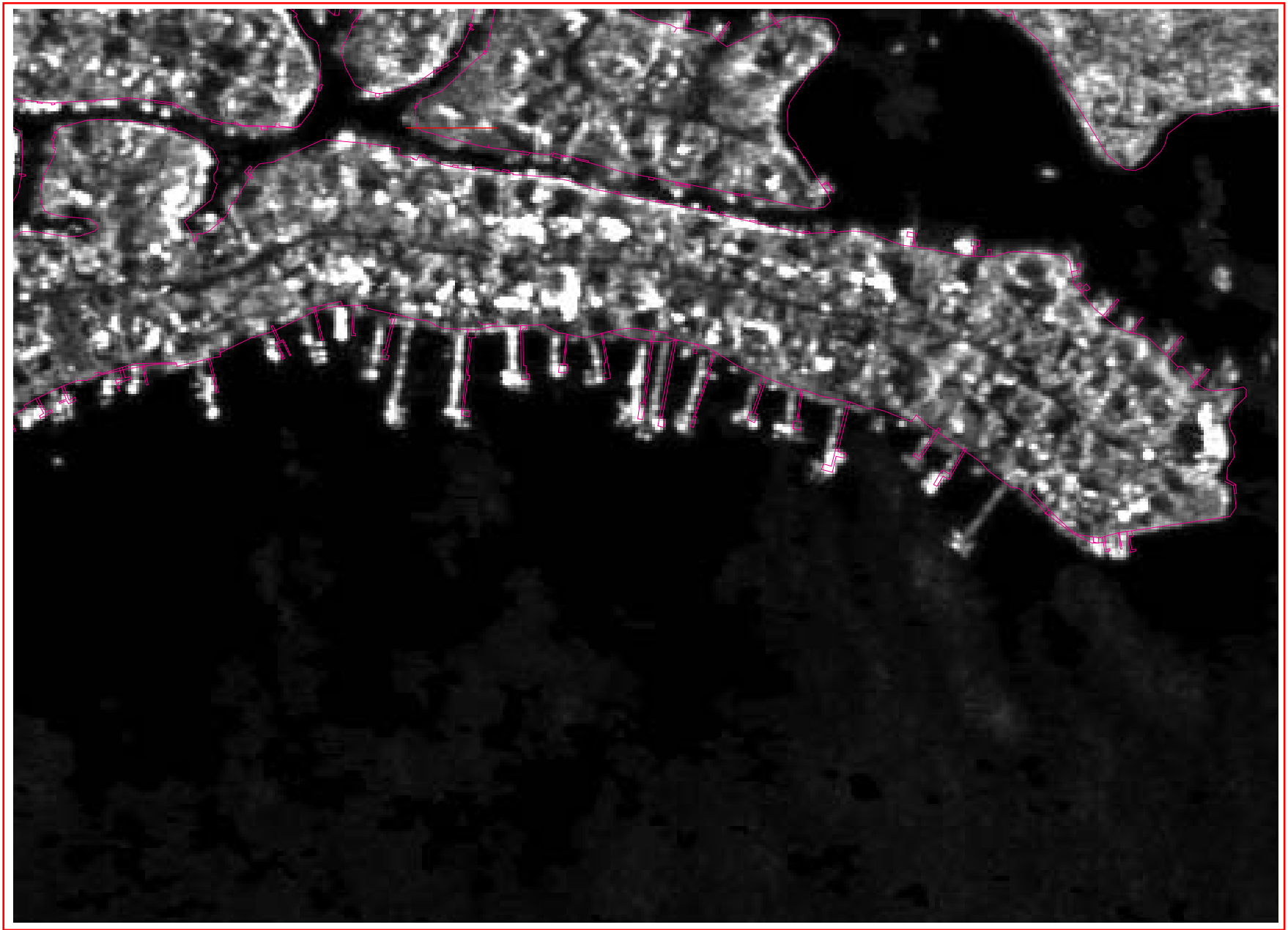


Figure 29. Hydrography - Pier Offset

DFIRM specifications and procedures call for the use of Digital Orthophoto Quarter Quadrangles (DOQs) produced by the USGS to be the default base map if suitable community data are not available (FEMA). Information on DFIRM's specifications can be found at [http://www.fema.gov/mit/tsd/MM\\_WIP5g.htm](http://www.fema.gov/mit/tsd/MM_WIP5g.htm). With the DOQ production taking as long as 12 to 14 months (FEMA), IFSAR ORIs can be produced within two to three months for large areas. The ORI contains more information than a DOQ and is also horizontally more accurate. The horizontal accuracy of the USGS DOQs is roughly 38 ft RMS. The IFSAR ORI with a horizontal accuracy of 2.5 m or 8.2 ft RMSE could be as much as 2.5 to 5 times more accurate than the USGS DOQ depending on quality of the control used to produce the DOQ product.

## CONCLUSIONS

The digital age has come to FEMA with the production of DFIRMs. The Virginia Beach DFIRMs are formatted on the DLG-3 standard with its own attribution scheme based on the technical document *Standards for Digital Flood Insurance Rate Maps* (FEMA). A DFIRM DLG and Arc interchange file (e00) formats were delivered to TEC for the purpose of this study. The first DLG was only partially finished and had several errors requiring extensive work to correct. Some of the errors included node, vertex, and alignment, which involved vectors from adjoining sheets. The first DLG version was found to be an intermediate version with numerous problems with vectors of adjoining sheets. The e00 files lacked the problems associated with the DLG files. The e00 files were easier to import with the same attribution as the DLG version. AMLs were written to import the DLG and e00 files into ArcInfo for the investigation. These AMLs are provided in appendixes D, E, F, G, I, J, K, L, and M and are available for open and free distribution.

The Virginia Beach DFIRMs were based on the horizontal datum NAD27 and vertical datum NAVD29. One problem with current DFIRM ERM's is the possibility that the markers are no longer located in their original position, and worse, cannot be found. ERM's in the NAD27 and NAVD29 datums may not convert easily to the accepted NAD83 and NAVD88 datums. The DFIRM ERM's do not contain information on the NGS benchmarks, which could be used to find the marker in the field and for updating future DFIRMs. The ERM's were projected to horizontal datum NAD83 to match the IFSAR DEM horizontal datum WGS84. Corpscon was used to project the ERM's to the NAD83 and NAVD88 datums with units in feet for the vertical height comparison. The IFSAR DEM height values were extracted using an AML and the units converted to feet using Corpscon. The ERM's and the IFSAR DEM height values were investigated and the highest level of confidence came from areas with little to no forest cover and no interfering urban structures. Since the IFSAR collection device is not a vegetation penetration system, forest canopies will affect the elevation values. Some of the ERM's came very close to the IFSAR DEM values and warrant further investigation. Intermap is perfecting a production method to produce a bare earth DEM product, which should be similar to the LIDAR bare earth DEM product. More information on the IFSAR bald earth DEM is located at [http://www.intermap.ca/HTML/research\\_new\\_bald.htm](http://www.intermap.ca/HTML/research_new_bald.htm). The IFSAR bald earth DEM could possibly help in the future determination of the flood plain within urban areas. At present, the IFSAR DEM is not suitable for flood plain mapping in predominately forested and urbanized areas.

The hydrography vectors are based on the DLG-3 specifications and can come from multiple data sources. This can create position problems for the user of the hydrography vectors. Hydrography features covered by forest canopies and less than 2.5 m wide cannot be easily distinguished using the IFSAR ORIs. The IFSAR ORI can be used to identify shorelines, coastal hard points (piers), and river boundaries out of alignment and easily edited to match current features using GIS. There are still questions of money and time associated with updating hydrography vectors using ORIs if made available. Nevertheless, the resolution of the ORI at 2.5

m or 8.2 ft is sufficient to update the current DLG-3 hydrography vectors used in the Virginia Beach DFIRMs.

The IFSAR DEM and ORI products could support efforts involved with the production of DFIRM 2.0 and DFIRM 2.1 products, which have been combined into a single product (FEMA). Further information on the DFIRM 2.0 and 2.1 specifications is located at [http://www.fema.gov/mit/tsd/MM\\_WIP3f.htm](http://www.fema.gov/mit/tsd/MM_WIP3f.htm). The minimal standards for base maps used for DFIRMs under the DFIRM 2.0 and 2.1 specifications are the 1-m resolution USGS-produced DOQs. The ORI resolution of 2.5 m does not meet this part of the DFIRM 2.0 and 2.1 standard, but still provides useful information to update hydrography vectors. The horizontal accuracy of the ORI product compared to the USGS DOQ could be as much as 2.5 to 5 times more accurate. The ORI product meets the DFIRM 2.0 and 2.1 file format specifications for base maps. The draft minimal standard for IFSAR DEMs is a DEM with a vertical accuracy of 15-cm RMSE and a maximum post spacing of 5 m. The IFSAR DEM product meets the 5-m resolution requirements for flood plain mapping, but does not meet the vertical height requirement. Intermap is researching a new product called Global Terrain Flood (GTF) with a proposed vertical accuracy of 50-cm RMSE. An independent review of the GTF product has not been taken and warrants further investigation, but should address FEMA's vertical height requirement if successful.

## REFERENCES

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## Appendix A. Header file for gt1n36w075h8m1.txt

Intermap Technologies Inc.  
Global Terrain Metadata File (DEM)

File Creation date: Wednesday, June 02, 1999  
Tile Identifier #: GT1N36W075H8V1.bil  
Project Area: Virginia Beach

### Product Description

Product Level: GT 1  
DEM posting (meters): 5.0  
Horizontal Accuracy: 2.5 meters (1 sigma)  
Vertical Accuracy: 3 meters (1 sigma)

### Sensor

Data Source: Intermap Star-3i Airborne Interferometric SAR  
Flying Height: 20,000 ft. Above Mean Ground  
Primary Look: West  
Alternate (Secondary) Look: South  
Mission #(s): 165  
Acquisition Date: 3/10/99  
Band: X-Band

### Processing

Interpolation: Continuous curvature spline over non-data areas  
Phase Unwrapper: Goldstein

### Data Format, Parameters, and Coordinates

Format: 32 bit BIL (float)  
Projection: UTM  
Horizontal Datum: WGS-84 Ellipsoid  
Vertical Datum: WGS-84 Ellipsoid  
Geoid Model: GEOID96  
Vertical Reference: Mean Sea Level (MSL)  
Central Scale: 0.9996  
UTM Zone: 18  
Central Meridian: 75 degrees West  
False Easting (meters): 500,000.0 meters  
False Northing (meters): 0.0 meters  
UTM Easting (meters): Min. 410,307.50 Max. 419,197.50  
UTM Northing(meters): Min. 4,081,102.50 Max. 4,095,102.50  
Pixel Origin: Center Center  
Pixels (columns): 1779  
Lines (rows): 2801

### Legacy Information

Intermap Project Number: 98063

|                             |                                                                                |              |
|-----------------------------|--------------------------------------------------------------------------------|--------------|
| Flight Acquisition Manager: | J. Keith Tennant                                                               | 403.266.0900 |
| Denver Processing Center:   | Ken Rath                                                                       | 303.708.0955 |
| Ottawa Processing Center:   | Ian Isaacs                                                                     | 613.226.5442 |
| Metadata File Creator:      | Tom Hutt                                                                       | 613.226.5442 |
| Mississippi DHS Center:     | Ron Birk                                                                       | 228.688.1465 |
| Project Manager:            | Cliff Holle                                                                    | 228.688.1783 |
| Metadata File Description:  | <a href="http://www.globalterrain.com">www.globalterrain.com</a>               |              |
| Intermap Information:       | <a href="http://www.intermaptechnologies.com">www.intermaptechnologies.com</a> |              |
| ISO 9001 Certification No.  | 0411-069                                                                       |              |

## Appendix B. ifsargrid.aml

```
/******
/* IFSARGRID AML
/* 09/29/99
/* POC: James J. Damron
/* U.S. ARMY Topographic Engineering Center (TEC)
/* Terrain Research Division
/* Terrain Representation Branch
/* 7701 Telegraph Road
/* Alexandria, VA 22315-3864
/*
/* (703) 428-8168 or 428-6838
/* (703) 428-8176 FAX
/*
/* jdamron@tec.army.mil
/*
/* variables ifsar - ifsar file names read
/* count - number of files completed
/*
/* FLOATGRID is used to import IFSAR DEM because of the IEEE, 32 bit binary
/* float format.
/* A text file is used to import the files for the California Collection.
/* A new text file can be used later to import different IFSAR collections.
/* This AML works on a UNIX and NT workstations running ArcInfo.
/******

&severity &error &ignore
&severity &warning &ignore
&type haaa.... This is working...
display 9999
&term 9999

&sv file := [open [getfile *.txt -file] ok -r]
&sv ifsar = [read %file% readstatus]
&sv count = 1

&do &while %readstatus% eq 0

&type Processing IFSAR file %ifsar%
&type
&sys mv %ifsar%.bil %ifsar%.dem
&type

/* Converts IFSAR DEM to Arc GRID
floatgrid %ifsar%.dem dem%ifsar%
&type
```

```
&type  
&type this many finished %count% and finished file %ifsar%  
&sv count = %count% + 1  
&sv ifsar = [read %file% readstatus]  
  
&end  
  
&return
```

## Appendix C. Header file for im2n36w075h8m1.txt

Intermap Technologies Inc.  
Global Terrain Metadata File (ORI)

File Creation date: Friday, May 28, 1999  
Tile Identifier #: IM2N36W075H8V1.tif  
Project Area: Virginia Beach

Product Description  
Product Level: GT 1  
Image Pixels (meters): 2.5  
Horizontal Accuracy: 2.5 meters (1 sigma)

Sensor  
Data Source: Intermap Star-3i Airborne Interferometric SAR  
Flying Height: 20,000 ft. Above Mean Ground  
Primary Look: West  
Alternate (Secondary) Look: South  
Mission #(s): 165  
Acquisition Date: 3/10/99  
Band: X-Band

Processing  
Interpolation: Continuous curvature spline over non-data areas  
Phase Unwrapper: Goldstein

Data Format, Parameters, and Coordinates  
Format: 8 bit GEOTIFF  
Projection: UTM  
Horizontal Datum: WGS-84 Ellipsoid  
Vertical Datum: WGS-84 Ellipsoid  
Geoid Model: GEOID96  
Central Scale: 0.9996  
UTM Zone: 18  
Central Meridian: 75 degrees West  
False Easting (meters): 500,000.0 meters  
False Northing (meters): 0.0 meters  
UTM Easting (meters): Min. 410,309.00 Max. 419,196.50  
UTM Northing(meters): Min. 4,081,102.50 Max. 4,095,100.00  
Pixel Origin: Upper Left  
Pixels (columns): 3556  
Lines (rows): 5600

Legacy Information  
Intermap Project Number: 98063  
Flight Acquisition Manager: J. Keith Tennant 403.266.0900

|                            |                                                                                |              |
|----------------------------|--------------------------------------------------------------------------------|--------------|
| Denver Processing Center:  | Ken Rath                                                                       | 303.708.0955 |
| Ottawa Processing Center:  | Ian Isaacs                                                                     | 613.226.5442 |
| Metadata File Creator:     | Tom Hutt                                                                       | 613.226.5442 |
| Mississippi DHS Center:    | Ron Birk                                                                       | 228.688.1465 |
| Project Manager:           | Cliff Holle                                                                    | 228.688.1783 |
| Metadata File Description: | <a href="http://www.globalterrain.com">www.globalterrain.com</a>               |              |
| Intermap Information:      | <a href="http://www.intermaptechnologies.com">www.intermaptechnologies.com</a> |              |
| ISO 9001 Certification No. | 0411-069                                                                       |              |

## Appendix D. femafldhaz.aml

```
/******  
/* Developed to add attributes to DFIRM DLGs on 1 December 1999 for Digital  
/* Flood Insurance Rate Maps  
/* femafldhaz.aml (FLOOD HAZARD ZONES DLG files)  
/* DLG files must be in same directory as this AML to work correctly  
/* 1 December 1999 James J. Damron (703) 428-8168 jdamron@tec.army.mil  
/* 7701 Telegraph Road Topographic Engineering Center Alexandria, VA 22315  
/******  
&severity &error &ignore  
&severity &warning &ignore  
display 9999  
&term 9999  
  
&type  
&type This might take some time on slower systems!!!!  
&type  
  
&if [exists flood.txt -file] &then  
&do  
&type  
&type File already exists.... deleting file flood.txt  
&type  
[delete flood.txt -file]  
&end  
  
[filelist *f*.dlg flood.txt -file]  
  
&sv file := [open flood.txt openstat -read]  
&sv line = [read %file% readstatus]  
&sv line = [locase %line%]  
  
&do &while %readstatus% = 0  
  
&if [exists %line% -file] &then  
&do  
&sv temp1 = [substr %line% 1 5]  
&sv temp2 = [substr %line% 6 3]  
&sv line2 = %temp2%%temp1%  
&type  
&type Processing file %line%.....  
&type  
dlgarc optional %line% %line2% %line2%pnt all  
build %line2% line  
clean %line2% %line2% # # poly  
build %line2%pnt point
```

```

&end
/*****
/* Flood Hazard Lines
/*****
&if [exists %line2% -line] &then
&do
&type
&type This sheet is %line2%
&type
joinitem %line2%.aat %line2%.acode %line2%.aat %line2%-id %line2%-id
ae
mape %line2%
ec %line2%
ef arc
de arc
draw
additem majdescript1 60 60 c
additem majdescript2 60 60 c
additem majdescript3 60 60 c
additem majdescript4 60 60 c
additem majdescript5 60 60 c
ef arc
de arc
draw
sel major1 = 440 and minor1 = 0204
drawsel
calc majdescript1 = 'Apparent Limit'
sel major1 = 440 and minor1 = 0245
drawsel
calc majdescript1 = '100-Year Floodplain Boundary'
sel major1 = 440 and minor1 = 0246
drawsel
calc majdescript1 = '500-Year Floodplain Boundary'
sel major1 = 440 and minor1 = 0247
drawsel
calc majdescript1 = 'Zone Break'
sel major1 = 440 and minor1 = 0248
drawsel
calc majdescript1 = 'Zone D'
sel major1 = 440 and minor1 = 0249
drawsel
calc majdescript1 = 'Floodway'
sel major1 = 440 and minor1 = 0250
drawsel
calc majdescript1 = 'Flow Easement'
sel major1 = 440 and minor1 = 0251
drawsel
calc majdescript1 = 'Limit of Detailed Study'

```

```

sel major1 = 440 and minor1 = 0252
drawsel
calc majdescript1 = 'Limit of Floodway'
sel major1 = 440 and minor1 = 0253
drawsel
calc majdescript1 = 'Limit of Study'
sel major1 = 440 and minor1 = 0254
drawsel
calc majdescript1 = 'State Encroachment Line'
sel major1 = 440 and minor1 = 0256
drawsel
calc majdescript1 = '1983 Undeveloped Coastal Barrier Area Boundary'
sel major1 = 440 and minor1 = 0257
drawsel
calc majdescript1 = '1990 Undeveloped Coastal Barrier Area Boundary'
sel major1 = 440 and minor1 = 0258
drawsel
calc majdescript1 = 'Otherwise Protected Area Boundary'
sel major1 = 440 and minor1 = 0261
drawsel
calc majdescript1 = 'Base Flood Elevation (BFE) Line'
sel major1 = 440 and minor1 = 0262
drawsel
calc majdescript1 = 'Interpolated Base Flood Elevation (BFE) Line'
sel major1 = 440 and minor1 = 0270
drawsel
calc majdescript1 = 'Zone Bisector'
sel major1 = 440 and minor1 = 0299
drawsel
calc majdescript1 = 'Processing Line'
sel major1 = 440 and minor1 = 0600
drawsel
calc majdescript1 = 'Multiple Source Data'
sel major3 = 440 and minor3 = 0610
drawsel
calc majdescript3 = 'Feet'
sel major3 = 440 and minor3 = 0611
drawsel
calc majdescript3 = 'Meters'
sel major4 = 440 and minor4 = 0620
drawsel
calc majdescript4 = 'NGVD 29'
sel major4 = 440 and minor4 = 0621
drawsel
calc majdescript4 = 'NAVD 88'
sel major4 = 440 and minor4 = 0622
drawsel
calc majdescript4 = 'Other Vertical Datum'

```

```

sel major1 = 440 and minor1 = 0710
drawsel
calc majdescript1 = 'Floodway'
sel major1 = 440 and minor1 = 0712
drawsel
calc majdescript1 = 'Flow Easement'
sel major1 = 440 and minor1 = 0713
drawsel
calc majdescript1 = 'State Encroachment Area'
sel major2 = 440 and minor2 = 0246
drawsel
calc majdescript2 = '500-Year Floodplain Boundary'
sel major2 = 440 and minor2 = 0249
drawsel
calc majdescript2 = 'Floodway'
sel major2 = 441
drawsel
calc majdescript2 = 'Elevation'
sel major3 = 440 and minor3 = 0246
drawsel
calc majdescript3 = '500-Year Floodplain Boundary'
sel major3 = 444
drawsel
calc majdescript3 = 'Decimal Fractions'
sel major2 = 445
drawsel
calc majdescript2 = 'Depth'
sel major2 = 447
drawsel
calc majdescript2 = 'Negative Elevation'
sel major5 = 449
drawsel
calc majdescript5 = 'Velocity in Whole Feet per Second'
save
q
build %line2% line
&end
/*****
/* POLY
/*****
&if [exists %line2% -poly] &then
&do
&type
&type This sheet is %line2%
&type
joinitem %line2%.pat %line2%.pcode %line2%.pat %line2%-id %line2%-id
ae
mape %line2%

```

```

ec %line2%
ef poly
de poly
draw
additem majdescript1 60 60 c
additem majdescript2 60 60 c
additem majdescript3 60 60 c
additem majdescript4 60 60 c
additem majdescript5 60 60 c
ef poly
de poly
draw
sel major1 = 000 and minor1 = 0000
drawsel
calc majdescript1 = 'Outside Area'
sel major1 = 440 and minor1 = 0150
drawsel
calc majdescript1 = 'Zone V'
sel major1 = 440 and minor1 = 0151
drawsel
calc majdescript1 = 'Zone VE'
sel major1 = 440 and minor1 = 0152
drawsel
calc majdescript1 = 'Zone A'
sel major1 = 440 and minor1 = 0153
drawsel
calc majdescript1 = 'Zone AE'
sel major1 = 440 and minor1 = 0154
drawsel
calc majdescript1 = 'Zone AO'
sel major1 = 440 and minor1 = 0155
drawsel
calc majdescript1 = 'Zone AO (Alluvial Fan)'
sel major1 = 440 and minor1 = 0156
drawsel
calc majdescript1 = 'Zone AH'
sel major1 = 440 and minor1 = 0157
drawsel
calc majdescript1 = 'Zone A99'
sel major1 = 440 and minor1 = 0158
drawsel
calc majdescript1 = 'Zone D'
sel major1 = 440 and minor1 = 0160
drawsel
calc majdescript1 = 'Zone X (500 Year)'
sel major1 = 440 and minor1 = 0161
drawsel
calc majdescript1 = 'Zone X'

```

```

sel major1 = 440 and minor1 = 0162
drawsel
calc majdescript1 = '1983 Undeveloped Coastal Barrier Area'
sel major1 = 440 and minor1 = 0163
drawsel
calc majdescript1 = '1990 Undeveloped Coastal Barrier Area'
sel major1 = 440 and minor1 = 0164
drawsel
calc majdescript1 = 'Otherwise Protected Area'
sel major1 = 440 and minor1 = 0170
drawsel
calc majdescript1 = '100-Year Flood Discharge Contained in Channel'
sel major1 = 440 and minor1 = 0171
drawsel
calc majdescript1 = '500-Year Flood Discharge Contained in Channel'
sel major1 = 440 and minor1 = 0172
drawsel
calc majdescript1 = 'Floodway Contained in Channel'
sel major1 = 440 and minor1 = 0180
drawsel
calc majdescript1 = 'Area Outside Study Limits'
sel major1 = 440 and minor1 = 0181
drawsel
calc majdescript1 = 'Area not Included'
sel major1 = 440 and minor1 = 0191
drawsel
calc majdescript1 = 'Area of Undesignated Flood Hazard'
sel major1 = 440 and minor1 = 0600
drawsel
calc majdescript1 = 'Multiple Source Data'
sel major1 = 440 and minor1 = 0164
drawsel
calc majdescript1 = 'Otherwise Protected Area'
sel major3 = 440 and minor3 = 0610
drawsel
calc majdescript3 = 'Feet'
sel major3 = 440 and minor3 = 0611
drawsel
calc majdescript3 = 'Meters'
sel major4 = 440 and minor4 = 0620
drawsel
calc majdescript4 = 'NGVD 29'
sel major4 = 440 and minor4 = 0621
drawsel
calc majdescript4 = 'NAVD 88'
sel major4 = 440 and minor4 = 0622
drawsel
calc majdescript4 = 'Other Vertical Datum'

```

```

sel major1 = 440 and minor1 = 0710
drawsel
calc majdescript1 = 'Floodway'
sel major1 = 440 and minor1 = 0712
drawsel
calc majdescript1 = 'Flow Easement'
sel major1 = 440 and minor1 = 0713
drawsel
calc majdescript1 = 'State Encroachment Area'
sel major2 = 441
drawsel
calc majdescript2 = 'Elevation'
sel major1 = 444
drawsel
calc majdescript1 = 'Decimal Fractions'
sel major2 = 445
drawsel
calc majdescript2 = 'Depth'
sel major2 = 447
drawsel
calc majdescript2 = 'Negative Elevation'
sel major1 = 449
drawsel
calc majdescript1 = 'Velocity in Whole Feet per Second'
save
q
build %line2% poly
&end
&sv line = [read %file% readstatus]
&end

&return

```

## Appendix E. femahydro.aml

```
/* **** */
/* Developed to add attributes to DFIRM DLGs on 1 December 1999 for Digital
/* Flood Insurance Rate Maps
/* femahydro.aml (HYDROGRAPHY DLG files)
/* DLG files must be in same directory as this AML to work correctly
/* 1 December 1999 James J. Damron (703) 428-8168 jdamron@tec.army.mil
/* 7701 Telegraph Road Topographic Engineering Center Alexandria, VA 22315
/* **** */

&severity &error &ignore
&severity &warning &ignore
display 9999
&term 9999
&type
&type This might take some time on slower systems!!!!
&type

&if [exists hydro.txt -file] &then
&do
&type
&type File already exists.... deleting file hydro.txt
&type
[delete hydro.txt -file]
&end

[filelist *h*.dlg hydro.txt -file]

&sv file := [open hydro.txt openstat -read]
&sv line = [read %file% readstatus]
&sv line = [locase %line%]

&do &while %readstatus% = 0

&if [exists %line% -file] &then
&do
&sv temp1 = [substr %line% 1 5]
&sv temp2 = [substr %line% 6 3]
&sv line2 = %temp2%%temp1%
&type
&type Processing file %line%.....
&type
dlgarc optional %line% %line2% %line2%pnt all
build %line2% line
build %line2% poly
build %line2%pnt point
&end
```

```

/*****
/* Hydrography Lines
/*****
&if [exists %line2% -line] &then
&do
&type
&type This sheet is %line2%
&type
joinitem %line2%.aat %line2%.acode %line2%.aat %line2%-id %line2%-id
ae
mape %line2%
ec %line2%
ef arc
de arc
draw
additem majdescript1 60 60 c
additem majdescript2 60 60 c
additem majdescript3 60 60 c
ef arc
de arc
draw
sel major1 = 430 and minor1 = 0250
drawsel
calc majdescript1 = 'Hydrography Bisector'
sel major1 = 430 and minor1 = 0260
drawsel
calc majdescript1 = 'Cross Section Shown on DFIRM'
sel major1 = 430 and minor1 = 0261
drawsel
calc majdescript1 = 'Computed Cross Section Not Shown on DFIRM'
sel major1 = 430 and minor1 = 0270
drawsel
calc majdescript1 = 'Stream, Channel, or Shoreline, Firm is Source'
sel major1 = 430 and minor1 = 0271
drawsel
calc majdescript1 = 'Stream, Channel, or Shoreline, USGS 100k DLG is Source'
sel major1 = 430 and minor1 = 0272
drawsel
calc majdescript1 = 'Stream, Channel, or Shoreline, USGS 24k DLG is Source'
sel major1 = 430 and minor1 = 0273
drawsel
calc majdescript1 = 'Stream, Channel, or Shoreline, Other Source'
sel major1 = 439 and minor1 = 0040
drawsel
calc majdescript1 = 'Coincidentce of Stream, Channel, or Shoreline with Zone Break'
sel major1 = 430 and minor1 = 0281
drawsel
calc majdescript1 = 'Profile Base Line'

```

```

sel major1 = 430 and minor1 = 0406
drawsel
calc majdescript1 = 'Dam or Weir'
sel major1 = 430 and minor1 = 0418
drawsel
calc majdescript1 = 'Culvert'
sel major1 = 430 and minor1 = 0435
drawsel
calc majdescript1 = 'Levee Crown/Floodwall'
sel major1 = 430 and minor1 = 0436
drawsel
calc majdescript1 = 'Road on Levee'
sel major1 = 430 and minor1 = 0466
drawsel
calc majdescript1 = 'Coastal Hard Point'
sel major2 = 433
drawsel
calc majdescript2 = 'Cross Section Alpha Character'
save
q
build %line2% line
&end
/*****
/* POINT
*****/
&if [exists %line2%pnt -point] &then
&do
&type
&type This sheet is %line2%pnt
&type
joinitem %line2%pnt.pat %line2%pnt.xcode %line2%pnt.pat %line2%pnt-id %line2%pnt-id
ae
map %line2%pnt
ec %line2%pnt
ef point
de point
draw
additem majdescript1 60 60 c
additem majdescript2 60 60 c
additem majdescript3 60 60 c
additem majdescript4 60 60 c
additem majdescript5 60 60 c
additem majdescript6 60 60 c
ef point
de point
draw
sel major1 = 430 and minor1 = 0350
drawsel

```

```

calc majdescript1 = 'Elevation Reference Mark (ERM)'
sel major1 = 430 and minor1 = 0351
drawsel
calc majdescript1 = 'River Mile/1000-Foot Marker'
sel major2 = 435
drawsel
calc majdescript2 = 'ERM Identifier'
sel major2 = 436
drawsel
calc majdescript2 = '1,000-Foot Marker Identifier'
sel major2 = 437
drawsel
calc majdescript2 = 'River Mile Marker Identifier'
sel major3 = 431
drawsel
calc majdescript3 = 'Elevation'
sel major4 = 432
drawsel
calc majdescript3 = 'Negative Elevation'
sel major4 = 434
drawsel
calc majdescript4 = 'Decimal Fraction'
sel major5 = 430 and minor5 = 0610
drawsel
calc majdescript5 = 'Feet'
sel major5 = 430 and minor5 = 0611
drawsel
calc majdescript5 = 'Meters'
sel major6 = 430 and minor6 = 0620
drawsel
calc majdescript6 = 'NGVD 29'
sel major6 = 430 and minor6 = 0621
drawsel
calc majdescript6 = 'NAVD 88'
sel major6 = 430 and minor6 = 0622
drawsel
calc majdescript6 = 'Other Vertical Datum'
save
q
build %line2%pnt point
&end
/*****
/* POLY
*****/
&if [exists %line2% -poly] &then
&do
&type
&type This sheet is %line2%

```

```
&type
joinitem %line2%.pat %line2%.pcode %line2%.pat %line2%-id %line2%-id
ae
mape %line2%
ec %line2%
ef poly
de poly
draw
additem majdescript1 60 60 c
ef poly
de poly
draw
sel major1 = 000 and minor1 = 0000
drawsel
calc majdescript1 = 'Outside Area'
save
q
build %line2% poly
&end
&sv line = [read %file% readstatus]
&end
&return
```

## Appendix F. femamappanel.aml

```
/******  
/* Developed to add attributes to DFIRM DLGs on 1 December 1999 for Digital  
/* Flood Insurance Rate Maps  
/* femamappanel.aml (MAP PANEL DLG files)  
/* Modified 11 Jan. 2000 by James J. Damron  
/* DLG files must be in same directory as this AML to work correctly  
/* 1 December 1999 James J. Damron (703) 428-8168 jdamron@tec.army.mil  
/* 7701 Telegraph Road Topographic Engineering Center Alexandria, VA 22315  
/******  
&severity &error &ignore  
&severity &warning &ignore  
display 9999  
&term 9999  
  
&type This might take some time on slower systems!!!!  
&type  
  
&if [exists mpanel.txt -file] &then  
&do  
&type  
&type File already exists.... deleting file mpanel.txt  
&type  
[delete mpanel.txt -file]  
&end  
  
[filelist *m*.dlg mpanel.txt -file]  
  
&sv file := [open mpanel.txt openstat -read]  
&sv line = [read %file% readstatus]  
&sv line = [locase %line%]  
  
&do &while %readstatus% = 0  
  
&if [exists %line% -file] &then  
&do  
&sv temp1 = [substr %line% 1 5]  
&sv temp2 = [substr %line% 6 3]  
&sv line2 = %temp2%%temp1%  
&type  
&type Processing file %line%.....  
&type  
dlgarc optional %line% %line2% %line2%pnt all  
build %line2% line  
build %line2% poly  
kill %line2%pnt all
```

```

&end
/*****
/* Map Panel Lines
/*****
&if [exists %line2% -line] &then
&do
&type
&type This sheet is %line2%
&type
joinitem %line2%.aat %line2%.acode %line2%.aat %line2%-id %line2%-id
ae
mape %line2%
ec %line2%
ef arc
de arc
draw
additem majdescript1 60 60 c
additem majdescript2 60 60 c
ef arc
de arc
draw
sel major1 = 420 and minor1 = 0250
drawsel
calc majdescript1 = 'FIRM Panel Neatline'
sel major2 = 420 and minor2 = 0250
drawsel
calc majdescript2 = 'FIRM Panel Neatline'
sel major1 = 420 and minor1 = 0270
drawsel
calc majdescript1 = 'Map Area Bisector'
sel major1 = 420 and minor1 = 0299
drawsel
calc majdescript1 = 'Processing Line'
save
q
build %line2% line
&end
/*****
/* POLY
/*****
&if [exists %line2% -poly] &then
&do
&type
&type This sheet is %line2%
&type
joinitem %line2%.pat %line2%.pcode %line2%.pat %line2%-id %line2%-id
ae
mape %line2%

```

```

ec %line2%
ef poly
de poly
draw
additem majdescript1 60 60 c
additem majdescript2 60 60 c
additem majdescript3 60 60 c
additem majdescript4 60 60 c
additem majdescript5 60 60 c
sel major1 = 000 and minor1 = 0000
drawsel
calc majdescript1 = 'Outside Area'
sel major1 = 420 and minor1 = 0150
drawsel
calc majdescript1 = 'Community-Based FIRM Panel'
sel major1 = 420 and minor1 = 0151
drawsel
calc majdescript1 = 'Area Outside FIRM Panel Neatline'
sel major1 = 420 and minor1 = 0152
drawsel
calc majdescript1 = 'Community Based FIRM Panel Not Printed'
sel major1 = 420 and minor1 = 0153
drawsel
calc majdescript1 = 'Countywide FIRM Panel'
sel major1 = 420 and minor1 = 0154
drawsel
calc majdescript1 = 'Countywide FIRM Panel Not Printed'
sel major1 = 420 and minor1 = 0155
drawsel
calc majdescript1 = 'Unmapped Community'
sel major2 = 421
drawsel
calc majdescript2 = 'FIRM Panel Number'
sel major3 = 422
drawsel
calc majdescript3 = 'FIRM Panel Alpha Character'
sel major4 = 423
drawsel
calc majdescript4 = 'State FIPS Code'
sel major5 = 424
drawsel
calc majdescript5 = 'Community Number'
sel major5 = 425
drawsel
calc majdescript5 = 'Countywide Map Number'
save
q
build %line% poly

```

```
&end  
&sv line = [read %file% readstatus]  
&end  
  
&return
```

## Appendix G. femapolitical.aml

```
/******  
/* Developed to add attributes to DFIRM DLGs on 1 December 1999 for Digital  
/* Flood Insurance Rate Maps  
/* femapolitical.aml (POLITICAL DLG files)  
/* DLG files must be in same directory as this AML to work correctly  
/* 1 December 1999 James J. Damron (703) 428-8168 jdamron@tec.army.mil  
/* 7701 Telegraph Road Topographic Engineering Center Alexandria, VA 22315  
/******  
&severity &error &ignore  
&severity &warning &ignore  
display 9999  
&term 9999  
  
&type This might take some time on slower systems!!!!  
&type  
  
&if [exists polit.txt -file] &then  
&do  
&type  
&type File already exists.... deleting file polit.txt  
&type  
[delete polit.txt -file]  
&end  
  
[filelist *p*.dlg polit.txt -file]  
  
&sv file := [open polit.txt openstat -read]  
&sv line = [read %file% readstatus]  
&sv line = [locase %line%]  
  
&do &while %readstatus% = 0  
  
&if [exists %line% -file] &then  
&do  
&type  
&type This sheet is %line%  
&type  
&sv temp1 = [substr %line% 1 5]  
&sv temp2 = [substr %line% 6 3]  
&sv line2 = %temp2%%temp1%  
&type  
&type Processing file %line%  
&type  
dlgarc optional %line% %line2% %line2%pnt all  
build %line2% line
```

```

build %line2% poly
kill %line2%pnt all
&end
/*****
/* Political Lines
*****/
&if [exists %line2% -line] &then
&do
&type
&type This sheet is %line2%
&type
joinitem %line2%.aat %line2%.acode %line2%.aat %line2%-id %line2%-id
ae
mape %line2%
ec %line2%
ef arc
de arc
draw
additem majdescript1 60 60 c
ef arc
de arc
draw
sel major1 = 410 and minor1 = 0200
drawsel
calc majdescript1 = 'Corporate Boundary'
sel major1 = 410 and minor1 = 0210
drawsel
calc majdescript1 = 'County Boundary'
sel major1 = 410 and minor1 = 0230
drawsel
calc majdescript1 = 'Area Not Included Boundary'
sel major1 = 410 and minor1 = 0240
drawsel
calc majdescript1 = 'Extraterritorial Jurisdictional Boundary'
sel major1 = 410 and minor1 = 0270
drawsel
calc majdescript1 = 'Community Bisector'
sel major1 = 410 and minor1 = 0299
drawsel
calc majdescript1 = 'Processing Line'
save
q
build %line2% line
&end
/*****
/* POLY
*****/
&if [exists %line2% -poly] &then

```

```

&do
&type
&type This sheet is %line2%
&type
joinitem %line2%.pat %line2%.pcode %line2%.pat %line2%-id %line2%-id link
ae
mape %line2%
ec %line2%
ef poly
de poly
draw
additem majdescript1 60 60 c
additem majdescript2 60 60 c
additem majdescript3 60 60 c
additem majdescript4 60 60 c
ef poly
de poly
draw
sel major1 = 000 and minor1 = 0000
drawsel
calc majdescript1 = 'Outside Area'
sel major1 = 410 and minor1 = 0101
drawsel
calc majdescript1 = 'Community Area'
sel major1 = 410 and minor1 = 0150
drawsel
calc majdescript1 = 'Undefined Political Area'
sel major2 = 410 and minor1 <> 0101 and minor <> 0150
drawsel
calc majdescript2 = 'State FIPS CODE'
sel major3 = 411
drawsel
calc majdescript3 = 'County FIPS Code'
sel major4 = 412
drawsel
calc majdescript4 = 'County Number'
save
q
build %line2% poly
&end
&sv line = [read %file% readstatus]
&end

&return

```

## **Appendix H. Readme for DFIRM e00 files**

May 02, 2000

Virginia Beach, VA 51810 - DFIRM export files

These files were generated from 2x precision coverages.

File names are as follows:

- vabch01e.e00 - Elevation Reference Marks tile01
- vabch01f.e00 - Flood Polygon/Arc tile01
- vabch01h.e00 - Hydrography Polygon/Arc tile01
- vabch01m.e00 - Map Panels Polygon/Arc tile01
- vabch01p.e00 - Political Areas Polygon/Arc tile01

Please note that Elevation Reference Marks are not applicable to all tiles.

These files represent tiles 1-12 for all other categories.

Master coverages are as follows :

- vb\_24k.e00 - USGS 24k quad tile grid
- vb\_erm.e00 - Elevation Reference Marks
- vb\_fall.e00 - Flood Polygon/Arc
- vb\_hall.e00 - Hydrography Polygon/Arc
- vb\_mall.e00 - Map Panels Polygon/Arc
- vb\_pall.e00 - Political Areas Polygon/Arc

These coverages are final as approved by Harvard Design & Mapping.

If there are any questions concerning the files, please contact:

Sue Hoegberg

Dewberry and Davis

8401 Arlington Blvd.

Fairfax, VA 22031-4666

(703) 849 - 0419

## Appendix I. femaflde00.aml

```
/******
/* Developed to add attributes to DFIRM E00 files for Digital
/* Flood Insurance Rate Maps (Modified AML from DFIRM DLG version)
/* Arc Interchange (e00) files
/* femaflde00.aml (FLOOD HAZARD ZONE files)
/* Modified May 2000 James J. Damron (703) 428-8168 jdamron@tec.army.mil
/* 7701 Telegraph Road Topographic Engineering Center Alexandria, VA 22315
/******

&severity &error &ignore
&severity &warning &ignore
display 9999
&term 9999

&type
&type This might take some time on slower systems!!!!
&type

&if [exists flood.txt -file] &then
&do
&type
&type File already exists.... deleting file flood.txt
&type
[delete flood.txt -file]
&end

[filelist *f*.e00 flood.txt -file]

/*&sv file := [open [getfile *.txt -file] ok -r]
&sv file := [open flood.txt openstat -read]
&sv line = [read %file% readstatus]
&sv line = [locase %line%]

&do &while %readstatus% = 0

&if [exists %line% -file] &then
&do
&sv temp1 = [substr %line% 1 8]
&sv line2 = %temp1%
&type
&type Processing file %line%.....
&type
import auto %line2%.e00 %line2%
build %line2% line
build %line2% poly
/*clean %line2% %line2% 0.65 0.65 poly
```

```

/*build %line2%pnt point
&end
/*****
/* Lines
/*****
&if [exists %line2% -line] &then
&do
&type
&type This sheet is %line2%
&type
/*joinitem %line2%.aat %line2%.acode %line2%.aat %line2%-id %line2%-id
ae
mape %line2%
ec %line2%
ef arc
de arc
draw
additem majdescript1 60 60 c
additem majdescript2 60 60 c
additem majdescript3 60 60 c
additem majdescript4 60 60 c
additem majdescript5 60 60 c
ef arc
de arc
draw
sel major1 = 440 and minor1 = 0204
drawsel
calc majdescript1 = 'Apparent Limit'
sel major1 = 440 and minor1 = 0245
drawsel
calc majdescript1 = '100-Year Floodplain Boundary'
sel major1 = 440 and minor1 = 0246
drawsel
calc majdescript1 = '500-Year Floodplain Boundary'
sel major1 = 440 and minor1 = 0247
drawsel
calc majdescript1 = 'Zone Break'
sel major1 = 440 and minor1 = 0248
drawsel
calc majdescript1 = 'Zone D'
sel major1 = 440 and minor1 = 0249
drawsel
calc majdescript1 = 'Floodway'
sel major1 = 440 and minor1 = 0250
drawsel
calc majdescript1 = 'Flow Easement'
sel major1 = 440 and minor1 = 0251
drawsel

```

```

calc majdescript1 = 'Limit of Detailed Study'
sel major1 = 440 and minor1 = 0252
drawsel
calc majdescript1 = 'Limit of Floodway'
sel major1 = 440 and minor1 = 0253
drawsel
calc majdescript1 = 'Limit of Study'
sel major1 = 440 and minor1 = 0254
drawsel
calc majdescript1 = 'State Encroachment Line'
sel major1 = 440 and minor1 = 0256
drawsel
calc majdescript1 = '1983 Undeveloped Coastal Barrier Area Boundary'
sel major1 = 440 and minor1 = 0257
drawsel
calc majdescript1 = '1990 Undeveloped Coastal Barrier Area Boundary'
sel major1 = 440 and minor1 = 0258
drawsel
calc majdescript1 = 'Otherwise Protected Area Boundary'
sel major1 = 440 and minor1 = 0261
drawsel
calc majdescript1 = 'Base Flood Elevation (BFE) Line'
sel major1 = 440 and minor1 = 0262
drawsel
calc majdescript1 = 'Interpolated Base Flood Elevation (BFE) Line'
sel major1 = 440 and minor1 = 0270
drawsel
calc majdescript1 = 'Zone Bisector'
sel major1 = 440 and minor1 = 0299
drawsel
calc majdescript1 = 'Processing Line'
sel major1 = 440 and minor1 = 0600
drawsel
calc majdescript1 = 'Multiple Source Data'
sel major3 = 440 and minor3 = 0610
drawsel
calc majdescript3 = 'Feet'
sel major3 = 440 and minor3 = 0611
drawsel
calc majdescript3 = 'Meters'
sel major4 = 440 and minor4 = 0620
drawsel
calc majdescript4 = 'NGVD 29'
sel major4 = 440 and minor4 = 0621
drawsel
calc majdescript4 = 'NAVD 88'
sel major4 = 440 and minor4 = 0622
drawsel

```

```

calc majdescript4 = 'Other Vertical Datum'
sel major1 = 440 and minor1 = 0710
drawsel
calc majdescript1 = 'Floodway'
sel major1 = 440 and minor1 = 0712
drawsel
calc majdescript1 = 'Flow Easement'
sel major1 = 440 and minor1 = 0713
drawsel
calc majdescript1 = 'State Encroachment Area'
sel major2 = 440 and minor2 = 0246
drawsel
calc majdescript2 = '500-Year Floodplain Boundary'
sel major2 = 440 and minor2 = 0249
drawsel
calc majdescript2 = 'Floodway'
sel major2 = 441
drawsel
calc majdescript2 = 'Elevation'
sel major3 = 440 and minor3 = 0246
drawsel
calc majdescript3 = '500-Year Floodplain Boundary'
sel major3 = 444
drawsel
calc majdescript3 = 'Decimal Fractions'
sel major2 = 445
drawsel
calc majdescript2 = 'Depth'
sel major2 = 447
drawsel
calc majdescript2 = 'Negative Elevation'
sel major5 = 449
drawsel
calc majdescript5 = 'Velocity in Whole Feet per Second'
save
q
build %line2% line
&end
/*****
/* POLY
*****/
&if [exists %line2% -poly] &then
&do
&type
&type This sheet is %line2%
&type
/*joinitem %line2%.pat %line2%.pcode %line2%.pat %line2%-id %line2%-id
ae

```

```

mape %line2%
ec %line2%
ef poly
de poly
draw
additem majdescript1 60 60 c
additem majdescript2 60 60 c
additem majdescript3 60 60 c
additem majdescript4 60 60 c
additem majdescript5 60 60 c
ef poly
de poly
draw
sel major1 = 000 and minor1 = 0000
drawsel
calc majdescript1 = 'Outside Area'
sel major1 = 440 and minor1 = 0150
drawsel
calc majdescript1 = 'Zone V'
sel major1 = 440 and minor1 = 0151
drawsel
calc majdescript1 = 'Zone VE'
sel major1 = 440 and minor1 = 0152
drawsel
calc majdescript1 = 'Zone A'
sel major1 = 440 and minor1 = 0153
drawsel
calc majdescript1 = 'Zone AE'
sel major1 = 440 and minor1 = 0154
drawsel
calc majdescript1 = 'Zone AO'
sel major1 = 440 and minor1 = 0155
drawsel
calc majdescript1 = 'Zone AO (Alluvial Fan)'
sel major1 = 440 and minor1 = 0156
drawsel
calc majdescript1 = 'Zone AH'
sel major1 = 440 and minor1 = 0157
drawsel
calc majdescript1 = 'Zone A99'
sel major1 = 440 and minor1 = 0158
drawsel
calc majdescript1 = 'Zone D'
sel major1 = 440 and minor1 = 0160
drawsel
calc majdescript1 = 'Zone X (500 Year)'
sel major1 = 440 and minor1 = 0161
drawsel

```

```

calc majdescript1 = 'Zone X'
sel major1 = 440 and minor1 = 0162
drawsel
calc majdescript1 = '1983 Undeveloped Coastal Barrier Area'
sel major1 = 440 and minor1 = 0163
drawsel
calc majdescript1 = '1990 Undeveloped Coastal Barrier Area'
sel major1 = 440 and minor1 = 0164
drawsel
calc majdescript1 = 'Otherwise Protected Area'
sel major1 = 440 and minor1 = 0170
drawsel
calc majdescript1 = '100-Year Flood Discharge Contained in Channel'
sel major1 = 440 and minor1 = 0171
drawsel
calc majdescript1 = '500-Year Flood Discharge Contained in Channel'
sel major1 = 440 and minor1 = 0172
drawsel
calc majdescript1 = 'Floodway Contained in Channel'
sel major1 = 440 and minor1 = 0180
drawsel
calc majdescript1 = 'Area Outside Study Limits'
sel major1 = 440 and minor1 = 0181
drawsel
calc majdescript1 = 'Area not Included'
sel major1 = 440 and minor1 = 0191
drawsel
calc majdescript1 = 'Area of Undesignated Flood Hazard'
sel major1 = 440 and minor1 = 0600
drawsel
calc majdescript1 = 'Multiple Source Data'
sel major1 = 440 and minor1 = 0164
drawsel
calc majdescript1 = 'Otherwise Protected Area'
sel major3 = 440 and minor3 = 0610
drawsel
calc majdescript3 = 'Feet'
sel major3 = 440 and minor3 = 0611
drawsel
calc majdescript3 = 'Meters'
sel major4 = 440 and minor4 = 0620
drawsel
calc majdescript4 = 'NGVD 29'
sel major4 = 440 and minor4 = 0621
drawsel
calc majdescript4 = 'NAVD 88'
sel major4 = 440 and minor4 = 0622
drawsel

```

```

calc majdescript4 = 'Other Vertical Datum'
sel major1 = 440 and minor1 = 0710
drawsel
calc majdescript1 = 'Floodway'
sel major1 = 440 and minor1 = 0712
drawsel
calc majdescript1 = 'Flow Easement'
sel major1 = 440 and minor1 = 0713
drawsel
calc majdescript1 = 'State Encroachment Area'
sel major2 = 441
drawsel
calc majdescript2 = 'Elevation'
sel major1 = 444
drawsel
calc majdescript1 = 'Decimal Fractions'
sel major2 = 445
drawsel
calc majdescript2 = 'Depth'
sel major2 = 447
drawsel
calc majdescript2 = 'Negative Elevation'
sel major1 = 449
drawsel
calc majdescript1 = 'Velocity in Whole Feet per Second'
save
q
build %line2% poly
&end
&sv line = [read %file% readstatus]
&end

&return

```

## Appendix J. femahydroe00.aml

```
/******
/* Developed to add attributes to DFIRM E00 files for Digital
/* Flood Insurance Rate Maps (Modified AML from DFIRM DLG version)
/* Arc Interchange (e00) files
/* femahydrography.aml (HYDROGRAPHY DLG files)
/* Modified May 2000 James J. Damron (703) 428-8168 jdamron@tec.army.mil
/* 7701 Telegraph Road Topographic Engineering Center Alexandria, VA 22315
/******

&severity &error &ignore
&severity &warning &ignore
display 9999
&term 9999
&type
&type This might take some time on slower systems!!!!
&type

&if [exists floodhaz.txt -file] &then
&do
&type
&type File already exists.... deleting file floodhaz.txt
&type
[delete floodhaz.txt -file]
&end

[filelist *h*.e00 floodhaz.txt -file]

/*&sv file := [open [getfile *.txt -file] ok -r]
&sv file := [open floodhaz.txt openstat -read]
&sv line = [read %file% readstatus]
&sv line = [locase %line%]

&do &while %readstatus% = 0

&if [exists %line% -file] &then

&if [exists %line% -cover] &then
&do
&sv temp1 = [substr %line% 1 8]
&sv line2 = %temp1%
&type
&type Processing file %line%.....
&type
import auto %line2%.e00 %line2%
build %line2% line
build %line2% poly
```

```

&end
/*****
/* Hydrography Lines
/*****
&if [exists %line2% -line] &then
&do
&type
&type This sheet is %line2%
&type
/*joinitem %line2%.aat %line2%.acode %line2%.aat %line2%-id %line2%-id
ae
mape %line2%
ec %line2%
ef arc
de arc
draw
additem majdescript1 60 60 c
additem majdescript2 60 60 c
additem majdescript3 60 60 c
ef arc
de arc
draw
sel major1 = 430 and minor1 = 0250
drawsel
calc majdescript1 = 'Hydrography Bisector'
sel major1 = 430 and minor1 = 0260
drawsel
calc majdescript1 = 'Cross Section Shown on DFIRM'
sel major1 = 430 and minor1 = 0261
drawsel
calc majdescript1 = 'Computed Cross Section Not Shown on DFIRM'
sel major1 = 430 and minor1 = 0270
drawsel
calc majdescript1 = 'Stream, Channel, or Shoreline, Firm is Source'
sel major1 = 430 and minor1 = 0271
drawsel
calc majdescript1 = 'Stream, Channel, or Shoreline, USGS 100k DLG is Source'
sel major1 = 430 and minor1 = 0272
drawsel
calc majdescript1 = 'Stream, Channel, or Shoreline, USGS 24k DLG is Source'
sel major1 = 430 and minor1 = 0273
drawsel
calc majdescript1 = 'Stream, Channel, or Shoreline, Other Source'
sel major1 = 439 and minor1 = 0040
drawsel
calc majdescript1 = 'Coincidentce of Stream, Channel, or Shoreline with Zone Break'
sel major1 = 430 and minor1 = 0281
drawsel

```

```

calc majdescript1 = 'Profile Base Line'
sel major1 = 430 and minor1 = 0406
drawsel
calc majdescript1 = 'Dam or Weir'
sel major1 = 430 and minor1 = 0418
drawsel
calc majdescript1 = 'Culvert'
sel major1 = 430 and minor1 = 0435
drawsel
calc majdescript1 = 'Levee Crown/Floodwall'
sel major1 = 430 and minor1 = 0436
drawsel
calc majdescript1 = 'Road on Levee'
sel major1 = 430 and minor1 = 0466
drawsel
calc majdescript1 = 'Coastal Hard Point'
sel major2 = 433
drawsel
calc majdescript2 = 'Cross Section Alpha Character'
save
q
build %line2% line
&end
/*****
/* POLY
*****/
&if [exists %line2% -poly] &then
&do
&type
&type This sheet is %line2%
&type
joinitem %line2%.pat %line2%.pcode %line2%.pat %line2%-id %line2%-id
ae
mape %line2%
ec %line2%
ef poly
de poly
draw
additem majdescript1 60 60 c
ef poly
de poly
draw
sel major1 = 000 and minor1 = 0000
drawsel
calc majdescript1 = 'Outside Area'
save
q
build %line2% poly

```

```
&end  
&sv line = [read %file% readstatus]  
&end  
&return
```

## Appendix K. femamape00.aml

```
/******
/* Developed to add attributes to DFIRM E00 files for Digital
/* Flood Insurance Rate Maps (Modified AML from DFIRM DLG version)
/* Arc Interchange (e00) files
/* femamape00.aml (MAP PANEL files)
/* Modified May 2000 James J. Damron (703) 428-8168 jdamron@tec.army.mil
/* 7701 Telegraph Road Topographic Engineering Center Alexandria, VA 22315
/******

&severity &error &ignore
&severity &warning &ignore
display 9999
&term 9999

&type This might take some time on slower systems!!!!
&type

&if [exists mpanel.txt -file] &then
&do
&type
&type File already exists.... deleting file mpanel.txt
&type
[delete mpanel.txt -file]
&end

[filelist *m*.e00 mpanel.txt -file]

/*&sv file := [open [getfile *.txt -file] ok -r]
&sv file := [open mpanel.txt openstat -read]
&sv line = [read %file% readstatus]
&sv line = [locase %line%]

&do &while %readstatus% = 0

&if [exists %line% -file] &then
&do
&sv temp1 = [substr %line% 1 8]
&sv line2 = %temp1%
&type
&type Processing file %line%.....
&type
import auto %line2%.e00 %line2%
build %line2% line
build %line2% poly
&end
/******
```

```

/* Map Panel Lines
/*****
&if [exists %line2% -line] &then
&do
&type
&type This sheet is %line2%
&type
joinitem %line2%.aat %line2%.acode %line2%.aat %line2%-id %line2%-id
ae
mape %line2%
ec %line2%
ef arc
de arc
draw
additem majdescript1 60 60 c
additem majdescript2 60 60 c
ef arc
de arc
draw
sel major1 = 420 and minor1 = 0250
drawsel
calc majdescript1 = 'FIRM Panel Neatline'
sel major2 = 420 and minor2 = 0250
drawsel
calc majdescript2 = 'FIRM Panel Neatline'
sel major1 = 420 and minor1 = 0270
drawsel
calc majdescript1 = 'Map Area Bisector'
sel major1 = 420 and minor1 = 0299
drawsel
calc majdescript1 = 'Processing Line'
save
q
build %line2% line
&end
/*****
/* POLY
/*****
&if [exists %line2% -poly] &then
&do
&type
&type This sheet is %line2%
&type
joinitem %line2%.pat %line2%.pcode %line2%.pat %line2%-id %line2%-id
ae
mape %line2%
ec %line2%
ef poly

```

```

de poly
draw
additem majdescript1 60 60 c
additem majdescript2 60 60 c
additem majdescript3 60 60 c
additem majdescript4 60 60 c
additem majdescript5 60 60 c
sel major1 = 000 and minor1 = 0000
drawsel
calc majdescript1 = 'Outside Area'
sel major1 = 420 and minor1 = 0150
drawsel
calc majdescript1 = 'Community-Based FIRM Panel'
sel major1 = 420 and minor1 = 0151
drawsel
calc majdescript1 = 'Area Outside FIRM Panel Neatline'
sel major1 = 420 and minor1 = 0152
drawsel
calc majdescript1 = 'Community Based FIRM Panel Not Printed'
sel major1 = 420 and minor1 = 0153
drawsel
calc majdescript1 = 'Countywide FIRM Panel'
sel major1 = 420 and minor1 = 0154
drawsel
calc majdescript1 = 'Countywide FIRM Panel Not Printed'
sel major1 = 420 and minor1 = 0155
drawsel
calc majdescript1 = 'Unmapped Community'
sel major2 = 421
drawsel
calc majdescript2 = 'FIRM Panel Number'
sel major3 = 422
drawsel
calc majdescript3 = 'FIRM Panel Alpha Character'
sel major4 = 423
drawsel
calc majdescript4 = 'State FIPS Code'
sel major5 = 424
drawsel
calc majdescript5 = 'Community Number'
sel major5 = 425
drawsel
calc majdescript5 = 'Countywide Map Number'
save
q
build %line% poly
&end
&sv line = [read %file% readstatus]

```

&end

&return

## Appendix L. femapolite00.aml

```
/******
/* Developed to add attributes to DFIRM DLGs on 1 December 1999 for Digital
/* Flood Insurance Rate Maps (Modified AML from DFIRM DLG version)
/* Arc Interchange (e00) files
/* femapolite00.aml (POLITICAL files)
/* 1 December 1999 James J. Damron (703) 428-8168 jdamron@tec.army.mil
/* 7701 Telegraph Road Topographic Engineering Center Alexandria, VA 22315
/******

&severity &error &ignore
&severity &warning &ignore
display 9999
&term 9999

&type This might take some time on slower systems!!!!
&type

&if [exists polit.txt -file] &then
&do
&type
&type File already exists.... deleting file polit.txt
&type
[delete polit.txt -file]
&end

[filelist *p*.e00 polit.txt -file]

/*&sv file := [open [getfile *p*.txt -file] ok -r]
&sv file := [open polit.txt openstat -read]
&sv line = [read %file% readstatus]
&sv line = [locase %line%]

&do &while %readstatus% = 0

&if [exists %line% -file] &then
&do
&type
&type This sheet is %line%
&type
&sv temp1 = [substr %line% 1 8]
&sv line2 = %temp1%
&type
&type Processing file %line%
&type
import auto %line2%.e00 %line2%
build %line2% line
```

```

build %line2% poly
&end
/*****
/* Political Lines
*****/
&if [exists %line2% -line] &then
&do
&type
&type This sheet is %line2%
&type
joinitem %line2%.aat %line2%.acode %line2%.aat %line2%-id %line2%-id
ae
mape %line2%
ec %line2%
ef arc
de arc
draw
additem majdescript1 60 60 c
ef arc
de arc
draw
sel major1 = 410 and minor1 = 0200
drawsel
calc majdescript1 = 'Corporate Boundary'
sel major1 = 410 and minor1 = 0210
drawsel
calc majdescript1 = 'County Boundary'
sel major1 = 410 and minor1 = 0230
drawsel
calc majdescript1 = 'Area Not Included Boundary'
sel major1 = 410 and minor1 = 0240
drawsel
calc majdescript1 = 'Extraterritorial Jurisdictional Boundary'
sel major1 = 410 and minor1 = 0270
drawsel
calc majdescript1 = 'Community Bisector'
sel major1 = 410 and minor1 = 0299
drawsel
calc majdescript1 = 'Processing Line'
save
q
build %line2% line
&end
/*****
/* POLY
*****/
&if [exists %line2% -poly] &then
&do

```

```

&type
&type This sheet is %line2%
&type
joinitem %line2%.pat %line2%.pcode %line2%.pat %line2%-id %line2%-id link
ae
mape %line2%
ec %line2%
ef poly
de poly
draw
additem majdescript1 60 60 c
additem majdescript2 60 60 c
additem majdescript3 60 60 c
additem majdescript4 60 60 c
ef poly
de poly
draw
sel major1 = 000 and minor1 = 0000
drawsel
calc majdescript1 = 'Outside Area'
sel major1 = 410 and minor1 = 0101
drawsel
calc majdescript1 = 'Community Area'
sel major1 = 410 and minor1 = 0150
drawsel
calc majdescript1 = 'Undefined Political Area'
sel major2 = 410 and minor1 <> 0101 and minor <> 0150
drawsel
calc majdescript2 = 'State FIPS CODE'
sel major3 = 411
drawsel
calc majdescript3 = 'County FIPS Code'
sel major4 = 412
drawsel
calc majdescript4 = 'County Number'
save
q
build %line2% poly
&end
&sv line = [read %file% readstatus]
&end

&return

```

## Appendix M. femaelevmrk.aml

```
/******
/* Developed to add attributes to DFIRM Elevation Reference Marks for
/* Arc Interchange (e00) files for Digital Flood Insurance Rate Maps
/* May 2000
/* FEMAELEVMRK.AML ( Elevation Reference Mark )
/* Modified June 6, 2000 James J. Damron (703) 428-8168 jdamron@tec.army.mil
/* 7701 Telegraph Road Topographic Engineering Center Alexandria, VA 22315
/******

&severity &error &ignore
&severity &warning &ignore
display 9999
&term 9999
&type
&type This might take some time on slower systems!!!!
&type

&if [exists elevrfmrk.txt -file] &then
&do
&type
&type File already exists.... Deleting file elevrfmrk.txt
&type
[delete elevrfmrk.txt -file]
&end

[filelist *e*.e00 elevrfmrk.txt -file]

/*&sv file := [open [getfile *.txt -file] ok -r]
&sv file := [open elevrfmrk.txt openstat -read]
&sv line = [read %file% readstatus]
&sv line = [locase %line%]

&do &while %readstatus% = 0
&if [exists %line% -file] &then
&do
&sv temp1 = [substr %line% 1 8]
&sv line2 = %temp1%
&type %temp1%
&type %line%
&type
&type Processing file %line2%.e00.....
&type
import auto %line2%.e00 %line2%pnt
build %line2%pnt point
&end
/******
```

```

/* POINT
/*****
&if [exists %line2%pnt -point] &then
&do
&type
&type This sheet is %line2%pnt
&type
/*joinitem %line2%pnt.pat %line2%pnt.xcode %line2%pnt.pat %line2%pnt-id %line2%pnt-id
ae
mape %line2%pnt
ec %line2%pnt
ef point
de point
draw
additem majdescript1 60 60 c
additem majdescript2 60 60 c
additem majdescript3 60 60 c
additem majdescript4 60 60 c
additem majdescript5 60 60 c
additem majdescript6 60 60 c
additem elev 16 16 n 4
ef point
de point
draw
sel major1 = 430 and minor1 = 0350
drawsel
calc majdescript1 = 'Elevation Reference Mark (ERM)'
sel major1 = 430 and minor1 = 0351
drawsel
calc majdescript1 = 'River Mile/1000-Foot Marker'
sel major2 = 435
drawsel
calc majdescript2 = 'ERM Identifier'
sel major2 = 436
drawsel
calc majdescript2 = '1,000-Foot Marker Identifier'
sel major2 = 437
drawsel
calc majdescript2 = 'River Mile Marker Identifier'
sel major3 = 431
drawsel
calc majdescript3 = 'Elevation'
sel major4 = 432
drawsel
calc majdescript3 = 'Negative Elevation'
sel major4 = 434
drawsel
calc majdescript4 = 'Decimal Fraction'

```

```
sel major5 = 430 and minor5 = 0610
drawsel
calc majdescript5 = 'Feet'
sel major5 = 430 and minor5 = 0611
drawsel
calc majdescript5 = 'Meters'
sel major6 = 430 and minor6 = 0620
drawsel
calc majdescript6 = 'NGVD 29'
sel major6 = 430 and minor6 = 0621
drawsel
calc majdescript6 = 'NAVD 88'
sel major6 = 430 and minor6 = 0622
drawsel
calc majdescript6 = 'Other Vertical Datum'
sel all
save
q
build %line2%pnt point
&sv line = [read %file% readstatus]
&end
&end
&return
```

## Appendix N. ERM's in NAD 27 and NGVD 29 Coordinates

| NAD27 x-coord | NAD27 y-coord | NGVD29  |
|---------------|---------------|---------|
| 396841.72000  | 4086656.13000 | 18.5200 |
| 399240.07000  | 4086026.08000 | 9.9100  |
| 397046.64000  | 4085956.90000 | 9.8500  |
| 394274.38000  | 4085372.63000 | 12.7900 |
| 401254.55000  | 4085367.89000 | 6.3500  |
| 396968.84000  | 4084967.63000 | 9.7600  |
| 398796.47000  | 4084653.51000 | 11.8800 |
| 398594.20000  | 4083033.83000 | 20.2300 |
| 393376.25000  | 4082586.98000 | 20.7100 |
| 407986.72000  | 4081567.85000 | 23.7600 |
| 411602.51000  | 4081242.74000 | 11.4600 |
| 412335.21000  | 4081130.30000 | 8.0500  |
| 398916.68000  | 4080984.20000 | 26.4700 |
| 397085.20000  | 4080297.93000 | 17.5800 |
| 412788.77000  | 4079500.59000 | 13.8300 |
| 406534.93750  | 4079260.25000 | 16.6900 |
| 409689.65625  | 4078651.25000 | 11.7100 |
| 400255.37500  | 4077885.25000 | 15.9700 |
| 406668.59375  | 4077671.00000 | 18.8700 |
| 405741.25000  | 4077589.25000 | 18.8700 |
| 394523.48000  | 4077565.11000 | 15.3400 |
| 399119.76000  | 4075987.59000 | 10.8000 |
| 392323.96654  | 4074643.24039 | 18.0400 |
| 404741.68750  | 4072198.75000 | 14.2800 |
| 399584.74000  | 4071874.52000 | 11.0400 |
| 396639.77000  | 4070827.25000 | 9.8600  |
| 406826.34375  | 4070778.00000 | 10.9900 |
| 411577.57000  | 4070741.06000 | 6.2000  |
| 402606.87500  | 4070370.25000 | 13.9500 |
| 409388.71875  | 4069045.25000 | 17.0100 |
| 398041.01000  | 4068666.68000 | 10.5700 |
| 415053.05000  | 4068459.81000 | 7.5600  |

|              |               |         |
|--------------|---------------|---------|
| 400496.09375 | 4068458.00000 | 11.4700 |
| 406174.03125 | 4067967.25000 | 8.3500  |
| 401042.37500 | 4067951.50000 | 11.5600 |
| 407701.34375 | 4067862.25000 | 7.1800  |
| 405143.26000 | 4067183.47000 | 15.8600 |
| 415650.96000 | 4066938.44000 | 12.0400 |
| 416084.73000 | 4065515.76000 | 10.5600 |
| 404210.34000 | 4064736.04000 | 9.8500  |
| 409120.55000 | 4064523.71000 | 19.4700 |
| 401744.29914 | 4064072.32589 | 2.4300  |
| 416597.79960 | 4063810.96260 | 10.3300 |
| 408799.30000 | 4063413.08000 | 12.9400 |
| 410847.42145 | 4063115.37484 | 5.1600  |
| 408528.45000 | 4061222.29000 | 15.8700 |
| 408609.18000 | 4059750.11000 | 14.2600 |
| 409575.44000 | 4059369.31000 | 6.1900  |

## Appendix O. elevextract.aml

```

/*****
/* ELEVEXTRACT.AML 07/12/99
/* James J. Damron
/* U.S. Army Topographic Engineering Center
/* 7701 Telegraph Road
/* Alexandria, VA 22315-3864
/* jdamron@tec.army.mil
/*
/* Extracts elevation data using an x,y ascii text file for a stack or
/* single grid
/*
/* filename - ASCII text file created          writefile - output of elevation
/*
/* type - type grid used for extraction        name - name of the grid or stack
/*
/* file - opens x,y ASCII coordinate file     line - selects new line of x,y
/*
*****/
&severity &error &ignore
&severity &warning &ignore
display 9999
&term 9999

/* Setting up files and output file name
&sv filename = [ response 'Please enter file name to write to' elev.txt ]
&sv writefile = [ open %filename% openstatus -write]
&type
&sv type = [ response 'Please enter type of grid: single or stack' stack ]
&type
&sv name = [ response 'Please enter name of the grid for extraction' grid ]
&type
/* Setting up environment
mape %name%
&sv file := [ open [getfile *.txt -file] ok -r]
&sv line = [ read %file% readstatus]
&sv count = 1

/* Examining file type and grid
&if %type% = single and [exists %name% -grid] &then
  /* Opening file for processing and output to ASCII
    &do &while %readstatus% eq 0
      &type %line%
      &type
      &sv elev = [ show cellvalue %name% %line% ]
      &if [write %writefile% %line%,%elev%] = 0 &then
```

```

        &type Writing file to %filename% ....
        &type
        &type this many finished %count%
        &type
        &sv count = %count% + 1
        &sv line = [read %file% readstatus]
    &end

/* Examining file type and grid
&if %type% = stack and [exists %name% -stack] &then
    /* Opening file for processing and output to ASCII
        &do &while %readstatus% eq 0
            &type %line%
            &type
            &sv elev = [ show cellvalue %name% %line% ]
            &if [write %writefile% %line%,%elev%] = 0 &then
                &type Writing file to %filename% ....
                &type
                &type this many finished %count%
                &type
                &sv count = %count% + 1
                &sv line = [read %file% readstatus]
            &end
        &sv count = %count% - 1
        &type
        &type File %filename% closed and this many files processed %count%.....
        &return

```

## Appendix P. USGS Generated Points and vb\_24k Results

| Map Panels | USGS | Meters   | Feet     | Inches   |
|------------|------|----------|----------|----------|
| 1          | 7    | 0.111740 | 0.366614 | 4.399375 |
| 1          | 10   | 0.111740 | 0.366614 | 4.399375 |
| 1          | 14   | 0.111740 | 0.366614 | 4.399375 |
| 1          | 22   | 0.111740 | 0.366614 | 4.399375 |
| 3          | 7    | 0.111740 | 0.366614 | 4.399375 |
| 3          | 10   | 0.111740 | 0.366614 | 4.399375 |
| 3          | 14   | 0.111740 | 0.366614 | 4.399375 |
| 3          | 22   | 0.111740 | 0.366614 | 4.399375 |
| 4          | 5    | 0.121300 | 0.397978 | 4.775747 |
| 4          | 9    | 0.121300 | 0.397978 | 4.775747 |
| 4          | 21   | 0.121300 | 0.397978 | 4.775747 |
| 8          | 7    | 0.111900 | 0.367138 | 4.405668 |
| 8          | 10   | 0.111900 | 0.367138 | 4.405668 |
| 8          | 14   | 0.111900 | 0.367138 | 4.405668 |
| 8          | 22   | 0.111900 | 0.367138 | 4.405668 |
| 9          | 7    | 0.111740 | 0.366614 | 4.399375 |
| 9          | 10   | 0.111740 | 0.366614 | 4.399375 |
| 9          | 14   | 0.111740 | 0.366614 | 4.399375 |
| 9          | 22   | 0.111740 | 0.366614 | 4.399375 |
| 12         | 7    | 0.111740 | 0.366614 | 4.399375 |
| 12         | 10   | 0.111740 | 0.366614 | 4.399375 |
| 12         | 14   | 0.111740 | 0.366614 | 4.399375 |
| 12         | 22   | 0.111740 | 0.366614 | 4.399375 |
| 15         | 27   | 0.113930 | 0.373780 | 4.485368 |
| 15         | 29   | 0.113930 | 0.373780 | 4.485368 |
| 15         | 32   | 0.113930 | 0.373780 | 4.485368 |
| 15         | 41   | 0.113930 | 0.373780 | 4.485368 |
| 18         | 5    | 0.121300 | 0.397978 | 4.775747 |
| 18         | 9    | 0.121300 | 0.397978 | 4.775747 |
| 18         | 21   | 0.121300 | 0.397978 | 4.775747 |
| 22         | 16   | 0.123020 | 0.403601 | 4.843227 |
| 25         | 5    | 0.121300 | 0.397978 | 4.775747 |
| 25         | 9    | 0.121300 | 0.397978 | 4.775747 |
| 25         | 21   | 0.121300 | 0.397978 | 4.775747 |
| 28         | 27   | 0.113930 | 0.373780 | 4.485368 |
| 28         | 29   | 0.113930 | 0.373780 | 4.485368 |
| 28         | 32   | 0.113930 | 0.373780 | 4.485368 |
| 28         | 41   | 0.113930 | 0.373780 | 4.485368 |

|      |    |          |          |          |
|------|----|----------|----------|----------|
| 33   | 27 | 0.113930 | 0.373780 | 4.485368 |
| 33   | 29 | 0.113930 | 0.373780 | 4.485368 |
| 33   | 32 | 0.113930 | 0.373780 | 4.485368 |
| 33   | 41 | 0.113930 | 0.373780 | 4.485368 |
| 39   | 27 | 0.113930 | 0.373780 | 4.485368 |
| 39   | 29 | 0.113930 | 0.373780 | 4.485368 |
| 39   | 32 | 0.113930 | 0.373780 | 4.485368 |
| 39   | 41 | 0.113930 | 0.373780 | 4.485368 |
| 51   | 48 | 0.105970 | 0.347685 | 4.172223 |
| 51   | 53 | 0.105970 | 0.347685 | 4.172223 |
| Mean |    | 0.114270 | 0.374909 | 4.498916 |
| Min  |    | 0.105970 | 0.347685 | 4.172223 |
| Max  |    | 0.123020 | 0.403601 | 4.843227 |
| STD  |    | 0.004046 | 0.013274 | 0.159294 |