Innovative approaches
Practical results
Outstanding service

# MITCHELL LAKE DAM
# PMF UPDATE AND BREACH ANALYSIS

Prepared for:

San Antonio Water System

*Under contract with Alan Plummer Associates, Inc.*

FEBRUARY 2019

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2/14/2019

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PLU17623

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**APPENDICES:**

## Acronyms and Abbreviations

| | |
|---|---|
| APAI | Alan Plummer & Associates, Inc. |
| cfs | Cubic feet per second |
| FNI | Freese and Nichols, Inc. |
| NAVD88 | North American Vertical Datum of 1988 |
| PMF | Probable Maximum Flood |
| PMP | Probable Maximum Precipitation |
| SAWS | San Antonio Water Authority |
| TCEQ | Texas Commission on Environmental Quality |

# 1.0 BACKGROUND

San Antonio Water System (SAWS) contracted with Freese and Nichols, Inc. (FNI) as a subcontractor to Alan Plummer Associates, Inc. (APAI) to perform engineering services as a part of the Mitchell Lake Wetlands Quality Treatment Initiatives project (Contract No. P-17-004-GC). Phase 1 of the project involves the evaluation of potential treatment options for discharges from Mitchell Lake, including options which may involve modifications to Mitchell Lake Dam. This report summarizes updates to the probable maximum flood (PMF) hydrologic model and development of the breach analysis for Mitchell Lake Dam under existing conditions. The purpose of the report is to determine the hazard classification for the existing structure in order to establish design criteria for preliminary design of modifications to the dam.

Note that elevations in this report are provided in feet above NAVD88. References to left and right are assuming the observer is facing downstream. All analysis in this report has been performed in accordance with *Hydrologic and Hydraulic Guidelines for Dams in Texas* by the Texas Commission on Environmental Quality (TCEQ) [4] which regulates dam safety in Texas.

## 1.1 DAM DESCRIPTION

Mitchell Lake Dam (TX01453) is located in south San Antonio, Texas in Bexar County. The dam was originally constructed in 1901 and consists of an earthen embankment and a principal spillway at the left abutment. The embankment is approximately 3,200 feet long with a maximum height of approximately 10 feet. The crest width is approximately 15 feet with side slopes ranging from approximately 2:1 (H:V) to 3:1. The crest elevation varies between approximately 526 feet and 528 feet. This study assumes an effective crest elevation of 528.0 feet.

The existing service spillway consists of a 55-foot long concrete gravity structure with eight 36-inch diameter gate valves, one of which is partially closed. A ninth gate valves discharges to a 36” RCP discharging to an irrigation canal away from Cottonmouth Creek. Three additional sealed gate valves exist in the dam, which were likely used for the irrigation system. The gate valves appear to be permanently rusted to their current positions and assumed to be fixed (i.e. not adjustable). The maximum normal water surface in Mitchell Lake is set by 8 gate valves in the service spillway with invert elevations at 520.7 feet. Water passing through the gate valves passes through a stone and mortar chute approximately 225 feet in length, terminating in an eroded plunge pool on Cottonmouth Creek, a tributary to the Medina River.

Mitchell Lake is a nationally significant water body as a refuge for migratory shore birds and waterfowl. In 2004, SAWS entered into an operating agreement with the National Audubon Society establishing the Mitchell Lake Audubon Center. A polder complex consisting of several basins is located at the north end of Mitchell Lake.

## 1.2 SIZE CLASSIFICATION

Dams are classified by the TCEQ according to height and maximum storage. Table 1-1 provides the size classification criteria. Classification is based on the larger of the height or maximum storage capacity (storage at the top of dam).

**Table 1-1: TCEQ Dam Size Classifications**

| Size Category | Maximum Storage (acre-feet) | Maximum Height (feet) |
|---|---|---|
| Small | 15 ≤ S < 1,000 or<br>50 ≤ S < 1,000 | 25 ≤ H < 40 or<br>6 ≤ H < 40 |
| Intermediate | 1,000 ≤ S < 50,000 | 40 ≤ H < 100 |
| Large | S ≥ 50,000 | H ≥ 100 |

With a maximum height of approximately 10 feet and a maximum storage of approximately 6,516 acre-feet at elevation 528.0 feet, Mitchell Lake Dam is classified as an intermediate sized structure. To be considered a large dam, the maximum storage would have to increase to at least 50,000 acre-feet or the maximum height would have to increase to at least 100 feet. Therefore, it is unlikely that the intermediate size classification could change in the future due to upgrades or modifications to the dam.

## 1.3 HAZARD CLASSIFICATION

Dams are classified by the potential for loss of human life and/or property damage within the area downstream of the dam. The hazard classification of a dam can be low, significant, or high depending on the potential downstream impacts that could result from failure. Table 1-2 summarizes the classifications.

**Table 1-2: TCEQ Dam Hazard Classifications**

| Hazard Category | Potential Loss of Human Life | Habitable Structures within Inundation Zone | Potential Economic Loss |
|---|---|---|---|
| Low | No loss of human life expected | 0 | Minimal: Farm buildings, limited agricultural improvements, and minor highways |
| Significant | Possible: 1 to 6 lives | 1 or 2 | Appreciable: Isolated homes, secondary highways, minor railroads, and interruption of public utilities |
| High | Expected: 7 or more lives | 3 or more | Excessive: Major public or private facilities, major public utilities, main highways, and major railroads |

Mitchell Lake Dam is currently classified by TCEQ as a low hazard structure. Justification for the current classification is based on review of aerial photography of the downstream area by TCEQ in 2008. Several factors can influence a dam's hazard classification over time. Increased development within the watershed can increase the peak inflow to the lake during the design storm, leading to a higher peak lake level and greater inundation during a potential breach. Development can also occur within the potential breach inundation area, increasing the number of lives at risk or the potential economic damage that could result from a breach. The purpose of this study is to evaluate the hydraulic adequacy and determine the hazard classification of the existing dam based on analysis of a potential breach of the structure.

## 1.4 HYDROLOGIC CRITERIA

Per the TCEQ, a dam is required to safely pass the minimum design flood hydrograph expressed as a percentage of the PMF without failure. For embankment dams, failure is assumed to occur if the reservoir water surface elevation exceeds the lowest elevation of the earthen embankment. For an intermediate size, low hazard dam, the minimum design flood is determined by interpolation between 25 and 50 percent of the PMF. With a maximum height of approximately 10 feet and a maximum storage volume of approximately 6,516 acre-feet, the minimum requirement is that the dam be able to safely pass 28 percent of the PMF under the existing classification.

For an intermediate size, significant hazard dam, the minimum design flood is determined by interpolation between 50 and 75 percent of the PMF. When the hazard classification is undetermined, the design storm used in a breach analysis should be at least as high a percentage of the PMF such that a higher percentage assumption would not increase the dam's hazard classification. Because SAWS owns much of the property between Mitchell Lake Dam and the Medina River, the likelihood of the dam being classified as high hazard is considered low. Therefore, the breach analysis assumes that Mitchell Lake Dam is a significant hazard structure for selecting the design storm event. In this case, the minimum design storm is 53 percent of the PMF.

The hazard classification of the dam is subject to change, particularly if modifications to the dam increase the height and/or maximum storage capacity. SAWS may select hydrologic design criteria for modifications to Mitchell Lake Dam that are more conservative than minimum TCEQ requirements in anticipation of a future escalation of the dam's hazard classification or increased development upstream.

## 1.5 PREVIOUS STUDIES

The most recent inspection of Mitchell Lake Dam was conducted by TCEQ in May 2008 [3]. Mitchell Lake Dam had previously been inspected five times (1970, 1975, 1977, 1981, and 2005). In their report, TCEQ noted that the latest hydrologic study for the dam was prepared in 1975, which indicated that the dam can pass 40 percent of the PMF. In response to TCEQ's recommendations, SAWS contracted with Arcadis U.S., Inc. to evaluate the dam using modern engineering methods. The final report was provided in January 2015 [1]. The results of Arcadis' 2015 study indicate that the existing spillway is not adequate to pass 28 percent of the PMF. The primary spillway is able to pass 26 percent of the PMF prior flow reaching a depression in the top of the dam at an elevation of 527 feet.

# 2.0 HYDROLOGY

## 2.1 ELEVATION-CAPACITY CURVE

Table 2-1 presents the elevation-capacity curve for Mitchell Lake Dam. Storage for elevations below 518 is based on bathymetric data collected by Vickrey and Associates Inc. under contract with APAI in January 2018. Storage for elevations between elevations 518 and 531 feet were estimated from Lidar topography provided by Bexar County. Elevations above 531 feet were extrapolated based on the shape of the storage curve.

**Table 2-1: Elevation-Capacity Curve**

| Elevation (ft-NAVD88) | Storage (acre-feet) |
|---|---|
| 514 | 0 |
| 515 | 46 |
| 516 | 214 |
| 517 | 482 |
| 518 | 648 |
| 519 | 835 |
| 520 | 1,261 |
| 521 | 1,732 |
| 522 | 2,240 |
| 523 | 2,767 |
| 524 | 3,318 |
| 525 | 3,892 |
| 526 | 4,506 |

| Elevation (ft-NAVD88) | Storage (acre-feet) |
|---|---|
| 527 | 5,832 |
| 528 | 6,516 |
| 529 | 7,273 |
| 530 | 8,017 |
| 531 | 8,787 |
| 532 | 9,516 |
| 533 | 10,259 |
| 534 | 11,001 |
| 535 | 11,744 |
| 536 | 12,487 |
| 538 | 13,973 |
| 540 | 15,459 |

## 2.2 SPILLWAY RATING CURVE

The primary spillway at Mitchell Lake Dam is 55 feet wide, with eight 36-inch-diameter gate valves (one of which is partially closed), which outfall to a steep 250-foot-long stone and mortar outfall channel on the eastern end of the dam. The invert elevation of the gates is 520.7 feet. The gate valves are welded open, except one noted as partially closed per a site visit in November 2017. The 2008 Inspection reported noted that all eight gates were open, and appeared to be in fair shape, however the gate control valves appeared as if they had not been operated in some time. A ninth gate exists, which outfalls to a 36-inch pipe discharging to an irrigation canal that diverts water away from Cottonmouth Creek. It is therefore not considered in the development of the spillway rating curve.

Table 2-2 presents the existing spillway rating curve. The rating curve is based on orifice flow through the circular gates and weir flow over the spillway bulkhead and catwalk. Note that the hydrologic and hydraulic models assume an infinitely high embankment. Flows over the top of the dam are not included in the discharge rating curve.

**Table 2-2: Spillway Rating Curve**

| Elevation (ft-NAVD88) | Discharge (cfs) | Elevation (ft-NAVD88) | Discharge (cfs) |
|---|---|---|---|
| 520.7 | 0 | 529.0 | 1906 |
| 521.0 | 11 | 530.0 | 2452 |
| 522.0 | 100 | 531.0 | 3092 |
| 523.0 | 260 | 532.0 | 3791 |
| 524.0 | 490 | 533.0 | 4544 |
| 525.0 | 690 | 534.0 | 5346 |
| 526.0 | 770 | 536.0 | 7088 |
| 527.0 | 1013 | 538.0 | 8997 |
| 528.0 | 1418 | 540.0 | 11061 |

## 2.3 HYDROLOGIC MODEL

The hydrologic model was developed by Arcadis as a part of their Hydrologic and Hydraulic Analysis report dated January 6, 2015. The model was reviewed and updated using HEC-HMS version 4.2.1 [5] and in accordance with TCEQ guidelines for estimation of the PMF. The model used the NRCS Curve Number method for estimating precipitation losses and unit hydrograph transformation to determine runoff hydrographs from individual subbasins. The Muskingum-Cunge method was used for reach routing. The model also included routing through three larger lakes upstream of Mitchell Lake: Ballasetal Lake, Timberlodge Lake, and Canvasback Lake. Digital files used to develop the model (e.g. shapefiles of subbasins or longest flow paths) or detailed calculations (e.g. lag times or curve number calculations) were not provided. The following revisions were made to the Arcadis hydrologic model for use in this study:

- The storage curve for Mitchell Lake was updated using the 2018 bathymetric survey, which was supplemented with Bexar County LIDAR data for elevations above normal pool as described in Section 2.1.

- Updated PMP rainfall values using the TCEQ PMP GIS Tool and the PMF distributions as described in TCEQ's Hydrologic and Hydraulic Guidelines for Dams in Texas (January 2007) and in Section 2.4.
- The principal spillway rating table was revised as described in Section 2.2.
- The outlet for the "Dam Top" was removed to exclude flows over the dam crest. Only flows through principal spillway were modeled.
- The model time step was revised from 30 minutes to 1 minute.
- Lag times were revised to have a minimum value of 5 minutes.
- Reach routes with a time of zero minutes were converted to element connections.
- The curve numbers assigned to each basin were assumed to be Antecedent Runoff Condition (ARC) II and were adjusted up to ARC III per TCEQ guidelines.
- Reach "R1480" was changed from 7 feet to 50 feet to eliminate a model reach routing error.
- The starting water surface elevation was set at the invert of the gates at elevation 520.7 feet.

## 2.4 PROBABLE MAXIMUM PRECIPITATION

Probable Maximum Precipitation (PMP) was estimated for the contributing basin using the TCEQ PMP geoprocessing service. PMP depths are summarized by storm type and duration in Table 2-3. The maximum depth for each duration was used to develop the PMF. The total precipitation for each PMP storm duration was temporally distributed per TCEQ guidelines to obtain the hyetograph for each storm event.

**Table 2-3: Probable Maximum Precipitation Summary**

| Storm Type | 1-hour | 2-hour | 3-hour | 6-hour | 12-hour | 24-hour | 48-hour | 72-hour |
|---|---|---|---|---|---|---|---|---|
| Local | 11.6 | 18.3 | 21.6 | 26.8 | 35.5 | 42.7 | 45.8 | 45.8 |
| General | 6.6 | 9.7 | 14.0 | 21.2 | 25.3 | 28.1 | 32.1 | 33.9 |
| Tropical | 13.6 | 18.0 | 20.3 | 24.1 | 31.5 | 37.8 | 45.8 | 45.8 |
| **Maximum** | **13.6** | **18.3** | **21.6** | **26.8** | **35.5** | **42.7** | **45.8** | **45.8** |

## 2.5 RESULTS

The PMP event with durations of 1, 2, 3, 6, 12, 24, 48, and 72 hours were evaluated in the HEC-HMS model to determine peak inflow and peak lake level. The 24-hour event was determined to be the critical event as it caused the greatest peak water surface elevation in Mitchell Lake. Therefore, the 24-hour PMP event is considered the PMF. The design storm (53% PMF) and barely overtopping storm (35% PMF) were also evaluated in the hydrologic model. Table 2-4 summarizes the hydrologic model results.

**Table 2-4: Hydrologic Model Results**

| Scenario | Duration (hours) | Ratio | Peak Inflow (cfs) | Peak Discharge (cfs) | Peak Storage (ac-ft) | Peak Elevation (ft) |
|---|---|---|---|---|---|---|
| 1-Hour PMP | 1 | 100% | 31,863 | 1,799 | 7,105 | 528.8 |
| 2-Hour PMP | 2 | 100% | 40,159 | 3,338 | 9,044 | 531.4 |
| 3-Hour PMP | 3 | 100% | 35,739 | 4,620 | 10,329 | 533.1 |
| 6-Hour PMP | 6 | 100% | 36,583 | 6,392 | 11,894 | 535.2 |
| 12-Hour PMP | 12 | 100% | 36,665 | 7,603 | 12,888 | 536.5 |
| 24-Hour PMP (PMF) | 24 | 100% | 26,247 | 9,829 | 14,572 | 538.8 |
| 48-Hour PMP | 48 | 100% | 15,054 | 9,516 | 14,347 | 538.5 |
| 72-Hour PMP | 72 | 100% | 10,038 | 7,699 | 12,962 | 536.6 |
| Barely Overtopping | 24 | 35% | 9,029 | 1,429 | 6,533 | 528.0 |
| Minimum Design | 24 | 53% | 13,821 | 3,215 | 8,915 | 531.2 |

# 3.0 HYDRAULIC MODEL DEVELOPMENT

## 3.1 HYDRAULIC MODEL LAYOUT

The dam breach analysis was performed using USACE HEC-RAS Version 5.0.3 hydraulic modeling software [6]. The model uses a two-dimensional flow mesh to represent the areas downstream of Mitchell Lake Dam. A two-dimensional model was selected because it can explicitly account for highly-dynamic, non-streamwise flows and can better represent shallow flow through wide floodplain regions. These flow conditions are frequently encountered in dam breaches. The parameters selected for use in the hydraulic model include 150-foot grid cell spacing, 5 second time step, and full momentum equations.

The mesh in the model covers an area of approximately 5.5 square miles and consists of approximately 7,600 cells. The upstream boundary of the flow area is the railroad crossing at Leon Creek. The downstream boundary of the model is approximately at IH-37. The downstream boundary condition was assigned a normal flow depth with the friction slope equal to the approximate bed slope in the Medina River.

## 3.2 SPATIALLY-VARYING ROUGHNESS

Spatially-varying roughness values for the model were developed from the 2011 National Land Cover Database (NLCD) [2]. Land cover classifications were correlated with Manning's roughness factors using aerial imagery and engineering judgement. Manning's n-values in two-dimensional flow models are generally lower than those used in one-dimensional models because 2D models can explicitly account for losses normally incorporated into frictional losses in 1D models (e.g. turbulence, eddies). Table 3-1 shows the Manning's n-values used in the hydraulic model.

**Table 3-1: Spatially-Varying Roughness Values**

| NLCD Designation | Grid Code | n-Value |
|---|---|---|
| Barren Land | 31 | 0.02 |
| Cultivated Crops | 82 | 0.04 |
| Deciduous Forest | 41 | 0.08 |
| Developed, High Intensity | 24 | 0.40 |
| Developed, Medium Intensity | 23 | 0.20 |
| Developed, Low Intensity | 22 | 0.10 |
| Developed, Open Space | 21 | 0.04 |
| Emergent Herbaceous Wetlands | 95 | 0.05 |

| NLCD Designation | Grid Code | n-Value |
|---|---|---|
| Evergreen Forest | 42 | 0.08 |
| Grassland/Herbaceous | 71 | 0.04 |
| Mixed Forest | 43 | 0.08 |
| Open Water | 11 | 0.02 |
| Pasture/Hay | 81 | 0.04 |
| Shrub/Scrub | 52 | 0.06 |
| Woody Wetlands | 90 | 0.07 |

## 3.3 CHANNEL CROSSINGS

Three crossings are located within the model area including one private road crossing Cottonmouth Creek, and two highway crossings of the Medina River (US-281 and South Flores Road). HEC-RAS 5.0.3 does not have an explicit routine for modeling bridge hydraulics in two-dimensional flow. The options for modeling a bridge include modeling only the embankment and abutments as weirs or modeling the bridge opening as a culvert or as an open gate. The dirt road crossing is known to be a four-barrel, 54-inch corrugated metal pipe culvert. This was added to the model using the culvert routine. It was assumed that the bridge piers and bridge deck at US-281 and South Flores Road have relatively little impact on the hydraulics of a breach wave, therefore the piers or bridge superstructures were not added to the model.

## 3.4 BOUNDARY CONDITIONS

Leon Creek and the Medina River confluence south of the Mitchell Lake dam. The dam outlets to Cottonmouth Creek, which joins the Medina River approximately 9,500 feet downstream of Pleasanton Road. The upstream boundary condition for the two-dimensional flow area is located approximately 5,000 feet upstream of the confluence of Leon Creek and the Medina River, near the railroad crossing at Leon Creek. The downstream boundary of the flow is located just west of IH-37. The boundary is assumed to have a normal flow depth with a friction slope equal to the upstream channel bed slope of approximately 0.006 ft/ft.

# 4.0 DAM BREACH ANALYSIS

## 4.1 BREACH SCENARIOS

TCEQ requires three breach scenarios be modeled for a dam which is hydraulically inadequate: sunny day breach, the barely overtopping breach, and the design flood breach. The sunny day breach is defined as a breach of the dam while the reservoir is at its maximum normal operating pool elevation. This scenario represents a non-storm breach situation. The design flood breach is defined as a breach of the dam at the peak water surface elevation during the full design flood (53% of the PMF for Mitchell Lake Dam). The barely overtopping breach describes a scenario in which the inflow design flood is set to the percentage of the PMF wherein the peak water surface elevation equals the top of dam elevation. In this case, the 35% PMF scenarios results in a lake elevation of 528 feet. For each scenario, a model was run assuming the left side of the dam breaches and another model was run assuming the right side of the dam breaches.

## 4.2 DOWNSTREAM FLOW CONDITIONS

For the hydrologic scenarios, the upstream boundary is assumed to have a constant inflow of 850 cfs at Leon Creek and 850 cfs at the Medina River prior to and during the breach of the Mitchell Lake Dam. This inflow was estimated to be the flow rate required for Leon Creek and the Medina River to be flowing at bankfull prior to a breach occurring. This assumption is intended to generate conservative initial conditions for the breach analysis. No baseflow was assumed for the sunny day scenario.

## 4.3 BREACH PARAMETERS

Two locations at the maximum section of the embankment were selected for the breach analysis. Breach characteristics were estimated per TCEQ's *Hydrologic and Hydraulic Guidelines for Dams in Texas*. In the sunny day, barely overtopping, and design flood scenarios, it was assumed that the breach height was equal to the top of dam minus the downstream toe elevation. In the sunny day scenario, the storage was assumed to be the volume of water at the maximum normal operating pool elevation. For the design storm, the storage at the top of dam elevation was used. The sunny day breach was assumed to occur due to piping since the peak water surface elevation was below the top of dam. Table 4-1 shows the breach parameters used in the analysis. These parameters were input into the HEC-RAS storage area connection breach module. For each scenario, a left breach location and a right breach location was modeled.

**Table 4-1: Mitchell Lake Dam Breach Parameters**

| Breach Scenario | Breach Height (ft) | Final Bottom Width (ft) | Formation Time (hours) |
|---|---|---|---|
| Sunny Day – Left Breach | 22.7 | 68.2 | 0.13 |
| Sunny Day – Right Breach | 6.7 | 20.2 | 0.04 |
| Barely Overtopping – Left Breach | 30 | 90 | 0.17 |
| Barely Overtopping- Right Breach | 14 | 42 | 0.08 |
| Design Flood – Left Breach | 30 | 100 | 0.18 |
| Design Flood – Right Breach | 14 | 52 | 0.10 |

## 4.4 BREACH ANALYSIS RESULTS

The maps for each breach scenario (Sunny Day, Barely Overtopping, and Design Storm) are included in Appendix A. The inundation areas shown represent a geometric union of the inundation zones for the left and right breach location scenarios. The breach scenarios impact two roadways and two habitable structures downstream of the dam. Detailed results of the breach analysis are shown in Table 4-2. If no value was shown, the structure was not impacted for that event. Pleasanton Road does not cross the channel but passes near the dam and runs parallel to the breach wave flow direction. Thus, the road is overtopped in several locations near the dam, and the maximum depth of overtopping is shown in the tables.

**Table 4-2: Breach Analysis Results (Left Side)**

| | | Sunny Breach Left | | | Barely Overtopping Breach Left | | | | Design Storm Breach Left | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Structure | Lowest Elev (ft) | Arrival Time (hours) | Elev (ft) | Depth | Non-Breach Elev (ft) | Arrival Time (hours) | Elev (ft) | Depth | Non-Breach Elev (ft) | Arrival Time (hours) | Elev (ft) | Depth |
| Struct. 1 | 513.5 | - | - | - | - | 0.3 | 515.4 | 1.9 | - | 0.3 | 515.8 | 2.3 |
| Struct. 2 | 514.2 | - | - | - | - | 0.3 | 515.2 | 1.0 | - | 0.3 | 515.6 | 1.4 |
| Pleasanton Rd | 510.0 | - | - | - | - | Varies | Varies | 2.0 | - | Varies | Varies | 2.5 |
| S Flores Rd | 449.3 | 3.0 | 449.4 | 0.1 | 447.1 | 1.5 | 458.7 | 9.4 | 450.5 | 1.3 | 462.2 | 12.9 |

**Table 4-3: Breach Analysis Results (Right Side)**

| | | Sunny Breach Right | | | Barely Overtopping Breach Right | | | | Design Storm Breach Right | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Structure | Lowest Elev (ft) | Arrival Time (hours) | Elev (ft) | Depth | Non-Breach Elev (ft) | Arrival Time (hours) | Elev (ft) | Depth | Non-Breach Elev (ft) | Arrival Time (hours) | Elev (ft) | Depth |
| Struct. 1 | 513.5 | - | - | - | - | 0.5 | 515.0 | 1.5 | - | 0.5 | 515.2 | 1.7 |
| Struct. 2 | 514.2 | - | - | - | - | 0.5 | 515.0 | 0.8 | - | 0.5 | 515.2 | 1.0 |
| Pleasanton Rd | 510.0 | Varies | Varies | 0.1 | - | Varies | Varies | 1.5 | - | Varies | Varies | 2.0 |
| S Flores Rd | 449.3 | 3.0 | 445.3 | - | 447.1 | 2.0 | 452.9 | 3.6 | 450.5 | 1.3 | 455.6 | 6.3 |

# 5.0 SUMMARY AND CONCLUSIONS

Under each of the scenarios analyzed, the flood wave resulting from a breach at Mitchell Lake would spread across the wide, flat area immediately downstream of the dam before quickly attenuating within the Medina River channel and floodplain. The breach analysis indicates that two habitable structures would experience inundation of greater than one foot in the event of a breach. In addition, both Pleasanton Road and South Flores Road would be overtopped by a breach. Both roads are classified as major collectors by Texas Department of Transportation. Finally, a breach of Mitchell Lake would likely require significant environmental remediation due to the settled wastewater sludge within the lake. Per 30 TAC §299.14, the potential breach impacts from Mitchell Lake Dam are consistent with a significant hazard classification, including appreciable economic loss in a primarily rural area where failure may cause damage to isolate homes, secondary highways, and interruption of service of public utilities.

Mitchell Lake Dam is currently classified by TCEQ as a low hazard structure. Modifications to the dam will require TCEQ review and approval of hydrologic and hydraulic analyses that serve as the basis of design for the modifications. Based on the results of this breach study, such a review would include changing the hazard classification of the dam from low to significant. This change may affect the dam's compliance to certain dam safety regulations. The primary implications associated with a change from low to significant hazard are summarized below:

- Minimum hydrologic criteria for dams are based on hazard classification. Per the results of the PMF analysis, Mitchell Lake Dam can safely pass approximately 35% of the PMF. As an intermediate size, significant hazard structure, the dam would be required to safely pass a minimum of 53% of the PMF. Therefore, Mitchell Lake Dam is considered hydraulically inadequate under current conditions.

- The owner of a significant hazard dam is required to prepare an emergency action plan (EAP) and submit the plan to TCEQ. EAPs should be reviewed and, if necessary, updated on an annual basis. A table top exercise of the EAP should be performed every five years.

- During construction of modifications, significant hazard dams have more reporting requirements to TCEQ than low hazard structures.

- Significant hazard dams are subject to periodic inspections by TCEQ while low hazard structures are generally not included in the agency's inspection program.

Note that a dam's hazard classification is not a static determination, and several factors can influence this classification over time. Increased development within the watershed can increase the peak inflow to the lake during the design storm, leading to a higher peak lake level and greater inundation during a potential breach. Development can also occur within the potential breach inundation area, increasing the number of lives at risk or the potential economic damage that could result from a breach. When selecting hydrologic design criteria for long-term modification of a dam, the owner should consider potential future conditions that may affect the dam's hazard classification to ensure that the dam remains in compliance with state regulations over the design life of the structure.

# 6.0 REFERENCES


1. Arcadis. *Hydrologic and Hydraulic Analysis. Mitchell Lake Dam, Cottonmouth Creek, Bexar County, Texas.* January 6, 2015.

2. Multi-Resolution Land Characteristics Consortium. "National Land Cover Dataset 2011." USGS Seamless Data Warehouse. <http://seamless.usgs.gove/nlcd.php>.

3. Samuelson, Warren. (Texas Commission on Environmental Quality). Letter to: Steve Clouse (Production and Treatment Operations, San Antonio Water System). *Mitchell Lake Dam Inspection, Inventory No.: TX01453, Bexar County, Texas.* July 8, 2008.

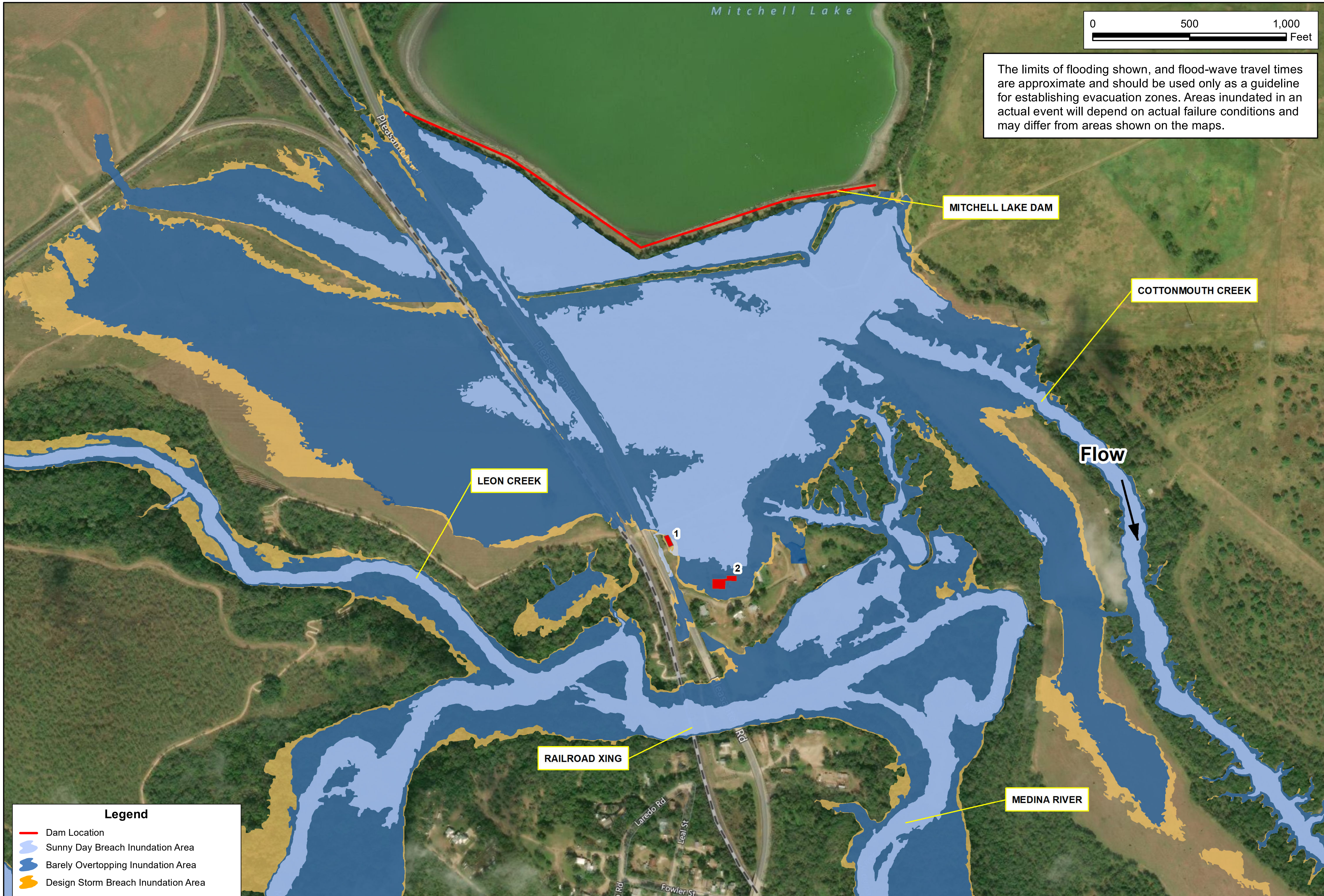
4. Texas Commission on Environmental Quality (TCEQ), Dam Safety Program: *Hydrologic and Hydraulic Guidelines for Dams in Texas*, January 2007.

5. U.S. Army Corps of Engineers, Hydrologic Engineering Center: *Hydrologic Modeling System HEC-HMS - User's Manual Version 4.2*, Davis, California, August 2016.

6. U.S. Army Corps of Engineers, Hydrologic Engineering Center: *River Analysis System - User's Manual Version 5.0*, Davis, California, February 2016.

# APPENDIX A

# BREACH INUNDATION MAPS




| | |
|---|---|
| FN PROJECT NO. | PLU17623 |
| DATE CREATED | Date: November 2018 |
| DATUM & COORDINATE SYSTEM | NAD83 State Plane (feet) Texas S Central |
| FILE NAME | Name: Figure1_Breach_Scenarios |
| PREPARED BY | JLJ |

N E S W

# MITCHELL LAKE DAM
# BREACH INUNDATION


FREESE AND NICHOLS, INC.
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P: 210-298-3800


**FIGURE**

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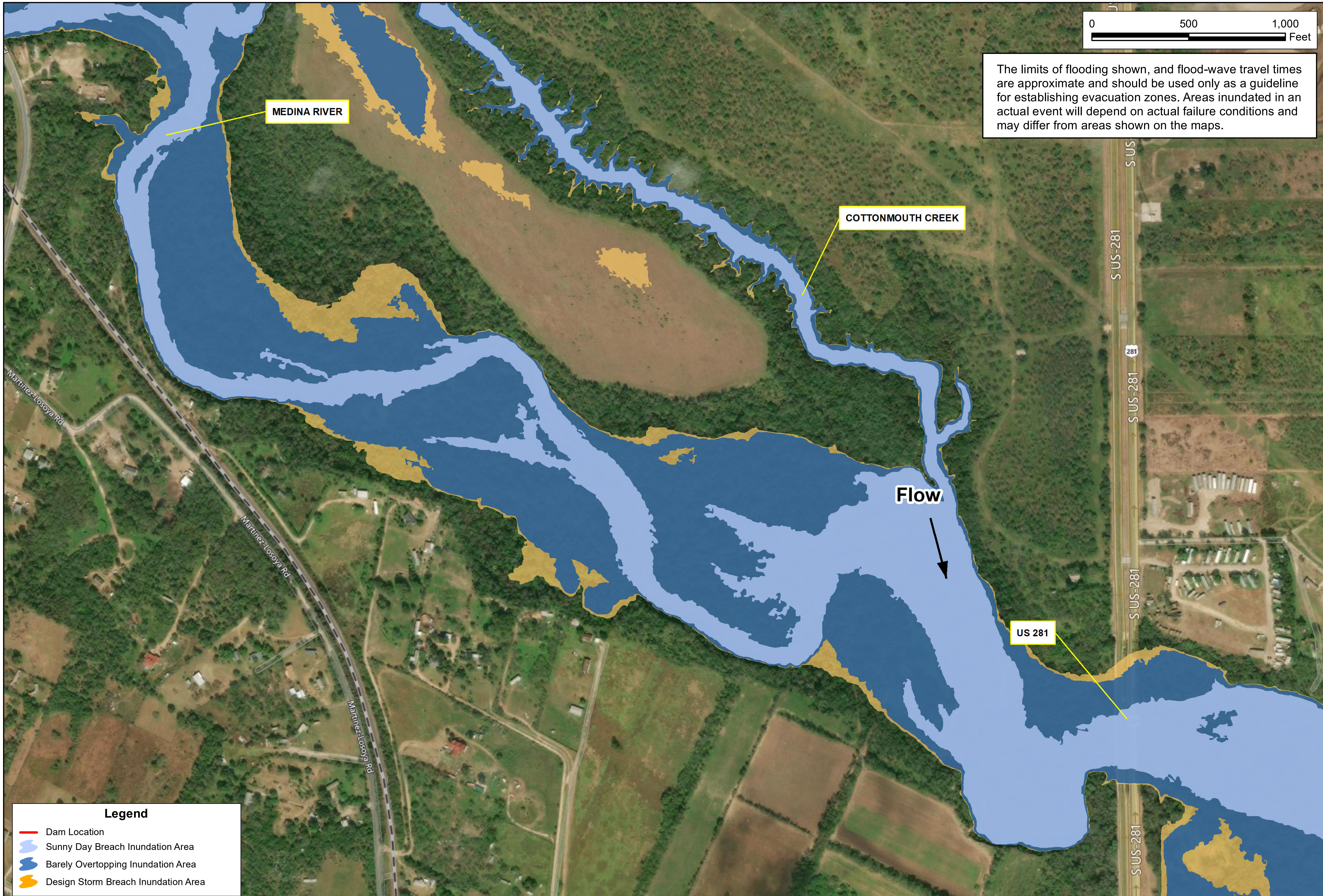


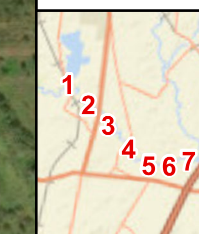


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| DATUM & COORDINATE SYSTEM | NAD83 State Plane (feet) Texas S Central |
| FILE NAME | Name: Figure1_Breach_Scenarios |
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# MITCHELL LAKE DAM

# BREACH INUNDATION


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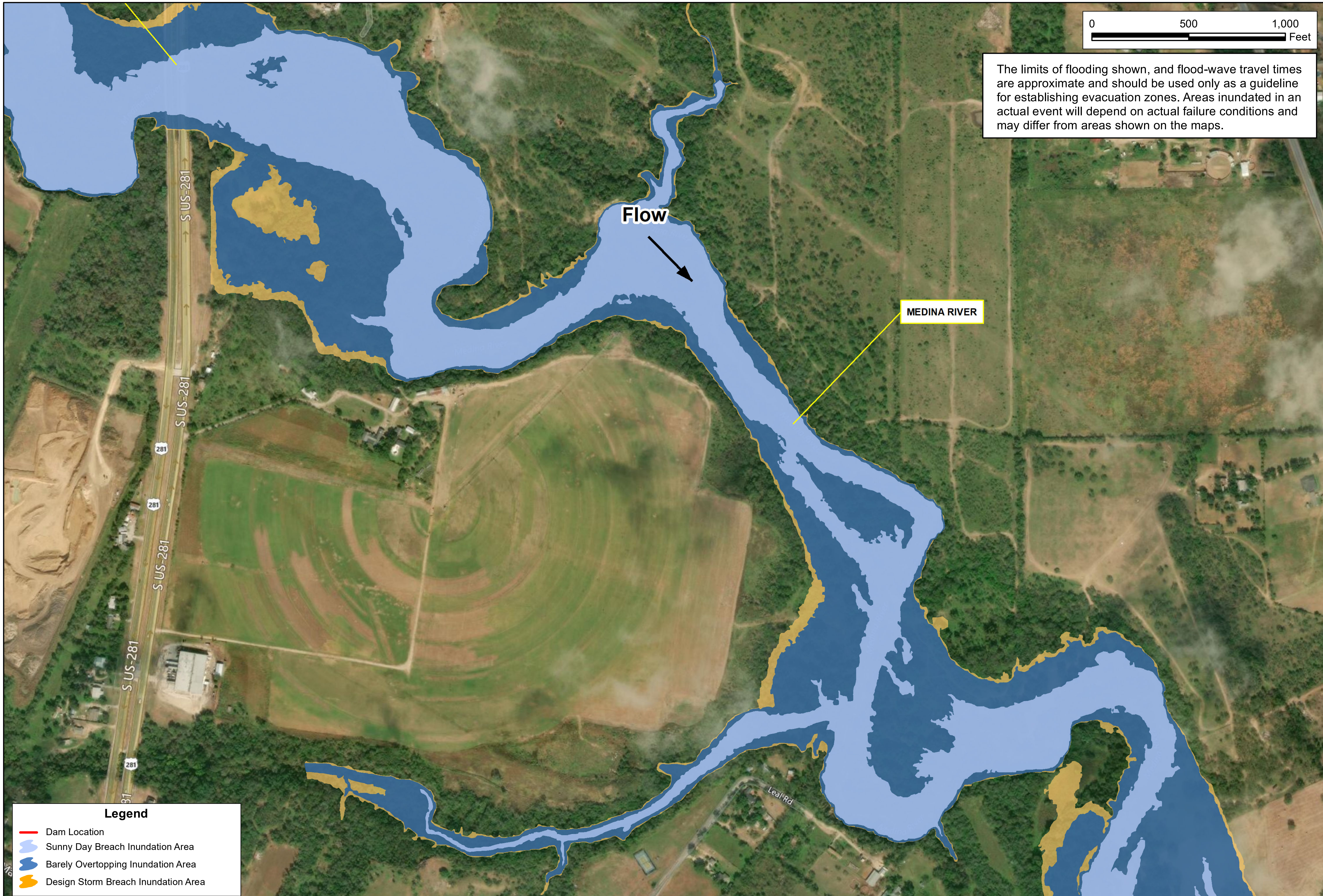
FIGURE

2

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FILE NAME Name: Figure1_Breach_Scenarios

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# MITCHELL LAKE DAM
# BREACH INUNDATION

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**FIGURE**

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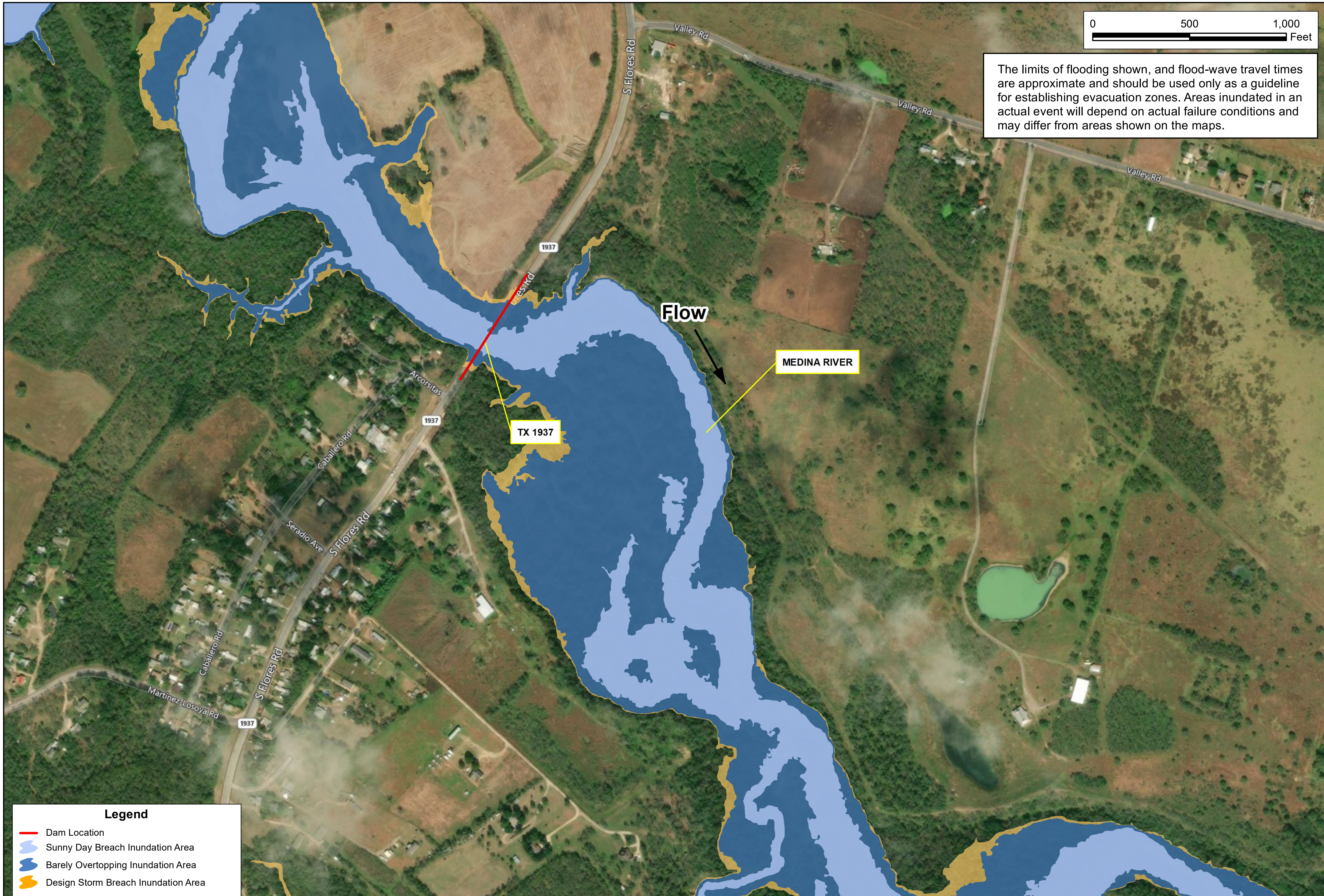


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| FN PROJECT NO. | PLU17623 |
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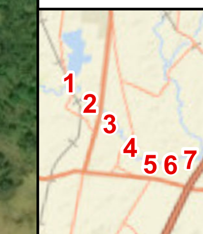


# MITCHELL LAKE DAM
# BREACH INUNDATION


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**FIGURE**

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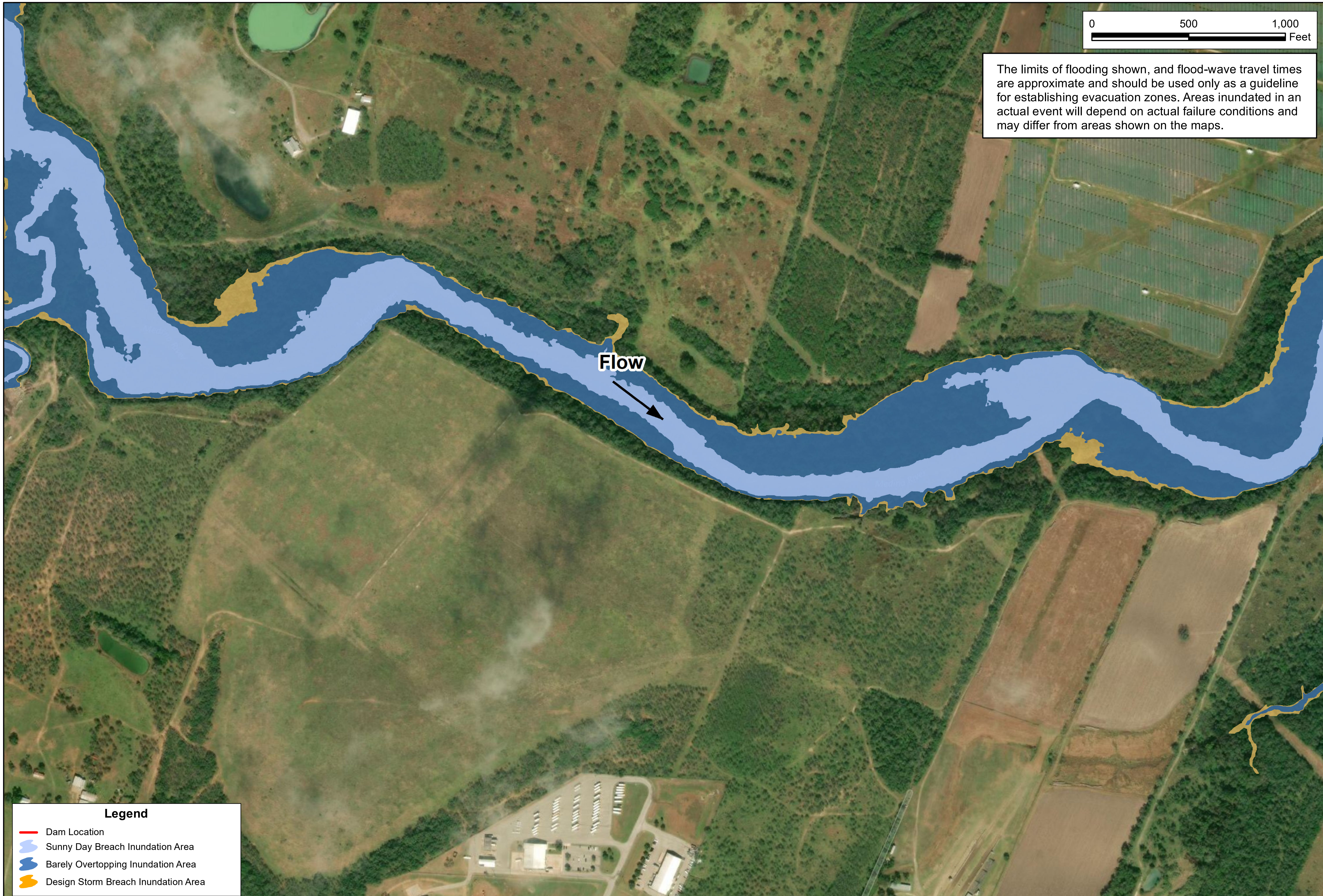


FN PROJECT NO. PLU17623

DATE CREATED Date: November 2018

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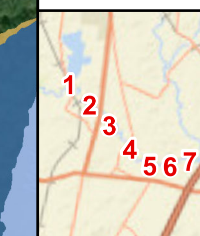


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FIGURE

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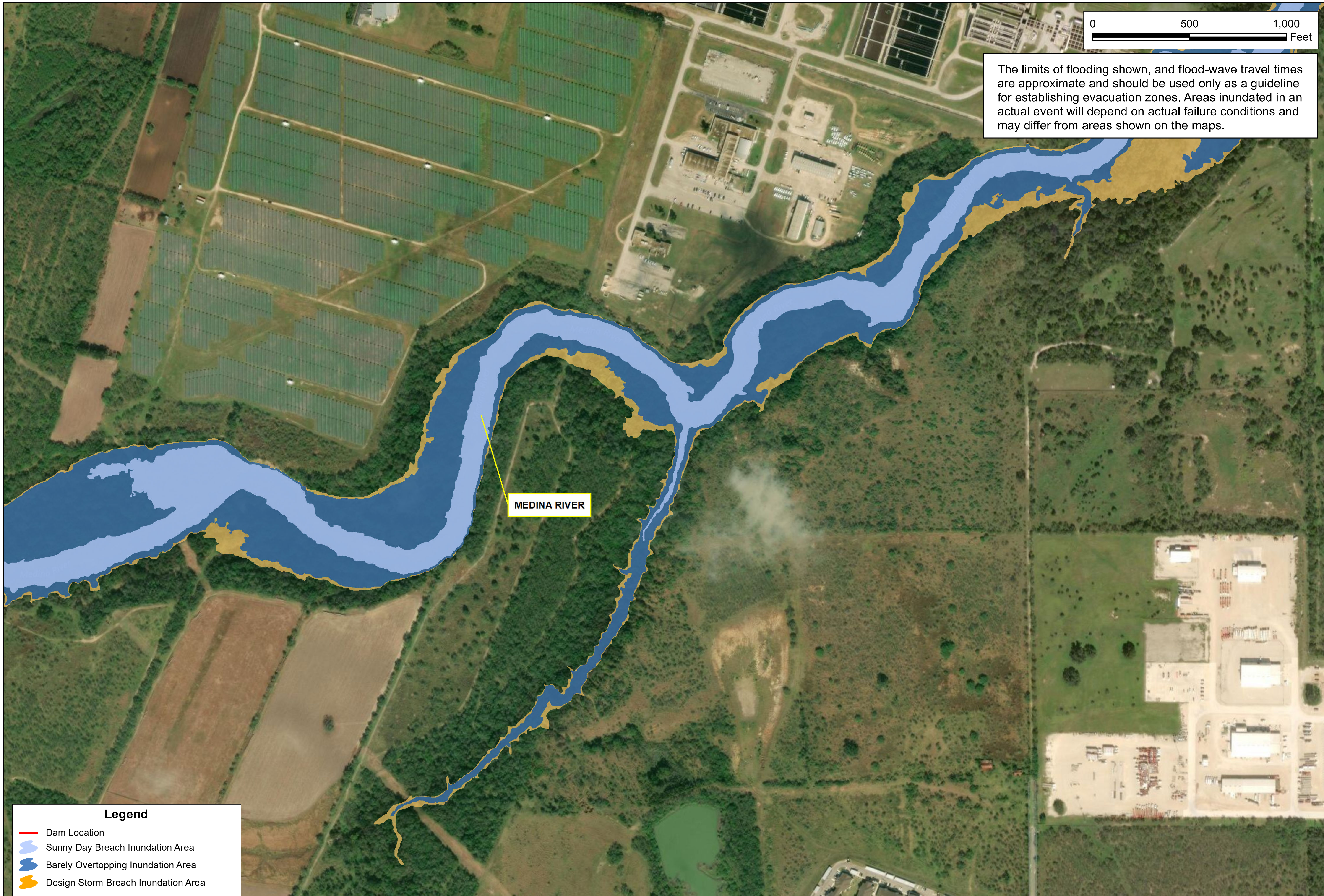


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# MITCHELL LAKE DAM

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FIGURE

6

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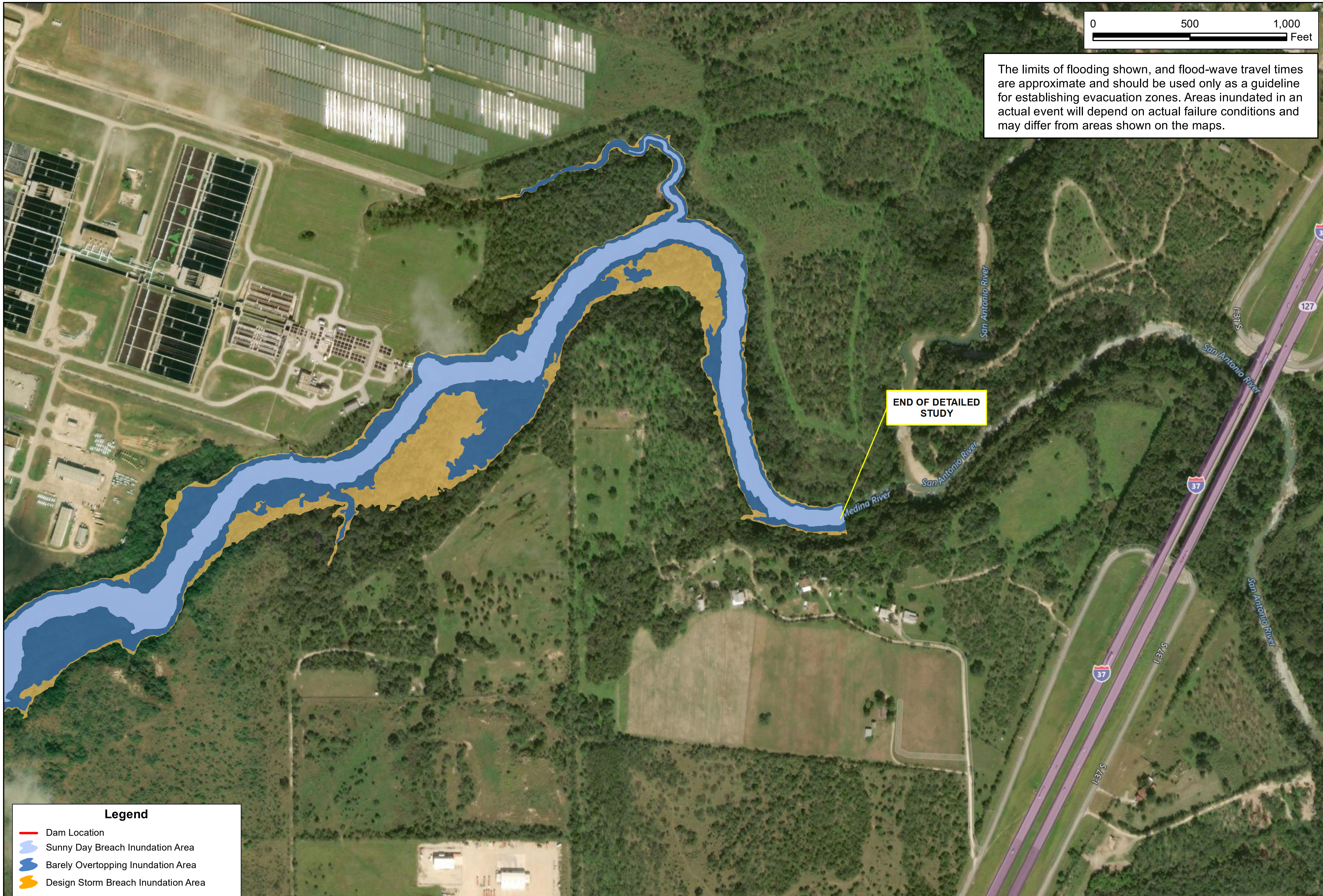


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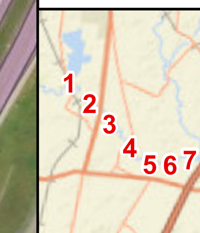


# MITCHELL LAKE DAM
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FIGURE
7

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**TO:** Tim Noack, P.E.

**CC:** Ryan Pierce, P.E.

**FROM:** Grady Hillhouse, P.E.

**SUBJECT:** PMF Update and Breach Analysis – Comment Responses

**DATE:** February 13, 2019

**PROJECT:** Mitchell Lake Dam (PLU17623)

---

Thank you for your comments on the draft PMF Update and Breach Analysis for the Mitchell Lake Dam project. The following table presents our responses your comments.

| No. | SAWS Comment | FNI Response |
|---|---|---|
| 1. | In the first sentence under Section 1.1 Dam Description, delete the unnecessary word "in. | The word has been deleted. |
| 2. | In first sentence of paragraph 2 of Section 1.1, add the word "a" before 55-foot. | The word has been added. |
| 3. | SAWS has always used 520.4 as the invert elevation for the 8 gate valves in the service spillway. Where did the 520.7' elevation come from. | The value of 520.7 feet above NAVD88 was based on the Vickrey survey conducted as a part of the project in 2017. |
| 4. | Treated effluent from the Leon Creek Recycling Center is not piped directly to the polders. It is released to Mitchell Lake first. Water transferred to the polders is a mixture of runoff and effluent. | This statement has been removed. |
| 5. | There is an inconsistency between the maximum storage shown in Section 1.2 of 6,558 acre-feet and the elevation storage curve previously provided. The previous curve shows storage as 6515.6 at 528. | The 6,558 acre-feet has been adjusted to 6,516 acre-feet to be consistent with the elevation-storage curve provided. |
| 6. | The maximum storage elevation should be 528.0. | The elevation has been changed from 558.0 feet to 528.0 feet. |
| 7. | In Section 1.4 and Table 2-1, the maximum storage volume is also referencing the wrong value of 6,558 acre-feet. | The 6,558 acre-feet has been adjusted to 6,516 acre-feet to be consistent with the elevation-storage curve provided. |
| 8. | In Section 2.2, transpose Lake Mitchell to Mitchell Lake Dam. | The sentence has been adjusted to say Mitchell Lake Dam. |
| 9. | In Section 2.2, the invert elevation of the gate is 520.73. See comment 2.3. | See response to comment 3. |
| 10. | It is unnecessary to assume the gates are permanently rusted open as the valves are welded in the open position. | The assumption has been removed and the sentence has been adjusted to state that the gates are welded open. |

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|---|---|---|
| 11. | In Section 2.3 the larger lake names are incorrect. The correct names from north to south are Ballasetal Lake, Timberlodge Lake, Canvbasback Lake. | The lake names have been corrected. |
| 12. | In Section 2.3, transpose Lake Mitchell to Mitchell Lake Dam. | The sentence has been adjusted to say Mitchell Lake Dam. |
| 13. | At our 9/4/18 Monthly Progress Meeting, Mr. Clouse asked for some details on the Proposed H&H Design Criteria of Intermediate Size/Significant Hazard. His radar went up at the notion of moving from Low to Significant Hazard.<br><br>To help us explain this to our executives, we'd like the document to contain a little more explanation and justification of the Significant classification, along with some discussion of the implications. Basically, we'd like a narrative version of the verbal explanation provided that day. | Further explanation and justification of the hazard classification determination has been provided in Section 5.0 Summary and Conclusions. |