

# PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT TECHNICAL PROCEDURE

**POLICY NO.:** Technical Procedure TECH-110

**EFFECTIVE DATE:** August 27, 2014  
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**POLICY TITLE:** Flood Response Guidelines and Field Manual

**POLICY:** Responding to flooding events is a critical function of the District. It is important to respond to flooding events in an organized and consistent way, and to be as prepared as possible before a flood event occurs.

**PURPOSE:** This Flood Response Guidelines SOP and the accompanying Flood Response Field Manual are designed to promote efficient, timely, effective, and accurate responses to flooding events throughout Pima County. This SOP addresses the appropriate emergency response based on the severity of the flooding, emergency coordination, flood documentation, and flood safety. The SOP and accompanying manual are not intended to be used as a public information handout, but rather as tools, outlining the proper investigative techniques.

**PROCEDURE:**

Flood response can be broken down into three main phases:

- 1) Investigation - Immediate information gathering and assessment. Includes situation reports to emergency management personnel
- 2) Identification - Determination of flood damages found during the investigation phase.
- 3) Mitigation - Correction of problems and repair of damaged infrastructure.

The primary focus of this procedure is the investigation phase. Within the investigation phase, there are a number of types of investigations that District personnel may be called upon to perform.

This procedure is divided into two main parts. The first part covers a broad overview of flood response investigations, including general guidelines for investigations. The second part is a Flood Response Field Manual and is designed to provide more detailed information for investigators on the ground before, during, and after a flood investigation. While the second part is a field manual, it should be read and thoroughly understood by a field investigator prior to going into the field to investigate a flood.

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## **1 Hazards and Safety**

Personal and public safety is the number one priority to consider while investigating a flood and associated flood damage. Flood investigations should be done in teams of two and at least one member of the team should carry a cell phone. The attached Flood Response Manual provides detailed information on safety. You must review this information prior to participating in a flood investigation.

## **2 Types of Investigations**

There are three different types of investigations a hydrologist may be called upon to make with regards to a flood. These are:

- 1) Pre-crest flood investigations
- 2) Post-crest flood investigations, and
- 3) Community response (Post event) investigations.

The type of investigation that may be assigned to the field hydrologist will be dependent upon the duration of the storm/flood, the extent of flood damage, and the warning time (if any), prior to a flood-crest. On minor watercourses, stream gauge information is often non-existent and times of concentration are often too short for staff to reach the scene of the flood prior to, or even immediately following, the crest.

In addition, the level of response may vary based on the impacted watershed and the size of the flood event. The response to flooding on a minor watercourse will likely be different than the response to a large event on a major watercourse. Since events on minor watercourses are likely to result only in post-event investigations, the difference in these types of investigations will be discussed in the post-event section. Pre-crest and post-crest flood response guidelines are assumed to be on major watercourses.

### **2.1 Pre-crest Flood Response**

Since pre-crest flood investigations will occur primarily on large scale events, they are critical to assist the community on where to direct emergency service and maintenance personnel. District staff will be called into the field to be the eyes and ears of the Flood Control District as it assists the Office of Emergency Management (OEM). Staff will be called on to monitor the rainfall, conditions of the watershed, or the stream flow. Staff may also be asked to look at critical infrastructure to verify condition and functionality.

Typical pre flood-crest investigations include the following activities:

- Reporting on rainfall conditions.
- Monitoring changes in water-surface elevations, especially at critical breakout points.
- Reporting the general condition of a watershed (i.e. soil saturation).
- Reporting the amount of flow coming into a watercourse from ungauged watersheds.
- Tracking the flood crest.
- Monitoring the conditions around structures or embankments which may be subject to damage.

For the most part, the field hydrologist should not be meeting with residents regarding individual flooding problems. Contact with the public during pre-crest investigations should be kept to a minimum, in that the degree of flood warning and possible disaster assistance will be continually

changing. All flood warning and emergency information will be made to the public via radio and television broadcasts by authorities. The OEM is responsible for sending emergency responders into areas that need to be evacuated. In most situations field staff will not have the complete picture from which to project any forecasts. Forecasting conditions to the general public shall not be done by field staff.

Please bear in mind that investigations involving a flow that has yet to peak, or is peaking, can be very fascinating. It is the uniqueness of the event that can lead to field staff taking risks he or she should not take. Remember, personal safety must always be the number one priority.

The excitement of being in an area before or during the time a flood crests can also lead to overestimations as to the depths and velocities that are actually present. It is important for field staff to keep a level head to relay accurate information back to the office so OEM personnel can assess where emergency services are most needed.

## **2.2 Post-crest Flood Response**

Post-crest flood investigations often seamlessly follow pre-crest investigations, but more specifically deal with documenting general flood damages, high-water marks, flow depths, direction of flow, and specific flood damage to regional areas and to public structures (bridges and embankments). The crest of the flood has passed, but the general scope of damage is not yet known. It is not uncommon for significant damage to occur as the flood recedes and exposed banks get undercut. It is the post-crest investigation that is the most essential for the community. Proper documentation of damages can lead to supplemental Federal and State funding assistance. This is especially true if it appears as though a disaster declaration may be enacted.

The primary goal for this type of investigation is good data gathering. Although there is a later section on information gathering, the following procedure should be used for a post flood-crest investigation:

- Use the field log sheets (in the flood investigation clipboards and file boxes) to write down observations. If you are taking notes by using a tape recorder, use the same format shown on the log sheets and transpose the tape notes onto this form. An example of some field notes on a log sheet can be found at the end of the manual.
- Take plenty of photographs. Avoid taking any photo that does not have an object that can be used as a visual reference for scale. See the section on documentation for the appropriate use of a camera.
- Note the direction of flow in flat areas or in confluence areas.
- Use the paint, ribbon, and/or survey lathes to mark high water levels. This will be useful for calibrating hydrologic and hydraulic models, should they occur.
- Document damages to embankments, bank protection, bridges, and other public facilities.
- Make assessments as to the number of flooded residential and business structures within an assigned area. This estimate should include approximate depths of flooding.
- When available, use aerial photographs to document high water marks, and extent of inundation as well as structural flooding.
- Public hazards such as downed electric lines or the smell of escaping gas requires immediate notification. If a phone is available, field staff should dial 911.

In post-crest flood investigations there will be more public contact. Although it should be pointed out that the primary goal for the field hydrologist is to meet the needs of the community rather than the individual during this phase. Therefore, excessive time with flood victims should be avoided. Field staff must be focused on the goals of trying to make assessments of regional flood damages.

The following is a list of situations to avoid during this type of investigation:

- Do not put yourself in a hazardous situation. See the section on Hazards and Safety.
- Do not make any promises of assistance to flood victims. It is unknown what resources the District will have and where they will be put to use until all the assessments are completed.
- Don't go outside your assigned area unless you first check in with the office.
- Avoid excessive public contact. Remember the goal of a post-crest investigation is to gather regional information.

### **2.3 Post Event**

Community response (or post event) investigations occur to document flood damages on individual properties. During this type of investigation the hydrologist concentrates on responding to the general public with regards to damages to residential and commercial structures. These investigations have the most contact with the flood victims. Good public communication skills are essential. The best thing to remember in responding to a flood victim is to be a good listener, rather than a good talker.

Field staff will be asked to meet with specific flood victims to document the damages that occurred, the depth of flow, whether or not there has been any historical flooding in the past, and to make recommendations to the owner and/or to the County regarding possible remedies to the flood problem. Points to remember in talking to a flood victim can be found in the Victim Response section of the Flood Response Field Manual.

In order to be consistent in documenting flood damages, please use the field log sheets as well as the "Flooded home/business questionnaire."

### **3 Special Items of Concern for Specific Regions or Watersheds**

Various regions and/or watercourses within Pima County have flood related issues that are specific to that region or watercourse, such as specific infrastructure that is vulnerable, frequently flooded or damaged roadways, and frequently flooded structures. These known points of concern are detailed in the field manual, and should be referred to by field staff in order to ensure that staff are aware of the nuances of the particular area to which they have been assigned.

### **4 Documentation**

Good documentation is essential with any flood investigation. Photographs, notes on high water marks, flood-damage reports, and note taking, are the most important task for the field staff. Good documentation can make all of the difference in getting additional relief to flood victims, documenting the need for future flood control improvements, or responding to a legal claim for damages. Below are some tips to consider when documenting a flood or flood damages.

State only facts, not opinions. For example, do not state that a plugged culvert caused a house to flood, as the plugged culvert may be unrelated to the house flooding. It is acceptable to note that the house flooded, and that the culvert was blocked, as those are facts, but the relationship between the two is unknown and is therefore an opinion. To reinforce this point, the District was forced to pay damages in such a situation because the field log stated the plugged culvert caused the house to flood even though the flooded house was located incorrectly in a floodplain and would have flooded regardless of whether the culvert was blocked up or not.

Note all observations. One good tool to utilize for documenting a flood, or flood damages, is a continuous field log. There is an example of a field log entry in the field manual. The objective of the field log is not to prepare a polished report, but to record pertinent information. A log is also a good

place to take notes on the photographs you have taken. Whenever possible use a stapler to attach material together. A stapler is provided in the field box.

If you are using a cassette recorder for note taking, have the tape transcribed at the end of the day or at the beginning of the next work day. If you fear that litigation over flood damages may occur, you may wish to consider removing the plastic record protection tab and store the tape in a safe place.

Most often, field staff will be working with a partner. Both members of the team should take notes and compare them later. One person may note something the other missed. Notes may also serve to re-enforce observations when in agreement, and lead to later discussion and verification if in disagreement.

Take numerous photos, preferably digital photos. Use the log book to document each photograph. Make sure to document the time, location and direction the photo was taken. During large floods there is always a shortage of cameras. If you have a personal camera, and you don't mind using it to photograph floods or flood damages, the County will reimburse you for the film.

*Avoid taking photographs that do not have an object that can be used as a visual reference for scale.* Most flood photographs taken without a scale reference are not usable. Use keys, a clipboard, or pen to photograph close-ups of cracks or watermarks. Have a person or a vehicle in the photograph when documenting larger scale photographs. An individual pointing to a high water mark is an excellent way to make a presentable photograph.

If using a digital camera (which is preferred), follow the photograph documentation policy outlined in ADM-212, however do not discard original photographs until after the flood response has ended. Take extra batteries and memory cards into the field, if possible. At the end of each day, or as soon as possible, label the photographs, preferably using Adobe Acrobat, with the time, location, direction of view, and any other important information that will help viewers interpret what they are looking at. It is important to do this while your memory is still fresh.

If using a film camera, turn in the film to get developed at the end of the work day. When handing in a film canister, for processing, put your initials on the canister, give the canister a reference number or letter, and make a reference note so that the film can be given to the right person and properly filed. Write on the back of the photographs as soon as they come back and before they get out of order. This documentation should include a brief description of the photograph as well as the date the photograph was taken and the initials of who took the picture. Keep careful track of the negatives. One method of negative storage is to place the negative in a protective sleeve and tape the sleeve to the back of the report that has the photographs. Or tape the sleeve on back of the photograph.

Documenting the observations of witnesses or flood victims is important. As much as possible, try to quote the individual. Sometimes the victim may tend to exaggerate the problem. Therefore, double check the accuracy of statements made and make the appropriate footnotes to add accuracy to your notes.

Identify high water marks. Use paint, markers, ribbon, and/or survey lathes to make an account of the crest of the flood waters. Fine debris may slough off in as little as a day with the right weather conditions. By marking the high water marks, field representatives can come in later and survey the cross-section. Never paint or make any other permanent high water mark on a privately owned structure, no matter how badly damaged it may appear, unless you have the owners written

permission. An alternative is to place a survey lathe next to the structure and paint it at the high water mark.

Note the direction of flow in flat areas or in confluence areas. Good documentation as to the flow direction, especially in confluence areas helps determine the timing of the tributary flows.

Examples of flood response documentation are found in the Flood Response Field Manual.

## **5 Victim response**

Because District field staff may be the first governmental representative contacting the flood victim, it is important to interact effectively with the victim. Guidelines for interacting with victims are located in the field manual.

## **6 Communications**

Communicating hazards to life and property is critical during and immediately following flood events. Immediate hazards such as downed power lines, fires, individuals trapped in flooded structures or vehicles, gas line ruptures, exposed sewage, and similar circumstances should be called in to 911 first, and in to the District after that. Non-immediate hazards, such as bank erosion that is not immediately threatening structures or roadways should be called in to the District flood response coordinator using the phone numbers in the field manual. The flood response coordinator will be determined at the beginning of each work day.

### **6.1 Administrative Support Response**

Especially during and after major flood events, administrative staff will often be the recipients of many phone calls with questions or concerns about the flood event. As the District is involved in flood response, it may be difficult to connect individuals with technical staff, many of whom may be in the field. Administrative support staff can greatly assist flood response staff by asking a few questions:

- 1) What is your name and phone number in case we get disconnected?
- 2) Are you calling regarding an immediate threat to life or property? (If yes, have the applicant call 911 immediately then, if safe to do so, call back.)
- 3) If calling regarding a threat to life or property (whether immediate or not), what is the location of the problem?
- 4) Briefly describe the nature of the problem. Flooded structure? Flooded street? Erosion of channel? Downed power line? Exposed gas line?
- 5) Approximately how deep is the flooding?
- 6) Is the problem on public or private property? If private property, explain that our ability to assist private property owners is limited, but the District will do all it can.

With answers to these questions, flood response staff can more easily prioritize which concerns to address first.

When ending the conversation with the customer, whether transferring the person to a hydrologist or terminating the call, please make sure to inform the individual that someone will assist him/her as quickly as possible, but that our response may not be immediate. Instruct the customer to call back with an update if the situation worsens.

## 7 National Incident Management System (NIMS)

The National Incident Management System (NIMS) was created in 2004 as required by Homeland Security Presidential Directive (HSPD)-5. NIMS establishes a framework within which different agencies and organizations are able to work together during the response to an emergency situation. It also establishes standard protocol and terminology with respect to emergency response.

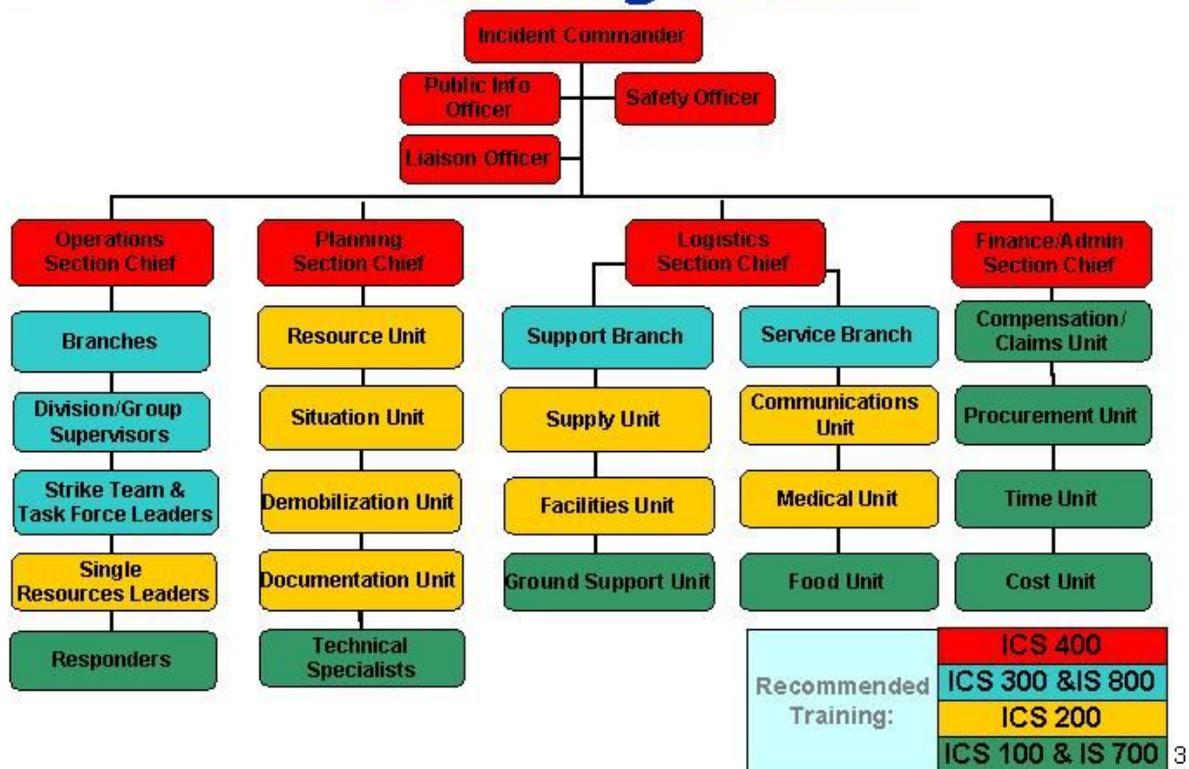
## 8 Incident Command System (ICS)

The Incident Command System is an on-scene hazard management protocol that provides a framework for effective hazard response. ICS is a first-on-scene protocol in which the first responder on the scene of an incident is in charge of the response until the incident is resolved or that role is transferred to an arriving, more qualified individual.

ICS also establishes training requirements for individuals involved in emergency response. **Field investigators are at the Responders level and are required to take ICS-100 and IS-700 courses prior to participating in a flood investigation.** Flood Response Coordinators are at the Group Supervisor level, and are required to also complete ICS-200, ICS-300 and IS-800 coursework. While ICS-100, ICS-200, IS-700, and IS-800 are on-line, self-directed courses available through the Emergency Management Institute (<http://www.training.fema.gov/>), ICS-300 is a classroom delivered course available through Pima County Office of Emergency Management (PCOEM). The following charts graphically represent the general structure and training requirements of ICS.

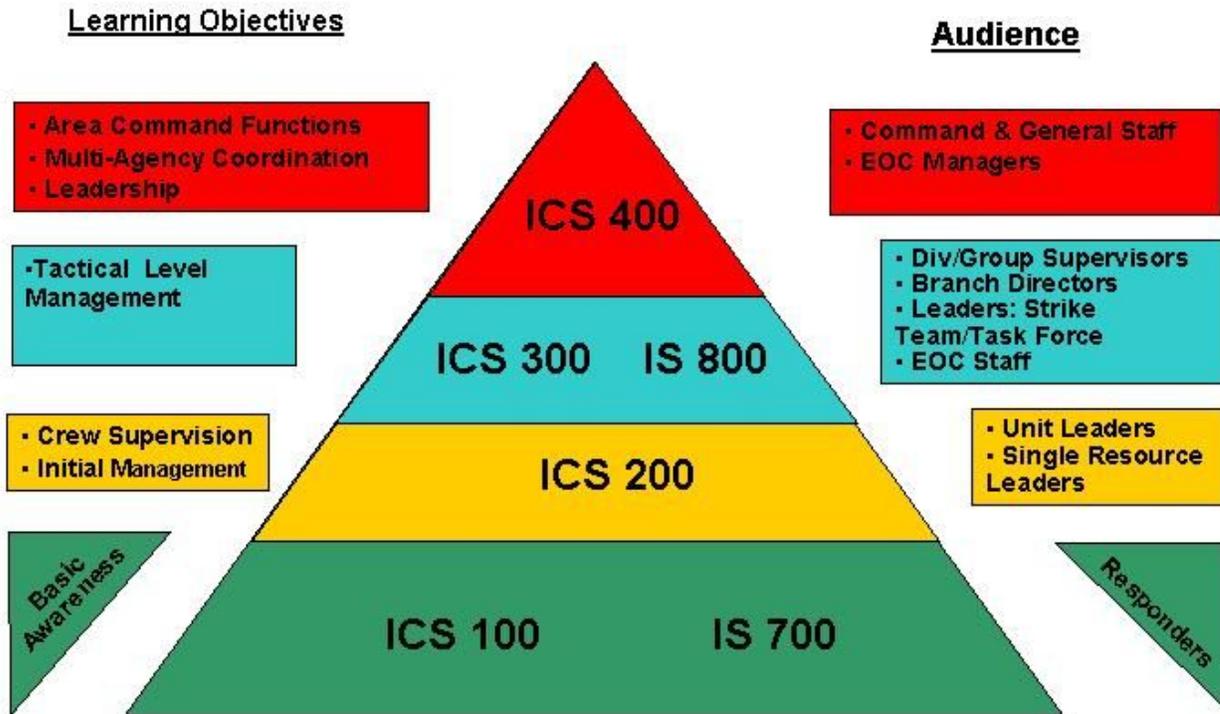


# Incident Command System Training Levels





# Incident Command System Training Levels



2

## 9 RFCD/Office of Emergency Management Coordination

Especially during significant flood events, coordinating the District response with the Pima County Office of Emergency Management (PCOEM) is crucial in order to effectively target all impacted areas with a minimum of duplication of effort. PCOEM also has two-way radios that can be made available to District staff to speed communications and improve safety for field staff by providing another means of communication with emergency personnel.

## 10 RFCD/Pima County Department of Transportation Coordination

After flood events, the public will contact the Flood Control District and/or the Pima County Department of Transportation (PCDOT) requesting assistance or repairs of damaged infrastructure. In order to properly respond to the public, it is necessary to determine who is responsible for maintenance. In general:

- Damage to private property, including private roads, easements, and washes, is the responsibility of private individuals.
- Damage to public roads and drainage infrastructure (culverts, etc.) within the road right-of-way is the responsibility of PCDOT (occasionally ADOT)
- Damage to public infrastructure outside the road right-of-way (public drainageways, public basins, etc.) is the responsibility of the District, though PCDOT may fix the problem on our behalf using District funding.

Flood prevention and flood damage mitigation with public funds on private property may occur only with a special declaration by the Board of Supervisors.

APPROVED BY:



Suzanne Shields  
Director

Date

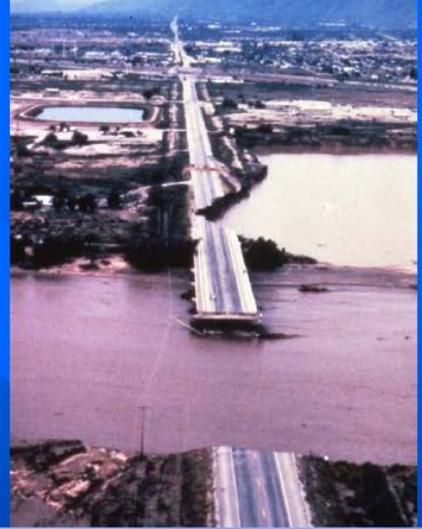
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# FLOOD RESPONSE FIELD MANUAL



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## **1 Hazards and Safety**

Personal and public safety is the number one priority to consider while investigating a flood and the damages associated with a flood. You must review this information prior to participating in a flood investigation.

The following is a list of safety tips for the field hydrologist to observe. Large portions of the information listed in this section is directly quoted from the Federal Emergency Management Agency's *Flood Emergency and Residential Repair Handbook*: March 1986).

## **2 Communications**

A critical component of the safety of field personnel is to have reliable communication with the Flood Response Coordinator (FRC) and emergency services (i.e. 911). Without the ability to communicate hazards to, and receive warnings from, emergency services, it is not possible to maintain adequate levels of safety. Each team member must have a cell phone and a vehicle charger for each phone. There is a micro-USB charger that will charge many modern cell phones in each flood response backpack.

Pima County Office of Emergency Management (PCOEM) also has two-way radios that can be made available to District staff to speed communications and improve safety for field staff by providing another means of communication with emergency personnel.

Communicating hazards to life and property is critical during and immediately following flood events. Immediate hazards such as downed power lines, fires, individuals trapped in flooded structures or vehicles, gas line ruptures, exposed sewage, and similar circumstances should be called in to 911 first, and in to the FRC after that. Non-immediate hazards, such as bank erosion that is not immediately threatening structures or roadways should be called in to the District using the phone numbers below.

PCOEM has two-way radios that can be made available to field staff to speed communications and improve safety by providing another means of communication with emergency services.

Following are the appropriate numbers to call in order to reach the FRC. Whenever possible, call directly to the command center, likely located in one of the conference rooms at 97 E. Congress. For smaller events where a command center is not established, call the office of the FRC.

Conference Room A - 724-4622

Conference Room B - 724-4628

Conference Room C - 724-4629

Main office number - 724-4600

Eric Shepp (primary FRC) – 724-4610

Brian Jones (secondary FRC) – 724-4612

## **3 Roadways and Driving:**

Roadways and driving are one of the main reasons why the District uses two person response teams. Many curious people will come out to see the flood, and when combined with the likelihood of less than ideal physical conditions for driving, good defensive driving skills are needed because other drivers may not be watching the road. The driver should focus only on driving while the navigator looks at maps, makes phone calls, and keeps an eye out for situations worth recording or reporting.

- Field investigators have the right to refuse to enter an area he or she has been assigned to if that person thinks the hazards are unacceptable

- Flooded roads can be very dangerous. When crossing a dip section that has water, always ask the question, "Is the pavement still there?" Should you see a standing wave within the roadway there is a good possibility the pavement is gone. It is more important to the District that all of the field staff remain safe, rather than risk a difficult route to get to an assigned area.



- Don't let the lack of swift flow trick you into a false sense of security about driving on a flooded roadway.
- If the region you have been assigned is not accessible, report that fact to the FRC, who will either reassign you to a new area or ask you to wait it out.
- Even after the flood has receded there may be unseen damages to roads, such as undercutting. Therefore, drivers should also remain alert to the road conditions. If either side of the road has a vertical drop-off, investigate that area to make sure there is solid ground underneath the pavement. Remember to report damaged roads (see the section on communication).
- Do not travel into an area that may be cut off due to rising flows unless you are prepared to remain there for an extended period of time.
- Do not go into areas where you could be threatened by flood waters.
- If you need to make observations within or near a road right-of-way, pull as far off of the road as possible without getting into an area where you will get stuck. Wear bright reflective clothing. Turn on the vehicle hazard lights.
- When driving, increase your awareness of other drivers, who may be distracted by watching the flooding rather than the road.



### 3.1 Embankments:

- Do not walk along the top of vertical, unprotected embankments. If you do have to monitor a watercourse along a vertical embankment, look for stress cracks and stay on the landward side of those cracks. If there are no cracks visible, stay a minimum of 6 to 8 feet away from the embankment. Further away is preferred. You may find you will get just as good of an observation by climbing higher (i.e. standing on a vehicle). (Moments after the photo at right was taken, the tree on the left fell into Tanque Verde Creek.)
- Never park your vehicle near a vertical unprotected embankment. The added weight of the vehicle could accelerate bank failure. This is especially true during the receding limb of the hydrograph.
- When an embankment is obscured by water, assume it is a vertical embankment.



### 3.2 Utilities:

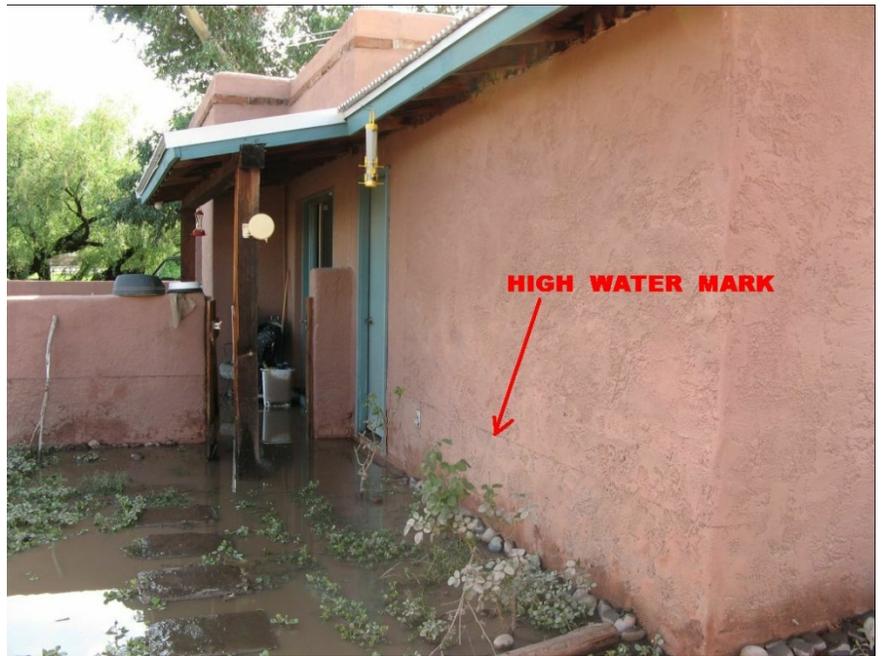
Damages can occur to utilities during floods.

- Downed power lines should be called in to 911.
- Assume all downed power lines are live. **Every source of electricity can be extremely hazardous during a flood.**
- If traveling on foot through a flood zone, observe overhead electrical lines for broken wires or evidence of arcing.
- Avoid the vicinity of power lines and if you must cross them, do so only at the mid-point between supporting poles.
- An energized electrical utility wire or utility pole, partially or totally submerged in water, whether metal or wet wood, can create an electrical field in the water that can create a serious electrical shock hazard. If water remains on the ground, heed the following safety precautions:
  - If utility wires are underwater, maintain a maximum distance from both utility poles and wires. In no case approach closer than 20 feet; and no closer than 50 feet for high-voltage transmission or feeder lines. Even if the utility wires are not broken or under water, stay at least 10 feet away from the poles.
  - **Do not enter a structure in which there is standing water.** It can be very dangerous to enter a flooded structure containing energized wiring. Even if fuses have been removed from the panel-board, or the circuit breaker had been switched off before the flood. **Water impurities and mud can cause circuits to be energized.**

- Do not touch a wet wall or baseboard near electrical outlets. They might conduct electrical current.
- If the area has been flooded, stay away from appliances such as clothes washers, dryers, electric stoves, and sump pumps.
- Avoid the use of open flames especially within an enclosed area and around areas that are still ponding water. Flammable vapors or fuels may be present. If any oil, fuel, or natural gas is seen or smelled, call 911.
- Avoid walking in an area with exposed sewage unless wearing a good pair of rubberized boots. Sewage may contain flammable gases and liquids and can have the potential of having toxic chemicals. If uncontained or leaking sewage is noticed call 911.

### 3.3 Flooded Structures:

- It is District policy not to enter a flood damaged structure soon after the flood event due to personal safety issues. If you must enter a structure during the course of a post-event investigation:
  - Walk around its perimeter and starting from the bottom, inspect it for signs of undermining, caving, shifting or collapse. If the building appears sound, enter it carefully. If there is evidence of significant undermining or settling, do not enter the home until it has been inspected and deemed safe to enter by local or Federal authorities.
  - Inquire about the possibility of damages to electrical services or to presence of gas. (Note in the photo above that the power is still on in the house, as the exterior porch light is on. Water got inside this structure to roughly the same depth as the exterior, therefore it is likely that the electrical wiring is wet and may pose a significant hazard.)
  - Smoking inside a flood damaged structure is prohibited.
  - Remain aware of the conditions on the ground surface or floor. Watch for slippery surfaces, as well as boards with nails, broken glass, and other sharp objects.
  - Move around slowly and carry a flashlight as you inspect for structural damage. Flooring and stairways should get particular attention. Watch for loose floor boards, holes in the floor, protruding nails, and sagging ceiling areas that may be ready to fall.



### 3.4 Other Hazards:

- Brushy and debris strewn areas may provide shelter for snakes, especially during the warmer times of the year. Probe brushy areas or debris piles with a long stick before entering during

the warmer months to avoid contact with venomous snakes. Remember that snakes may be active on any warm day, no matter what time of year.

- Quick-sand or quick-mud conditions are very rare in the southwest deserts. However, after a flood event pockets of silty mud can form. Avoid walking in areas subject to deep deposits of fine silts. The recommended procedure for getting out of quicksand is to lay flat and “swim” or drag yourself horizontally out of the area rather than try to walk. Dispersing your body weight will prevent or minimize further sinking. Use any available objects (branches, backpack, etc.) to increase your surface area.
- Avoid walking in moving water.
- Avoid confrontations with looters. Should you witness looting, call 911. Document your observations in your field log.

### 3.5 Clothing and supplies

- If conditions are still wet, wearing knee-high rubberized boots is recommended. Exercise caution when wearing such boots in flowing water, as the openings of such boots could fill up with water and pull a person down. If you are pulled down by flows catching the boots, and if footing is not regained, the boots should be removed.
- It is recommended that a complete set of extra clothes and shoes be taken into the field.
- Rain gear will be provided by the County; however a personal jacket should be taken.
- In the fall, winter or spring, take a heavy jacket or multiple layers of clothing for changing conditions.
- At a minimum, a quart of water should be taken into the field. The field backpacks have pockets for holding water bottles.
- Take sufficient food and snacks to get you through a full day in the field. Avoid taking foods into the field that need refrigeration.

## 4 Victim response

Because the field hydrologist may be the first government representative contacting the flood victim, there are some points that need to be discussed regarding this important first communication:

- The field hydrologist may run into situations where a flood victim is angry that damage has happened to their business or home. It is very rare that such anger becomes physical. It is best to let victims vent their anger by allowing them to explain the damage that has occurred. The best communication skill to put into practice when meeting with flood victims is to be a good listener rather than a good talker.
- Never get into justification arguments with a flood victim, as they are unproductive and time-consuming. Always avoid justifying work done by the District in other areas. Instead, have the victim focus on their account of what happened in their area.
- Do not promise a response time/date. It is common for assignments to change daily. Your workload may increase dramatically during flood events often making it difficult or impossible to meet deadlines.
- Do not promise any specific action on the part of Pima County.
- The hydrologist should refer the flood victim to both the Red Cross (800)-733-2767 and to Pima County Office of Emergency Management (520) 724-9300, if they need to seek

assistance, unless directed otherwise. Please be advised that the Red Cross may only offer assistance when structures are made non-habitable.

- Give victims of flooded structures a *Flood Emergency and Residential Repair Handbook*. Emphasize the reason that the book is being given is there may be some other damages to the structure that the victim is unaware of. The handbook describes how to look for such damages and also provides the flood victim with tips on how to salvage appliances, furniture, and other items to reduce flood losses.
- Avoid using humor. Responding to a flood victim can be stressful. As a result, there is a natural human tendency to lighten the tension of an uncomfortable situation with humor. There is nothing humorous to someone who has incurred flood damages.
- Document your findings. Field staff should always strive to take good notes and write a brief description of their findings and the statements made, before leaving the scene. Be professional, anything written down could be used in court, should a claim be filed. Use the *Flooded Home/Business Questionnaire* to document flood damages.
- Briefly document flood damage inside a structure. Encourage the flood victim to make their own specific list of all of their flood damages.
- When informing the public that the District is going to recommend that the county perform work in the area, make sure to also inform the flood victim that the response for maintenance work will be based on the overall needs of the community, as well as on priorities and the availability of limited resources. After requesting the work, the actual response, if it happens at all, is out of your control. Making this known up front will hopefully reduce tensions later if the county is not able to respond quickly.

## 5 Types of Investigations

There are three different types of investigations a responder may be called upon to perform with regards to a flood. These are:

- 1) Pre-crest flood investigations
- 2) Post-crest flood investigations, and
- 3) Post event (Community response) investigations.

Pre-crest and post-crest flood investigations involve similar tasks, which are outlined below.

### 5.1 Pre-crest and Post-crest Flood Investigation

The primary interest of pre-crest investigations is ensuring public safety as flood waters continue to rise. Post-crest flood investigations have the same goal but more specifically deal with documenting general flood damages, flow depths, direction of flow, and specific flood damage to regional areas and to public infrastructure (bridges and embankments). Following are some guidelines to follow:

#### Do

Typical pre-flood-crest investigations include the following activities:

- Taking notes, even when working with a partner. Notes from one person might fill in the gap of another, may help to reinforce facts, or might lead to additional data gathering if reports are in conflict.
- Reporting on rainfall conditions.

- Monitoring changes in water-surface elevations, especially at critical breakout points. (Helpful tip: To monitor water surface elevations, chose a fixed object, such as a rock that is at or near the current water surface or some man-made object and watch closely for changes in water height around it.)
- Reporting the general condition of a watershed (i.e. soil saturation).
- Reporting the amount of flow coming into a watercourse from ungaged watersheds.
- Tracking the flood crest as it progresses downstream.
- Monitoring the condition around structures or embankments which may be subject to damage.
- Accurately documenting what you observe, report and monitor.
- Note the direction of flow in flat areas or in confluence areas. (Helpful tip: The direction of channel bed forms or vegetation matting can help determine the direction of flow and therefore help determine the timing of flows at confluences.)
- Take plenty of photographs. Avoid taking any photo that does not have an object that can be used as a visual reference for scale. See the section on documentation for the appropriate use of a camera.
- Use the paint, ribbon, and/or survey lathes to mark high water levels. **(Do not, however, paint on private property or make other permanent marks without written permission.)**
- Document damages to embankments, bank protection, bridges, and other public facilities.
- Make assessments as to the number of flooded residential and business structures within an assigned area. This estimate should include approximate depths of flooding.
- When available, use aerial photographs to document high water marks, and locations of inundation as well as structural flooding.
- Immediately report public hazards such as downed electric lines or the smell of escaping gas by calling 911.
- Use the field log sheets (in the flood investigation boxes) to write down observations. If you are taking notes using an audio recorder, use the same format shown on the log sheets and transpose the tape notes onto this form. An example of some field notes on a log sheet can be found in Appendix C.

### Don't

The following actions are examples of what NOT to do during a flood response:

- Don't get caught up in the moment and take risks. Flood investigations of ongoing events can be fascinating and exciting. It is important to remain cognizant of the extreme hazards that flood events generate and keep yourself safe.
- Don't allow the excitement of the moment cause you to overestimate flood depths and/or velocities. It is



important to relay accurate information back to the FRC so that any emergency response is appropriate to actual conditions.

- To the greatest extent possible, unless directed otherwise, minimize meeting with residents regarding individual flooding problems. In post-crest flood investigations there will be more public contact, but remember that your primary goal is to meet the needs of the community as a whole, rather than the individual, during this time.
- Don't act in a flood warning role. All flood warning and emergency information will be made to the public via radio and television broadcasts by public safety officials. That doesn't mean you shouldn't caution someone acting in an unsafe manner, such as attempting to cross a flooded wash, standing too close to an eroding channel bank, etc.
- Do not forecast conditions to the public.
- Do not make any promises of assistance to flood victims. It is unknown what resources the District or the county will be able to utilize and when, or even if, they will be utilized until all the assessments are completed.
- Don't leave your assigned area unless you first check in with the FRC.

## **5.2 Post Event**

Post event or community response investigations document flood damages on individual properties. During this type of investigation field staff concentrates on responding to the general public with regards to damages to residential and commercial structures. As a general rule, these investigations will follow the guidelines established by Administrative Policy 203, as they will often be tracked through the Drainage Complaint process.

Following are some guidelines to follow:

- Good public communication skills are essential. These investigations have the most contact with the flood victims.
- The best thing to remember in responding to a flood victim is to be a good listener, rather than a good talker.
- Be cautious about making recommendations to flood victims. They may misconstrue your statements and perform tasks that might harm themselves or others. Recommend victims get a Floodplain Use Permit for any activity that might affect the flow of water across their property.

Points to remember in talking to a flood victim can be found in the Victim Response section of this manual (Section 4).

## **6 Documentation**

Good documentation is essential with any flood investigation. Photographs, notes on high water marks, flood-damage reports and note taking are the most important tasks for field staff. Below are some tips to consider when documenting a flood or flood damages:

- Note all observations.
- State only facts, not opinions. For example, do not state that a plugged culvert caused a house to flood, as the plugged culvert may be unrelated to the house flooding. It is acceptable to note that the house flooded, and that the culvert was blocked, as those are facts, but the relationship between the two is unknown and is therefore an opinion.

- All field staff should take notes, even when working with someone else who is taking notes. Notes should be compared later for consistency and completeness. Notes may serve to reinforce observations when in agreement, and lead to later discussion and verification if in disagreement.
- Take numerous photos.
- When available, use a GPS-enabled camera
- If possible, write the picture number and GPS coordinates (if not using a GPS-enabled camera) in large writing on a piece of paper prior to taking the picture and place it in the shot so that the photo information is an inherent component of the photograph itself.
- Notes and photographs should be accompanied by GPS coordinates whenever possible.
- Take a photo of the address or street signs at each new location to make it easier to remember where each photograph was taken once you're back in the office.
- If possible, take photographs with identifiable features in the background to help establish the location of the photograph.
- Use the log book to document each photograph. Make sure to document the time, location and direction the photo was taken.
- *Avoid taking photographs that do not have an object that can be used as a visual reference for scale.* Use keys, a clipboard, or pen to photograph close-ups of cracks or watermarks. Use a person or a vehicle for scale in the photograph when documenting larger scale photographs.
- At the end of each day, or as soon as possible, label the photographs, preferably using Adobe Acrobat, with the time, location, direction of view, and any other important information that will help viewers interpret what they are looking at. It is important to do this while your memory is still fresh.
- Document the conversation of witnesses or flood victims. As much as possible, try and quote the individual. Sometimes the victim may tend to exaggerate the problem. Therefore, double-check the accuracy of statements made and make the appropriate footnotes to add accuracy to your notes.
- Documenting the observations of witnesses or flood victims is important. As much as possible, try and quote the individual. Sometimes the victim may tend to exaggerate the problem. Therefore, double check the accuracy of statements made and make the appropriate footnotes to add accuracy to your notes.
- Identify high water marks. Use paint, markers, ribbon, and/or survey lathes to make an account of the crest of the flood waters. Fine debris may slough off in as little as a day with the right weather conditions. By marking the high water marks, Survey Section can come in later and survey the cross-section. Never paint or make any other permanent high water mark on a privately owned structure, no matter how badly damaged it may appear, unless you have the owners permission. An alternative is to place a survey lathe next to the structure and paint it at the high water mark.
- Monitor and document buildup of flood debris on piers of bridge crossings. The majority of the debris accumulation is typically wrapped around the upstream bridge piers.
- Note the direction of flow in flat areas or in confluence areas. Good documentation as to the flow direction, especially in confluence areas helps determine the timing of the tributary flows.

Examples of flood response documentation are found at the end of this manual.

## 7 Flood Investigation Backpacks and Boxes

Flood investigation supplies have been prepared for use during flood investigations. These supplies are found in the red flood investigation backpacks and grey canvas-sided file boxes. Each team of two field hydrologists should take two backpacks and one file box. The backpacks are intended to be carried by the hydrologist while away from the vehicle. The file box contains vehicle supplies as well as extra documents to re-supply items in the backpacks and is intended to remain in the vehicle.

Do not leave backpacks or file boxes in vehicles overnight, as they cannot then be re-supplied, and may lead to unprepared teams the next day or to lost staff time when others are unaware of the location of these items and try to find them.

The contents of the field backpacks and file boxes should be checked by administrative staff at least annually to ensure they are properly supplied and up to date. During ongoing flood investigations, hydrologists should either re-supply the backpacks and file boxes themselves, or request administrative staff to complete the task.

Below is a list of the items that should be found in the backpacks and file boxes, including a description of how those items should or might be used.

### 7.1 Field Backpacks

The field backpacks should contain the following items:

- A plastic compartmentalized clipboard containing the following items:
  - At least 20 field log sheets (provided for the hydrologist to document their observations (see section on documentation)
  - At least 10 *Post-Flood Requirements and Recommendations* handouts
  - At least 2 *Repairing Your Flooded Home* manuals (in English and Spanish) to distribute to flood damaged residents
  - At least 1 *Flood Emergency and Residential Repair Handbook* to distribute to flood damaged residents
  - At least 10 *Flooded Home/Business Questionnaire* sheets to distribute to flood damaged residents
  - At least 5 *Pima County Home Repair Programs* brochures to distribute to flood damaged residents. (Please be advised, these programs are only available to low income individuals.)
  - At least 10 generic Flood Control District business cards
  - 1 ultra-fine tip blue Sharpie pen
  - 1 blue pen
  - 1 mechanical pencil with plenty of lead
- Reflective safety vest (to be worn at all times when near roadways, and recommend even when not near roadways)
- A 100-foot fiberglass tape for field measurements
- A 12-foot (or longer) metal tape for field measurements
- A flashlight
- Two flares have been provided for traffic and individual safety needs.
- One roll of pink flagging for identifying locations of high waterlines, marking hazards, or blocking off an area of hazard

- One can of pink marking spray paint for marking high water marks
- One disposable cameras (24 exposure) cameras for documentation as a back-up to digital cameras. The field hydrologist should bring a digital camera from the office, if available.
- A micro-USB car charger (capable of charging many modern cell phones)

There is plenty of extra room in the backpacks for carrying a digital camera, extra handouts and personal items such as food, water, raingear, etc.

## 7.2 Field File Boxes

The interior of the field file boxes should contain the following items:

- File folders containing the following items:
  - At least 50 field log sheets (provided for the hydrologist to document their observations (see section on documentation)
  - At least 6 *Repairing Your Flooded Home* manuals (in English and Spanish) to distribute to flood damaged residents
  - At least 3 *Flood Emergency and Residential Repair Handbook* to distribute to flood damaged residents
  - At least 20 *Flooded Home/Business Questionnaire* sheets to distribute to flood damaged residents
  - At least 10 *Pima County Home Repair Programs* brochures to distribute to flood damaged residents. (Please be advised, these programs are only available to low income individuals.)
  - A sheet of paper with important phone numbers
  - At least 10 Floodplain Use Permit Applications
  - A copy of this field manual
  - A copy of the most recent Ordinance
  - A “To Look At” file for placing documents related to assignments, for assistance in staying organized while in the field.
  - An empty “Investigated File” to place completed field logs and other completed documentation while out in the field, for assistance in staying organized while in the field
- A current Pima County Roadway Atlas
- The 2006 roadway atlas (which has better wash/floodplain information)
- An *Aerial Photo Guide* (located between back of plastic file box and inside of canvas carrier)
- A 25-foot tow rope. (The tow rope can be removed temporarily once out in the field to make accessing file folders easier, but be sure to place it back in the box at the end of the day.)

The following items should be located in the front pockets:

- At least 20 generic Flood Control District business cards
- 1 ultra-fine tip blue Sharpie pen
- 1 ultra-fine tip red Sharpie pen
- 2 blue pens
- 1 red pen
- 1 highlighter
- 1 mechanical pencil with plenty of lead

- At least one grease pencil (preferably red or yellow)
- 1 small engineer's scale for measuring distances on maps or aerial photographs
- 1 stapler
- Container of paper clips
- Container of rubber bands

The following item(s) should be located in zipper pocket on back of case:

- At least one flare for traffic and individual safety needs.

### 7.3 Description of Certain Flood Response Items

"Aerial Photo Guide" This photo map contains aerial photography of most of eastern Pima County. Superimposed on the photographs are section numbers, section corners, major watercourse names, and some road names. Use the grease pencil contained in the file box to document the areas of inundation of flows. In addition, the size of smaller watersheds can be estimated with this guide.

"Flood Emergency and Residential Repair Handbook" The "Flood Emergency and Residential Repair Handbook" put out by the Federal Emergency Management Agency, is an excellent publication to give to flood victims. This book not only informs flood victims how to clean up from a flood, it explains how to salvage appliances, how to avoid electrical and other hazards, and how to take steps to reduce flood losses should additional flooding be imminent. The field box contains a limited number of these publications. If the field hydrologists' task will be meeting with flood victims, he or she is encouraged to take additional copies of this publication into the field.

Flood Response Manual This manual is provided in the field box as a tool for the field hydrologist.

Flooded Home/Business Questionnaire This questionnaire has been developed to provide consistent documentation of flood damages to business, homes, and other private structures. Please refer to the tips outlined in the "Responding to Flood Victims" portion of this manual to be more effective in using this form and to respond appropriately to a flood victim.

Floodplain Use Permit Applications Floodplain Use Permit Applications have been included to assist flood victims in getting the necessary permits for any repairs.

Tow rope A 25 foot tow rope has been included, should the field hydrologist get stuck. The rope has not been included to provide assistance to private individuals whose vehicles become stuck. Should an individual request assistance getting a vehicle un-stuck, the field hydrologist should call for assistance for stranded motorists, and continue monitoring flooding conditions, or documenting flood damages.

## 8 Specific Items of Concern by Watershed

Below are areas or items of special concern for specific watersheds and/or data gathering needs during times of flooding. The four types of items are:

- **Data Gathering Needs (DAT):** This section generally contains locations where field observations are necessary to help determine at what flood stage watercourses break out from the primary channel and cause adverse impacts or to determine flood peak timing at points downstream of a stream gage.

- **Frequently Flooded Structures and Properties Subject to Damage (FSP):** This section contains structures or properties and areas that are either known to have been flooded repeatedly, that are subject to severe flooding, or are at severe risk of erosion damage. The list of properties in this section are generally limited to those along major watercourses and does not contain every structure that is known to have flooded. This section specifically does not contain structures that have flooded due to local drainage.
- **Infrastructure (INF):** This section contains public infrastructure that should be monitored in times of flooding because there is a higher than normal probability that it may become damaged and/or fail during flood events. This includes bank protection, roadways that may get washed out and undersized drainage infrastructure.
- **Safety Concerns (SAF):** This section contains information primarily intended to keep flood investigators safe. It includes roadways that are subject to flooding, areas that may become cut off from ingress/egress and private infrastructure that may fail and create an immediate and unexpected hazard.

## 8.1 Agua Caliente Wash (ACW)

### 8.1.1 Data Gathering Needs

- Monitor effects of 2006 debris flow event on areas that, prior to the 2006 event, did not experience flooding. How is the new sediment deposition affecting flow? (T13S R16E Sec. 18/19) <GIS Point ID: ACW-DAT-001>
- Agua Caliente Wash: The trigger discharge to monitor the area east and south of the spur dike is approximately 7,500 cfs at the Tanque Verde Road Gage (ALERT ID# 2203). Location is the intersection of Melpomene Way and Sundance Dr. (T13S R16E Sec. 31) <GIS Point ID: ACW-DAT-002>

### 8.1.2 Frequently Flooded Structures and Properties Subject to Damage

- Agua Caliente Wash breaks out near 2861 N. Melpomene Road. in the Melpomene and Glenn area. (T13S R16E Sec. 19) <GIS Point ID: ACW-FSP-001>
- Agua Caliente Wash overbanks on the left bank near Limberlost and Soldier Trail. Flooding is exacerbated by tributary flows. (T13S R16E Sec. 19) <GIS Point ID: ACW-FSP-002>
- Agua Caliente Wash: there are erosion issues along Bel Air Ranch Estates. (T13S R16E Sec. 30) <GIS Point ID: ACW-FSP-003>
- Agua Caliente Wash: channel migration of Agua Caliente Wash threatens 3980 N. Homestead Road (T13S R16E Sec. 19) <GIS Point ID: ACW-FSP-004>
- Soldier Trail Wash: due to elevated roadway and lack of a dip section at Snyder road, flow tends to divert, at least partially, toward 11610 E. Snyder Road, instead of remaining in the main channel of wash. DOT has placed large berm in front of property for protection. Elevated roadway has caused sediment deposition upstream of Snyder road between Catalina Hwy and Soldier Trail (DOT issue). Several structures downstream of Snyder Road have flooded in the past. (T13S R16E, Sec. 19) <GIS Point ID: ACW-FSP-005>
- Soldier Trail Wash: immediately downstream of Mt. Lemmon Short Road, 5267 N. Mt. Lemmon Short Road and 5247 N. Mt. Lemmon Short Road, properties and structures experience flooding during large storm events. (T13S R16E, Sec. 18) <GIS Point ID: N ACW-FSP-006>

- Castle Rock Wash contains a lot of sediment and the overbank floods frequently. (T13S R15E Sec. 35) <GIS Point ID: ACW-FSP-007>
- Fortyniners Wash: Upstream development has caused problems southwest of Redington and Wentworth in the area around Calle Tatita and Calle Tango. (T13S R16 Sec. 32) <GIS Point ID: ACW-FSP-008>
- Agua Caliente Wash: When flows go around the spur dike (possibly at 7,500 cfs at Tanque Verde Road Gage (ALERT ID# 2203), property/homes may be flooded. Inundation of homes may start around the Q25. The first homes at risk would be upstream of Fort Lowell and downstream of Tanque Verde Road. (T13S R15E Sec. 36) <GIS Point ID: ACW-FSP-009>

### 8.1.3 Infrastructure

- Agua Caliente Wash is head-cutting (6-8 ft. deep) up towards Soldier Trail. Damage to roadway likely as head-cutting progresses up stream. (T13S R16E Sec. 19) <GIS Point ID: ACW-INF-001>
- Snyder Road is potentially subject to damage along the eastern portion of the Santa Catalina mountain front. (T13S R16E Sec. 18) <GIS Point ID: ACW-INF-002>

### 8.1.4 Safety Concerns

- Agua Caliente Wash: The entire Agua Caliente base flood will not fit through the Tanque Verde Road Bridge on major floods. Some flow will go over Tanque Verde Road east of the bridge. On the 100-year flood or less, flow depths over the roadway are expected to be less than one foot deep. If you are traveling down Tanque Verde Road and it appears to have shallow flow going over the roadway to the east of the bridge, proceed with extreme caution. (T13S R15E Sec. 36) <GIS Point ID: ACW-SAF-001>
- Access to the area east of Agua Caliente Wash and north of Caliente Hills Wash (north of Fort Lowell Rd.) can get cut-off during flood events. Do not enter this area during a flood event unless prepared to remain there until the flood waters subside. (T13S R16E Sec. 30) <GIS Point ID: ACW-SAF-002>
- Fort Lowell often remains closed at Agua Caliente Wash after major flow events due to sand bar deposition on the roadway. (T13S R16E Sec. 30) <GIS Point ID: ACW-SAF-003>
- This area contains numerous wash crossings that may become impassable. Paved crossings are subject to flood damage and may be severely damaged. Snyder Road between Harrison Rd. and Soldier Trail is particularly problematic. (T13S R16E Sec. 19) <GIS Point ID: ACW-SAF-004>
- Agua Caliente Wash: When flows go around the spur dike (possibly at 7,500 cfs at Tanque Verde Road Gage (ALERT ID# 2203) a key emergency services issue is Tanque Verde Road east of the bridge will start to be flooded. For the Q100 the depth on the roadway will be about 1 foot. (T13S R15E Sec. 36) <GIS Point ID: ACW-SAF-005>

## 8.2 Ajo (AJO)

### 8.2.1 Data Gathering Needs

- No site specific issues identified.

### 8.2.2 Frequently Flooded Structures and Properties Subject to Damage

- 701 W. Rocalla (401-24-0880) There is a culvert that goes under the house and outlets right next to the house. Flooding source is Gibson Arroyo (T12S R06W Sec. 22) <GIS Point ID: AJO-FSP-001>
- 530 W. Morondo Ave. (401-24-0150) Flooding source is a tributary to the Gibson Arroyo (T12S R06W Sec. 22) <GIS Point ID: AJO-FSP-002>
- 400 W. Morondo Ave. (401-23-2520) Water backs up behind bridge and floods property. Flooding source is a tributary to the Gibson Arroyo (T12S R06W Sec. 22) <GIS Point ID: AJO-FSP-003>
- 401 W. Rocalla Ave. (401-23-2610) Water backs up behind bridge and floods property. Flooding source is a tributary to the Gibson Arroyo Sewer pipe broke in July 2003 event and flooded basement. (T12S R06W Sec. 22) <GIS Point ID: AJO-FSP-004>
- 201 W. Solana Ave. (401-23-1410) A fully lined channel goes underneath the home. Flooding source is a tributary to the Gibson Arroyo (T12S R06W Sec. 22) <GIS Point ID: AJO-FSP-005>
- 341 W. Arroyo Ave. (401-55-2440) Flooding source is the Gibson Arroyo (T12S R06W Sec. 15) <GIS Point ID: AJO-FSP-006>
- 140 W. Arroyo Ave. (401-55-2420) Flooding source is the Gibson Arroyo (T12S R06W Sec. 14) <GIS Point ID: AJO-FSP-007>
- 130 W. Arroyo Ave. (401-55-2430) Flooding source is the Gibson Arroyo (T12S R06W Sec. 14) <GIS Point ID: AJO-FSP-008>
- 131 W. First Ave. (401-55-2210) Flooding source is the Gibson Arroyo (T12S R06W Sec. 14) <GIS Point ID: AJO-FSP-009>
- 120 W. First Ave. (401-55-1960) Flooding source is the Gibson Arroyo (T12S R06W Sec. 14) <GIS Point ID: AJO-FSP-010>
- 111 W. Second Ave. (401-55-1830) Flooding source is the Gibson Arroyo (T12S R06W Sec. 14) <GIS Point ID: AJO-FSP-011>
- 100 W. Second Ave. (401-55-1690) Flooding source is the Gibson Arroyo (T12S R06W Sec. 14) <GIS Point ID: AJO-FSP-012>

### 8.2.3 Infrastructure

- Water may come up out of the storm drain on the south side of Esperanza Avenue, east of Montecito Street, due to head created by water backing up behind the headwall located at the southwest corner of Esperanza and Montecito. (T12S R06W Sec. 22) <GIS Point ID: AJO-INF-001>
- The Curly School Detention Basin near Esperanza Ave. and Orilla Ave. The old high school football field has been transformed into a storm detention basin. Inspect the conditions of the inlet spillways and note if slope erosion has occurred along the basin walls. The culvert outlet should also be inspected for debris blockage. (T12S R06W Sec. 22) <GIS Point ID: AJO-INF-002>



- The drainage ditch along the south side of the Ajo Community Health Center. Inspect for damage to or blockage of the drainage ditch south of the Community Health Center. County maintenance responsibilities stop at the north side of Solana Avenue. The culvert at Solana Ave. belongs to the Arizona Department of Transportation and the drainage upstream (south) of Solana is private. (T12S R06W Sec. 14) <GIS Point ID: AJO-INF-003>



- The County maintains the Gibson Arroyo upstream of 2nd Avenue to Cedar Street via a maintenance easement granted by Phelps Dodge. This area is subject to deposition. Bank erosion can occur in upstream and downstream of Cedar Street. Upstream of Cedar street there are no construction plans for the channel. Utilities crossing to the channel are shallow and in some locations exposed. The channel lacks capacity for moderate to strong storm events and widespread flooding is likely. Flood damage reports should address channel conditions. (T12S R06W Sec. 15) <GIS Point ID: AJO-INF-004>



- The County maintains that portion of the drainage ditch north of Ocatillo Avenue that lies within the road right-of-way from Sahuaro Street



east to a point approximately 170 feet east of Tecolote Street, at which point the channel leaves the road right-of-way. It is unknown if we maintain the foot bridges across the

channel. Flood damage reports should address the condition of the channel. (T12S R06W Sec. 15) <GIS Point ID: AJO-INF-005>

#### 8.2.4 Safety Concerns

- No site specific issues identified.

### 8.3 Arivaca (ARI)

#### 8.3.1 Data Gathering Needs

- No site specific issues identified.

#### 8.3.2 Frequently Flooded Structures and Properties Subject to Damage

- No site specific issues identified.

#### 8.3.3 Infrastructure

- No site specific issues identified.

#### 8.3.4 Safety Concerns

- The dam containing Arivaca Lake is deficient. (T22S R11E Sec. 07) <GIS Point ID: ARI-SAF-001>
- Arivaca Road at Proctor Wash is an at-grade crossing and may be impassable even after flow events due to sediment and debris deposits on the roadway. This location is within Santa Cruz County but Arivaca Road provides access to portions of Pima County. (T20S R12E Sec. 05) <GIS Point ID: ARI-SAF-002>
- Arivaca Road at Batamote Wash is an at-grade crossing and may be impassable even after flow events due to sediment and debris deposits on the roadway. This location is within Santa Cruz County but Arivaca Road provides access to portions of Pima County. (T20S R12E Sec. 06) <GIS Point ID: ARI-SAF-003>

### 8.4 Black Wash (BLW)

#### 8.4.1 Data Gathering Needs

- No site specific issues identified.

#### 8.4.2 Frequently Flooded Structures and Properties Subject to Damage

- Homes have been known to flood near Tillery St. and Jeffrey Rd. (T15S R12E Sec. 13) <GIS Point ID: BLW-FSP-001>
- Branding Iron Park is a dense development in the Black Wash Floodway. (T15S R12E Sec. 10) <GIS Point ID: BLW-FSP-002>
- Wade Road south of Bilby Road. (T15S R12E Sec. 10) <GIS Point ID: BLW-FSP-003>

#### 8.4.3 Infrastructure

- Look at collector channels for Camino Verde Estates II. (T15S R12E Sec 03) <GIS Point ID: BLW-INF-001>

- Look at collector channels for Star Valley subdivisions. (T15S R12E Sec 16) <GIS Point ID: BLW-INF-002>
- The drainageway on the east side of Tucson Estates Unit 6 , Book 20 Page 65, parcel 212-22-6370 is maintained by the county. (T14S R12E Sec. 25) <GIS Point ID: BLW-INF-003>

#### 8.4.4 Safety Concerns

- Hazardous conditions exist where the Black Wash crosses Valencia Road. (T15S R12E Sec. 10) <BLW-SAF-001>

### 8.5 Brawley Wash (BRW)

#### 8.5.1 Data Gathering Needs

- The trigger discharge for the break-out from the east bank of Brawley Wash north of Ajo Highway and Quinlin Trail is not known. The trigger is only known to be lower than 11,800 cfs (official USGS discharge for August 14, 2005 event per USGS Publication, Water Data Report AZ-05-1 Titled: Water Resources Data, Arizona Water Year 2005.) (T15S R10E Sec. 28) <GIS Point ID: BRW-DAT-001>

#### 8.5.2 Frequently Flooded Structures and Properties Subject to Damage

- Hazardous conditions exist at the location of a break-out flow from the Brawley Wash north of Ajo Highway and Quinlin Trail. Properties at least as far south as 16474 W Quinlin Trail (208-62-002G) and as far north as 16375 W. Hermans Road (208-57-004K) are affected by this flow. The northern properties have been subject to permit denials. The breakout occurs at flows below 11,800 cfs (official USGS discharge for August 14, 2005 event per USGS Publication, Water Data Report AZ-05-1 Titled: Water Resources Data, Arizona Water Year 2005.) (T15S R10E Sec. 27) <GIS Point ID: BRW-FSP-001>
- A site-built structure on 16310 W. Honeysuckle View (208-63-0330) was built at grade without a permit. This structure was originally built as a single-family residence and has been converted to a non-habitable structure by the new owner. It is expected to get flooded during the base flood and during smaller events. (T15S R10E Sec. 34) <GIS Point ID: BRW-FSP-002>
- The area around Honeysuckle Farm Trail is subject to potential break-out flow from the Brawley Wash as well as the large wash to the east. Both washes have levees containing flow that are not designed to withstand the base flood. (T15S R10E Sec. 34) <GIS Point ID: BRW-FSP-003>
- A number of washes converge on an area just north of Los Reales Road west of Marstellar Road, creating potentially hazardous conditions. (T15S R11E Sec. 17) <GIS Point ID: BRW-FSP-004>
- Several properties near 15350 W Avra Valley Road (208-24-012H) are between the West Branch of the Brawley Wash and an agricultural levee. Depths of flow are expected to exceed three feet with high DV2 values. (T12S R10E Sec. 11) <GIS Point ID: BRW-FSP-005>
- Homes in the Avra Vista subdivision have experienced erosion of fill pads. Structures were supposed to be constructed on fill pads with engineered erosion protection, but most were permitted by DSD without this requirement. (T12S R10E Sec. 15) <GIS Point ID: BRW-FSP-006>

- Millstone Manor #6 has frequent flooding problems. (T14S R12E Sec. 30) <GIS Point ID: BRW-FSP-007>
- The Blue Aloe Street area flooded in 2013 when a 3,340 cfs (measured at Ajo Highway) flow broke out of the Brawley Wash and moved northeast, per USGS Water Data Report 2013. (T14S R11E Sec. 32 and T15S R11E Sec. 05) <GIS Point ID: BRW-FSP-008>

### 8.5.3 Infrastructure

- The drainageways within Tucson West Ranchettes, Book 32 Page 099, are county maintained. They are not specifically dedicated to the District. (T15S R11E Sec. 09) <GIS Point ID: BRW-INF-001>

### 8.5.4 Safety Concerns

- Fuller Road is subject to flooding from tributary flows coming into the Brawley Wash from the west. (T15S R10E Sec. 32). <GIS Point ID: BRW-SAF-001>
- A break-out flow from the Brawley Wash north of Ajo Highway and Quinlin Trail has the potential to create highly hazardous conditions on properties to the east of the main channel. The trigger for the breakout is not known, but is lower than 11,800 cfs (official USGS discharge for August 14, 2005 event per USGS Publication, Water Data Report AZ-05-1 Titled: Water Resources Data, Arizona Water Year 2005.) (T15S R10E Sec. 28) <GIS Point ID: BRW-SAF-002>
- The levee on Buckelew Farms on the east bank of Brawley Wash north of Ajo Highway is not designed to withstand the base flood and may fail to contain the flood. The base flood may overtop the levee. (T15S R10E Sec. 33) <GIS Point ID: BRW-SAF-003>
- Berms along Kay Linn Dr. between Deaver Rd. and Camino Verde has been known to cause flooding problems. (T14S R12E Sec. 34) <GIS Point ID: BRW-SAF-004>
- Snyder Hill Rd. washes out west of Desert Sunrise Tr. (T14S R11E Sec. 36) <GIS Point ID: BRW-SAF-005>
- Hazardous conditions exist where the Black Wash crosses Sandario Road. (T14S R11E Sec. 22) <BRW-SAF-006>
- There are numerous at-grade crossings on Kinney Road near Saguaro National Park West. The Kings Canyon crossing was heavily damaged in a 2006 event. (T14S R11E Sec. 01) <BRW-SAF-007>
- Most of the Brawley Wash area is subject to flooding and may become difficult or impossible to access during major events. Utmost caution should be observed when proceeding into this area before or during a flood crest. <BRW-SAF-008>

## 8.6 Catalina Foothills (CAT)

### 8.6.1 Data Gathering Needs

- No site specific issues identified.

### 8.6.2 Frequently Flooded Structures and Properties Subject to Damage

- 5584 N. Ventana Vista (114-64-4650) has been flooded by Esperero Wash. (T13S R15E Sec. 17) <GIS Point ID: CAT-FSP-001>

- 5572 N. Ventana Vista (114-64-4660) has been flooded by Esperero Wash. (T13S R15E Sec. 17) <GIS Point ID: CAT-FSP-002>
- Homes near the intersection of Havasu Road and Placita Arquilla and to the north are in the bottom of the geologic floodplain of Finger Rock Wash and are likely to get damaged during large events. (T13S R14E Sec. 03) <GIS Point ID: CAT-FSP-003>

### 8.6.3 Infrastructure

- There are undersized culverts under Sunrise Rd. at Esperero Wash. Water weirs over the road, forcing the road to be closed. The water gets diverted and has caused flooding damage at 5584 N. Ventana Vista and 5572 N. Ventana Vista. Gabions have been damaged downstream of Sunrise. (T13S R15E Sec. 17) <GIS Point ID: CAT-INF-001>
- Monitor and document the flood water level at the UPRR railroad crossing. If the water level appears to be within 18 inches of the crossing infrastructure, call District or 911. (T13S R13E Sec 8) <GIS Point ID: CAT-INF-002>

### 8.6.4 Safety Concerns

- The Valley View Wash creates hazardous conditions, including erosion and deposition issues, on Calle Pantera. (T13S R14E Sec. 15) <GIS Point ID: CAT-SAF-001>
- Do not attempt to cross Camino de la Tierra Road if there is any flood water on roadway. Otherwise, watch for flash flooding. (T13S R13E Sec. 08) <GIS Point ID: CAT-SAF-002>

## 8.7 Canada del Oro (CDO)

### 8.7.1 Data Gathering Needs

- No site specific issues identified.

### 8.7.2 Frequently Flooded Structures and Properties Subject to Damage

- 4335 E. Wilds Road. (222-35-018A) Flow breaks out of the channel in this area at around 1500-2000 cfs. (T11S R14E Sec. 15) <GIS Point ID: CDO-FSP-001>
- 4525 E. Golder Ranch Road (222-35-039D) is subject to erosion damage from a tributary to the Canada del Oro (T11S R14E Sec. 15) <GIS Point ID: CDO-FSP-002>
- 14350 N. Lago del Oro Parkway (222-47-0030), structures in the floodway. (T11S R14E Sec. 22) <GIS Point ID: CDO-FSP-003>

### 8.7.3 Infrastructure

- Carmack Wash is eroding laterally towards Shannon Road. Sediment and water overtops Shannon Road as well. (T13S R13E Sec. 04) <GIS Point ID: CDO-INF-001>

### 8.7.4 Safety Concerns

- There is an unpermitted berm in the floodway at 15900 N. Lago del Oro Parkway (222-32-0040) that may not be designed to withstand flood forces. (T11S R14E Sec. 11) <GIS Point ID: CDO-SAF-001>
- Flow breaks out of the primary channel near Golder Ranch Road at around 1500-2000 cfs. (T11S R14E Sec. 15) <GIS Point ID: CDO-SAF-002>

## **8.8 Lee Moore Wash (LMW)**

### 8.8.1 Data Gathering Needs

- No site specific issues identified.

### 8.8.2 Frequently Flooded Structures and Properties Subject to Damage

- 10200 S. Country Club Rd. (303-10-419A) and properties to the south and west are in the primary flood corridor of Franco Wash and subject to potentially serious flood and erosion hazards. This property owner was allegedly evacuated from the property by the National Guard during the 2005 flood event. (T16S R14E Sec. 05) <GIS Point ID: LMW-FSP-001>
- 2742 E. Wooden Bucket St. (303-10-5860) was flooded during the 2005 event of Franco Wash, while under construction. (T16S R14E Sec. 05) <GIS Point ID: LMW-FSP-002>
- The J D Ranch subdivision is adversely impacted by non-regulatory flows. (T16S R16E Sec. 34) <GIS Point ID: LMW-FSP-003>

### 8.8.3 Infrastructure

- No site specific issues identified.

### 8.8.4 Safety Concerns

- Berms along Dawson Road and along Columbus Road have breached and caused downstream flood and erosion hazards. (T17S R14E Secs. 20-22) <GIS Point ID: LMW-SAF-001>

## **8.9 Pantano Wash (PAN)**

### 8.9.1 Data Gathering Needs

- Monitor Pantano Wash tributary repair area off of Nebraska Rd, next to the County Nebraska Gravel Pit near the confluence of this tributary wash and Pantano Wash. Grouted riprap was constructed in the tributary channel and cement bank stabilization was installed along the west side of the gravel pit in 2007. (T15S R15E Sec. 01) <GIS Point ID: PAN-DAT-001>

### 8.9.2 Frequently Flooded Structures and Properties Subject to Damage

- No site specific issues identified.

### 8.9.3 Infrastructure

- No site specific issues identified.

### 8.9.4 Safety Concerns

- Access to the Pantano Wash tributary repair area off of Nebraska Rd can get cut off during flood events. Do not enter this area during a flood event unless prepared to remain there until the flood waters subside. (T15S R15E Sec. 01) <GIS Point ID: PAN-SAF-001>
- Jeremy Wash (tributary to Rincon Creek) creates flood hazards, but it's all on private property/roads. Alvord Road is a private road that has many problems during flood events. No Access to the road during flood events, but worth looking at after the flooding has occurred. (T15S R16E Sec. 08) <GIS Point ID: PAN-SAF-002>

## **8.10 Rillito Creek (RIL)**

### 8.10.1 Data Gathering Needs

- No site specific issues identified.

### 8.10.2 Frequently Flooded Structures and Properties Subject to Damage

- Rillito River breaks-out of the channel near Alvernon Road. (T13S R14E Sec. 27) <GIS Point ID: RIL-FSP-001>
- Rillito River breaks-out of the channel near Dodge Blvd. (T13S R14E Sec. 28) <GIS Point ID: RIL-FSP-002>
- There are levee-like conditions upstream and downstream of Swan Road between Alamo Wash and Alvernon Wash, on the south side of the Rillito. (T13S R14E Secs. 26 and 27) <GIS Point ID: RIL-FSP-003>
- 3371 E. River Rd. (111-02-003B) - Repetitive Loss Property, with losses claimed in 1993 and 1996. (T13S R14E Sec. 28) <GIS Point ID: RIL-FSP-004>

### 8.10.3 Infrastructure

- Monitor and document the flood water level at the Dodge Blvd. If the water level appears to be within 18 inches of the crossing infrastructure, call the District or 911. (T13S R14E Sec 28) <GIS Point ID: RIL-INF-001>

### 8.10.4 Safety Concerns

- Do not attempt to cross Dodge Blvd. if the flood water level is near the bridge deck. (T13S R14E Sec. 28) <GIS Point ID: RIL-SAF-001>

## **8.11 Rincon Creek (RIN)**

### 8.11.1 Data Gathering Needs

- Little is known about the timing of Rincon Creek flooding downstream of the stream gage. If in the area pre-crest, watch for the flood crest at Camino Loma Alta. (T15S R16E Sec. 14) <RIN-DAT-001>
- Little is known about the timing of Rincon Creek flooding downstream of the stream gage. If in the area pre-crest, watch for the flood crest at Old Spanish Trail. (T15S R16E Sec. 08) <RIN-DAT-002>

### 8.11.2 Frequently Flooded Structures and Properties Subject to Damage

- 6810 S. Avenida de la Potranca (205-81-0230) (Ranchos Pequenos, Rincon Creek) (T15S R16E Sec. 17) <GIS Point ID: RIN-FSP-001>
- 12441 E. Camino del Garanon (205-81-0280) (Ranchos Pequenos, Rincon Creek) (T15S R16E Sec. 17) <GIS Point ID: RIN-FSP-002>
- 12620 E. Old Spanish Trail (205-81-032F) (Ranchos Pequenos, Rincon Creek) (T15S R16E Sec. 17) <GIS Point ID: RIN-FSP-003>
- A levee on 205-64-010D SE of Ranchos Pequenos that became a sediment dam on a tributary to Rincon Creek has been breached, supplying sediment downstream that is causing problems on Old Spanish Trail. There is a diversion of flow into this watershed upstream at

a stock tank. The tributary has been cleaned out, and DOT is supposed to maintain it. (T15S R16E Sec. 16) <GIS Point ID: RIN-FSP-004>

#### 8.11.3 Infrastructure

- A major breach of the mine west of Old Spanish Trail (205-67-006C) could capture flows from Rincon Creek and cause severe damage to the road. (T15S R16E Sec. 08) <GIS Point ID: RIN-INF-001>

#### 8.11.4 Safety Concerns

- Hazardous conditions exist where Rincon Creek crosses Old Spanish Trail. (T15S R16E Sec. 08) <GIS Point ID: RIN-SAF-001>
- Hazardous conditions exist where Rincon Creek crosses Camino Loma Alta. The channel has aggraded above the level of the culverts, causing water to flow over the road. DOT maintains the right-of-way, but sediment keeps causing problems. The area north of Rincon Creek on Camino Loma Alta is inaccessible during flow events. (T15S R16E Sec. 14) <GIS Point ID: RIN-SAF-002>
- Dike/levee protecting structures along eastern edge of Thunderhead Ranch subdivision may fail. (T15S R16E Sec. 08) <GIS Point ID: RIN-SAF-003>
- DOT is called whenever Rincon Creek flows reach 1000 cfs. (T15S R17E Sec. 17) <RIN-SAF-004>

### 8.12 Sabino Creek (SAB)

#### 8.12.1 Data Gathering Needs

- No site specific issues identified.

#### 8.12.2 Frequently Flooded Structures and Properties Subject to Damage

- Woodland Wash and other area channels do not have enough capacity to convey the base flood. (T13S R15E Sec. 23) <GIS Point ID: SAB-FSP-001>
- 3591 N. Bear Canyon Road (114-27-4380) (T13S R15E Sec. 27) <GIS Point ID: SAB-FSP-002>
- 3537 N. Camino Seco (114-28-015D) (T13S R15E Sec. 28) <GIS Point ID: SAB-FSP-003>
- 3720 N. Camino Seco (114-27-445C) - Repetitive Loss Property, with claims in 1993 and 1999. (T13S R15E Sec. 27) <GIS Point ID: SAB-FSP-004>
- 8525 E. Cloud Road (114-28-016B) (T13S R15E Sec. 28) <GIS Point ID: SAB-FSP-005>
- 4575 N. Palisade Drive (114-19-010U) (T13S R15E Sec. 22) <GIS Point ID: SAB-FSP-006>
- 4830 N. Hidden Valley Road (114-12-083A) (T13S R15E Sec. 16) <GIS Point ID: SAB-FSP-007>
- There are erosion concerns on Sabino Creek near Cloud Road (T13S R15E Sec. 28) <GIS Point ID: SAB-FSP-008>
- Springs may appear and septic systems may be adversely affected after significant moisture and/or sustained flows along the eastern Santa Catalina mountain front. (T13S R15E Sec. 13-16, T13S R16E Sec. 16-18) <SAB-FSP-009>

### 8.12.3 Infrastructure

- Snyder Road is potentially subject to damage along the eastern portion of the Santa Catalina mountain front. Snyder Road is also roughly the breakline between steep slopes and shallower slopes, and is an area of concern with respect to sediment deposition filling channels and causing flows to take unpredictable and uncertain flow paths. (T13S R15E Sec. 14) <SAB-INF-001>

### 8.12.4 Safety Concerns

- Rio Vista Drive conveys flow. (T13S R15E Sec. 23) <GIS Point ID: SAB-SAF-001>
- A wall along the west side of Houghton Road blocks flow. (T13S R15E Sec. 14) <GIS Point ID: SAB-SAF-002>
- This area contains numerous wash crossings that may become impassable. Paved crossings are subject to flood damage and may be severely damaged. Snyder Road between Harrison Rd. and Soldier Trail is particularly problematic. (T13S R15E Sec. 24) <GIS Point ID: SAB-SAF-003>
- Woodland Wash crosses Harrison road and Bear Canyon Road over at-grade crossings that are hazardous. (T13S R15E Sec. 22) <GIS Point ID: SAB-SAF-004>

## 8.13 Santa Cruz River - Lower (SCL)

### 8.13.1 Data Gathering Needs

- No site specific issues identified.

### 8.13.2 Frequently Flooded Structures and Properties Subject to Damage

- Berry Acres subdivision is subject to flooding (T11S R10E Sec. 24) <GIS Point ID: SCL-FSP-001>. (within the limits of the Town of Marana)

### 8.13.3 Infrastructure

- No site specific issues identified.

### 8.13.4 Safety Concerns

- No site specific issues identified.

## 8.14 Santa Cruz River - Middle (SCM)

### 8.14.1 Data Gathering Needs

- No site specific issues identified.

### 8.14.2 Frequently Flooded Structures and Properties Subject to Damage

- The Casas Arroyo subdivision is located on the outside of a bend in the Santa Cruz River and may experience flooding and erosion problems. (T13S R12E Sec. 01) <GIS Point ID: SCM-FSP-001>
- Tetakusim Road and Settler Avenue (T15S R13E Sec. 19) <GIS Point ID: SCM-FSP-002>

- The homes in the vicinity of Oriole Circle and Mayes Place are some of the most frequently flooded structures in Pima County. Water in structures up to 18 inches deep due to Valencia Wash. (T15S R13E Sec. 09) <GIS Point ID: SCM-FSP-003>
- Homes have been known to flood south of Irvington Rd. and east of San Joaquin Ave. (T15S R13E Sec. 04) <GIS Point ID: SCM-FSP-004>
- Wyoming Wash in the vicinity of Irvington Rd. and La Cholla Blvd. flows approximately 300 feet wide (across Sindle Pl, to the north) T15S R13E Sec. 03) <GIS Point ID: SCM-FSP-005>

#### 8.14.3 Infrastructure

- The Ina Road bridge gets shut down when flow is approximately 4-5 feet, equivalent to roughly the 25 year event, approximately 20,000 cfs. This issue is in the Town of Marana. (T13S R12E Sec. 01) <GIS Point ID: SCM-INF-001>
- The storm grate on the west side of Westover Ave. between Drexel Rd. and Canada St. has been subject to getting plugged up and causing flooding on nearby properties. A 2006 fix should improve the grate, but it's worth following up on. (T15S R13E Sec. 04) <GIS Point ID: SCM-INF-002>
- The channel of the Santa Cruz West Branch is largely earthen and is heavily eroded in certain areas, such as where Dakota Wash enters the West Branch east of Mission Rd. and south of Irvington Rd. (T15S R13E Sec. 03) <GIS Point ID: SCM-INF-003>
- The floodwall for Mission West II subdivision is on private, individual lots and may not be properly maintained. (T15S R13E Sec. 20) <GIS Point ID: SCM-INF-004>
- The earthen embankment near the NW corner of San Xavier Estates is overtopped during the base flood. (T15S R13E Sec. 20) <GIS Point ID: SCM-INF-005>
- Santa Cruz River: 6700 N Silverbell Road (214-03-0400) is subject to channel bank migration. Based on the Sunset Road Bridge Study it is suspected that the bulk of the vegetation will be removed at 21,800 cfs. That vegetation is at the toe of the cut-slope and at a gentle outside meander. The home at 6700 N Silverbell Road is less than 100 feet from what will be a 30 foot cut-slope. (T13S R12E Sec. 01) <GIS Point ID: SCM-INF-006>
- Santa Cruz River: 6730 N Silver Ridge Road (214-03-0430) is subject to channel bank migration. Based on the Sunset Road Bridge Study it is suspected that the bulk of the vegetation will be removed at 21,800 cfs. That vegetation is at the toe of the cut-slope and at a gentle outside meander. The home at 6730 N Silver Ridge Road is less than 150 feet from what will be a 30 foot cut-slope. (T13S R12E Sec. 01) <GIS Point ID: SCM-INF-007>

#### 8.14.4 Safety Concerns

- No site specific issues identified.

### 8.15 Santa Cruz River - Upper (SCU)

#### 8.15.1 Data Gathering Needs

- No site specific issues identified.

#### 8.15.2 Frequently Flooded Structures and Properties Subject to Damage

- The Lee Moore Wash and tributaries to the Lee Moore have created head cuts and other erosional features that are a potential threat to structures in the vicinity of Camino San Matias and Calle San Julian. (T16S R14E Sec. 18) <GIS Point ID: SCU-FSP-001>
- The Madera Highlands subdivision may not have been adequately designed to deal with flooding from the Santa Cruz River and Sawmill Canyon Wash. (T18S R13E Sec. 13) <GIS Point ID: SCU-FSP-002>

#### 8.15.3 Infrastructure

- No site specific issues identified.

#### 8.15.4 Safety Concerns

- Green Valley drainageway # 6, does not have enough capacity to convey the base flood. (T18S R13E Secs. 10, 11) <GIS Point ID: SCU-SAF-001>
- Green Valley drainageway # 9 does not have enough capacity to convey the base flood. (T18S R13E Secs. 14, 15)<GIS Point ID: SCU-SAF-002>
- Green Valley drainageway # 13 does not have enough capacity to convey the base flood. (T18S R13E Secs. 14, 15, 22, 23) <GIS Point ID: SCU-SAF-003>
- Green Valley drainageway # 17 does not have enough capacity to convey the base flood. (T18S R13E Secs. 22, 23) <GIS Point ID: SCU-SAF-004>
- Green Valley drainageway # 6 has vertical embankments. (T18S R13E Secs. 10 11) <GIS Point ID: SCU-SAF-005>
- Green Valley drainageway # 9 has vertical embankments. (T18S R13E Secs. 14, 15) <GIS Point ID: SCU-SAF-006>
- Santa Cruz River: The channel of the Santa Cruz River will contain the 10 year event (about 16,000 cfs) at the Green Valley Sewage Treatment facility. The channel upstream will not contain the 50-year event (about 32,000 cfs). Once it gets out in the right overbank, access along the Nogales highway could be compromised. In a 50-yr event someone in Sahuarita should monitor the highway and railroad adjacent to Madera Highlands. (T17S R14E Sec. 31) <GIS Point ID: SCU-SAF-007>
- Santa Cruz River: The channel capacity of the Santa Cruz River at Pima Mine Road is 16,000 cfs according to the Flood Insurance Study. Head cutting has increased the channel capacity, so the threshold of concern is approximately 20,000 cfs. If flows break out the intersection of Pima Mine and Old Nogales will start to flood. (T16S R14E Sec. 31) <GIS Point ID: SCU-SAF-008>

### 8.16 Tortolita Fan (TRT)

#### 8.16.1 Data Gathering Needs

- No site specific issues identified.

#### 8.16.2 Frequently Flooded Structures and Properties Subject to Damage

- No site specific issues identified.

### 8.16.3 Infrastructure

- No site specific issues identified.

### 8.16.4 Safety Concerns

- Hartman Lane as it enters Marana (near Countryside Vista and Countryside Terrace) is subject to flooding and can become impassable, especially at the crossing near Wood Owl Dr. Also, the wash south of Condor Dr. is prone to filling up with sediment. (T12S R12E Sec. 24) <GIS Point ID: TRT-SAF-001>

## 8.17 Tanque Verde Creek (TVC)

### 8.17.1 Data Gathering Needs

- No site specific issues identified.

### 8.17.2 Frequently Flooded Structures and Properties Subject to Damage

- Tanque Verde Creek breaks-out on the right overbank onto Woodland Road at 13,000-15,000 cfs. There is an ALERT system trigger for this discharge. (T14S R15E Sec. 03) <GIS Point ID: TVC-FSP-001>
- Based on modeling, Tanque Verde Creek breaks-out of the main channel at Tanque Verde Loop Road between 14,000-16,000 cfs. (T14S R16E Sec. 06) <GIS Point ID: TVC-FSP-002>
- Based on modeling, Tanque Verde Creek breaks-out of the main channel at Houghton Road between 12,000-14,000 cfs. (T14S R15E Sec. 01) <GIS Point ID: TVC-FSP-003>
- The south half of 49ers subdivision is subject to overbank flooding from Tanque Verde Creek at around 14,000-16,000 cfs. (T14S R16E Sec. 05) <GIS Point ID: TVC-FSP-004>
- 12140 E. Barbary Coast Rd. (205-50-0890) - Repetitive Loss Property, with losses claimed in 1983, 1984 and 2010. (T14S R16E Sec. 05) <GIS Point ID: TVC-FSP-005>
- 12150 E. Barbary Coast Rd. (205-50-0900) - Repetitive Loss Property, with losses claimed in 1978, 1983, 1984, 1990 and 2010. (T14S R16E Sec. 05) <GIS Point ID: TVC-FSP-006>
- 12530 E Gold Dust Dr. (205-50-0130) - Repetitive Loss Property, with losses claimed in 2006 and 2010. (T14S R16E Sec. 05) <GIS Point ID: TVC-FSP-007>

### 8.17.3 Infrastructure

- Washes within Forty Niners subdivision become filled with sediment and the reduced channel capacity may increase flooding, especially west of the bend in Gold Dust Drive. The washes are public except for one. (T14S R16E Sec. 05) <GIS Point ID: TVC-INF-001>
- An interceptor sewer follows the north bank of Tanque Verde Creek upstream of Sabino. There is no bank protection for this infrastructure. (T13S R15E Sec. 33) <GIS Point ID: TVC-INF-002>

### 8.17.4 Safety Concerns

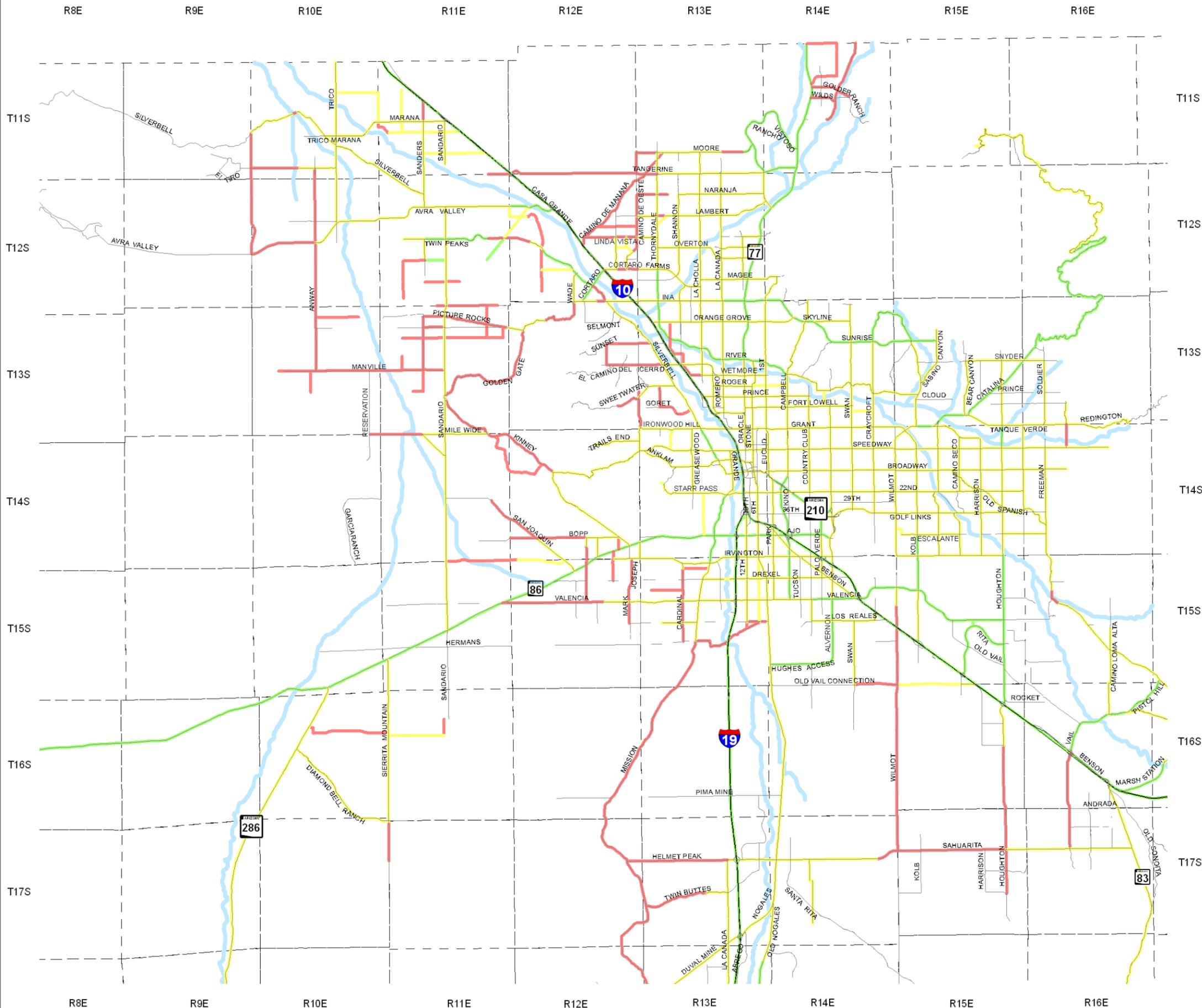
- Hazardous conditions exist at the dip crossings of Tanque Verde Creek at Tanque Verde Loop Road (T14S R16E Sec. 06) <GIS Point ID: TVC-SAF-001>

- Hazardous conditions exist at the dip crossings of Tanque Verde Creek at Wentworth Road. (T15S R16E Sec. 04) <GIS Point ID: TVC-SAF-002>

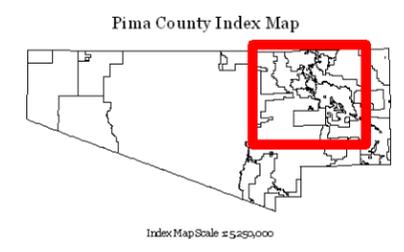
## **APPENDIX A**

# **EMERGENCY VEHICLE ACCESS DURING FLOODING FOR THE TUCSON AREA**

# EMERGENCY VEHICLE ACCESS DURING FLOODING TUCSON AREA



- Road Questionable During Storms
- Roads Passable During Moderate Storms
- Roads Passable During Major Floods
- Major Washes
- Township / Range



The information depicted on this display is the result of digital analysis performed on a variety of databases provided and maintained by several governmental agencies. The accuracy of the information presented is limited to the collective accuracy of these databases on the date of the analysis. The Pima County Regional Flood Control Department makes no claims regarding the accuracy of the information depicted herein.

This product is subject to the Department of Transportation Technical Services Division's Use Restriction Agreement.

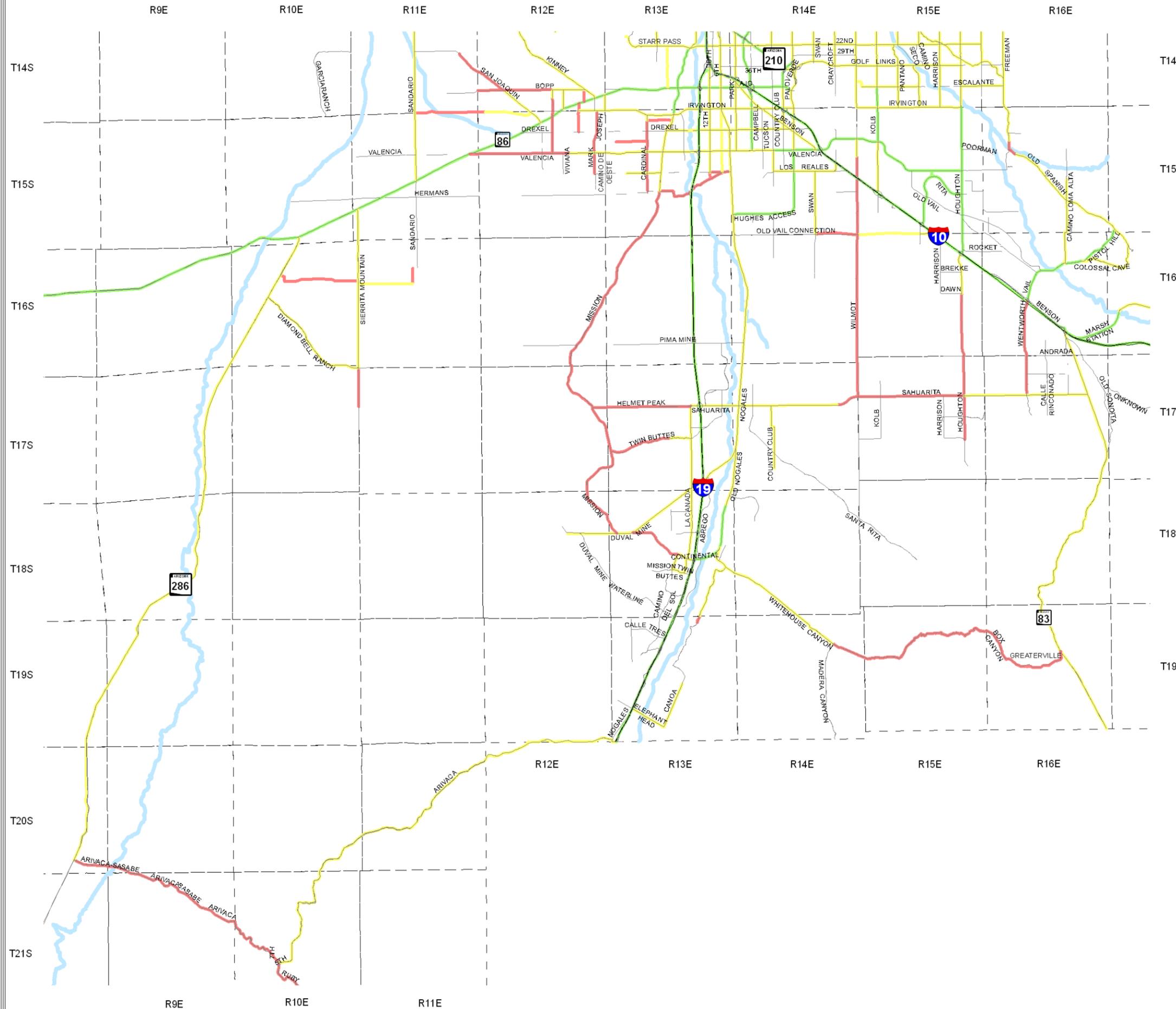


Scale 1:300,000

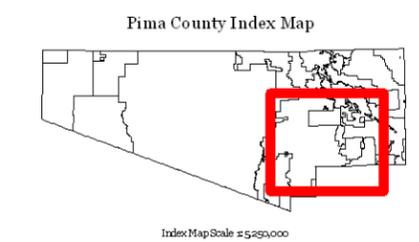


7/3/2007

# EMERGENCY VEHICLE ACCESS DURING FLOODING GREEN VALLEY AREA



- Major Streets
- Road Questionable During Storms
- Roads Passable During Moderate Storms
- Roads Passable During Major Floods
- Major Washes
- Township / Range



The information depicted on this display is the result of digital analysis performed on a variety of databases provided and maintained by several governmental agencies. The accuracy of the information presented is limited to the collective accuracy of these databases on the date of the analysis. The Pima County Regional Flood Control Department makes no claims regarding the accuracy of the information depicted herein.

This project is subject to the Department of Transportation Technical Services Division's Use Restriction Agreement.

Pima County Regional Flood Control District  
**FLOOD CONTROL DISTRICT**

Scale 1:300,000

7/3/2007

**APPENDIX B**

**FLOOD INVESTIGATION FIELD LOG**



## **APPENDIX C**

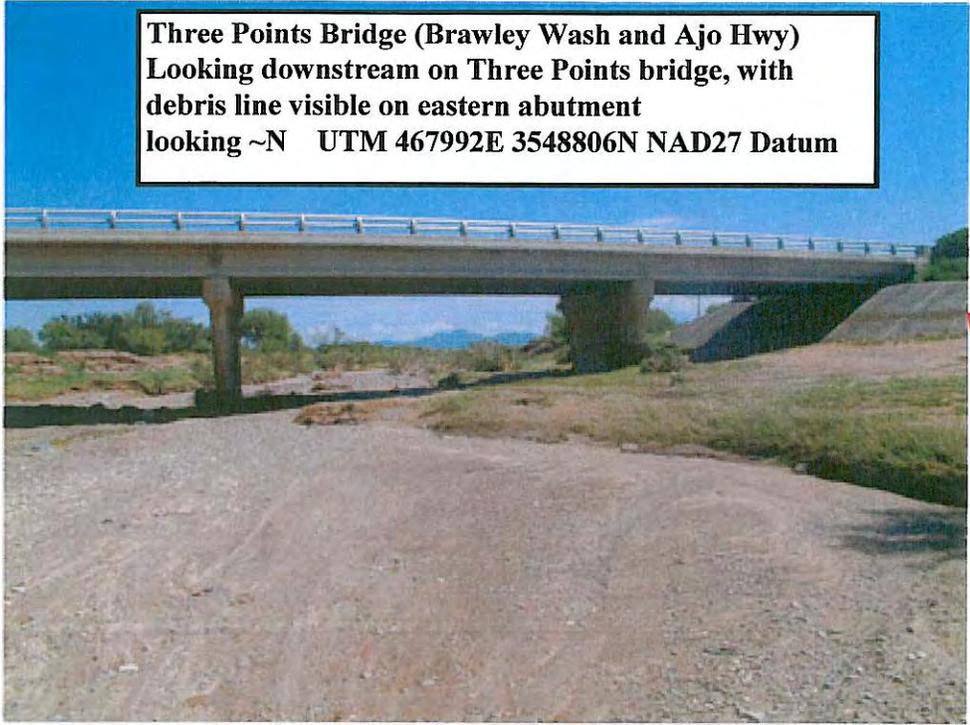
### **EXAMPLE FLOOD INVESTIGATION FIELD LOG**





## **APPENDIX D**

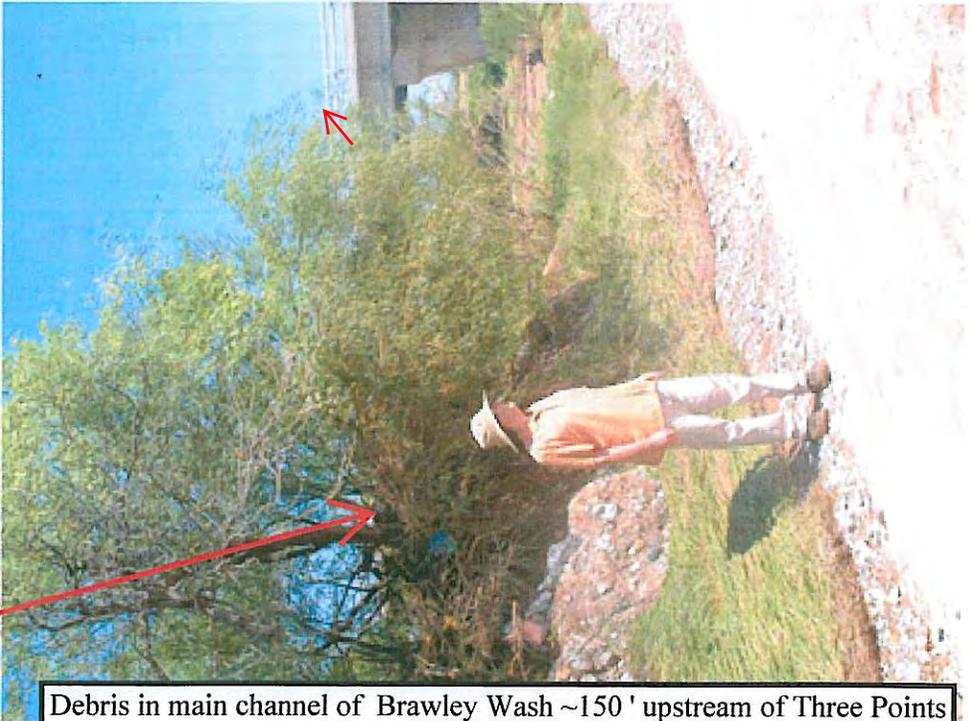
### **EXAMPLE PHOTO ANNOTATION**



**Three Points Bridge (Brawley Wash and Ajo Hwy)  
Looking downstream on Three Points bridge, with  
debris line visible on eastern abutment  
looking ~N UTM 467992E 3548806N NAD27 Datum**

**Debris  
line  
approx. 5  
ft below  
the bottom  
of the  
deck of  
the bridge**

IMG\_MISC\_BrawleyFlood08-15-05\_05

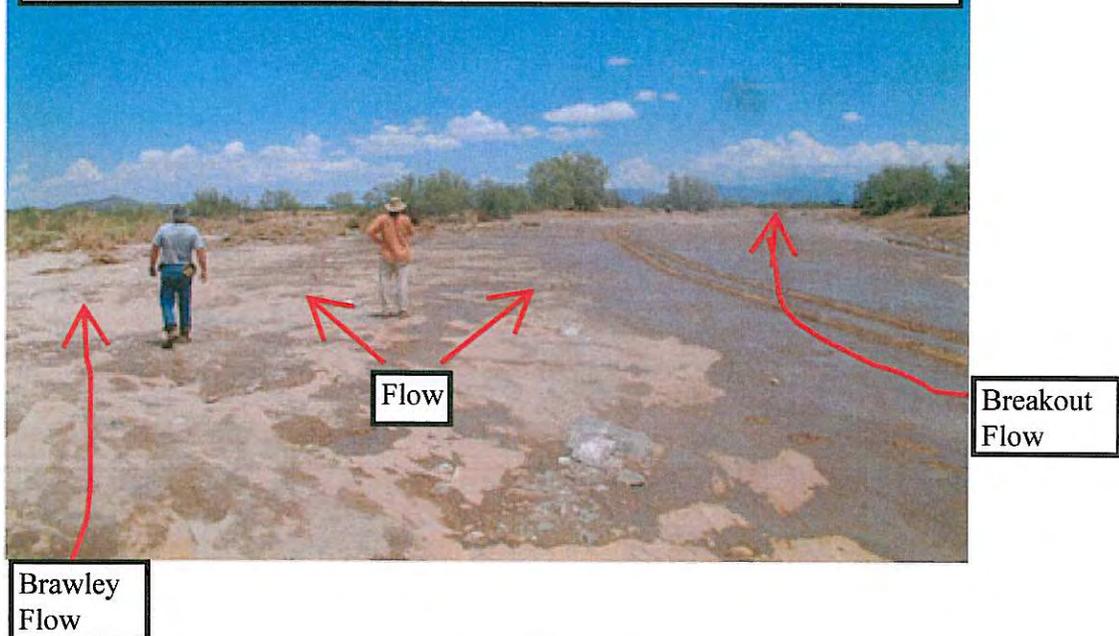


**Debris  
line**

**Debris in main channel of Brawley Wash ~150 ' upstream of Three Points  
bridge - Debris approximately 9-10 ft. above channel bottom  
approx UTM 467990E 3548806N (NAD27 Datum)**

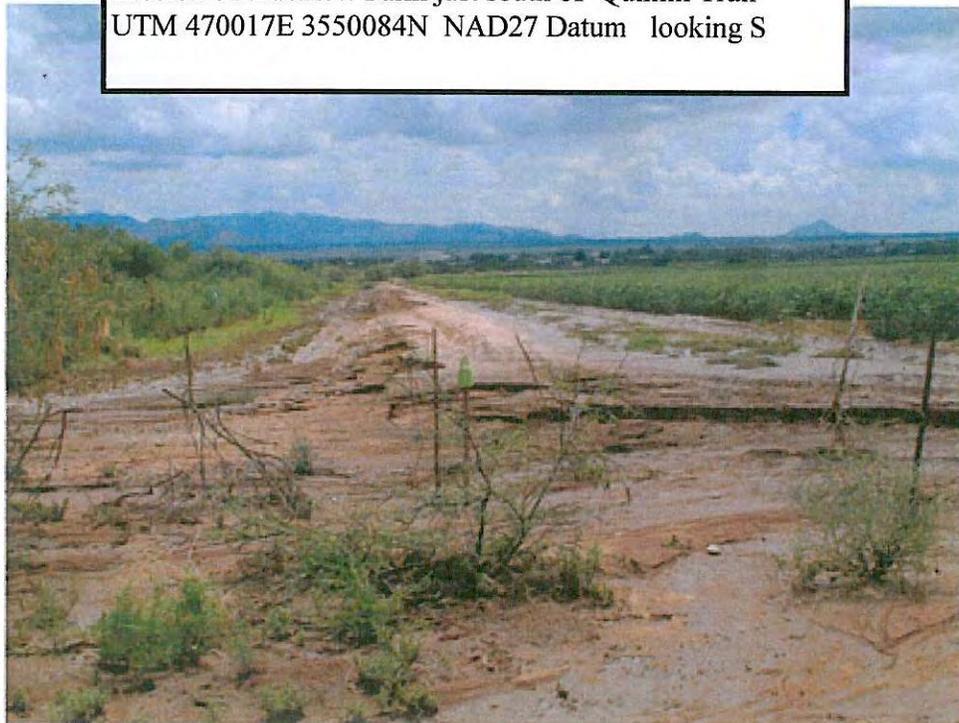
IMG\_MISC\_BrawleyFlood08-15-05\_06

Brawley Wash (left) and breakout (right) that sent water towards 16478 W. Quinlin Tr. (left) and 16482 W. Quinlin Tr. The elevation of the breakout channel is approximately 5-6 ft above the main channel of the Brawley approx UTM 469342E 3550194N WGS84 Datum



IMG\_MISC\_BrawleyFlood08-15-05\_33

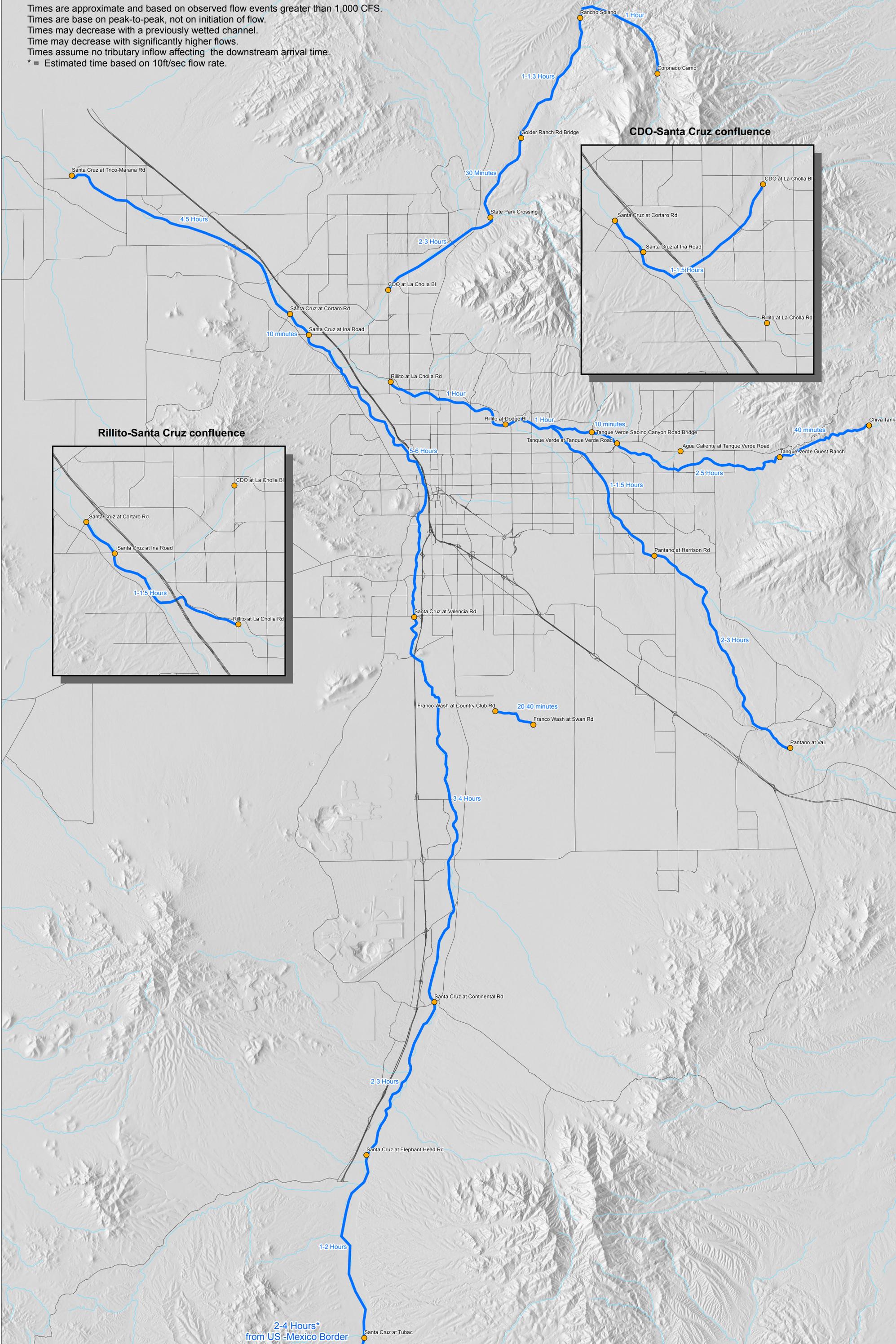
Erosion on Bucklew Farm just south of Quinlin Trail  
UTM 470017E 3550084N NAD27 Datum looking S



IMG\_MISC\_BrawleyFlood08-15-05\_34

**APPENDIX E**  
**FLOOD PEAK TRAVEL TIMES**

Times are approximate and based on observed flow events greater than 1,000 CFS.  
 Times are base on peak-to-peak, not on initiation of flow.  
 Times may decrease with a previously wetted channel.  
 Time may decrease with significantly higher flows.  
 Times assume no tributary inflow affecting the downstream arrival time.  
 \* = Estimated time based on 10ft/sec flow rate.



**Flood Peak Travel Times (01/01/2014)**

Times are approximate and based on observed flow events greater than 1,000 cfs..

Times are based on peak-to-peak, not on initiation of flow.

Time may decrease with a previously wetted channel.

Time may decrease with significantly higher flows.

Times assume no tributary inflow affecting the downstream arrival.

<b>From</b>	<b>To</b>	<b>Time</b>
<b>Tanque Verde Creek</b>		
Tanque Verde Creek at Chiva (2073)	Tanque Verde Creek at Guest Ranch (2093)	40 minutes
Tanque Verde Creek at Guest Ranch (2093)	Tanque Verde Creek at Tanque Verde Rd (2109)	2.5 hours
Agua Caliente Wash at Tanque Verde Rd (2203)	Tanque Verde Creek at Tanque Verde Rd (2109)	1 hour
Tanque Verde Creek at Tanque Verde Rd (2109)	Tanque Verde Creek at Sabino Canyon Rd (2123)	10 minutes
Sabino Creek at Forest Service Dam (2163)	Tanque Verde Creek at Sabino Canyon Rd (2123)	1 - 1.5 hours
Tanque Verde Creek at Sabino Canyon Rd (2123)	Rillito Creek at Dodge Blvd (2353)	1 hour
<b>Rillito Creek</b>		
Tanque Verde Creek at Sabino Canyon Rd (2123)	Rillito Creek at Dodge Blvd (2353)	1 hour
Rillito Creek at Dodge Blvd (2353)	Rillito Creek at La Cholla (2363)	1 hour
Rillito Creek at La Cholla (2363)	Santa Cruz River at Cortaro Rd	1 - 1.5 hours
<b>Santa Cruz River</b>		
Santa Cruz at U.S.-Mexico border	Santa Cruz at Tubac	2 - 4 hours *
Santa Cruz at Tubac	Santa Cruz at Elephant Head Rd (6063)	1 - 2 hours
Santa Cruz at Elephant Head Rd (6063)	Santa Cruz at Continental Rd (6053)	2 - 3 hours
Santa Cruz at Continental Rd (6053)	Santa Cruz at Valencia (6043)	3 - 4 hours
Santa Cruz at Valencia (6043)	Santa Cruz at Ina (6023)	5 - 6 hours
Rillito Creek at La Cholla (2363)	Santa Cruz River at Ina Rd (6023)	50 minutes
Santa Cruz @ Cortaro Rd (USGS)	Santa Cruz @ Trico Rd (USGS)	4.5 hours
<b>Cañada Del Oro Wash</b>		
Cañada Del Oro Wash at Coronado Camp (1113)	Cañada Del Oro Wash at Rancho Solano (1083/1079)	1 hour
Cañada Del Oro Wash at Rancho Solano (1083/1079)	Cañada Del Oro Wash at Golder Rd (1103/1099)	1 - 1.3 hours
Cañada Del Oro Wash at Golder Rd (1103/1099)	Cañada Del Oro Wash at State Park Road Crossing	30 minutes
Cañada Del Oro Wash at Golder Rd (1103/1099)	Cañada Del Oro Wash at Overton Rd	2 - 3 hours
Cañada Del Oro Wash at Overton Rd	Cañada Del Oro Wash at La Cholla	10 min
<b>Pantano Wash</b>		
Pantano Wash at Vail (4253)	Pantano Wash at Harrison Rd	2 - 3 hours
<b>Other</b>		
Franco Wash at Swan (6213)	Franco Wash at Country Club Road	20-40 minutes

\* = Estimated time based on 10ft/sec flow rate.

**APPENDIX F**  
**SCOUR CRITICAL BRIDGES**

# Pima County DOT

## Scour Critical Bridges

### Unknown Foundations

- 8258 Telera Street over Ajo Wash
- 8259 Silverbell Road over Blanco Wash
- 8279 Soldier's Trail over Small Wash
- 8299 Marsh Station Road over Cienega Wash
- 8300 Greaterville Road over Medium Wash
- 8301 Madera Canyon Road over Medium Wash
- 8302 Madera Canyon Road over Florida Canyon Wash
- 8474 Mile Wide Road over Brawley Wash
- 8475 Mile Wide Road over Brawley Wash
- 9565 Houghton Road over Small Wash

### Spread Footing Foundations

- 7563 Old SR 76 over Redfield Canyon
- 9969 Sunrise Drive over Ventana Wash

### Steel H-Pile Foundations

- 7562 Old SR 76 over San Pedro River
- ~~8636 La Cholla Boulevard over Rillito River~~ **REPLACED**
- 9339 Flowing Wells Road over Rillito River
- 9552 Trico-Marana Road over Santa Cruz River
- 9557 River Road over Ventana Wash
- 10487 Nogales Highway over Lee Moore Wash

### Timber Pile Foundations

- 8262 Trico Road over Santa Cruz River

### Steel Pipe Pile Foundations

- 8273 Dodge Boulevard over Rillito River
- 9553 Trico Road over Brawley Wash