



# Lake Havasu City **Wash Management Plan**



Adopted by Resolution No. 25-3878  
City Council October 28, 2025

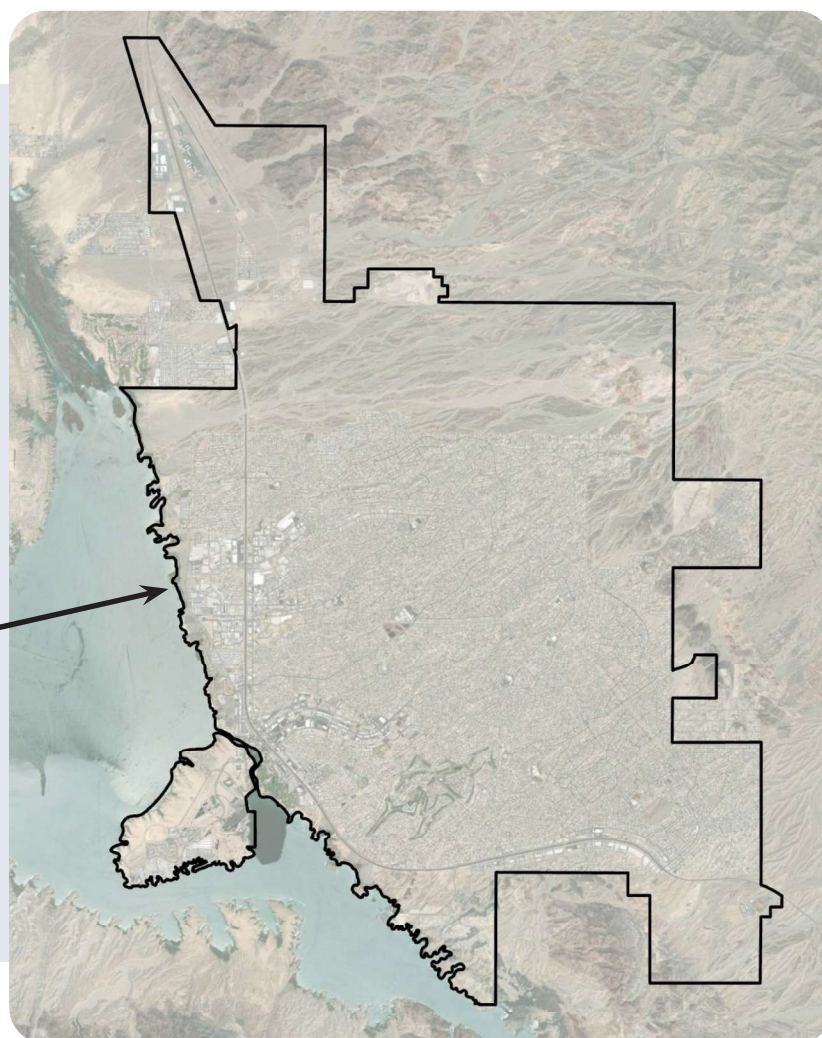


# Executive Summary

## Intro

### General/Purpose/Goals

Lake Havasu City (City) is located in northwest Mohave County. The City was incorporated in 1978 around the impounded waters of the Colorado River as a result of the Parker Dam. The City has a significant amount of residential developments paired with commercial and recreational landuse. The residential developments were developed around the natural washes that pass through the City. The large washes carry offsite runoff from the Mohave Mountains to the lake. Most of the washes were large unprotected trapezoidal channels when first developed. The channels regularly experience erosion, scour, sedimentation and head-cutting due to common storm events. Over the past 15 years, the City has been analyzing, evaluating and implementing mitigation measures to stabilize the existing washes throughout the City limits.





## Purpose:

1. Re-evaluate the existing washes based on previous studies to determine the highest priorities for future wash stabilization
2. Conduct existing and proposed hydraulic analysis on the prioritized washes.
3. Develop alternatives and recommended plans for the prioritized washes with detailed cost estimates for the City to integrate into the Capital Improvement Program (CIP)
4. Prepare an implementation plan for the design and construction of the prioritized washes.

*The goal of the City's wash stabilization program is to provide protection for adjacent residential homes from further wash scour and migration. There are numerous homes located along many of the washes that are at high risk of damage to habitable structures.*

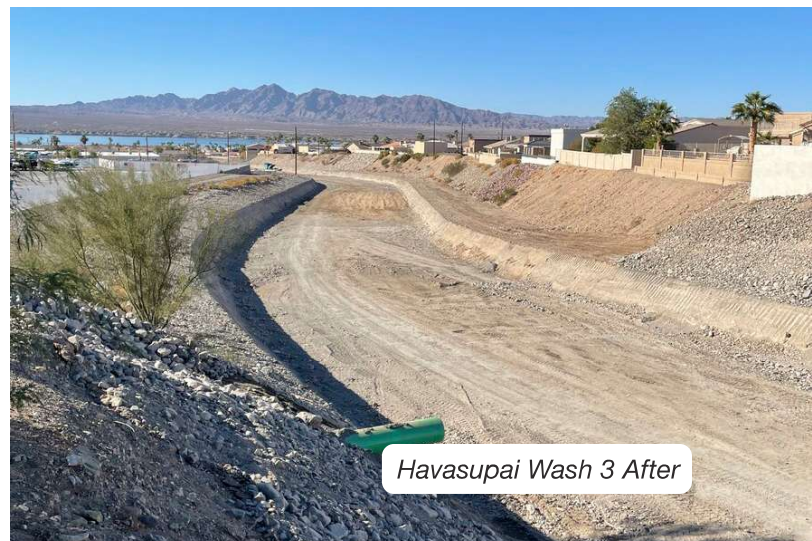
*The stabilization also provides significant maintenance benefits to the City public works staff. Many of the washes require frequent maintenance after common storm events. Stabilizing the washes significantly reduces maintenance efforts for the public works staff providing long-term cost savings.*

## Background

The City completed a Drainage Master Plan (DMP) in 2008 to initially evaluate the conditions and develop initial hydrologic and hydraulic analysis for all of the washes. In 2015, the City completed an Existing Conditions and Prioritization Report (ECPR) to update the evaluation from the DMP and rank the washes in the system. The ECPR performed a detailed ranking system for the entire system. The top 10 washes were evaluated for future improvements as part of the Engineering Analysis & Recommendations Report (EARP) completed in 2015. Since 2015, the City has completed the recommended design as part of the EARP. More than ten (10) wash stabilization projects have been completed since 2015.



Havasupai Wash 3 Before



Havasupai Wash 3 After



# Wash Priorities

## Hydrology/Hydraulics

The original DMP developed a detailed hydrologic model to quantify the amount of runoff reaching each of the washes. The DMP also established sub-reaches within the washes. The DMP established over 200 reaches within all of the City washes. The ECPR revised the original hydrology and provided more detail based on newer methodologies and more available information. A detailed hydrologic and hydraulic model in FLO-2D was completed in 2023 as part of a Federal Emergency Management Agency (FEMA) Cooperating Technical Partner (CTP) project. The FLO-2D model is highly detailed with updated methodologies. The hydrologic and hydraulic results from the FLO-2D model were utilized to assess the prioritized washes from the ECPR. The top 10 washes from the ECPR were removed from the rankings as a result of the wash stabilization improvements that have been completed. The next 15 washes were evaluated with the FLO-2D results as a part of this report. The peak discharges, depths, and velocities for each of the washes are shown in the table below.

| Reach               | ECPR Prioritization Rank | Reach Length | 100-year, 24-hour Discharge (FLO2D) | Average Velocity | Maximum Velocity | Average Depth | Maximum Depth |
|---------------------|--------------------------|--------------|-------------------------------------|------------------|------------------|---------------|---------------|
| Smoketree Wash 3    | 10                       | 1,334        | 804                                 | 6.7              | 11.9             | 2.2           | 5.8           |
| Pima Wash 8         | 12                       | 2,499        | 1,109                               | 7.8              | 16.3             | 3.2           | 8.4           |
| El Dorado Wash 6    | 14                       | 2,378        | 3,636                               | 10.1             | 18.5             | 4.6           | 12.4          |
| Indian Peak Wash 16 | 15                       | 911          | 2,709                               | 9.8              | 15.5             | 3.6           | 7.9           |
| Chemehuevi Wash 13  | 16                       | 613          | 783                                 | 7.5              | 13.2             | 2.6           | 7.7           |
| Kiowa Drain 6       | 18                       | 909          | 1,633                               | 8.3              | 13.2             | 2.9           | 5.7           |
| Havasupai Wash 7    | 20                       | 3,001        | 2,451                               | 9.5              | 16.5             | 3.5           | 8.8           |
| Avalon Drain 1      | 23                       | 358          | 866                                 | 6.5              | 12.8             | 2.3           | 5.9           |
| Buena Vista 2       | 25                       | 1,617        | 948                                 | 7.7              | 14.8             | 3.3           | 8.7           |
| Indian Peak Wash 18 | 26                       | 1,201        | 1,505                               | 8.5              | 13.8             | 3.1           | 6.3           |
| Smoketree Wash 4    | 27                       | 1,786        | 752                                 | 6.2              | 11.5             | 1.9           | 5.1           |
| Pima Wash 6         | 31                       | 1,023        | 1,575                               | 8.2              | 14.0             | 3.8           | 7.1           |

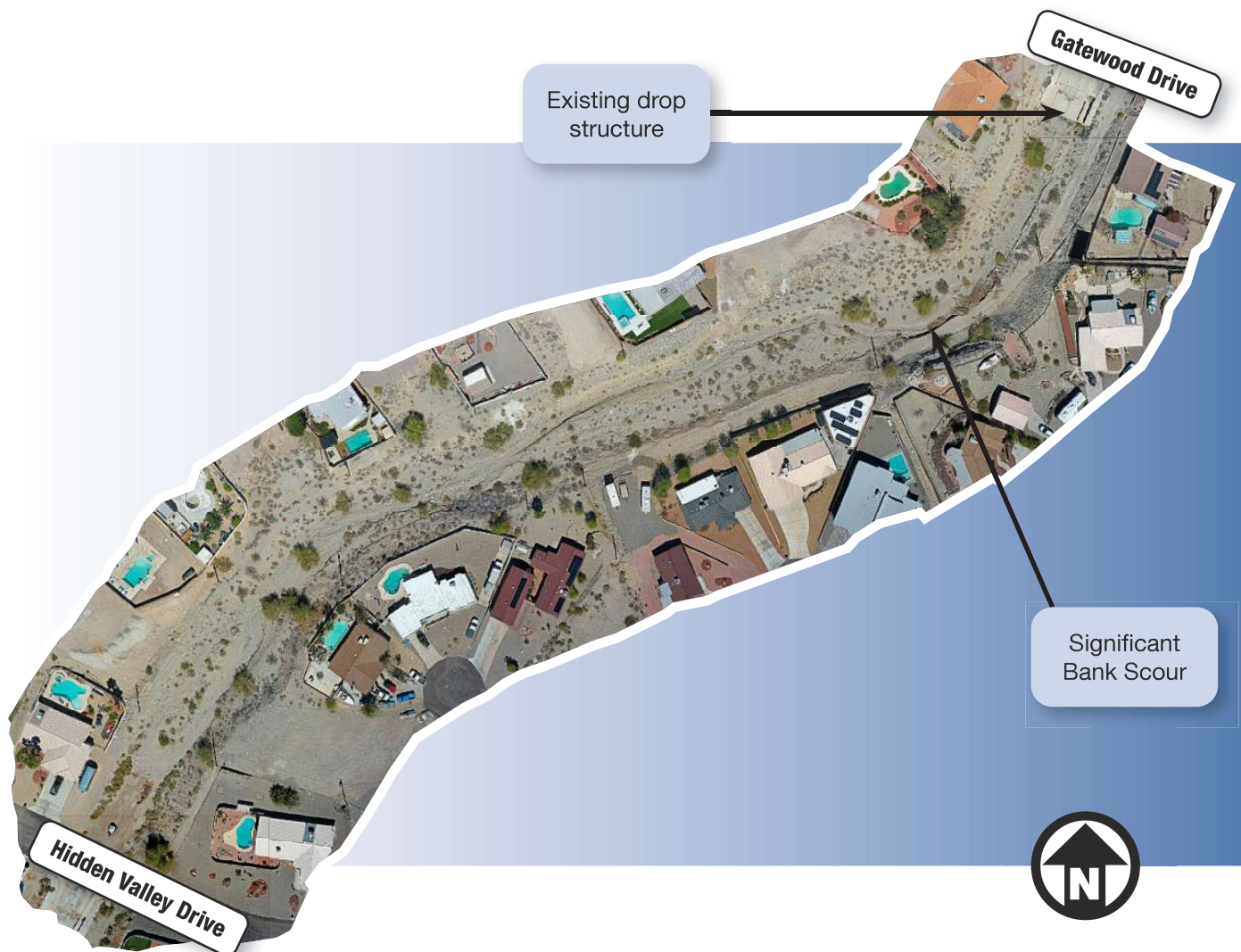
The FLO-2D hydraulic results were paired with anecdotal evidence from field visits by the project team and reviewing detailed aerial views. Several of the next 15 wash showed visual evidence of significant erosion, headcutting or lateral migration while others did not. Based on the hydrologic and hydraulic results and the anecdotal evidence, the re-ranked next ten (10) washes that were evaluated with this report are below.



Aerial drone photography was done for each of the 10 prioritized washes to assess the level of magnitude of erosion hazards. A summary of the key components of each of the washes is provided below.

### Smoke Tree Wash 3

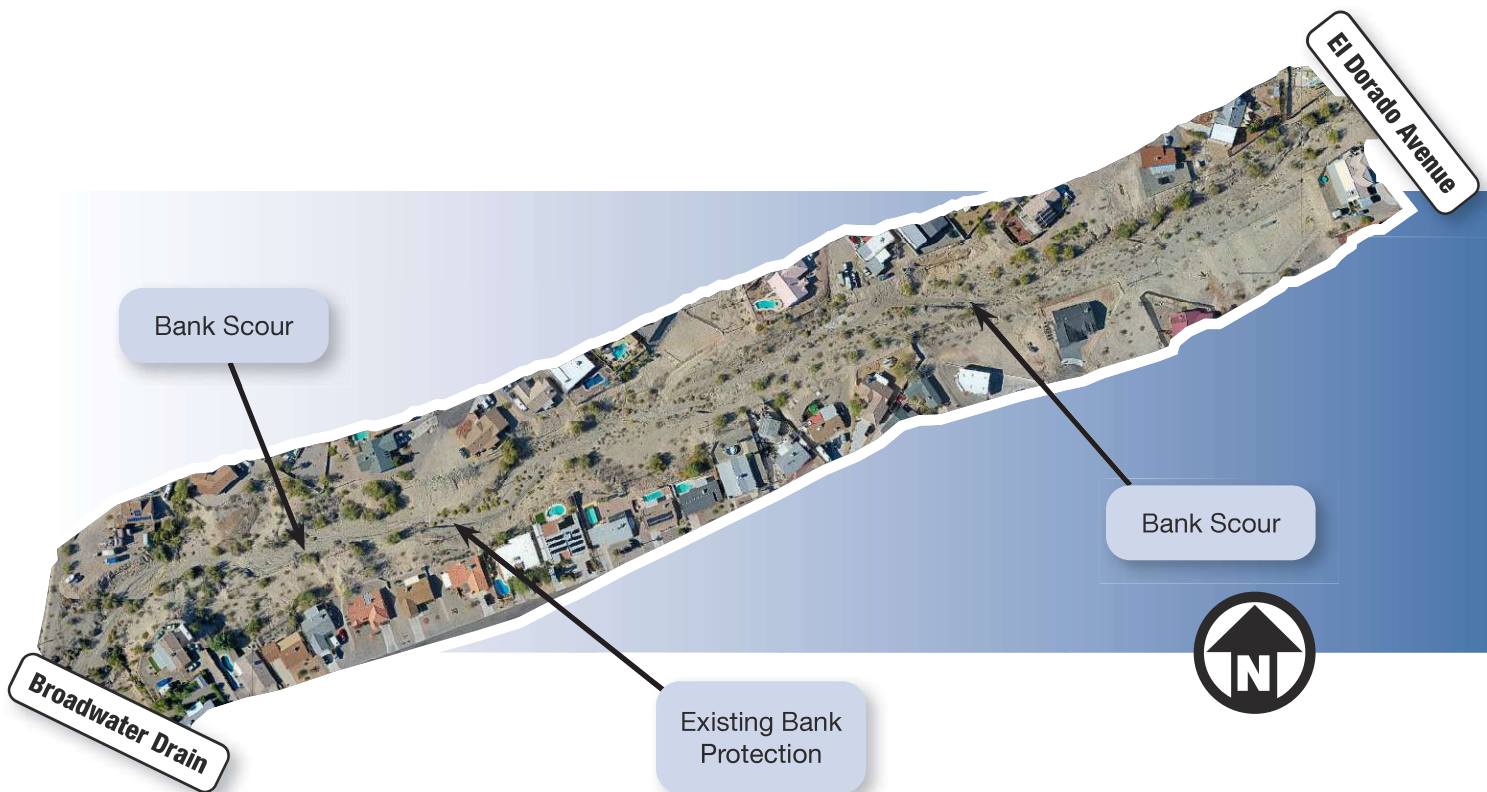
Smoketree Wash 3 is located between Gatewood Drive and Hidden Valley Drive. The reach has moderate meandering and shows evidence of significant scour along the banks approximately 250 feet south of Gatewood Drive. There are also several other spot locations where the meandering reach has become very concise. Utility poles are located along the tops of the banks.





## Pima Wash 8

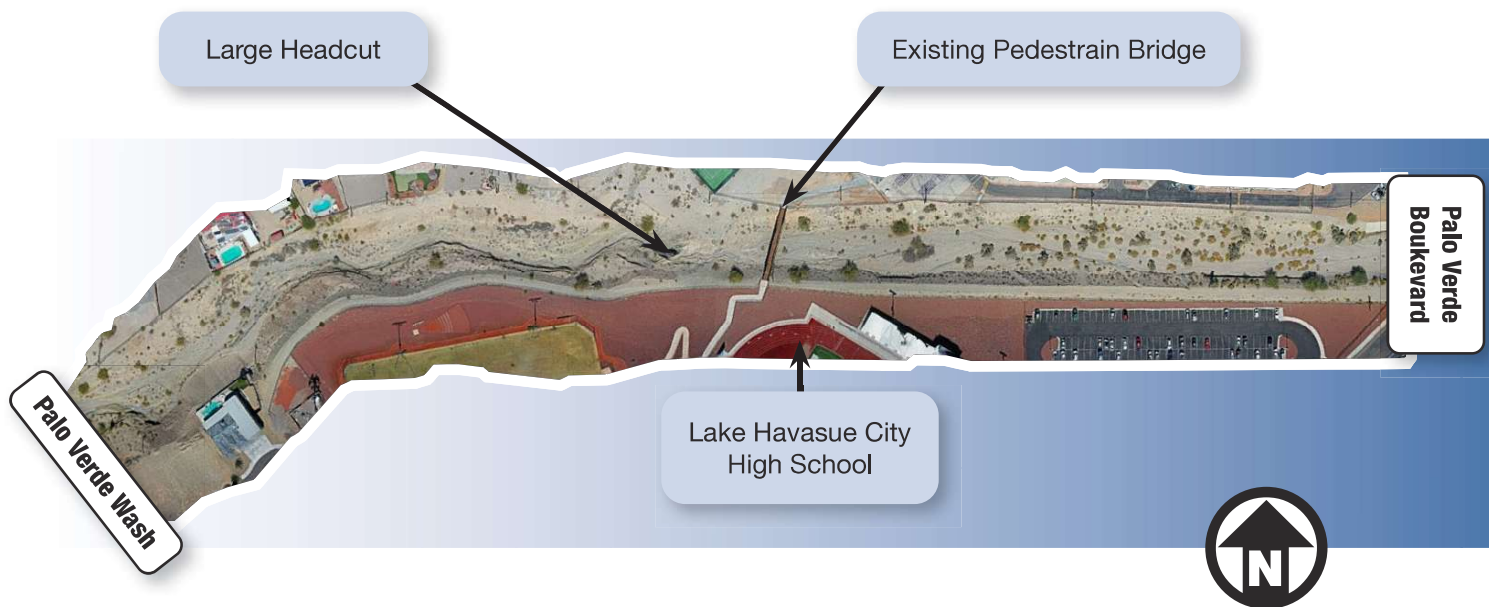
Pima Wash 8 is located between El Dorado Avenue and the confluence with Broadwater Drain. The reach has moderate meanders and shows evidence of bank scour at several locations throughout the reach. Gabion bank protection was installed along the southern bank approximately 1,500 feet downstream of El Dorado Avenue. This reach was identified in the previous top 10 reaches.





## El Dorado 6

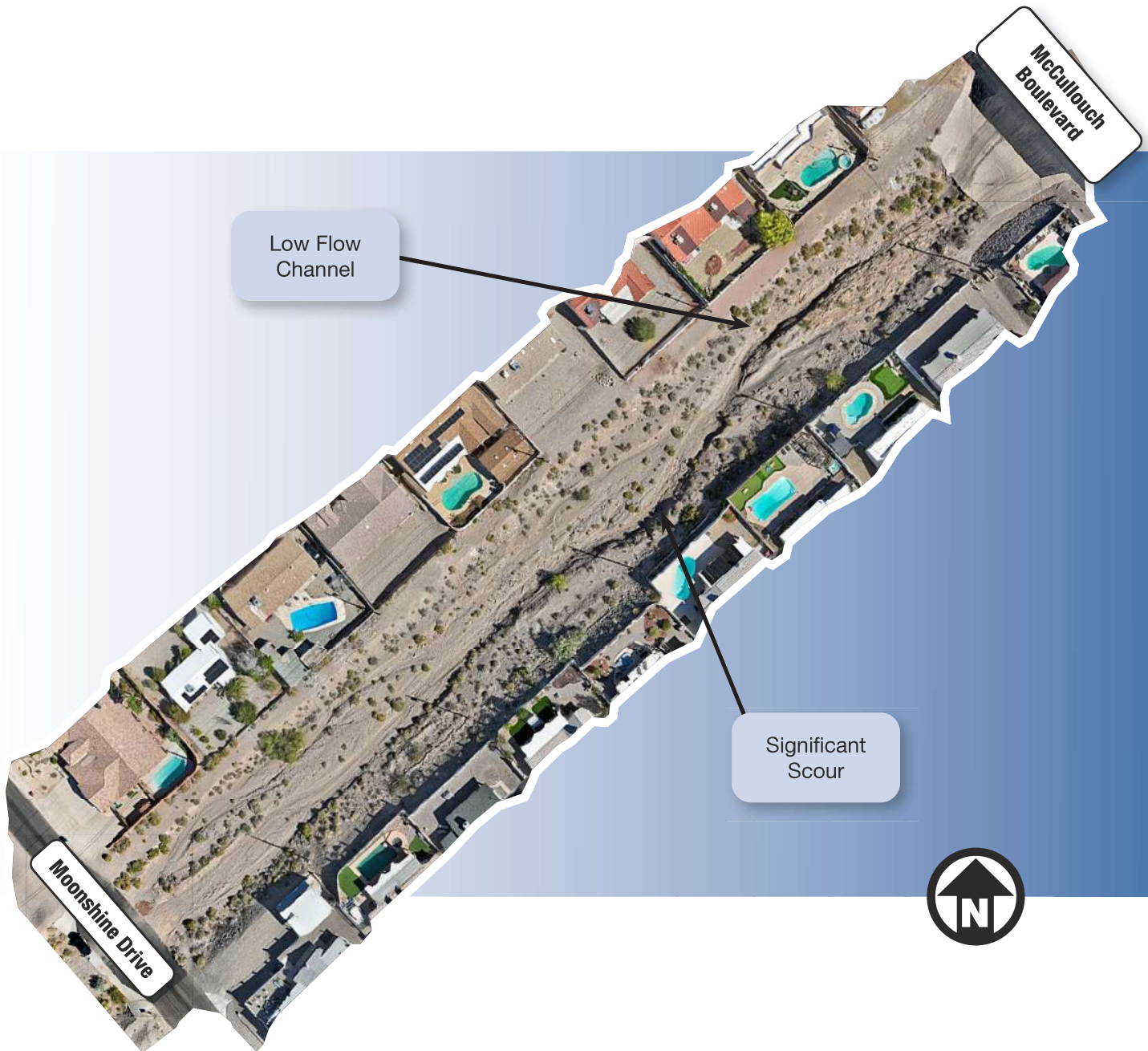
El Dorado 6 is located between Palo Verde Boulevard and the confluence with Palo Verde Wash. The wash is located along the athletic fields for Lake Havasu City high school. The reach is split by a pedestrian bridge spanning the wash. The eastern portion of the wash is straight, steeper and less depth. A large headcut is located 125 feet downstream of the pedestrian bridge. The wash has significant meandering and evidence of scour downstream of the headcut.





## Indian Peak Wash 16

Indian Peak Wash 16 is located between McCulloch Boulevard and Moonshine Drive. The overall reach is straight but shows evidence of significant scour along the banks. A low flow channel has carved out significant scour in the middle of wash. Utility poles are located along the banks of the reach.





## Chemehuevi Wash 13

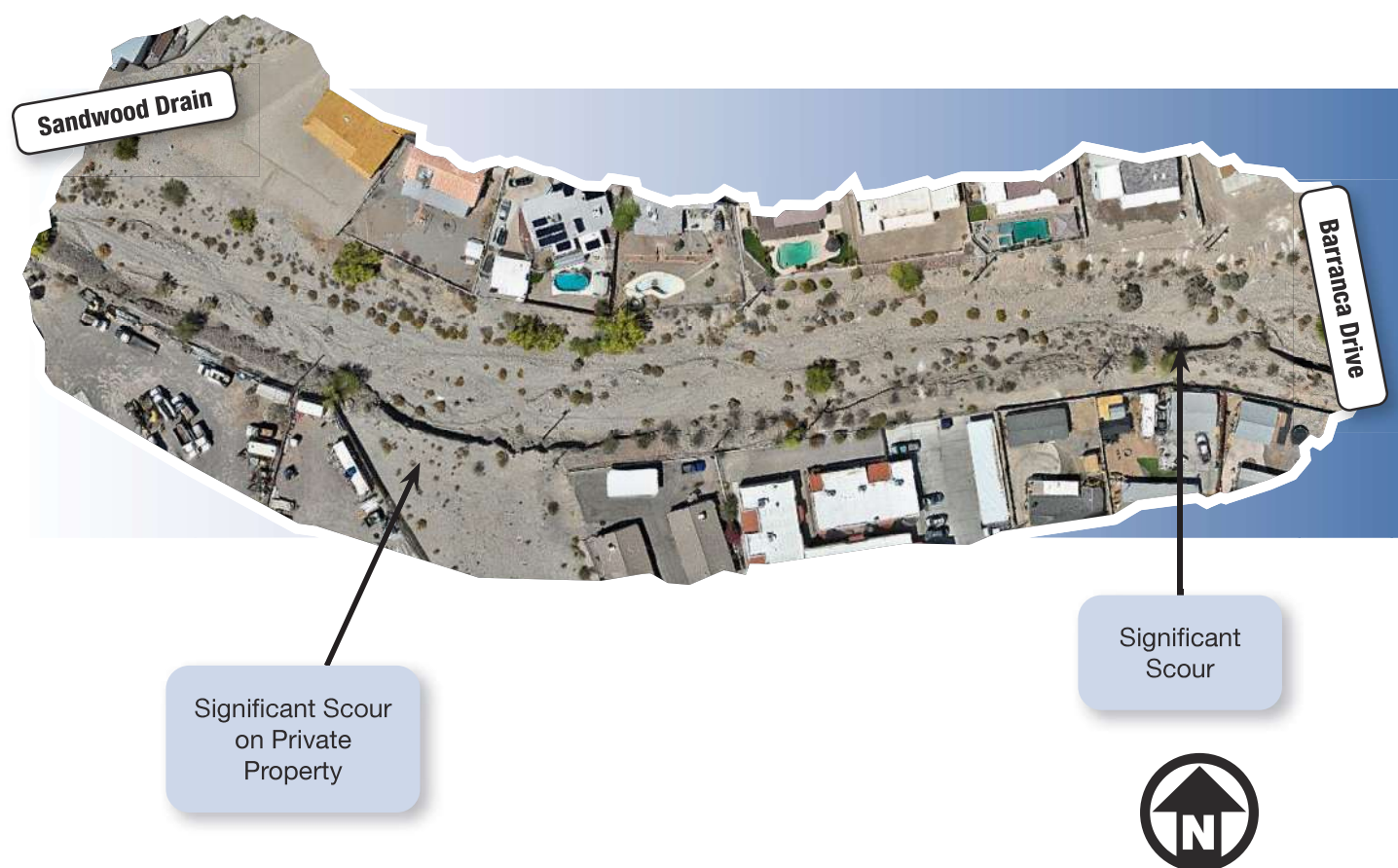
Chemehuevi Wash 13 is located between the eastern boundary of the City limits and Chickasaw Drive. The overall reach is straight with significant scour along the southern banks. Utility poles are located along the top of the banks.





## Kiowa Drain 6

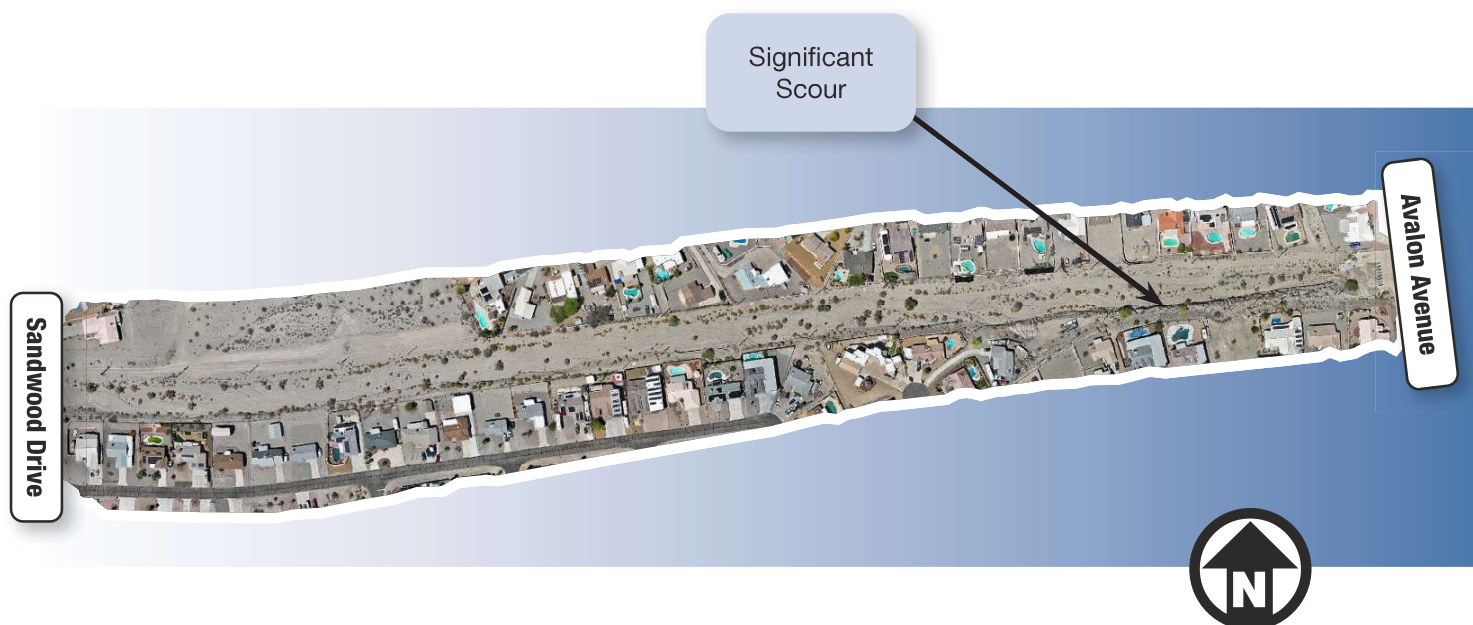
Kiowa Drain 6 is located between Barranca Drive and the confluence with Sandwood Drain. The reach has a mild meander with evidence of significant bank scour along the south banks. Private property is at risk of further damage as a result of the bank scour.





## Havasupai Wash 7

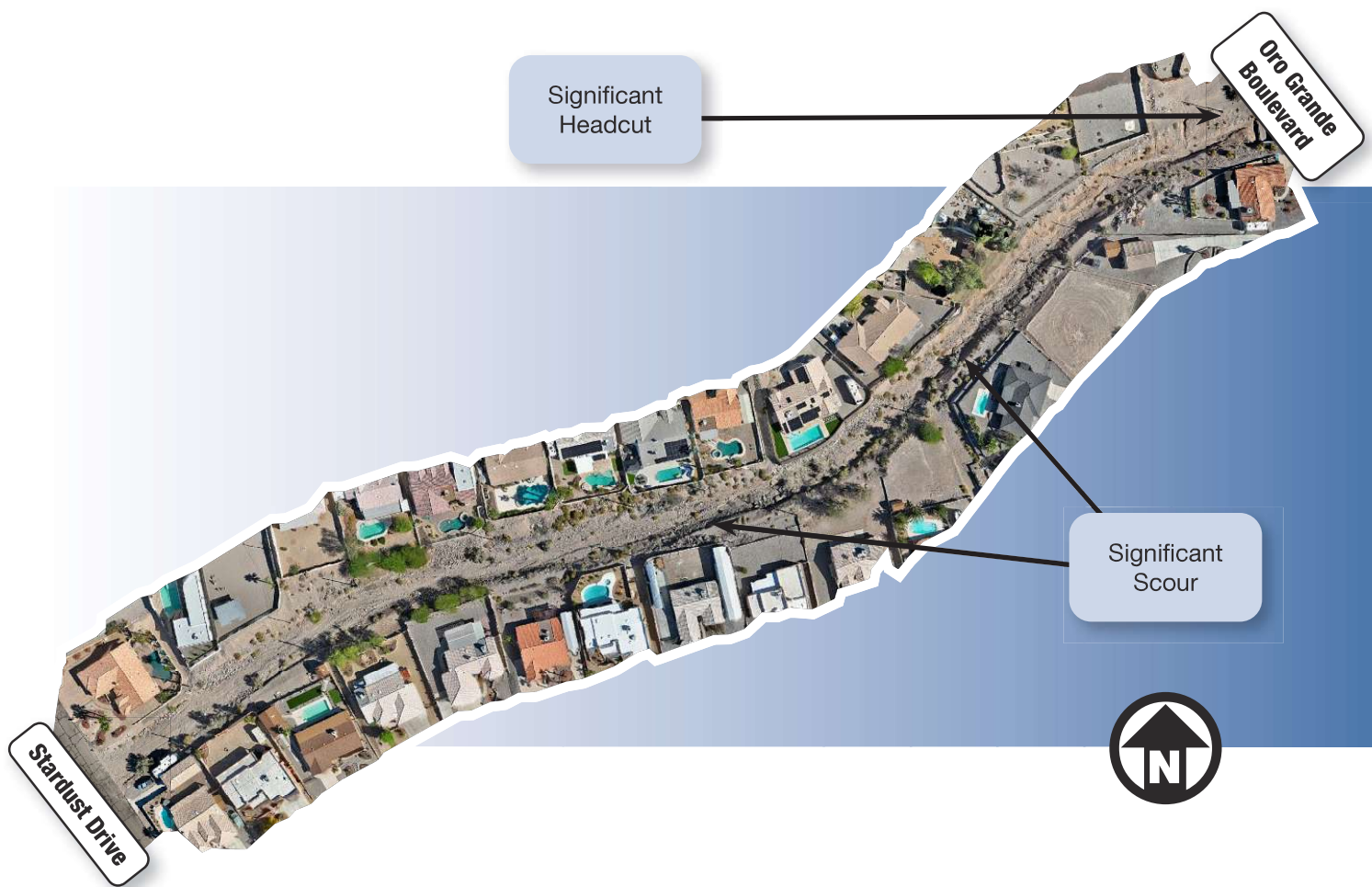
Havasupai Wash 7 is located between Avalon Avenue and Sandwood Drive. The reach is mostly straight but has significant scour along the southern banks in the upstream portion of the reach. Utility poles are located along the top of the banks throughout the reach.





## Buena Vista Wash 2

Buena Vista 2 is located between Oro Grande Boulevard and Stardust Drive. The reach has moderate meandering. Significant scour is evident along the southern bank. A significant headcut is evident at the upstream drop structure at the beginning of the reach. Utility poles are located along the tops of the banks.





## Indian Peak 18

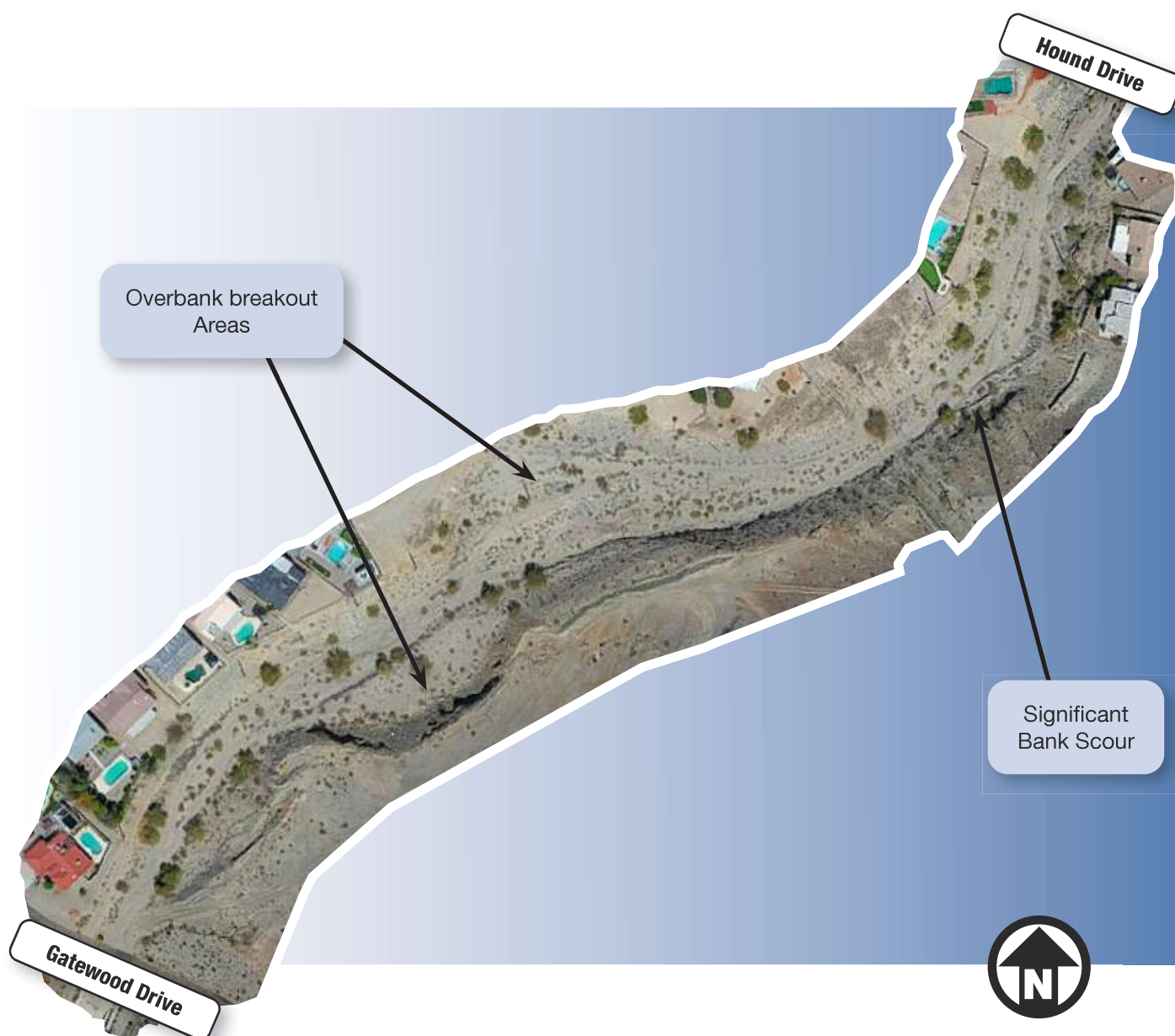
Indian Peak Wash 18 is between Black Hill Place and Sloop Drive. Residential structures are very close to the existing water surface elevation and high velocities. Significant low flow scour has created a meandering, concise channel at the bottom of the wash. Utility poles are located along the top of banks





## Smoketree Wash 4

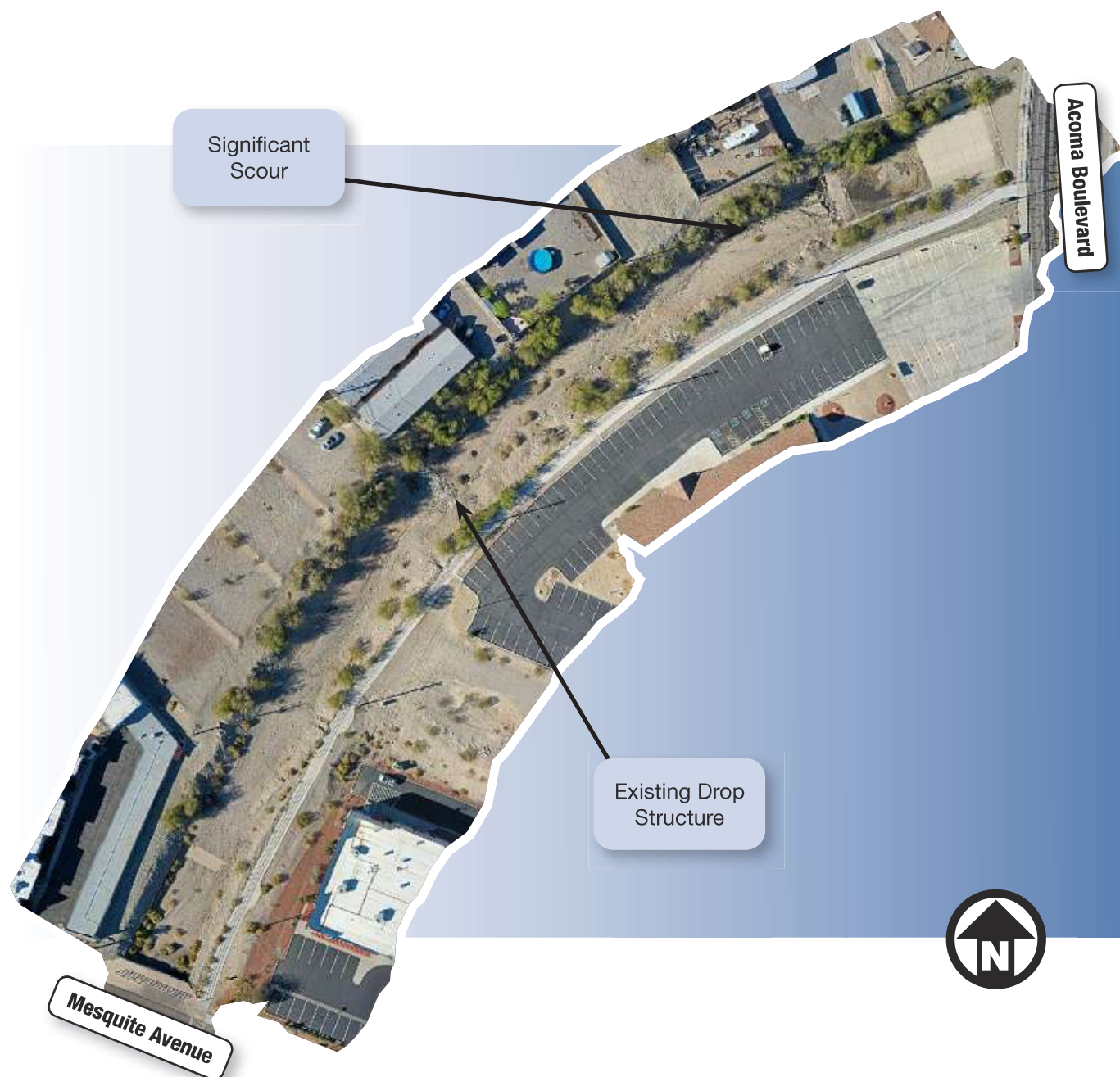
Smoketree Wash 4 is between Hound Drive and Gatewood Drive. The reach has significant meandering with evidence of significant bank scour at multiple locations. There are also large areas of overbank where the wash has meandered on to private property.





## Pima Wash 6

Pima Wash 6 is located between Acoma Boulevard and Mesquite Avenue. The reach has mild meandering but evidence of scour at multiple locations along the banks. An existing drop structure is located in the middle and near the end of the reach.





## Existing Condition Hydraulics

A detailed existing conditions hydraulic analysis was conducted for each of the next 10 washes. USGS LiDar mapping was obtained for each of the washes. A HEC-RAS 1D model was prepared for each wash. Manning's N roughness were applied based on the existing wash conditions shown in current aerials. Refer to Appendix X for the existing conditions hydraulics.

## Alternatives

Wash stabilization techniques in the City use two (2) different approaches. The first approach is utilizing drop structures to achieve a stable slope in the washes where scour will not occur. Typical drop structures are four (4) feet tall and the wash is re-graded to achieve the stable slope with the drop structures. The second approach is bank protection. The City has utilized cement stabilized alluvium (CSA) in the past. Significant CSA quantities are needed to make it feasible for suppliers to have competitive pricing. However, recent bank protection projects utilized large dumped rock riprap. Local rock suppliers have made the rock riprap a feasible solution. All bank protection alternatives utilize dumped riprap in this report. The size of the riprap varies based on the velocities in each of the washes. If supply of riprap diminishes, CSA can be an alternative for bank protection.

Each wash evaluated up to two (2) alternatives for wash stabilization. Some washes could not use the drop structure due to capacity of the existing wash relative to the elevations of the adjacent residential structures. Full channel protection was also evaluated for numerous washes due to the narrow width of the existing wash. A summary of the alternatives considered for each wash is shown in the table below.

| Wash                | Alternative 1           | Alternative 2           |
|---------------------|-------------------------|-------------------------|
| Smoketree Wash 3    | Drop Structures         | Bank Protection Only    |
| Pima Wash 8         | Drop Structures         | Full Channel Protection |
| El Dorado Wash 6    | Bank Protection Only    |                         |
| El Dorado Wash 6    | Full Channel Protection | Drop Structures         |
| Indian Peak Wash 16 | Bank Protection Only    | Full Channel Protection |
| Chemehuevi Wash 13  | Drop Structures         | Full Channel Protection |
| Kiowa Drain 6       | Drop Structures         | Bank Protection Only    |
| Havasupai Wash 7    | Bank Protection Only    |                         |
| Buena Vista 2       | Full Channel Protection |                         |
| Indian Peak Wash 18 | Full Channel Protection |                         |
| Smoketree Wash 4    | Drop Structures         | Bank Protection Only    |
| Pima Wash 6         | Drop Structures         | Bank Protection Only    |

## Proposed Hydraulics

A proposed conditions hydraulics analysis was conducted for each of the proposed alternatives. The preliminary grading for each of the washes was imported into the existing conditions hydraulic analysis. Manning's N roughness were adjusted for areas with dumped riprap. Dumped riprap Manning's N roughness varied based on the size of riprap and water depth in each of the washers. Refer to Appendix X for the proposed conditions hydraulics.



## Recommended Implementation Plan

A detailed opinion of probable cost (OPC) was developed for each of the alternatives. A summary of the costs are included in the table below. Refer to Appendix X for a detailed breakdown for each of the alternatives.

| Summary             | Alternative 1   | Alternative 2   |
|---------------------|-----------------|-----------------|
| Smoketree Wash 3    | \$ 1,344,010.00 | \$ 1,126,780.00 |
| Pima Wash 8         | \$ 1,897,100.00 | \$ 2,712,200.00 |
| El Dorado Wash 6    | \$ 7,443,370.00 | \$ 3,869,800.00 |
| Indian Peak Wash 16 | \$ 1,912,920.00 | \$ 2,694,870.00 |
| Chemehuevi Wash 13  | \$ 353,080.00   | \$ 722,930.00   |
| Kiowa Drain 6       | \$ 955,550.00   | \$ 1,326,310.00 |
| Havasupai Wash 7    | \$ 6,632,730.00 |                 |
| Buena Vista 2       | \$ 1,834,420.00 |                 |
| Indian Peak Wash 18 | \$ 3,039,470.00 |                 |
| Smoketree Wash 4    | \$ 1,512,670.00 | \$ 1,110,580.00 |
| Pima Wash 6         | \$ 1,045,750.00 | \$ 959,170.00   |

Assumptions for developing the OPC for each alternatives are:

- A 30% contingency was included to account for unidentified items.
- No maintenance access costs are included
- Utility relocation is not included in the costs.
- No design costs are included in the costs.

## References

Kimley-Horn and Associates, Inc. Lake Havasu City Drainage Master Plan, Data Collection Report, February 2007.

Kimley-Horn and Associates, Inc. Lake Havasu City Drainage Master Plan, Facility Inventory Maps and Appendix, December 2007.

Kimley-Horn and Associates, Inc. Lake Havasu City Drainage Master Plan, Final Hydraulics Report, February 2008.

Kimley-Horn and Associates, Inc. Lake Havasu City Drainage Master Plan, Final Hydrology Report, February 2007.

Kimley-Horn and Associates, Inc. Lake Havasu City Drainage Master Plan, Final Recommended Drainage Master Plan Report, April 2009.

Dibble Engineering, Inc., Existing Conditions Analysis and Prioritization Report, September 2015.

Dibble Engineering, Inc., Engineering Analysis and Recommendations, November 2015.



# Appendix **A**

## **Existing Conditions Hydraulics**

