# TECHNICAL MEMORANDUM

**TO:** Ryan Gayler, City of Palm Desert

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**DATE:** December 28, 2022
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**SUBJECT:** Haystack Channel Improvements – Project No. 509-22

The following Technical Memorandum is related to the analysis and design for the rehabilitation of the Haystack Channel. This documents represents research and analysis completed to-date. Major topics covered herein include the project setting, research, hydrologic analysis, HEC-RAS modeling of the existing condition along the Haystack Channel, and alternative development, analysis and recommendation.

| Prepared under the Supervision of: |
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## PROJECT SETTING

Aligned north of Haystack Road, the Haystack Channel provides an outlet for a drainage area defined by Highway 74, as far south as Indian Hills Way, Andreas Canyon Drive, Carriage Trail, and Irontree Drive and as far east as Portola Road. Haystack Channel is a combination of improved and unimproved channel reaches that begins at Highway 74 and flows east to Portola Avenue and beyond. Three distinct reaches define the channel, including.

1. Highway 74 to Alamo Drive: This reach of channel is characterized by a shallow swale located within a green belt. Two small diameter culverts cross under Alamo Drive at the low end of the reach.
2. Alamo Drive to Heliotrope Drive: The middle reach of the project area, this length of channel is improved, and grass lined. Storm drain outlets are located on both sides of this channel reach that vary in size and geometry. A minimally functional subsurface nuisance water drain composed of 24-inch grated inlets, sporadic clean outs, and an 8-inch diameter pipeline runs the length of this channel reach. Four 48-inch diameter culverts cross under Heliotrope Drive at the downstream end of the reach.
3. Heliotrope Drive to Portola Avenue: The final reach of the Haystack Channel is generally unimproved. There is historic evidence of a prismatic channel that has succumbed to bank erosion. There is also evidence of decreased capacity related to long-term maintenance activities. Two existing (visible) storm drain inlets are located along the south side of this reach. Each inlet includes minimal improvements. The downstream end of this reach of the channel is Portola Avenue. Surface and subsurface improvements at Portola Avenue indicate the roadway floods during larger return frequency storms. The low-level crossing here is a multiple cell reinforced concrete box culvert that is currently operating at greatly diminished capacity due to sedimentation.

Runoff tributary to the Haystack Channel is generated primarily in residential areas located south of Haystack Road. Minimal runoff is introduced to the channel from Calliandra Street via inlets located on Alamo Drove north of the channel. Review of aerial photography and field reconnaissance indicate four potential drainage areas in a larger tributary area south of Haystack Road. These drainage areas are tributary to the Haystack Channel at Alamo Road, Chia Road, downstream of the intersection of Silver Spur Trail and Sun Coral Trail, and Portola Avenue.

### Objectives and Project Scope

The Haystack Channel Rehabilitation project will consider numerous issues including non-operational nuisance water drains, hydraulic capacity, impact of flood waters on existing utilities, erosion and sedimentation, and protection of existing storm drain outlets. More specifically, the project requires the analysis and recommended mitigation measures for the following facilities.

- A nuisance water drain located between Alamo Drive and Heliotrope Drive.
- The hydraulic capacity of culverts crossing Alamo Drive, Heliotrope Drive and Portola Avenue.
- Existing SCE facilities crossing the channel.
- Remediation of sedimentation and diminished channel capacity east of Heliotrope Drive.
- Protection of storm drain outlets east of Heliotrope Drive.

In general, the Haystack Channel Rehabilitation project will require the development of a preliminary design report detailing the hydrology and hydraulics of the channel, analysis of culvert crossings, analysis of scour and sedimentation, remediation of certain storm drain outlets, and presentation, analysis and recommendation of proposed improvements. Once the preliminary design report is complete and accepted, special studies and other documents will be prepared in compliance with the California Environmental Quality Act. The final outcome of the Haystack Channel Rehabilitation project will be plans, specifications and estimates for construction, as wells as, regulatory permits issued by the U.S. Army Corps of Engineers, California Department of Fish and Wildlife, and the Regional Water Quality Control Board associated with the recommended improvements.

## BASELINE CONDITIONS

Documents summarized below were reviewed, analyzed and compared to data gathered during site investigations to form a basis for establishing baseline conditions for the Haystack Channel. Based on field conditions and record drawings, project hydrology and an existing conditions hydraulic model have been developed for use during the evaluation of alternative measures to remediate the existing nuisance water drain and mitigate continued erosion along the unimproved reach of the channel.

### Data Summary

Data used to form opinions related to possible mitigation of concerns along the Haystack Channel were received from the City of Palm Desert. Documents that form the basis for the development of the baseline condition and potential methods of mitigation are summarized below.

**Table 1 – Record Drawings**

| Project | Plan Type | Design Engineer | File No. | Dated |
|---|---|---|---|---|
| TM 11636 | Street Improvement | Morse Consulting Group | E-358 | 04.79 |
| PM 23798 | Storm Drain Imp. | Kicak & Associates | E-614 | 04.90 |
| Bike Path "Oasis" | Landscape | Ron Gregory & Assoc. | L-141 | |
| Haystack Rd. Drainage Swale | Landscape | Ron Gregory & Assoc. | L-167 | 06.97 |
| Haystack Bikeway | Bike Trail | ASL Consulting | CIP 1124 | 02.87 |
| Portola/Haystack Widening | Street Improvement | ASL Consulting | CIP 1139 | 06.91 |
| Haystack Road | Street Improvements | City of Palm Desert | CIP 1161 | 07.94 |
| Haystack Drainage Channel imp. | Storm Drain | City of Palm Desert | CIP 1196 | 11.97 |
| Homestead Rd./Alamo Dr. Storm Drain | Storm Drain | ASL Consulting | CIP 1047 | 10.85 |
| Portola/Haystack Sidewalk Imp. | Sidewalk | NAI Consulting | CIP 1240 | 03.02 |

Each of these documents and plan sets have been reviewed as part of establishing the baseline condition for the Haystack Channel.

All runoff generated north or south of the Haystack Channel enters the channel via an existing storm drain. Facilities identified from the record drawings tabulated above are summarized in the following table.

**Table 2 – Storm Drain Inlet Geometry and Location**

| Location/Tributary | Size/Type | File No. |
|---|---|---|
| 575' upstream of Portola Avenue/Street Flow | 45-inch CMP | CIP-1124 |
| 835' upstream of Portola Avenue/Area "C" | Parallel 36-inc RCP | E-614 |
| 2,445' upstream of Portola Avenue/South Storm Drain | 18-inch RCP | CIP-1139 |
| 190' upstream Heliotrope Drive/Area C-4 | Parallel 18-inch RCP | E-358 |
| 1,135' upstream of Heliotrope Drive/Area "B" | 30-inch RCP | E-358 |
| 340' upstream of Chia Drive/North Storm Drain | 36-inch RCP | E-358 |
| Immediately downstream of Alamo Road/Area "A" | 2' by 6 ' RCB | CIP-1047 |
| Immediately downstream of Alamo Road/Street Flow | 42-Inch RCP | E-358 |

**Hydrology and Design Methods**

Design criteria for the hydrology of the watershed tributary to the Haystack Channel and the hydraulic analysis of the alternatives and final design are based on the Riverside County Flood Control and Water Conservation District Hydrology Manual dated April 1978 and the Los Angeles County Flood Control District Hydraulic Design Manual. Rational Method calculations for the tributary watersheds were developed using CIVIL CADD/CIVIL DESIGN software and the existing conditions and final design hydraulic models were developed using GEO HEC-RAS by the U.S. Army Corps of Engineers Hydraulic Engineering Center.

**Watershed Boundaries**

Watershed boundaries and the limits of the subareas within the watershed were delineated based on readily available aerial imagery. The overall watershed is loosely bound by Haystack Road, State Route 74 (SR 74), Carriage Trail and Irontree Drive and Portola Avenue. To facilitate the rational method analysis, the overall watershed is divided into "A" through "E" and the North Storm Drain subareas.

The subareas of the overall watershed are described below and depicted on the Hydrology Exhibit; Haystack Channel provided in Appendix A.

- Subarea "A" – This area is bounded by Haystack Road, SR-74, Mesa View Drive, and Alamo Road. Subarea "A" covers 138.2 acres.
- Subarea "B" – This area is bounded by Haystack Road, Alamo Road, Mesa View Drive, and Chia Drive and SR-74, Indian Hills Way and Carriage Trail, and the western boundary of the Ironwood County Club. Subarea "B" covers 150 acres.
- Subarea "C" – This area is bounded by Haystack Road, Chia Drive and Silver Spur Trail. Subarea "C" covers 140.1 acres.

- Subarea "D" – This area is bounded by Haystack Road, Silver Spur Trail and Portola Avenue. Subarea "D" covers 36.9 acres.
- Subarea "E" – This area is bounded by the western boundary of the Ironwood Country Club, Carriage Trail, Irontree Drive, portion of the Ironwood Country Club, the southern boundary of the Living Desert, Portola Avenue, and Buckboard Trail. Subarea "E" covers 283.2 acres.

**Watershed Hydrology**

Hydrologic models were developed for each watershed noted above and two small watersheds not included in the list above. These watersheds included the North Storm Drain and the South Storm Drain located along Calliandra Street west of Calico Cactus Lane and on Haystack Road east of Heliotrope Drive.

Rational Method calculations for each watershed for the 100-year return frequency are tabulated below.

**Table 3 – Runoff Quantity by Watershed**

| Watershed Designation | Area – Acres | Runoff - cfs |
|---|---|---|
| Watershed "A" | 138.2 | 321.5 |
| Watershed "B" | 150.0 | 194.2 |
| Watershed "C" | 114.1 | 278.6 |
| Watershed "D" | 36.9 | 104.9 |
| Watershed "E" | 283.2 | 660.8 |
| North Storm Drain | Calliandra St. | 27.0 |
| South Storm Drain | Haystack Road | 4.5 |

All watersheds tabulated above are tributary to the Haystack Channel except Watershed "E." Watershed "E" outlets to the east near Reserve Drive.

**Channel Hydraulics**

Modeling of the baseline condition for the Haystack Channel utilizes the U.S. Army Corps of Engineers River Analysis System or HEC-RAS. Model development was completed using a version of HEC-RAS available through a third party identified as GEO HEC-RAS. GEO HEC-RAS utilizes vectorized topography of the project area along with cross section locations developed in AutoCAD to derive cross sections within the limits of the study area. Using steady state hydraulic calculations, the program balances energy between downstream and upstream cross sections to determine the water surface profile, the associated depth of flow and flow velocity.

Tabulated results from the HEC-RAS model and the associated work map for the baseline condition are available in Appendix B.

The baseline condition model along the Haystack Channel begins well downstream of Portola Avenue to ensure the model has stabilized prior to reaching the study area. In the reach downstream of Portola Avenue the flow regime is "critical" and model results indicated flow depths of 2.0 feet to 3.7 feet with associated velocities in the range of 7.5 to 9.5 feet per second.

Field observation of the crossing at Portola Avenue leads to the conclusion the roadway is designed to overtop during significant storms. A conclusion that is supported by available record drawings. The design storm is unknown, however, the multiple cell reinforced box culvert will provide conveyance of smaller return frequency storms. In the baseline condition, Portola Avenue overtops and runoff crossing the roadway is contained within highpoints located north and south of the culvert. The depth of flow immediately upstream of the roadway is 4.53 feet and across the roadway the flow depth is approximately 1.0-foot.

Upstream of Portola Avenue, the channel has the appearance of an unimproved watercourse. However, it is general consensus that at one time, the channel was graded to a prismatic section. It is further concluded the section has been altered over time through erosion and subsequent maintenance activities. Immediately upstream of Portola Avenue, the section appears to be in transition from a uniform section to the width of the multiple cell reinforced box culvert crossing. This reach of channel is approximately 500 feet long and exhibits flow depths between three and four feet and channel velocities up to 10.0 feet per second.

Upstream of this reach, the channel cross section becomes more uniform but continues to show the effects of erosion mainly along the channel banks. There are three storm drain inlets in this channel reach all located on the south bank. Specific details related to these inlets are available in Tables 2 and 3 and Appendix A. Flow velocity in this reach is fairly uniform and ranges between 6.5 and 8.5 feet per second and the depth of flow is uniform and slightly deeper that two feet.

Near Heliotrope Drive, the channel changes significantly in the vertical direction, invert elevations increase in an upstream direction approximately 7.5 feet due to a scour hole that has developed at the end of the grass lined section downstream of Heliotrope Drive. At Heliotrope Drive, storm flows are conveyed under the roadway via 4 - 48-inch reinforced concrete pipe culverts. At this location, the hydraulic model indicates that storm flows are contained within the channel. The depth of flow and velocity at the culvert outlet are 3.7 feet and 7.8 feet per second.

Upstream of Heliotrope Drive the channel section changes significantly from unlined and exhibiting characteristics of an unimproved channel to a uniform, prismatic, and grass-lined section. At four locations along this reach of channel, three on the south bank and one on the north, storm drains enter that channel. These inlets are characterized by concrete headwalls, concrete invert (apron), and concrete slope protection. Specific details related to these inlets are available in Tables 2 and 3 and in Appendix A. Flow velocity is this reach is uniform and ranges between 6.7 and 7.6 feet per second. Associated flow depths are typically on the order of 2.5 feet.

This channel reach terminates at Alamo Road. The crossing at Alamo Road consists of two 30-inch reinforced concrete pipes. The hydraulic model indicates the existing culverts have the capacity to safely convey the anticipated storm flow under the roadway. Upstream of Alamo Road, the study area becomes a greenbelt with a low flow swale rather than a well-defined channel. Depth of flow and velocity are minimal.

## ALTERNATIVE DEVELOPMENT

Development of the alternatives considered for the rehabilitation of the Haystack Channel is dependent on several factors. Factors affecting the potential alternatives include, but are not limited to, nuisance water, existing drainage facilities, materials, construction methods, and the regulatory environment.

The primary concerns related to the development of alternatives for the rehabilitation of the Haystack Channel include:

- ✓ Controlling nuisance water from storm drain inlets between Alamo Road and Heliotrope Drive.
- ✓ Developing a system to control nuisance water that will function long-term between Alamo Road and Heliotrope Drive.
- ✓ Controlling the production of sediment in the channel reach downstream of Heliotrope Drive.
- ✓ Developing proposed improvements downstream of Heliotrope Drive that work within the regulatory framework of the U.S. Army Corps of Engineers and the Department of Fish and Wildlife.

Rehabilitation of the Haystack Channel includes two distinct elements.

1. Rehabilitation or reconstruction of the nuisance water drain between Alamo Road and Heliotrope Drive.
2. Resolution of uncontrolled bank erosion and scour in the channel reach downstream of Heliotrope Drive.

Alternatives for the resolution of the various concerns along the Haystack Channel are discussed below.

### Design Criteria

In general, design criteria will conform to the policies and procedures of the Riverside County Flood Control and Water Conservation District. These criteria will be augmented by criteria from the Coachella Valley Water District, and procedures stated in Section C Open Channels and Section F Miscellaneous, Levee Criteria of the Los County Flood Control District Hydraulic Design Manual. Design of rock slope protection will also give consideration to methods and procedures outlined in the Hydraulic Design of Flood Control Channels published by the U.S. Army Corps of Engineers.

### Alternative Descriptions

Two specific categories of improvements require consideration as part of the rehabilitation of the Haystack Channel, including nuisance water drains and sections of open channel. Specific concerns related to each location are described above as part of the discussion of the Scope of Work. The following discussion is related to possible methods of resolving the issues affecting each location, including capacity, functionality, long-term maintenance, and erosion.

***Alamo Road***
As described on the City's request for proposals, the project includes the area upstream of Alamo Road that extends to Highway 74. ERSC's analysis of the area finds runoff generation to be localized and flow velocities that are typically below 3.0 feet per second or non-erosive. Further, the existing condition hydraulic model indicates the existing 30-inch (2 ea.) culverts at Alamo Road have the capacity to safely convey localized flows under the roadway. Therefore, no improvements are anticipated at this location.

***Alamo Road to Heliotrope Drive***
The channel reach between Alamo Road and Heliotrope Drive is characterized as grass lined. Mature trees and other landscaping occupy the upslope areas. However, the flowline of the channel is unobstructed. Storm drain inlets of varying diameter enter the channel on the north and south sides downstream of Alamo Road, upstream and downstream of Chia Drive, and upstream of Heliotrope Drive.

Each storm drain inlet includes a grated inlet near the end of the structure that is connected to an "Infiltrator Equalizer 36 Chamber" serving as a nuisance water drain. The nuisance water drain extends along the channel invert from Alamo Road to Heliotrope Drive and is constructed using the infiltrator chambers and 12-inch square grated inlets spaced uniformly across the alignment. See the record drawings for CIP-1196 for specific detail.

Field observations along the alignment of the nuisance water drain do not indicate the presence of regularly spaced grated inlets. At certain locations, near storm drain outlets, open PVC pipes have been observed near the ground surface. In each location, these open pipes are discharging nuisance water to the surface. These observations lead to the conclusion that the nuisance water drain has failed. Likely causes of failure are saturation of the subsurface soils and/or blinding of the rock underlayment by organic matter.

*Alternative No. 1* – Remove and replace the existing nuisance water drain system as envisioned on plans identified as the City of Palm Desert, Channel Improvements, Project No. 500B-97 (CIP 1196). This system includes Infiltrator Equalizer 36 Chambers over rock coupled with grated inlets spaced uniformly along the channel alignment. New drop inlets and connections to the nuisance drain will be reconstructed at each storm drain inlet.

*Alternative No.2* – Remove the existing nuisance water drain and replace the system with underground infiltration chambers located at each of the four storm drain outlets. This proposal includes reconstruction of existing drop inlets associated with each storm drain outlet and connection of the new inlet to the proposed infiltration chambers. Each infiltration chamber will include a manhole at each with grates .

*Alternative No. 3* – Remove the existing nuisance water drain and replace the system with a concrete invert from downstream of Alamo Road to upstream Heliotrope Drive. Replace the existing nuisance water drain system with a concrete invert placed between the downstream side of Alamo Road and the upstream side of Heliotrope. The baseline conditions hydraulic indicates the sections within the grass lined reach are rather uniform and can be retrofit with a concrete invert that will not disrupt regular landscape maintenance.

***Heliotrope Drive***
The existing crossing at Heliotrope Drive includes four 48-inch reinforced concrete pipe (RCP) culverts crossing the roadway from west to east. The culverts outlet onto a concrete apron that discharges to a grass lined section. Immediately downstream of the concrete apron, a scour hole has formed and extends approximately 70' downstream to the end of the grass lined section. Downstream of this point of the channel is unlined.

The existing conditions hydraulic model indicates that the culverts crossing Heliotrope Drive have the capacity to safely convey a 100-year rainfall event under the roadway.

Additional improvements are proposed roughly 70 feet downstream of Heliotrope Drive to mitigate an expanding scour hole. A rock drop structure is proposed at this location to mitigate further damage to the grass channel lining, as well as provide for the change in grade necessary to maintain a stable bed slope downstream. These improvements will be incorporated into plans for the mitigation of erosion in the channel reach extending downstream to Portola Avenue.

***Heliotrope Drive to Portola Avenue***
Downstream of Heliotrope Drive the Haystack Channel is unlined and takes on the appearance of an unimproved channel. It is likely the channel, at one time, was graded to a prismatic section, however, this cannot be verified from public record. Today, the channel shows evidence of past erosion and the city's efforts to slow the erosion. Even though the channel is described as unimproved, the alignment and section are consistent until a bend located approximately 500 feet upstream of Portola Avenue. Downstream of this point, the channel becomes less prismatic likely due to on-going sediment removal.

Field observations along this channel reach indicated braided, intermittent flow. Two storm drain inlets have been identified that are associated with runoff from Haystack Road and drainage areas lying south of Haystack Road. Plans for the widening of Haystack Road (CIP-1139) also show a storm drain outlet just downstream of Heliotrope Drive. While the catch basin is visible on the north side of the roadway, no outlet has been visually identified at this time.

Prior to developing the potential alternatives for upgrades to this reach of channel, ERSC has engaged the staff at Terra Nova Planning and Research, Inc to discuss the current regulatory environment related to the improvement of open channels. Given the outcome of this conversation, the options are limited to soft-bottom construction. Therefore, the options will include a series of soft-bottom channels with distinct types of slope protection as described below.

*Alternative No. 1* -- A soft bottom channel with rock slope protection design per Section C Open Channels and Section F Miscellaneous, Levee Criteria of the Los Angeles County Flood Control District Hydraulic Design Manual. Storm drain inlets located along the south side of the channel will be upgraded with appropriate junction structures and/or headwalls.

*Alternative No. 2* -- A soft bottom channel with Armor flex revetment systems. Channel design and cut-off depth will be per Section C Open Channels and Section F Miscellaneous, Levee Criteria of the Los Angeles County Flood Control District Hydraulic Design Manual. Storm drain inlets located along the south side of the channel will be upgraded with appropriate junction structures and/or headwalls.

*Alternative No. 3* -- A soft bottom channel with turf reinforced mats. Channel design will be per Section C Open Channels of the Los Angeles County Flood Control District Hydraulic Design Manual. Storm drain inlets located along the south side of the channel will be upgraded appropriate junction structures and/or headwalls.

Each alternative described above will include a new apron upstream of the Portola Avenue crossing, a drop structure downstream of Heliotrope Drive and invert erosion protection at storm drain outlets. Further, existing SCE infrastructure (overhead power) downstream of Heliotrope Drive, within the limits of scour hole to be mitigated by the proposed drop structure, are in danger of collapsing and will be relocated as part of the channel rehabilitation project. Finally, reconstruction of the channel reach between Heliotrope Drive and Portola Avenue will take into account the existing vegetation and trees. Every effort will be made to preserve and reuse healthy specimens taken from the limits of channel construction.

**Alternative Analysis**

Analysis of multiple alternatives is typically based on a set of criteria that are applied to each alternative under consideration. As a result, a ranking of the alternatives can be established that leads to the determination of the most applicable solution under the given criteria.

Rehabilitation of the Haystack Channel requires analysis of various issues at specific locations along the channel alignment including conveyance of nuisance water, and erosion and sedimentation. These categories apply to the Haystack Channel along the reach between Alamo Road and Heliotrope Drive, and the channel reach between Heliotrope Drive and Portola Avenue, respectively.

Criteria applied to the alternatives under consideration for rehabilitation of the Haystack Channel are summarized below by channel reach.

*Alamo Road to Heliotrope Drive*

1. Ability to easily maintain nuisance water drain and channel.
2. Minimal disruption of aesthetics.
3. Useful life.
4. Constructability.

*Heliotrope Drive to Portola Avenue*

1. Minimize erosion and sedimentation.
2. Minimal maintenance requirements.
3. Minimal concerns relative to regulatory compliance.
4. Ability to maintain aesthetics of the area.

These criteria will be applied to the alternatives under consideration to determine the appropriate recommendation for each improvement category.

***Comparison***
Alternative selection is typically based on common factors, such as those outlined above. Previous sections of this document have focused on the many issues affecting the Haystack Channel and possible resolution of these issues. Considering the alternatives presented for each reach and the stated criteria, an evaluation matrix has been prepared for each channel reach to complete the analysis of the various alternatives under consideration.

Within each matrix, the criteria established above are treated as a "yes" or "no" question. A "yes" answer receives one point, while a "no" answer receives zero points. Points for each alternative will be totaled and considered as part of the final recommendation.

**Alamo Road to Heliotrope Drive**

| Criteria | Alt. No. 1 | Alt. No. 2 | Alt. No. 3 |
|---|---|---|---|
| Ability to easily maintain nuisance water drain, appurtenant facilities, and channel. | 0 | 1 | 0 |
| Minimal Disruption to aesthetics. | 1 | 1 | 0 |
| Useful life. | 1 | 1 | 1 |
| Constructability. | 1 | 1 | 1 |
| Total | 3 | 4 | 2 |

**Heliotrope Drive to Portola Avenue**

| Criteria | Alt. No. 1 | Alt. No. 2 | Alt. No. 3 |
|---|---|---|---|
| Minimize erosion and sedimentation. | 1 | 1 | 1 |
| Minimal maintenance requirements. | 1 | 0 | 0 |
| Minimal concerns relative to regulatory compliance. | 1 | 1 | 0 |
| Ability to maintain aesthetics of the area. | 1 | 0 | 0 |
| Total | 4 | 2 | 1 |

***Analysis***
Each alternative under consideration for improvement of the two reaches included in the Haystack Channel Rehabilitation have been subjected to a set of decision criteria that has resulted in the ranking of each project in each reach.

Comparison of the Alternatives to the stated criteria through the matrices presented above has resulted in the following ranking.

*Alamo Road to Heliotrope Drive*

1. Alternative No. 2
2. Alternative No. 1
3. Alternative No. 3

Alternative No. 2 – Alternative No. 2 provides a closed system that terminates at an underground infiltration chamber located near each storm drain outlet. A catch basin located in the apron of each storm drain outlet will convey nuisance water to the underground chambers via a short reach of HDPE pipe. In general, the catch basins and piping can be maintained with readily available equipment. While the underground chambers are slightly more difficult to maintain, certain design elements can be introduced to the system that limit the introduction of debris and, therefore, limit the overall maintenance requirements. The predominantly underground system will not disrupt the aesthetic appearance of the channel, except during construction, and the useful life (25-years) is comparable to the system being replaced. Finally, the project is constructable using standard construction techniques and readily available equipment.

Alternative No. 1 – Alternative No 1 is direct replacement of the existing system constructed in 1997 as CIP-1196. With the exception of the catch basins and laterals, the system cannot be maintained and will be subject to failure. Once constructed, the system will not disrupt the aesthetics of the channel and the useful life (25-years) has been determined based on the life of CIP-1196. Constructability is not a concern and can be accomplished through standard construction techniques using readily available equipment.

Alternative No. 3 – Alternative No.3 is the simplest option considered for this channel reach. Unfortunately, this Alternative while maintenance free itself, has the potential to disrupt the overall maintenance of the channel and definitely impacts the aesthetics of the channel. Alternative No. 3 does meet the useful life criteria and, while slightly more involved, is constructable using standard construction techniques using readily available equipment.

*Heliotrope Drive to Portola Avenue*

1. Alternative No. 1
2. Alternative No. 2
3. Alternative No. 3

Alternative No. 1 – Alternative No. 1 involves the reconstruction of the channel side slopes and the construction of rock slope protection with toe protection extended to the general scour depth. This option will eliminate bank erosion and minimize overall maintenance by confining these activities, if necessary, to the channel invert. The soft-bottom channel coupled with rock slope protection works well within today's regulatory framework and is equally compatible with the surrounding desert environment.

Tabulated results from the HEC-RAS model and the associated work map for Alternative No. 1 are available in Appendix B.

Alternative No. 2 – Alternative No. 2, Armor flex slope protection, will help minimize erosion and sedimentation and also work within the regulatory framework similar to rock slope protection. However, this material is typically buried after construction and therefore presents a maintenance concern. In addition, if not properly maintained, this product takes on a very institutional appearance and will not blend well with the surrounding environment.

Alternative No. 3 – Alternative No. 3, reinforced turf mat slope protection, will help minimize erosion sedimentation but is not compliant with any other selection criteria. It will not likely fit within the regulatory framework as the materials may be considered non-native and will require access to the channel for regular maintenance. Finally, the appearance of the material will disrupt the natural desert environment surrounding the project area.

***Recommended Alternatives***

Multiple alternatives have been developed for two distinct reaches of the Haystack Channel: Alamo Road to Heliotrope Drive and Heliotrope Drive to Portola Avenue. In the upstream reach, the primary concern is related to collecting and adequately mitigating nuisance water tributary to the channel generated as a result of irrigation runoff from adjacent residential areas. In the downstream reach, channel improvements are necessary to eliminate a scour hole directly downstream of Heliotrope Drive, control and mitigate erosion and sedimentation along the entire reach and provide upgraded storm drain connections along the south side of the channel.

Three alternatives were developed for each reach being studied. As part of the Alternative Analysis, each alternative, for each reach, was subject to comparison with the others through a matrix analysis each yielding a score based on points assigned to various criteria. This comparison has yielded to following recommendations.

- ✓ Alamo Road to Heliotrope Drive: Alternative No. 2.
- ✓ Heliotrope Drive to Portola Avenue: Alternative No. 1.

The subsequent analysis of each alternative provided discussion relative to the specific selection criteria applied to the alternatives through the matrix analysis. Additional discussion is provided below that focuses on specific concerns related to each alternative.

*Alamo Road to Heliotrope Drive:* A Technical Memorandum focused on Alternative Development was issued to the city in draft form on November 11, 2022. At that time, Alternative No. 2 included the removal of the existing nuisance water drain system and its replacement with a new system constructed of 12-inch, HDPE pipe, regularly spaced inlets along the drain line, and an outlet downstream of Heliotrope Drive.

After reviewing the description for Alternative No. 2, the city voiced concerns related to the location of the outlet and the potential of long-term maintenance related to a continually wet environment. To avoid the potential maintenance concerns, city staff recommended the use of underground infiltration chambers as the terminus of the nuisance water drain.

On December 29, 2022, a draft of the Final Technical Memorandum was submitted to the city for review. As a result of their review, city staff recommended a further refinement of Alternative No. 2. The suggested revision splits the previously proposed underground chamber near Heliotrope Drive and provides four similarly sized underground chambers at each storm drain outlet within this reach of the channel.

The design of these facilities requires the development of design criteria that results in a reasonable outcome. Potential design criteria for the proposed underground chambers were discussed with city staff and the following options were identified.

1. 2-year, 24-hour rainfall event over the watershed tributary to the culvert crossing at Heliotrope Drive (Areas A, B ,and C)
2. 2-year, 24-hour rainfall event over the channel right-of-way between Highway 74 and Heliotrope Drive.
3. The capacity of the existing equalizer chambers and rock bed per the plans for CIP-1196.

The required storage volumes associated with each criterion are 323,890 cubic feet, 10,349 cubic feet and 7,000 cubic feet, respectively. Considering these design criteria, an underground chamber system has been designed using the volume associated with the existing equalizer chambers and rock bed (7,000 cubic feet). The resulting system requires the installation of 100 feet of 48-inch diameter underground stormwater chamber at each storm drain outlet. This design is based on storing 100 percent of the storm volume, without consideration of infiltration. As the project progresses, the chamber design will be finalized using an appropriate infiltration rate for the area.

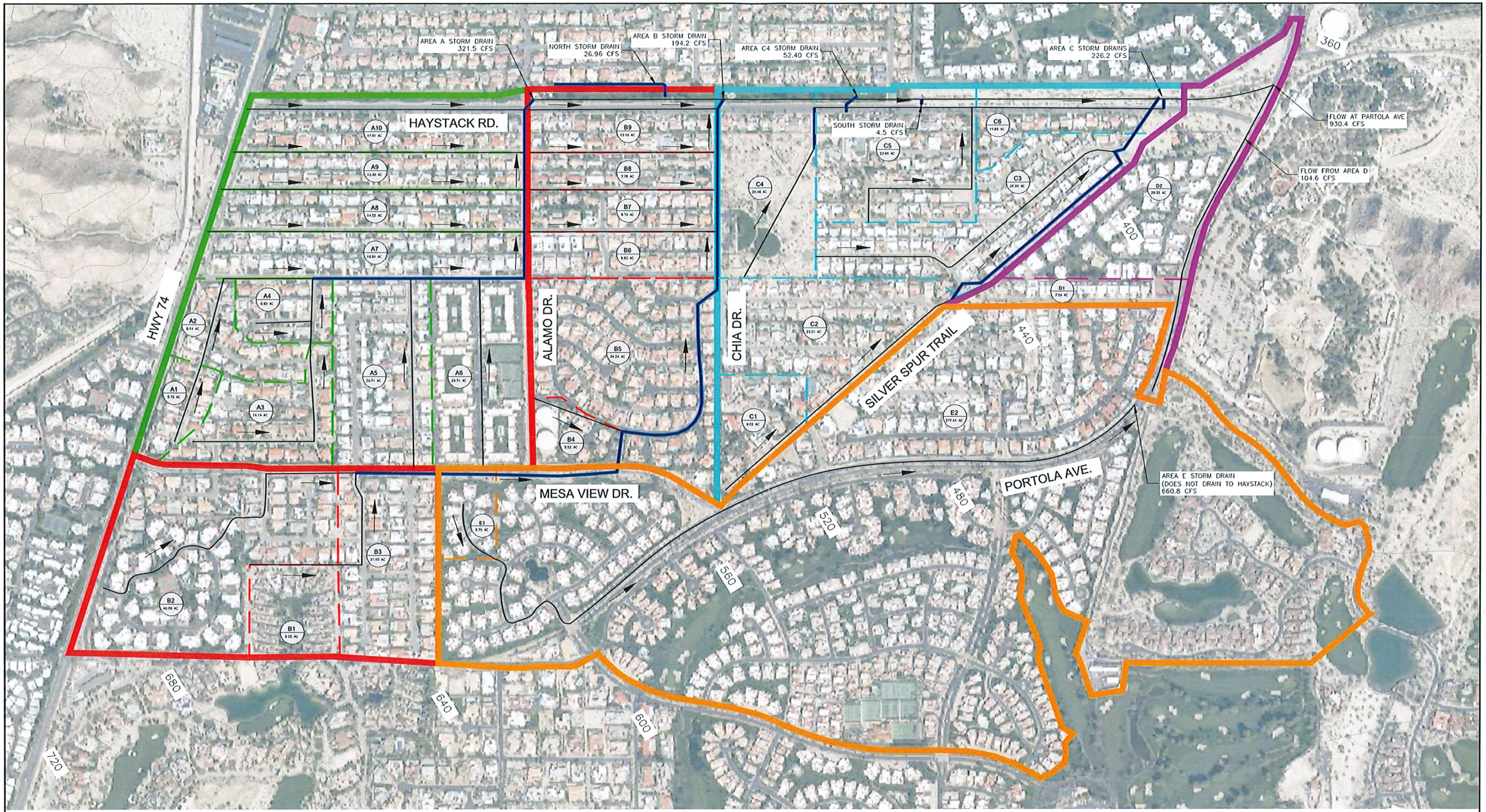
*Heliotrope Drive to Portola Avenue:* Sections of the Technical Memorandum dedicated to the channel reach between Heliotrope Drive and Portola Avenue provided options for slope protection in a soft-bottom channel. The options for slope protection included rock, armor flex, and turf reinforced mat (TRM). Comments by city staff showed concern for aesthetics (Armor Flex) and aesthetics and maintenance (TRM) related to Alternatives 2 and 3, respectively.

Given city staff's concerns with Alternatives 2 and 3, it would be reasonable to discount these options in favor of Alternative No. 1. However, to a provide thorough analysis of the project through the California Environmental Quality Act, Alternatives 2 and 3 were included in the analysis and comparison sections of this memorandum.

30 percent complete plans are available in Appendix C - Preliminary Plans and Cost Estimate.

*Preliminary Construction Cost:* A preliminary estimate of the probable cost of construction for the recommended Alternatives, Alternative No. 2 and Alternative No. 1, has been prepared and is presented in Appendix C - Preliminary Plans and Cost Estimate. Overall construction cost for Alternative No. 2, Alamo Road to Heliotrope Drive, and Alternative No. 1, Heliotrope Drive to Portola Avenue, has been established as $3,189,385. It is important to note, this estimate includes mobilization, labor, materials and equipment, contingencies, contract administration, construction inspection and staking, and soils and materials testing.

# Appendix A
## Hydrology Exhibit – Haystack Channel




## LEGEND

| | |
|---|---|
| DRAINAGE AREA A | |
| DRAINAGE AREA B | |
| DRAINAGE AREA C | |
| WATERCOURSE | |
| DRAINAGE AREA D | |
| DRAINAGE AREA E | |
| STORM DRAINS | |
| SUB-AREA ACRES | XX / 00.00 AC |
| ELEVATION | 100 |

| HYDROLOGY DATA | |
|---|---|
| AREA | Q (100 YR) |
| A | 321.5 CFS |
| B | 194.2 CFS |
| C | 283.1 CFS |
| D | 104.6 CFS |
| E | 660.8 CFS |
| NORTH SD | 26.96 CFS |
| SOUTH SD | 4.5 CFS |

N

0 300 600 Feet

1"=300'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**HYDROLOGY EXHIBIT**
**HAYSTACK CHANNEL**

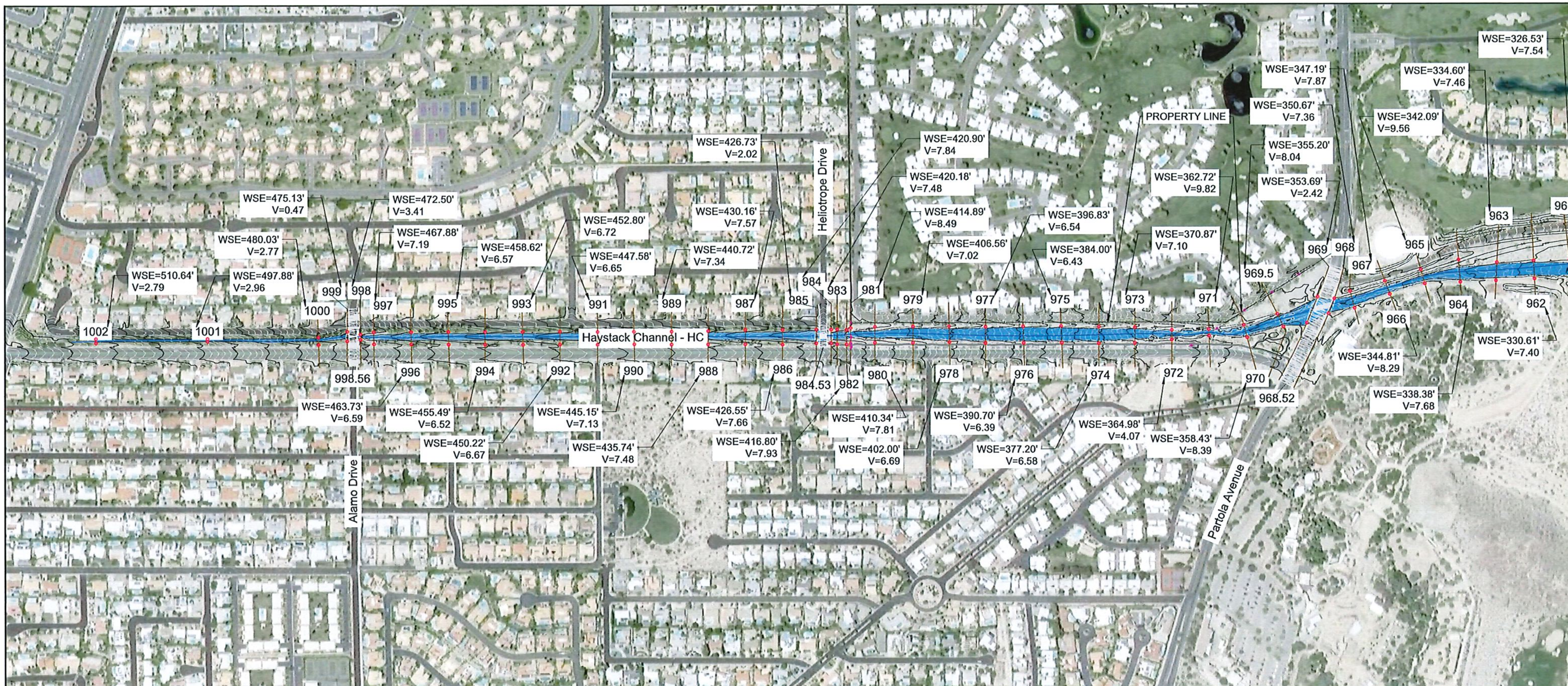
# Appendix B
## HEC-RAS Models

HEC-RAS Plan: Default Scenario River: Haystack Channel Reach: HC Profile: Q100

| Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| HC | 1002 | Q100 | 10.00 | 510.23 | 510.64 | 510.64 | 510.76 | 0.014051 | 2.79 | 3.59 | 14.37 | 0.98 |
| HC | 1001 | Q100 | 10.00 | 497.45 | 497.88 | 497.88 | 498.02 | 0.014444 | 2.96 | 3.37 | 12.57 | 1.01 |
| HC | 1000 | Q100 | 10.00 | 479.59 | 480.03 | 480.03 | 480.15 | 0.015134 | 2.77 | 3.61 | 15.42 | 1.01 |
| HC | 999 | Q100 | 10.00 | 473.76 | 475.13 | 474.25 | 475.14 | 0.000082 | 0.47 | 21.17 | 25.43 | 0.09 |
| HC | 998.56 | | Culvert | | | | | | | | | |
| HC | 998 | Q100 | 10.00 | 471.89 | 472.50 | 472.50 | 472.68 | 0.014303 | 3.41 | 2.93 | 8.29 | 1.01 |
| HC | 997 | Q100 | 321.50 | 465.35 | 467.88 | 467.88 | 468.68 | 0.008174 | 7.19 | 44.73 | 27.96 | 1.00 |
| HC | 996 | Q100 | 321.50 | 461.43 | 463.73 | 463.73 | 464.40 | 0.008357 | 6.59 | 48.79 | 36.20 | 1.00 |
| HC | 995 | Q100 | 321.50 | 456.64 | 458.63 | 458.63 | 459.31 | 0.008409 | 6.57 | 48.93 | 36.64 | 1.00 |
| HC | 994 | Q100 | 321.50 | 453.61 | 455.49 | 455.49 | 456.15 | 0.008519 | 6.52 | 49.30 | 37.74 | 1.01 |
| HC | 993 | Q100 | 321.50 | 450.49 | 452.80 | 452.80 | 453.51 | 0.008226 | 6.72 | 47.85 | 34.01 | 1.00 |
| HC | 992 | Q100 | 348.46 | 448.10 | 450.22 | 450.22 | 450.91 | 0.008220 | 6.67 | 52.28 | 37.68 | 1.00 |
| HC | 991 | Q100 | 348.46 | 445.53 | 447.58 | 447.58 | 448.26 | 0.008168 | 6.65 | 52.44 | 37.78 | 0.99 |
| HC | 990 | Q100 | 542.66 | 442.52 | 445.15 | 445.15 | 445.94 | 0.007803 | 7.13 | 76.14 | 47.81 | 1.00 |
| HC | 989 | Q100 | 542.66 | 437.96 | 440.72 | 440.72 | 441.56 | 0.007727 | 7.34 | 73.91 | 43.94 | 1.00 |
| HC | 988 | Q100 | 542.66 | 432.95 | 435.74 | 435.74 | 436.61 | 0.007639 | 7.48 | 72.55 | 41.51 | 1.00 |
| HC | 987 | Q100 | 542.66 | 427.30 | 430.16 | 430.16 | 431.05 | 0.007694 | 7.57 | 71.72 | 40.50 | 1.00 |
| HC | 986 | Q100 | 595.06 | 423.97 | 426.55 | 426.55 | 427.46 | 0.007533 | 7.66 | 77.72 | 42.46 | 1.00 |
| HC | 985 | Q100 | 595.06 | 419.73 | 426.73 | 422.32 | 426.80 | 0.000161 | 2.02 | 294.34 | 64.70 | 0.17 |
| HC | 984.53 | | Culvert | | | | | | | | | |
| HC | 984 | Q100 | 595.06 | 418.54 | 420.90 | 420.90 | 421.86 | 0.007599 | 7.84 | 75.88 | 39.89 | 1.00 |
| HC | 983 | Q100 | 595.06 | 417.74 | 420.18 | 420.18 | 421.05 | 0.007690 | 7.48 | 79.55 | 45.83 | 1.00 |
| HC | 982 | Q100 | 595.06 | 413.10 | 416.80 | 416.80 | 417.78 | 0.007600 | 7.93 | 75.05 | 38.28 | 1.00 |
| HC | 981 | Q100 | 595.06 | 410.92 | 414.89 | 414.89 | 416.01 | 0.014666 | 8.49 | 70.07 | 31.12 | 1.00 |
| HC | 980 | Q100 | 599.56 | 407.93 | 410.34 | 410.34 | 411.29 | 0.014819 | 7.81 | 76.75 | 40.42 | 1.00 |
| HC | 979 | Q100 | 599.56 | 404.62 | 406.56 | 406.56 | 407.33 | 0.015728 | 7.02 | 85.40 | 55.69 | 1.00 |
| HC | 978 | Q100 | 599.56 | 400.23 | 402.00 | 402.00 | 402.70 | 0.016193 | 6.69 | 89.68 | 64.61 | 1.00 |
| HC | 977 | Q100 | 599.56 | 395.06 | 396.83 | 396.83 | 397.50 | 0.016583 | 6.54 | 91.72 | 69.76 | 1.00 |
| HC | 976 | Q100 | 599.56 | 388.97 | 390.70 | 390.70 | 391.33 | 0.016435 | 6.39 | 93.89 | 73.43 | 1.00 |
| HC | 975 | Q100 | 599.56 | 382.30 | 384.00 | 384.00 | 384.64 | 0.016545 | 6.43 | 93.26 | 72.42 | 1.00 |
| HC | 974 | Q100 | 599.56 | 375.19 | 377.20 | 377.20 | 377.88 | 0.016529 | 6.58 | 91.06 | 67.98 | 1.00 |
| HC | 973 | Q100 | 599.56 | 368.85 | 370.87 | 370.87 | 371.66 | 0.015620 | 7.10 | 84.47 | 53.88 | 1.00 |
| HC | 972 | Q100 | 599.56 | 359.50 | 364.98 | 362.91 | 365.24 | 0.001754 | 4.07 | 147.37 | 40.14 | 0.37 |
| HC | 971 | Q100 | 825.76 | 358.71 | 362.72 | 362.72 | 364.22 | 0.013897 | 9.82 | 84.08 | 28.24 | 1.00 |
| HC | 970 | Q100 | 825.76 | 355.40 | 358.43 | 358.43 | 359.52 | 0.014110 | 8.39 | 98.43 | 44.79 | 1.00 |
| HC | 969.5 | Q100 | 825.76 | 352.38 | 355.20 | 355.20 | 356.20 | 0.014374 | 8.04 | 102.75 | 51.04 | 1.00 |
| HC | 969 | Q100 | 930.36 | 349.16 | 353.69 | 351.53 | 353.78 | 0.000869 | 2.42 | 385.77 | 157.32 | 0.26 |
| HC | 968.52 | | Culvert | | | | | | | | | |

HEC-RAS Plan: Default Scenario River: Haystack Channel Reach: HC Profile: Q100 (Continued)

| Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| HC | 968 | Q100 | 930.36 | 348.55 | 350.67 | 350.67 | 351.51 | 0.015338 | 7.36 | 126.33 | 75.78 | 1.01 |
| HC | 967 | Q100 | 930.36 | 343.84 | 347.19 | 347.11 | 348.15 | 0.012882 | 7.87 | 118.20 | 55.75 | 0.95 |
| HC | 966 | Q100 | 930.36 | 341.09 | 344.81 | 344.55 | 345.87 | 0.010218 | 8.29 | 112.27 | 40.24 | 0.87 |
| HC | 965 | Q100 | 930.36 | 338.36 | 342.09 | 342.09 | 343.51 | 0.013428 | 9.56 | 97.36 | 34.47 | 1.00 |
| HC | 964 | Q100 | 930.36 | 335.83 | 338.38 | 338.38 | 339.29 | 0.014543 | 7.68 | 121.09 | 65.42 | 1.00 |
| HC | 963 | Q100 | 930.36 | 332.47 | 334.60 | 334.60 | 335.47 | 0.015024 | 7.46 | 124.77 | 72.16 | 1.00 |
| HC | 962 | Q100 | 930.36 | 328.56 | 330.61 | 330.61 | 331.46 | 0.015052 | 7.40 | 125.65 | 73.44 | 1.00 |
| HC | 961 | Q100 | 930.36 | 324.47 | 326.53 | 326.53 | 327.42 | 0.015173 | 7.54 | 123.42 | 70.10 | 1.00 |




| ANALYSIS RESULTS | | | | |
|---|---|---|---|---|
| STA | Q100 (CFS) | WSE | VELOCITY | TOP OF BANK |
| 1002 | 10 | 510.64 | 2.79 | 510.73 |
| 1001 | 10 | 497.88 | 2.96 | 497.95 |
| 1000 | 10 | 480.03 | 2.77 | 480.39 |
| 999 | 10 | 475.13 | 0.47 | 476.70 |
| 998 | 10 | 472.50 | 3.41 | 474.29 |
| 997 | 321.50 | 467.88 | 7.19 | 472.02 |
| 996 | 321.50 | 463.73 | 6.59 | 465.08 |
| 995 | 321.50 | 458.63 | 6.57 | 459.84 |
| 994 | 321.50 | 455.49 | 6.52 | 456.52 |
| 993 | 321.50 | 452.80 | 6.72 | 454.24 |

| ANALYSIS RESULTS | | | | |
|---|---|---|---|---|
| STA | Q100 (CFS) | WSE | VELOCITY | TOP OF BANK |
| 992 | 348.46 | 450.22 | 6.67 | 451.68 |
| 991 | 348.46 | 447.58 | 6.65 | 448.57 |
| 990 | 542.66 | 445.15 | 7.13 | 445.30 |
| 989 | 542.66 | 440.72 | 7.34 | 441.33 |
| 988 | 542.66 | 435.74 | 7.48 | 437.20 |
| 987 | 542.66 | 430.16 | 7.57 | 432.66 |
| 986 | 595.06 | 426.55 | 7.66 | 428.61 |
| 985 | 595.06 | 426.73 | 2.02 | 427.22 |
| 984 | 595.06 | 420.90 | 7.84 | 424.59 |
| 983 | 595.06 | 420.18 | 7.48 | 423.04 |

| ANALYSIS RESULTS | | | | |
|---|---|---|---|---|
| STA | Q100 (CFS) | WSE | VELOCITY | TOP OF BANK |
| 982 | 595.06 | 416.80 | 7.93 | 420.58 |
| 981 | 595.06 | 414.89 | 8.49 | 419.97 |
| 980 | 599.56 | 410.34 | 7.81 | 417.66 |
| 979 | 599.56 | 406.56 | 7.02 | 411.68 |
| 978 | 599.56 | 402.00 | 6.69 | 405.84 |
| 977 | 599.56 | 396.83 | 6.54 | 699.82 |
| 976 | 599.56 | 390.70 | 6.39 | 393.30 |
| 975 | 599.56 | 384.00 | 6.43 | 387.04 |
| 974 | 599.56 | 377.20 | 6.58 | 381.16 |
| 973 | 599.56 | 370.87 | 7.10 | 375.42 |

| ANALYSIS RESULTS | | | | |
|---|---|---|---|---|
| STA | Q100 (CFS) | WSE | VELOCITY | TOP OF BANK |
| 972 | 599.56 | 364.98 | 4.07 | 369.04 |
| 971 | 825.76 | 362.72 | 9.82 | 364.65 |
| 970 | 825.76 | 358.43 | 8.39 | 360.74 |
| 969.5 | 825.76 | 355.20 | 8.04 | 356.58 |
| 969 | 930.36 | 353.69 | 2.42 | 353.32 |
| 968 | 930.36 | 350.67 | 7.36 | 351.90 |
| 967 | 930.36 | 347.19 | 7.87 | 350.49 |
| 966 | 930.36 | 344.81 | 8.29 | 348.28 |
| 965 | 930.36 | 342.09 | 9.56 | 346.98 |
| 964 | 930.36 | 338.38 | 7.68 | 342.76 |

| ANALYSIS RESULTS | | | | |
|---|---|---|---|---|
| STA | Q100 (CFS) | WSE | VELOCITY | TOP OF BANK |
| 963 | 930.36 | 334.60 | 7.46 | 337.96 |
| 962 | 930.36 | 330.61 | 7.40 | 335.06 |
| 961 | 930.36 | 326.53 | 7.54 | 332.23 |

## LEGEND

- 1000 — STATION NUMBER
- CROSS SECTION
- BANK STATIONS
- POWER POLE
- WATERCOURSE
- FLOOD EXTENTS

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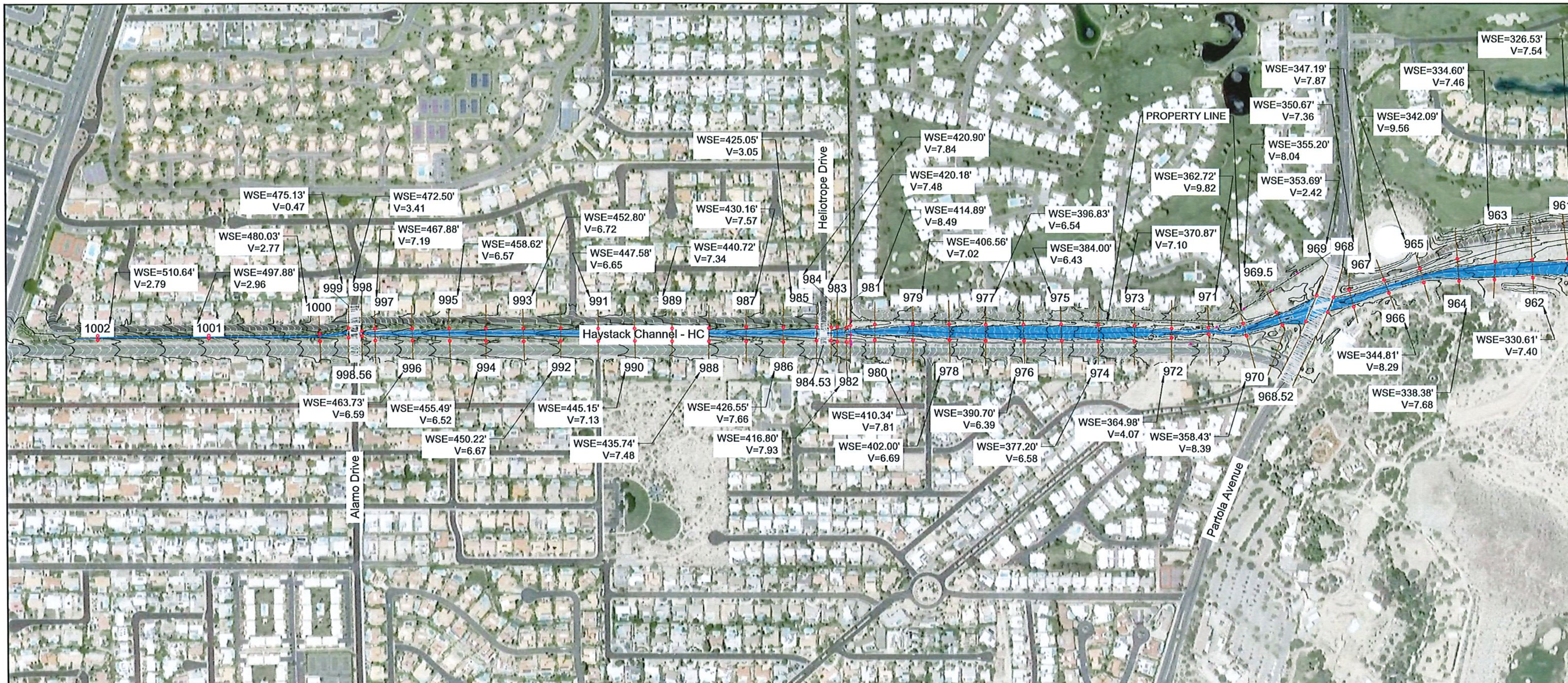
# BASELINE CONDITION
# HAYSTACK CHANNEL




### ANALYSIS RESULTS

| STA | Q100 (CFS) | WSE | VELOCITY | TOP OF BANK |
|---|---|---|---|---|
| 1002 | 10 | 510.64 | 2.79 | 510.73 |
| 1001 | 10 | 497.88 | 2.96 | 497.95 |
| 1000 | 10 | 480.03 | 2.77 | 480.39 |
| 999 | 10 | 475.13 | 0.47 | 476.70 |
| 998 | 10 | 472.50 | 3.41 | 474.29 |
| 997 | 321.50 | 467.88 | 7.19 | 472.02 |
| 996 | 321.50 | 463.73 | 6.59 | 465.08 |
| 995 | 321.50 | 458.63 | 6.57 | 459.84 |
| 994 | 321.50 | 455.49 | 6.52 | 456.52 |
| 993 | 321.50 | 452.80 | 6.72 | 454.24 |

### ANALYSIS RESULTS

| STA | Q100 (CFS) | WSE | VELOCITY | TOP OF BANK |
|---|---|---|---|---|
| 992 | 348.46 | 450.22 | 6.67 | 451.68 |
| 991 | 348.46 | 447.58 | 6.65 | 448.57 |
| 990 | 542.66 | 445.15 | 7.13 | 445.30 |
| 989 | 542.66 | 440.72 | 7.34 | 441.33 |
| 988 | 542.66 | 435.74 | 7.48 | 437.20 |
| 987 | 542.66 | 430.16 | 7.57 | 432.66 |
| 986 | 595.06 | 426.55 | 7.66 | 428.61 |
| 985 | 595.06 | 425.05 | 3.05 | 427.22 |
| 984 | 595.06 | 420.90 | 7.84 | 424.59 |
| 983 | 595.06 | 420.18 | 7.48 | 423.04 |

### ANALYSIS RESULTS

| STA | Q100 (CFS) | WSE | VELOCITY | TOP OF BANK |
|---|---|---|---|---|
| 982 | 595.06 | 416.80 | 7.93 | 420.58 |
| 981 | 595.06 | 414.89 | 8.49 | 419.97 |
| 980 | 599.56 | 410.34 | 7.81 | 417.66 |
| 979 | 599.56 | 406.56 | 7.02 | 411.68 |
| 978 | 599.56 | 402.00 | 6.69 | 405.84 |
| 977 | 599.56 | 396.83 | 6.54 | 699.82 |
| 976 | 599.56 | 390.70 | 6.39 | 393.30 |
| 975 | 599.56 | 384.00 | 6.43 | 387.04 |
| 974 | 599.56 | 377.20 | 6.58 | 381.16 |
| 973 | 599.56 | 370.87 | 7.10 | 375.42 |

### ANALYSIS RESULTS

| STA | Q100 (CFS) | WSE | VELOCITY | TOP OF BANK |
|---|---|---|---|---|
| 972 | 599.56 | 364.98 | 4.07 | 369.04 |
| 971 | 825.76 | 362.72 | 9.82 | 364.65 |
| 970 | 825.76 | 358.43 | 8.39 | 360.74 |
| 969.5 | 825.76 | 355.20 | 8.04 | 356.58 |
| 969 | 930.36 | 353.69 | 2.42 | 353.32 |
| 968 | 930.36 | 350.67 | 7.36 | 351.90 |
| 967 | 930.36 | 347.19 | 7.87 | 350.49 |
| 966 | 930.36 | 344.81 | 8.29 | 348.28 |
| 965 | 930.36 | 342.09 | 9.56 | 346.98 |
| 964 | 930.36 | 338.38 | 7.68 | 342.76 |

### ANALYSIS RESULTS

| STA | Q100 (CFS) | WSE | VELOCITY | TOP OF BANK |
|---|---|---|---|---|
| 963 | 930.36 | 334.60 | 7.46 | 337.96 |
| 962 | 930.36 | 330.61 | 7.40 | 335.06 |
| 961 | 930.36 | 326.53 | 7.54 | 332.23 |

### LEGEND

- 1000 — STATION NUMBER
- CROSS SECTION
- BANK STATIONS
- POWER POLE
- WATERCOURSE
- FLOOD EXTENTS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## CITY OF PALM DESERT

## ALTERNATIVE DEVELOPMENT HAYSTACK CHANNEL

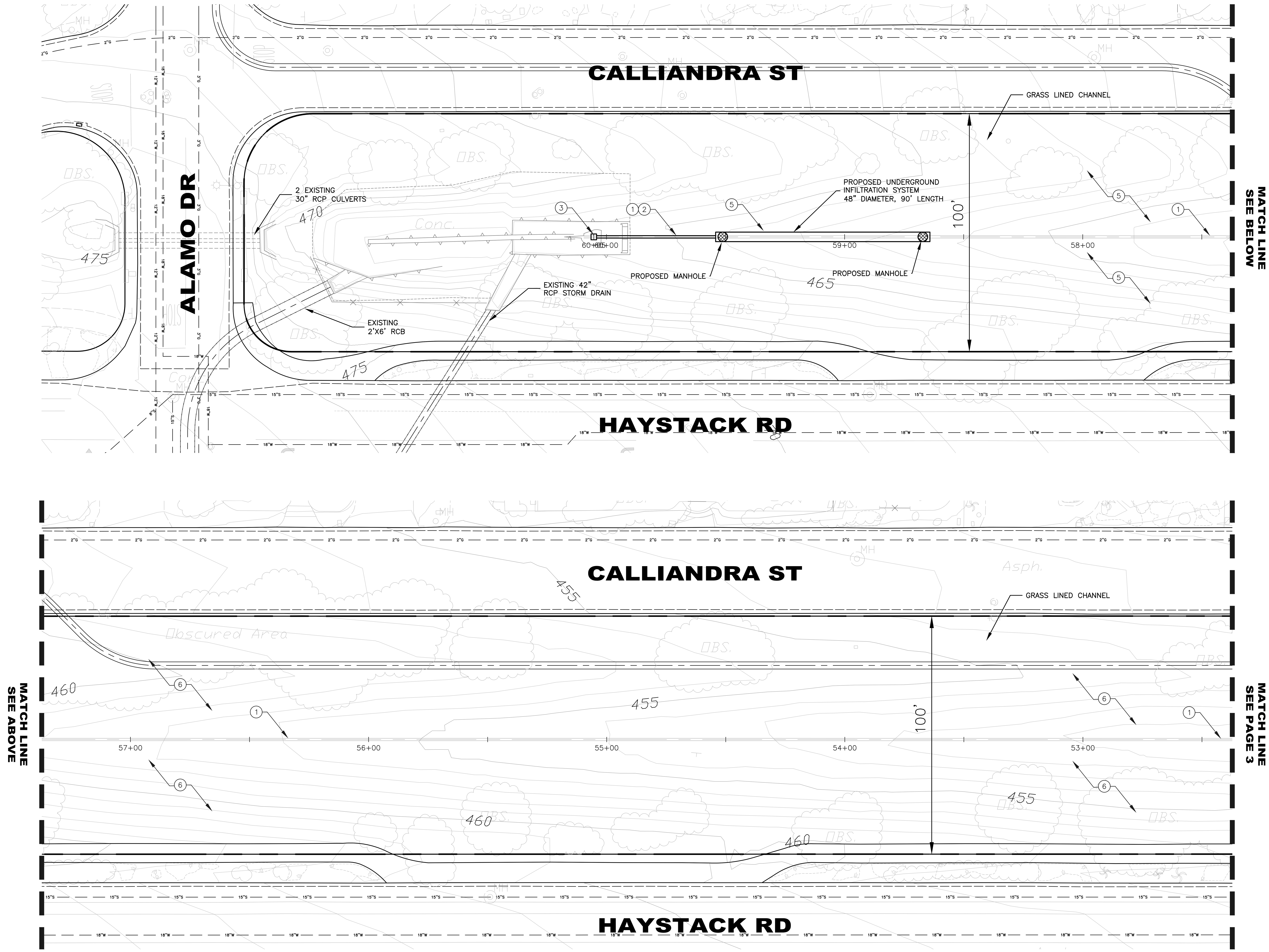
HEC-RAS Plan: Default Scenario River: Haystack Channel Reach: HC Profile: Q100

| Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | Top Width | Froude # Chl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (cfs) | (ft) | (ft) | (ft) | (ft) | (ft/ft) | (ft/s) | (sq ft) | (ft) | |
| HC | 1002 | Q100 | 10.00 | 510.23 | 510.64 | 510.64 | 510.76 | 0.014051 | 2.79 | 3.59 | 14.37 | 0.98 |
| HC | 1001 | Q100 | 10.00 | 497.45 | 497.88 | 497.88 | 498.02 | 0.014444 | 2.96 | 3.37 | 12.57 | 1.01 |
| HC | 1000 | Q100 | 10.00 | 479.59 | 480.03 | 480.03 | 480.15 | 0.015134 | 2.77 | 3.61 | 15.42 | 1.01 |
| HC | 999 | Q100 | 10.00 | 473.76 | 475.13 | 474.25 | 475.14 | 0.000082 | 0.47 | 21.17 | 25.43 | 0.09 |
| HC | 998.56 | | Culvert | | | | | | | | | |
| HC | 998 | Q100 | 10.00 | 471.89 | 472.50 | 472.50 | 472.68 | 0.014303 | 3.41 | 2.93 | 8.29 | 1.01 |
| HC | 997 | Q100 | 321.50 | 465.35 | 467.88 | 467.88 | 468.68 | 0.008174 | 7.19 | 44.73 | 27.96 | 1.00 |
| HC | 996 | Q100 | 321.50 | 461.43 | 463.73 | 463.73 | 464.40 | 0.008357 | 6.59 | 48.79 | 36.20 | 1.00 |
| HC | 995 | Q100 | 321.50 | 456.64 | 458.63 | 458.63 | 459.31 | 0.008409 | 6.57 | 48.93 | 36.64 | 1.00 |
| HC | 994 | Q100 | 321.50 | 453.61 | 455.49 | 455.49 | 456.15 | 0.008519 | 6.52 | 49.30 | 37.74 | 1.01 |
| HC | 993 | Q100 | 321.50 | 450.49 | 452.80 | 452.80 | 453.51 | 0.008226 | 6.72 | 47.85 | 34.01 | 1.00 |
| HC | 992 | Q100 | 348.46 | 448.10 | 450.22 | 450.22 | 450.91 | 0.008220 | 6.67 | 52.28 | 37.68 | 1.00 |
| HC | 991 | Q100 | 348.46 | 445.53 | 447.58 | 447.58 | 448.26 | 0.008168 | 6.65 | 52.44 | 37.78 | 0.99 |
| HC | 990 | Q100 | 542.66 | 442.52 | 445.15 | 445.15 | 445.94 | 0.007803 | 7.13 | 76.14 | 47.81 | 1.00 |
| HC | 989 | Q100 | 542.66 | 437.96 | 440.72 | 440.72 | 441.56 | 0.007727 | 7.34 | 73.91 | 43.94 | 1.00 |
| HC | 988 | Q100 | 542.66 | 432.95 | 435.74 | 435.74 | 436.61 | 0.007639 | 7.48 | 72.55 | 41.51 | 1.00 |
| HC | 987 | Q100 | 542.66 | 427.30 | 430.16 | 430.16 | 431.05 | 0.007694 | 7.57 | 71.72 | 40.50 | 1.00 |
| HC | 986 | Q100 | 595.06 | 423.97 | 426.55 | 426.55 | 427.46 | 0.007533 | 7.66 | 77.72 | 42.46 | 1.00 |
| HC | 985 | Q100 | 595.06 | 419.73 | 425.05 | 422.32 | 425.19 | 0.000487 | 3.05 | 195.36 | 53.23 | 0.28 |
| HC | 984.53 | | Culvert | | | | | | | | | |
| HC | 984 | Q100 | 595.06 | 418.54 | 420.90 | 420.90 | 421.86 | 0.007599 | 7.84 | 75.88 | 39.89 | 1.00 |
| HC | 983 | Q100 | 595.06 | 417.74 | 420.18 | 420.18 | 421.05 | 0.007690 | 7.48 | 79.55 | 45.83 | 1.00 |
| HC | 982 | Q100 | 595.06 | 413.10 | 416.80 | 416.80 | 417.78 | 0.007600 | 7.93 | 75.05 | 38.28 | 1.00 |
| HC | 981 | Q100 | 595.06 | 410.92 | 414.89 | 414.89 | 416.01 | 0.014666 | 8.49 | 70.07 | 31.12 | 1.00 |
| HC | 980 | Q100 | 599.56 | 407.93 | 410.34 | 410.34 | 411.29 | 0.014819 | 7.81 | 76.75 | 40.42 | 1.00 |
| HC | 979 | Q100 | 599.56 | 404.62 | 406.56 | 406.56 | 407.33 | 0.015728 | 7.02 | 85.40 | 55.69 | 1.00 |
| HC | 978 | Q100 | 599.56 | 400.23 | 402.00 | 402.00 | 402.70 | 0.016193 | 6.69 | 89.68 | 64.61 | 1.00 |
| HC | 977 | Q100 | 599.56 | 395.06 | 396.83 | 396.83 | 397.50 | 0.016583 | 6.54 | 91.72 | 69.76 | 1.00 |
| HC | 976 | Q100 | 599.56 | 388.97 | 390.70 | 390.70 | 391.33 | 0.016435 | 6.39 | 93.89 | 73.43 | 1.00 |
| HC | 975 | Q100 | 599.56 | 382.30 | 384.00 | 384.00 | 384.64 | 0.016545 | 6.43 | 93.26 | 72.42 | 1.00 |
| HC | 974 | Q100 | 599.56 | 375.19 | 377.20 | 377.20 | 377.88 | 0.016529 | 6.58 | 91.06 | 67.98 | 1.00 |
| HC | 973 | Q100 | 599.56 | 368.85 | 370.87 | 370.87 | 371.66 | 0.015620 | 7.10 | 84.47 | 53.88 | 1.00 |
| HC | 972 | Q100 | 599.56 | 359.50 | 364.98 | 362.91 | 365.24 | 0.001754 | 4.07 | 147.37 | 40.14 | 0.37 |
| HC | 971 | Q100 | 825.76 | 358.71 | 362.72 | 362.72 | 364.22 | 0.013897 | 9.82 | 84.08 | 28.24 | 1.00 |
| HC | 970 | Q100 | 825.76 | 355.40 | 358.43 | 358.43 | 359.52 | 0.014110 | 8.39 | 98.43 | 44.79 | 1.00 |
| HC | 969.5 | Q100 | 825.76 | 352.38 | 355.20 | 355.20 | 356.20 | 0.014374 | 8.04 | 102.75 | 51.04 | 1.00 |
| HC | 969 | Q100 | 930.36 | 349.16 | 353.69 | 351.53 | 353.78 | 0.000869 | 2.42 | 385.77 | 157.32 | 0.26 |
| HC | 968.52 | | Culvert | | | | | | | | | |

# Appendix C
## Preliminary Plans and Cost Estimate

| City of Palm Desert -- Haystack Channel Rehabilitation – Preliminary Construction Cost | | | | | |
|---|---|---|---|---|---|
| **Item** | **Description** | **Unit** | **Quantity** | **Unit Price** | **Line Total** |
| 1 | Mobilization (2.5% of Total) | LS | 1 | | $62,000 |
| | **Alamo Rd. to Heliotrope Drive – Alternative No. 2** | | | | |
| 2 | Remove and Dispose of Improvements per CIP 1196 | LS | 1 | $75,000 | $75,000 |
| 3 | Furnish and Install 12-inch HDPE Pipe | LF | 200 | $100 | $20,000 |
| 4 | Remove/Replace Catch Basin at Storm Drain Outlet (Basin, Piping & Conc.) | EA | 4 | $10,000 | $40,000 |
| 5 | Furnish and Install Contech Underground Chamber System | EA | 4 | $100,000 | $400,000 |
| 6 | Remove/Replace Landscape and Irrigation | SF | 18,000 | $7.50 | $135,000 |
| | **Subtotal** | | | | **$670,000** |
| | **Heliotrope Drive to Portola Avenue – Alternative No. 1** | | | | |
| 7 | Clear and Grub | LS | 1 | $30,000 | $30,000 |
| 8 | Earthwork – Excavation and Backfill | CY | 19,240 | $25.00 | $481,025 |
| 9 | Construct Rock Slope Protection | CY | 12,400 | $80.00 | $992,000 |
| 10 | Construct Drop Structure (1/4-ton stone) | CY | 200 | $80.00 | $16,000 |
| 11 | Construct Junction Structure no. 6 per RCFC&WD Std. JS231 | EA | 3 | $10,000 | $30,000 |
| 12 | Construct Access Road (north side only) per RCFC&WCD Std. CH323 | LF | 2,726 | $50.00 | $163,000 |
| 13 | Underground Existing Overhead Electric | LS | 1 | $100,000 | $100,000 |
| | **Subtotal** | | | | **$1,812,025** |
| | **Total** | | | | **$2,482,025** |
| | | | | | |
| | **Project Contingencies (15% of Total)** | | | | **$372,300** |
| | **Contract Administration (1% of Total)** | | | | **$24,820** |
| | **Construction Inspection (5% of Total)** | | | | **$124,100** |
| | **Construction Staking (3% of Total)** | | | | **$74,500** |
| | **Soils Testing (1% of Total)** | | | | **$24,820** |
| | **Material Testing (1% of Total)** | | | | **$24,820** |
| | **Total – Construction, Contingencies, & Project Administration** | | | | **$3,189,385** |

Revised 01.08.2023




**CONSTRUCTION NOTES**

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9. CONSTRUCT ACCESS ROAD ALONG NORTH SIDE OF CHANNEL PER RCFCD STD. CH323
10. RELOCATE EXISTING POWERPOLES
11. INSTALL ½ TON RIP-RAP

**HYDROLOGY DATA**

| STATION RANGE | Q100 |
|---|---|
| 60+05–52+00 | 322 CFS |
| 52+00–47+50 | 348 CFS |
| 47+50–38+50 | 543 CFS |
| 38+50–34+50 | 595 CFS |
| 34+50–15+50 | 600 CFS |
| 15+50–10+50 | 826 CFS |
| 10+50–10+00 | 930 CFS |

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A PUBLIC SERVICE BY UNDERGROUND SERVICE ALERT

BENCHMARK: P.D. #164 (USC&GS N-517 1955)
ELEVATION: 360.103 FT DATUM: NGVD29
LOCATION: 3.75" UCS&GS BRONZE DISC IN CONCRETE MONUMENT WELL LOCATED 49 FT WEST AND 152 FT NORTH OF THE INTERSECTION CENTERLINE OF HIGHWAY 74 AND THE CENTERLINE OF SHADOW MOUNTAIN DRIVE, 12.75 FT WEST OF WESTERLY CURB. (NGVD 29)
BASIS OF BEARINGS: THE CENTERLINE OF STATE HIGHWAY 74 BEING N79°29'32"E PER PM.......

| ENGINEER | | | REVISIONS | CITY | |
|---|---|---|---|---|---|
| MARK | BY | DATE | | APPR. | DATE |
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ENGINEERS SEAL
REGISTERED PROFESSIONAL ENGINEER NO. #### MON. DD, YEAR CIVIL STATE OF CALIFORNIA

LOGO
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ENGINEER'S ADDRESS
ENGINEER'S CITY, STATE, ZIP
ENGINEER'S PHONE AND FAX NUMBER
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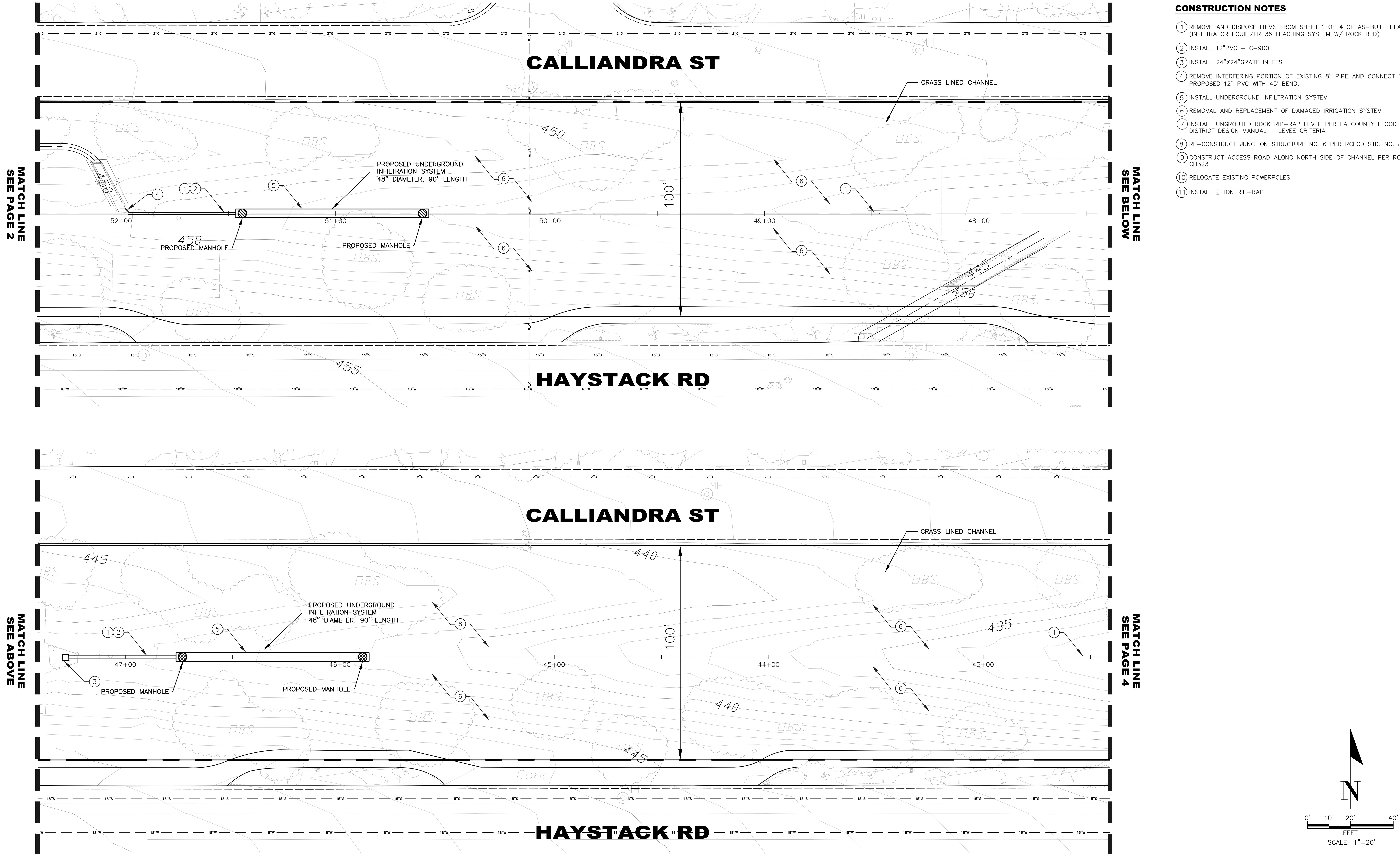
DATE:
ENGINEERS NAME, R.C.E. NO. ##### EXP. ##/##/##

CITY OF PALM DESERT
DEPARTMENT OF DEVELOPMENT SERVICES
APPROVED BY:
JOHN D. TANNER III, P.E. DATE
ACTING CITY ENGINEER
R.C.E. 60132, EXP. 6/30/2022
REVIEWED AND RECOMMENDED BY: DATE

PLAN CHECKED BY:
CIVIL
TRAFFIC
LANDSCAPE

CITY OF PALM DESERT
CHANNEL PLAN
CHANNEL IMPROVEMENTS
HAYSTACK CHANNEL
LEGAL DESCRIPTION (I.E. LOCATED IN A PORTION OF THE NW 1/4 OF SECTION 19, T5S, R6E, SBBM

SHEET 2 OF SHEETS 7
CITY FILE NUMBER




**CONSTRUCTION NOTES**

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10. RELOCATE EXISTING POWERPOLES
11. INSTALL ¼ TON RIP-RAP

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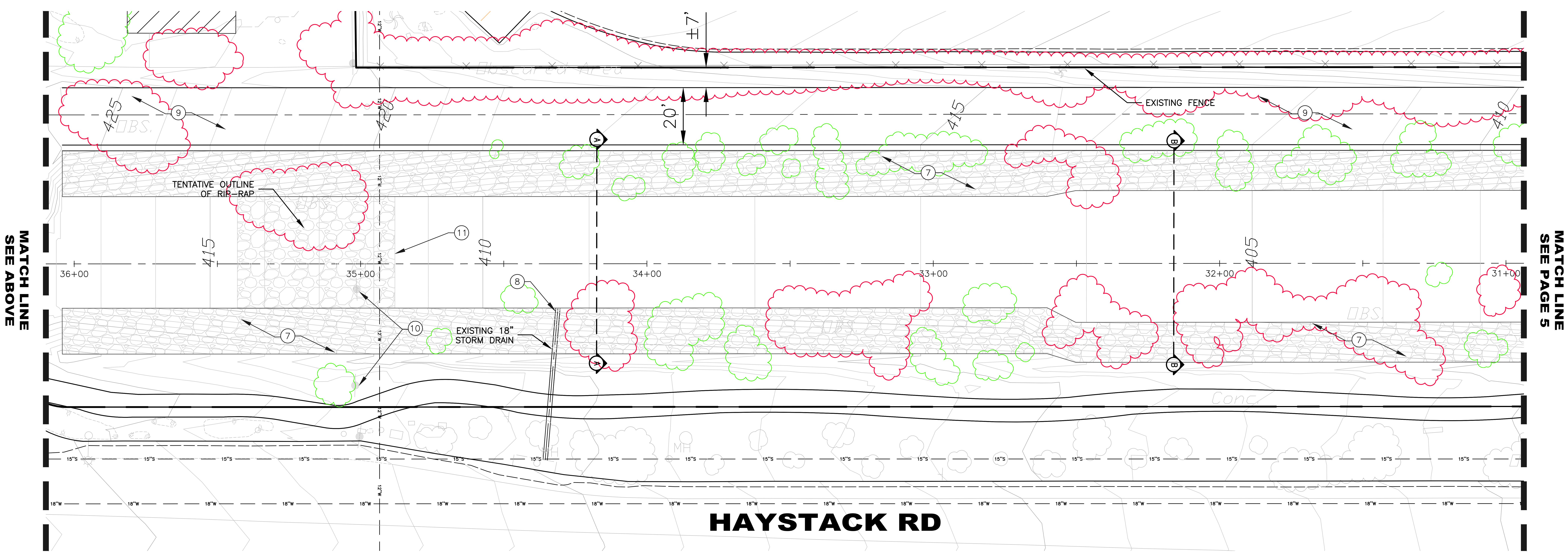
TRAFFIC
LANDSCAPE

CITY OF PALM DESERT
CHANNEL PLAN
CHANNEL IMPROVEMENTS
HAYSTACK CHANNEL
LEGAL DESCRIPTION (I.E. LOCATED IN A PORTION OF THE NW 1/4 OF SECTION 19, T5S, R6E, SBBM

SHEET 3 OF SHEETS 7
CITY FILE NUMBER


## CONSTRUCTION NOTES

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9. CONSTRUCT ACCESS ROAD ALONG NORTH SIDE OF CHANNEL PER RCFCD STD. CH323
10. RELOCATE EXISTING POWERPOLES
11. INSTALL $\frac{1}{4}$ TON RIP-RAP

N

0' 10' 20' 40'
FEET
SCALE: 1"=20'

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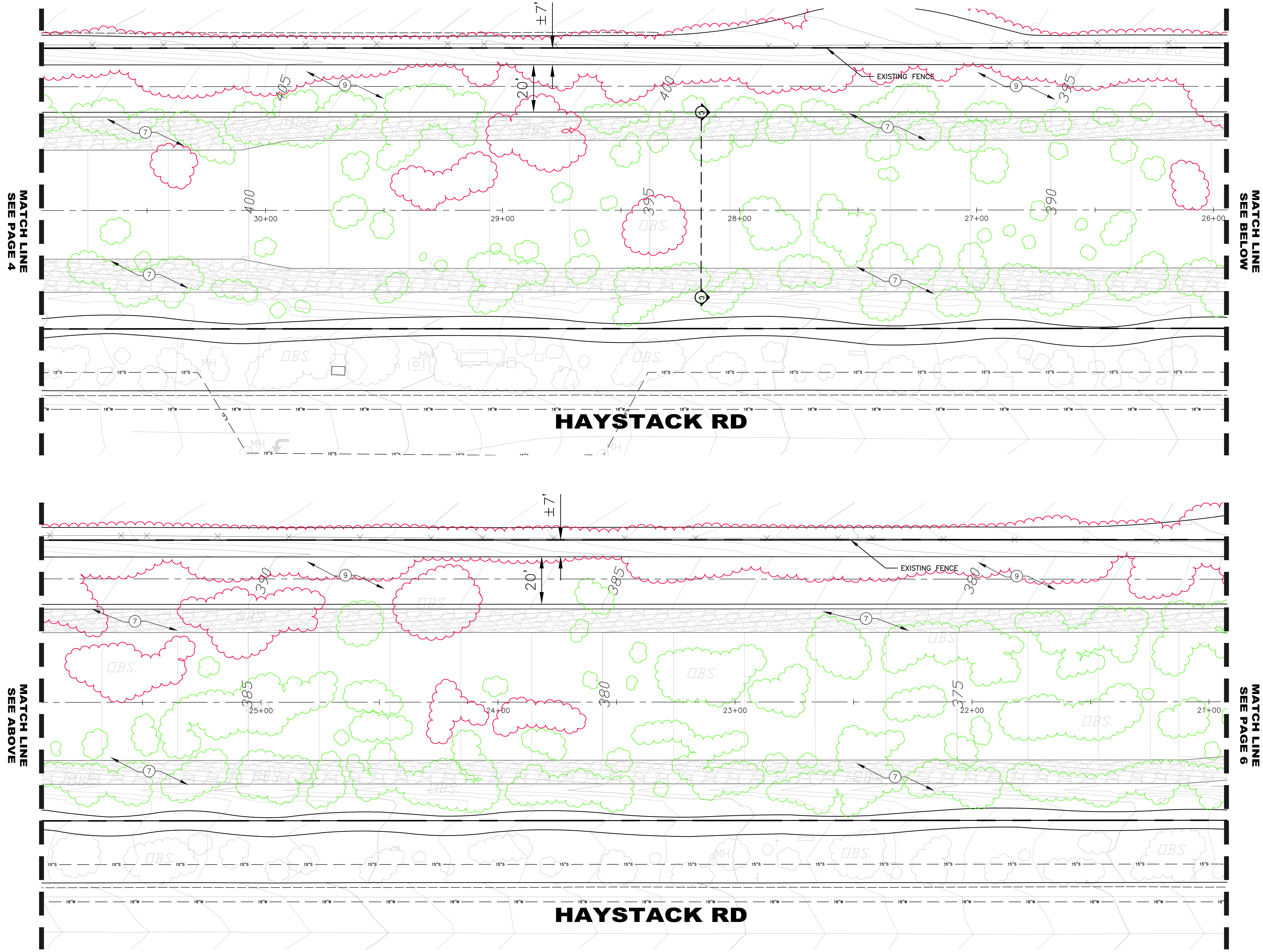
TRAFFIC
LANDSCAPE

CITY OF PALM DESERT
CHANNEL PLAN
CHANNEL IMPROVEMENTS
HAYSTACK CHANNEL
LEGAL DESCRIPTION (I.E. LOCATED IN A PORTION OF THE NW 1/4 OF SECTION 19, T5S, R6E, SBBM

SHEET 4 OF SHEETS 7
CITY FILE NUMBER




## CONSTRUCTION NOTES

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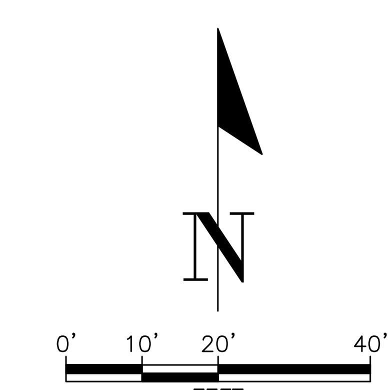
10. RELOCATE EXISTING POWERPOLES
11. INSTALL 1/4 TON RIP-RAP




SCALE: 1"=20'

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R.C.E. 60132, EXP. 6/30/2022
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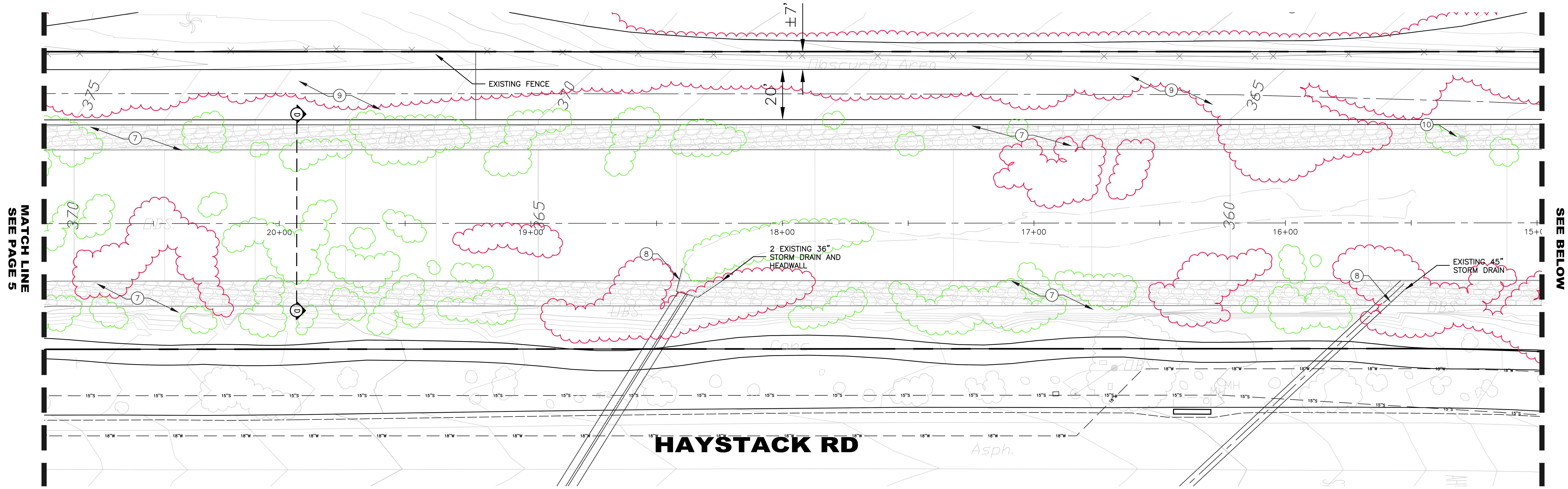
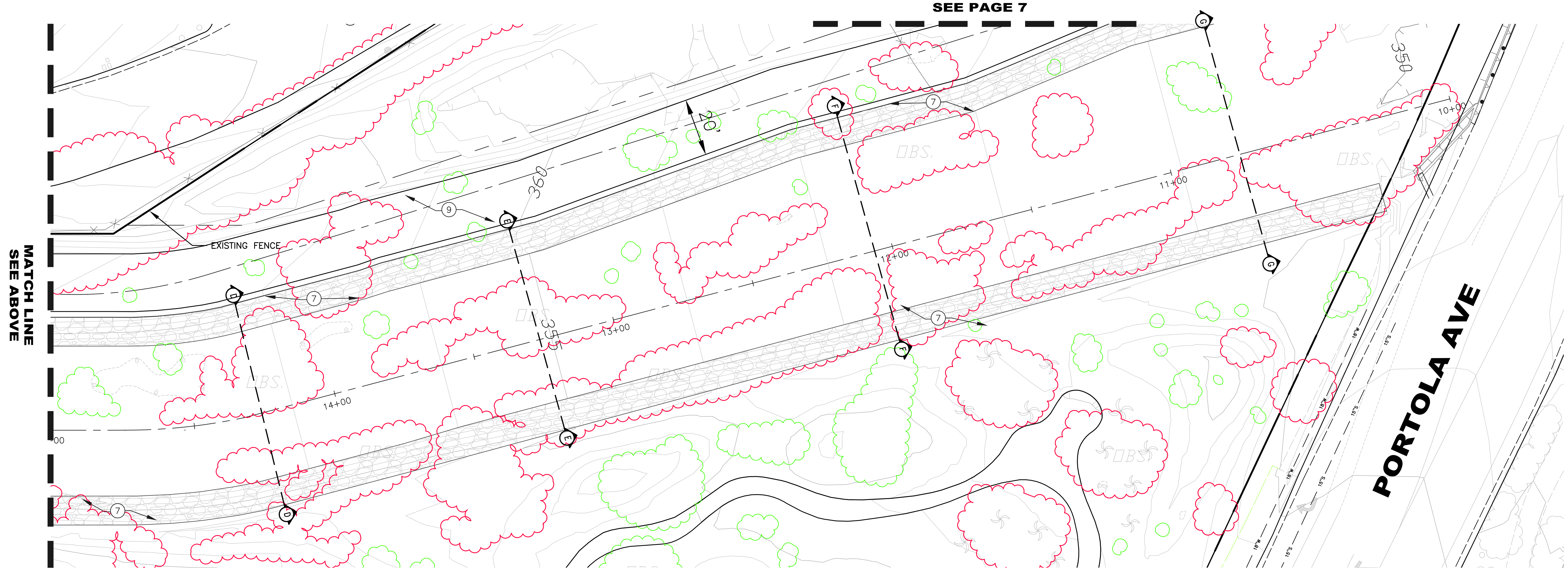
LANDSCAPE

CITY OF PALM DESERT
CHANNEL PLAN
CHANNEL IMPROVEMENTS
HAYSTACK CHANNEL
LEGAL DESCRIPTION (I.E. LOCATED IN A PORTION OF THE NW 1/4 OF SECTION 19, T5S, R6E, SBBM

SHEET 5 OF 7 SHEETS
CITY FILE NUMBER

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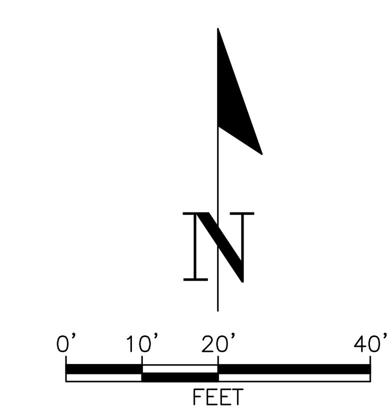


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ENGINEERS SEAL
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NO. #### MON. DD, YEAR
CIVIL
STATE OF CALIFORNIA

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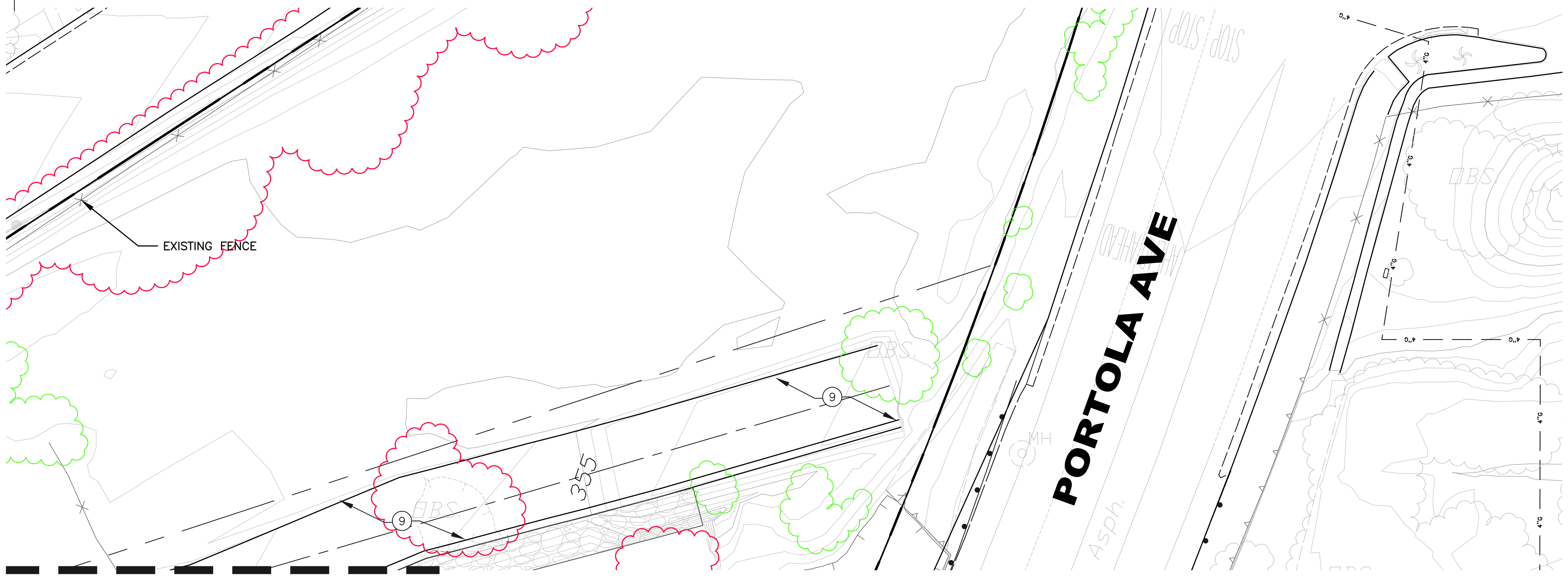
# CITY OF PALM DESERT

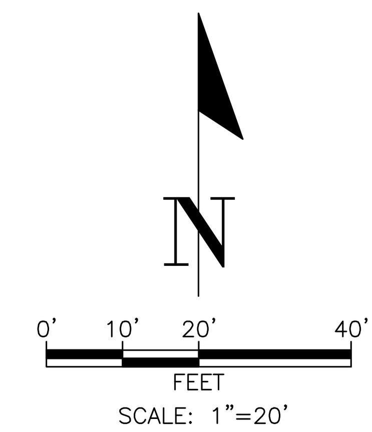
## CHANNEL PLAN
## CHANNEL IMPROVEMENTS
## HAYSTACK CHANNEL

LEGAL DESCRIPTION (I.E. LOCATED IN A PORTION OF THE NW 1/4 OF SECTION 19, T5S, R6E, SBBM

SHEET 6 OF 7 SHEETS
CITY FILE NUMBER




**ACCESS ROAD MATCH LINE SEE PAGE 6**

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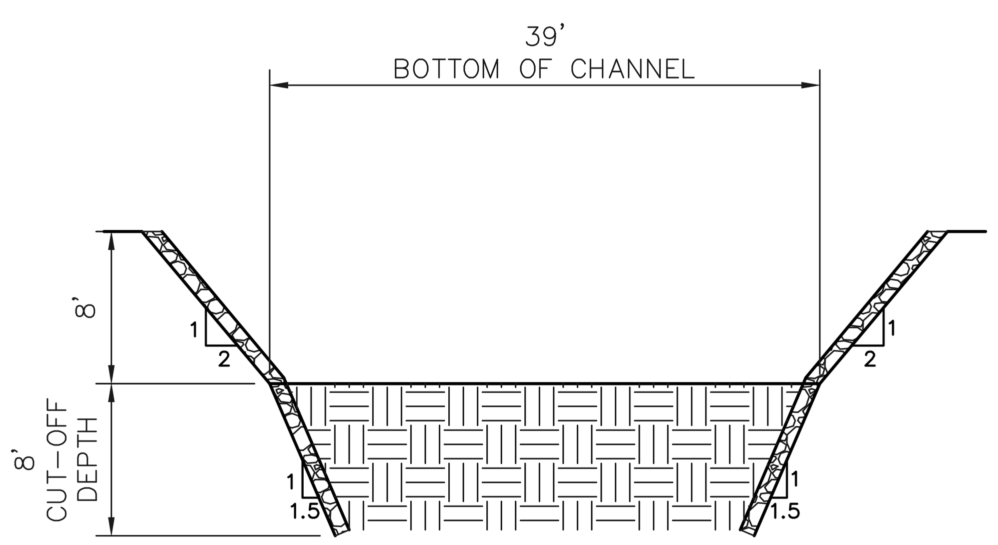
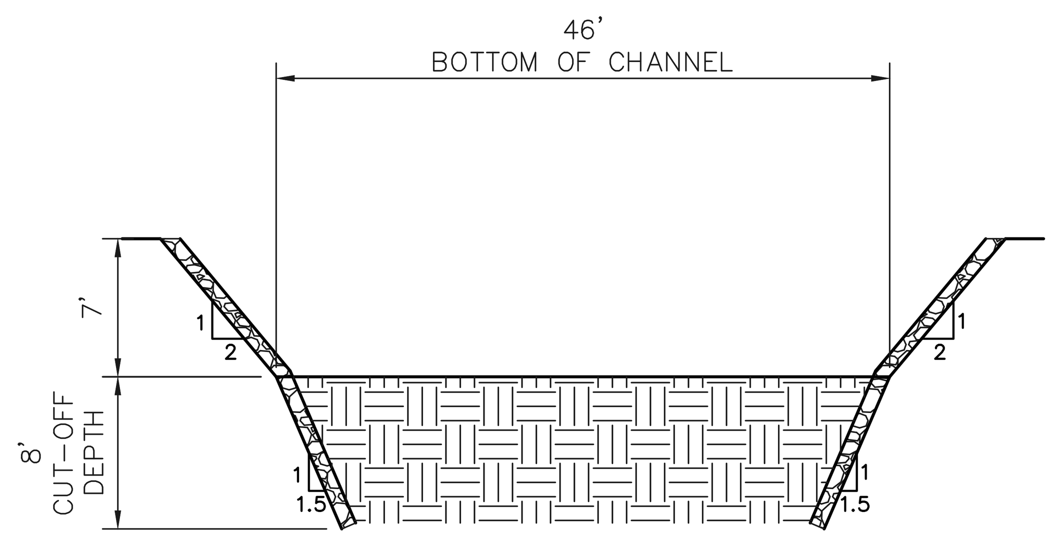
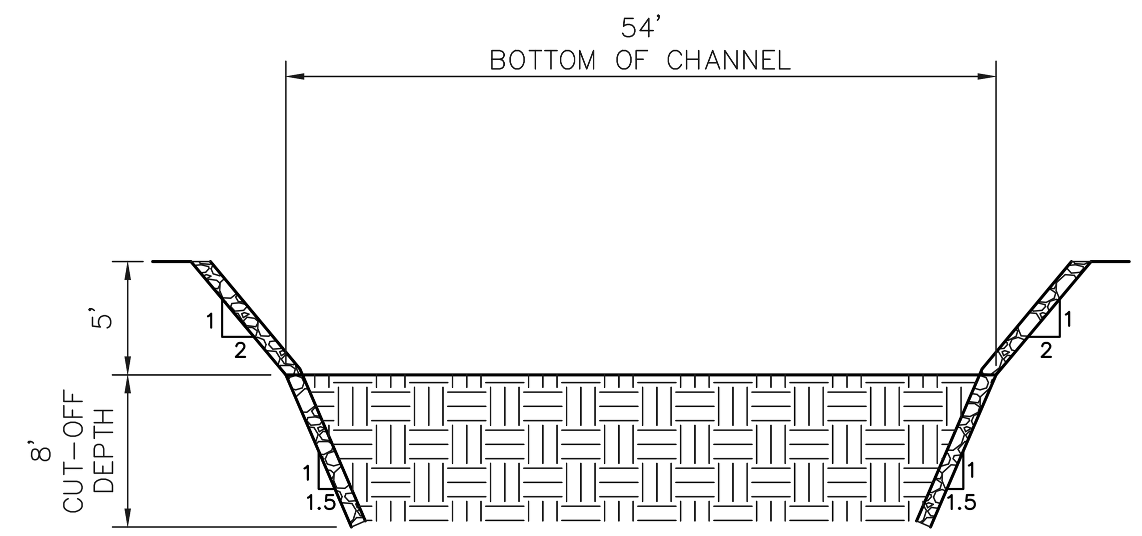


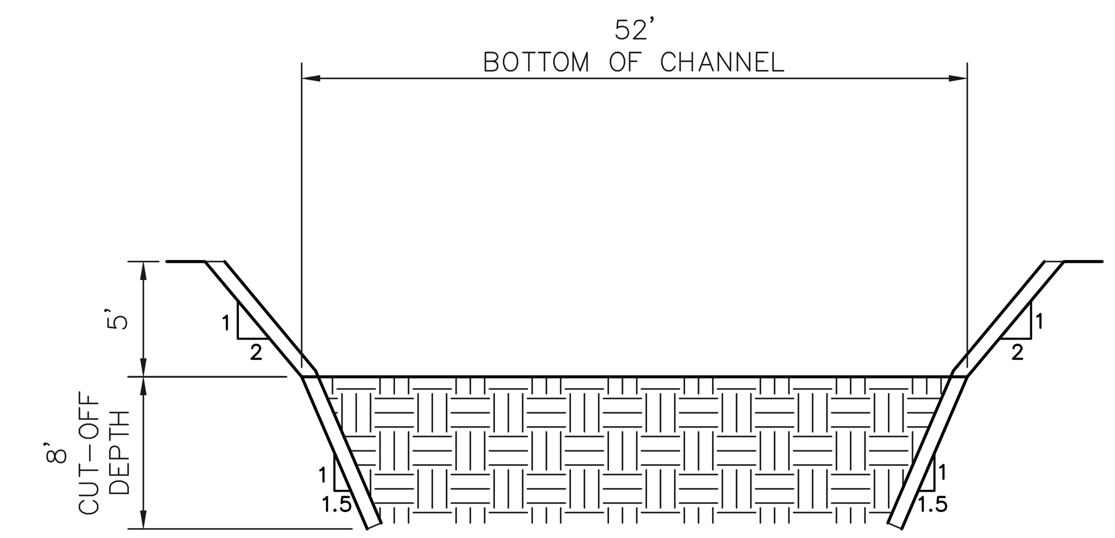

TYPICAL CROSS SECTION A-A
STATION 36+00-33+50
N.T.S.



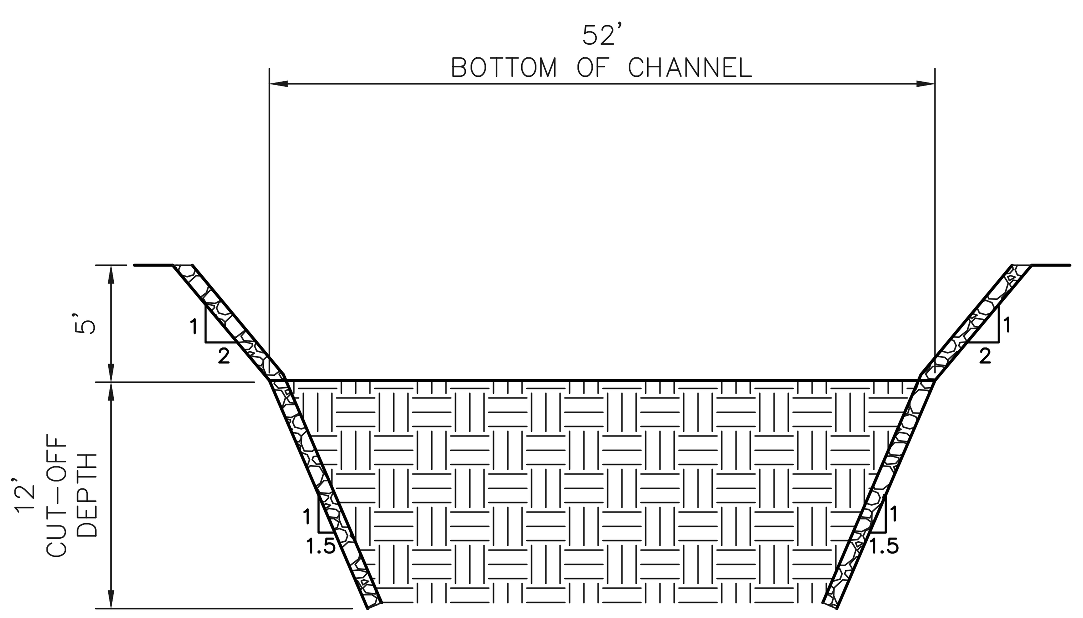

TYPICAL CROSS SECTION B-B
STATION 33+50-30+00
N.T.S.



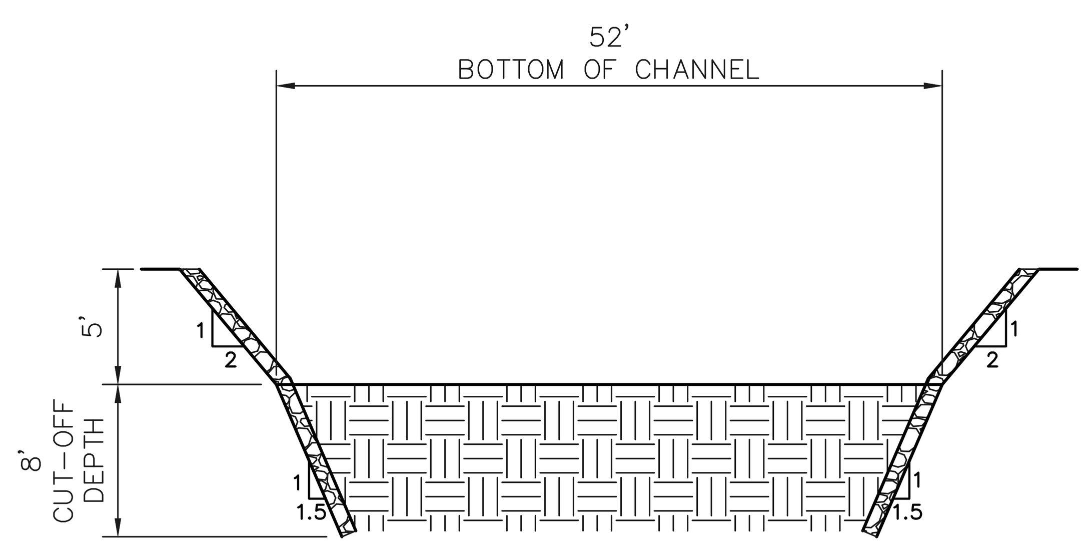

TYPICAL CROSS SECTION C-C
STATION 30+00-21+00
N.T.S.



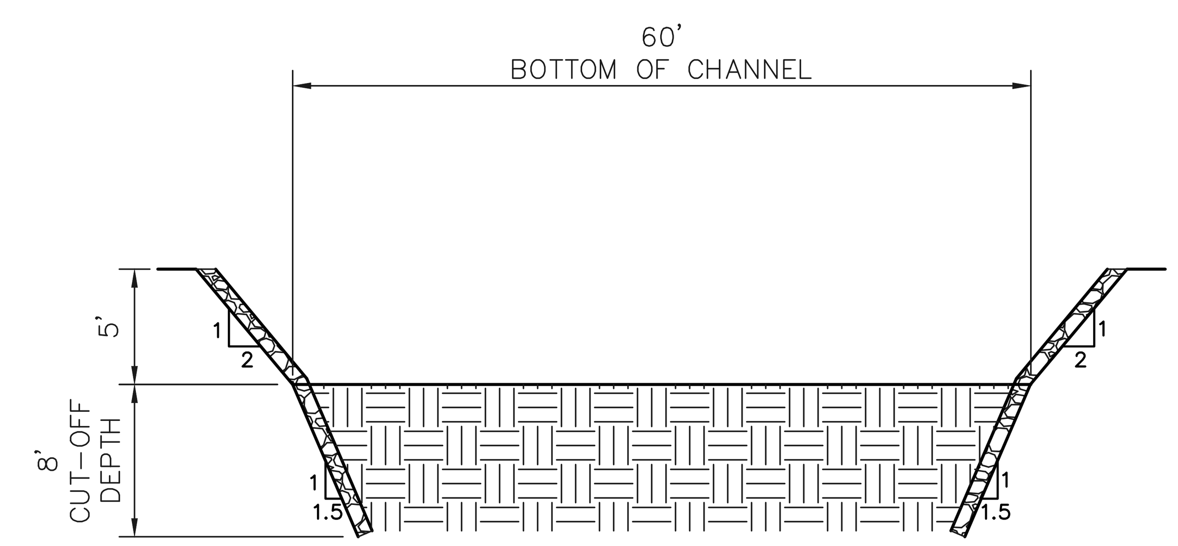

TYPICAL CROSS SECTION D-D
STATION 21+00-13+50
N.T.S.



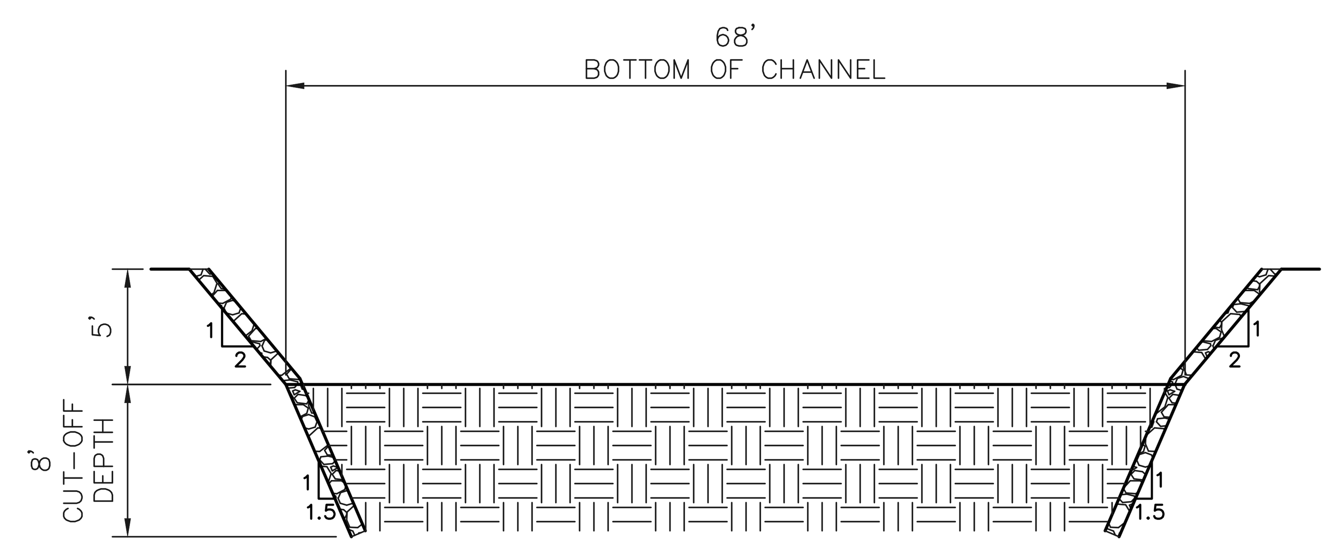

TYPICAL CROSS SECTION D-D
(CURVED REACH)
STATION 15+00-14+00 ONLY
N.T.S.




TYPICAL CROSS SECTION E-E
STATION013+50-13+00
N.T.S.




TYPICAL CROSS SECTION F-F
STATION 13+00-11+50
N.T.S.




TYPICAL CROSS SECTION G-G
STATION 11+50-10+00
N.T.S.

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CITY OF PALM DESERT
DEPARTMENT OF DEVELOPMENT SERVICES
APPROVED BY:
JOHN D. TANNER III, P.E. DATE
ACTING CITY ENGINEER
R.C.E. 60132, EXP. 6/30/2022
REVIEWED AND RECOMMENDED BY: DATE

PLAN CHECKED BY:
CIVIL
TRAFFIC
LANDSCAPE

CITY OF PALM DESERT
CHANNEL PLAN
CHANNEL IMPROVEMENTS
HAYSTACK CHANNEL
LEGAL DESCRIPTION (I.E. LOCATED IN A PORTION OF THE NW 1/4 OF SECTION 19, T5S, R6E, SBBM

SHEET 7 OF 7 SHEETS
CITY FILE NUMBER