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CITY OF SUNNYVALE
MASTER PLAN AND PRIMARY
TREATMENT DESIGN
TECHNICAL MEMORANDUM
HYDROLOGY REPORT:
MASTER PLAN

FINAL
November 2013



CITY OF SUNNYVALE
MASTER PLAN AND PRIMARY TREATMENT DESIGN

TECHNICAL MEMORANDUM
HYDROLOGY REPORT:
MASTER PLAN

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HYDROLOGY REPORT: MASTER PLAN

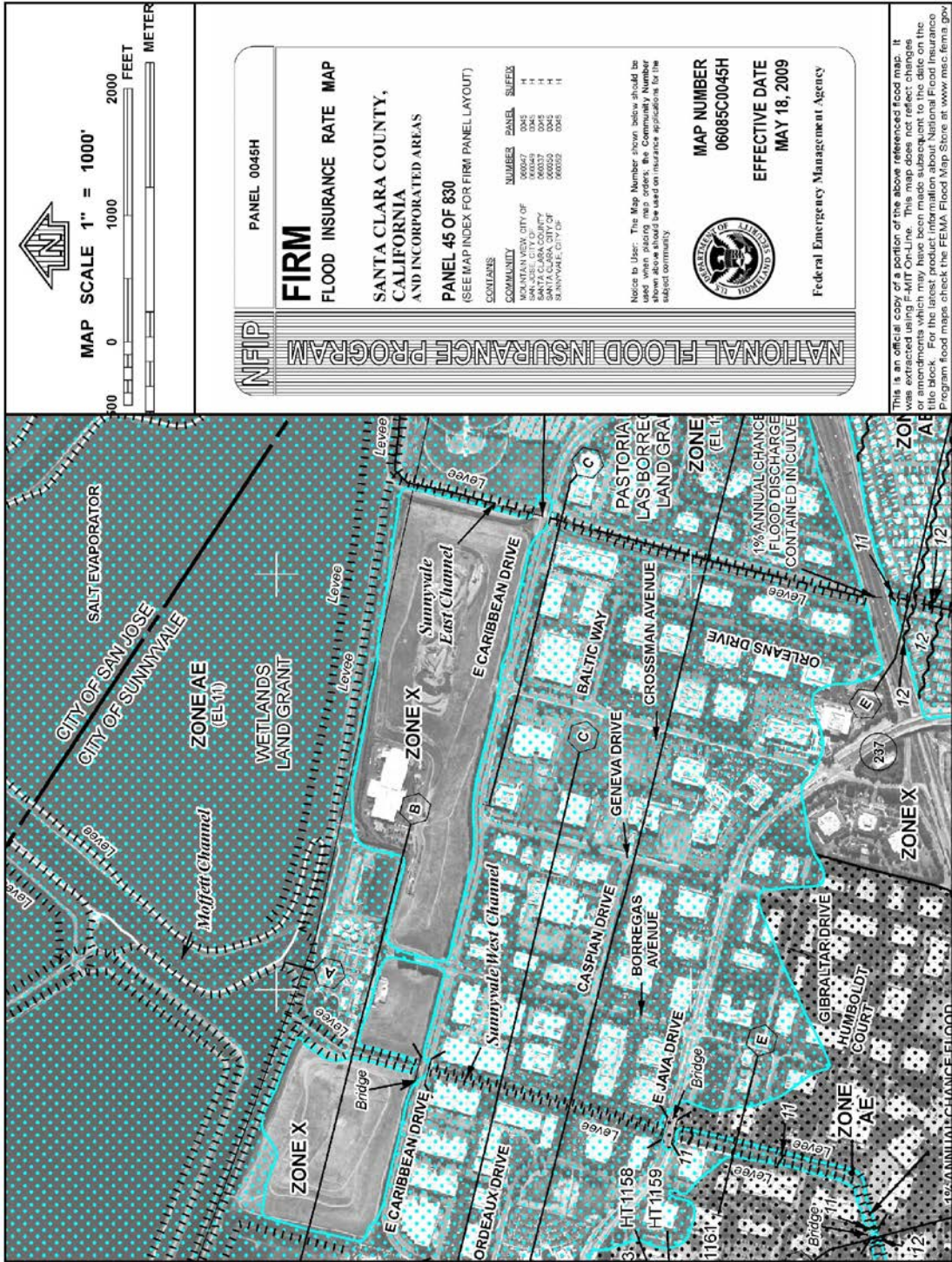
1.0 INTRODUCTION

The City of Sunnyvale's (City) overall goal for its Master Plan is to provide a 20-year plan for the renovation of the existing Water Pollution Control Plant (WPCP). The renovated WPCP will allow the City to meet all regulatory and permit requirements through best practices, sustainability, and cost-effectiveness, with a bias toward reducing overall lifecycle costs, and being good stewards of the land and public trust. The renovated facilities at the WPCP will be able to address expected and new challenges by being reliable, flexible, and adaptable. This includes an understanding of how to protect the plant site from riverine and tidal flooding considerations.

The WPCP is surrounded on three sides by levees providing an unknown level of protection from a combination of riverine and tidal flooding. Figure 1 shows a map of the WPCP and the surrounding levees. Currently these levees are not certifiable per Federal Emergency Management Agency's (FEMA) 44 Code of Federal Regulations (CFR) 65.10 criteria because they do not provide the WPCP with 100-year level of protection due to inadequate freeboard. Also, due to the WPCP's close proximity to the San Francisco South Bay, sea level rise will become a significant issue to consider over the next 50 years. Figure 2 shows the FEMA Flood Insurance Rate Map (FIRM) for the WPCP and surrounding areas. The FIRM shows that the WPCP is in Zone AE, which means that the levees do not protect against a 100-year flood event. According to 44 CFR 65.10, "In order for a levee to be accredited by FEMA and shown on a Flood Insurance Rate Map (FIRM) as providing protection from the base flood, a levee must first be certified by a Professional Engineer or a Federal Agency that designs levees. Levees are accredited when levee owners, communities, or other interested parties provide appropriate data and documentation demonstrating compliance in the following five areas: General Criteria, Design Criteria, Operation Plans and Criteria, Maintenance Plans and Criteria, and Certification Requirements."

The purpose of this Hydrology Report is to summarize the level of potential inundation in and around the WPCP under current conditions based upon recent studies performed in the San Francisco South Bay Area as well as to address on-going design projects that will impact the level of protection of the WPCP. This technical memorandum (TM) will also provide recommendations for how to address the potential inundation, the details of which will be addressed in a separate site TM.





2.0 DATA COLLECTION

The following section provides a brief summary of the known reports and on-going studies that were consulted to aid in the development of this Hydrology TM. These reports and studies provided recommended design criteria for sea level rise elevations, freeboard, and riparian and tidal flooding, and are all in close proximity to the WPCP. Carollo/HDR believe that these reports/studies provided credible data upon which recommendations regarding flood protection for the WPCP can be made. A comparison of the results will be used to assess the potential inundation of WPCP facilities from a 100-year water event, including sea level rise (SLR) and wave run-up.

2.1 SCVWD's Sunnyvale East and West Channels Design

Santa Clara Valley Water District (SCVWD) is currently designing improvements associated with two channels stretching from the San Francisco Bay to Inverness Way and San Francisco Bay to Almanor Avenue. The Sunnyvale East Channel and West Channels Flood Protection Project is undergoing improvements to provide riverine flood protection to the areas in and around the WPCP.

Through this project, SCVWD intends to provide better flood protection to approximately 47 acres of industrial and residential land. Currently, the channels provide a 10-year level of protection. However, after completion of the project, the reconstructed levees, floodwalls, and channels will provide 100-year level of protection against riverine flooding. Based on a projected water surface elevation of 12.24 feet, floodwalls near where the channels meet the San Francisco Bay will be constructed to an elevation of 16.68 feet (NAVD 88).

Appendix A contains excerpts from the 90% plan set for the Sunnyvale East and West Channels near the WPCP. The plan set shows the channel alignments with the 100-year water surface elevation and the height of the new levee segments and flood walls.

2.2 South Bay Shoreline Feasibility Study

The U.S. Army Corps of Engineers (USACE) is conducting a flood risk management and ecosystem restoration feasibility study for the South San Francisco Bay Shoreline (Shoreline Study) approximately 3 miles northeast from the WPCP. Similar to the WPCP, the risk of tidal flooding exists for former salt ponds directly north of the Shoreline area. The existing dikes surrounding the salt ponds and the town of Alviso generally range in elevation from 8 feet to 12 feet (NAVD 88).

The USACE had conducted extensive tidal hydrodynamic modeling to understand the future risk from coastal storm events. The model concluded that there is less than a 25-year level of protection currently in the Shoreline area.

SLR was taken into consideration when designing the levees to a feasibility-level of detail. The Shoreline Study team assumed that future SLR would be consistent with the "Curve III scenario" presented by the National Research Council of the National Academies in the

1987 report “Responding to the Changes in Sea Level: Engineering Implications”. Using NRC Curve III, the Shoreline Study team estimated that over 50 years there would be approximately 25.56 inches (2.13 feet) of SLR. The NRC Curve III scenario is consistent with the State of California’s planning requirements. Over the course of 50 years, without the construction of new levees, the existing level of protection would become even less.

To combat this potential issue, the USACE looked at a series of different alignments and levels of protection. The selected locally preferred plan consisted of constructing levees bordering the salt ponds to provide 100-year level of protection. For feasibility-level design purposes, the post-settlement, top of levee elevation for a 100-year level of protection was determined to be 16 feet (NAVD 88) for a 100-year water surface elevation of 12.56 feet (NAVD 88). The levee elevation includes freeboard, wind/wave, and potential SLR.

2.3 San Francisquito Creek Levee Project

In August 2010, the San Francisquito Creek Flood Protection Capital Project produced a Hydraulic Review Technical Memorandum (HRTC). The project is located approximately six miles northeast from the Sunnyvale WPCP. The purpose of the project is to provide the flood protection elements needed for homes, businesses, and other facilities in the cities of Palo Alto and East Palo Alto downstream of Highway 101 from a 100-year design riverine flood event. The HRTC detailed the design water surface elevation along with the freeboard requirement to satisfy FEMA’s design criteria for leveed riverine channels as found in 44 CFR 65.10.

The San Francisquito Creek Joint Powers Authority used the published 100-year tide value of 10.35 feet from the 2005 *USACE 905b Reconnaissance Study*, plus the expected SLR value of 26 inches (2.17 feet), for a total of 12.52 feet (NAVD 88).

3.0 GENERAL

The following section compiles the various design standards identified during the review of the previous studies and reports and presents the assumed 100-year water surface elevation for the WPCP. A comparison table has been prepared (Table 1) which includes each study used to determine the assumed 100-year water surface elevation for the WPCP.

3.1 FEMA’s Levee Design Criteria

For levees to be recognized by FEMA, evidence that adequate design and operation and maintenance systems are in place to provide reasonable assurance that protection from the base flood exists. When the water surface elevation is below the adjacent natural ground elevation, no freeboard is required. When the water surface elevation is above the adjacent natural ground elevation, three (3) feet of freeboard is required with an additional one (1) foot of freeboard required 100 feet on either side of structures that are within the leveed section of a creek or where the flow is constricted such as at bridges. The purpose of 44 CFR 65.10 is to outline the steps a community needs to take to assist FEMA’s effort in providing up-to date identification and publication on special flood, mudslide (i.e., mudflow)

and flood-related erosion hazards. More detailed information can be found in Appendix B Levee Mapping -Complying with 44 CFR 65.10.

3.2 Sea Level Rise

Sea level rise caused by thermal expansion of water (water expands as it warms) and contribution of melted land-based ice has been observed globally and is expected to continue as the global climate changes. Projecting the effects of sea level rise caused by climate change through modeling is a complex and evolving process. Based on the comparison of the previous studies and reports in the South San Francisco Bay area, it is recommended that the WPCP facilities be assessed for the impacts from a future SLR of between 24 and 26 inches over the next 50 years.

3.3 Wind and Wave Run-up

Wind run-up and wave run-up must also be contained within the freeboard height, or additional levee or floodwall height will need to be added until such containment is met. For coastal levees, the freeboard must be established at one foot above the height of the one percent wave or the maximum wave run-up (whichever is greater) associated with the 100-year stillwater surge elevation at the site (referenced from the San Francisquito Creek Levee Project).

3.4 Comparison of Design Elevations

Table 1 shows the comparison of the design water surface elevations recommended by each of the nearby studies and reports. The table shows the anticipated sea level rise assumed over the next 50 years, and the 100-year water surface elevation that includes the anticipated sea level rise. Section 3.5 describes the assumed water surface elevation for determining the potential inundation for the WPCP.

Table 1 Comparison of Design Water Surface Elevations in the South Bay		
South Bay On-going Projects	Sea Level Rise Assumed Over 50 years	100-Year Water Surface Elevation ¹
Sunnyvale East and West Channels Levee Design Project	24 inches	12.24 feet (NAVD 88)
South Bay Shoreline Feasibility Study	25.56 inches	12.56 feet (NAVD 88)
San Francisquito Creek Levee Design Project	26 inches	12.52 feet (NAVD 88)

¹ Elevation includes 100-year water surface elevation and sea level rise

3.5 Design Water Surface Elevation (100-Year)

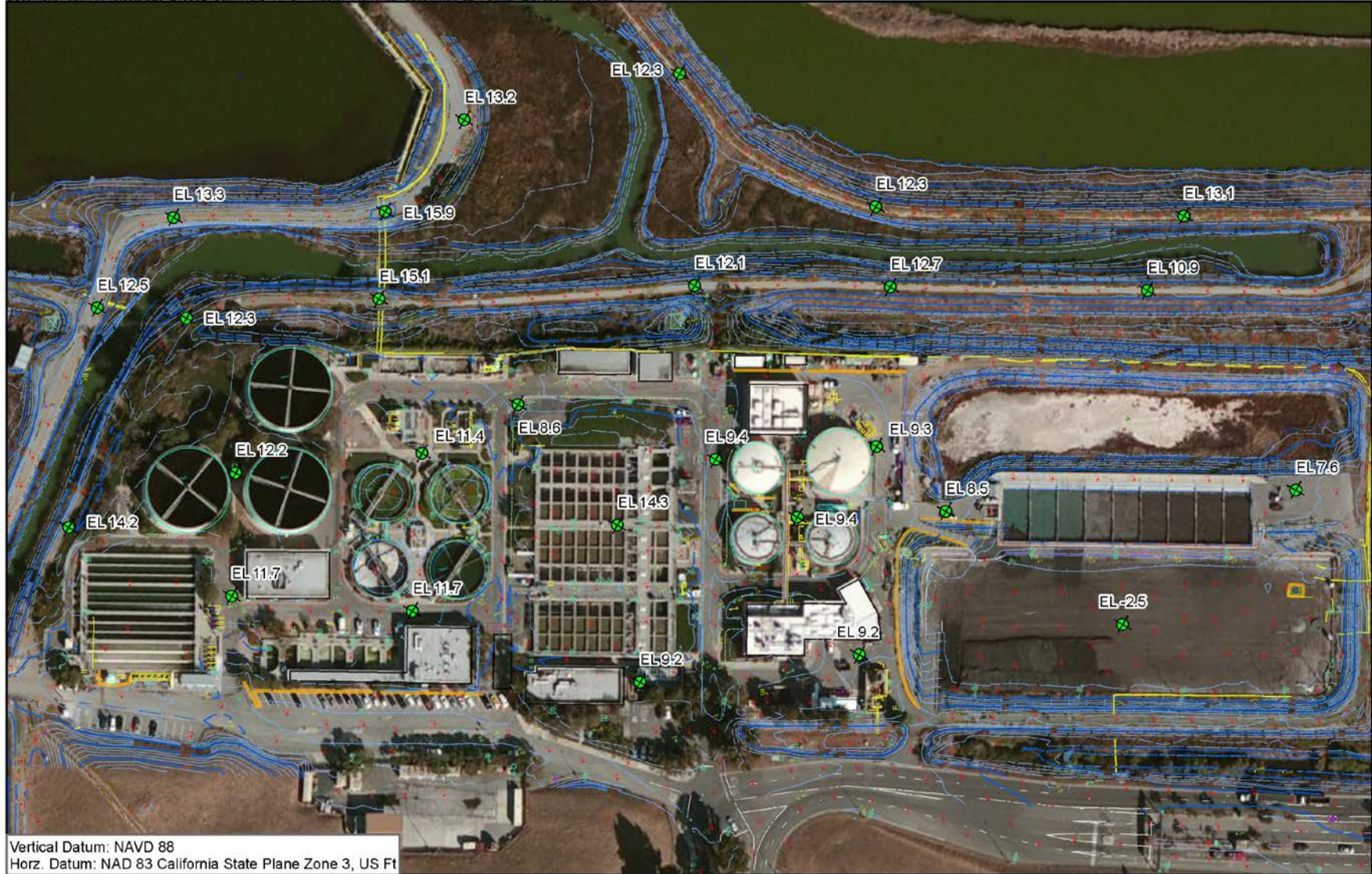
After the Carollo/HDR team evaluated and compared the previous studies, it was determined that the referenced studies provide an adequate basis for an assumed 100-year water surface elevation. The Sunnyvale East and West Channels Project design elevation was chosen for the WPCP design water surface elevation because it is the closest in proximity and therefore would simulate the type of potential flooding. For the purposes of determining the level of inundation at the WPCP, it is recommended that a 100-year design water surface elevation of 12.24 feet be utilized.

4.0 SUMMARY

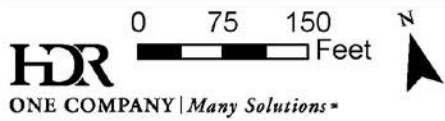
As previously stated, the purpose of this Hydrology Report is to identify the level of potential inundation in and around the WPCP. Based on existing contour data (Baumann, 2013), many locations along the existing levee and most of the facilities at the WPCP are below the 100-year water surface elevation of 12.24 feet. Figure 3 shows a plan view of the WPCP and the elevation of current facilities. As shown in Figure 3, most of the facilities at the WPCP would be inundated during a 100-year event (some by more than 3 feet) with the existing levees.

The levees surrounding the WPCP do not meet FEMA standards because at many locations, they are either below the 100-year water surface elevation, or do not provide the necessary amount of freeboard required by 44 CFR 65.10 (SCVWD, 2013). The Draft Environmental Impact Report for the Sunnyvale East and West Channels Flood Protection Project identifies a maximum freeboard deficiency of 5.6 feet near the WPCP (SCVWD 2013). The SCVWD's Sunnyvale East and West Channels Project intends to raise portions of the levees or construct flood walls to address the freeboard deficiencies in the levees surrounding the WPCP. Figure 4 shows a cross-section of the existing levee elevation relative to the 100-year water surface elevation along with the elevation of the improvements that the SCVWD East and West Channels project will incorporate to provide 100-year level of protection. Based on the elevations presented in Figure 3, the cross section shows that although many facilities would be below the 100-year elevation, the improvements to the levees and construction of floodwalls will provide adequate 100-year level of protection to the WPCP and the City of Sunnyvale.

Assuming the SCVWD East and West Channels levee improvements are constructed, the facilities at the WPCP would not need to be raised above the 100-year water surface elevation. Coordination with SCVWD will be important for the City of Sunnyvale to make sure they are apprised of the status of the levee improvements and if any changes to the designs have occurred. If no levee improvements are made, it would require that all the WPCP facilities be raised or constructed above the design water surface elevation of 12.24 feet (which would not be practical for existing facilities). Should there be delays in the construction of the SCVWD East and West Channels levee improvements, the City of Sunnyvale could choose to move forward with the design and construction of the levees to protect the WPCP without the support of the SCVWD. This issue will be further addressed as part of the WPCP site TM.

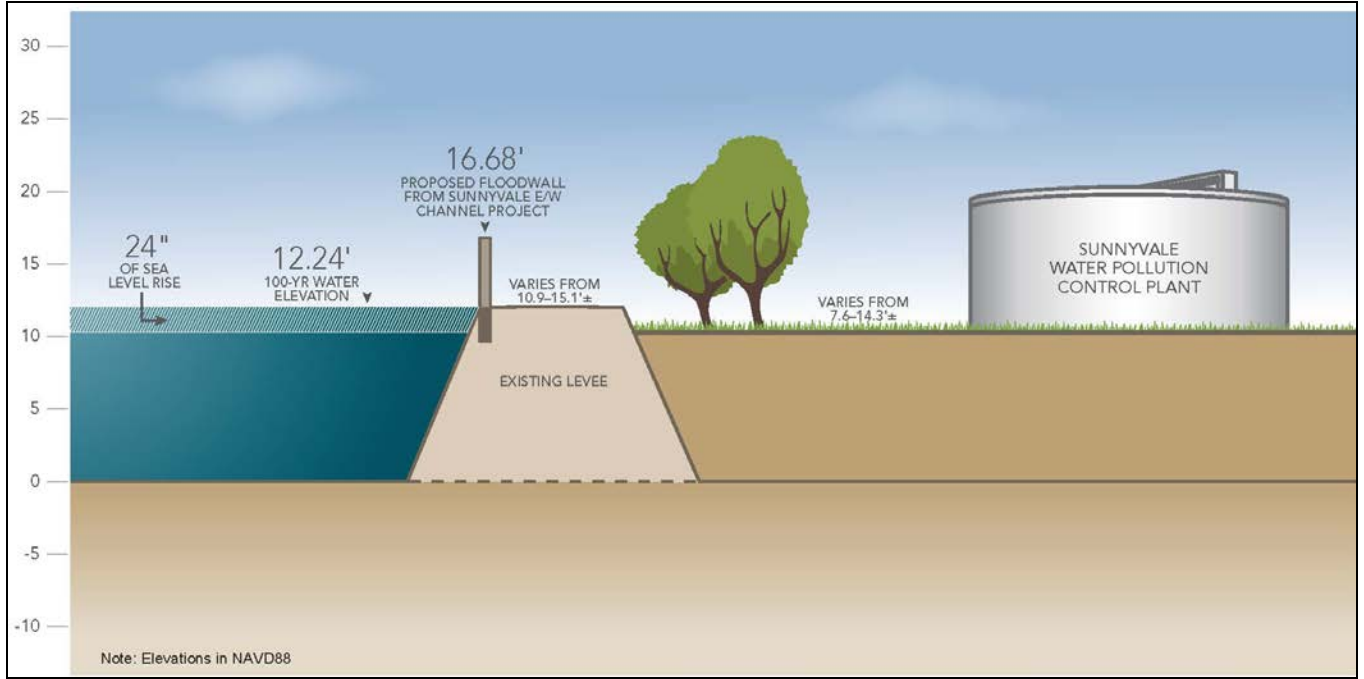


Vertical Datum: NAVD 88
 Horz. Datum: NAD 83 California State Plane Zone 3, US Ft



✕ Spot Elevation Location
 Sunnyvale E/W Channels Design Ele. 16.68 ft

Figure 3
SUNNYVALE WPCP FACILITY ELEVATIONS
 HYDROLOGY REPORT
 MASTER PLAN AND PRIMARY TREATMENT DESIGN
 CITY OF SUNNYVALE



5.0 REFERENCES

Baumann, David (PLS 7309). Mark Thomas and Co., Inc. *Survey*. July 2013.

Code of Federal Regulations. "*Emergency Management and Assistance*." 44 CFR 65.10. October 1, 2000.

Hydraulic Review Technical Memorandum, San Francisquito Creek Flood Protection Capital Project, HDR Engineering, Inc. August 3, 2010.

Santa Clara Valley Water District, *Sunnyvale East Channel and West Channel Flood Protection Projects 90% Plans*, October 2013.

Santa Clara Valley Water District, *Sunnyvale East Channel and West Channel Flood Protection Projects Draft Environmental Impact Report*, October 2013.

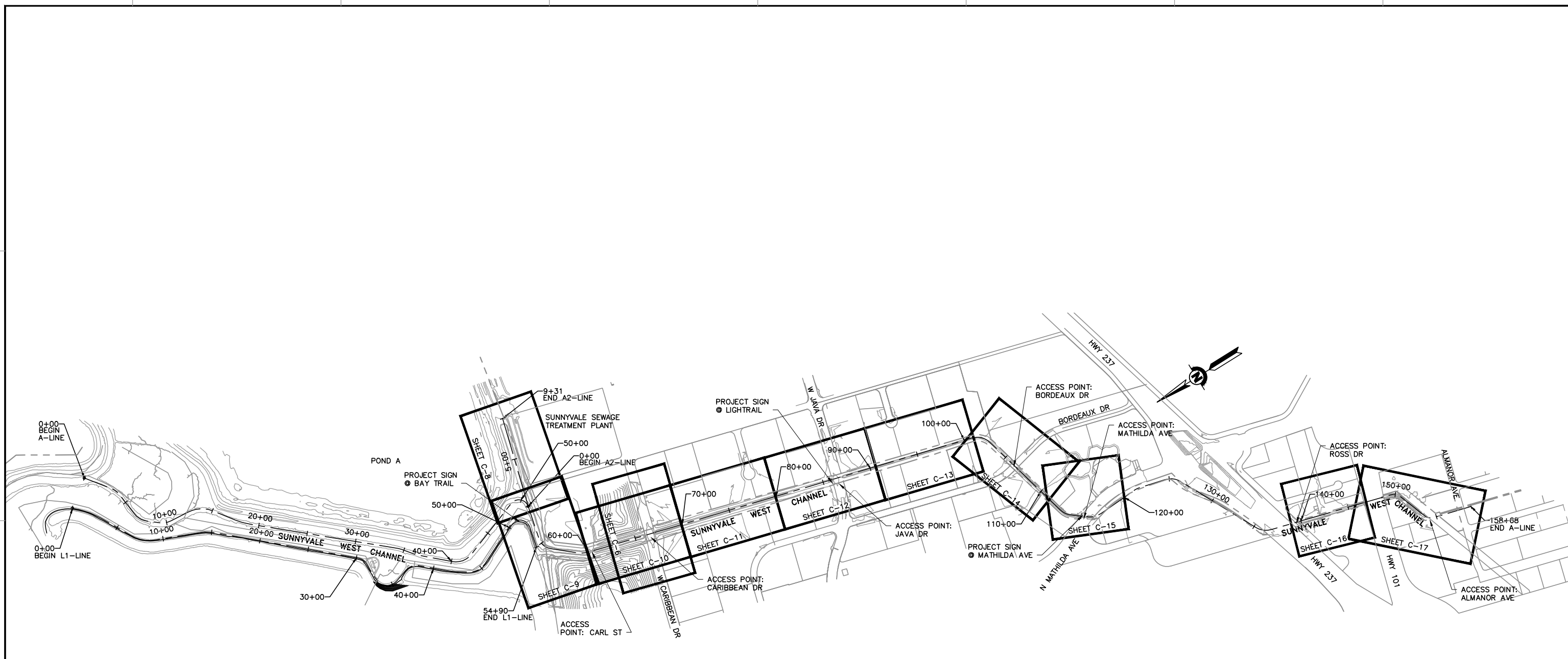
United States Army Corps of Engineers. *Integrated Interim Feasibility Study and Environmental Impact Statement/Report South San Francisco Bay Shoreline Phase I Study*. June 2013.

United States Army Corps of Engineers. *Civil Design Appendix, Shoreline Phase I Study*. May 2013.

**APPENDIX A – EXCERPT FROM THE 90% PLAN SET FOR THE
SUNNYVALE EAST AND WEST CHANNELS PROJECT**

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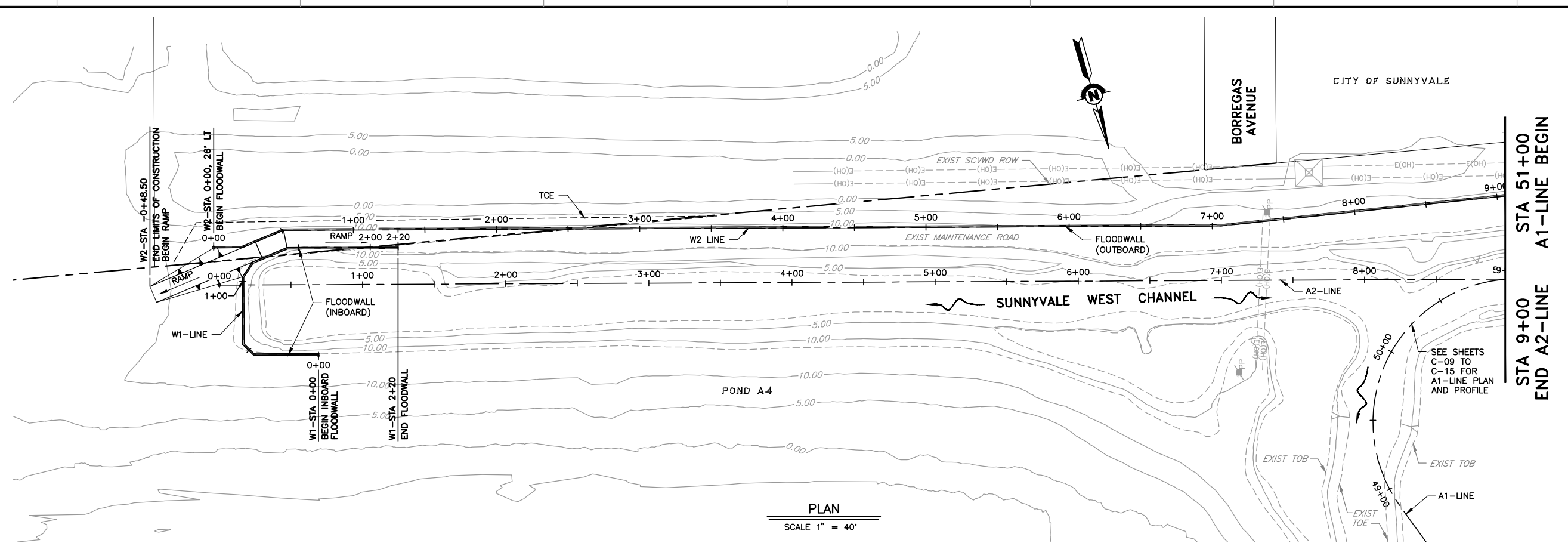


**SUNNYVALE WEST
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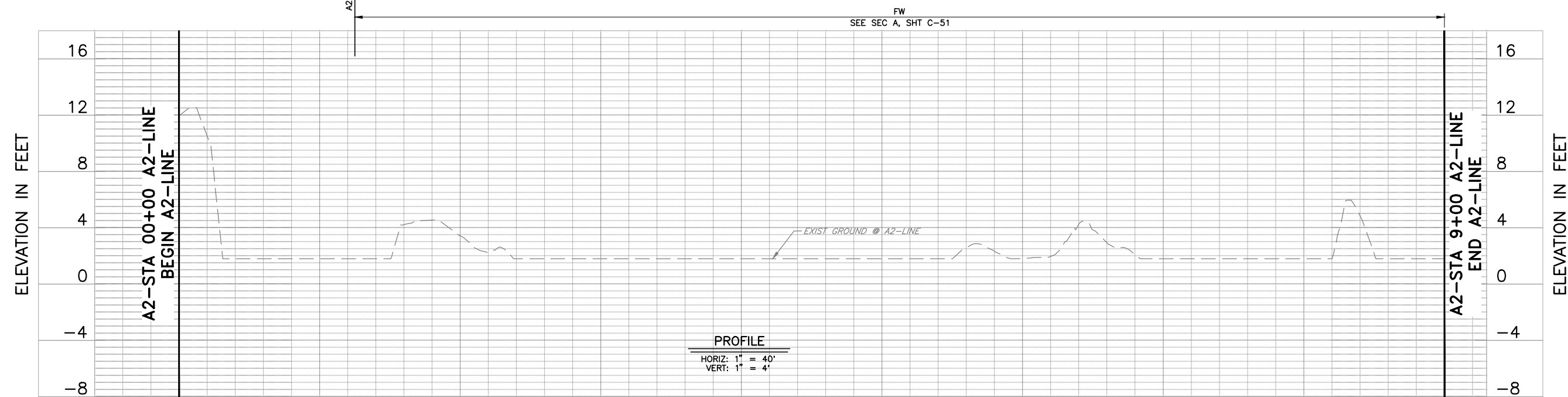
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2.	SEE SHEETS C-69 AND C-70 FOR FLOODWALL PROFILES.
3.	SHEET MATCH LINES BASED ON A2-LINE ALIGNMENT.

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Santa Clara Valley Water District

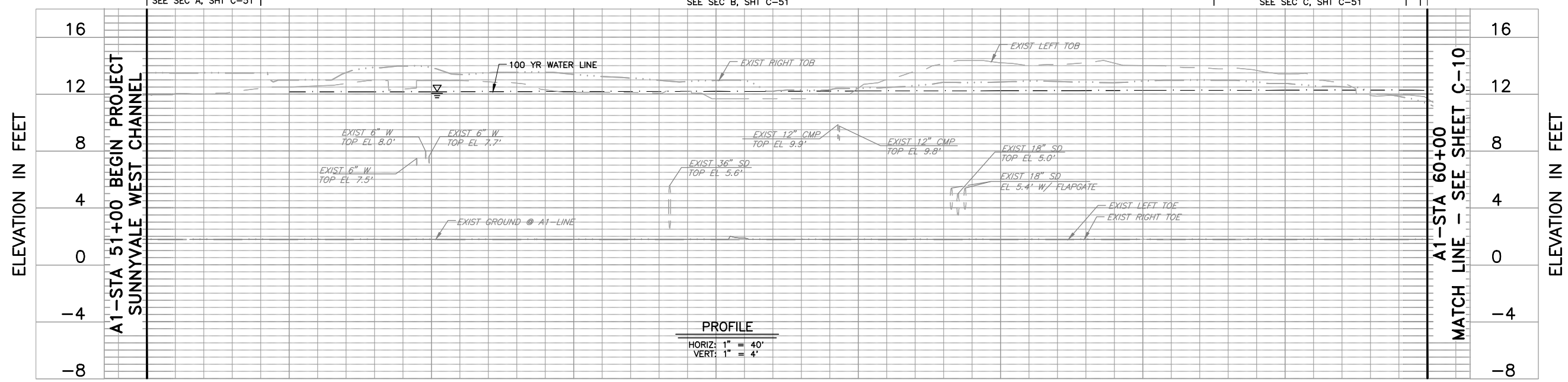
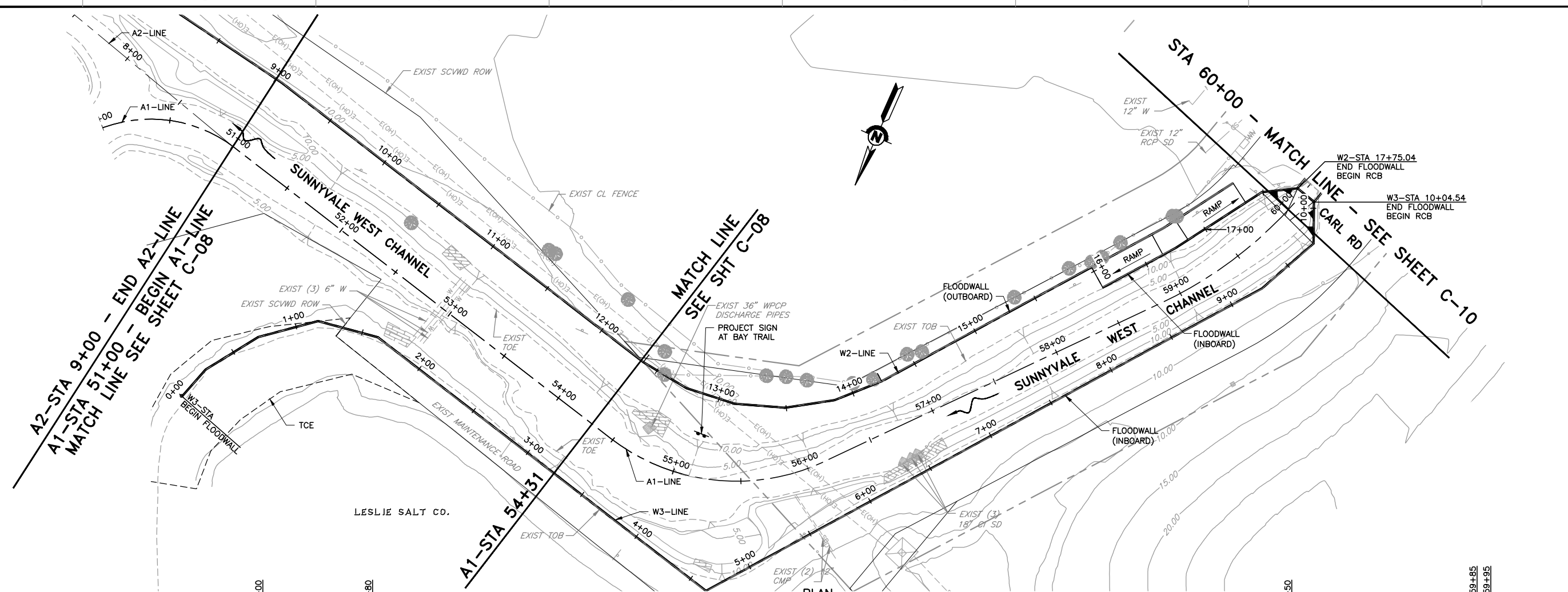


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Santa Clara Valley Water District

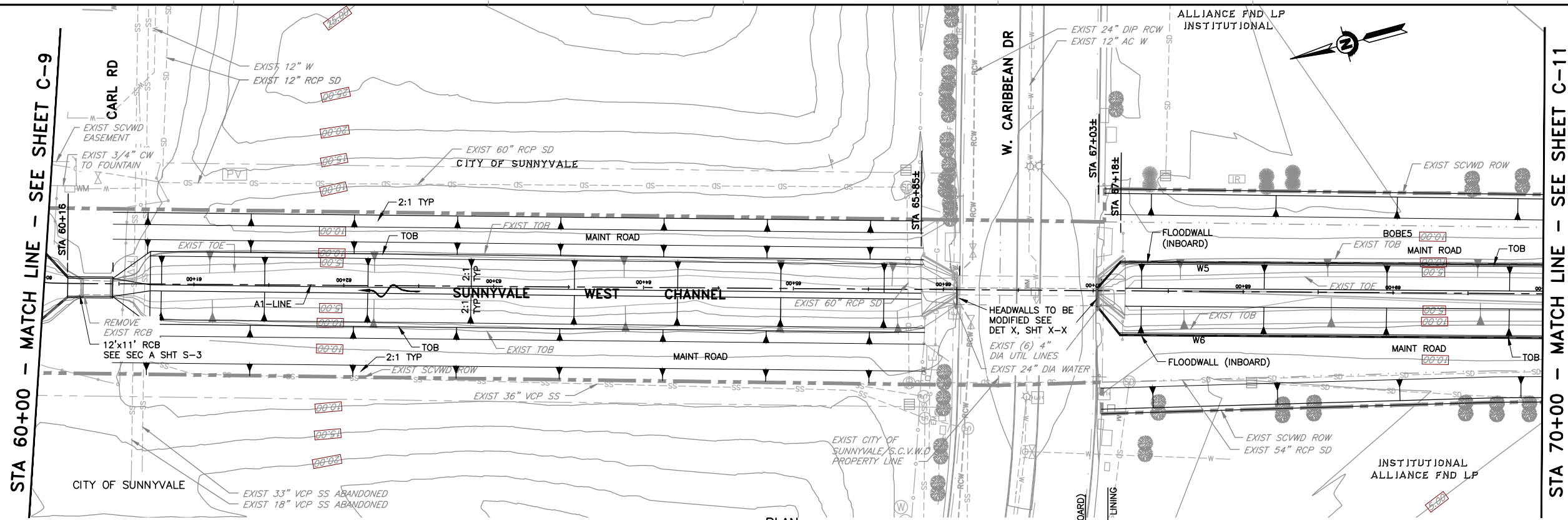
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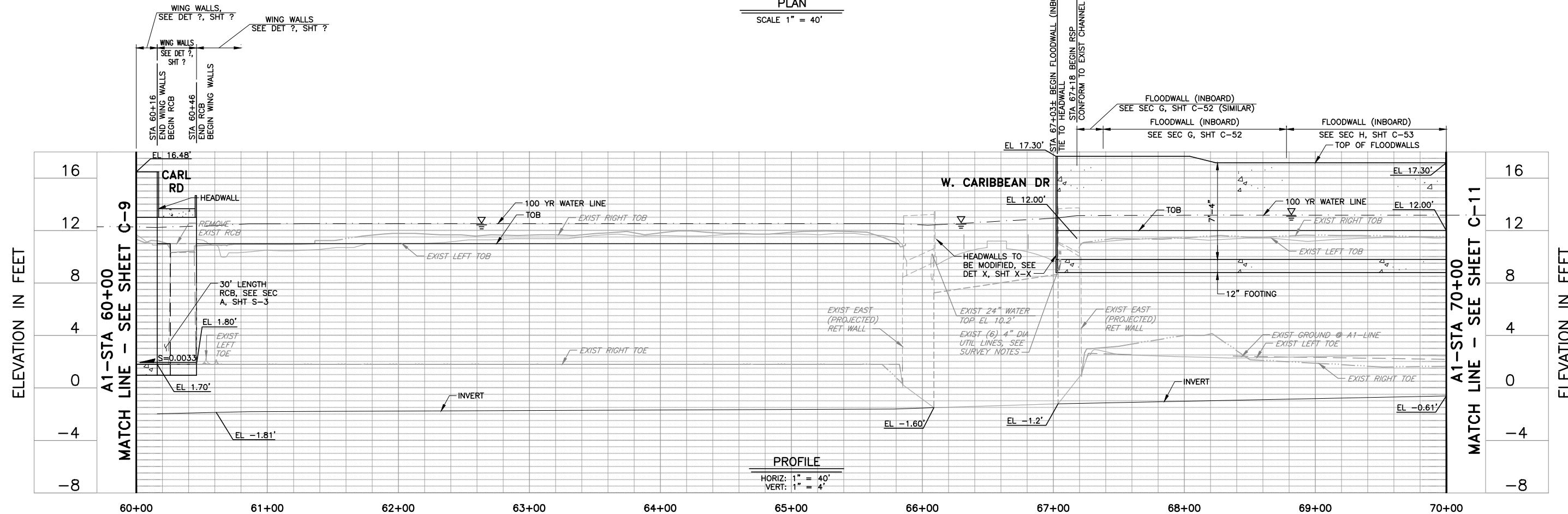
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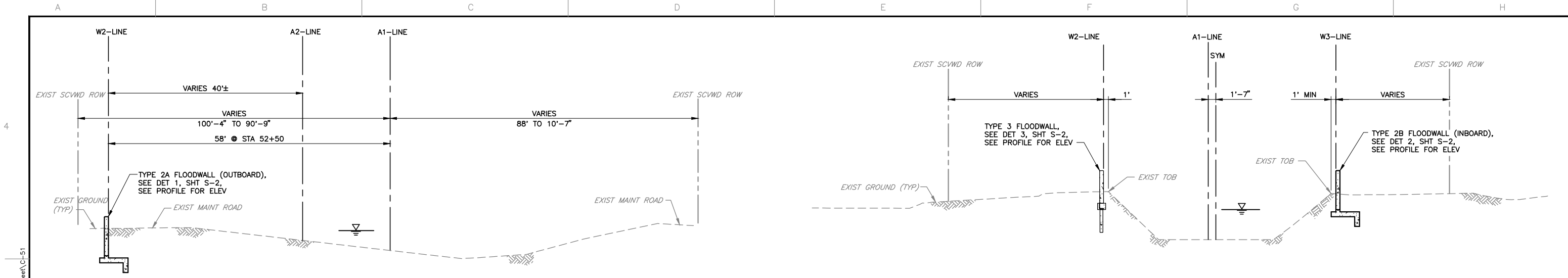
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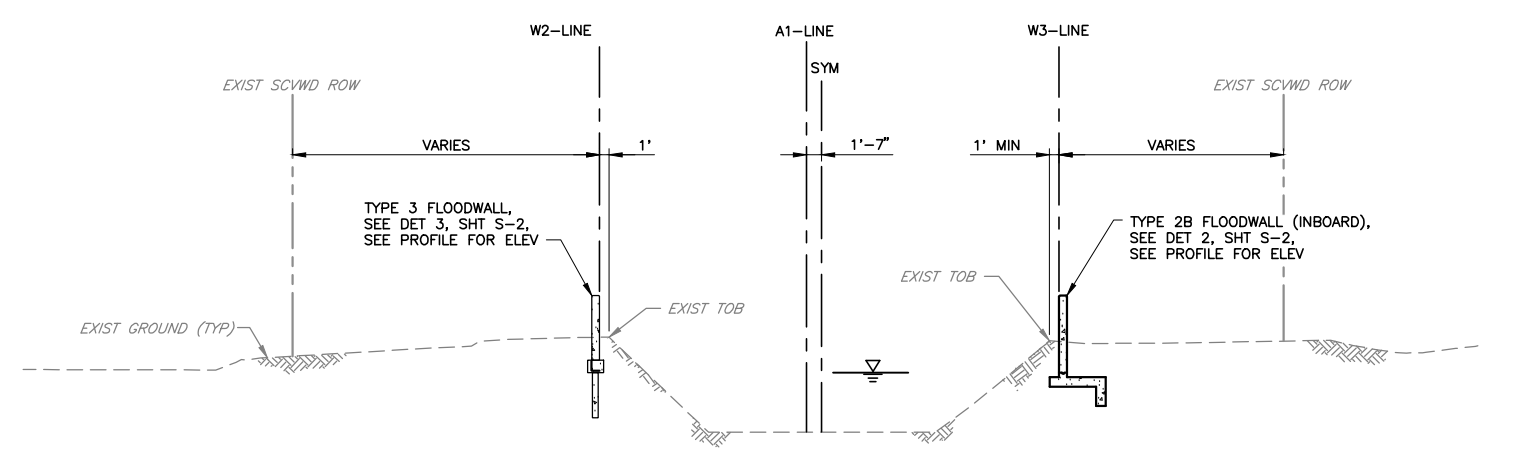


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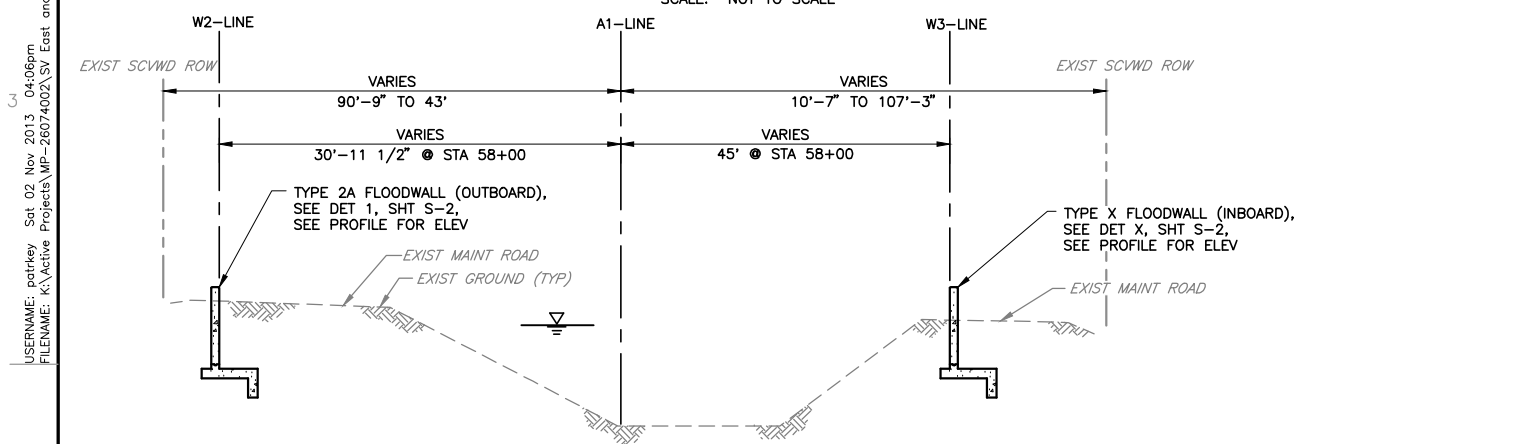
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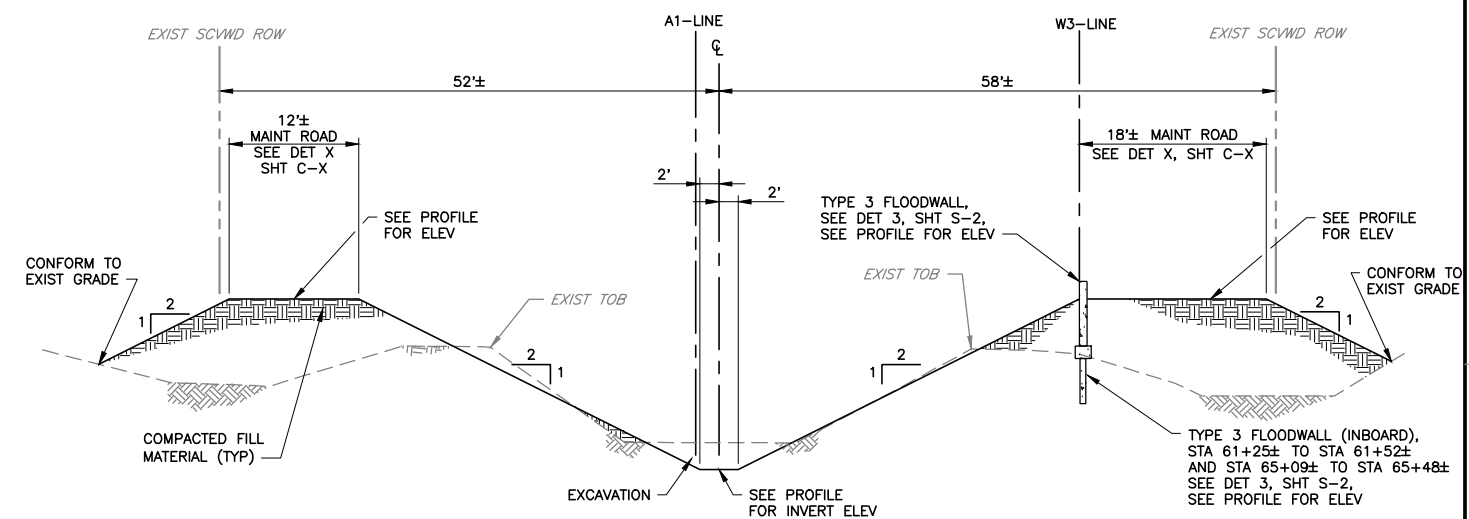
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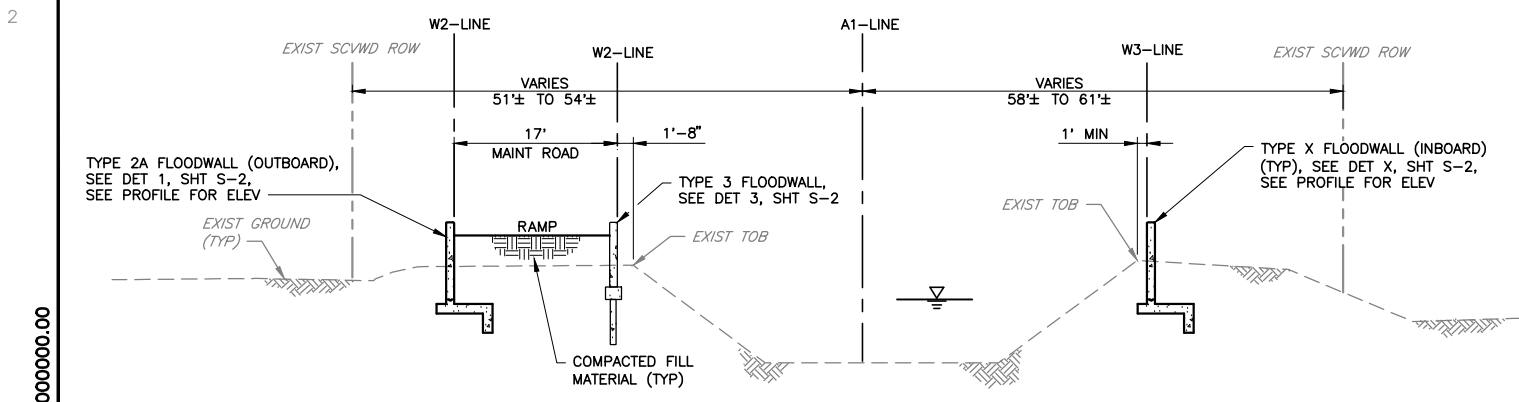
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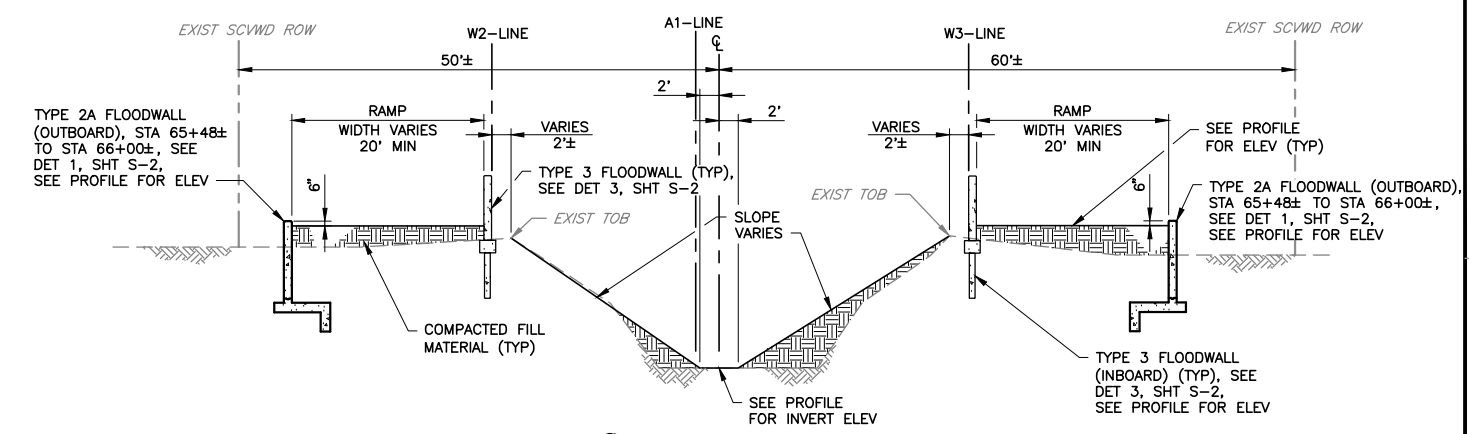
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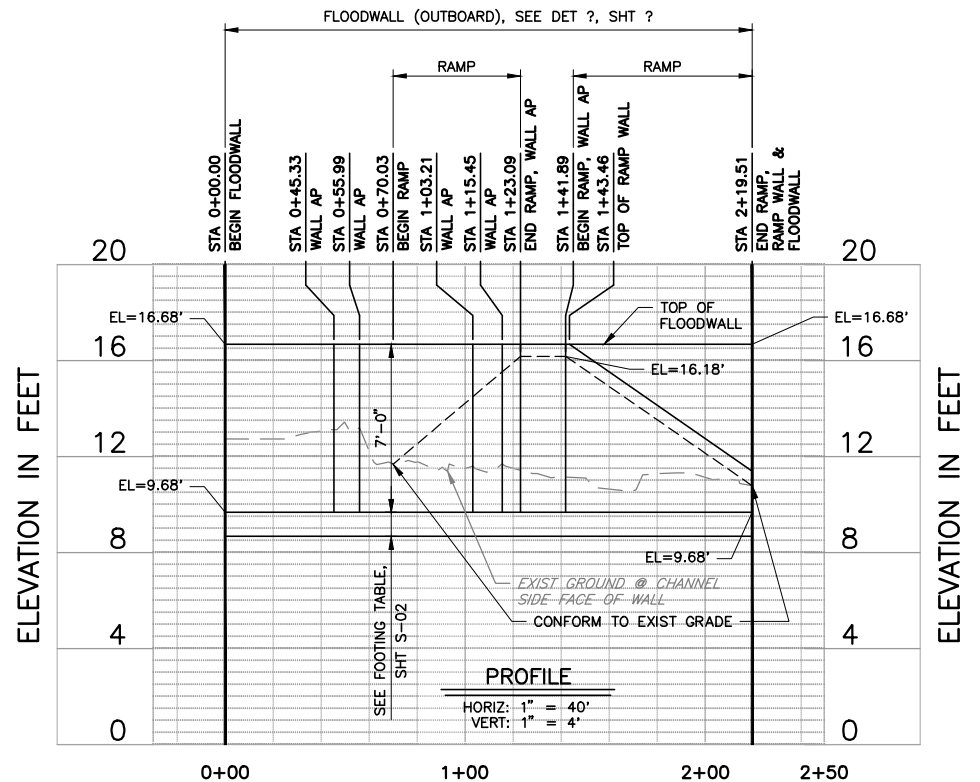
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**APPENDIX B – LEVEE MAPPING – COMPLYING
WITH 44 CFR 65.10**



FEMA



Levee Mapping - Complying with 44 CFR 65.10

What are the Requirements of 44 CFR 65.10?

In order for a levee to be accredited by FEMA and shown on a FIRM as providing protection from the base flood, a levee must first be certified by a Professional Engineer or a Federal Agency that designs levees. Levees are accredited when levee owners, communities, or other interested parties provide appropriate data and documentation demonstrating compliance with 44 CFR 65.10 in the following five areas: General Criteria, Design Criteria, Operation Plans and Criteria, Maintenance Plans and Criteria, and Certification Requirements. Communities with levees are not required to demonstrate compliance with 44 CFR 65.10, but must do so for any levee they wish to have recognized on a FIRM.

General Criteria

FEMA will recognize only those levees that meet, and continue to meet, minimum standards consistent with the level of protection sought through comprehensive floodplain management criteria found in 44 CFR Section 60.3.

Design Criteria

A registered Professional Engineer must certify data and documentation demonstrating the structural design criteria are met. The submitted documentation must include certified “as built” plans. Additionally, recent photographs of the levee, including embankments and levee closures, while not required, will be helpful to FEMA in performing the review. Mandatory information includes:

- Freeboard design, including that for riverine and coastal levees
- Closure designs showing all openings have closure devices, closures are designed according to sound engineering practice and are a structural part of the levee during operation
- Embankment protection demonstrating no appreciable erosion of levee embankment during the base flood



Code of Federal Regulations

Title 44, Chapter 1, Section 65.10 of the Code of Federal Regulations (44 CFR 65.10) is titled, “Mapping of areas protected by levee systems.” It provides the minimum design, operation, and maintenance standards levees must meet and continue to meet in order to be recognized as providing protection from the base flood (also known as one-percent-annual-chance flood) on Flood Insurance Rate Maps (FIRMs).

The Federal Emergency Management Agency (FEMA) recognizes (accredits) levees based on data and documentation provided by a community or other responsible party.

FEMA review is solely for establishing flood hazard zones and does not constitute a determination as to how a levee will perform during a flood event. If a levee is accredited, FEMA will reflect the levee as providing protection from the base flood on the FIRM.

RiskMAP

Increasing Resilience Together

- Embankment and foundation stability analyses evaluating expected seepage during base flood loading conditions, including flooding depth, duration, penetrations, and other seepage and stability factors
- Settlement analysis assessing potential freeboard loss due to settlement, showing that minimum freeboard will be maintained
- An interior drainage analysis identifying the source(s) and magnitude of interior flooding performed by a registered Professional Engineer
- In some unique situations FEMA may require additional design criteria to ensure the levee provides adequate risk reduction

Operations and Maintenance Plans and Criteria

The Operations and Maintenance (O&M) plans must include information fulfilling the minimum requirements of 44 CFR 65.10(C) and 44 CFR 65.10 (D). The O&M of the levee must be under the jurisdiction of an approved agency and officially adopted by that agency. Official adoption generally requires a vote by a governing body.

Certification Requirements

Data submitted to support a given levee complies with the structural requirements outlined above must be certified by a registered Professional Engineer, along with certified as-built plans for the levee. Certification, as defined in 44 CFR 65.2(b), is a statement that the submitted information is accurate and in accordance with sound engineering practices.

Accredited Levees Still Present Residual Risks

Even after the Professional Engineer certification and FEMA accreditation processes are completed, there is still a flood risk associated with levees. While levees are designed to reduce risk, even properly maintained levees can fail or be overtopped by large flood events. *Levees reduce risk, they do not eliminate it.*



Many communities and public agencies seek the minimum one-percent-annual-chance level of flood risk reduction. However, this cannot be viewed as a health and safety standard; it is simply a level of flood risk.

Living with Levees – It’s a Shared Responsibility

FEMA and other government agencies are working to make citizens aware of their risk through various forms of outreach including fact sheets such as this. Most local officials have adopted protocols and procedures for ensuring public safety and individual property owners are learning more about their risk and the steps for protecting their families, businesses, and communities from the threat of flooding. Remember, levees are not fail proof – protect your future by knowing your flood risk, knowing your role in reducing the risk from flood, and taking the steps today to ensure the safety of lives and property in areas behind levees.



For More Information

- To review 44 CFR, please visit: www.access.gpo.gov/nara/cfr/waisidx_00/44cfr1_00.html.
- For a formatted version of 44 CFR 65.10, it can be downloaded at: www.fema.gov/library/viewRecord.do?id=2741.
- For additional information on levees, please visit: www.fema.gov/living-levees-its-shared-responsibility.
- For additional information on flood hazard mapping, please visit: <http://www.fema.gov/national-flood-insurance-program-flood-hazard-mapping>.