APPENDIX F.1

CHINO II EXPANSION PRODUCT WATER DELIVERY FACILITIES TECHNICAL MEMORANDUM

Jurupa Community Services District
City of Ontario
Western Municipal Water District

CHINO PHASE 3 COMPREHENSIVE PREDESIGN

TECHNICAL MEMORANDUM NO. 1
PRODUCT WATER DELIVERY FACILITIES

DRAFT
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JURUPA COMMUNITY SERVICES DISTRICT
CITY OF ONTARIO
WESTERN MUNICIPAL WATER DISTRICT

CHINO PHASE 3 COMPREHENSIVE PREDESIGN

PRODUCT WATER DELIVERY FACILITIES
TECHNICAL MEMORANDUM NO. 1

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PRODUCT WATER DELIVERY FACILITIES

1.0 INTRODUCTION

From 2006 through 2007 the City of Ontario (Ontario) and Western Municipal Water District (WMWD) jointly developed a project scope for the expansion of the existing Chino Desalter Facilities. This project was designated the Chino Desalter Phase 3 Expansion.

An evaluation of the project alternatives was conducted by Ontario, WMWD and their consultants resulting in a report entitled "Chino Desalter Phase 3 Alternatives Evaluation: Final Report," May 2007, prepared by Carollo Engineers.

The 2007 report proposed that treatment of 40,000 acre-feet of groundwater through the Chino Desalters would require the addition of 10.5 mgd of treatment capacity at Chino II and that Ontario and WMWD would share the additional product water capacity equally.

This assumption was changed by the addition of Jurupa Community Service District (JCSD) as a project sponsor. The current intent is that Ontario, WMWD and JCSD will share equally in the additional Chino II product water capacity. The proposed division of the additional product water supply is shown in Table 1.

The purpose of this Technical Memorandum is to describe the criteria for proposed facilities used to convey product water from Chino II to the sponsors. After the sponsors confirm or revise the proposed criteria, we will proceed with the detailed predesign analysis of the approved facilities.

2.0 PRODUCT WATER DELIVERY FACILITIES

On March 16, 2009 the sponsors requested that the comprehensive predesign report include a description of two alternative methods of delivering product water, designated herein as Option A and Option B. The product water delivery concepts are the same in both options for JCSD and Ontario, although the size of the facilities used to deliver water to JCSD and Ontario will depend on which alternative is selected for delivery to WMWD.

Under Option A, a dedicated pump station and pipeline will convey Chino II product water jointly to Ontario and WMWD. Under Option B, Chino II product water will be transported through the JCSD distribution system to WMWD.

In each option, the flow capacity assumes a 90 percent operating factor, that is, the facility operates at capacity 90 percent of the time in order to deliver the annual product water volume.

2.1 Option A: Dedicated Delivery System

Option A provides for the delivery of Chino II product water directly to the sponsors through dedicated facilities without commingling with local groundwater supplies. Under this option, the water quality received by the sponsor is the Chino II product water quality, without blending with other local supplies.

2.1.1 <u>JCSD: Option A Product Water Delivery</u>

Currently, JCSD receives product water from Chino II through an on-site pump station that delivers product water to the 1110 pressure zone via a 24-inch pipeline. It is anticipated that JCSD will continue to receive its current Chino II allocation (5,500 acre-feet/year) through the 1110 pressure zone pump station. Therefore, the new product water delivery facilities are sized for only JCSD's additional Chino II allotment (3,533 acre-feet/year).

2.1.1.1 Design Criteria

Design criteria for the delivery of Chino II expansion product water to JCSD.

- Flow: 3.5 mgd.
- Pressure: As required for delivery to the JCSD 870 pressure zone.

2.1.1.2 Pump Stations

This option requires a new 870 pressure zone product water pump station constructed on the Chino II site adjacent to the existing 1110 pressure zone product water pump station. JCSD will be the only sponsor receiving delivery from the new pump station.

2.1.1.3 Pipelines

Preliminary analysis indicates that it is feasible to use the existing pipeline from JCSD Well No. 23 (located at the Chino II site) as the discharge pipeline for the new 870 pressure zone product water pump station. Other than the yard piping connections, no additional pipeline construction is required, based upon preliminary analysis.

2.1.1.4 Water Quality

JCSD will receive Chino II product water at the point of connection to its 870 pressure zone. Chino II product water nitrate levels range from 5-23 mg/L (as NO^{-}_{3}), depending upon the percentage of untreated by-pass water.

2.1.2 <u>Ontario: Option A Product Water Delivery</u>

Currently, Ontario receives product water from Chino II through the same on-site pump station that delivers JCSD product water to the 1110 pressure zone. Therefore, Ontario receives Chino II product water transported through the JCSD distribution system and commingled with JCSD well water.

As part of the Chino Phase 3 project, Ontario will take delivery of its current Chino II allotment through a new dedicated delivery system. Therefore, the new product water facilities are sized to allow delivery of all Ontario's Chino II allotment, both current (3,500 acre-feet/year) and additional (3,533 acre-feet/year).

2.1.2.1 Design Criteria

Design criteria for the delivery of Chino II expansion product water to Ontario.

- Flow:
  - Current Chino II allotment capacity: 3.5 mgd.
  - Additional Chino II allotment capacity: 3.5 mgd.
  - Total Chino II Ontario capacity: 7.0 mgd.
  - Milliken Booster flow: 4 mgd.
- Pressure:
  - Chino II: As required for delivery to the Ontario 1010 pressure zone.
  - Milliken Booster: As required for delivery to the Ontario 1212 pressure zone.

2.1.2.2 Pump Stations

This option requires a new 1010 pressure zone product water pump station constructed on the Chino II site adjacent to the existing 1110 pressure zone product water pump station. Ontario and WMWD will both receive deliveries from the new pump station.

As part of the Chino Phase 3 project, Ontario intends pumping Chino II product water, commingled with other supplies, from its 1010 pressure zone into its 1212 pressure zone. The required booster pump station, located at the Milliken Reservoir site, has a proposed capacity of 4 mgd.

2.1.2.3 Pipelines

This option requires construction of a dedicated pipeline to deliver Chino II product water to the Ontario 1010 pressure zone. The pipeline will begin at the discharge of the new Chino II 1010 pressure zone pump station and terminate at the intersection of Riverside Drive and Hamner Avenue. The pipeline will serve Ontario and WMWD jointly.

2.1.2.4 Water Quality

Ontario will receive only Chino II product water at the point of connection to its 1010 pressure zone. Product water nitrate levels range from 5-23 mg/L (as NO^-_3), depending upon the percentage of untreated by-pass water.

2.1.3 WMWD: Option A Product Water Delivery

At the present time, WMWD receives no product water from Chino II. Under Option A, WMWD will share in the capacity of the dedicated 1010 pressure zone Chino II product water pump station and pipeline that deliver water to Ontario at the intersection of Riverside Drive and Hamner Avenue.

An extension of the dedicated pipeline will continue south on Hamner Avenue to connect to the existing 30" Arlington pipeline south of the Santa Ana River. The discharge pressure of the Chino II 1010 pressure zone pump station will allow delivery of Chino II product water to the City of Norco through the 30" Arlington pipeline. The equivalent volume and flow currently delivered to Norco from the Arlington Desalter is then available to WMWD.

2.1.3.1 Design Criteria

Design criteria for the delivery of Chino II expansion product water to WMWD.

- Flow:
  - Chino II product water delivered to Norco: 3.5 mgd.
  - Arlington Desalter product water delivered to WMWD: 3.5 mgd.
- Pressure: As required for delivery to Norco via the Arlington pipeline.

2.1.3.2 Pump Stations

This option requires a new 1010 pressure zone product water pump station constructed on the Chino II site adjacent to the existing 1110 pressure zone product water pump station. Ontario and WMWD will both receive deliveries from the new pump station.

The 1010 pressure zone pump station can deliver water to the Arlington pipeline for use by Norco. To deliver Chino II product water directly to other customers, such as the WMWD retail system, Riverside or Corona will require construction of additional facilities.

2.1.3.3 Pipelines

This option requires construction of a dedicated pipeline to deliver Chino II product water to the Ontario 1010 pressure zone. The pipeline will begin at the discharge of the new Chino II 1010 pressure zone pump station and continue to the intersection of Riverside Drive and Hamner Avenue. At this point, Ontario will take delivery of product water.

The dedicated pipeline will continue south on Hamner Avenue to connect to the existing 30" Arlington pipeline. A crossing of the Santa Ana River is required. Once product water is delivered to the Arlington pipeline it is available for use by Norco so that a corresponding flow produced at the Arlington Desalter (and previously delivered to Norco) is available for delivery elsewhere.

2.1.3.4 Water Quality

Norco will receive Chino II product water at the point of connection to the Arlington pipeline. Chino II product water nitrate levels range from 5-23 mg/L (as NO-3), depending upon the percentage of untreated by-pass water.

WMWD will receive product water from the Arlington Desalter. Currently, the Arlington Desalter bypasses groundwater around the RO process in order to achieve a blended product water with a nitrate level of 22-23 mg/L (as NO^-_3).

2.2 Option B: Delivery to WMWD through the JCSD System

Option B provides for the delivery of Chino II product water to WMWD through the JCSD distribution system. By using existing facilities to transport water, the capital cost to WMWD is reduced. However, under this option, the water quality received by WMWD is the quality of the water in the JCSD 870 pressure zone, after commingling with other local supplies.

2.2.1 JCSD: Option B Product Water Delivery

Same as in Option A except that JCSD will share the capital cost of the Chino II 870 pressure zone product water pump station with WMWD, thus lowering the capital cost paid by JCSD.

2.2.1.1 Design Criteria

Design criteria for the delivery of Chino II expansion product water to JCSD are the same as in Option A.

- Flow: 3.5 mgd.
- Pressure: As required for delivery to the JCSD 870 pressure zone.

2.2.1.2 Pump Stations

Same as in Option A except that the total capacity of the pump station is greater because WMWD will also take delivery through the JCSD 870 pressure zone.

2.2.1.3 Pipelines

Same as in Option A except that it is more likely that detailed analysis will require the construction of a new pipeline from Chino II to Etiwanda Avenue because of the added capacity required to deliver product water to WMWD through the JCSD 870 pressure zone.

2.2.1.4 Water Quality

Same as in Option A at the point of delivery into the 870 pressure zone. In addition, the water quality throughout the JCSD 870 pressure zone will likely improve (i.e., decrease in nitrate level) because of the additional WMWD product water delivery to this zone.

2.2.2 Ontario: Option B Product Water Delivery

Same as in Option A except that Ontario will no longer share the capital cost of the Chino II 1010 pressure zone product water pump station and pipeline with WMWD, thus increasing the capital cost paid by Ontario.

2.2.2.1 Design Criteria

Design criteria for the delivery of Chino II expansion product water to Ontario are the same as in Option A.

- Flow:
  - Current Chino II allotment capacity: 3.5 mgd.
  - Additional Chino II allotment capacity: 3.5 mgd.
  - Total Chino II Ontario capacity: 7.0 mgd.
  - Milliken Booster flow: 4 mgd.
- Pressure:
  - Chino II: As required for delivery to the Ontario 1010 pressure zone.
  - Milliken Booster: As required for delivery to the Ontario 1212 pressure zone.

2.2.2.2 Pump Stations

Same as in Option A except that the total capacity of the 1010 pressure zone pump station is less because WMWD will no longer share the facility. Ontario will pay 100 percent of the capital cost. The size of the Milliken Booster is the same as in Option A.

2.2.2.3 Pipelines

Same as in Option A except that the total capacity of the pipeline from Chino II to Riverside Drive and Hamner Avenue is less because WMWD will no longer share the facility. Ontario will pay 100 percent of the capital cost.

2.2.2.4 Water Quality

Same as in Option A.

2.2.3 WMWD: Option B Product Water Delivery

Option B is based upon delivery of Chino II product water to WMWD through the JCSD 870 pressure zone. Because this pressure zone also receives water from other sources the water quality received by WMWD is no longer the Chino II product water quality but is, instead, the quality of the JCSD 870 pressure zone.

The long-term strategy is to transfer product water from Chino II through the JCSD 870 pressure zone to a connection with the proposed Riverside-Corona Feeder. Once water is delivered to the Riverside-Corona Feeder, it can be conveyed to WMWD wholesale or retail customers.

It is likely that Chino II expansion capacity will be available before the completion of the Riverside-Corona Feeder. A short-term delivery strategy is to transfer Chino II product water through the JCSD 870 pressure zone to a connection with the existing Arlington Pipeline, for exchange with Norco as in Option A.

2.2.3.1 Design Criteria

Design criteria for the short-term delivery of Chino II expansion product water to WMWD.

- Short-Term Flow:
  - Chino II product water delivered to Norco: 3.5 mgd.
  - Arlington Desalter product water delivered to WMWD: 3.5 mgd.
- Pressure:
  - Chino II: As required for delivery to the JCSD 870 pressure zone.
  - Norco Booster: As required for delivery to the Norco 857 pressure zone.

Design criteria for the long-term delivery of Chino II expansion product water.

- Long-Term Flow: 3.5 mgd.
- Pressure:
  - Chino II: As required for delivery to the JCSD 870 pressure zone.
  - RCF Booster: As required for delivery to the Riverside-Corona Feeder.

2.2.3.2 Pump Stations

In Option B, WMWD will no longer share capacity with Ontario in the 1010 pressure zone Chino II product water pump station. Instead, WMWD will share capacity with JCSD in the 870 pressure zone Chino II product water pump station.

For short-term deliveries, prior to construction of the Riverside-Corona Feeder, WMWD will require a booster pump station (located in the vicinity of Citrus Street and Hamner Avenue) to transfer water from the JCSD 870 pressure zone to the Arlington pipeline for delivery to Norco, thus allowing WMWD to use the equivalent volume and flow from the Arlington Desalter. WMWD will be the sole user of this pump station (Norco Booster).

For long-term deliveries, after construction of the Riverside-Corona Feeder, WMWD will require a booster pump station located in the vicinity of Clay Street and the Santa Ana River to transfer water from the JCSD 870 pressure zone to the Riverside-Corona Feeder for delivery to WMWD wholesale and retail customers. WMWD will be the sole use of this pump station (RCF Booster).

2.2.3.3 Pipelines

A detailed analysis will determine whether the construction of a new pipeline from Chino II to Etiwanda Avenue is required because of the added capacity to deliver WMWD's Chino II product water to the JCSD 870 pressure zone.

The pipeline improvements required to transport water through the ~~JCWD~~ **JCSD**[3] distribution system depend upon the capacity required. To date, WMWD has consider**ed**[3] the following capacity alternatives:

- WMWD's Chino II product water capacity only.
- WMWD's Chino II product water capacity plus additional capacity to purchase Chino II product water from JCSD, Ontario or others (up to the entire capacity of the Chino II expansion).
- Chino II product water capacity plus Chino Basin dry year yield capacity.

Required WMWD capacity in the JCSD 870 pressure zone could range from 3.5 mgd (WMWD's Chino II expansion capacity) to 10.5 mgd (entire Chino II expansion capacity) plus any dry year yield capacity that WMWD intends to develop from the Chino Basin.

At this point, we are assuming that WMWD will only require capacity for its Chino II product water (3.5 mgd). One of the major purposes for this technical memorandum is to allow WMWD to confirm or modify this assumption.

2.2.3.4 Water Quality

In the short-term alternative, Norco will receive delivery of water through the JCSD 870 pressure zone. The current JCSD Consumer Confidence Report shows nitrate levels (as NO^-_3) in the 870 zone water ranging from 27-32 mg/L (IXP) to 12 mg/L (Chino I). The addition of Chino II product water, at 5-23 mg/L, could affect 870 zone nitrate levels. WMWD would receive Arlington Desalter product water (now delivered to Norco) with a nitrate level that is currently 22-23 mg/L (as NO^-_3).

In the long-term alternative, Norco will continue to receive water from the Arlington Desalter and, therefore, will see no change in quality from the present. WMWD will receive water that is pumped from the JCSD 870 pressure zone into the Riverside-Corona Feeder. The nitrate levels could approach or exceed 30 mg/L (as NO^-_3), due to commingling with local JCSD supplies. This would represent an increase over the direct delivery of Chino II water at 5-23 mg/L (as NO^-_3) under Option A or the short-term delivery of Arlington Desalter water at 22-23 mg/L (as NO^-_3).

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[3] Addendum No. 3

3.0 SUMMARY

A summary of facilities and criteria is presented in Table 2. We request that the sponsors review and confirm or revise these criteria before we continue with detailed predesign analysis for Option A and Option B.

Table 1 Summary of Chino II Production
Chino Phase 3 Comprehensive Predesign
JCSD/Ontario/WMWD

Agency	SARWC	Norco	JCSD	Ontario	WMWD	Total
Volume						
Existing (af/yr)	400	1,000	5,500	3,500	0	10,400
Expansion (af/yr)	0	0	3,533	3,533	3,534	10,600
Total (af/yr)	**400**	**1,000**	**9,033**	**7,033**	**3,534**	**21,000**
Flow Delivered Through Chino Phase 3 Facilities						
Existing (mgd)	–	–	–	3.5	–	3.5
Expansion (mgd)	–	–	3.5	3.5	3.5	10.5
Total (mgd)	**–**	**–**	**3.5**	**7.0**	**3.5**	**14.0**

Table 2 Summary Of Additional Chino II Product Water Alternatives
Chino Phase 3 Comprehensive Predesign
JCSD/Ontario/WMWD

	Option A: Dedicated Pipeline to WMWD			Option B: Transportation through JCSD to WMWD		
Description	**JCSD**	**Ontario**	**WMWD**	**JCSD**	**Ontario**	**WMWD**
Additional Chino II Product						
Water Criteria						
Flow (mgd)	3.5	7.0	3.5	3.5	7.0	3.5
Volume (AF/YR)	3,533	7,033	3,534	3,533	7,033	3,533
Pump Stations						
Chino II 870 P.Z. (mgd)	3.5	–	–	7.0	–	7.0
Capacity Share (mgd)	3.5	–	–	3.5	–	3.5
Capacity Share (%)	100%	–	–	50%	–	50%
Pressure Zone From	801	–	–	801	–	801
Pressure Zone To	870	–	–	807	–	870
Chino II 1010 P.Z. (mgd)	–	10.5	10.5	–	7.0	–
Capacity Share (mgd)	–	7.0	3.5	–	7.0	–
Capacity Share (%)	–	67%	33%	–	100%	–
Pressure Zone From	–	801	801	–	801	–
Pressure Zone To	–	1010	1010	–	1010	–
RCF Booster (mgd)	–	–	–	–	–	3.5
Capacity Share (mgd)	–	–	–	–	–	3.5
Capacity Share (%)	–	–	–	–	–	100%
Pressure Zone From	–	–	–	–	–	870
Pressure Zone To	–	–	–	–	–	1250

Table 2 Summary Of Additional Chino II Product Water Alternatives
Chino Phase 3 Comprehensive Predesign
JCSD/Ontario/WMWD

Description	Option A: Dedicated Pipeline to WMWD			Option B: Transportation through JCSD to WMWD		
	JCSD	Ontario	WMWD	JCSD	Ontario	WMWD
Norco Booster (mgd)	–	–	–	–	–	3.5
Capacity Share (mgd)	–	–	–	–	–	3.5
Capacity Share (%)	–	–	–	–	–	100%
Pressure Zone From	–	–	–	–	–	870
Pressure Zone To	–	–	–	–	–	857
Milliken Booster (mgd)	–	4	–	–	4	–
Capacity Share (mgd)	–	4	–	–	4	–
Capacity Share (%)	–	100%	–	–	100%	–
Pressure Zone From	–	1010	–	–	1010	–
Pressure Zone To	–	1212	–	–	1212	–
Pipelines						
Chino II to Riverside/Hamner						
Total Capacity (mgd)	–	10.5	10.5	–	7.0	–
Capacity Share (mgd)	–	7.0	3.5	–	7.0	–
Capacity Share (%)	–	67%	33%	–	100%	–
Riverside/Hamner to 30” Arlington						
Total Capacity (mgd)	–	–	3.5	–	–	–
Capacity Share (mgd)	–	–	3.5	–	–	–
Capacity Share (%)	–	–	100%	–	–	–

Table 2 Summary Of Additional Chino II Product Water Alternatives
Chino Phase 3 Comprehensive Predesign
JCSD/Ontario/WMWD

	Option A: Dedicated Pipeline to WMWD			Option B: Transportation through JCSD to WMWD		
Description	**JCSD**	**Ontario**	**WMWD**	**JCSD**	**Ontario**	**WMWD**
Chino II to Etiwanda						
Total Capacity (mgd)	3.5	–	–	7.0	–	7.0
Capacity Share (mgd)	3.5	–	–	3.5	–	3.5
Capacity Share (%)	100%	–	–	50%	–	50%
JCSD 870 P.Z. Piping						
Total Capacity (mgd)	–	–	–	–	–	3.5
Capacity Share (mgd)	–	–	–	–	–	3.5
Capacity Share (%)	–	–	–	–	–	100%
Citrus/Hamner to 30” Arlington						
Total Capacity (mgd)	–	–	–	–	3.5	–
Capacity Share (mgd)	–	–	–	–	3.5	–
Capacity Share (%)	–	–	–	–	100%	–
<u>Water Quality</u>						
Nitrate (mg/L as No_3)	5-23	5-23	22-23	5-23	5-23	Short-term: 22-23 Long-term: 27-32

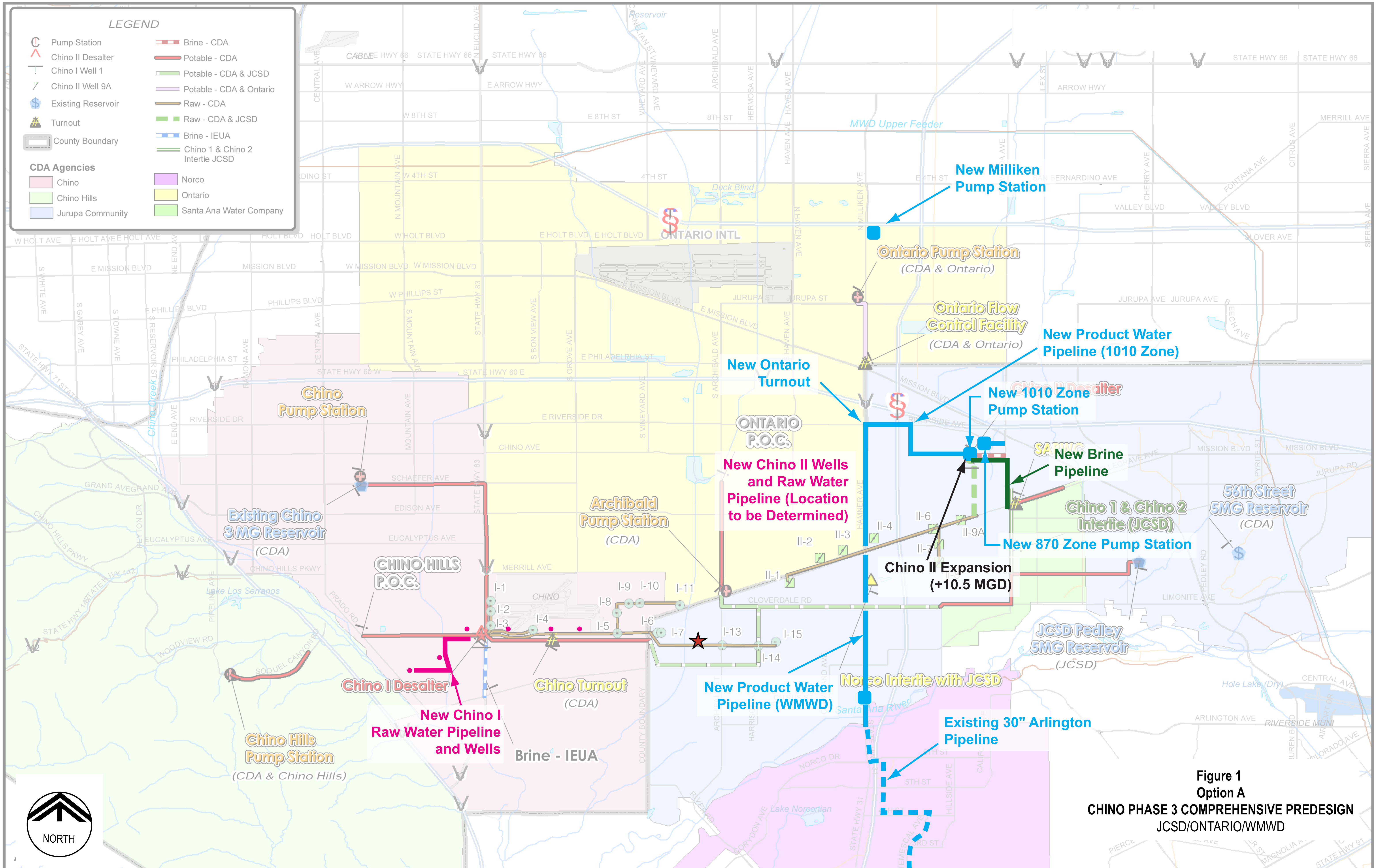


Figure 1
Option A
CHINO PHASE 3 COMPREHENSIVE PREDESIGN
JCSD/ONTARIO/WMWD

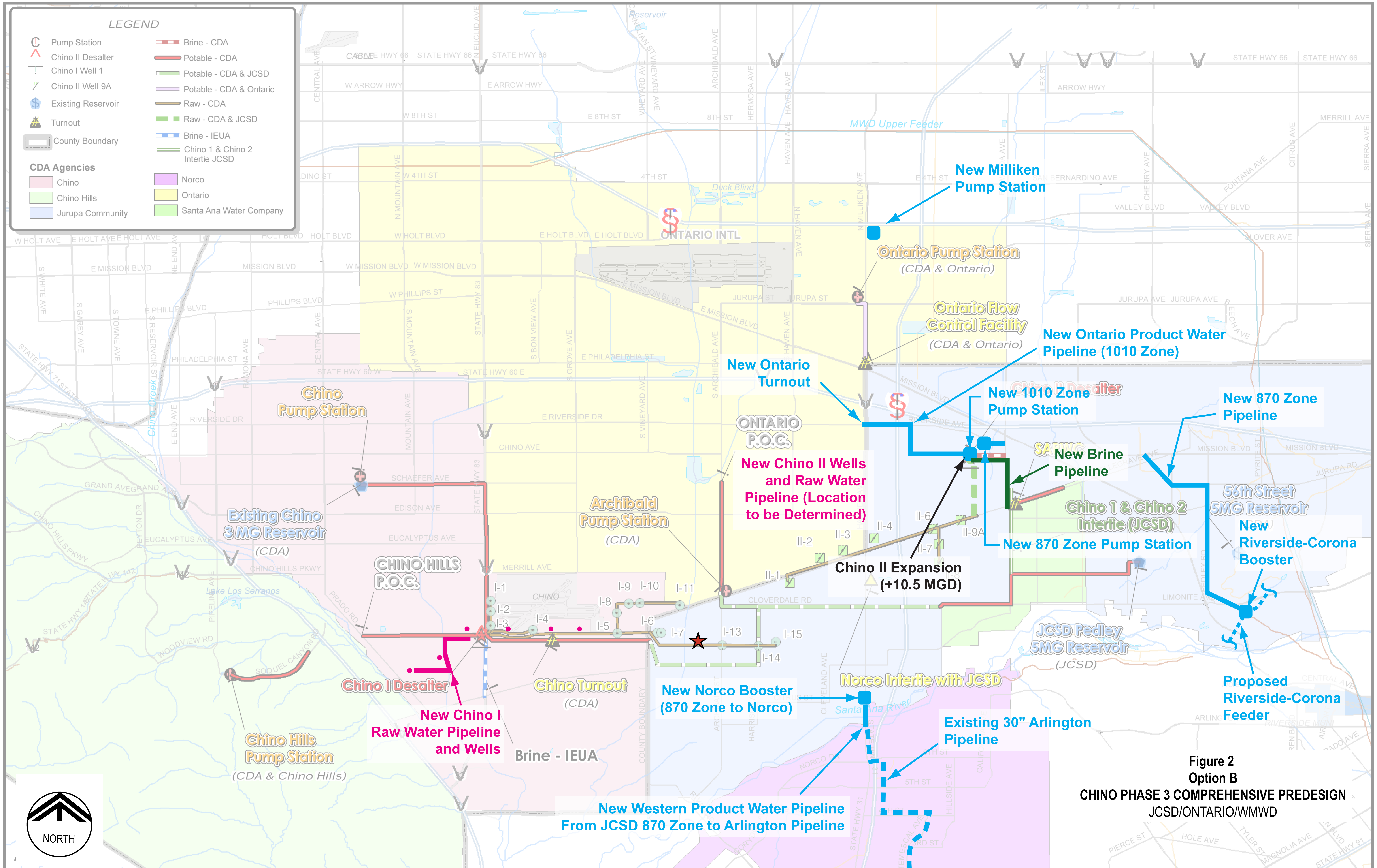


Figure 2
Option B
CHINO PHASE 3 COMPREHENSIVE PREDESIGN
JCSD/ONTARIO/WMWD

APPENDIX F.2

PIPELINE DESIGN CRITERIA

SECTION 2. PIPELINE DESIGN CRITERIA

The following design criteria are recommended for the proposed Chino III Desalter pipeline project and are based on standards from City of Ontario, WMWD, and JCSD. At the time that this study is prepared, no maintenance or ownership agreements are signed. Design standards for specific pipe reach will be decided at a later time. Overall design requirements for the pipeline, as well as specific standards from each agency are provided for design considerations.

2.1 Pipeline Type, Pressure Class, and Materials

For pipelines 16" or smaller, pipe type shall be PVC C900. 16" lines may also be CML/CMC steel. All pipeline larger than 16" diameter shall be CML/CMC steel pipeline. Cement mortar coating and lining shall conform to AWWA C-205. Pipe sections are to be supplied at 40' maximum lengths. All materials shall conform to AWWA C-200.

City of Ontario standards specify that all steel pipe should be 10 GA. minimum steel plate per ASTM A-570 with a minimum yield strength of 33,000 psi but shall not exceed stresses of 16,500 psi in actual design (a safety factor of 2). JCSD steel plate standards also require 10 GA minimum plate thickness, and shall be designed with a minimum steel strength of 33,000 psi and a design stress of no more than one half of the steel strength. Similarly, WMWD minimum steel plate yield strength is 36,000 psi and design stresses shall not exceed one half of the yield strength.

In City of Ontario jurisdictions, a Hazen-Williams coefficient of 120 should be used for CMC pipelines and 150 for PVC pipelines. Maximum velocity in pipelines should not exceed 5 feet per second. JCSD requires a Hazen-Williams coefficient of 120 for all pipe types. WMWD limits the Hazen-Williams coefficient for PVC to 130. For CMC pipelines WMWD requires a Hazen-Williams coefficient of 120. Western allows mainline fluid velocities of up to 7.5 ft/sec.

A Surge analysis is normally a part of the pipeline design and a preliminary result is presented in Section 6. Even with a surge allowance of 50 percent increase over operating HGL, the pipeline pressure requirements are less than 150 psi. 150 psi is the minimum recommended design pressure for distribution system mains.

2.2 Minimum Earth Cover Requirements

In general, minimizing the depth of burial reduces the construction cost of a pipeline. This consideration, however, must be balanced against greater live loading and floatation concerns. The minimum cover required over the pipeline will be established by determining the soil weight required to prevent flotation of the empty pipeline in high ground water conditions with a minimum safety factor of 1.33. The design cover will then be established after considering other criteria such as existing utilities, tie-in points, and localized topography. As a general rule, the minimum depth of cover is proposed at 4 feet for the 30-inch diameter pipeline, and 3½ - 4 feet for the 24-inch diameter pipeline (in order to also minimize conflicts with existing utilities). Normally, crossing utilities will dictate the cover at many locations. Caltrans and the railroads will, by permit, require minimum cover on a site-specific basis. Also, the pipe for the air valve requires a 2% grade from the mainline to the valve, which may drive the mainline deeper.

2.3 Determining Pipe Wall Thickness

Generally, the 24″ and 30″ diameter underground pipelines are subjected to the following types of loads:

- **Permanent Loads:** Dead weights of pipe and earth cover, and the tributary earth pressure from adjacent footings.
- **Semi-permanent Loads:** Roadway and railway live loads and surge pressures.
- **Exceptional Loads:** Earthquakes, soil liquefaction, loads resulting from pipeline operational errors or malfunctions of mechanical equipment, etc.

It is common practice in large water pipeline design (greater than 24-inch) to consider transient loads as acting simultaneously with permanent and semi-permanent loads. Exceptional loads are handled separately. The design will consider two loading conditions: the empty pipe condition and the pressurized pipe condition.

1. **Empty Pipe Condition**

This condition prevails during construction, before the pipeline is put into operation, as well as during short inspection periods occurring in the lifetime of the facility. Pipes are designed for external loads resulting from roadway (or railway as applicable) live loads acting simultaneously with dead loads.

Welded steel pipes are designed as flexible pipe. Taking advantage of the supporting effect of lateral soil, the maximum vertical deflection is limited to 3 percent of the pipe diameter for field-lined pipe with flexible coating. This deflection is limited to 2 percent for pipe with cement-mortar coating and shop lining.

2. **Pressurized Pipe Condition**

This condition prevails during most of the lifetime of the pipeline. The effect of the internal pressure on flexible steel pipes is investigated separately from other loads. Hoop stresses due to internal pressure are limited to permissible values. Permissible values are 50% of specified yield strength for steel pipe not to exceed 16,500 psi. Basic tensile and flexural stresses in outlet and elbow sections will be limited to 67 percent of yield stress. Combined stresses will be limited to 90 percent of yield stress. Localized stress concentrations on outlets and elbows will be kept below the yield stress of the material.

3. **Transient Loads**

The design internal pressure of the pipeline should be above the internal pressures resulting from surge. The effect of surge as a transient load will be investigated after the final operating conditions of the new proposed pumps. In the interim, use 20 percent above operating HGL for surge pressure. This criterion will not affect the smaller diameter pipeline segments, because of the minimum thicknesses required. For the 30″ pipeline, the thickness will increase only if the calculated surge pressures are greater than 50 psi, because the static pressures are all anticipated to be less than 100 psi.

2.4 Mainline Valve Type and Spacing Requirements

Resilient seat gate valves shall be used for all pipeline diameters up to and including 12" diameter, and shall be flanged ductile iron, epoxy lined and coated according to AWWA C-509.

Per City of Ontario, butterfly valves shall be used for all pipeline diameters 16" and larger. Butterfly valves shall be flanged ductile iron, epoxy lined and coated according to AWWA C-509. All butterfly valves shall be Class 150B according to AWWA C-504, and shall have valved by-pass features according to AWWA C500 section 3.2 and Table 8. (By-pass gate valves shall be 6" for pipelines 14" to 24", and 10" for pipelines larger than 42").

JCSD requires 14" diameter and larger pipelines to be equipped with butterfly valves. WMWD also requires 14" diameter and larger pipelines to be equipped with butterfly valves with a maximum velocity through valves of 20 fps. In general, valve diameters should match pipeline diameters unless WMWD approves a swollen valve on the basis that hydraulic head-losses are insignificant.

Per City of Ontario and JCSD, space between mainline valves shall not exceed 1000 feet. WMWD standards require mainline valving at a maximum spacing of 1320 feet. City of Ontario and JCSD require a minimum of three valves to be located at crosses, and a minimum of two valves to be located at tees. WMWD requires three valves at tees and at crosses. Valves are to be the direct bury type, and should be flanged to tees or crosses where possible. Valves shall also be located at the beginning of any dead end.

2.5 Blow-off and Air Valve Sizing Criteria

Blowoffs will be provided at significant low points which can be drained by gravity. Maximum velocity through the valves and discharge piping should not exceed 25 fps. An energy dissipater and transition section to a culvert-type outlet should be evaluated at blowoff locations which discharge into natural drainage courses. Blow-offs are to be located at all dead ends and local low points of pipeline alignment. Per JCSD blow-offs are also to be located at the up-hill side of all mainline valves for pipelines 14-in diameter and larger. WMWD requires to use fire hydrants in place of blow-offs where applicable. Minimum size of blowoff shall be 4-in. City of Ontario requires 6-in for 18-in through 24-in diameter main pipeline.

The functions of air valves are threefold:

1. Release air displaced by water upon pipeline filling;
2. Admit air to displace water released by pipeline drainage; and,
3. Release air which comes out of solution during normal pipeline operation.

The first two functions are accomplished with large orifice "Air and Vacuum" valves. The third function is accomplished with small orifice "Air Release" valves. "Combination Air Valves" incorporate multiple orifices to accomplish all three functions in one body. Custom combinations of the two valve styles can also be assembled where standard single-body configurations are inappropriate.

In general, locate large orifice "Air and Vacuum" valves at pipeline summits. These locations are usually good collectors of air during pipeline operation, so locate a small orifice "Air Release" valve there too. Also locate large orifice "Air and Vacuum" valves where negative pressures are otherwise possible, such as at the top of a steep down slope, and where identified in a surge analysis. Another candidate for large orifice "Air and Vacuum" valves is either side of an in-line isolation valve.

Small orifice "Air Release" valves should be located at high points and at regular intervals not exceeding 1500-feet on long flat slopes. Because many of these locations are under pressure at all times, a single small body-small orifice valve will suffice (such as at a minor rise in elevation). But most air valve locations will coincide with the large orifice "Air and Vacuum" valves, procedures will be as follows:

- Size the design main valve body to exhaust air during pipeline filling.
- Check the main valve body size to admit air.
- Size and air release valves to release entrained air.

Generally, air-valves can be sized as follows (from WMWD):

Main size:	Air-Valve Size
8” to 12”	1”
16” to 24”	2”
30”	4”
Larger than 30”	Consult with agency

2.6 Cathodic Protection

Soil analysis is to be performed in order to determine ph, redox, sulfide, resistivity, and sulfate conditions. Where soils are shown to be corrosive or potentially corrosive, cathodic test stations will be required. Generally, transmission lanes are subject to cathodic protection regardless of soil investigation results. Test stations shall be spaced no more than 1000 feet apart. Pipelines shall be bonded for cathodic continuity according to each agency’s standard drawings and specifications. Bonding and test cable shall be provided without splicing between commencing point and cathodic test stations.

Wraps and coatings are typically used to preserve pipeline wall integrity in corrosive soils. While typical specifications call for cement mortar lining and coating on steel pipelines, additional exterior dielectric wrap may be required by the jurisdictional ageny regardless of soil test findings. This is particularly likely for critical system transmission pipelines. Wraps shall be in accordance with AWWA C-214-07.

Insulating materials such as flanges shall be designated according to working pressures (150 psi) and temperatures of the pipeline. Sleeves and washers shall be phenolic. Flanges shall be full-face neoprene-faced phenolic.

2.7 Bedding and Backfill Requirements

Generally, pipeline bedding shall be evenly laid and compacted such that uneven settlement is avoided and the pipeline has continuous bearing on the bedding material. No particles exceeding 2” in any dimension shall be placed within 6” of any pipeline surfaces.

Pipeline bedding and trench backfill within City of Ontario jurisdiction shall conform to Green Book standards. Elsewhere, bedding a backfill shall conform to WMWD or JCSD Standards, according to the jurisdictional agency.

Trench shoring during compaction of bedding and placement of pipeline shall be in strict accordance with OSHA requirements.

2.8 Interties, Connections and Stubouts

A minimum of three (3) valves shall be located at all crosses and a minimum of two (2) valves shall be located at all tees, except as described in Section 2.4. Either a temporary air vacuum or temporary blow off is required at all ends of lines, and should be installed per the jurisdictional agency's standard drawings.

Dead ends more than 300 feet in length shall have circulating ties on twenty-foot easements through side lot lines. Blowoffs and/or air valves are appropriate along such ties (see Section 2.5). Blowoffs and air valves along such ties should be installed at the standard locations shown in standard drawings.

2.9 Thrust Protection Methods

All pipelines shall be restrained at joints for thrust protection. PVC pipelines require Uni-Flange or Mega Lug type of mechanical restraints. Steel pipeline shall be welded at the joints in order to meet thrust restraint requirements. All restrained joints shall be designed and constructed with a safety factor of 2, per each agency's specific standards.

2.10 Design Requirements for Operation and Maintenance

- Telemetering / Fiber optics

The City of Ontario telemetering system is via radio instead of direct burial cable. The City is contemplating paralleling water pipeline with a fiber optics conduit and may be specified during the final design.

Additional telemetry for JCSD or WMWD shall be designed according to each agency's specific direction after an appropriate consultation takes place; each agency requires such a consultation in order to determine specific telemetry needs and design.

- Manways

Manways are provided on the pipeline for internal joint welding, inspection and video documentation during construction, and access for maintenance if required. The maximum practical distance for extending welding equipment is 750 feet each way from an access manway. This limits the maximum spacing of manways to 1,500 feet. The minimum clear diameter for a manway riser is 20". Locate manways where possible to coincide with requirements for combination air valves, air-release valves, and blowoffs to minimize number of structures required. Manways may also be required at blowoffs to provide a means to lower a suction hose or submersible pump into the pipe and completely dewater the low section on the profile. The nominal 20-inch diameter riser required for construction and maintenance is adequate for lowering a submersible pump of sufficient capacity to pump out the trapped water at blowoffs and pump wells. WMWD has no specific requirements for Manways. City of Ontario and JCSD each require Manways as described above.

We recommend that manways be buried, without permanent vaults.

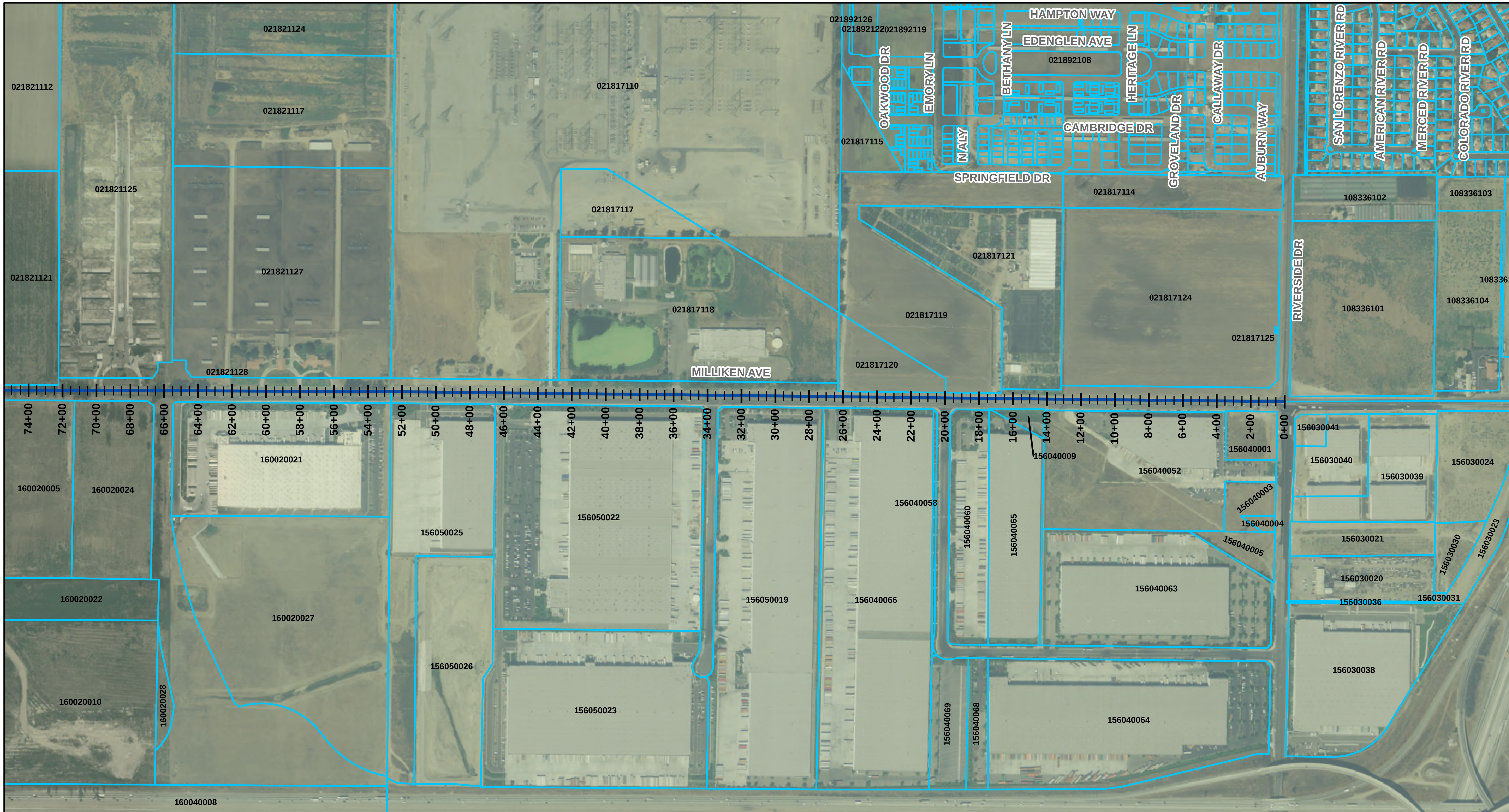
1. Manways should consist of 20" or 24" diameter outlets with 20" or 24" blind flanges.
2. Manways should have a maximum spacing of 1500 feet on center. At mainline valve installations, manways should be located on both sides of each valve a maximum of 35 feet.
3. Manway locations should be selected to minimize impact to traffic, and should be approved prior to pipe fabrication.

- Material Specification

Pipelines in the City of Ontario jurisdiction shall meet the City's material specifications sections 4.1.1 – 4.2, including the following: butt-straps shall have two (2) hand-holes for pipe 14" in diameter and larger. PVC pipe shall have common profiles for inter-changeability between rough-barrel dimensions, couplings, ends, and elastomeric gaskets to facilitate future repairs.

APPENDIX F.3

PLAN AND PROFILE OF PROPOSED RIVERSIDE-HAMNER PIPELINE



Legend

Existing Pipe

Parcels

NORTH

0 300 600 1,200 Feet

1 inch = 600 feet

Figure No. F.3.1

HAMNER AVENUE PIPELINE PLAN

CHINO DESALTER PHASE 3 PDR

JCSD/Ontario/WMWD

carollo

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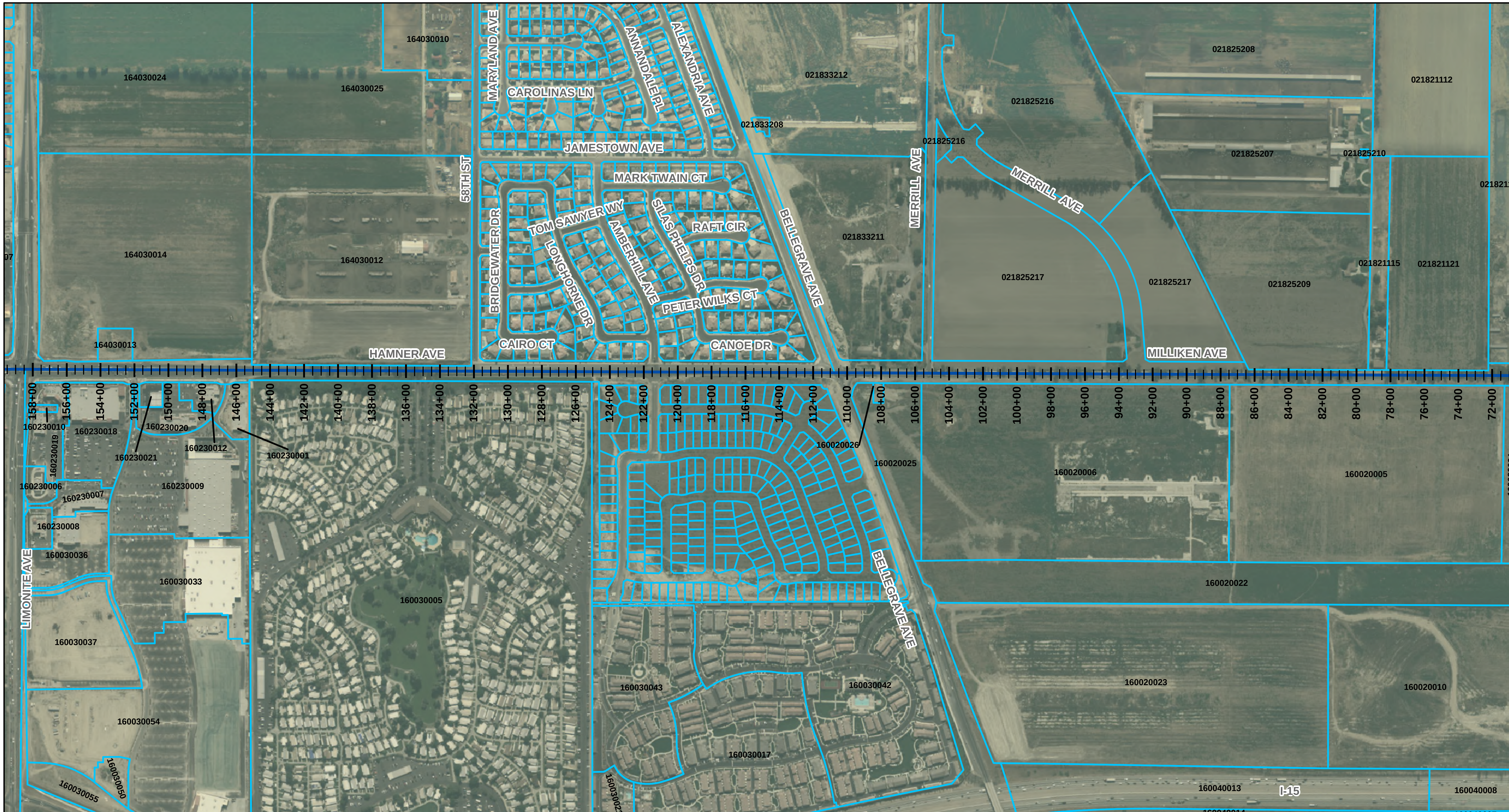

Legend

- Existing Pipe
- Parcels

NORTH

0 300 600 1,200 Feet

1 inch = 600 feet

Figure No. F.3.2

HAMNER AVENUE PIPELINE PLAN

CHINO DESALTER PHASE 3 PDR

JCSD/Ontario/WMWD

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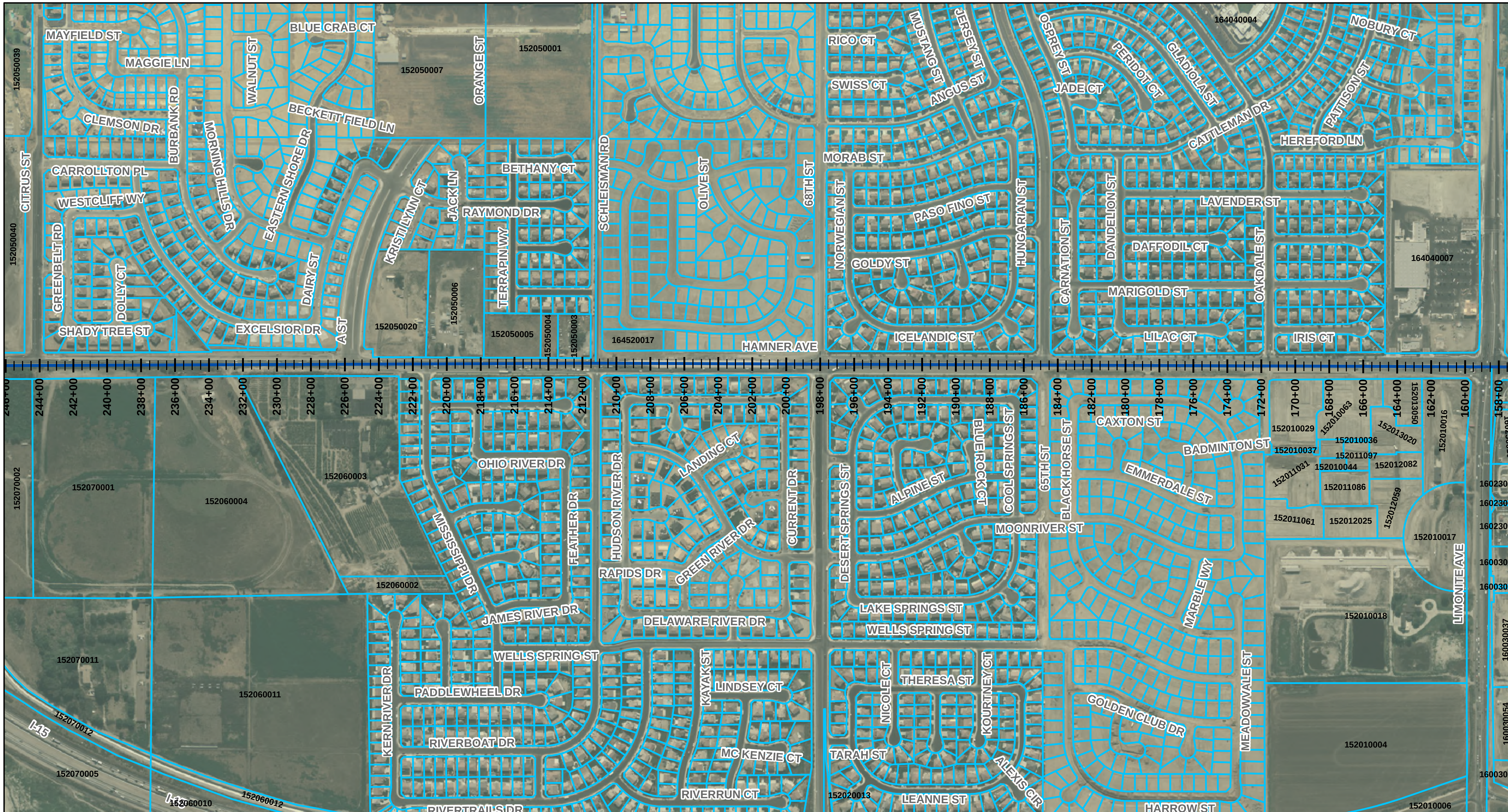

Legend

- Existing Pipe
- Parcels

NORTH

0 300 600 1,200 Feet

1 inch = 600 feet

Figure No. F.3.3
HAMNER AVENUE PIPELINE PLAN
CHINO DESALTER PHASE 3 PDR
JCSD/Ontario/WMWD

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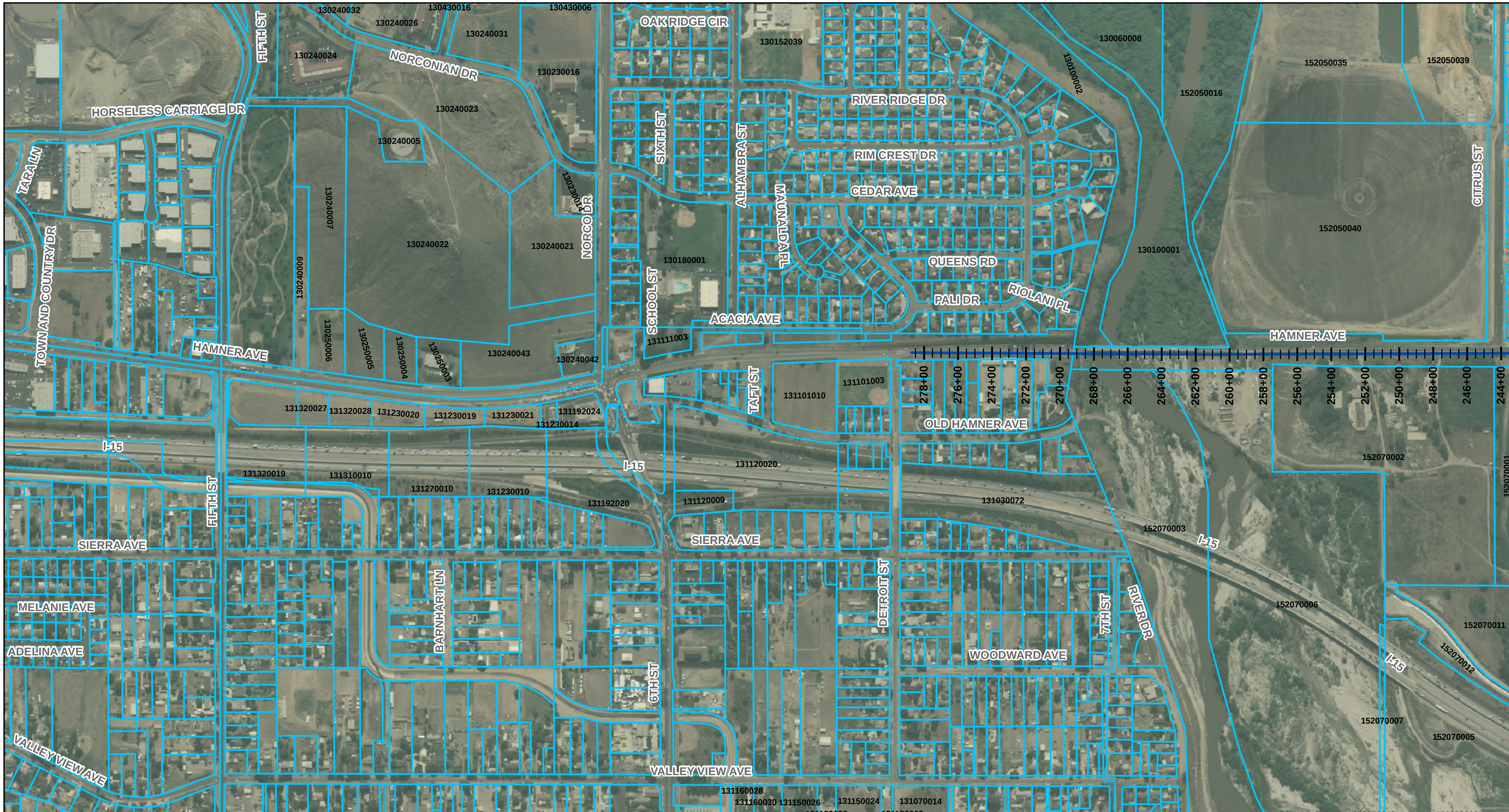

Legend

Existing Pipe

Parcels

NORTH

0 300 600 1,200 Feet

1 inch = 600 feet

Figure No. F.3.4
HAMNER AVENUE PIPELINE PLAN
CHINO DESALTER PHASE 3 PDR
JCSD/Ontario/WMWD

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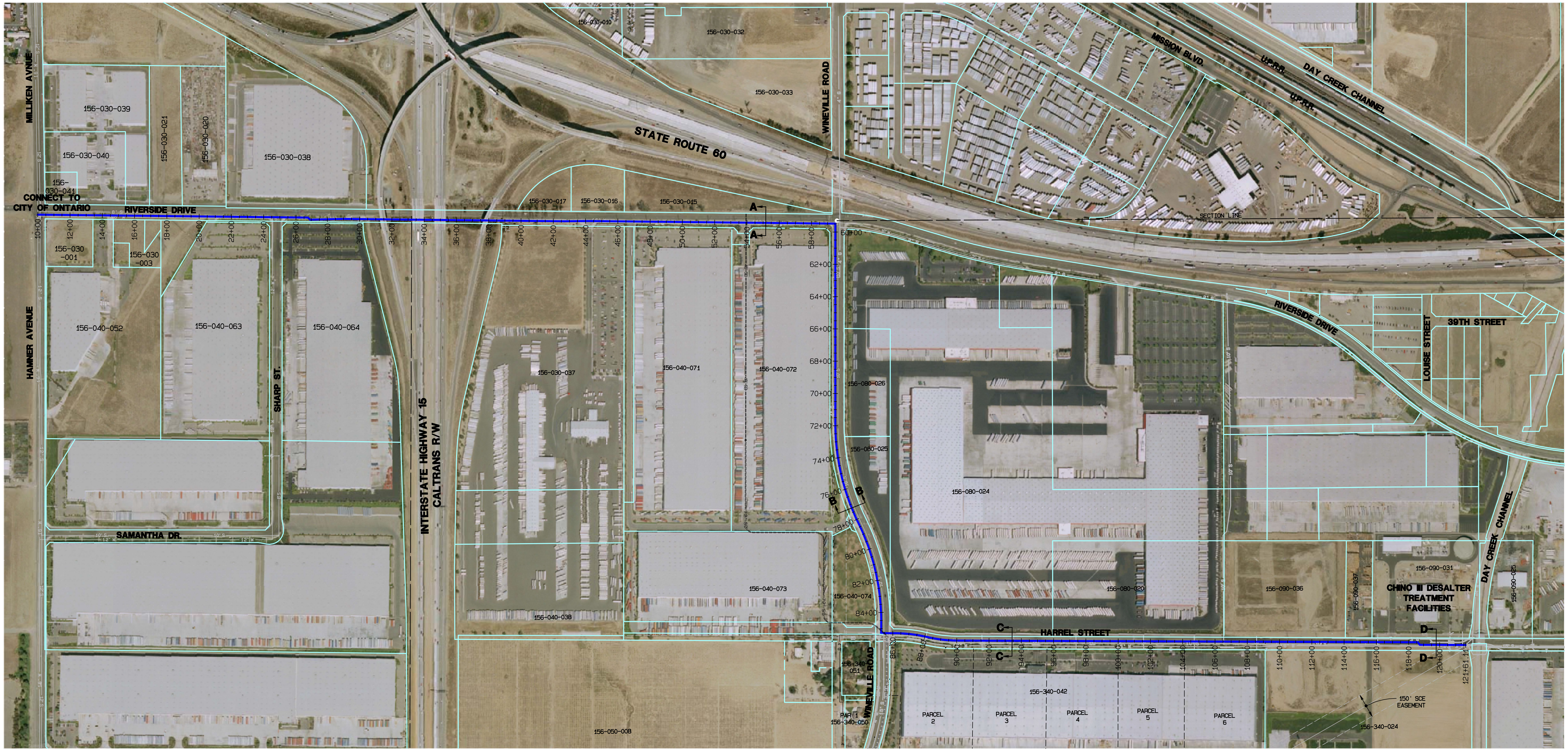


FIGURE 4-1: CHINO III ALIGNMENT
FOR CITY OF ONTARIO (P.Z. 1010')

GRAPHIC SCALE
300 0 600 900 1200

CITY OF ONTARIO, JCSD, WMWD
RIVERSIDE, CALIFORNIA

SCALE: DATE: 3-8-2008 DESIGNED: SW CHECKED: PLN CK REF: F.B. 2007/-----	ALBERT A. WEBB ASSOCIATES CIVIL ENGINEERS 3788 McCRAY STREET RIVERSIDE, CA 92506 (951) 686-1070 G:\2007\07-0345\DWG & Pros\CFD Ontario.pro 7/22/2008	W.O. 07-0345 SHEET OF SHEETS DWG. NO.

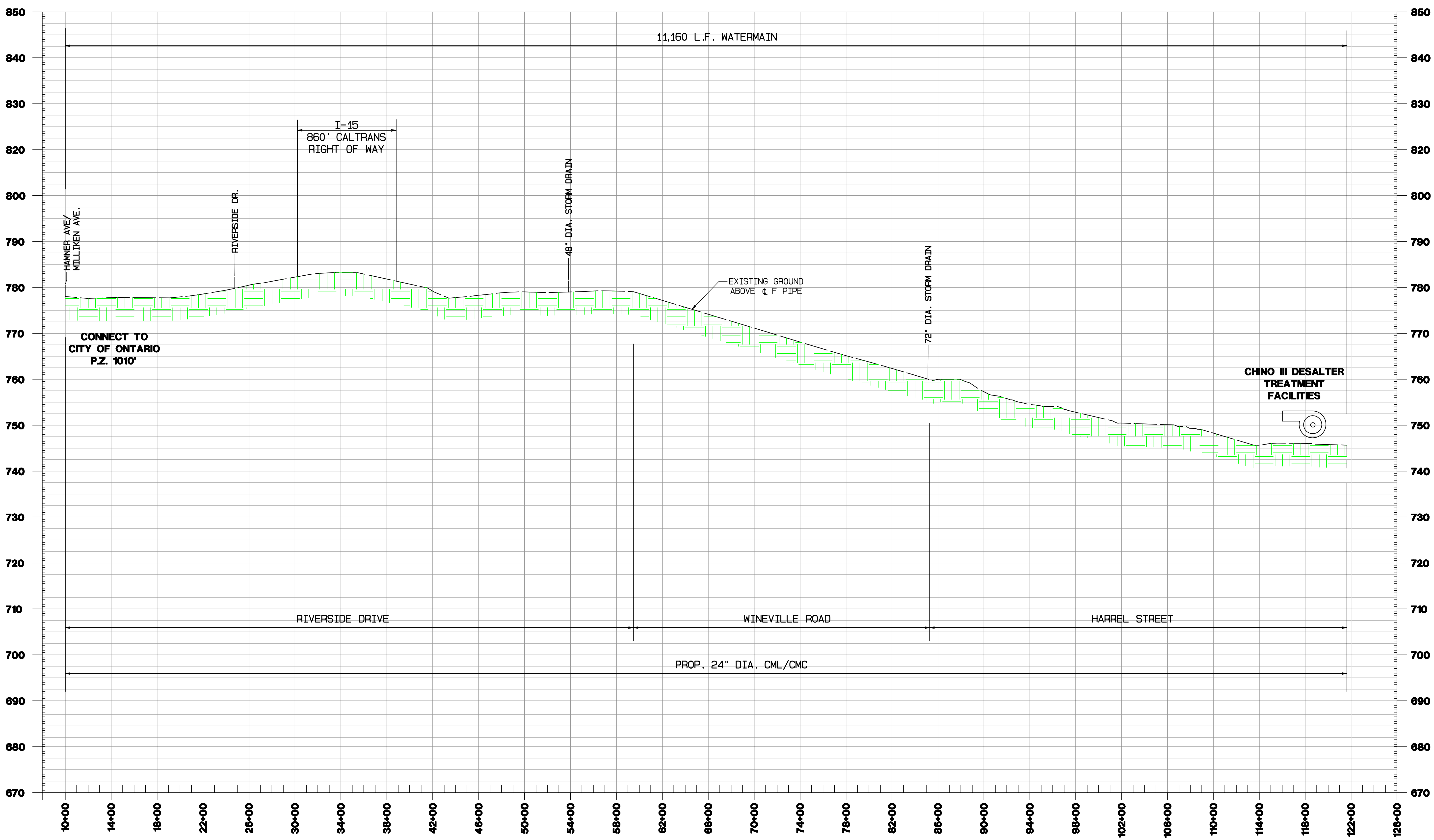


FIGURE 4-2: CHINO III ALIGNMENT
PROFILE FOR CITY OF ONTARIO (P.Z. 1010')

CITY OF ONTARIO, JCSD, WMWD
RIVERSIDE, CALIFORNIA

SCALE: 1"=400'	ALBERT A. WEBB ASSOCIATES — CIVIL ENGINEERS, 3788 McCRAY STREET, RIVERSIDE, CA 92506, (951) 686-1070	W.O. 07-0345
DATE: 3-8-2008		SHEET
DESIGNED: SW		
CHECKED:		OF SHEETS
PLN CK REF:	G:\2007\07-0345\DWG & Pros\CFD Ontario.pro 7/22/2008	DWG. NO.
F.B. 2007/-----		----

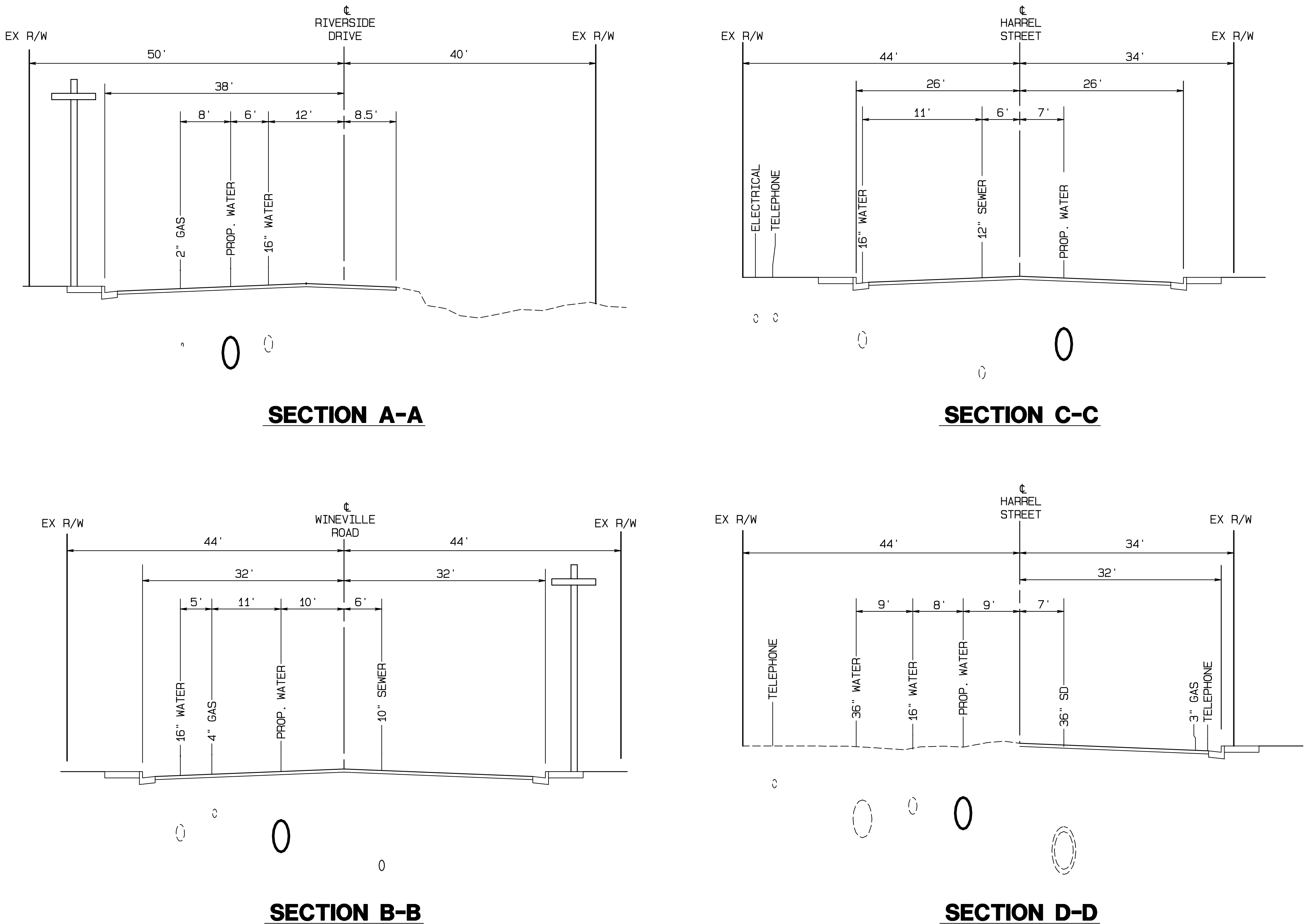
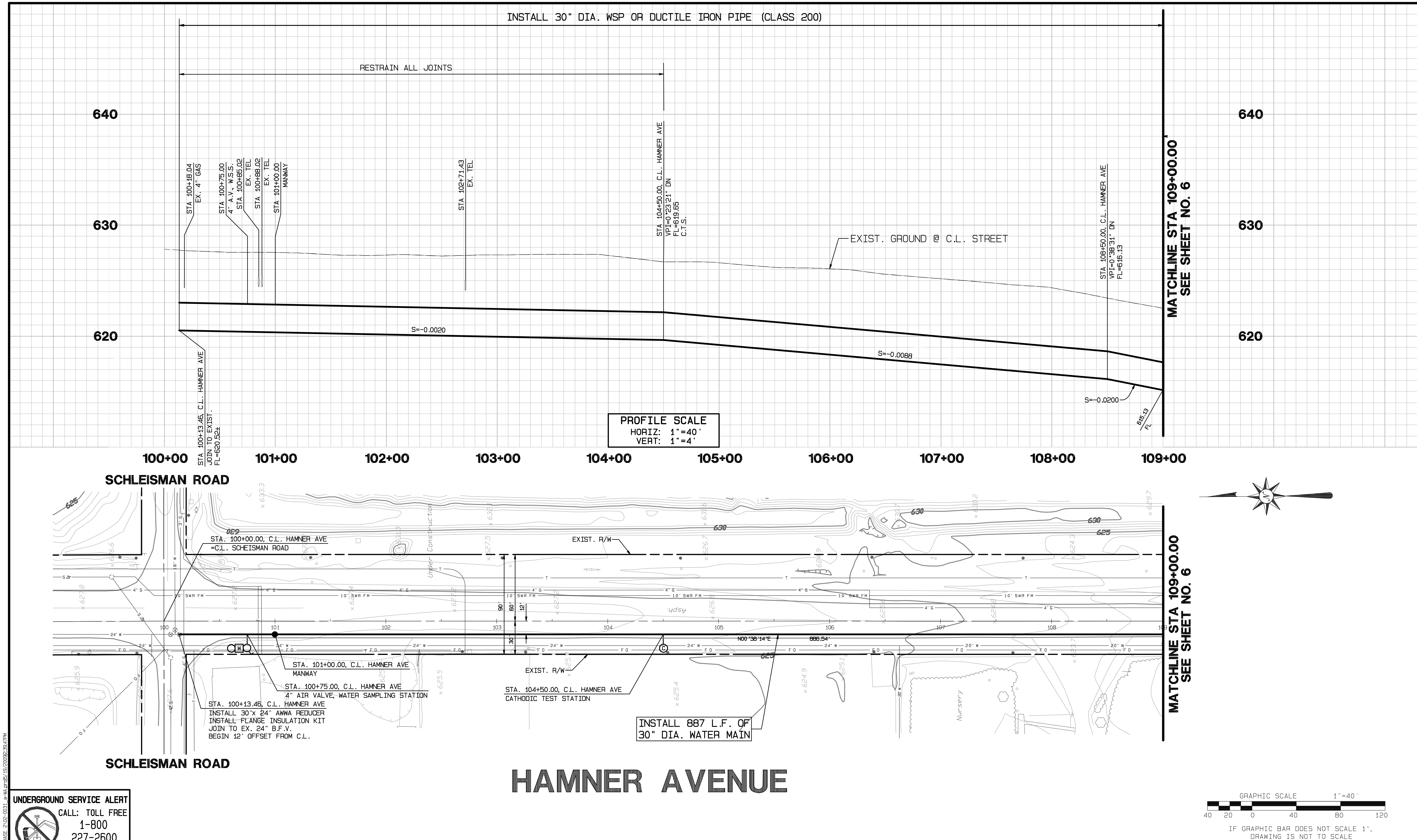


FIGURE 4-3: CHINO III ALTERNATIVE ALIGNMENT
STREET CROSS SECTIONS FOR CITY OF ONTARIO (P.Z. 1010')

CITY OF ONTARIO, JCSD, WMWD **RIVERSIDE, CALIFORNIA**		
SCALE: NTS DATE: 3-8-2008 DESIGNED: SW CHECKED: PLN CK REF: F.B. 2007/-----	ALBERT A. WEBB ASSOCIATES CIVIL ENGINEERS 3788 McCRAY STREET RIVERSIDE, CA 92506 (951) 686-1070 G:\2007\07-0345\DWG & Pros\CFD Ontario.pro 7/22/2008	W.O. 07-0345 SHEET OF SHEETS DWG. NO. ----

HAMNER PIPELINE DRAWINGS

- **Schliesman Rd to south of Santa Ana River (design drawings): Sheets 5-10**
- **South of Santa Ana River to West side of Detroit Street Bridge (record drawings): Sheets 11-12, 13A**
- **Detroit Street Bridge (design drawing): Sheet 13B**



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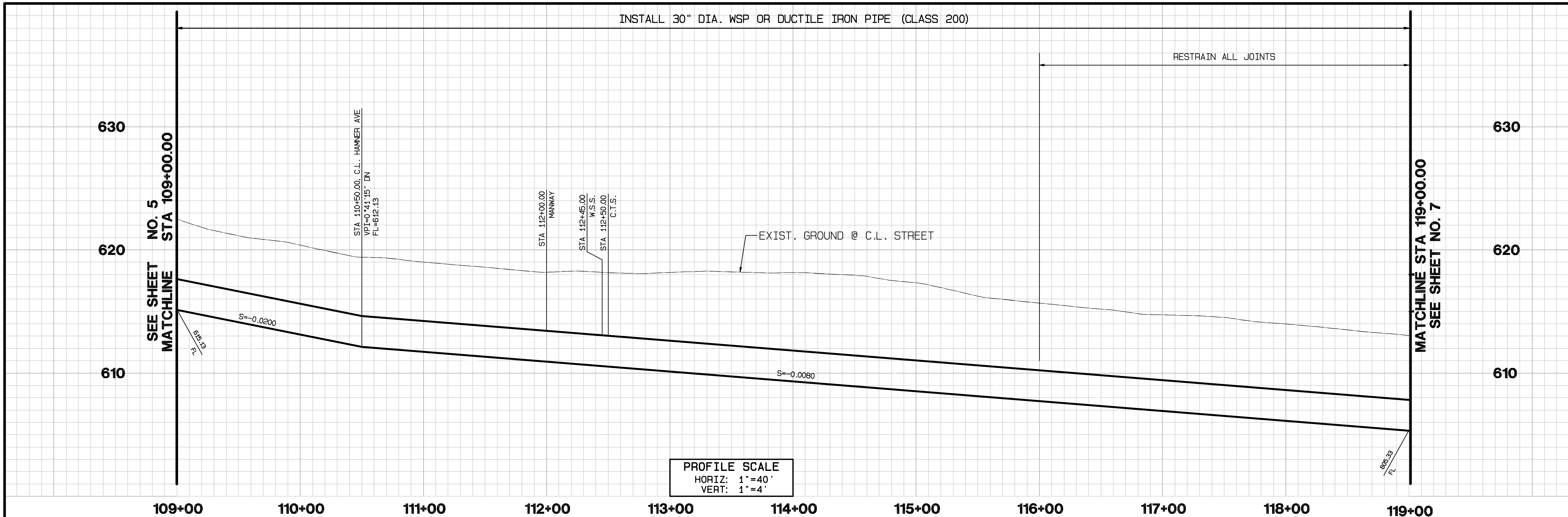
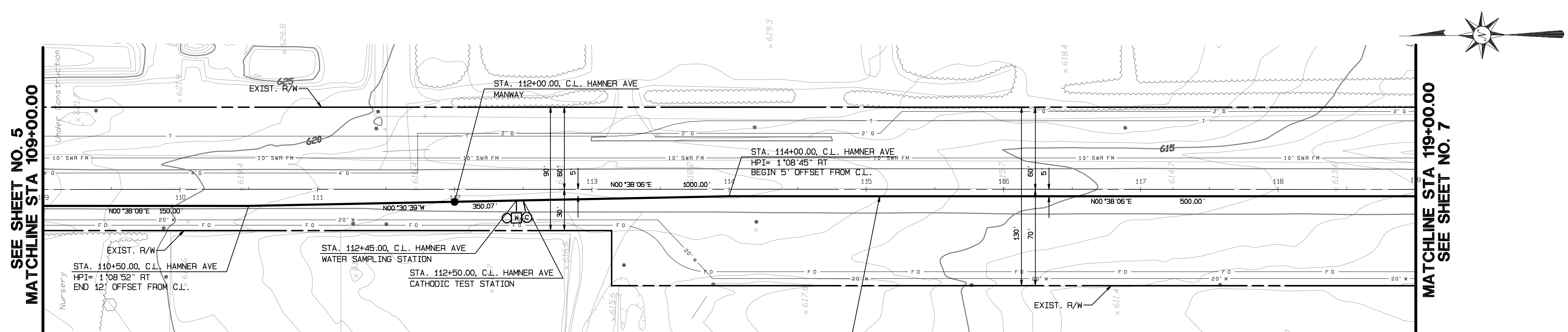
909-785-5411

ARLINGTON DESALTER PRODUCT WATER PIPELINE

PLAN & PROFILE OF WATER IMPROVEMENTS ON HAMNER AVENUE FROM STA 100+00 TO STA 109+00

DRAWING NO. 02-0031
SHEET: 5 OF 73 SHEETS
FILE NO





INSTALL 1000 L.F. OF
30" DIA. WATER MAIN

HAMNER AVENUE

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PLAN & PROFILE OF WATER IMPROVEMENTS ON HAMNER AVENUE FROM STA 109+00 TO STA 119+00

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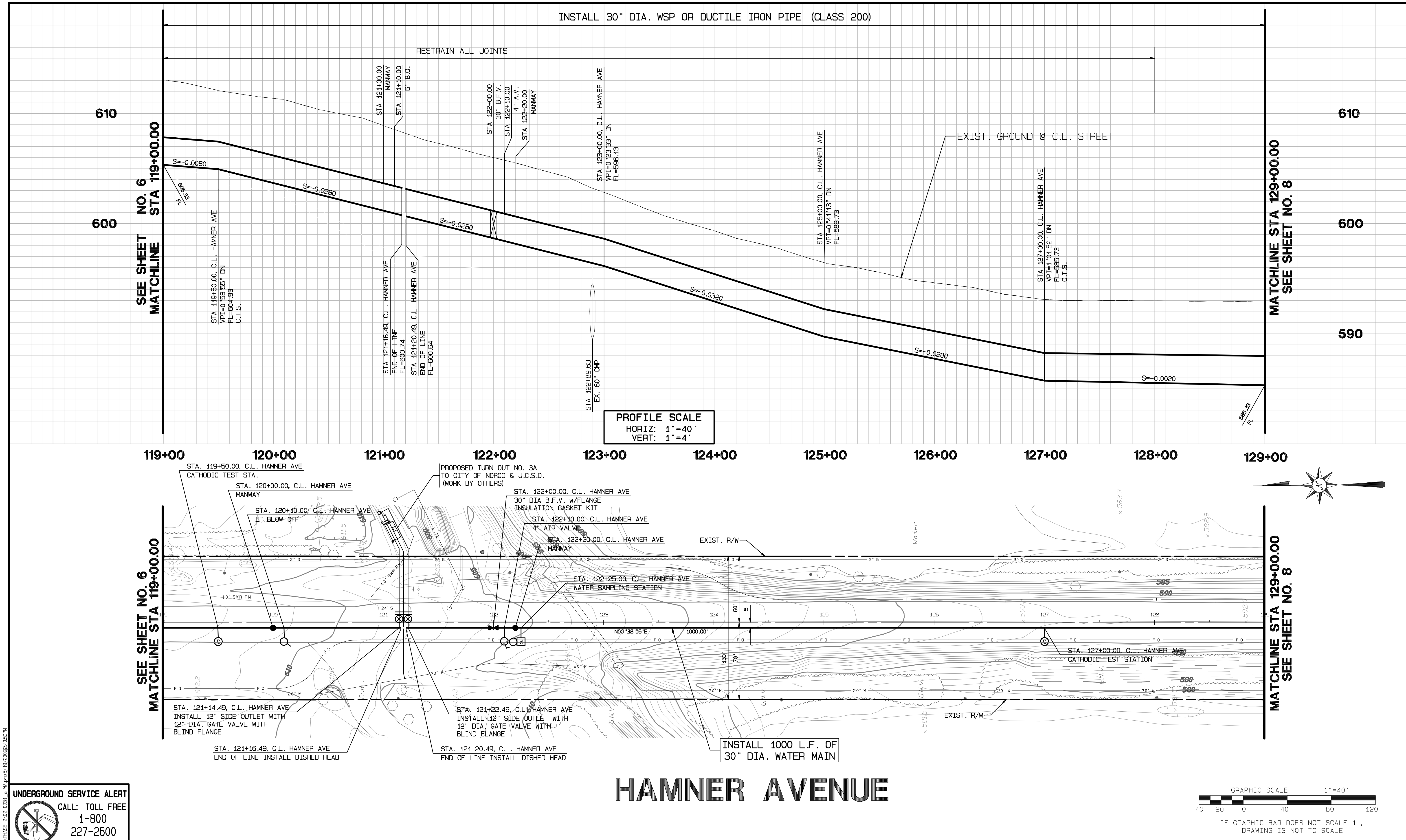

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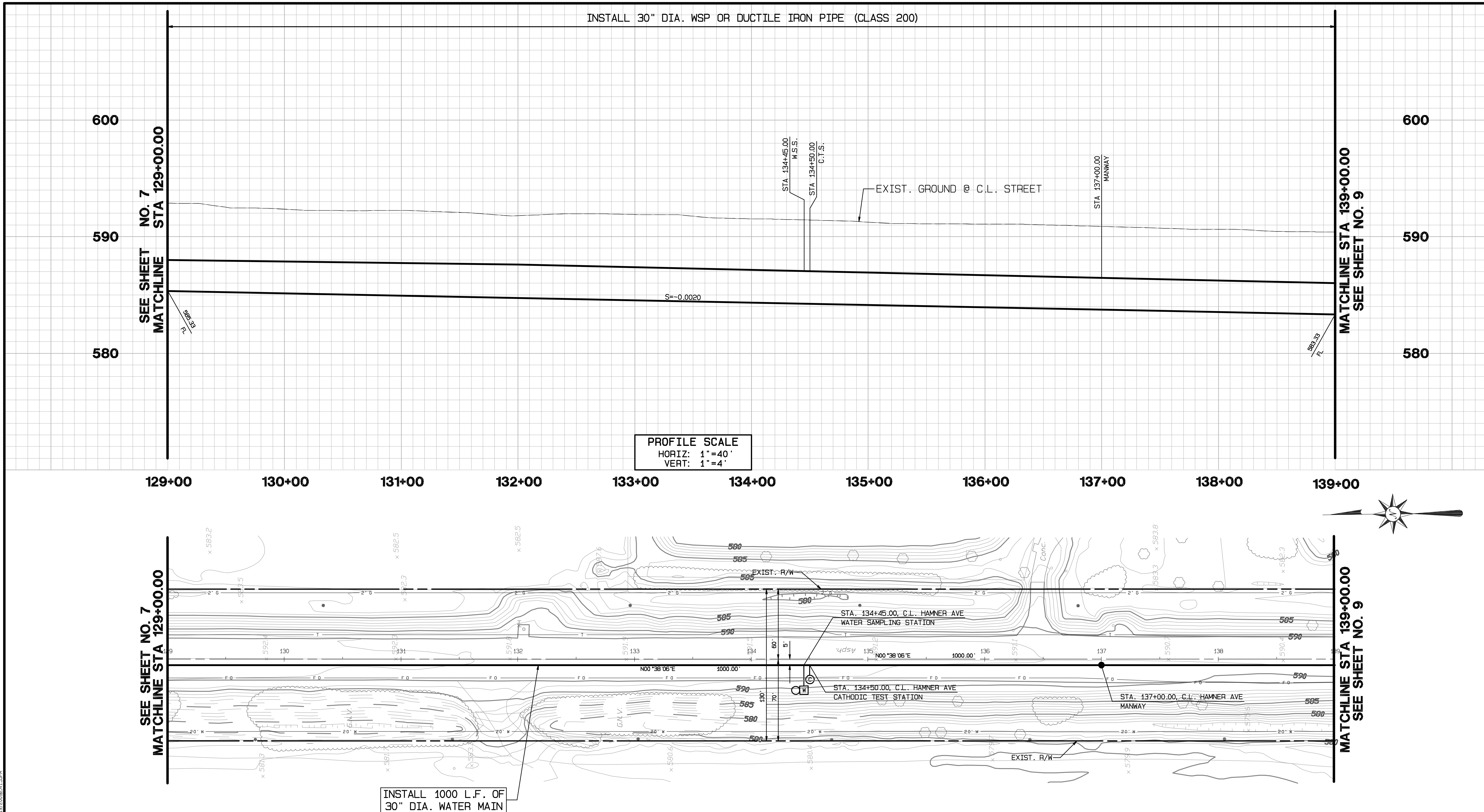
ARLINGTON DESALTER PRODUCT WATER PIPELINE

PLAN & PROFILE OF WATER IMPROVEMENTS ON HAMNER AVENUE FROM STA 119+00 TO STA 129+00

DRAWING NO. 02-0031

SHEET: 7 OF 73 SHEETS

FILE NO



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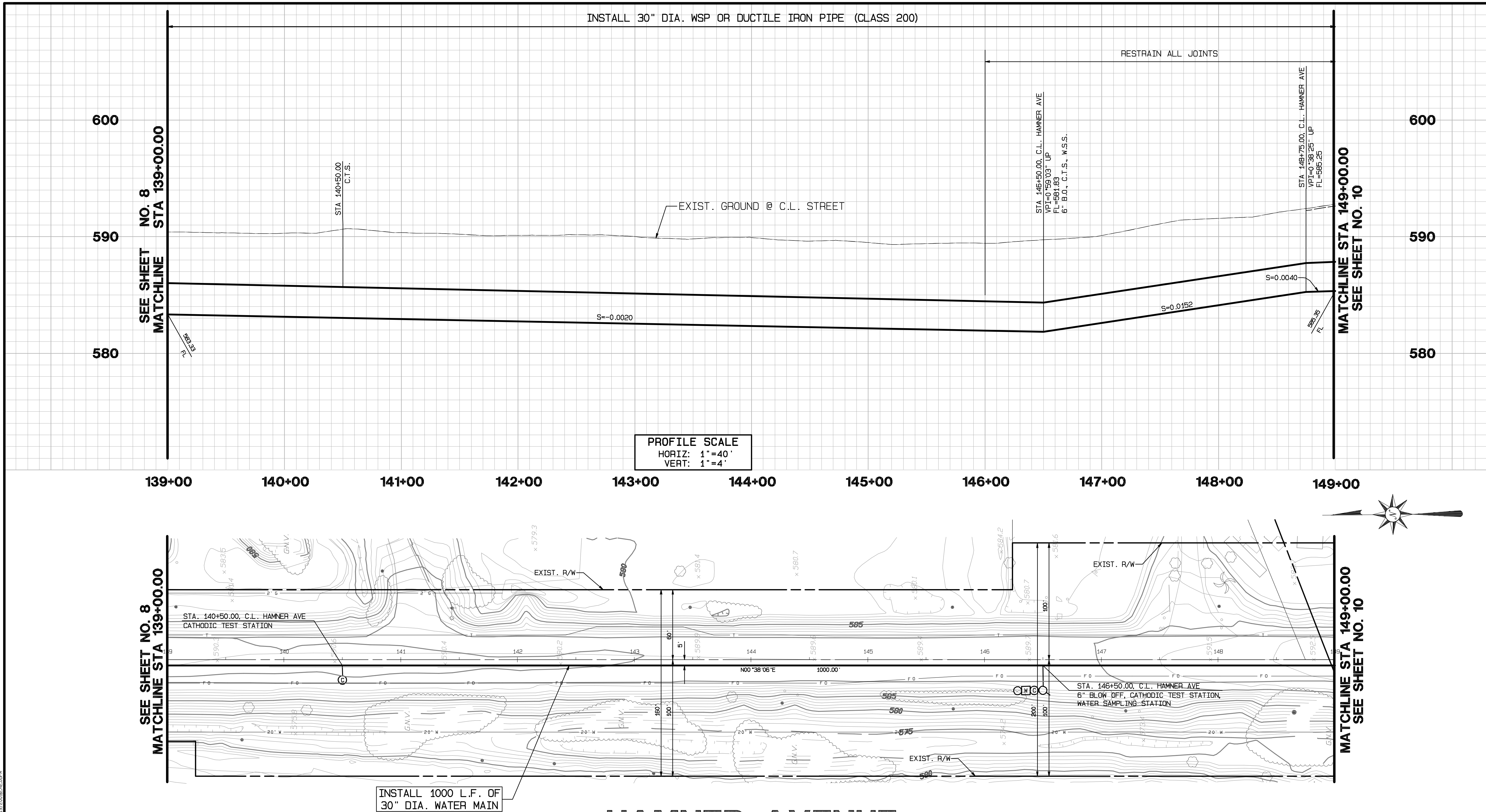
PLAN & PROFILE OF WATER IMPROVEMENTS ON HAMNER AVENUE FROM STA 129+00 TO STA 139+00

DRAWING NO. 02-0031

SHEET 8 OF 73 SHEETS



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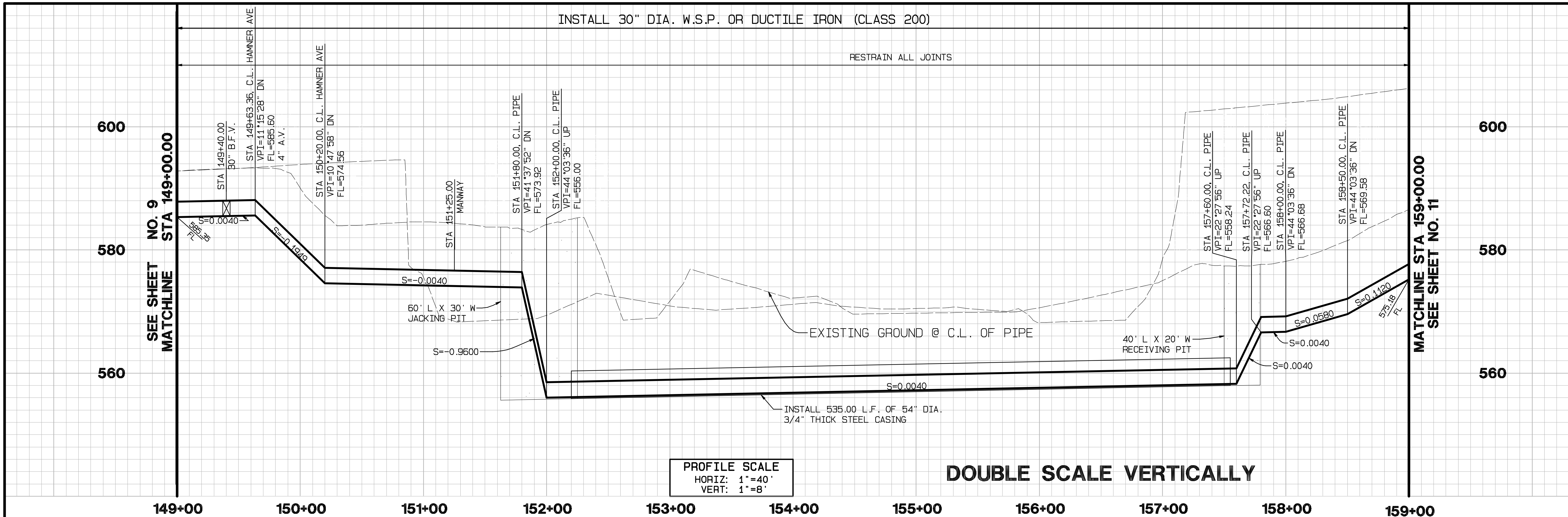
ARLINGTON DESALTER PRODUCT WATER PIPELINE

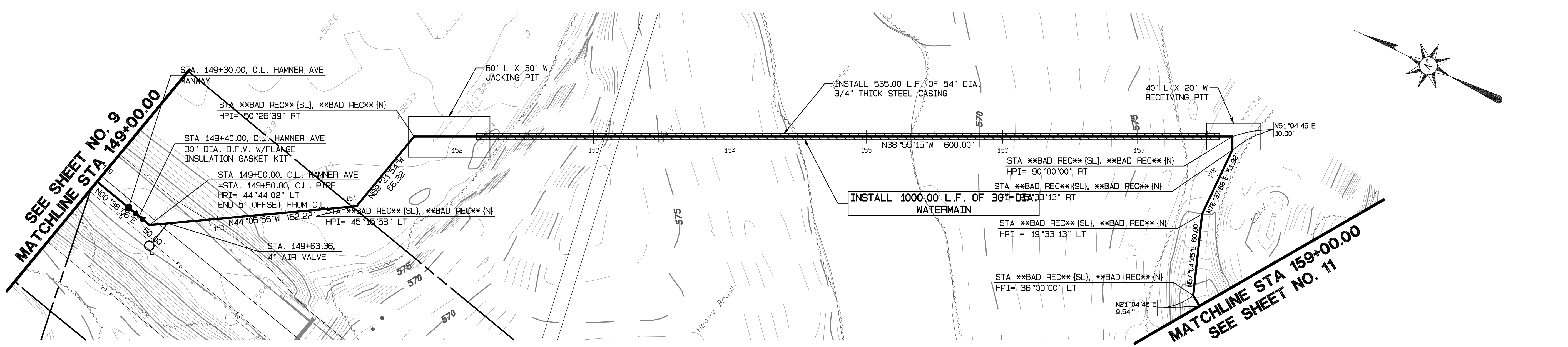
PLAN & PROFILE OF WATER IMPROVEMENTS ON HAMNER AVENUE FROM STA 139+00 TO STA 149+00

DRAWING NO. 02-0031

SHEET: 9 OF 73 SHEETS

FILE NO





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DEPARTMENT OF PUBLIC WORKS

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ARLINGTON DESALTER PRODUCT WATER PIPELINE
PLAN & PROFILE OF WATER IMPROVEMENTS ON HAMNER AVENUE FROM STA 149+00.00 TO STA 159+00.00

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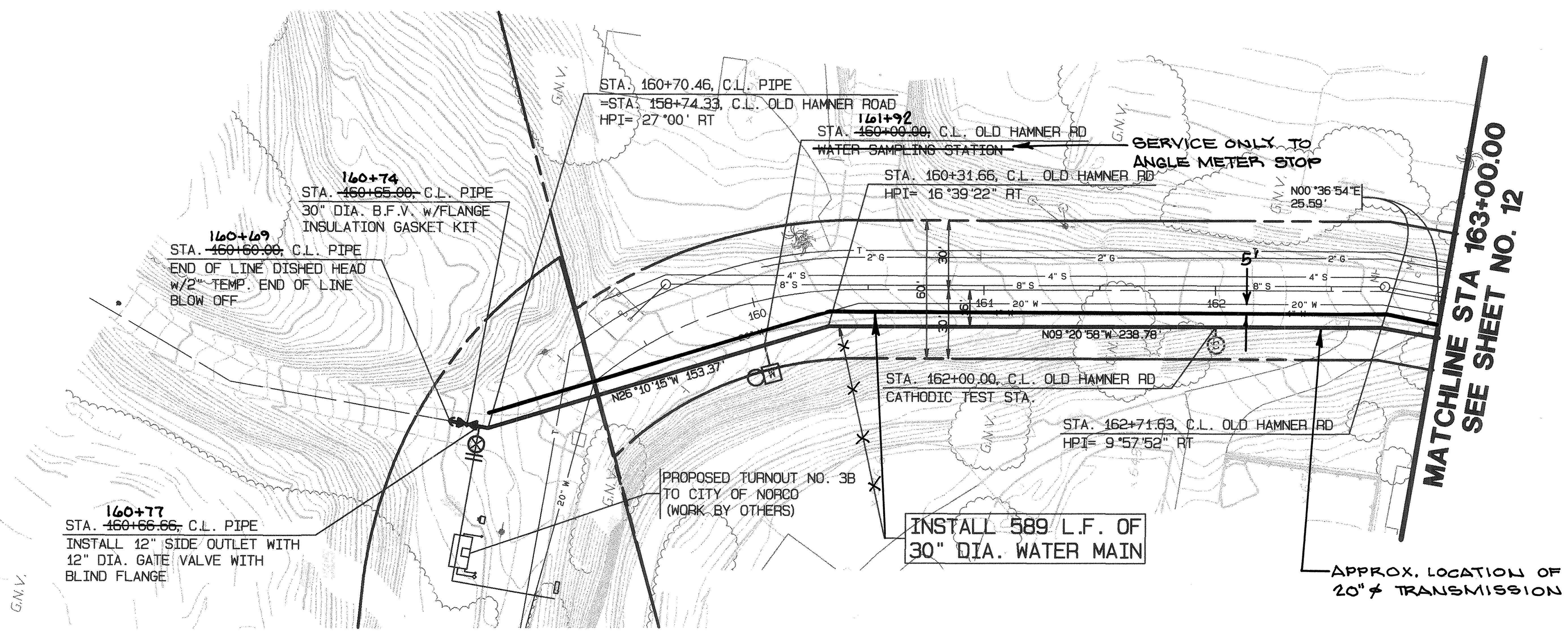
SHEET 10 OF 73 SHEETS

STATIONING REVISED PER CUT SHEET INFO PROVIDED AND IS FOLLOWING C.L. PIPE NOT C.L. OLD HAMNER.



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APPROVED: Joseph S. Schenk, CITY ENGINEER — DATE 9/16/02

OLD HAMNER ROAD

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CHECKED BY: W.T.M.
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Santa Ana Watershed Project Authority, 11615 STERLING AVENUE, RIVERSIDE, CA 92503, 909-785-5411 — SAWPA

ARLINGTON DESALTER PRODUCT WATER PIPELINE

PLAN & PROFILE OF WATER IMPROVEMENTS ON OLD HAMNER ROAD FROM STA 159+00 TO STA 163+00

DRAWING NO. 02-0031 — SHEET: 11 OF 73 SHEETS

OLD HAMNER ROAD

GRAPHIC SCALE 1"=40'

40 20 0 40 80 120

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DEPARTMENT OF PUBLIC WORKS

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CITY ENGINEER DATE

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William T. Malone C47569 12/31/03
PROJECT ENGINEER RE NO. DATE

ALBERT A. WEBB ASSOCIATES — ENGINEERING CONSULTANTS
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Santa Ana Watershed Project Authority
11615 STERLING AVENUE
RIVERSIDE, CA 92503
909-785-5411
SAWPA

ARLINGTON DESALTER PRODUCT WATER PIPELINE

PLAN & PROFILE OF WATER IMPROVEMENTS ON OLD HAMNER ROAD FROM STA 163+00 TO STA 169+85.01

DRAWING NO. 02-0031

SHEET 12 OF 73 SHEETS

UNDERGROUND SERVICE ALERT
CALL: TOLL FREE 1-800 227-2600
TWO WORKING DAYS BEFORE YOU DIG

CITY OF NORCO
DEPARTMENT OF PUBLIC WORKS

APPROVED: CITY ENGINEER DATE

DETROIT STREET

CALTRANS PERMIT NO. 08-02-6MC-0931

REV	DATE	DESCRIPTION	APP
2	12/03	"RECORD DRAWING"	
1	11/02	DELETE WSS AT STA 180+25.00	WTM

DESIGN BY: M.A.E.
DRAWN BY: M.A.E.
CHECKED BY: W.T.M.
DATE: 11/12/02

William T. Maler C47569 12/31/03
PROJECT ENGINEER RE NO. DATE

ALBERT A. WEBB ASSOCIATES — CIVIL ENGINEERS, 3788 McCRAY ST., RIVERSIDE, CA. 92506, PH: (909) 686-1070, FX: (909) 788-1256 — ENGINEERING CONSULTANTS

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ARLINGTON DESALTER PRODUCT WATER PIPELINE

PLAN & PROFILE OF WATER IMPROVEMENTS ON DETROIT STREET FROM STA 174+84.01 TO STA 181+90.70

DRAWING NO. 02-0031
SHEET: 13A OF 73 SHEETS

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CITY OF NORCO
DEPARTMENT OF PUBLIC WORKS

APPROVED: ______ CITY ENGINEER ______ DATE

DETROIT STREET

SEE SHEET 13A

CALTRANS PERMIT NO. 08-02-6MC

REV	DATE	DESCRIPTION	APP
2	12-03	"RECORD DRAWING"	
1	11/02	DELETE WSS AT STA 180+25.00	WTM

DESIGN BY: M.A.E.
DRAWN BY: M.A.E.
CHECKED BY: W.T.M.
DATE: 11/12/02

PROJECT ENGINEER: William T. Malone C47569 — 12/31/03

ALBERT A. WEBB ASSOCIATES — CIVIL ENGINEERS, 3788 McCRAY ST., RIVERSIDE, CA. 92506, PH (909) 686-1070, FX (909) 788-1256

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ARLINGTON DESALTER PRODUCT WATER PIPELINE
PLAN & PROFILE OF WATER IMPROVEMENTS ON DETROIT STREET FROM STA 174+84.01 TO STA 181+90.70

DRAWING NO. 02-0031
SHEET: 13B OF 73 SHEETS

APPENDIX F.5

CHINO II 1010 ZONE
PRODUCT WATER PUMP STATION
HYDRAULIC GRADE LINE
CALCULATIONS

PROJECT : Chino Phase 3 PDR
Chino II 1010 Zone Pump Station HGL

JOB # : 7651C.00 **REVISION:**

CHECKED : **DATE :**

BY : M. Marshall **DATE :** 7/30//2009

				Equation Ref.	HGL	EGL
DOWNSTREAM CONTROL						
Ontario 1010 Zone Reservoir WSE =	980.00		*Max WSE = 1010; Min WSE = 980*		980.00	980.00
Chino II Clearwell WSE =	801.00		*Max WSE = 801; Min WSE = 775.5*			
Static Lift =	179.0 ft					
Headloss (Pump Discharge Side) =	46.6 ft					
Headloss (Pump Suction Side) =	4.4 ft					
Headloss (Suction + Discharge) =	50.9 ft					
Pump TDH =	229.9 ft		*Sum of static lift and dynamic headloss*			
Norco Flow =	0.96	mgd =	1.49 cfs			
WMWD Flow =	3.50	mgd =	5.41 cfs			
Delivery to Norco =	4.46	mgd =	6.90 cfs			
Ontario Flow =	6.87	mgd =	10.63 cfs			
Total 1010 Zone PS Flow =	11.33	mgd =	17.53 cfs			
Total 1110 Zone PS Flow =	5.70	mgd =	8.82 cfs			
Total 870 Zone PS Flow =	3.50	mgd =	5.41 cfs			
Total Chino II Product Water Flow =	20.53	mgd =	31.76 cfs			
Riverside to Schliesman (Pipe Dia.) =	18	inches				
	3.9	fps				
Chino II to Hamner (Pipe Dia.) =	30	inches				
	3.6	fps				
Riverside/Hamner (Ontario Side) =	999					
Riverside/Hamner (CDA Side) =	1002					
Required EGL for Norco Turnout =	900					
Norco Turnout (CDA side) =	925		**CDA Pressure OK**			

PROJECT : Chino Phase 3 PDR
Chino II 1010 Zone Pump Station HGL

JOB # : 7651C.00 **REVISION:**

CHECKED : **DATE :**

BY : M. Marshall **DATE :** 7/30//2009

Equation Ref.	HGL	EGL

TABLE FOR CHART

Flow Adjustment Factor = 1.00 *MUST BE EQUAL TO 1. Used only in preparing Table for Chart.*

Flow (mgd)	Total HLoss (ft)	Norco (mgd)	Total (mgd)	EGL @ Norco Meter	EGL @ Ontario Meter
	51	4.46	11.33	925	1002
0.001	22	0.00	0.01	1002	1002
0.10	22	0.45	0.73	1001	1002
0.20	23	0.89	1.55	999	1002
0.30	23	1.34	2.46	995	1002
0.40	25	1.78	3.46	989	1002
0.50	27	2.23	4.55	982	1002
0.60	29	2.68	5.73	974	1002
0.70	33	3.12	6.99	964	1002
0.80	38	3.57	8.35	952	1002
0.90	44	4.01	9.80	939	1002
1.00	51	4.46	11.33	925	1002
1.10	60	4.91	12.95	909	1002
1.20	71	5.35	14.67	891	1002

PROJECT : Chino Phase 3 PDR
Chino II 1010 Zone Pump Station HGL

JOB # : 7651C.00 **REVISION:**

CHECKED : **DATE :**

BY : M. Marshall
DATE : 7/30//2009

	Equation Ref.	HGL	EGL
PIPELINE FROM RIVERSIDE/HAMNER TO ONTARIO 1010 ZONE RESERVOIR			
Downstream Condition (WSE in Ontario 1010 Zone Reservoir)		980.00	980.00

PIPELINE WITHIN ONTARIO 1010 ZONE

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow	8.3 mgd =	12.8 cfs =	5,760 gpm *Max Ontario 1010 Zone demand flow (Webb, June 2008, pg 5-7)*
Pipe Diameter, D	24 inch		
Pipe Length, L	6645 ft		
Absolute Roughness, ε	0.00200 ft		
Pipe velocity, v	4.09 fps		
Kinematic Viscosity	1.000E-05 ft^2/sec		
Reynold's Number, R	817398		
Friction factor, f	0.0200		
Friction Energy Loss, h_L	17.24 ft		

MINOR PIPE LOSS HEADING

Flow, Q 6.9 mgd = 10.6 cfs *Ontario 1010 zone flow thru CDA meter station*

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Outlet Loss - Still Water	6.87	10.63	1.00	24	----	3.38	----	0.18	0.18
4	Mitre Bend - 90 º Deflection	6.87	10.63	1.27	24	----	3.38	----	0.18	0.90
7	Butterfly Valve (Open)	6.87	10.63	0.50	24	----	3.38	----	0.18	0.62
									Sum =	1.70

Total Energy Loss = 18.94 ft

	HGL	EGL
Condition at Riverside/Hamner (Ontario Side of turnout)	998.94	998.94

PROJECT : Chino Phase 3 PDR
Chino II 1010 Zone Pump Station HGL

JOB # : 7651C.00 **REVISION:**

CHECKED : **DATE :**

BY : M. Marshall
DATE : 7/30//2009

	Equation Ref.	HGL	EGL
ONTARIO METER STATION AT RIVERSIDE/HAMNER			
[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)]	**{ 4 }**		

Flow	6.9	mgd =	10.6	cfs
Pipe Diameter, D	24	inch		
Pipe Length, L	50	ft		
Absolute Roughness, ε	0.00250	ft		
Pipe velocity, v	3.38	fps		
Kinematic Viscosity	1.000E-05	ft^2/sec		
Reynold's Number, R	676592			
Friction factor, f	0.0211			
Friction Energy Loss, h_L	0.09	ft		

MINOR PIPE LOSS HEADING

Flow, Q 6.9 mgd = 10.6 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Butterfly Valve (Open)	6.87	10.63	0.50	24	----	3.38	----	0.18	0.09
1	Increaser	6.87	10.63	0.25	14	24	9.94	3.38	1.36	0.34
1	Meter	6.87	10.63	1	14	----	9.94	----	1.53	1.53
1	Reducer	6.87	10.63	0.25	24	14	3.38	9.94	1.53	0.38
1	Butterfly Valve (Open)	6.87	10.63	0.50	24	----	3.38	----	0.18	0.09
1	Mitre Bend - 90 º Deflection	6.87	10.63	1.27	24	----	3.38	----	0.18	0.22
1	Tee - Thru Side Outlet	6.87	10.63	1.80	24	----	3.38	----	0.18	0.32
									Sum =	2.98

Total Energy Loss = 3.07 ft

	HGL	EGL
Condition at Ontario Turnout (CDA side of turnout)	1001.84	1002.02

PROJECT : Chino Phase 3 PDR
Chino II 1010 Zone Pump Station HGL

JOB # : 7651C.00 **REVISION:**

CHECKED : **BY :** M. Marshall
DATE : **DATE :** 7/30//2009

Equation Ref.	HGL	EGL

PIPELINE FROM RIVERSIDE/HAMNER TO CHINO II

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow	11.3	mgd =	17.5 cfs
Pipe Diameter, D	30	inch	
Pipe Length, L	11610	ft	
Absolute Roughness, ε	0.00250	ft	C=120
Pipe velocity, v	3.57	fps	
Kinematic Viscosity	1.000E-05	ft^2/sec	
Reynold's Number, R	892669		
Friction factor, f	0.0200		
Friction Energy Loss, h_L	18.37	ft	

MINOR PIPE LOSS HEADING

Flow, Q 11.3 mgd = 17.5 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
6	Mitre Bend - 90 º Deflection	11.33	17.53	1.27	30	----	3.57	----	0.20	1.50
4	Mitre Bend - 45 º Deflection	11.33	17.53	0.32	30	----	3.57	----	0.20	0.25
1	Tee - Thru Straight Run	11.33	17.53	0.60	30	----	3.57	----	0.20	0.12
9	Butterfly Valve (Open)	11.33	17.53	0.50	30	----	3.57	----	0.20	0.89
									Sum =	2.77

Total Energy Loss = 21.13 ft

	HGL	EGL
Condition at Chino II Zone 1010 Pump Station Discharge Header	1022.95	1023.15

PROJECT : Chino Phase 3 PDR
Chino II 1010 Zone Pump Station HGL

JOB # : 7651C.00 **REVISION:**

CHECKED : **DATE :**

BY : M. Marshall **DATE :** 7/30//2009

	Equation Ref.	HGL	EGL

CHINO II 1010 ZONE PUMP STATION DISCHARGE

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Total Pumped Flow	11.3	mgd =	17.5	cfs
No. of Pumps In-service	2.0			
Flow	5.7	mgd =	8.8	cfs
Pipe Diameter, D	16	inch		
Pipe Length, L	20	ft		
Absolute Roughness, ε	0.00100	ft		
Pipe velocity, v	6.28	fps		
Kinematic Viscosity	1.000E-05	ft^2/sec		
Reynold's Number, R	836877			
Friction factor, f	0.0188			
Friction Energy Loss, h_L	0.17	ft		

MINOR PIPE LOSS HEADING

Flow, Q 5.7 mgd = 8.8 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Tee - Thru Side Outlet	5.67	8.76	1.80	16	----	6.28	----	0.61	1.10
1	90 º Elbow - Regular Fl.	5.67	8.76	0.30	16	----	6.28	----	0.61	0.18
1	Butterfly Valve (Open)	5.67	8.76	0.50	16	----	6.28	----	0.61	0.31
1	Check Valve	5.67	8.76	2.50	16	----	6.28	----	0.61	1.53
1	Increaser	5.67	8.76	0.25	14	16	8.20	6.28	0.43	0.11
									Sum =	3.23

Total Energy Loss = 3.40 ft

Condition at Pump Discharge Flange 1023.51 1026.55

PROJECT : Chino Phase 3 PDR
Chino II 1010 Zone Pump Station HGL

JOB # : 7651C.00 **REVISION:** **CHECKED :** **DATE :** **BY :** M. Marshall **DATE :** 7/30//2009

Equation Ref.	HGL	EGL

PUMP SUCTION PIPE FROM CAN TO HEADER

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow	5.7	mgd =	8.8 cfs
Pipe Diameter, D	18	inch	
Pipe Length, L	20	ft	
Absolute Roughness, ε	0.00100	ft	
Pipe velocity, v	4.96	fps	*6 fps max. velocity per HI 9.8, Fig. 9.8.11*
Kinematic Viscosity	1.000E-05	ft^2/sec	
Reynold's Number, R	743891		
Friction factor, f	0.0184		
Friction Energy Loss, h_L	0.09	ft	

MINOR PIPE LOSS HEADING

Flow, Q 5.7 mgd = 8.8 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Outlet Loss - Still Water	5.67	8.76	1.00	18	----	4.96	----	0.38	0.38
1	Butterfly Valve (Open)	5.67	8.76	0.50	18	----	4.96	----	0.38	0.19
1	Tee - Thru Side Outlet	5.67	8.76	1.80	18	----	4.96	----	0.38	0.69
									Sum =	1.26

Total Energy Loss = 1.35 ft

Condition at Pump Suction Header	HGL 797.58	EGL 797.97

PROJECT : Chino Phase 3 PDR
Chino II 1010 Zone Pump Station HGL

CHECKED :   **BY :** M. Marshall
JOB # : 7651C.00   **REVISION:**   **DATE :**   **DATE :** 7/30//2009

	Equation Ref.	HGL	EGL

PIPELINE FROM PUMP SUCTION HEADER TO TEE WITH EXISTING CLEARWELL OUTLET PIPE

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow	11.3	mgd =	17.5 cfs
Pipe Diameter, D	30	inch	
Pipe Length, L	150	ft	
Absolute Roughness, ε	0.00250	ft	
Pipe velocity, v	3.57	fps	
Kinematic Viscosity	1.000E-05	ft^2/sec	
Reynold's Number, R	892669		
Friction factor, f	0.0200		
Friction Energy Loss, h_L	0.24	ft	

MINOR PIPE LOSS HEADING

Flow, Q 11.3 mgd = 17.5 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Mitre Bend - 90 º Deflection	11.33	17.53	1.27	30	----	3.57	----	0.20	0.25
2	Mitre Bend - 45 º Deflection	11.33	17.53	0.32	30	----	3.57	----	0.20	0.13
1	Tee - Thru Side Outlet	11.33	17.53	1.80	30	----	3.57	----	0.20	0.36
									Sum =	0.73

Total Energy Loss = 0.97 ft

	HGL	EGL
Condition at Connection to Existing 30" Pipe	798.74	798.94

	Equation Ref.	HGL	EGL

EXISTING CLEARWELL OUTLET PIPE (36")

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow	20.5	mgd =	31.8	cfs
Pipe Diameter, D	36	inch		
Pipe Length, L	20	ft		
Absolute Roughness, ε	0.00250	ft		
Pipe velocity, v	4.49	fps		
Kinematic Viscosity	1.000E-05	ft^2/sec		
Reynold's Number, R	1347932			
Friction factor, f	0.0191			
Friction Energy Loss, h_L	0.04	ft		

MINOR PIPE LOSS HEADING

Flow, Q 20.5 mgd = 31.8 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Tee - Thru Straight Run	20.53	31.76	0.60	36	----	4.49	----	0.31	0.19
1	Increaser	20.53	31.76	0.25	30	36	6.47	4.49	0.34	0.08
									Sum =	0.27

Total Energy Loss = 0.31 ft

	HGL	EGL
Upstream Condition	798.94	799.25

	Equation Ref.	HGL	EGL

EXISTING CLEARWELL OUTLET PIPE (30")

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow	20.5 mgd =	31.8 cfs
Pipe Diameter, D	30 inch	
Pipe Length, L	25 ft	
Absolute Roughness, ε	0.00250 ft	
Pipe velocity, v	6.47 fps	
Kinematic Viscosity	1.000E-05 ft^2/sec	
Reynold's Number, R	1617519	
Friction factor, f	0.0198	
Friction Energy Loss, h_L	0.13 ft	

MINOR PIPE LOSS HEADING

Flow, Q 20.5 mgd = 31.8 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Mitre Bend - 90 º Deflection	20.53	31.76	1.27	30	----	6.47	----	0.65	0.82
1	90 º Elbow - Long Rad. Fl.	20.53	31.76	0.23	30	----	6.47	----	0.65	0.15
1	Butterfly Valve (Open)	20.53	31.76	0.50	30	----	6.47	----	0.65	0.33
1	Entrance Loss - Flush	20.53	31.76	0.50	----	30	----	6.47	0.65	0.33
									Sum =	1.62

Total Energy Loss = 1.75 ft

	HGL	EGL
Upstream Condition (WSE in Chino II Clearwell)	801.00	801.00

PROJECT : Chino Phase 3 PDR
Chino II 1010 Zone Pump Station HGL

JOB # : 7651C.00 **REVISION:**

CHECKED : **DATE :**

BY : M. Marshall **DATE :** 7/30//2009

	Equation Ref.	HGL	EGL
PIPELINE FROM CHINO II TO ARLINGTON 30" (NORCO)			
Condition at Riverside/Hamner Ontario Turnout (CDA side of meter)		1002.02	1002.02

PIPELINE FROM SCHLEISMAN/HAMNER TO RIVERSIDE/HAMNER

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] **{ 4 }**

Flow 4.5 mgd = 6.9 cfs

Pipe Diameter, D 18 inch
Pipe Length, L 21,074 ft
Absolute Roughness, ε 0.00200 ft C=120
Pipe velocity, v 3.90 fps
Kinematic Viscosity 1.000E-05 ft^2/sec
Reynold's Number, R 585658
Friction factor, f 0.0215

Friction Energy Loss, h_L 71.53 ft

MINOR PIPE LOSS HEADING

Flow, Q 4.5 mgd = 6.9 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
6	Mitre Bend - 90 º Deflection	4.46	6.90	1.27	18	----	3.90	----	0.24	1.80
16	Butterfly Valve (Open)	4.46	6.90	0.50	18	----	3.90	----	0.24	1.89
									Sum =	3.69

Total Energy Loss = 75.22 ft

	HGL	EGL
Condition at Norco Turnout (CDA side of turnout)	926.56	926.80

Hydraulix by Carollo Engineers

PROJECT : Chino Phase 3 PDR
Chino II 1010 Zone Pump Station HGL

JOB # : 7651C.00 **REVISION:**

CHECKED : **DATE :**

BY : M. Marshall **DATE :** 7/30//2009

Equation Ref.	HGL	EGL

PIPELINE FROM SCHLIESMAN/HAMNER TO DETROIT STREET

[PIPE FRICTION LOSSES (DARCY-WEISBACH / COLEBROOK)] { 4 }

Flow	4.5	mgd =	6.9 cfs
Pipe Diameter, D	30	inch	
Pipe Length, L	7306	ft	
Absolute Roughness, ε	0.00250	ft	
Pipe velocity, v	1.41	fps	
Kinematic Viscosity	1.000E-05	ft^2/sec	
Reynold's Number, R	351395		
Friction factor, f	0.0205		
Friction Energy Loss, h_L	1.84	ft	

MINOR PIPE LOSS HEADING

Flow, Q 4.5 mgd = 6.9 cfs

No.	Description	Flow (mgd)	Flow (cfs)	K	Dia Up (in)	Dia Down (in)	Vel Up (fps)	Vel Down (fps)	Vel Head (ft)	Minor Loss (ft)
1	Increaser	4.46	6.90	0.25	18	30	3.90	1.41	0.21	0.05
5	Mitre Bend - 22.5 º Deflection	4.46	6.90	0.15	30	----	1.41	----	0.03	0.02
5	Mitre Bend - 45 º Deflection	4.46	6.90	0.32	30	----	1.41	----	0.03	0.05
2	Mitre Bend - 90 º Deflection	4.46	6.90	1.27	30	----	1.41	----	0.03	0.08
6	Butterfly Valve (Open)	4.46	6.90	0.50	30	----	1.41	----	0.03	0.09
									Sum =	0.29

Total Energy Loss = 2.13 ft

	HGL	EGL
Condition at West Side of I-15 Bridge	924.64	924.67

APPENDIX F.6

[NOT USED]

MILLIKEN PUMP STATION
MWH TECHNICAL MEMORANDUM

TECHNICAL MEMORANDUM

To:	Ray Hahn, City of Ontario	**Date:**	December 22, 2006
From:	Ganesh Krishnamurthy and Parag Kalaria	**Reference:**	1342454/6.2
Subject:	**DRAFT** - Hydraulic Analysis of the 1010' Zone Pump Station		

INTRODUCTION

The Chino Desalter II (CDA-II) was constructed by the Chino Desalter Authority (CDA) to provide 10,400 acre-ft/yr of water deliveries to Jurupa Community Services District (JCSD), the City of Ontario (City), the City of Norco and the Santa Ana River Water Company. Currently, the City receives 3,500 acre-ft/yr of water from the CDA-II facility. This plant delivers water to the City through the JCSD system at two connections, one near the intersection of Philadelphia Street and Milliken Avenue and one near the intersection of Galena Street and Milliken Avenue.

The City plans to increase its water supply intake from the CDA by 4 mgd. This technical memorandum (TM) presents the findings of the hydraulic analysis performed for the City's water distribution system with the addition of a pump station in the 1010 Zone to transfer water from the CDA to the 1212 Zone. The design and construction of the pump station is scheduled to commence in the near future. The City requested MWH to evaluate the impact of the proposed pump station on the distribution system hydraulics using the City's calibrated hydraulic model. The methodology, evaluation results, and conclusions are presented herein.

ASSUMPTIONS AND EVALUATION METHODOLOGY

The system evaluation criteria is consistent with those used for the City's Water Master Plan (WMP). System pressures at all demand nodes in the 1010 Zone should be above 40 pounds per square inch (psi) or greater when the proposed 1010 Zone pump station is operational. System pressures at all demand nodes in the 1212 Zone should not exceed 125 psi when the proposed pump station is operational. Pipeline velocities should not exceed 6 feet per second (fps) when the proposed pump station is operational.

Modifications to System Operations and Controls

Certain modifications are made to the system operations to account for the proposed pump station in the 1010 Zone. These modifications are intended to ensure that a demand-supply balance is maintained during the hydraulic evaluation of the proposed pump station. These modifications are described below:

Reduction in Water Facilities Authority Joint Powers Agency (WFA-JPA) Supply
In order to maintain a supply-demand balance in the 1212 Zone and to offset the additional supply of up to 3,500 gpm from the proposed pump station, the supply from WFA is reduced by a comparable amount when the pump is operational under full flow conditions.

Changes in System Controls
In order to prevent cyclical transfer of water between the 1212 Zone and the 1010 Zone, the altitude valve transferring water from the 1212 Zone to the1010 Zone is closed when the pump station is operational. The operational status of the various facilities in the 1010 Zone and the 1212 Zone during the course of the hydraulic evaluation is listed in the **Appendix**.

Location of the Pump Station

The proposed pump station located at the Reservoir 1010-2 site. The location of the proposed pump station and the vicinity area are depicted in **Figure 1**. The pump station is modeled as a combination of two identical pumps, each having a pumping capacity of 2 mgd. For preliminary sizing of the pumps, a total dynamic head of 232 feet is assumed. In order to be conservative for planning purposes, 30 feet of dynamic head losses are assumed between the two zones while the pump station is operational. The 30-inch diameter pipeline, located to the west of the reservoir site, serves as the discharge pipeline to this pump station.

Evaluation Scenarios

Hydraulic evaluations are performed for the following scenarios to evaluate the range of hydraulic conditions experienced by the new pump station:

1. Year 2010 Minimum Demand Conditions (MinDD)
2. Year 2010 Maximum Demand conditions (MaxDD)
3. Year 2030 MinDD conditions
4. Year 2030 MaxDD condition

In addition, for each scenario, hydraulic evaluations are performed for low water level (LWL) and high water level (HWL) conditions. HWL refers to the maximum static condition while LWL refers to the minimum static condition. Under LWL conditions, the initial water level in all 1010 Zone reservoirs is set at 5 feet and the initial water level in all 1212 Zone reservoirs is set at the maximum level. Under HWL conditions, the initial water level in all 1010 Zone reservoirs is set at the maximum level and the initial water level in all 1212 Zone reservoirs is set at 5 feet. The results of the hydraulic evaluation are presented in **Table 1** through **Table 8**. System head curves for the different hydraulic evaluations are presented in **Figure 2** and **Figure 3**.

System pressures at demand nodes in the vicinity of the pump station are verified with the pressure criterion discussed earlier in the TM. Similarly, pipeline velocities are also verified for all scenarios. The 6 fps velocity criterion is marginally exceeded for few pipes in the vicinity of the pump station under 2030 MinDD and 2030 MaxDD conditions. The increased velocity, which occurs only in a few short pipeline segments in the vicinity area, does not negatively impact system pressures. Therefore, no recommendations are made to address this issue.

CONCLUSIONS

As shown in **Figure 2** and **Figure 3**, the system head curves for the various evaluation conditions do not show a considerable increase in system head as the flow through the pump station increases. The flat nature of the system head curve is attributed to the fact that the discharge pipeline from the booster station to the 1212 Zone is a 30-inch diameter pipeline. This pipeline can deliver flows of up to 13,500 gpm without exceeding the system evaluation velocity criterion.

It should be noted that the system head curves presented in this evaluation are sensitive to the operation of various facilities in the City's water distribution system. There is a possibility that when the pump station is operating under full flow conditions (4 mgd), the wells in the 1212 Zone might operate at a different point on their pump curve and deliver lower flows due to the increased discharge head created by the pump station. This effect might be more pronounced in the vicinity of the pump station. As a result, the head loss in the system, which should increase under increased flow conditions, will only increase marginally due to a reduction in the flows from the surrounding 1212 Zone wells.

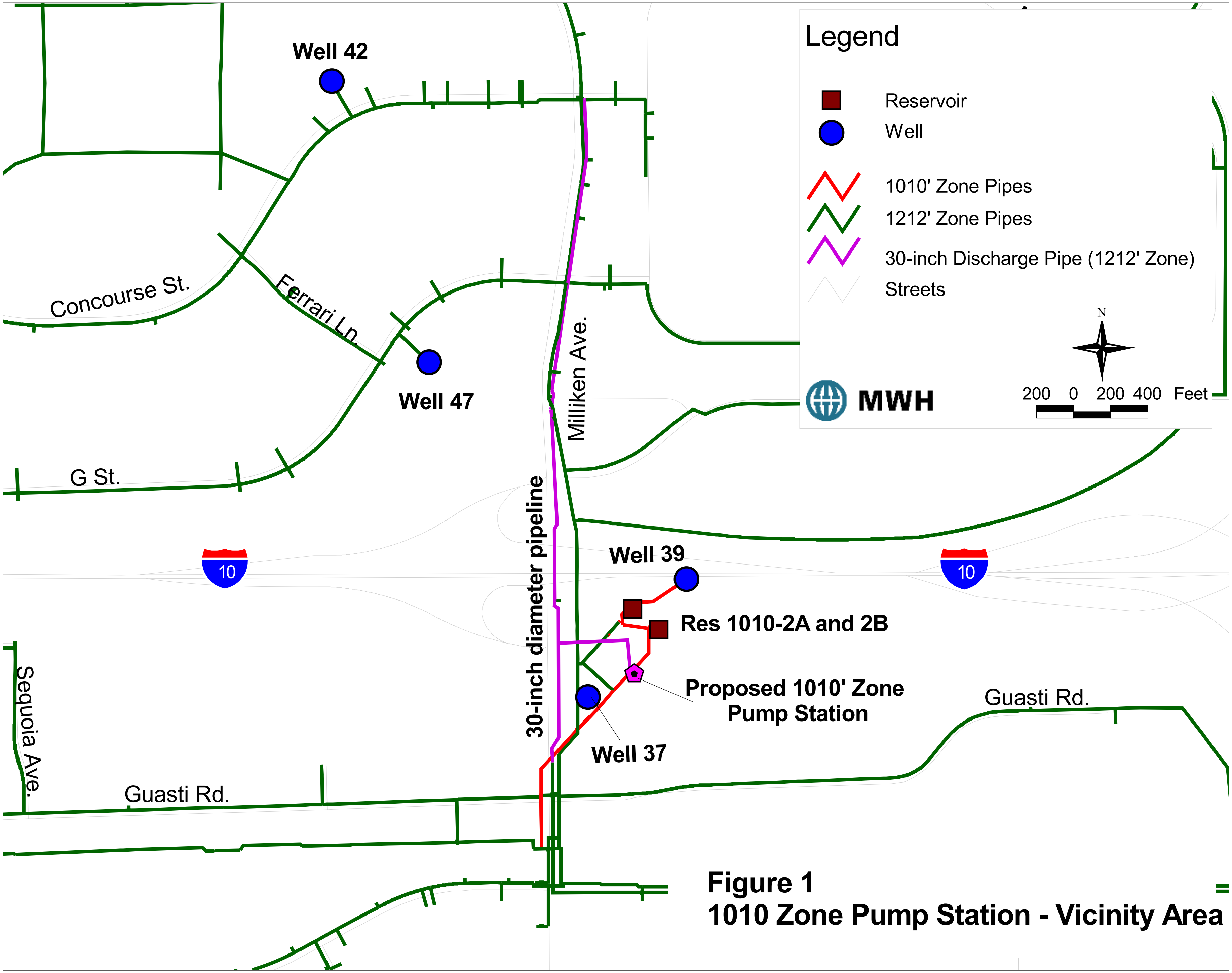

Figure 1
1010 Zone Pump Station - Vicinity Area

RESULTS:

Table 1
2010 MinDD – LWL

Total Design Flow (gpm)	Design Flow (gpm)		Model Output Flow (gpm)		Total Output Flow (gpm)	Total Head (feet)		Flow From WFA (gpm)			Flow From CDA (gpm)	Total (gpm)
	Pump 1	Pump 2	Pump 1	Pump 2	Pump1+2	Pump 1	Pump 2	1212-1	1212-2	1348	1010	
500	250	250	261	261	521	225	225	2,000	2,500	2,000	500	7,000
1,000	500	500	520	520	1,040	226	226	1,500	2,500	2,000	1,000	7,000
1,500	750	750	778	778	1,557	226	226	1,000	2,500	2,000	1,500	7,000
2,000	1,000	1,000	1,036	1,036	2,072	226	226	500	2,500	2,000	2,000	7,000
2,500	1,250	1,250	1,293	1,293	2,587	227	227	500	2,000	2,000	2,500	7,000
3,000	1,500	1,500	1,550	1,550	3,100	227	227	500	1,500	2,000	3,000	7,000
3,500	1,750	1,750	1,806	1,806	3,612	227	227	500	1,000	2,000	3,500	7,000

Table 2
2010 MinDD – HWL

Total Design Flow (gpm)	Design Flow (gpm)		Model Output Flow (gpm)		Total Output Flow (gpm)	Total Head (feet)		Flow From WFA (gpm)			Flow From CDA (gpm)	Total (gpm)
	Pump 1	Pump 2	Pump 1	Pump 2	Pump1+2	Pump 1	Pump 2	1212-1	1212-2	1348	1010	
500	250	250	320	320	640	183	183	2,000	2,500	2,000	500	7,000
1,000	500	500	639	639	1,278	183	183	1,500	2,500	2,000	1,000	7,000
1,500	750	750	958	958	1,915	183	183	1,000	2,500	2,000	1,500	7,000
2,000	1,000	1,000	1,276	1,276	2,551	184	184	500	2,500	2,000	2,000	7,000
2,500	1,250	1,250	1,593	1,593	3,185	184	184	500	2,000	2,000	2,500	7,000
3,000	1,500	1,500	1,909	1,909	3,818	184	184	500	1,500	2,000	3,000	7,000
3,500	1,750	1,750	2,224	2,224	4,447	184	184	500	1,000	2,000	3,500	7,000

Table 3
2010 MaxDD – LWL

Total Design Flow (gpm)	Design Flow (gpm)		Model Output Flow (gpm)		Total Output Flow (gpm)	Total Head (feet)		Flow From WFA (gpm)			Flow From CDA (gpm)	Total (gpm)
	Pump 1	Pump 2	Pump 1	Pump 2	Pump1+2	Pump 1	Pump 2	1212-1	1212-2	1348	1010	
500	250	250	277	277	553	215	215	5,916	6,416	5,111	500	17,943
1,000	500	500	549	549	1,097	216	216	5,416	6,416	5,111	1,000	17,943
1,500	750	750	816	816	1,633	218	218	4,916	6,416	5,111	1,500	17,943
2,000	1,000	1,000	1,080	1,080	2,161	219	219	4,416	6,416	5,111	2,000	17,943
2,500	1,250	1,250	1,341	1,341	2,682	220	220	3,916	6,416	5,111	2,500	17,943
3,000	1,500	1,500	1,598	1,598	3,197	222	222	3,416	6,416	5,111	3,000	17,943
3,500	1,750	1,750	1,853	1,853	3,706	223	223	2,916	6,416	5,111	3,500	17,943

Table 4
2010 MaxDD – HWL

Total Design Flow (gpm)	Design Flow (gpm)		Model Output Flow (gpm)		Total Output Flow (gpm)	Total Head (feet)		Flow From WFA (gpm)			Flow From CDA (gpm)	Total (gpm)
	Pump 1	Pump 2	Pump 1	Pump 2	Pump1+2	Pump 1	Pump 2	1212-1	1212-2	1348	1010	
500	250	250	319	319	638	183	183	5,916	6,416	5,111	500	17,943
1,000	500	500	637	637	1,273	184	184	5,416	6,416	5,111	1,000	17,943
1,500	750	750	952	952	1,905	185	185	4,916	6,416	5,111	1,500	17,943
2,000	1,000	1,000	1,266	1,266	2,532	185	185	4,416	6,416	5,111	2,000	17,943
2,500	1,250	1,250	1,578	1,578	3,157	186	186	3,916	6,416	5,111	2,500	17,943
3,000	1,500	1,500	1,888	1,888	3,776	187	187	3,416	6,416	5,111	3,000	17,943
3,500	1,750	1,750	2,195	2,195	4,390	188	188	2,916	6,416	5,111	3,500	17,943

Table 5
2030 MinDD – LWL

Total Design Flow (gpm)	Design Flow (gpm)		Model Output Flow (gpm)		Total Output Flow (gpm)	Total Head (feet)		Flow From WFA (gpm)			Flow From CDA (gpm)	Total (gpm)
	Pump 1	Pump 2	Pump 1	Pump 2	Pump1+2	Pump 1	Pump 2	1212-1	1212-2	1348	1010	
500	250	250	259	259	518	226	226	2,000	2,000	1,800	500	6,300
1,000	500	500	517	517	1,034	227	227	1,500	2,000	1,800	1,000	6,300
1,500	750	750	775	775	1,549	227	227	1,000	2,000	1,800	1,500	6,300
2,000	1,000	1,000	1,031	1,031	2,062	227	227	500	2,000	1,800	2,000	6,300
2,500	1,250	1,250	1,286	1,286	2,571	228	228	500	1,500	1,800	2,500	6,300
3,000	1,500	1,500	1,539	1,539	3,077	228	228	500	1,000	1,800	3,000	6,300
3,500	1,750	1,750	1,789	1,789	3,577	229	229	500	500	1,800	3,500	6,300

Table 6
2030 MinDD – HWL

Total Design Flow (gpm)	Design Flow (gpm)		Model Output Flow (gpm)		Total Output Flow (gpm)	Total Head (feet)		Flow From WFA (gpm)			Flow From CDA (gpm)	Total (gpm)
	Pump 1	Pump 2	Pump 1	Pump 2	Pump1+2	Pump 1	Pump 2	1212-1	1212-2	1348	1010	
500	250	250	305	305	610	194	194	2,000	2,000	1,800	500	6,300
1,000	500	500	608	608	1,215	195	195	1,500	2,000	1,800	1,000	6,300
1,500	750	750	907	907	1,814	196	196	1,000	2,000	1,800	1,500	6,300
2,000	1,000	1,000	1,204	1,204	2,408	197	197	500	2,000	1,800	2,000	6,300
2,500	1,250	1,250	1,498	1,498	2,996	198	198	500	1,500	1,800	2,500	6,300
3,000	1,500	1,500	1,788	1,788	3,577	199	199	500	1,000	1,800	3,000	6,300
3,500	1,750	1,750	2,076	2,076	4,151	201	201	500	500	1,800	3,500	6,300

Table 7
2030 MaxDD – LWL

Total Design Flow (gpm)	Design Flow (gpm)		Model Output Flow (gpm)		Total Output Flow (gpm)	Total Head (feet)		Flow From WFA (gpm)			Flow From CDA (gpm)	Total (gpm)
	Pump 1	Pump 2	Pump 1	Pump 2	Pump1+2	Pump 1	Pump 2	1212-1	1212-2	1348	1010	
500	250	250	310	310	620	191	191	10,611	6,416	5,111	500	22,638
1,000	500	500	615	615	1,229	192	192	10,111	6,416	5,111	1,000	22,638
1,500	750	750	915	915	1,830	194	194	9,611	6,416	5,111	1,500	22,638
2,000	1,000	1,000	1,210	1,210	2,421	196	196	9,111	6,416	5,111	2,000	22,638
2,500	1,250	1,250	1,502	1,502	3,003	198	198	8,611	6,416	5,111	2,500	22,638
3,000	1,500	1,500	1,789	1,789	3,577	199	199	8,111	6,416	5,111	3,000	22,638
3,500	1,750	1,750	2,071	2,071	4,143	201	201	7,611	6,416	5,111	3,500	22,638

Table 8
2030 MaxDD – HWL

Total Design Flow (gpm)	Design Flow (gpm)		Model Output Flow (gpm)		Total Output Flow (gpm)	Total Head (feet)		Flow From WFA (gpm)			Flow From CDA (gpm)	Total (gpm)
	Pump 1	Pump 2	Pump 1	Pump 2	Pump1+2	Pump 1	Pump 2	1212-1	1212-2	1348	1010	
500	250	250	328	328	656	176	176	10,611	6,416	5,111	500	22,638
1,000	500	500	653	653	1,306	178	178	10,111	6,416	5,111	1,000	22,638
1,500	750	750	975	975	1,950	179	179	9,611	6,416	5,111	1,500	22,638
2,000	1,000	1,000	1,294	1,294	2,588	180	180	9,111	6,416	5,111	2,000	22,638
2,500	1,250	1,250	1,611	1,611	3,223	181	181	8,611	6,416	5,111	2,500	22,638
3,000	1,500	1,500	1,927	1,927	3,854	182	182	8,111	6,416	5,111	3,000	22,638
3,500	1,750	1,750	2,241	2,241	4,481	183	183	7,611	6,416	5,111	3,500	22,638

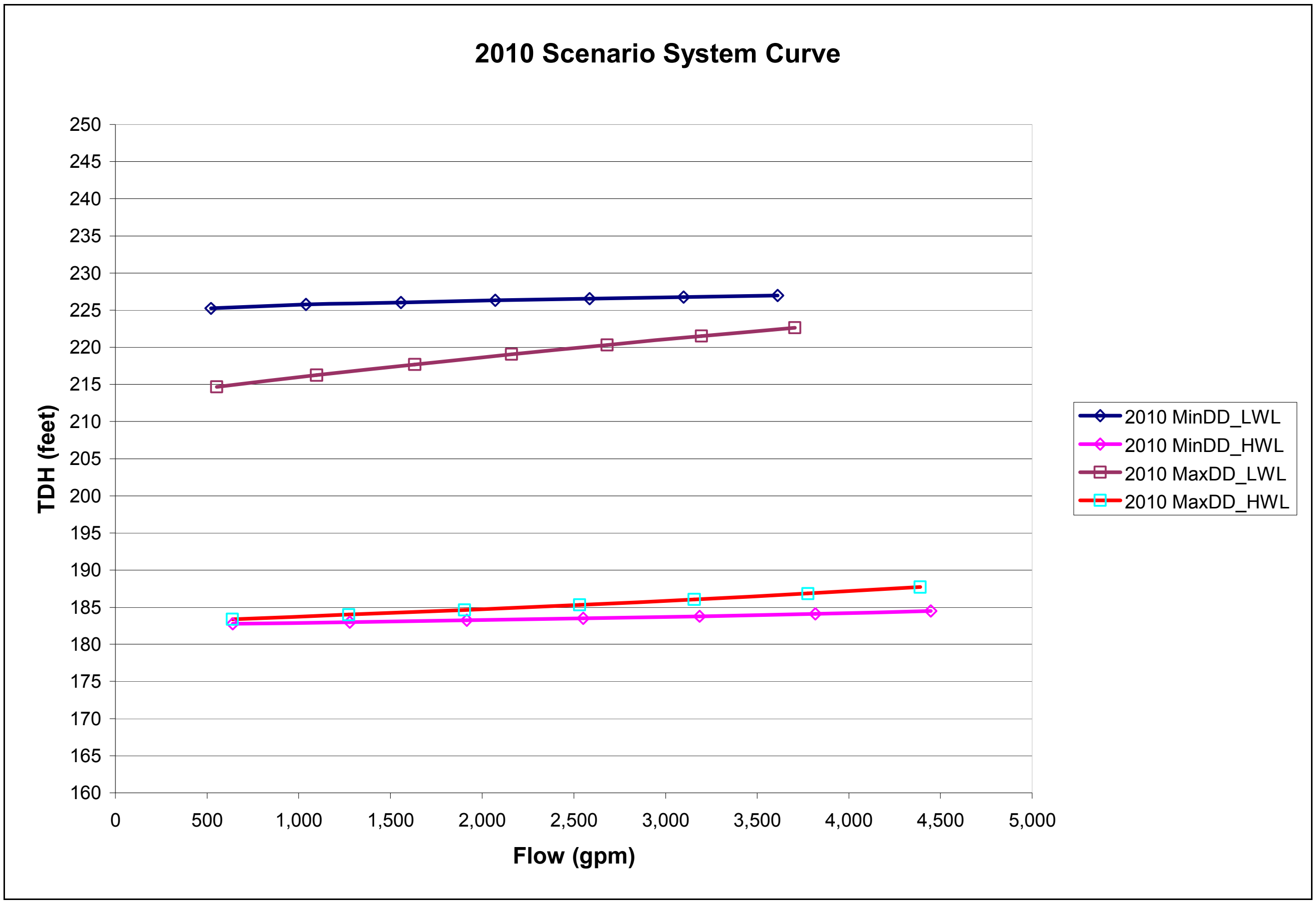

FIGURE 2
2010 Scenario System Curve

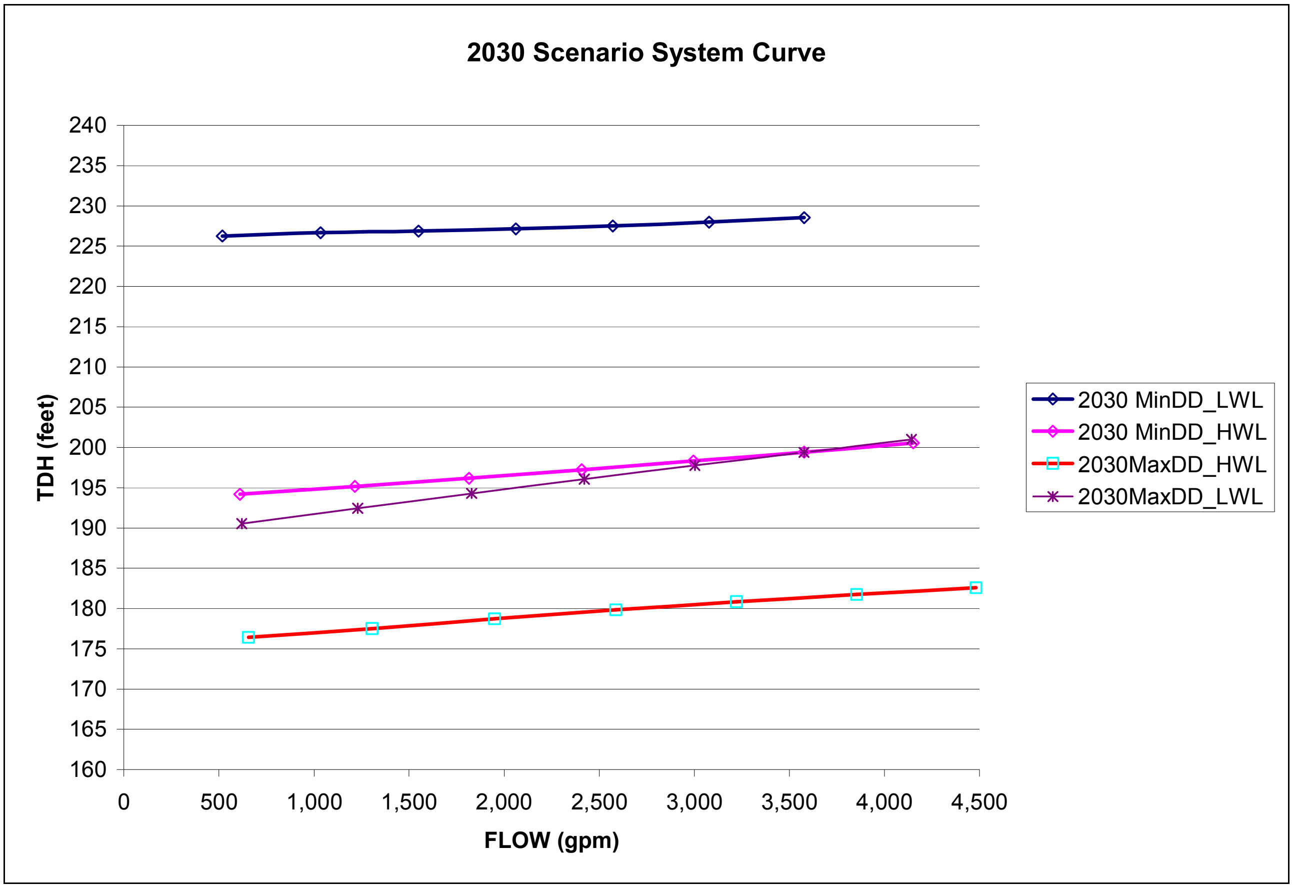

FIGURE 3
2030 Scenario System Curve

APPENDIX

2010 MinDD Conditions

Pump	Status
WELL-37	OFF
WELL-39	ON
WELL-47	OFF
WELL-42	OFF
1010PS-1	ON
1010PS-2	ON

2010 MaxDD Conditions

Pump	Status
WELL-37	OFF
WELL-39	OFF
WELL-47	ON
WELL-42	OFF
1010PS-1	ON
1010PS-2	ON

2030 MinDD Conditions

Pump	Status
WELL-37	OFF
WELL-39	ON
WELL-47	ON
WELL-42	ON
1010PS-1	ON
1010PS-2	ON

2030 MaxDD Conditions

Pump	Status
WELL-37	OFF
WELL-39	ON
WELL-47	ON
WELL-42	ON
1010PS-1	ON
1010PS-2	ON