TALBERT SEAWATER INTRUSION BARRIER OPERATIONS & MAINTENANCE MANUAL

March 2023

1st Edition

ORANGE COUNTY WATER DISTRICT
ORANGE COUNTY'S GROUNDWATER AUTHORITY

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Preface

This manual has been prepared to introduce and develop skills pertaining to the operation and maintenance of the Talbert Seawater Intrusion Barrier.

The document presents a comprehensive overview of the Talbert Barrier injection system in the main body (first 71 pages). The main body is supported by detailed appendices. Many of the appendices provide procedural instructions for critical operational tasks introduced in the main body. For this reason it is strongly recommended that the reader completely read the main body prior to reading the appendices.

Certain important concepts are discussed more than once in manual. The redundancy is designed to help the reader retain these important concepts. Research has proven that the more times a human see's something the more likely they are to retain it.

As with learning anything new, terminology is key. A list of acronyms and key terms are presented in this document following the Appendix section.

Additionally, a list of pertinent books that an injection recharge system operator may find useful is presented at the end of this manual in the Reference section.

The concepts in this manual range from simple to complex. If the reader struggles to understand any of these concepts after reading this document, the reader should seek clarification from their supervisor.

Table of Contents

1. INTRODUCTION

The Orange County Water District (OCWD, the District) was formed by a special act of the California Legislature in 1933 for the purpose of managing the Orange County Groundwater Basin (the Basin, Figure 1). Since its formation, the District has developed a sustainable recharge program. Aquifer recharge activities conducted by OCWD fall into two categories: 1) Surface Recharge and 2) Injection Recharge. This manual is a working document aimed at providing the reader with a good understanding of OCWD's Talbert Barrier injection recharge program.

The objective of this manual is to present a comprehensive system overview supported by detailed operational procedures to be used by Injection Recharge System Operators (IRSOs) and Groundwater Replenishment System (GWRS) treatment plant operators based at the GWRS facility in Fountain Valley, CA. This operations manual is a living document that will be updated with changes in District policy, operational procedure or physical changes to the injection recharge facilities. The responsibility of updating this manual lies with the Distribution and Injection Well Supervisor.

2. BACKGROUND

The District is tasked with assuring an ample supply of suitable quality groundwater for 2.2 million people in north and central Orange County. The responsibility includes full utilization and management of the groundwater basin beneath the District (Figure 1).

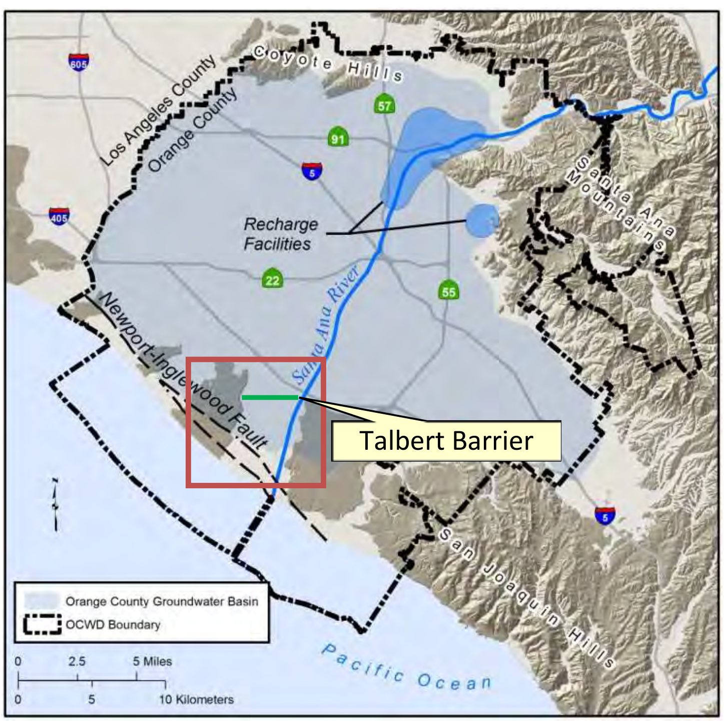


Figure 1 The 270 mi^2 OCWD Groundwater Basin is shown by black dashed border. The Talbert Seawater Intrusion Barrier can inject up to 32 million gallons per day of freshwater along the coast to form a high-pressure hydraulic ridge and prevent the landward migration of seawater into the groundwater basin.

The Basin is comprised of various layers of earth material. Layers comprised of sands and gravel that can store and transmit large quantities of water are called aquifers. Layers comprised of silts and clay that cannot transmit water easily are called aquitards. Aquifers and aquatards range in thickness from 10's of feet to over 100 feet.

Successive layers of aquifers and aquatards extend as deep as 2,400 feet below ground surface in the Basin. Along the coast, where the Santa Ana River enters the ocean, some of the shallow aquifers connect to the ocean and provide a pathway for salt water to enter the Basin (Figure 2). This area is known as the Talbert Gap. OCWD operates the Talbert Seawater Intrusion Barrier to control seawater intrusion into the Talbert Gap area.

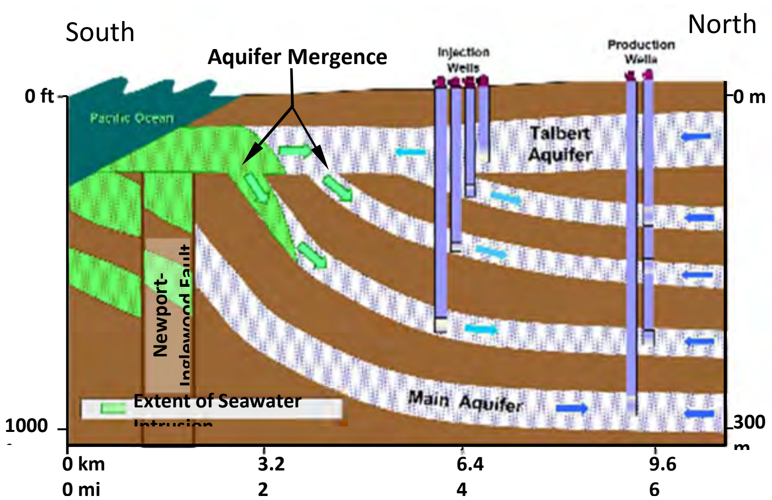


Figure 2 A geologic cross section of the Basin near the coast along the Santa Ana River. This figure illustrates the dynamic pathway (arrows) that seawater (green) can travel into the Basin and shows the location of injection and production wells.

The single greatest long-term challenge to effectively managing the Basin is controlling seawater intrusion along the coast. Seawater intrusion occurs when water levels within the Basin are drawn down below sea level. Seawater intrusion is controlled by operating the Talbert Seawater Intrusion Barrier - an alignment of 104 injection wells that inject between 15 and 32 million gallons per day of fresh water.

OCWD's Talbert Seawater Barrier (Talbert Barrier, Barrier) has been in operation since 1976. Since 1976 the Barrier has undergone many changes including new well designs and improved injection water quality. Since 2008, the Talbert Barrier has been injecting advanced treated wastewater from OCWD's GWRS treatment plant. This manual will examine in detail the various types of injection wells, their operational procedures and the procedures followed to monitor the quality of the injection water and evaluate injection well performance.

It is important for the IRSO to understand that the Talbert Barrier is designed to offset forces of nature. The IRSO does not have the luxury of being able to see the larger picture underground and therefore relies upon information provided by monitoring wells and injection well instrumentation to understand the operational conditions. This manual will help the IRSO develop the skills needed to see the invisible beneath the Talbert Gap.

3. TALBERT BARRIER OVERVIEW

The Barrier can be viewed as a two-part system 1) the distribution system and 2) the injection wells.

A. Distribution System

The distribution system is a piping network that conveys injection water from three different sources to the injection wells for recharge into the aquifer. Figure 3 shows the Talbert Barrier Distribution system.

It's important to note that the Barrier distribution system is *not* a looped system. For this reason the IRSO must be conscious that mainline isolation will result in flow and pressure drops downstream. The Barrier Distribution system is comprised of many different materials and is discussed in detail in Section 4 of this manual.

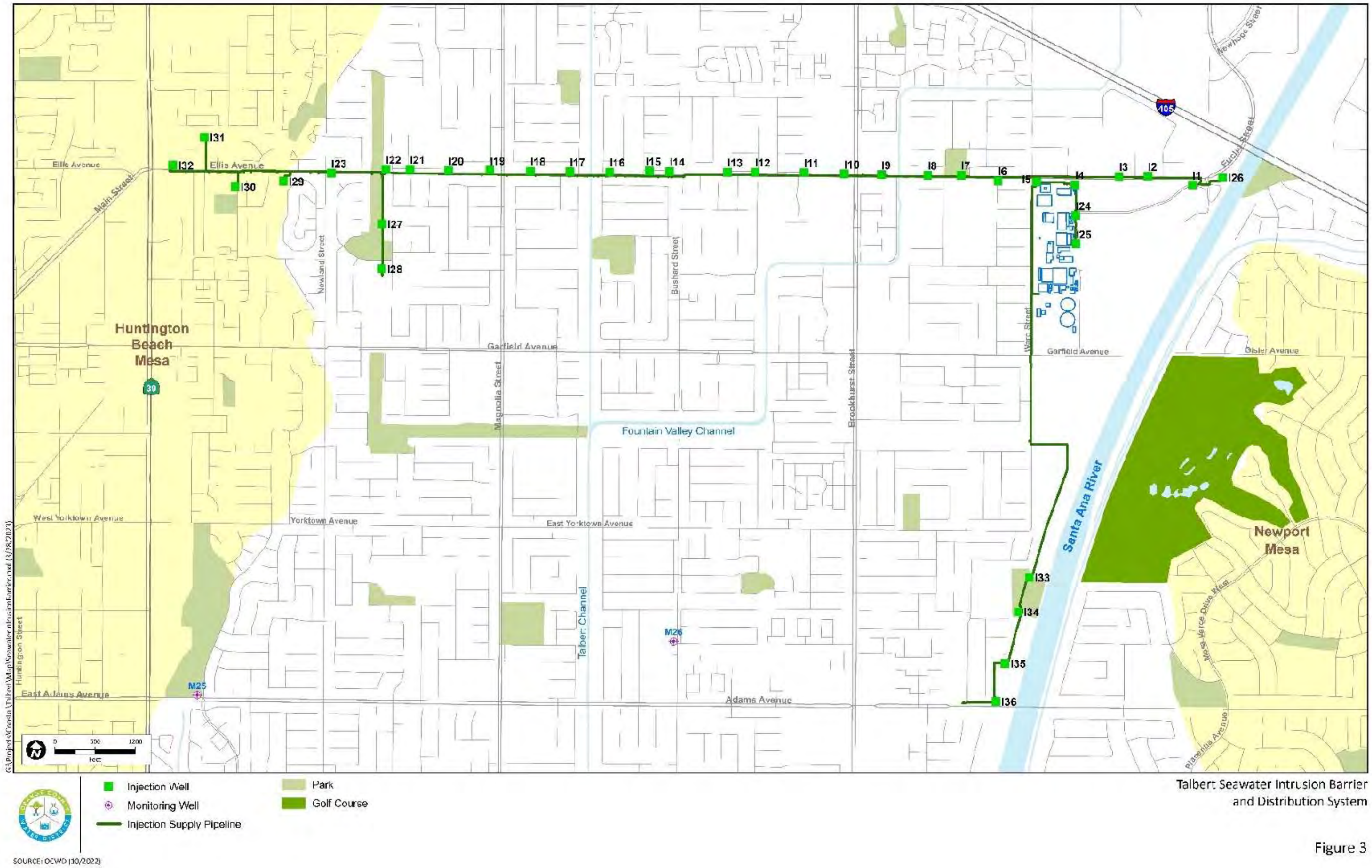
B. Injection Well Field

The Talbert Barrier injection well field is comprised of 104 injection casings grouped into 36 well sites Figure 3. There are two primary types of injection wells: 1) Modern Wells (Figure 3, I-26 through I-36) and 2) Legacy Wells (Figure 3, I-1 through I-23). In addition, there is a third type of injection well, the Hybrid Well. The Hybrid Well combines design aspects of Legacy wells and Modern Wells. There are only two of these Hybrid Injection wells in the Talbert Barrier system: I-24 and I-25 (Figure 3).

C. Legacy Wells

The Legacy Wells are the Talbert Barriers' original injection wells. Constructed between 1968 and 1974 these wells can inject up to approximately 50% of the total daily injection through the Talbert Barrier.

Legacy wells are "nested" wells and contain up to four 6-inch casings inside a 30-inch borehole. Each casing in the nest is screened at different depths and subsequently inject into different aquifers. From shallowest to deepest these aquifers are named: Talbert, Alpha, Beta and Lambda. All four aquifers are not always present at each Legacy Well site so not every well site will have all four casings in the nest; however, most Legacy Wells sites do have four casing. An as-built drawing of a typical Legacy Well is shown in Figure 4.



Talbert Seawater Intrusion Barrier and Distribution System

Figure 3

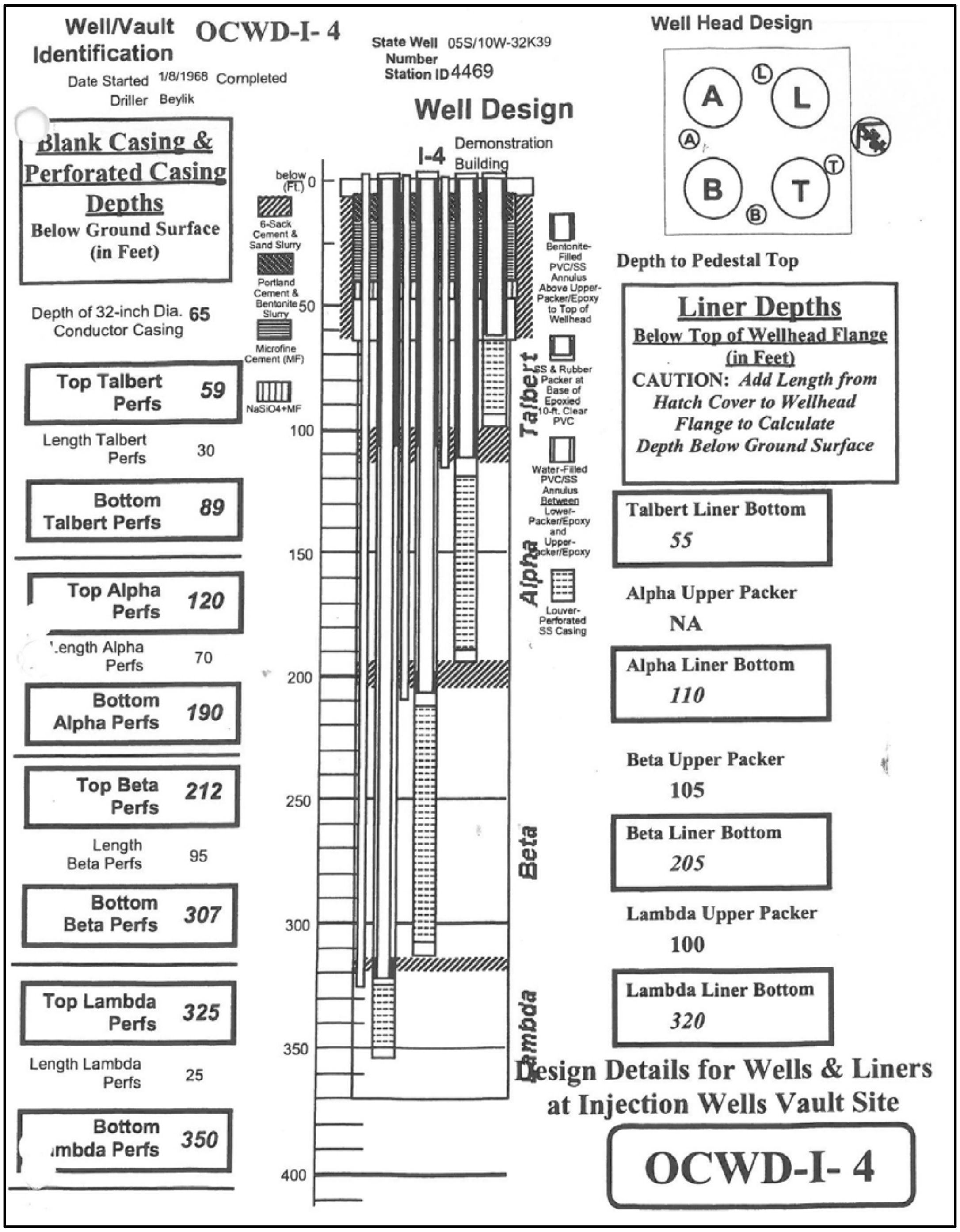


Figure 4 As-built drawing of typical Legacy

All Legacy wells are completed in vaults except for I-4 (Figure 5). I-4 is in the NE corner of the OCWD Fountain Valley campus and is used for public tours. The I-4 well-head lies inside a demonstration building above grade. This concrete block structure has a removable panel metal roof for well maintenance access. All legacy wells vaults are equipped with continuous ventilation and are considered C-5 confined spaces. Many Legacy Wells are located in public right-of-way. For these reasons the IRSO should use additional caution when accessing Legacy Wells.

Figure 5 Legacy Well I-4. I-4 contains four 6-inch casings targeting the Talbert, Alpha, Beta and Lambda aquifers. Legacy Well I-4 is the only Legacy Well completed above ground surface.

Legacy Wells inject passively utilizing pressure from the Barrier Product Water Pump Station (BPWPS) to deliver water to the well site. Just prior to injection the BPWPS pressure is reduced at the Legacy Well well-head. Flow is then metered and directed down-well. Flow is delivered into the Legacy Well using a 3-inch open ended eductor pipe. The water level inside the casing will rise (mound) slowly as injection proceeds. This level may rise to the well-head elevation and occasionally pressure can build underneath the well-head flange. This pressurized condition lets the IRSO know that the well could be backflushed to improve its performance. Ideally Legacy Well flange pressure is zero; however, the well flange pressure should not exceed 10 pounds per square inch (psi) before flow to the well is secured. Legacy Well operation and maintenance is discussed in detail in Section 5 of this manual.

D. Modern Wells

Groundwater modeling of the Talbert Gap in the late 1990's indicated the need to expand the Talbert Barrier. Modern Wells, constructed between 2000 and 2006, incorporate into their design advancements developed from 25 years of operating Legacy Wells. Modern Wells contribute approximately 50% of the total daily average injection through the Talbert Barrier. An as-built drawing of a typical Modern Well is shown in Figure 6.

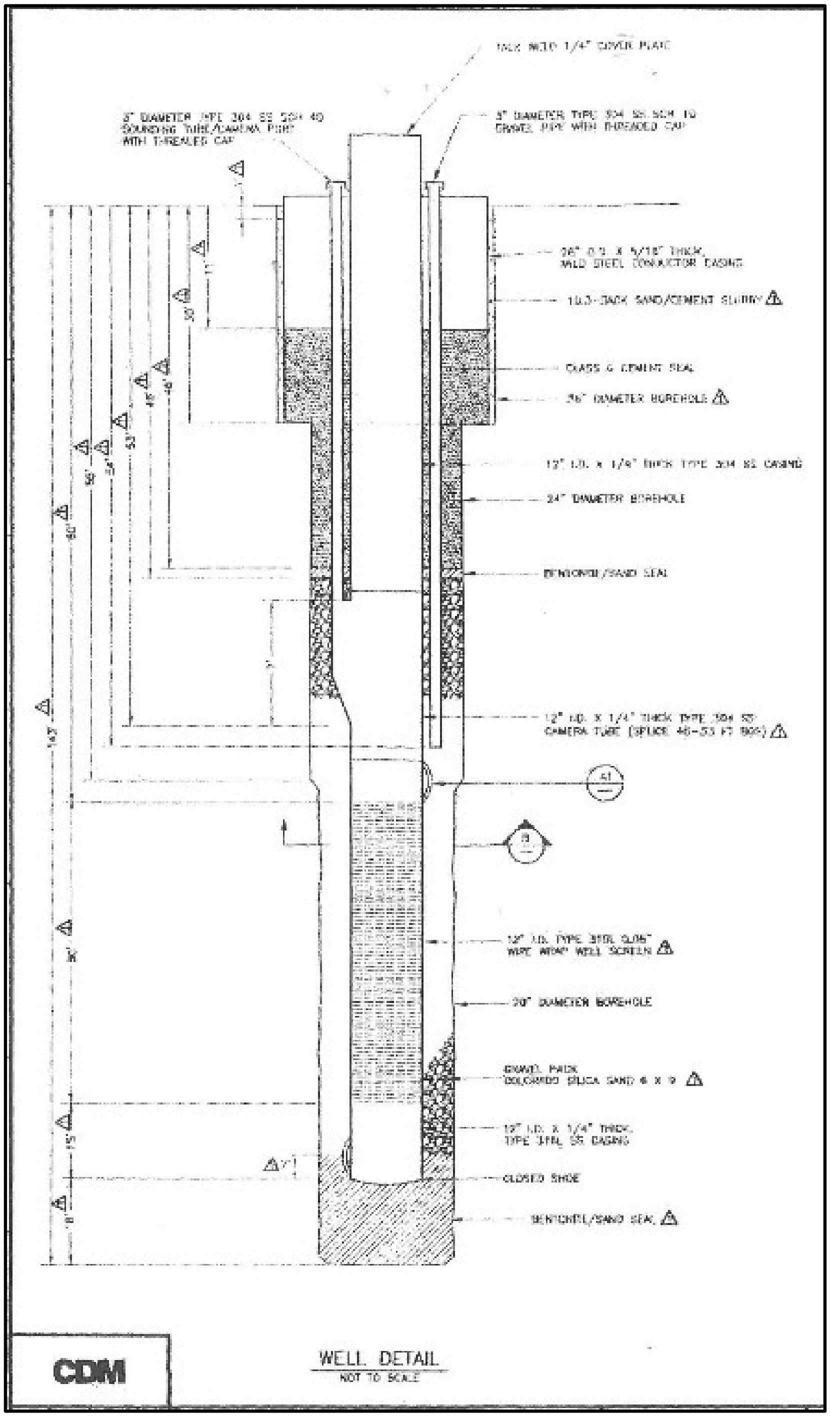


Figure 6 As-built drawing of a typical Modern Well (I-36). Modern Wells are 12-inch diameter single-casing injection wells. Modern Wells sites contain 1 or 3 casings. Some Talbert Barrier Modern Wells are capable of injection up to 1 million gallons per day.

All Modern Wells are completed above ground and outside public-right-of way utilizing one 12-inch injection casing per bore hole (Figure 7). Modern Well sites have either three injection casings per site (Figure 3, wells I-26 through I-32) or one injection casing per site (Figure 3, wells I-33 through I-36). In addition to taping the Talbert, Alpha, Beta and Lambda aquifers, some Modern Wells also inject into the Main aquifer. The Main aquifer, which is deeper and less susceptible to seawater intrusion, is recharged artificially by injecting into these deep Modern Wells.

Figure 7 Modern Well I-36. I-36 is a single casing Modern Well that injects into the mergence zone between the Talbert and Lambda aquifers. I-36 is located along the west levee of the Santa Ana River at Adams Ave.

Unlike the Legacy Wells, Modern Wells are equipped with a down-well flow control valve on the end of the eductor pipe. Modern wells are also fully automated allowing the IRSO to operate all Modern Wells remotely. The process control system software – Delta V (Delta V) provides the IRSO three different operational options for Modern Wells. The IRSO has the choice to operate a Modern Well based on 1) flow, 2) flow and pressure or 3) flow and level. Modern Well operation and maintenance are discussed in detail in Section 6 of this manual.

E. Hybrid Wells

Bridging the time gap between Legacy and Modern Wells, Hybrid Wells I-24 and I-25 were constructed between 1998 and 2000. There are only two Hybrid Wells in the Talbert Barrier. Hybrid Well I-24 and I-25 are completed above ground on the OCWD Fountain Valley campus along the East Perimeter Road (Figure 3 and 8).

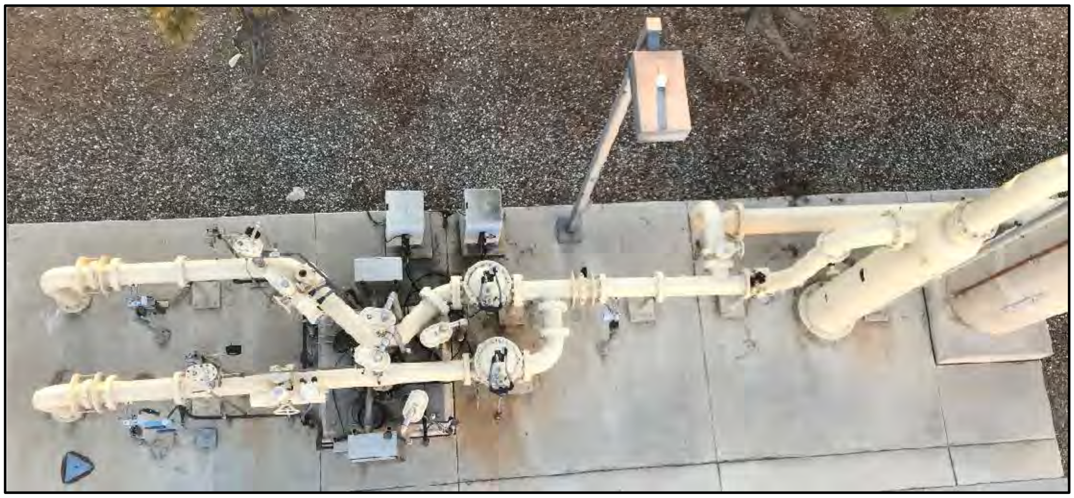


Figure 8 Hybrid Well I-24 located on the OCWD Fountain Valley campus along the East Perimeter Road.

Well I-24 is a nested well with two 12-inch diameter casings in one 36-inch diameter borehole. Well I-25 is a single casing well inside a 22-inch borehole. Figure 9 shows an as-built drawing of Hybrid Well I-24.

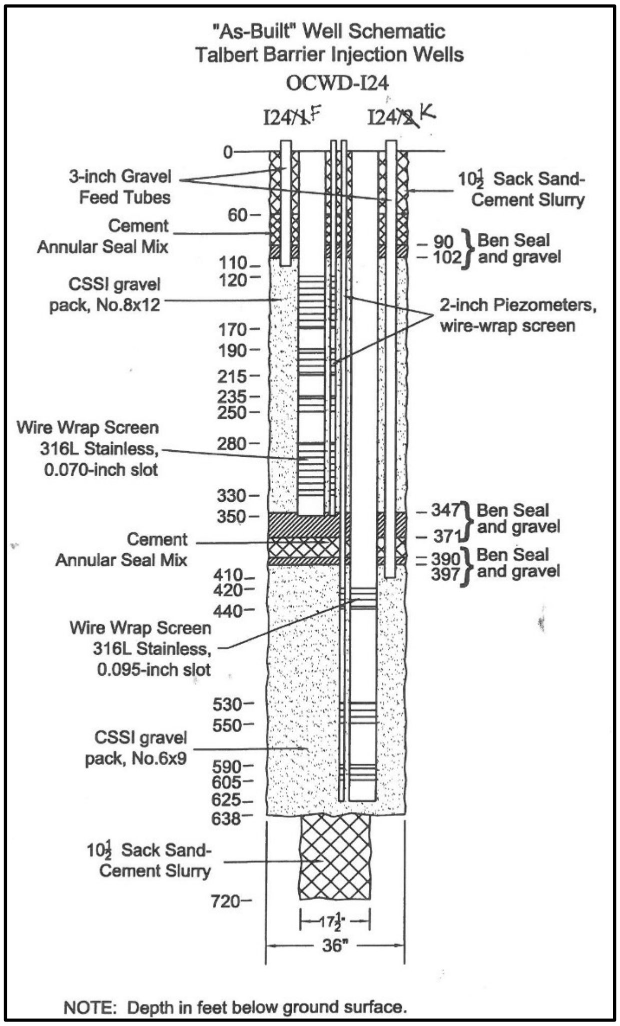


Figure 9 As-built drawing of nested Hybrid Well I-24. Notice the sounding tubes are independent of the main casing but screened similarly.

Hybrid wells I-24 and I-25 are both equipped with down-well flow control valves. I-24 and I-25 are both fully automated allowing the IRSO to operate Hybrid Wells remotely using Delta V. The process control system software – Delta V provides the IRSO three different operational options for Hybrid Wells. The IRSO has the choice to operate a Hybrid Well based on 1) flow, 2) flow and pressure and 3) flow and level. Hybrid Well operation and maintenance are discussed in Section 7 of this manual.

As-built drawings of all Talbert Barrier injection wells can be found in an electronic file "Talbert Barrier Injection Well As-built Drawings" located here: H:\OCWD\Operations\Water Production\Water Production Shared\WaterProd\Barrier\Talbert Barrier O&M Manual. All Talbert Barrier injection well borehole depths, casing diameters, casing depths, screened intervals and aquifer targets are summarized in Table 1. It is recommended that the IRSO print copies of all injection well as-built drawings and Table 1 and place this information in his/her pick-up truck for quick reference. Table 1 is also available electronically here: H:\OCWD\Operations\Water Production\Water Production Shared\WaterProd\Barrier\Talbert Barrier O&M Manual\ Talbert Barrier Injection Well – Construction Details.

TABLE 1

CASING DETAILS TALBERT INJECTION WELLS

Well	Screen interval (feet bgs)	Dia (inches)	Total Depth (feet bgs)	Zone
I-1/1	65 -100	6	105	Talbert
I-1/2	150-200	6	205	Alpha
I-1/3	235-350	6	355	Beta
I-1/4	365-400	6	405	Lambda
I-2/1	64-96	6	101	Talbert
I-2/2	147-210	6	215	Alpha
I-2/3	225-335	6	340	Beta
I-2/4	350-390	6	395	Lambda
I-3/1	65-96	6	101	Talbert
I-3/2	145-200	6	205	Alpha
I-3/3	225-325	6	330	Beta
I-3/4	340-380	6	385	Lambda
I-4/1	59-89	6	100	Talbert
I-4/2	120-190	6	195	Alpha
I-4/3	212-307	6	315	Beta
I-4/4	325-350	6	360	Lambda
I-5/1	70-95	6	100	Talbert
I-5/2	115-180	6	185	Alpha
I-5/3	210-265	6	270	Beta
I-5/4	320-345	6	350	Lambda
I-6/1	70-100	6	105	Talbert
I-6/2	120-175	6	180	Alpha
I-6/3	195-250	6	255	Beta
I-6/4	315-335	6	340	Lambda
I-7/1	70-95	6	100	Talbert
I-7/2	110-150	6	155	Alpha
I-7/3	165-250	6	255	Beta
I-7/4	315-336	6	341	Lambda
I-8/1	60-95	6	100	Talbert
I-8/2	110-165	6	170	Alpha
I-8/3	180-240	6	245	Beta
I-8/4	300-325	6	330	Lambda
I-9/1	65-90	6	95	Talbert
I-9/2	110-150	6	155	Alpha
I-9/3	175-235	6	240	Beta
I-9/4	300-330	6	335	Lambda
I-10/1	60-90	6	95	Talbert
I-10/2	105-185	6	190	Alpha
I-10/3	205-290	6	295	Beta
I-10/4	305-330	6	335	Lambda
I-11/1	65-95	6	100	Talbert
I-11/2	115-180	6	185	Alpha
I-11/3	200-225	6	230	Beta
I-12/1	60-95	6	100	Talbert
I-12/2	110-165	6	170	Alpha
I-12/3	180-260	6	265	Beta
I-12/4	290-310	6	315	Lambda
I-13/1	77-100	6	105	Talbert
I-13/2	120-160	6	165	Alpha
I-13/3	175-250	6	255	Beta
I-13/4	280-305	6	310	Lambda
I-14/1	70-95	6	100	Talbert
I-14/2	115-150	6	155	Alpha
I-14/3	175-250	6	255	Beta
I-14/4	265-300	6	305	Lambda
I-15/1	70-95	6	100	Talbert
I-15/2	115-145	6	150	Alpha
I-15/3	170-235	6	240	Beta
I-15/4	262-285	6	290	Lambda

Well	Screen interval (feet bgs)	Dia (inches)	Total Depth (feet bgs)	Zone
I-16/1	63-120	6	125	Talbert
I-16/2	145-210	6	215	Beta
I-16/3	245-285	6	290	Lambda
I-17/1	62-130	6	135	Talbert
I-17/2	150-215	6	220	Beta
I-17/3	250-275	6	280	Lambda
I-18/1	57-125	6	130	Talbert
I-18/2	150-210	6	215	Beta
I-18/3	260-275	6	280	Lambda
I-19/1	57-127	6	132	Talbert
I-19/2	145-200	6	205	Beta
I-19/3	235-270	6	275	Lambda
I-20/1	90-125	6	130	Talbert
I-20/2	140-170	6	175	Beta
I-20/3	240-265	6	270	Lambda
I-21/1	55-125	6	130	Talbert
I-21/2	150-170	6	175	Beta
I-21/3	230-250	6	255	Lambda
I-22/1	60-160	6	165	Talbert
I-22/2	250-275	6	280	Lambda
I-23/1	70-155	6	160	Talbert
I-23/2	215-255	6	260	Lambda
I-24F	120-170, 190-215	12		Alpha, Beta
	235-250, 280-330	12	350	Lamb., U.Rowe
I-24K	420-440, 530-550	12		L.Rowe, Main
	590-605	12	625	
I-25F	120-165, 185-205	12		Alpha, Beta,
	225-320		340	Lamb., U. Rowe
I26L	56-66, 76-108	12		Alpha
	133-143, 154-196		215	
I26H	271-297, 322-333	12		Beta, Lambda
	343-358, 374-400		420	Omicron, U. Rowe
I26K	476-496	12		L. Rowe
	557-577			Main
	598-660		680	
I-27A	78'-148'	12	163'	Talbert-Alpha
I-27H	210.5'-260.5'	12	274'	Beta 3, Lambda, Upper Rho
I-27K	355'-420'	12	440'	Main
I-28A	80'-140'	12	140'	Talbert-Alpha
I-28H	185'-235'	12	250'	Beta, Lambda
I-28K	360'-460'	12	480'	Main
I-29A	90'-120'	12	135'	Alpha 1,2,3
I-29H	200'-250'	12	265'	Beta, Lambda
I-29K	365'-475'	12	495'	Main
I-30B	95'-160'	12	175'	Alpha 1,2,3
I-30H	230'-295'	12	310'	Beta, Lambda
I-30K	425'-650'	12	665'	Main
I-31B	90'-165'	12	180'	Alpha 1,2,3
I-31H	235'-295'	12	310'	Beta, Lambda
I-31K	440'-590'	12	605'	Main
I-32B	90'-155'	12	170'	Alpha 1,2,3
I-32H	226'-295'	12	310'	Beta, Lambda
I-32K	425'-670'	12	685'	Main
I-33M	61'-156'	12	171'	Talbert, Beta, Lambda
I-34M	60'-135'	12	150'	Talbert, Lambda
I-35M	60'-115'	12	130'	Talbert, Lambda
I-36M	60'-110'	12	125'	Talbert, Lambda

4. DISTRIBUTION SYSTEM

A. Background

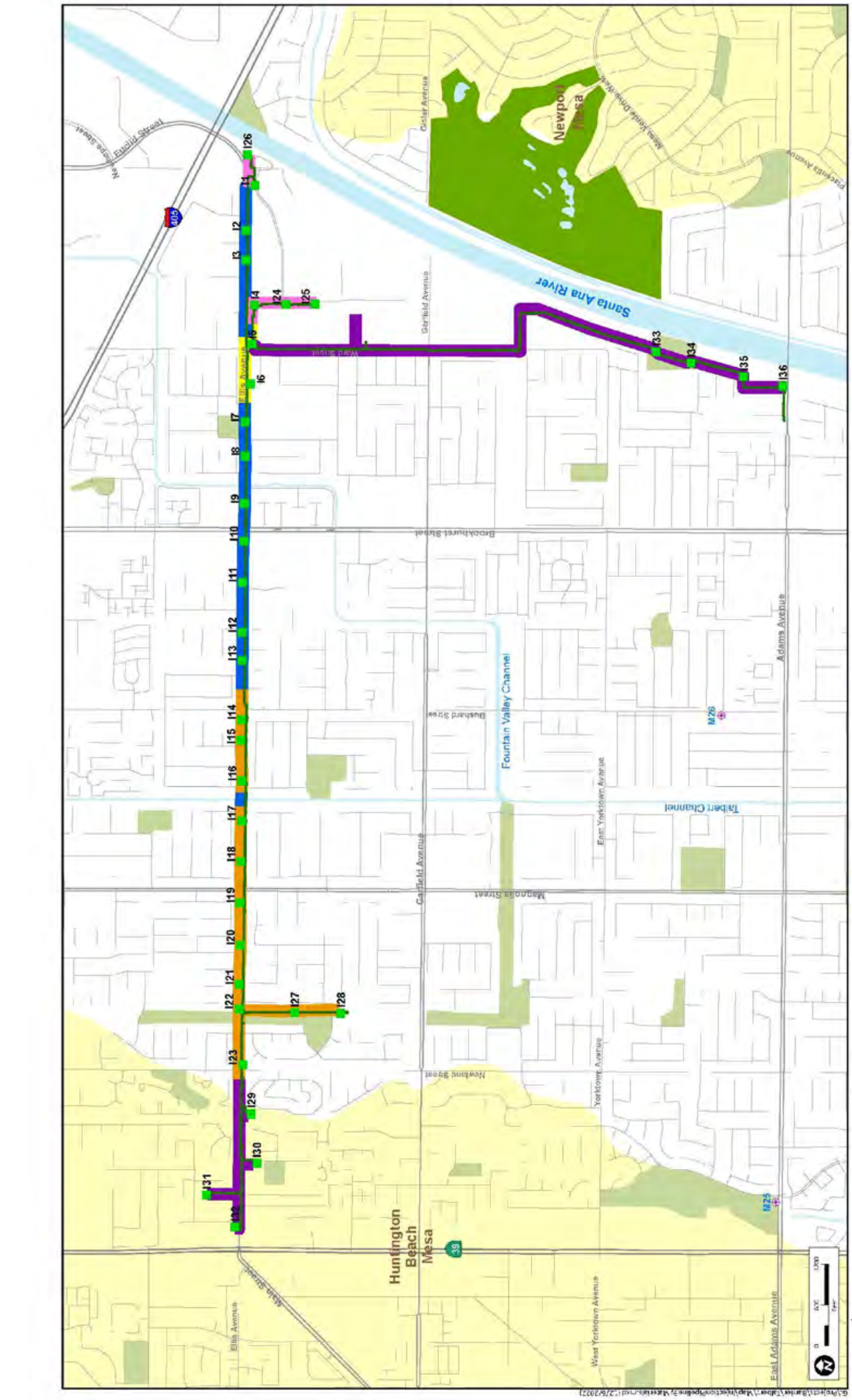
The Talbert Barrier has grown over time and so has the piping system feeding the injection wells. Subsequently, the Barrier distribution system mains are comprised of multiple materials. The Barrier distribution system can be looked upon as two connected distribution systems 1) the north-south trending South-East Barrier Pipeline and 2) the east-west trending Ellis Avenue Pipeline. Figure 3 shows the Talbert Barrier Distribution System. Figure 10 shows the various material that make up the Talbert Barrier distribution system.

A water atlas for the Talbert Barrier Distribution System was prepared in 2012 but is only partially complete. This water atlas: Orange County Water District Talbert Barrier Pipeline Atlas Drawings February 2012 (Psomas) is available through the OCWD Engineering Department.

Because the atlas is incomplete, the IRSO should also utilize as-built construction drawing to better understand buried features of the Barrier distribution system. These as-built drawings include:

- Orange County Water District Contract Drawings for Orange County Coastal Project Reclamation and Barrier Facilities Injection Well Piping Contract No. 72-2 Volume V (Toups Engineering)
- Orange County Water District Talbert Barrier Pipeline Atlas Drawings February 2012 (Psomas)
- Construction Plans South East Barrier Pipeline Contract no. GWRS-2001-3 August 2002 (CDM w/ B&C, Tetra Tech)
- Construction Plans for Orange County Water District – Seawater Barrier Pipeline Replacement Project Contract No. TAL-2006-1 (2006 Tetra Tech)
- Construction Plans for Orange County Water District – Talbert Barrier Injection system, Cathodic Protection Improvements – Contract No. TAL-97-2 (1997, Harper & Associates)
- Talbert Barrier West End Pipeline Cathodic Protection System and Semi-Deep Anode Replacement TAL-2015-1 (Corrpro)
- OCWD Talbert Barrier East End Improvement Project Injection Well Head Facilities and Pipeline for Injection Well Site No. OCWD I-26 Contract No. TAL-2000-1 (2000, Boyle)
- OCWD Talbert Barrier West End Improvement Project, Injection Well Drilling, Completion and Development, Injection Wellhead facilities & Pipeline for Injection Well Sites Nos. I-27 and I-28 Contract No. TAL-2002-2 June 2002 (D. Boyle)

Electronic copies and full-size plots of these drawings are available by submitting a request to the OCWD Engineering Department Administrative Specialist. Half-size copies of these drawings can be acquired by sharing the electronic file with the OCWD Water Production Department Administrative Specialist and working with a reprographics company. Additionally, full-size copies of these drawings are available for reference in the Talbert Barrier shop library.



Talbert Seawater Intrusion Barrier
Distribution System Materials

Figure 10

The general locations of major water distribution appurtenances are plotted on Figure 11.

Hard copies of the water atlas and as-built drawings should be kept in the IRSO's vehicle for quick reference. If the IRSO is still uncertain about buried locations, the District's utility location contractor – Utiliquest can be contacted for assistance. Utiliquest can employ line locating equipment that can be helpful. The District's current field contact for Utiliquest is: Luis Castro (714) 829-9792.

Both the Ellis Avenue and the SEB pipelines receive their flow and pressure from the BPWPS at the GWRS campus. The IRSO is responsible for maintaining the SEB and Ellis Avenue Pipelines. The IRSO is not responsible for maintaining the BPWPS. The GWRS Maintenance Department maintains the BPWPS.

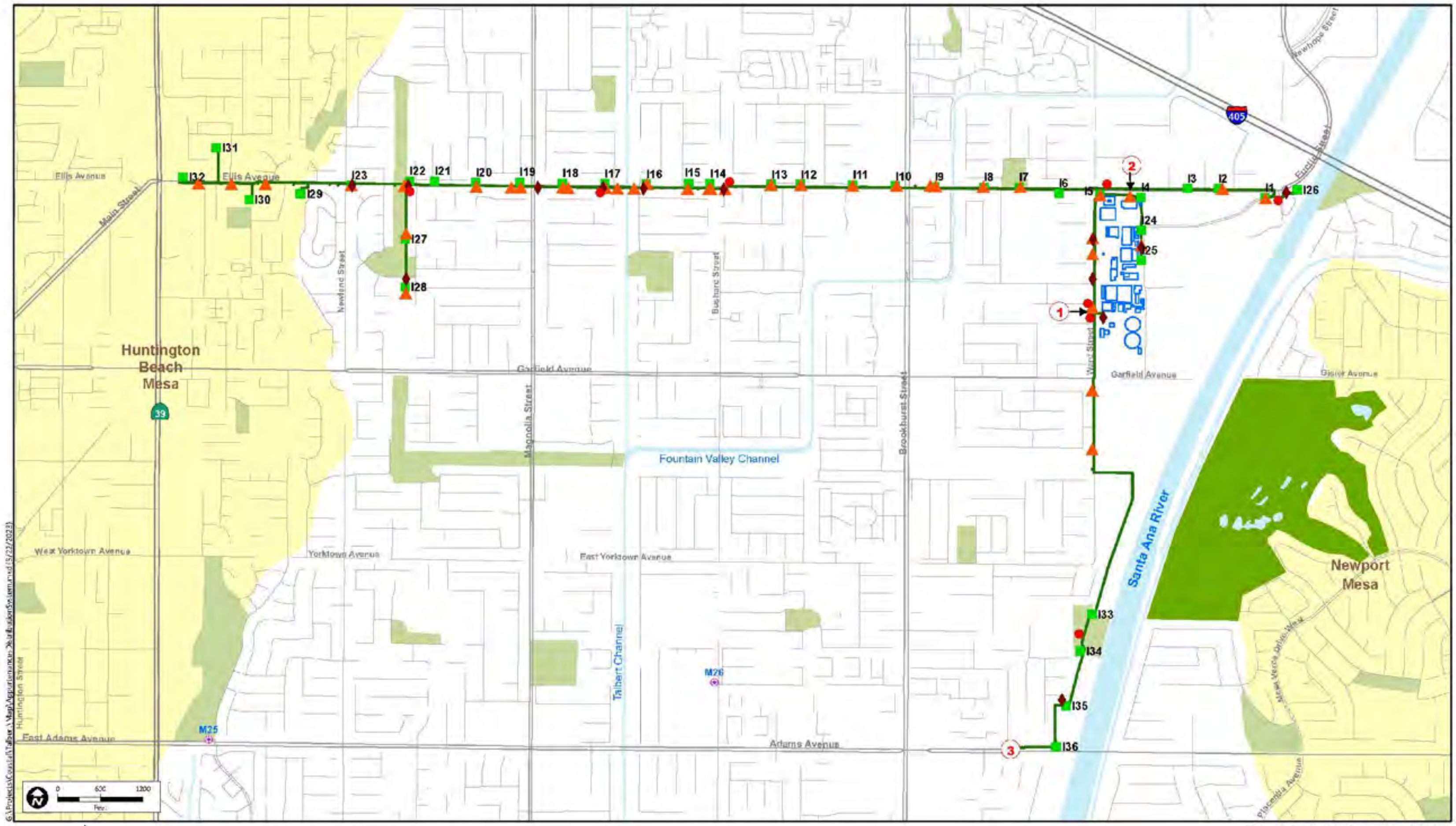
Power and fiberoptic cables lie in buried conduits near the Barrier Distributing System piping. The District's Instrumentation and Electrical (I&E) Department is responsible for maintaining these cables; however, pull box vault lids within roadways can wiggle loose with time drawing noise disturbance complaints requiring the IRSO to respond.

The Talbert Barrier Distribution system lies beneath several miles of high-traffic roadway. It is very important that the IRSO exercise good judgment when working in public right-of-way. If lane closure is required, the IRSO should obtain all necessary permits, make all required notifications and follow all permit instructions. If a permit is not required, the IRSO will follow the current version of the Work Area Traffic Control Handbook (Watchbook). A copy of the most current (2019) version of the Watchbook is available in Appendix A-1.

B. South-East Barrier Pipeline

The South-East Barrier (SEB) Pipeline was constructed in the early 2000's for the purpose of supplying SEB injection wells I-33 thru I-36. Initially, the SEB pipeline was used to supply import water into the barrier system during GWRS construction. The SEB Pipeline connects to the GWRS treatment plant through a 54-inch pipe that tee's into the 42-inch SEB Pipeline in Ward St. between Egret Avenue and Flacon Avenue. Two 36-inch butterfly valves are located at the north and south ends of the tee (Figure 11).

The SEB Pipeline connects to the Metropolitan Water District of Southern California (MWD) distribution system through the OC-44 connection. The OC-44 connection is located along the westbound Adams Avenue frontage road between Ranger Lane and Lexington Lane in the City of Huntington Beach. The City of Huntington Beach water distribution system also connects to OC-44 in the area. A flow meter contained inside a vault is located near and just downstream of the OC-44 connection (Figure 12). The IRSO will rarely need to enter this vault. This vault is a permit required confined space.



Air and Vacuum Release Valve
Blow-Off Valve
Main Valve
Injection Well
Monitoring Well
Injection Supply Pipeline
Park
Golf Course
1 GWRS Connection
2 City of Fountain Valley Connection
3 OC-44/SEB Connection

Note: All injection wells have an isolation valve at the Lateral tee with the Main. For visual clarity, these lateral isolation valves are not show on this figure. These tee's between most of the Legacy Well laterals and the main are also tapped with 2-inch air-vac's that surface to atmosphere near each well vault as shown in Figure 3B.

Talbert Seawater Intrusion Barrier
Appurtenances of the Distribution System
Major Water Distribution Appurtenances

Figure 11

SOURCE: OCWD (09/2022)

Figure 12 Looking west along Adams Avenue. The OC-44 flow meter vault in the foreground, the City of Huntington Beach distribution system connection can be seen in the background. The red arrow indicates access into the vault.

Currently the OC-44 connection is used by the IRSO to maintain pipeline pressure during GWRS plant outages. A 16-inch reduced port dual pilot globe valve manufactured by Cla-Val is located approximately 22 feet downstream of the OC-44 connection and approximately 35 feet north of injection well I-36 (Figure 13). This valve is located inside a shallow vault. This vault is considered a C-5 confined space. When originally constructed, a consultant prepared a South East Barrier Pipeline operating document. This document is provided as Appendix A-2. This document references a second pressure reducing valve labeled PRV #2. Since the document was written PRV # 2 has been removed and replaced with a pipe spool. Maximum flow through the OC-44 connection is 6,000 gpm. Service for this valve and associated electronics is completed by the manufacturer- CLA-VAL. The current CLA-VAL field service representative is Lance Phillips (925) 519-2154.

Figure 13(A) Image looking south showing the OC-44 flow control valve vault. The backflow prevention device is behind the vault. Modern Injection Well I-36 can barely be seen behind the backflow device.

Figure 13(B) Inside the vault showing the OC-44 flow control valve.

Approximately 10 feet south (upstream) of the OC-44 control valve vault lies an above ground 10-inch double reduced pressure backflow prevention devise (Figure 13A). This devise requires third party inspections quarterly. This testing is conducted by an authorized 3rd party contractor and coordinated by the GWRS Planner/Scheduler. The IRSO works with the GWRS Planner / Scheduler to insure that these inspections occur and the certification paperwork is delivered to the City of Huntington Beach. If any leakage is visually detected at this devise, the ISRO should notify their supervisor. Occasionally the devise will become overgrown with vegetation and require trimming by the District's landscape contractor.

The SEB Pipeline main is constructed of cement-mortar lined (cml) and coated steel pipe ranging in diameter from 42 to 20-inch. The IRSO follows a maintenance program for the SEB Pipeline that includes:

- main valve exercising, lateral valve exercising
- blowing off the main pipeline
- monitoring air vacuum and release (air-vac) valves for leakage

To avoid water hammer, main system valves are ideally exercised when there is no pressure on the main. For details on exercising main line and lateral valves see Appendix A-3.

Flow is transferred from the main pipeline to the injection wells through lateral pipelines (lateral) constructed of 6, 8 or 12-inch diameter steel cml or ductile iron pipe. A butterfly valve (lateral valve) located at the tee with the main can be used to isolate the well from the main.

Debris accumulates in the low spots of the main pipeline and needs to be removed periodically to maintain pipeline efficiency. Located at the deep spots along the main pipeline will be a tee with an 8-inch diameter pipe and an 8-inch diameter butterfly valve. The 8-inch pipe terminates in a shallow vault at ground surface near the curb and gutter. Inside the shallow vault the 8-inch pipe is blind flanged and tapped with a threaded fire hose fitting. When the 8-inch valve is opened and the firehouse fitting cap is removed, water and debris flow from the main and discharge to the curb and gutter. This assembly is called a blow-off (b/o) valve. The IRSO can successfully remove accumulated debris from the main pipeline by operating the b/o valves under pressurized and flowing conditions. For b/o valve operational procedures, see Appendix A-4.

Changes in water chemistry and pipeline pressure can cause dissolved gas to come out of solution. The gas usually becomes trapped in the high spots along the main pipeline. These trapped pockets of gas reduce pipeline efficiency. The high spots in the SEB pipeline are tapped with 2-inch diameter tubing. These tubing segments stub up, above grade along the margin of the roadway and are fitted with an air-vac valve. The air-vac valve allows dissolved gasses to escape during a pressurized condition and allows atmosphere to enter the pipeline during draining operations. The air-vac is designed to operate passively. Occasionally an air-vac will not seat correctly. Visual inspection by the IRSO will determine a leak. Leaks are usually the result of a faulty seat. To reseat an air-vac valve, gently tap the valve body with a hammer. This should seat the valve. If the air-vac valve does not seat, it will need to be replaced by the IRSO.

Air-vac replacement is done utilizing at least two IRSOs and the auto crane mounted in the bed of T-89. First, close the ball valve below the air-vac. Then unthread the defective air-vac at the nipple below the air-vac and above the insolation ball valve and remove air-vac with crane. Lift new air-vac into place with crane and thread onto the nipple. Lastly, open the ball valve below the air-vac.

The SEB Pipeline is not protected from corrosion using cathodic protection.

C. Ellis Avenue Pipeline

The Ellis Ave. Pipeline is approximately 2.5 miles long and extends from the 405 freeway on the east to Beach Boulevard to the west (Figure 3). The Ellis Avenue pipeline is composed of many different materials (Figure 11) and ranges in diameter from 17-inch to 30-inch diameter. Flow from this pipeline feeds all injection wells along Ellis Avenue.

The oldest and most fragile portion of the Ellis Avenue Pipeline is the segment located at the intersection of Ward St. and Ellis Avenue. The OCWD Engineering Department is planning a future project to replace this pipe segment. This intersection is also where the SEB and Ellis Avenue Pipelines connect.

Imported water can be delivered to the Barrier through the City of Fountain Valley connection located on the OCWD campus between the Phil Anthony Water Quality Assurance Laboratory building and Ellis Avenue (Figure 14). When in need of import water, the IRSO should use the City of Fountain Valley connection first, OC-44 is used only as a back up to the City of Fountain Valley connection. Maximum flow through the City of Fountain Valley connection is 800 gpm.

The City of Fountain Valley import water connection (CFV) contains a flow meter and backflow devise that is owned, maintained and compliance tested by the City of Fountain Valley.

The CFV contains a pressure reducing flow control valve and corresponding electronic controller. The controller and the valve are owned by OCWD. Maintenance of the flow control valve and electronic controller is done by the manufacturer – CLA-VAL.

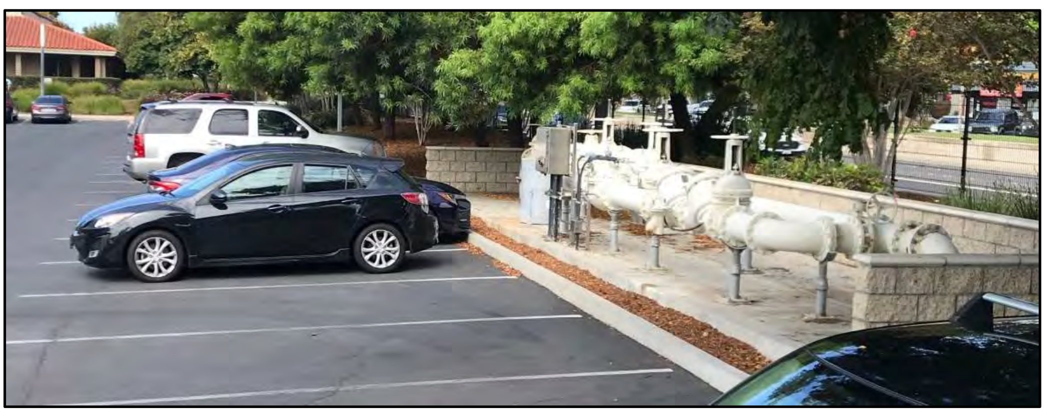


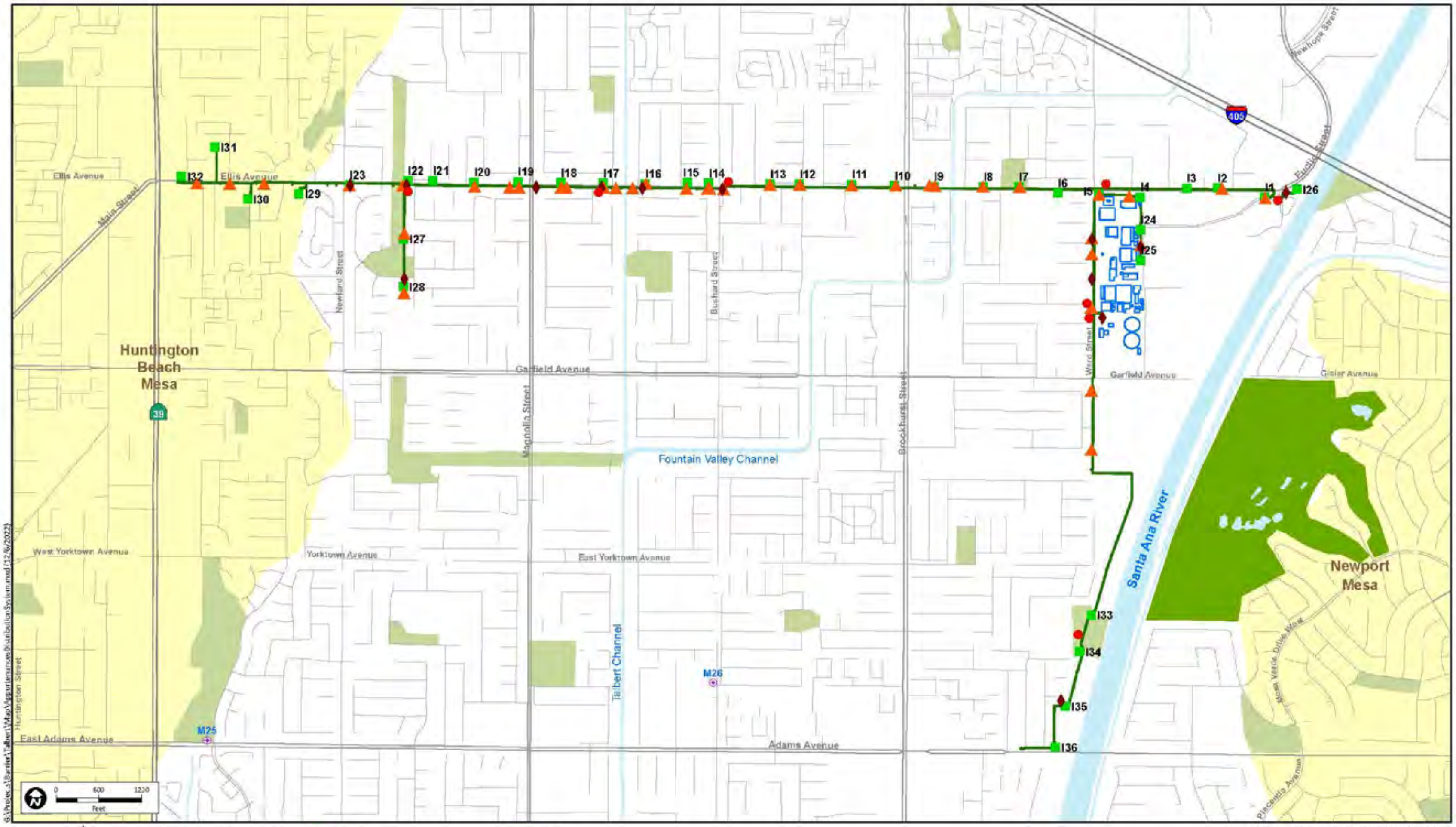
Figure 14 City of Fountain Valley import water connection. This connection is the first source of import water the IRSO uses and is limited to 800 gpm. MWD's OC-44 connection is to be used when import flows greater than 800 gpm are required.

GWRS flow enters the Ellis Avenue Pipeline through the same 54-inch pipe that tee's into the 42-inch SEB Pipeline in Ward Street between Egret Avenue and Flacon Avenue. From this tee some flow travels north along Ward Street to the SEB / Ellis Avenue Pipeline intertie (tee) underneath the Ward St. and Ellis Avenue intersection.

The IRSO follows a maintenance program for the Ellis Avenue Pipeline that includes:

- main valve exercising, lateral valve exercising
- blowing off the main pipeline
- monitoring air-vac valves for leakage
- monitoring and maintaining the cathodic protection system for the Ellis Avenue Pipeline lateral lines.

To avoid water hammer in the distribution system, main system valves are ideally exercised when there is no or little pressure on the main. For details on exercising main line and lateral line valves see Appendix A-3.



Note: All injection wells have an isolation valve at the Lateral tee with the Main. For visual clarity, these lateral isolation valves are not show on this figure. These tee's between most of the Legacy Well laterals and the main are also tapped with 2-inch air-vac's that surface to atmosphere near each well vault as shown in Figure 3B.

Talbert Seawater Intrusion Barrier
Appurtenances of the Distribution System
Major Water Distribution Appurtenances

Figure 11

SOURCE: OCWD (09/2022)

Flow is transferred from the Ellis Avenue Pipeline to the Legacy Wells through lateral pipelines constructed of 6 or 8-inch diameter ductile iron pipe. A lateral butterfly valve located at the tee with the main can be used to isolate the well from the main. For details on exercising lateral valves see Appendix A-3.

Like the SEB pipeline, debris accumulates in the low spots of the Ellis Avenue Pipeline and needs to be removed periodically to maintain pipeline efficiency. Located at the deep spots along the main pipeline will be a tee with an 8-inch diameter pipe and an 8-inch diameter butterfly valve. The 8-inch pipe terminates in a shallow vault at ground surface near the curb and gutter. Inside the shallow vault the 8-inch pipe is blind flanged and tapped with a threaded fire hose fitting. When the 8-inch valve is opened and the firehouse cap is removed, water and debris flow from the main and discharges to the curb and gutter. This assembly is called a blow-off (b/o) valve. The IRSO can successfully remove accumulated debris from the main pipeline by operating the b/o valves under pressurized and flowing conditions. For b/o valve operational procedures, see Appendix A-4.

A passive cathodic protection system is currently in place along the Ellis Avenue Pipeline. This system utilizes zinc sacrificial anodes submerged in a special grout located adjacent to injection wells I-1 through I-23. The IRSO is responsible for maintaining the grout levels at these locations. Appendix A-5 provides instructions for maintaining the grout level. The OCWD Engineering Department periodically contracts with a vendor to evaluate the condition of the zinc anodes and replace if necessary.

D. Pipeline Liner Deterioration

The GWRS final product water chemistry reacts with the cement-mortar lining in the SEB Pipeline and cml portions of the Ellis Avenue Pipeline. This reaction dissolves the cement matrix, liberating the mortar aggregate (sand) to be mobilized into the injection well, adversely affecting its' performance. For this reason, the IRSO manages the following pipeline monitoring programs along the Talbert Barrier distribution system:

- 5 and 1 micron bypass filters (Figure 15)
- laser turbidity monitoring
- Corrosion using traditional metal coupons and real-time linear polarization resistance
- Silt Density Index (SDI)

Operating procedures for the laser turbidity monitoring station is located in Appendix A-6.

Operating procedures for the 5 and 1 micron bypass filter stations is located in Appendix A-7.

Operating procedures for the corrosion monitoring station is located in Appendix A-8.

Operating procedures for the SDI test is located in Appendix A-9.

Figure 15 (A) 5 and 1 micron bypass filter test skid used to determine the amount of solids being delivered into the injection wells. There are several of these skids located throughout the Talbert Barrier distribution system.

Figure 15 (B) Inside the blue filter housing (Figure 15 (A) are the 1 and 5 micron filter elements. **A** new 1 micron filter element is shown on the left and a loaded 1 micron filter element after 1 month of service is shown on the right. The filters are weighed and the difference in weight is mathematically extrapolated to determine the mass loading of the injection wells. The red color is thought to be the result of iron oxidation occurring at the GWRS treatment plant.

E. Filling the Distribution System

The Barrier distribution system can be filled using two primary sources: MWD's OC-44 connection and the CFV import water connection. Both of these sources are operated electronically using the GWRS process control system Delta V. For instructions on filling the distribution system using the OC-44 connection see Appendix A-10. For instructions on filling the distribution system using the CFV import water connection see Appendix A-11.

While the BPWPS can be used to fill the Talbert Barrier distribution system, it is not recommended. The BPWPS produces a higher than desirable flow rate that increases the likelihood of developing a water hammer. For this reason the BPWPS should be utilized only as a last resort option and the IRSO must work with the GWRS treatment plant operators to fill using the BPWPS.

F. Distribution System Leaks

Occasionally leaks develop along the Barrier distribution system. The IRSO should always be looking for leaks in the field. Should a leak surface, the IRSO should take an electrical conductivity (EC) measurement of the leaked water using a field meter. GWRS water has an EC generally in the vicinity of 150 microsiemens, CFV water is typically between 700 -900 microsiemens and Green Acres Project (GAP) water is usually above 1,200 microsiemens. If the water chemistry fits an OCWD profile the IRSO needs to try and determine the location of the leak, then isolate the leak if possible. The Barrier distribution system is not a looped system so isolating a small portion of the main eliminates flow downstream. Determining the location of the leak could be challenging. A specialty contractor like American Leak Detection can employ acoustic technology to accurate locate the leak. Once the leak is located and isolated, a repair contractor can be dispatched. The IRSO shall notify the Distribution & Injection Well Supervisor immediately after noticing a leak.

G. Pressure Profiles

Once a month the IRSO group teams up to conduct a wellness check (pressure profile) at each of the injection facilities along the Talbert Barrier distribution system. Pressure profiles require the IRSO to visit the well site and record various pressures at the well site. A form is completed by the IRSO while on-site. The form is different for Legacy Wells and Modern Wells. These forms are located at: *H:\OCWD\Operations\Water Production\Water Production Shared\WaterProd\Barrier\Talbert Barrier O&M Manual\ Forms*. Figure 16 shows Legacy Well and Modern Well profiling forms respectively. The recorded data from each well is analyzed collectively to gauge the overall health of the distribution system. Pressure profiling is also a great opportunity to conduct any housekeeping activities. If the IRSO notices anything unusual during the pressure profile visit, the IRSO should notify their supervisor immediately and document the issue on the pressure profiling form.

ORANGE COUNTY WATER DISTRICT
Modern Well Monitoring Sheet

Date:
Time:

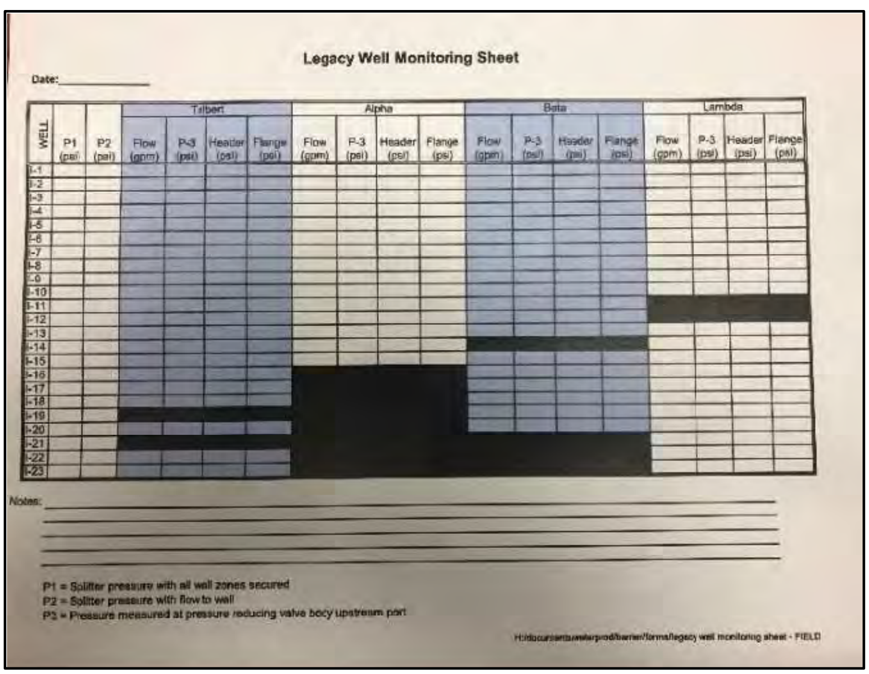
Your Name ____________

	Well No.	Flow (Delta V)	Flow (Display)	Date/time	Delta V Level	Hand Level (ft.)	DELTA hand level	Influent Pressure (Delta V)	Influent Pressure (Display)	Flange Pressure (Delta V)	Flange Pressure (Display)	HVAC Temp	N_2 (psi)
	24F												Oil
	24K												Oil
	25F												Oil
	26H												
	26L												
	26K												
	27H												
	27A												
	27K												
	28H												
LO	28A												
	28K												
	29H												
	29A												
	29K												
	30K												
LC	30B												
	30H												
LO	31H												
	31B												
LO	31K												
	32K												
	32B												
	32H												
	33M												
	34M												
	35M												
	36M												
	MBI-1												
	MBI-2												
	MBI-3												
	MBI-4												
	MBI-5												
	EW-1												

H:\OCWD\Operations\Water Production\Water Production Shared\WaterProd\Barrier\Forms\Modern Well Monitoring Sheet

Figure 16 Pressure profiling forms for Modern and Hybrid Wells (top) and Legacy Wells (bottom). These forms are available electronically at:

H:\OCWD\Operations\Water Production\Water Production Shared\WaterProd\Barrier\Talbert Barrier O&M Manual\ Forms



Legacy Well Monitoring Sheet

Date: ____________

			Talbert				Alpha				Beta				Lambda			
WELL	P1 (psi)	P2 (psi)	Flow (gpm)	P-3 (psi)	Header (psi)	Flange (psi)	Flow (gpm)	P-3 (psi)	Header (psi)	Flange (psi)	Flow (gpm)	P-3 (psi)	Header (psi)	Flange (psi)	Flow (gpm)	P-3 (psi)	Header (psi)	Flange (psi)
I-1																		
I-2																		
I-3																		
I-4																		
I-5																		
I-6																		
I-7																		
I-8																		
I-9																		
I-10																		
I-11																		
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I-14																		
I-15																		
I-16																		
I-17																		
I-18																		
I-19																		
I-20																		
I-21																		
I-22																		
I-23																		

Notes:

P1 = Splitter pressure with all well zones secured
P2 = Splitter pressure with flow to well
P3 = Pressure measured at pressure reducing valve body upstream port

H:\documents\waterprod\barrier\forms\legacy well monitoring sheet - FIELD

H. Pipeline Velocity Concern

Along the Ellis Avenue Pipeline, between Legacy Wells I-16 and I-17 the Ellis Avenue Pipeline travels underneath the Talbert Channel. This segment of pipe was never upsized, while the pipe upstream and downstream was upsized. This section of pipe is the bottleneck of the Talbert Barrier distribution system. The OCWD Engineering Department recommends keeping total flow to the Barrier at or below a flow rate of 32 million gallons per day (MGD) to maintain a safe velocity under the channel. Flow rates exceeding 32 MGD could create an unsafe velocity condition in the bottle neck and could cause the pipe to fail. The IRSO should seek guidance from the OCWD Engineering group before adjusting flow higher than 32 MGD.

5. LEGACY WELL OPERATIONS AND MAINTENANCE

The Legacy Wells are the Talbert Barriers' original injection wells. Constructed between 1968 and 1974 these wells can inject up to approximately 50% of the Talbert Barrier's total daily injection.

A. Background

In 1968 the District installed three demonstration wells and began experimental injection of recycled water into these wells. These three demonstration wells are still in operation today as I-4, I-5, and I-6 (Figure 3).

With favorable results achieved through the demonstration wells, the District embarked on building a full-scale sea water injection barrier. By 1974 contractors were completing an additional 20 injection wells along Ellis Avenue. By 1975 Water Factory 21 began recycling water to feed all 23 injection wells. These original 23 injection wells are called “Legacy Wells”.

Legacy wells are “nested” wells and contain up to four 6-inch casings inside a 30-inch borehole. Each casing in the nest is screened at different depths and subsequently injects into different aquifers. From shallowest to deepest these aquifers are named: Talbert, Alpha, Beta and Lambda. All four aquifers are not always present at each Legacy Well site so not every well site will have all four casings in the nest; however, most Legacy Wells sites do have four casing. An as-built drawing of a typical Legacy Well is shown as Figure 4.

Factory installed witness holes at the collar of each Legacy Well casing joint were never properly welded in the field by the contractor. Over time water velocity leaving these witness holes proved problematic, so the District completed a project to line each 6-inch Legacy Well casing with 4-inch PVC liners above the well screen. At the bottom of each liner is a flush-thread, stainless steel “Figure K” packer. Over the years some of these Figure K packers have been accidentally bent by well redevelopment contractors accessing the well screen. The 4-inch PVC liners prevents the use of conventional well redevelopment tools like tight-fitting swabs, surge blocks and wire brushes.

All Legacy Wells are completed in vaults except for I-4. I-4 is in the northeast corner of the OCWD Fountain Valley campus and is used for public tours. The I-4 well-head lies inside a demonstration building above grade. This concrete block structure has a metal roof with removable panels for well maintenance access (Figure 17).

Figure 17 Demonstration building that houses the I-4 well-head, located in the northeast corner of the Fountain Valley campus. Removable metal roof panels allow access for well

B. Legacy Well Vaults

Legacy Well vaults are reinforced concrete subgrade structures approximately 10' feet deep and measure 10' x 15'. All legacy wells vaults are equipped with continuous ventilation fans and are considered C-5 confined spaces. The IRSO is required to test the vault atmosphere and complete the appropriate paperwork prior to entry. The IRSO uses a 4-gas detection meter to test air quality. The District's Maintenance Department is responsible for the calibration on the personal 4-gas detection equipment. Each IRSO has their own meter. A copy of the manufacturers owner's manual for the 4-gas meter is presented as Appendix A-12. Legacy well vault entries require 2 people - an entrant and an attendant outside the vault. The confined space entry form guides the IRSO step by step and can be found here: H:\OCWD\Operations\Water Production\Water Production Shared\WaterProd\Barrier\Talbert Barrier O&M Manual\ Forms. The entry form must be completed for each vault entry. The IRSO is to return completed vault entry forms to their supervisor weekly.

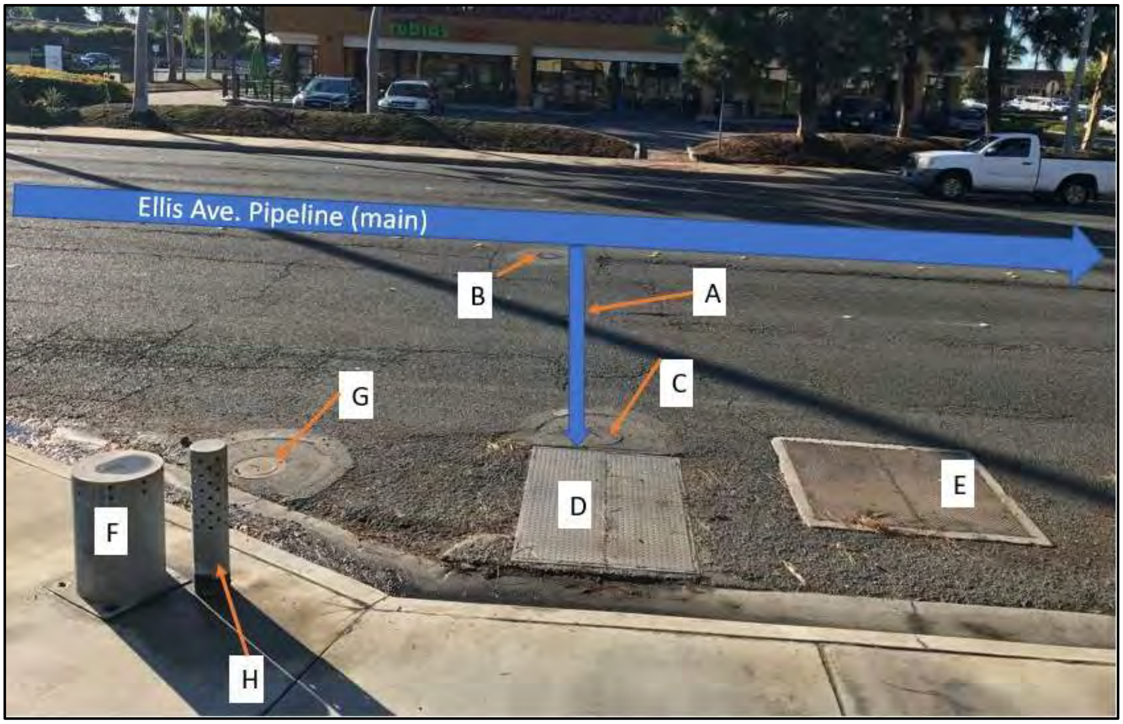


Figure 18 Typical Legacy Well vault site layout. Blue arrows indicate injection flow direction and approximate locations of pipes. **A** Lateral pipeline. **B** Lateral Isolation butterfly valve operator. **C** Cathodic protection test station. **D** Legacy Well vault manway hatch. **E** Legacy Well well-head access hatch. **F** Lateral line air-vac. **G** Cathodic Protection anode access. **H** Vault ventilation riser. (Location: I-10 - northeast corner of Ellis Avenue & Brookhurst

Most Legacy Wells are located in public right-of-way. For this reason the IRSO should use additional caution when accessing Legacy Wells. When a traffic lane closure is required, the IRSO should follow the Watchbook and utilize the arrow board mounted on the roof of their pick-up truck. Lane closures are a team effort involving two or more IRSO's. Wherever possible the IRSO should work with the pickup truck as a barrier between himself / herself and oncoming traffic. The most current version of the Watchbook can be found in Appendix A-1.

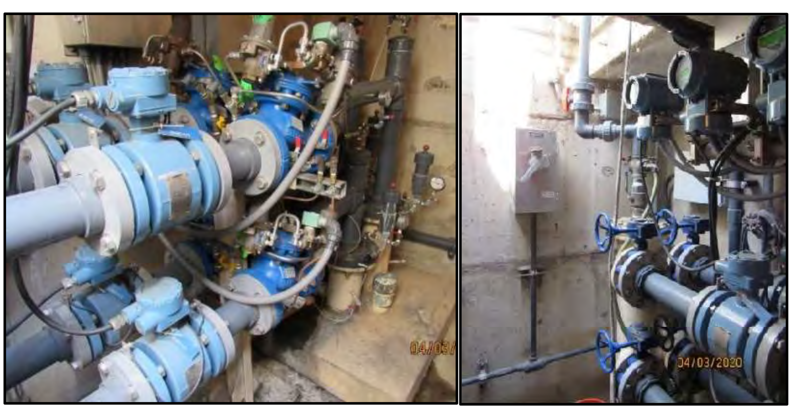


Figure 19 Views looking inside a typical Legacy Well vault. Legacy Well vaults are compact requiring the IRSO to be aware of their surroundings. The Legacy Well well-head is visible in the left image. The Legacy Well components visible in these images are defined later in this manual.

Figure 20 Most Legacy Wells are located in public right-of-way. Legacy well I-10, shown here, is located at the NE corner of the intersection of Ellis Avenue and Brookhurst Street. Notice the vault manway hatch double leaf doors are open. The well-head access hatch has been removed and boards are covering the opening. The white portable desilting tank is owned by OCWD to aid in maintaining backwash discharge compliance.

Each Legacy Well Vault has a well access hatch and a manway hatch (Figure 18). Well access hatches are only used during well redevelopment activities only. The well access hatch bolts are firmly torqued and any gaps are sealed with silicone to avoid leakage into the vaults.

The manway access hatch requires unlocking a padlock and use of a hand tool ("T-handle") to open the hinged lid (Figure 21). The I-1 and I-12 Legacy Well vault manway hatches require the use of a ½ inch allen wrench to open instead of the T-handle. Legacy Well vault manway hatches for I-6 and I-23 are unable to receive a padlock. For this reason, I-6 and I-23 are equipped with intrusion alarm triggered by a spring mounted whisker pole (Figure 22). When the hatch opens, the position of the whisker pole changes from horizontal to vertical. This change in position sends an electronic signal to Delta V that the hatch is open. The IRSO should always call into the GWRS control room prior to entering I-6 or I-23 and make the operators aware of the vault entry ahead of time. When the IRSO closes the hatch, care should be taken to return the whisker pole to a safe horizontal position.

Figure 21 Hand tool ("T-handle") used to open Legacy Well Vault manway hatch.

Figure 22 Intrusion alarm whisker pole switch at the I-6 vault manway hatch.

Just below the manway hatch a metal ladder is mounted to the wall. The ladder is equipped with a spring assisted extension bar. For safety purposes the IRSO should always use the extension bar and always maintain 3-points of contact when ascending and descending. Near the top of the ladder is a light switch that activates a single bulb light fixture mounted to the vault ceiling.

Near the bottom of the access ladder, mounted on the wall is a red button (Figure 23). This "e-call" button, if pushed, creates a red banner alarm in Delta V alerting the viewers that assistance is needed and identifies the vault location. This button should be used by the IRSO when assistance from outside is required beyond the confined space attendant's ability to help.

Figure 23 Near the bottom of the vault access ladder is an e-call button that sends a distress alarm to Delta V. Also in view is the secondary flood alarm float switch. This stainless steel ball is very sensitive and will automatically cut-off all injection into that Legacy Well if activated. *(Not something the IRSO wants to accidentally bump into.)*

The Legacy Well annular space above the Talbert casing well seal was never properly backfilled/ sealed. As a result, the injection water would sometimes surface and flood the vaults. To mitigate the potential to flood the fault, the District completed a project that used microfine cement under high pressure to seal the voids. This effort helped to reduce the amount of leakage into Legacy Well vaults.

Additionally, the District installed a sump in all Legacy Well vault floors (Figure 24). Each vault is equipped with two sump pumps that discharge to the curb/gutter, flood control channel or area of dense vegetation through a common polyvinyl chloride (PVC) discharge line. The lead sump pump resides inside the sump while the supporting pump lies on the vault floor. Both sump pumps are equipped with float switches. Occasionally these pumps and sump pump float switches fail, requiring replacement by the IRSO. The warehouse stocks sump pumps and float switches.

Each Legacy Well vault sump has a small hole cored into the sump wall. This hole prevents shallow groundwater from building up outside the vault by allowing groundwater to flow into the sump and be pumped out of the vault.

Figure 24 A typical Legacy Well vault sump. The supporting sump pump and float switch is visible on vault floor. The lead pump discharge tubing is seen leaving the sump and cam lock connecting to the PVC discharge line. Also present is the lowest (floor elevation) vault flood alarm float switch (just to the right of the supporting sump pump). The perched groundwater weep hole cored high into the sump wall can be seen at 12:00 o'clock.

The Legacy Well vaults are equipped with two flood alarms that send signals back to Delta V. Both of these alarms are float switch activated. The first flood alarm float switch is located on the vault floor (see Figure 24). The second flood alarm float switch is located above the vault floor and typically mounted underneath the electrical panel labeled "RTU". The second float switch is very sensitive and is made of a stainless steel ball (Figure 23). When this float switch is activated a signal is sent through Delta V and the PRV solenoids are closed, securing all flow to the Legacy Well automatically. This alarm can only be reset manually inside the RTU cabinet.

Although the PRV's can be secured automatically by triggering the second flood alarm float switch, leakage upstream of the PRV can still flood the vault. For this reason, it is important that the IRSO respond to all flood alarms quickly and in person. Each Legacy Well vault contains high voltage electrical panels. If faced with a flooded vault situation, the IRSO should notify their supervisor and I&E staff immediately and not enter into a flooded vault. The IRSO should work above ground surface to isolate the source of flooding and pump down the vault.

Legacy Well vaults are continuously ventilated 24/7 utilizing a high-volume fan and influent / effluent ventilation risers outside the vault. The electric fan is mounted to the vault wall (Figure 25) and occasionally fails. The IRSO is responsible for replacing inoperable fans. The fans plug into the 110 volt AC power outlet mounted near the fan on the vault wall. The warehouse stocks replacement Legacy Well vault fans.

Figure 25 Legacy Well vault ventilation fan. Four bolts mount the fan to the vault wall near the ceiling. These fans occasionally fail and require replacement by the IRSO. Fans plug into a 110V electrical receptacle for energy. Replacement fans are stocked in the warehouse.

IRSO's are responsible for the maintenance and operation of sump pumps, sump pump float switches, ventilation fans and ceiling light bulb. I&E staff takes care of maintaining all other electrical components of the Legacy Well vault.

It is the IRSO's responsibility to keep the Legacy Well vaults clean and free from debris. While visiting a Legacy Well, if the IRSO notices anything unusual about the condition of the vault, the IRSO should notify their supervisor immediately.

In the event of an electrical power interruption, the Legacy Wells are equipped with an uninterruptable power supply (UPS) that can provide enough power to keep the Legacy Well PRV solenoid from closing, allowing the well to continue injecting for up to 1 hour without power from the electrical grid.

C. Legacy Well Operation

All Legacy Wells are equipped similarly and operate using the same operational theory. Because of their age and delicate well seals, Legacy Wells inject passively utilizing pressure from the BPWPS to deliver water to the well site. The discharge pressure for the BPWPS is set at 60 pounds per square inch (psi).

Figure 26 shows the anatomy of Legacy Well I-4. All components shown in Figure 26 are also inside Legacy Well vaults. All Legacy Well casings and vaults are equipped similarly. Legacy Well I-4 injects into all 4 aquifers while other Legacy Wells range between 1 and 4 casings per vault (see as-built drawings I-1 through I-23).

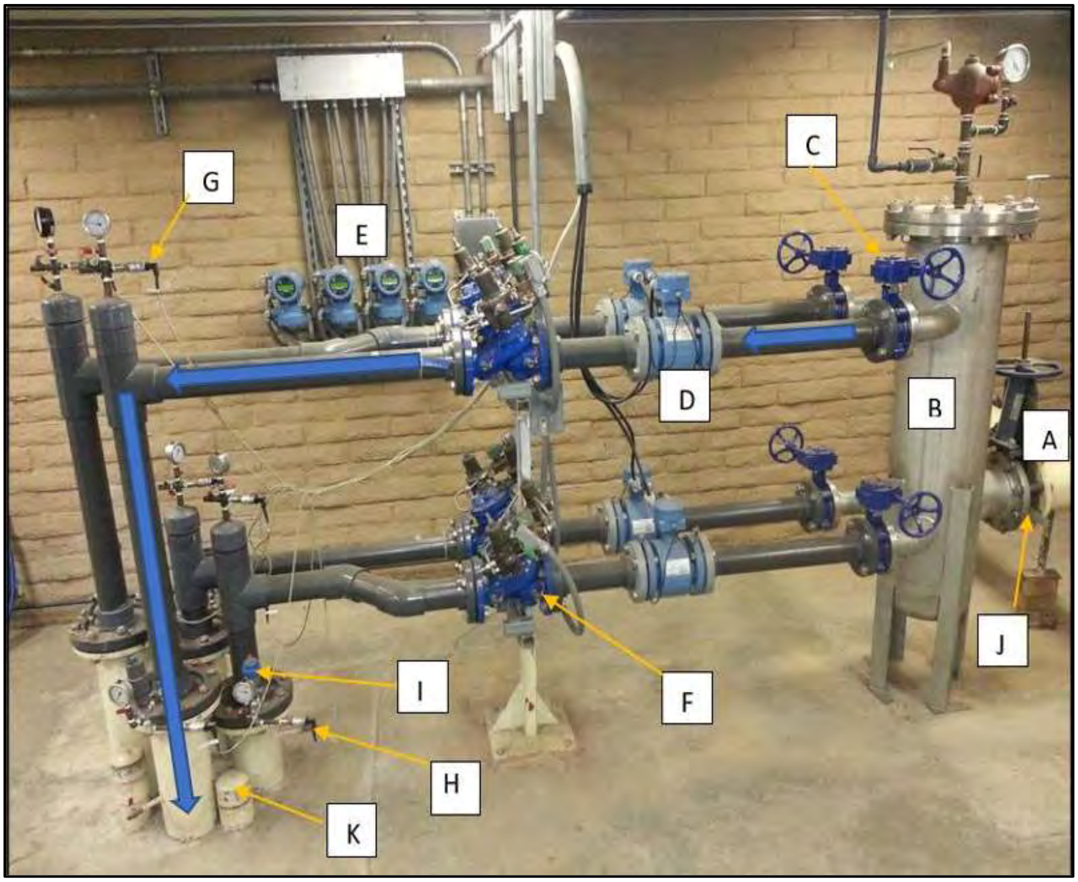


Figure 26 Anatomy of a 4 zone Legacy Well (blue arrows indicate injection flow path). **A** Lateral pipeline connecting main to the Legacy Well site. **B** Splitter box that divides flow from the lateral into individual 3-inch diameter flow tubes that feed injection casings (4 injection casing at this well). **C** Butterfly valve used to manually control flow into well casing and reduce influent pressure. **D** 3-inch diameter magnetic flow meter for each injection casing. **E** Local flow meter display for each injection casing. **F** Pressure reducing valve (PRV) for each injection casing. **G** Well-head pressure transmitter, one for each injection casing (also ported for pressure gauge). **H** Well flange pressure transmitter, one for each injection casing (also ported for pressure gauge). **I** 1-inch PVC air-vac tapping well flange allowing the casing to breath. **J** Orifice plate at the lateral pipeline connection to the splitter box. **K** capped 3-inch gravel feed tube. There is a gravel feed tube for each Legacy Well casing. For exact orientations of all Legacy Well gravel feed tubes see as-built drawings.

Because of their age and delicate well seals, Legacy Wells operate under lower influent pressure conditions than modern and hybrid wells. Pressure is reduced at several points along the injection flow stream. First, an orifice plate is installed at the flange connection between the splitter box and the lateral (Figure 25, J).

Legacy wells are aged and the seals separating the injection zones inside the well bore have degraded. For this reason, pressure into the Legacy Wells needs to be reduced beyond the splitter box orifice plate.

Located upstream of each Legacy Well injection casing are 3-inch Bermad pressure reducing valves (PRVs). These hydraulic, solenoid actuated, valves regulate downstream pressure and communicate with the process control software – Delta V. The PRV can only be started or stopped in Delta V, any adjustments are done manually in the field by an IRSO. The PRV owners manual explains how to manually operate and maintain this valve. A copy of the PRV owners manual is provided as Appendix A-13.

Upstream of the hydraulic pressure reducing valve lies a butterfly valve. This butterfly valve is used by the IRSO to 1) manually secure injection into the well casing and 2) reduce pressure into the PRV.

The PRV can be used by the IRSO to remotely start and stop injection into a Legacy Well. The PRV *cannot* be adjusted in Delta -V only started or stopped. Appendix A-14 provides instructions for remote Legacy Well start/stop operations. Sometimes these pilot valves (solenoids) can physically stick, requiring the IRSO to visit the valve and gently tap the solenoid. If gentle taping does not retore solenoid functionality, the valve will need to be rebuilt and solenoid replaced. The IRSO is responsible for rebuilding PRVs and replacing PRV solenoids. The Warehouse stocks PRV solenoids and rebuild kits. The PRV solenoid rebuild / replacement instructions are also found in Appendix A-13.

PRV malfunction can also be the result of an aged diaphragm inside the valve body. The IRSO is responsible for replacing PRV diaphragms. Figure 27 shows a PRV diaphragm being prepared for replacement. A set of 18 images of PRV diaphragms being replaced can be found at H:\OCWD\ Operations\ Water Production\ Water ProductionShared\ WaterProd\ Barrier\ Photos\ Bermad rebuild photos.

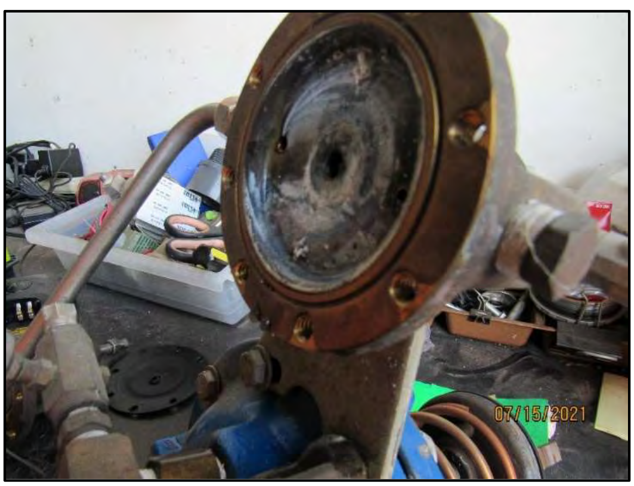


Figure 27 PRV valve diaphragm being prepared for replacement . A new replacement diaphragm is visible in the lower left quadrant of this image.

The PRV reduces pressure at a ratio of 5:1. The upstream butterfly valve can be throttled by the IRSO to achieve even lower pressure into the well. Ideally, the Legacy Well header should be 8 psi or less. If flange pressure reaches 10 psi flow to the well should be secured.

Because Legacy Well seals are compromised, it is important the IRSO maintain the same (or close to the same) header pressure for all casings in the well bore. This will reduce the potential for fine grained materials to travel from one zone to another across the compromised well seals. This migration of fines causes loss of well performance as the fines get lodged in the pore opening of aquifer and restricts flow.

Flow is delivered into the injection well using a 3-inch open-ended eductor pipe. This 3-inch PVC tubing threads into the underside of the well flange and extends 20 feet below the lowest historic static water level for that well casing. Some of the down-well eductor pipes contain a slightly less than 3-inch diameter stainless steel orifice plate designed to create a small amount of backpressure necessary for optimal PRV function.

As flow is delivered into the well casing through the eductor pipe, the water level inside the Legacy Well casing will rise (mound) slowly as injection proceeds. This level may rise to the well-head and occasionally pressure can build underneath the well-head flange. This pressurized condition lets the IRSO know that the well is becoming a good candidate for redevelopment. Ideally the Legacy Well flange pressure is zero; however, the well flange pressure should not exceed 10 psi before flow to the well is secured.

Delta V allows the IRSO to set an automatic shut-down pressure setpoint. All Legacy Wells are programed to automatically shut-down once the flange pressure exceeds 15 psi.

Legacy Wells are equipped with pressure indicating transmitters (PIT) at the injection casing header and at the injection casing flange. Occasionally these transmitters fail and need replacement. It is the IROS's responsibility to replace these transmitters. The PIT (Figure 26, G, H) and (Figure 28) is a "plug and play" devise. The Warehouse stocks replacement PITs.

Figure 28 Legacy Well pressure indicating transmitter assembly. Pressure sensing device (top), gasket (middle) and plug (bottom). The plug rarely fails. Gaskets should be changes when replacing the pressure sensing devise. This is a low voltage assembly. The warehouse stocks these parts.

D. Legacy Well Maintenance

While the IRSO has several Legacy Well maintenance responsibilities including rebuilding PRVs, vault sump pumps and float switches; of *paramount* concern to the IRSO is injection well performance.

Legacy Well Performance

Legacy well performance is a function of flow into the well and the corresponding pressure response. Ideally injection wells would inject high flow rates with gradual pressure responses over long periods of time. Primary factors affecting injection well performance include: biological growth down-well, dissolved gas binding and deposition of fine grained solids.

Since 2009 the Talbert Barrier began injecting 100% recycled water, providing OCWD complete control of injection water quality. The advanced treatment process employed by GWRS does a good job of eliminating any organic nutrient and consequently biological growth in Legacy Wells is minimal.

To address well fouling by air-binding, Legacy Well-heads are equipped with a 1-inch diameter air vacuum and release valves at the well-head flange to allow the well casing to breath (see Figure 26, I).

As discussed previous in the "Distribution System" section of this manual, GWRS final product water reacts with the cement mortar lining of distribution pipe to shed particles that accumulate in the well screen and adversely affects injection well performance. To address this, the District periodically contracts well redevelopment services.

E. Legacy Well Redevelopment

The District periodically hires well redevelopment contractors to remove accumulated solids from the Legacy Wells (Figure 29). Prior to GWRS, OCWD has tried many different well redevelopment techniques to remove an array of foulants produced by various water quality changes. Since GWRS and the stability of injection water quality, Legacy Wells clog slower because the primary fouling agent is solid deposition. Solids are removed from Legacy Wells by reversing the flow direction and purging the well. Because static water levels are high along the coast, air-lift pumping can be employed to pump the well.

Since 2000, IRSO staff has been developing various technical specifications for these periodic Legacy Well redevelopment contracts. The latest version of the contract's technical specifications is located at: *H:\OCWD\Operations\Water Production\Water Production Shared\WaterProd\Barrier\Talbert Barrier O&M Manual\ Legacy Well Redevelopment Specifications*.

Figure 29 Injection Well redevelopment contractor working on Legacy Well I-14 (Ellis @ Bushard). The contractor is air-lift pumping the well to dislodge and remove fine grained particles that accumulate in the well screen and adversely impact well performance. Air-lift pump discharge is desilted in the white baffled tank and placed in the local sewer. The discharge will be return to GWRS for treatment and future injection.

Additionally, IRSO staff provides field guidance for all contracted Legacy Well redevelopment work. Since 2000, IRSO staff has been documenting Legacy Well redevelopment activities by completing reports. Electronic copies of these documents are located here: *H:\OCWD\Operations\Water Production\Water Production Shared\WaterProd\Barrier\Talbert Barrier O&M Manual\Legacy Well Rehab Reports*. Hard copies of these documents, the yellow field book and any pre 2000 Legacy Well field or construction notes can be found in the lower two file cabinet drawers along the Southeast wall of the 540 Building of the GWRS campus (see Figure 30). The Legacy Well redevelopment blank forms used by the IRSO to guide and document Legacy Well redevelopment activities are located here: *H:\OCWD\Operations\Water Production\Water Production Shared\WaterProd\Barrier\Talbert Barrier O&M Manual\Forms.*

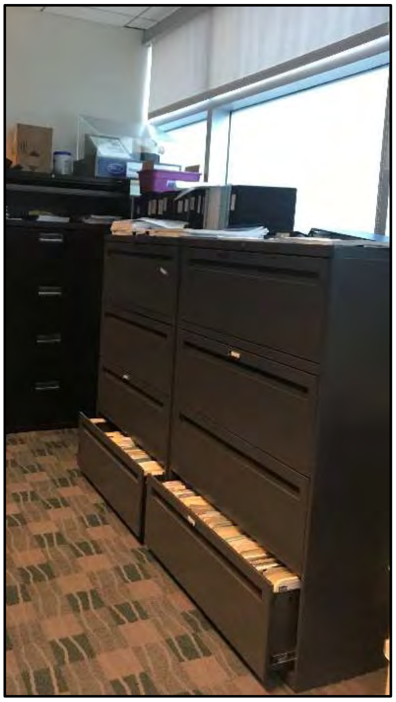


Figure 30 File cabinet in the SE corner of the 540 building. The two open drawers contain files for each Legacy Well. Files include hard copies of images, records, drawings and well redevelopment summary reports.

Legacy Well redevelopment contracts typically occur every third year and contain budget to cover approximately half of the Legacy Well sites. Legacy Wells are selected for redevelopment based upon the IRSO's observations of long-term flow and pressure response trends using Delta V. All legacy Wells perform differently. Some Legacy Wells inject 375 million gallons prior to redevelopment, others 55 million gallons. The IRSO observations are critical in determining the need for Legacy Well redevelopment.

F. Gravel Feed Tube Measurements

The IRSO should periodically measure the depth of Legacy Well gravel feed tubes. Measurements should be recorded on the form entitled Gravel Tube Depths CURRENT located on the local network at *H:\OCWD\Operations\Water Production\Water Production Shared\WaterProd\Barrier\Talbert Barrier O&M Manual\ Forms*.

6. MODERN WELLS

Modern Wells, constructed between 2000 and 2006, incorporate into their design advancements developed from 25 years of operating Legacy Wells and 5 years of operating Hybrid Wells. Modern Wells contribute approximately 50% of the total daily average injection through the Talbert Barrier. An as-built drawing of a typical Modern Well is attached as Figure 6.

A. Background

All modern wells are completed above ground and outside public-right-of way utilizing one 12-inch injection casing per bore hole. Modern Well sites have either three injection casings per site (Figure 31) (*also see* Figure 3: I-26 through I-32) or one injection casing per site (Figure 31) (*also see* Figure 3: wells I-33 through I-36). In addition to tapping the Talbert, Alpha, Beta and Lambda aquifers, some Modern Wells also inject into the Main aquifer. The Main aquifer, which is deeper and less susceptible to seawater intrusion, is recharged artificially by injecting into these deep Modern Wells.

Figure 31 Images of Modern Injection Well I-26 (left) containing three injection casings and Modern Well I-34 (right) containing one injection casing.

B. Modern Well Operational Theory

All Talbert Barrier Modern Wells are equipped similarly and operate using the same operational theory. Figure 32 shows the layout of a typical Modern Well and identifies the flow paths for injection influent and backwash discharge.

Figure 32 Typical Talbert Seawater Intrusion Barrier Modern Injection Well. Blue arrows indicate the flow path from the lateral pipeline into the well casing. Orange arrows indicate the backwash discharge flow direction. **A** Lateral isolation butterfly valve operator.

The Modern Well well-head is shown in greater detail in Figure 33.

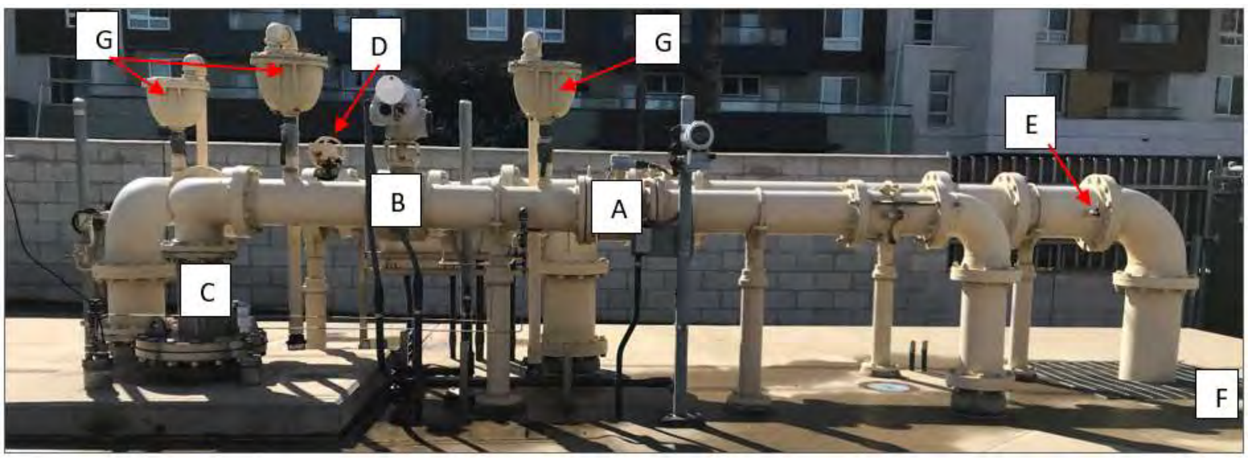


Figure 33 Modern Well components identified. **A** Magnetic flow meter (station mounted local display visible above and to the right of the meter). **B** Motor operated butterfly valve (MOV). **C** Well-head. **D** Discharge butterfly valve (manually operated). **E** Discharge sample spigot. **F** Storm drain catchment basin. **G** Air-vacs.

Injection flow is delivered from the main to the Modern Well via the lateral pipeline. The lateral pipeline daylights just downstream of the isolation valve (see Figure 32, A) and makes a 90^{o} turn (towards the well-head) above ground. Flow is first measured using a magnetic flow meter and displayed in Delta V and at the site. Flow then travels through a motor operated butterfly valve (MOV) with upstream and downstream air-vacs. Flow is then deflected down-well through another pipe elbow. A pressure transducer measures the injection level from inside the camera tube and communicates the level to Delta V. The transducer measures the weight of the water above it and mathematically converts this to an accurate water level inside the casing.

A detailed look at the components of a typical Modern Well well-head is shown as Figure 34.

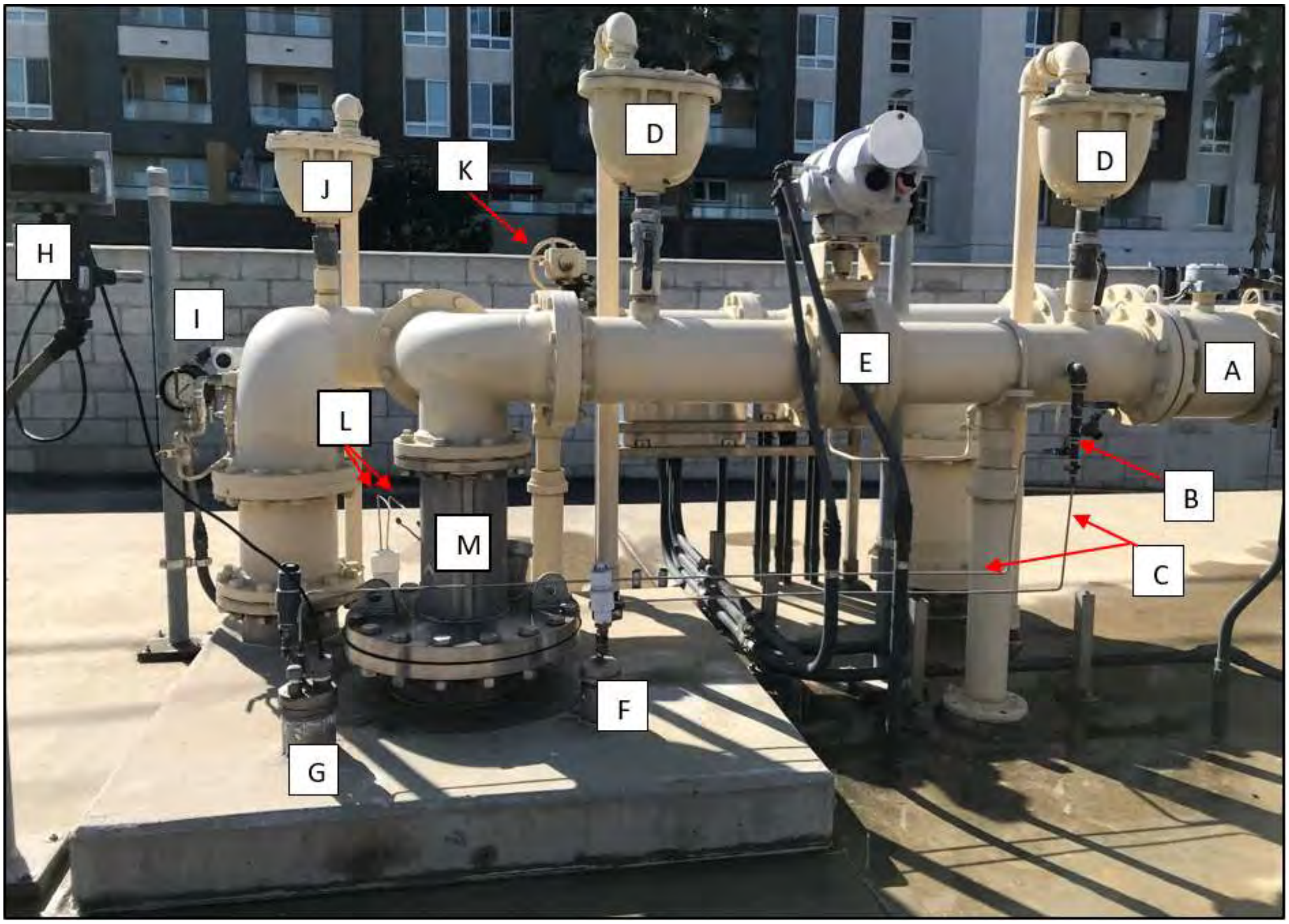


Figure 34 Details of a Talbert Barrier Modern Injection Well well-head. **A** Magnetic flow meter. **B** Injection influent flow sample spigot. **C** ¼-inch diameter stainless steel tubing used to trickle continuous flow into the gravel feed tube and the camera tube to prevent stagnation and biological growth. **D** Injection influent air vacuum and release valves (2-inch diameter). **E** Motor operated butterfly valve (MOV). **F** Gravel feed tube. Cap is ported to receive ¼-inch stainless tubing for trickle flow and a 1-inch air vacuum and release valve. **G** Camera tube access port (4-inch diameter). Camera tube cap is ported to receive ¼-inch stainless tubing for trickle flow, 1-inch air vacuum and release valve and level sensor cable. A level sensing transducer is submerged below the static water level inside the camera tube. The level sensor cable is visible leaving the camera tube and connecting to a level indication transmitter (LIT). **H** LIT with local injection level display. local injection level displays at all Modern Well sites have been disabled and any of the display boxes painted black. **I** Pressure indication transmitter (PIT) with pressure gauge. **J** Backwash discharge air vacuum and release valve (2-inch diameter). **K** Backwash discharge manual butterfly valve. **L** Baski Valve influent and effluent ¼-inch stainless steel tubing [completes a nitrogen cylinder to Baski Valve to atmosphere route]. **M** Well-head eductor spool.

Figure 35 shows the buried components of the Modern Well well-head.

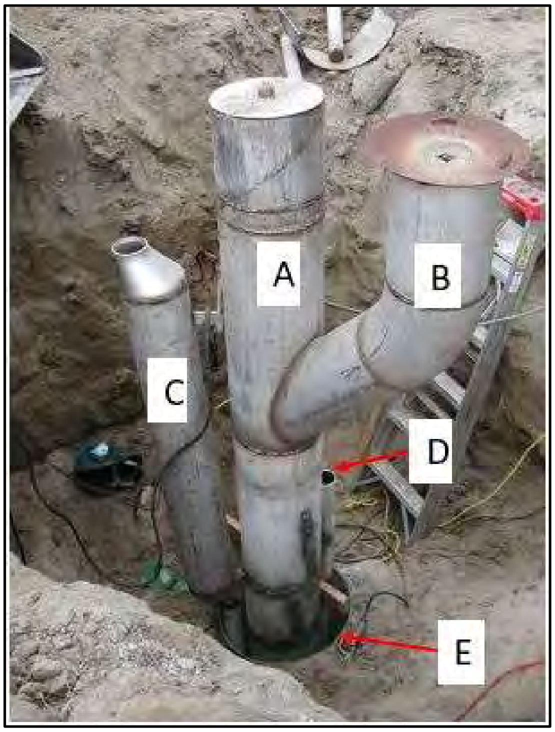


Figure 35 Modern Well well-head below ground surface. **A** 12-inch injection casing. **B** Backwash discharge piping. **C** 3-inch camera tube. Note the two eccentric reducers and pipe spool used to allow for the passage of long geophysical tools without getting stuck as the camera tube angels away from the injection casing. The top eccentric reducer is 4-inch, the lower eccentric reducer is 3-inch. This camera tube acts as an airline in most Modern Wells when backflushing. The camera tube acts a stilling well and houses the LIT while injecting. **D** 3-inch gravel feed tube. This tube contains two 11.5° bends (not visible in image) to clear well-head equipment at the surface. **E** Conductor casing.

C. Flow Meters

The Modern Well flow meters are magnetic flow meters maintained by the District's I&E Department. If the IRSO observes a trend of irregular and erroneous flow reading, an I&E request should be submitted. The IRSO should explain all observed irregularities to the I&E technician. The flow meters communicate with Delta V and also have a local display mounted at the well site. Modern Well flow meters are calibrated and serviced by the OCWD I&E department. If the IRSO observes inaccurate flow rates an I&E request should be submitted.

When Modern Well flow meters typically fail it is because the flow tube liner deteriorates. Original flow tubes were lined with neoprene. The District is replacing flow tubes as they fail with flow tubes lined with Teflon^{tm} for longer life.

D. MOV

Each Modern Wells is equipped with an MOV just upstream of the injection well-head. Modern Wells I-29 through I-36 are equipped with modulating MOVs that allow the IRSO to choose a valve position between 0 – 100% open. MOVs at Modern Wells I-26 through I-28 do not modulate and only provide the IRSO the option of closed or fully open.

All Modern Well MOV's are maintained and serviced through the I&E Department or a factory field technician. The IRSO should coordinate MOV service or repair by submitting an I&E request and supporting the I&E tech when applicable.

E. Level Sensors and Transmitters

Modern Well level sensors and level transmitters are calibrated and maintained by the District I&E Department with support from the IRSO group. Pressure transducer level sensors are housed inside the Modern Well 3-inch camera tube. These sensors are delicate and require that the IRSO take great care when handling. The IRSO is required to temporarily remove the sensor from the camera tube to conduct backwash activities.

In the summer and in the winter the IRSO takes a hand level at each Modern Well site. The hand level is recorded on the well profiling forms described in section 4G of this manual. If the discrepancy between the hand level and the transducer level is greater than 1 foot, the IRSO must notify his supervisor.

F. Air-Vac's

Occasionally the 1-inch and 2-inch air-vacs on Modern Wells fail to consistently seat properly and require replacement. Modern Well air-vac replacement is the responsibility of the IRSO. For safety purposes, replacing the 2-inch air-vac should be completed by two or more IRSO's using the auto crane mounted in the bed of T-89. First, close the ball valve below the air-vac. Then unthread the defective air-vac at the nipple below the air-vac and above the insolation ball valve and remove air-vac with crane. Lift new air-vac into place with crane and thread onto the nipple. Lastly, open the ball valve below the air-vac.

G. Down-Well Flow Control Valve

Unlike the Legacy Wells, Modern Wells are equipped with a down-well flow control valve mounted to the end of the eductor pipe. All Modern Wells are equipped with an 8-inch Baski down-well flow control valve (Baski Valve) manufactured and tested by Baski Inc. , Denver Colorado. The Baski Valve operates on the principle of an inflatable / deflatable rubber bladder inside a stainless steel body. Nitrogen gas is used to inflate the bladder to stop flow. Conversely, when nitrogen gas is bled from the Baski Valve, flow initiates. Pressure on the bladder determines the flowrate of water passing through the Baski Valve. The entire assembly is encased inside a stainless steel housing (Figure 36). Factory information about the Baski Valve can be found in Appendix A-15**.** A Table showing the depth placement of all Talbert Barrier Baski Valves is located here: *H:\OCWD\Operations\Water Production\Water Production Shared\WaterProd\Barrier\Talbert Barrier O&M Manual\ Talbert Barrier Injection Well – construction Details***.** The Baski Valve communicates directly with Delta V.

Figure 36 Baski Valve identified by the red bracket in the left image. A close up of the valve discharge port is shown in the right image. Note the 2-inch dedicated airline passing through the Baski Valve and bullnose pipe end-piece at the end of the assembly. This allows greater airline submergence for shallow Modern Well settings.

H. Modern Well Operational Choices

The IRSO uses Delta V to operate Modern Wells. Delta V provides the IRSO three different operation choices for Modern Wells. The IRSO has the choice to operate a Modern Well based on:

- Flow
- Flow and Level
- Flow and Pressure

a. Flow Mode

Delta V allows the IRSO to input a flow setpoint in flow mode. The Baski Valve will modulate to maintain the flow setpoint regardless of injection level inside the well casing and pressure that builds up underneath the injection well-head.

Operating Modern Wells in flow mode long term can potentially damage the well by pushing fine grained particles far away from the well into areas of the aquifer that are unrecoverable during backwashing. For this reason, Modern Wells are only operated in flow mode when the wells level instrument is malfunctioning.

b. Flow and Level Mode

Delta V allows the IRSO to input setpoints for flow and level. When a set point is triggered, a certain action is initiated. For example, in a "flow and level" scenario the IRSO may input a flow rate of 100 gpm and a level setpoint of 5 feet below ground surface (bgs). Under these conditions Delta V tells the well to inject 100 gpm until the water level inside the casing reaches 5 feet bgs. When the input level of 5 feet bgs is reached the Baski Valve partially closes gradually until the flow leaving the Baski Valve is low enough to maintain the level setpoint. Over time, as the aquifer fills and the well clogs, the well will continue to ramp down it's flow to maintain the desired setpoint level. Note: 100 gpm and 5 feet bgs were randomly selected, the IRSO has a wide range of flows and levels available for setpoint input. Typically the flow rate setpoints vary from well to well. Modern Well level setpoints are summarized in the table below:

Modern Well	Level Setpoint
I-26 through I-29 (all casings)	2 feet bgs
I-33 through I-36	2 feet bgs
I-29 through I-32 (shallow & deep casings)	15 feet bgs
I-29 through I-32 (intermediate depth casings)	60* feet bgs

* This level setpoint can be raised with the approval of the District's Chief Hydrogeologist

The majority of the time Talbert Barrier Modern Wells operate in flow and level mode. This operational mode reduces the risk of surfacing water (and the potential to damage nearby buried infrastructure) yet achieves protective groundwater levels in the Talbert Gap.

c. Flow and Pressure Mode

If desired, Delta V allows the IRSO to input setpoints for flow and pressure. In a "flow and pressure" scenario the IRSO can, for example, input a flow rate of 100 gpm and a pressure setpoint of 5 pounds per square inch (psi). Under these conditions Delta V tells the well to inject 100 gpm until the pressure underneath the well-head flange reaches 5 psi. When the 5 psi input pressure is reached the Baski Valve partially closes until the flow leaving the down-well flow control valve is low enough to maintain the pressure setpoint. Over time, the well will continue to ramp down it's flow to maintain the desired setpoint pressure. Note: 100 gpm and 5 psi were randomly selected, the IRSO has a wide range of flows and pressures available for setpoint input.

The majority of the time Talbert Barrier Modern Wells operate in "flow and level" mode. Operating Talbert Barrier Modern Wells in flow and pressure mode long term can potentially damage the well by pushing fine grained particles far away from the well into areas of the aquifer that are unrecoverable during backwashing. For this reason, Modern Wells are rarely operated in flow and pressure mode.

For instructions on how to operate Modern Wells see Appendix A-16.

I. Eductor Leakage

Sometimes minor leakage from the Modern Well eductor pipe ("drop pipe") occurs when the Baski Valve is fully closed. Modulating MOV's allow the IRSO to keep the eductor pipe full during a Baski Valve closed situation when there is leakage at the eductor pipe couplings. To remedy the leaky drop pipes at Modern Well sites not equipped with modulating MOV's (I-26, I-27 and I-28) a 1-inch bypass line around the MOV has been installed (Figure 37). The flow through the 1-inch bypass line is greater than the leakage from the eductor pipe, subsequently the eductor remains fully charged and ready for degassed injection flow to resume once the Baski Valve is opened.

Figure 37 1-inch MOV bypass line. These lines are installed at: I-24, I-25, I-26, I-27 and I-28 and used to combat eductor pipe leakage from the couplings when the Baski Valve is closed.

J. Modern Well Maintenance

While the IRSO has several Modern Well maintenance responsibilities, of *paramount* concern to the IRSO is well performance.

Modern Well Performance

Modern Well performance is a function of flow into the well and the corresponding pressure response. Ideally Modern Wells would inject high flow rates with gradual pressure responses over long periods of time. Primary factors affecting injection well performance include: biological growth, dissolved gas binding and deposition of fine grained solids.

Since 2009 the Talbert Barrier began injecting long-term 100% recycled water, providing OCWD complete control of injection water quality. The advanced treatment process employed by GWRS does a good job of eliminating organic nutrient and consequently biological growth in Modern Wells is minimal.

To address well fouling by air-binding in Modern Wells, the Baski Valve is closed and the eductor pipe is filled. The air-vac at the top of the well-head expels trapped gasses. Once the well-head air-vac seats, the Baski Valve can be opened to begin the injection of degassed water.

As discussed in the "*Distribution System*" section of this manual, GWRS final product water reacts with the cement mortar lining of distribution pipe to shed particles that accumulate in the well screen and adversely affects injection well performance. To address this, the District invested in a trailer mounted high pressure, large volume air compressor (Figure 37). This piece of equipment allows the IRSO to backwash Modern Wells without any outside support services.

Figure 37 Airlift backwashing Modern Well I-29 utilizing the District-owned portable air compressor (TR-64). This image was captured the moment when air-lift break over pressure was achieved and discharge first reached atmosphere. Most of the time discharge is fully contained within the on-site storm drain catchment basin.

K. Modern Well Redevelopment

Fine grained particles that clog Modern Injection Wells can be removed by backwash pumping the well for a short period of time, usually less than 1 hour. These particles range in size from one micron to visible with the naked eye. During injection, these particles can enter the void openings of the aquifer and sharply reduce the wells ability to inject water easily. Research indicates that the particles originate from two sources: 1) shedding of the distribution system pipe interior and 2) particles in the lime deliveries that do not completely dissolve during the GWRS treatment stabilization process.

A typical Talbert Barrier Modern Well is taken off-line and backwashed after 30 – 50 million gallons injected. Reduction in injection flow and elevated injection levels are good indicators that a Modern Well is ready to be backwashed. The IRSO reviews historic trends of Modern Well performance in Delta V.

The IRSO mobilizes the District owned, trailer mounted, high volume/ high pressure air compressor to the well and performs backwashing by air-lift pumping the Modern Well (Figure 38). Modern Well backflushing procedures are provided as Appendix A-17.

Figure 38 Two IRSO's backwashing Modern Well I-36. The operator on the left is controlling the air from the compressor into the well. The operator on the right is monitoring and documenting the discharge water quality for regulatory compliance. The well can be seen discharging into the storm drain catchment basin.

L. Other Modern Well Maintenance Activities

a. Baski Valve

The Baski Valve consumes nitrogen during it's operation. Periodically the IRSO will need to change out the spent nitrogen cylinder with a full cylinder. Baski Valve nitrogen cylinder replacement instructions are presented in Appendix A-18. Figure 39 shows the inside of a Modern Well Baski Valve cabinet. If nitrogen is being consumed at a higher than normal rate there may be a leak in the ¼-inch stainless steel tubing that delivers nitrogen from the control panel to the Baski Valve. The IRSO can spray Snoop^{TM} leak detection solution along the tubing and look for bubbles. The bubble will occur at the leak location. Leaks usually occur at fittings. The IRSO can usually stop the leak by tightening the fitting. The Baski Valve requires no routine service. Should the valve malfunction, Baski Inc. will need to be notified. The IRSO does not repair the BASKI Valve, only factory representatives. The Baski Engineer who is most familiar with the Talbert Barrier Baski Valves is Nick Hemmingway [cell phone (303) 901-5559, office (303)789-1200].

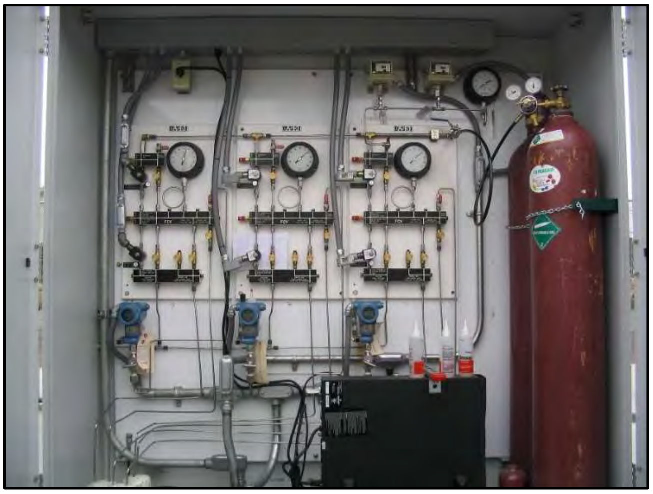


Figure 39 Typical 3 casing Modern Well Baski Cabinet. The nitrogen cylinder and regulator are featured along the right. Influent and effluent nitrogen line pressure gauges are mounted to the back wall. The uninterruptable power supply (UPS) is visible on the floor.

b. Uninterruptable Power Supply

The UPS is a back-up power supply that is engaged when power to the Modern Well site is interrupted (Figure 39). Should an electrical power black-out at the well occur, the UPS will deliver the energy required for the Baski Valve solenoids to secure flow through the Baski Valve. The UPS usually holds a charge for 15 to 30 minutes and remains plugged into the 110V power outlet inside the Baski Cabinet. When power is restored to the well site, the MOV automatically closes and the Modern Well is ready to receive commands from Delta V to restore injection.

The IRSO is not responsible for maintaining the UPS. The I&E department maintains the UPS systems at Modern Well sites. Occasionally the IRSO may hear a high pitch beeping sound coming from the UPS signaling that some type of service is required. In this case, the IRSO should submit an I&E request to have it looked at by a technician.

c. Process Control Panel

All Modern Wells have a process control panel. This panel houses the electronic circuitry that communicates with Delta V and the Modern Well valves, flow meters and other devices. This panel is temperature sensitive and is equipped with air conditioning unit mounted to the panel door. I&E staff maintains and repairs all items inside the process control panel. The IRSO is responsible for maintaining the air conditioner filter. This filter simply slides out from the side of the unit as shown in Figure 40. The filter is rinsed out using the on-site water supply, air dried and then reassembled. The filter can be cleaned while the air conditioner unit is running. This procedure should take less than 20 minutes to complete. Cleaning the air conditioner unit filters is a monthly task usually accomplished during the Modern Well monitoring site visit (pressure profile).

Figure 40 Modern Well Process Control Cabinet. Note the air conditioner unit mounted to the door. The air conditioner filter removes by gently pulling on the tab sown. The filter in this image is partially removed. The IRSO removes, rinses and reinstalls these filters monthly as a preventative maintenance activity.

d. Air-Vac Replacement

Occasionally a Modern Well air-vac will fail. The IRSO is responsible for replacing failed air-vacs. Air-vac replacement is done utilizing at least two IRSOs and the auto crane mounted in the bed of T-89. First, close the ball valve below the air-vac. Then unthread the defective air-vac at the nipple below the air-vac and above the insolation ball valve and remove air-vac with crane. Lift new air-vac into place with crane and thread onto the nipple. Lastly, open the ball valve below the air-vac.

e. Gravel Feed Tube Measurements

The IRSO should periodically measure the depth of Modern Well gravel feed tubes. Measurements should be recorded on the form entitled <u>Gravel Tube Depths Current</u> located on the local network at:

H:\OCWD\Operations\Water Production\Water Production Shared\WaterProd\Barrier\Talbert Barrier O&M Manual\ Forms.

High Voltage Electrical Panel

Electrical Panels labeled “High Voltage” are located at Modern Well sites I-29 through I-36. Modern Well sites I-29 through I-36 were originally designed to be backwashed using electric submersible pumps. The District decided to backwash by airlift pumping prior to installing the submersible pumps. As a result, these panels were never equipped. There is no need for the IRSO to open these panels.

7. HYBRID WELLS

A. Background

Bridging the time gap between Legacy and Modern Wells, Hybrid Wells I-24 and I-25 were constructed between 1998 and 2000. There are only two Hybrid Well sites in the Talbert Barrier. Hybrid Well sites I-24 and I-25 are both located on the OCWD Fountain Valley campus along the East Perimeter Road (Figures 3 and 41).

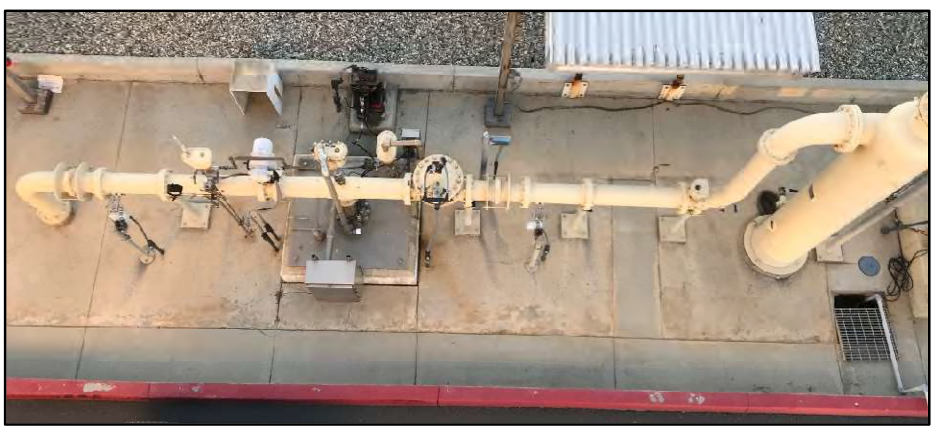


Figure 41 Hybrid Well site I-24 (above) and I-25 (below) located on the OCWD Fountain Valley campus along the East Perimeter Road. I-24 is nested with 2 casings in 1 bore hole. I-25 is a single casing well. Although these two wells are only separated by 420 feet, the geology is different, hence, the different well completions. Geologists claim that a splay of the Newport Inglewood Fault Zone runs between the two Hybrid wells.

Currently I-24 and I-25 are non-operational. A project to upgrade both Hybrid Wells is being planned at the time of this writing.

Well I-24 is a nested well with two 12-inch diameter casings in one 36-inch diameter borehole. Well I-25 is a single 12-inch casing well inside a 22-inch borehole. Figure 9 shows an as-built drawing of Hybrid Well I-24.

Hybrid Wells are the only Barrier wells completed with stand-alone 2-inch diameter sounding tubes. Each sounding tube is screened identical to its respective injection casing and houses a pressure transducer / water level indicator.

All Hybrid Wells are equipped with 200 HP electric submersible backwash pumps. Hybrid wells are the only wells in the Barrier equipped with dedicated pumps for backwashing.

Hybrid Wells I-24 and I-25 are the only Talbert Barrier injection wells that discharge to a GWRS treatment plant waste discharge line called the “brine line”. The brine line is connected to the ocean outfall that is owned and operated by the Orange County Sanitation District (OC San). OC San required a sand separator at each well site to reduce sand intake into the brine line and ocean outfall. The vertical metal cylinder near the right margin of the I-24 well pad in Figure 8 shows the “Lakos” sand filter. The Lakos filter is a centrifuge that uses the backwash pump pressure to operate. Gravity pulls the sand downward and the sand-free discharge drops into a concrete standpipe connected to the brine line. The Lakos filter is a passive filter requiring no maintenance. Periodically the IRSO will need to shovel and discard the sand which accumulates at the base of the filter. Hybrid Well I-24K produces a considerable amount of sand when pumped.

Like Modern Wells, Hybrid Wells have a flow control valve at the end of the eductor pipe. Currently I-24 and I-25 are equipped with down-well flow control valves. Hybrid Wells employ a down-well flow control valve called a variable orifice valve (VOV). The trade name for this valve is the “V-Smart Valve”. The VOV valve operates on the principle of a solid sleeve hydraulically sliding over a ported cylinder and exposing or covering the ports to flow or secure water. The sleeve is driven by hydraulic pressure from a pump on the surface. Mineral oil is used as the hydraulic fluid.

The VOV valves at I-24 and I-25 have a history of failure. Currently all 3 VOV valves are inoperable. The District is currently pursuing a project to replace all 3 VOV valves with Baski Valves, bringing uniformity and time-tested reliability to all Talbert Barrier down-well flow control valves. Hybrid Wells I-24 and I-25 cannot operate until this project is complete. This project will involve reengineering and rebuilding certain aspects of the I-24 and I-25 well-heads. This will also change the way the IRSO will operate the well in the future.

The remainder of this “Hybrid Wells Operation and Maintenance” section will be completed once the well-heads have been modified and the operational protocols have been established for injecting and backwashing. It is likely that the well-head modification project will be completed in fiscal year. 2023/24 or 2024/25. Figure 42 show the injection and backwash flow path for a typical Hybrid Well.

Figure 42 Hybrid Well I-25. Blue arrows indicate the flow path from the exposed lateral pipeline into the injection well. Orange arrows indicate the backwash discharge flow path to waste.

8. ROUTINES, UNFORESEENS AND A VERY IMPORTANT TOOL

A. Background

This section describes a typical day that the Talbert Barrier IRSO is likely to encounter, atypical interruptions to a typical day and a very important tool.

Routine activities are discussed in the Typical Day (Routines) portion of this section. Interruptions of the GWRS treatment plant and distribution system leaks are discussed in the Atypical Interruptions section. A gauge that tells the IRSO how strong the Barrier is in real-time is the focus of the Important Tool section.

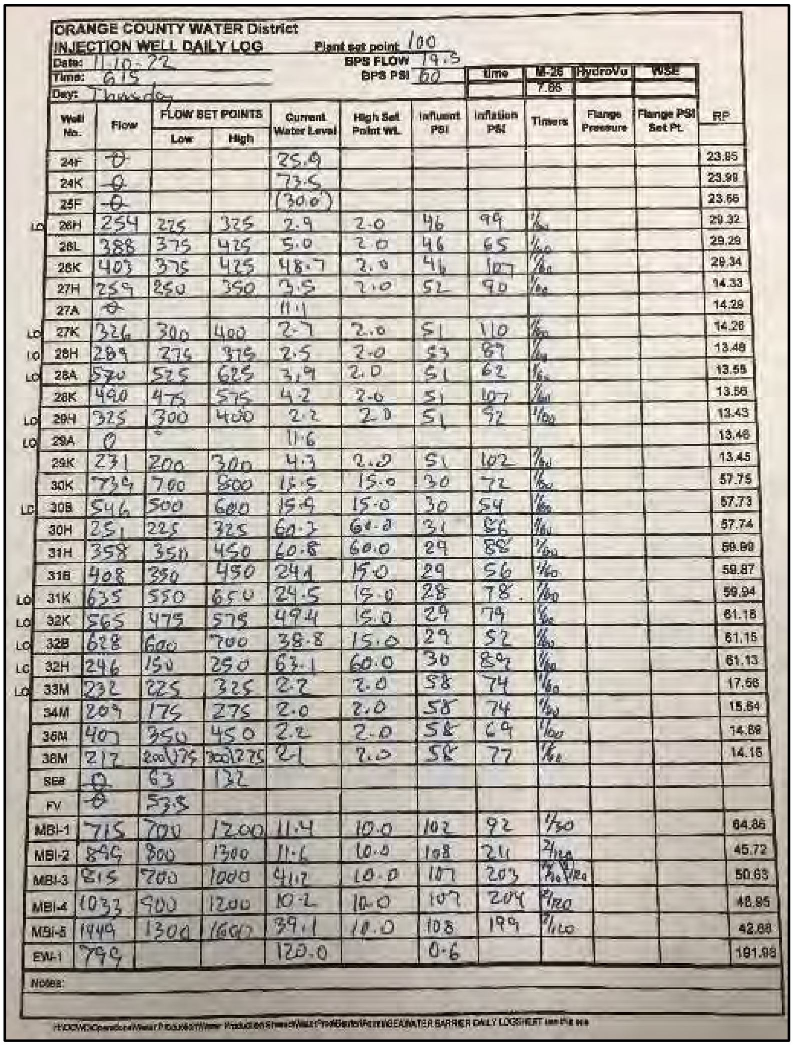
It is important to understand that the IRSO has responsibilities beyond the Talbert Barrier which include the operations and maintenance of the Mid-Basin Injection Well Field and distribution system, the GWRS pipeline and the Green Acres Plant recycled water distribution systems. This manual focuses solely on IRSO's Talbert Barrier responsibilities.

B. Typical Day (Routines)

The IRSO arrives at work on time and in uniform, usually meeting in the shop first thing in the morning. A brief discussion with other team members and the injection well supervisor typically results in the gameplan for the day.

At least one IRSO must complete and archive the daily sheets package for the day. The daily sheets package includes three sheets: 1) Injection Well Daily Log, 2) OCWD I Well Daily Flow and 3) Barrier Wells Total Flow.

The IRSO completes the Injection Well Daily Log by hand, utilizing real-time data found on Delta V. This sheet features instantaneous flow rates and groundwater levels for all Modern and Hybrid Wells. This form also includes the instantaneous Barrier Pump Station flow and pressure data, and Modern Well Baski Valve high and low setpoints. Figure 43 shows the Injection Well Daily Log form. The electronic Injection Well Daily Log form is located at: *H:\OCWD\Operations\Water Production\Water Production Shared\WaterProd\Barrier\Talbert Barrier O&M Manual\ Forms*. Instructions on how to complete the Injection Well Daily Log are found in Appendix A-16.



ORANGE COUNTY WATER District
INJECTION WELL DAILY LOG

Plant set point: 100
BPS FLOW 19.5
BPS PSI 60

Date: 11-10-22
Time: 615
Day: Thursday

time	M-26	HydroVu	WSE
	7.86		

	Well No.	Flow	FLOW SET POINTS Low	FLOW SET POINTS High	Current Water Level	High Set Point WL	Influent PSI	Inflation PSI	Timers	Flange Pressure	Flange PSI Set Pt.	RP
	24F	-0-			25.9							23.85
	24K	-0-			73.5							23.99
	25F	-0-			(30.0)							23.66
LO	26H	254	275	325	2.9	2.0	46	99	1/60			29.32
	26L	388	375	425	5.0	2.0	46	65	1/60			29.29
	26K	403	375	425	48.7	2.0	46	107	1/60			29.34
	27H	259	250	350	3.5	2.0	52	90	1/60			14.33
	27A	-0-			11.1							14.29
LO	27K	326	300	400	2.7	2.0	51	110	1/60			14.26
LO	28H	289	275	375	2.5	2.0	53	89	1/60			13.48
LO	28A	570	525	625	3.9	2.0	51	62	1/60			13.55
	28K	490	475	575	4.2	2.0	51	107	1/60			13.56
LO	29H	325	300	400	2.2	2.0	51	92	1/60			13.43
LO	29A	0			11.6							13.46
	29K	231	200	300	4.3	2.0	51	102	1/60			13.45
	30K	739	700	800	15.5	15.0	30	72	1/60			57.75
LO	30B	546	500	600	15.9	15.0	30	54	1/60			57.73
	30H	251	225	325	60.2	60.0	31	86	1/60			57.74
	31H	358	350	450	60.8	60.0	29	88	1/60			59.99
	31B	408	350	450	24.1	15.0	29	56	1/60			59.87
LO	31K	635	550	650	24.5	15.0	28	78	1/60			59.94
LO	32K	565	475	575	49.4	15.0	29	79	1/60			61.16
LO	32B	628	600	700	38.8	15.0	29	52	1/60			61.15
LO	32H	246	150	250	63.1	60.0	30	89	1/60			61.13
LO	33M	232	225	325	2.7	2.0	58	74	1/60			17.56
	34M	209	175	275	2.0	2.0	58	74	1/60			15.64
	35M	407	350	450	2.2	2.0	58	69	1/60			14.89
	36M	217	200\175	300\275	2.1	2.0	58	77	1/60			14.16
	SE8	-0-	63	132								
	FV	-0-	53.5									
	MBI-1	715	700	1200	11.4	10.0	102	92	1/30			64.86
	MBI-2	849	800	1300	11.6	10.0	108	24	2/120			45.72
	MBI-3	815	700	1000	41.2	10.0	107	203	[illegible]			50.63
	MBI-4	1033	900	1200	10.2	10.0	107	204	2/120			46.95
	MBI-5	1449	1300	1600	39.1	10.0	108	199	2/120			42.68
	EW-1	799			120.0		0.6					191.98

Notes:

Figure 43 Completed Injection Well Daily Log. This form includes the instantaneous Barrier Pump Station flow and pressure data Modern Well Baski Valve high and low setpoints, and instantaneous flow and water level for each Modern and Hybrid Well. The IRSO completes this form each workday morning.

The OCWD I Well Daily Flow sheet is also printed directly from Delta V. Figure 44 show the I Well Daily Flow Sheet. This sheet features instantaneous flow rates in gallons per minute for all Barrier Injection wells, flow source data from GWRS and the import water connections (if applicable). Instantaneous header pressures are provided for all Legacy Wells while influent pressures to Hybrid and Modern Wells are also featured. The OCWD I Well Daily Flow sheet can be found in Delta V by navigating to the Delta V page entitled "OCWD AWTF Control System". Select the orange rectangle labeled "Area 001 – 036 Wells". A map of the Talbert Barrier will appear with a white rectangle in the center near the top labeled "View Daily Flows", select the rectangle and the OCWD I Well Daily Flow sheet will appear.

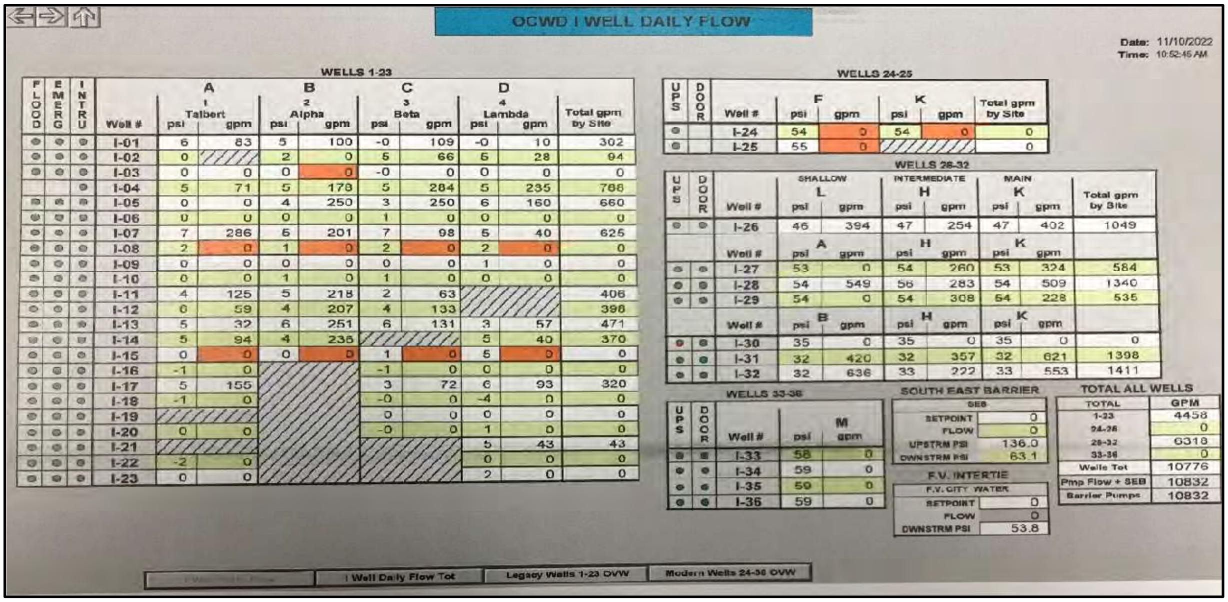
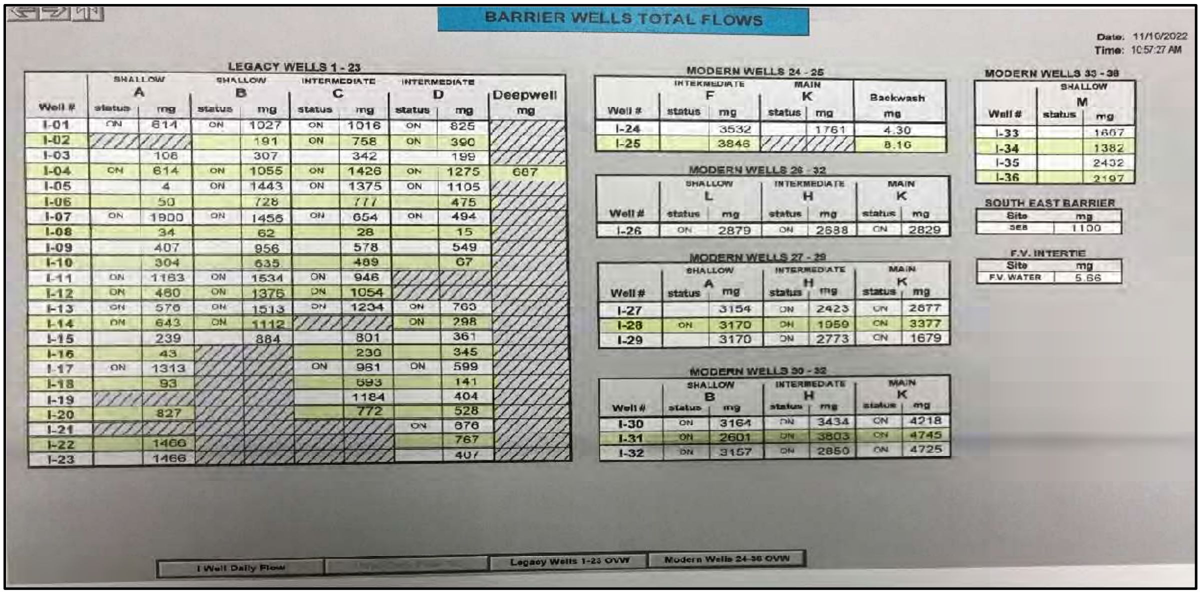


Figure 44 OCWD I Well Flow Data sheet. This sheet is printed each morning by the IRSO and contains instantaneous flow rates in gallons per minute for all Talbert Barrier Injection wells, flow source data from GWRS and the import water connections.

The Barrier Wells Total Flow sheet is printed directly from Delta V. Figure 45 show the Barrier Wells Total Flows sheet. This sheet features volumes injected at flow rates in million gallons for all Talbert Barrier Injection wells, flow source data from GWRS and the import water connection dating back to the inception of GWRS in January 2008. The Barrier Wells Total Flow can be found in Delta V by navigating to the Delta V page entitled "OCWD AWTF Control System". Click on the orange rectangle labeled "Area 001 – 036 Wells". A map of the Talbert Barrier will appear with a white rectangle in the center near the top labeled "View Daily Flows", click the rectangle and the OCWD I Well Daily Flow sheet will appear. At the bottom of this page is a rectangular tab entitled "I Well Daily Flow Total", click this tab and the Barrier Wells Total Flows sheet will appear.



BARRIER WELLS TOTAL FLOWS

Date: 11/10/2022
Time: 10:57:27 AM

LEGACY WELLS 1 - 23

	SHALLOW A		SHALLOW B		INTERMEDIATE C		INTERMEDIATE D		Deepwell
Well #	status	mg	status	mg	status	mg	status	mg	mg
I-01	ON	614	ON	1027	ON	1016	ON	825	
I-02				191	ON	758	ON	390	
I-03		108		307		342		199	
I-04	ON	614	ON	1055	ON	1426	ON	1275	687
I-05		4	ON	1443	ON	1375	ON	1105	
I-06		50		728		777		475	
I-07	ON	1900	ON	1456	ON	654	ON	494	
I-08		34		62		28		15	
I-09		407		956		578		549	
I-10		304		635		489		67	
I-11	ON	1163	ON	1534	ON	946			
I-12	ON	460	ON	1376	ON	1054			
I-13	ON	576	ON	1513	ON	1234	ON	763	
I-14	ON	643	ON	1112			ON	298	
I-15		239		884		801		361	
I-16		43				230		345	
I-17	ON	1313			ON	961	ON	599	
I-18		93				693		141	
I-19						1184		404	
I-20		827				772		528	
I-21							ON	676	
I-22		1466						767	
I-23		1466						407	

MODERN WELLS 24 - 25

	INTERMEDIATE F		MAIN K		Backwash
Well #	status	mg	status	mg	mg
I-24		3532		1761	4.30
I-25		3846			8.16

MODERN WELLS 26 - 32

	SHALLOW L		INTERMEDIATE H		MAIN K	
Well #	status	mg	status	mg	status	mg
I-26	ON	2879	ON	2688	ON	2829

MODERN WELLS 27 - 29

	SHALLOW A		INTERMEDIATE H		MAIN K	
Well #	status	mg	status	mg	status	mg
I-27		3154	ON	2423	ON	2677
I-28	ON	3170	ON	1959	ON	3377
I-29		3170	ON	2773	ON	1679

MODERN WELLS 30 - 32

	SHALLOW B		INTERMEDIATE H		MAIN K	
Well #	status	mg	status	mg	status	mg
I-30	ON	3164	ON	3434	ON	4218
I-31	ON	2601	ON	3803	ON	4745
I-32	ON	3157	ON	2850	ON	4725

MODERN WELLS 33 - 36

	SHALLOW M	
Well #	status	mg
I-33		1667
I-34		1382
I-35		2432
I-36		2197

SOUTH EAST BARRIER

Site	mg
SEB	1100

F.V. INTERTIE

Site	mg
F.V. WATER	5.66

I Well Daily Flow | Legacy Wells 1-23 OVW | Modern Wells 24-36 OVW

Figure 45 Barrier Wells Total Flows sheet. This sheet is printed each morning by the IRSO and features volumes injected at flow rates in million gallons for all Talbert Barrier injection wells and flow source data from GWRS and the import water connections dating back to the inception of GWRS in January 2008.

All three of these sheets are combined and scan / e-mailed to jbonsangue@ocwd.com each morning.

In addition to completing the daily sheets package it is a good idea for the IRSO to check in with the treatment plant operators. A good time to do this is during their morning shift change. The night shift crew shares any plant issues that may have occurred during the night with the day shift crew. Sometimes these issues are important to the IRSO, so it is a good idea to pay attention to GWRS treatment plant morning shift changes that occur at 7:00am daily in the GWRS Operations Control room.

A typical day on the Talbert Barrier may involve the IRSO working on the following tasks that have already been discussed in this manual including: Air-lift backwashing Modern Wells, overseeing Legacy Well redevelopment, conducting pressure profiles, monitoring gravel feed tube levels, rebuilding valves in the shop, downloading data from water quality instruments, operating bypass filter monitoring skids and general housekeeping at all injection well sites.

While the IRSO is working in the well field it is important to be observant and look for irregularities at well sites and along the distribution system. Irregularities may include running or standing water, open vault hatches, open perimeter fencing gates, overgrown vegetation, property damage, homeless encroachment and graffiti.

Any irregularities observed should be reported immediately to the supervisor. The supervisor will address the issue. A deficiency list for the Talbert Barrier is maintained by the supervisor and includes issues that can be addressed over time. Issues like pipe leaks need immediate attention and are therefore not placed on the deficiency list. A copy of the deficiency list is provided as Appendix A-19.

C. Atypical Interruptions

Unforeseen events the IRSO is likely to encounter fall into two categories: 1) shutdowns of the GWRS treatment plant and 2) pipeline leaks.

a. Shutdowns of the GWRS Treatment Plant

Shutdowns of the GWRS treatment plant are not very frequent and usually result from operator error or insufficient electrical power. The District purchases electrical power through a program whereby power to the GWRS treatment plant can be reduced during times of peak demand on the electrical grid. This type of shutdown is called a “demand response” shutdown. Demand response shutdowns usually occur during times of hot weather and limits the total plant to producing 15 mgd. All 15 mgd during a demand response event flows to the Talbert Barrier. If this type of shutdown is to occur, the IRSO usually has a small amount of time to secure Legacy Wells and reduce Barrier flow to 15 mgd. Sometimes all power to the GWRS treatment plant is completely lost unexpectedly giving the IRSO no preparation time.

When the BPWPS goes down the primary concern of the IRSO is to minimize loss of pressure in the Talbert Barrier distribution system. When the BPWPS stops pumping the Modern and Hybrid Well MOV’s quickly and reliably close automatically through Delta V. Legacy Wells shut down less reliably.

Legacy Well PRVs communicate with Delta V using 4 to 20 milliamp signals and solenoids. Sometimes the solenoids fail and prevent the valve from closing. Most commonly Legacy Well PRV failure occurs when the valve needs service. Service includes rebuilding the solenoids, replacing the diaphragm and installing the rebuild kit. When Legacy Well PRV valves fail, the IRSO must visit the site and manually close the “Cock 2” on the Bermad PRV or manually close the butterfly valve upstream of the problematic PRV (Figure 46). This takes time and pressure in the pipeline is dropping all the while. It is not uncommon to have more than one problematic Legacy Well PRV during a GWRS treatment plant shutdown event. The IRSO uses import water to recover pressure losses in the pipeline.

Figure 46 Legacy Well pressure reducing valve (PRV). Red arrows indicate the location of "Cock 2". The IRSO can secure flow to a PRV that is nonresponsive to Delta V by manually closing cock 2 or by closing the upstream butterfly valve. When pipeline pressure is restored Cock 2 will automatically reset and be ready for a remote restart. If the IRSO chooses to secure flow with the butterfly valve, a second well site visit is required upon start-up to open the butterfly valve.

The IRSO should always use the City of Fountain Valley import water supply connection (see Appendix A-11) first. This connection is limited to 800 gpm. Depending upon how many Legacy Wells fail to close, 800 gpm may or may not be enough to maintain pressure in the pipeline. The OC-44 connection can be used as a back-up to the Fountain Valley connection. Between May 1 and September 30, flow taken from the OC-44 connection could place the District in an unfavorable position with MWD at the Forebay where the District purchases large quantities of imported water from MWD to recharge through spreading basins. For this reason, ***it is very important that the IRSO seek approval from his supervisor to take OC-44 flow between May 1 and September 30***.

By balancing imported water flow(s) against flow losses into (stuck open) Legacy Wells, the IRSO can build back pipeline pressure. The IRSO can use a Modern Well for any fine tuning of pipeline pressure. Ideally the pipeline pressure at the BPWPS is between 50 and 60 psi when the Talbert Barrier is ready to begin injecting GWRS water.

When the GWRS treatment plant operators restore plant functionality, GWRS effluent initially flows up to the Forebay through the GWRS Pipeline via the GWRS Final Product Water Pump Station (Figure 47). The BPWPS is then started and the IRSO begins opening injection wells. Instructions for bringing the Talbert Barrier down for a GWRS treatment plant shutdown and back on-line following a shutdown are located in Appendix A-20.

Figure 47 GWRS Final Product Water Pump Station. The four shorter pump motors in the foreground power the Barrier Product Water Pumps. The larger motors in the background power the pumps that lift GWRS water over 200 feet in elevation to the recharge spreading grounds in Anaheim.

b. Pipeline Leaks

Pipeline leaks occur without warning and can range from a nuisance drip that can be easily fixed by tightening a fitting to pipeline ruptures.

When visiting the injection well sites and traveling between wells, the IRSO should be looking for leaks. The IRSO should report all leaks to the supervisor immediately. If the leak is an obvious nuisance drip that can be easily sealed by tightening a fitting or joint above ground, the IRSO may do so. Typically however, leaks are larger and require assistance.

Historically, most Talbert Barrier leaks are large and occur to a buried section of the main or lateral pipeline. Since these leaks are buried, they may not be obvious. The IRSO looks for clues such as pressure drops in the distribution system, water surfacing through cracks in the concrete or asphalt, standing (ponding water) in areas that should be dry. Sometimes it is obvious like when an unobservant motorist drives onto the sidewalk and sheers off an air-vac sending water shooting up into the air.

In the case of a buried pipeline leak, the IRSO should report their findings to their supervisor immediately. The supervisor will determine an appropriate course of action. Typically, the supervisor will ask the IRSO to isolate the leak by securing an upstream and downstream valve. A contractor will be dispatched to excavate, repair the pipe, backfill and restore the surface conditions at the leak site. The IRSO will assist the contractor by providing background information and act as a liaison between District Engineers and the contractor. Once the contractor completes the repair to the pipe, pressure can be restored.

In the case of a sheered air-vac, the IRSO will isolate the air-vac using the buried upstream isolation valve. If a new air-vac can be easily replaced, a team of IRSOs can remove the damaged air-vac and replace it with a new one. The Talbert Barrier operations group stocks 2-inch air-vac valves in the shop. If the damaged air-vac cannot be easily replaced, a contractor will need to be called.

D. Important Tool

The Talbert Barrier was designed and constructed for the purpose of protecting the Orange County Groundwater Basin. The goal of the Talbert Barrier operator is to use injection wells to create a high-pressure ridge in the aquifer system to stop the landward migration of seawater. How does the IRSO know when to increase or reduce the amount of injection flow to control seawater? Luckily the IRSO has a very important tool.

Fortunately, the IRSO has a very important tool that aids in determining the appropriate amount of flow required to control seawater intrusion. Water levels in monitoring wells landward and seaward of the Talbert Barrier are used to determine the overall effectiveness of the Barrier. While there are many monitoring wells near the Talbert Barrier that provide data regarding seawater intrusion, monitoring well M-26 (Figure 2, 48) provides the IRSO with the most meaningful information.

Monitoring Well M-26 taps a critical geologic structure (erosional unconformity) that merges the Lambda and Talbert aquifers. This mergence zone provides the first opportunity for seawater to enter the Lambda Aquifer (Figure 48).

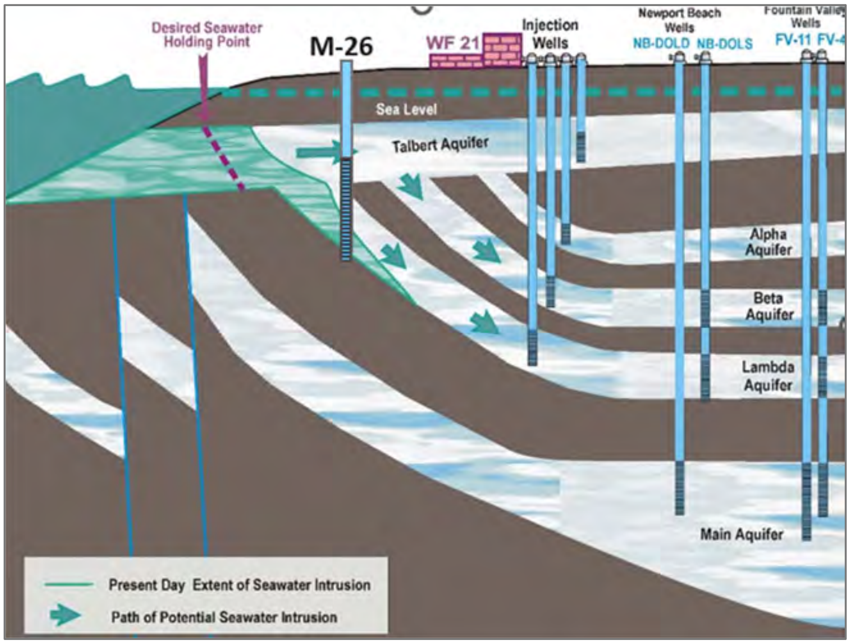


Figure 48 Cross section of the Talbert Gap along the Santa Ana River showing the underground pathways for seawater to enter into the groundwater Basin. Note the location of M-26 in the mergence zone between the Talbert and Lambda aquifers. The IRSO uses the water level in M-26 to gauge the strength of the Talbert Barrier. Water levels from M-26 are available to the IRSO in real-time electronically.

The District's Chief Hydrogeologist has declared that to effectively hold the advancement of seawater, the groundwater level in monitoring well M-26 must be at a protective elevation of 3 feet above sea level or higher. Considering the well-head elevation of 7.86 feet above mean sea level, a water level of 4.86 feet bgs in monitoring well M-26 equates to 3 feet above sea-level or "protective elevation". The IRSO operates the Talbert Barrier by increasing or decreasing overall Talbert Barrier flows to achieve a water level at or above 4.86 feet bgs in monitoring well M-26.

Monitoring well M-26 is equipped with an automatic data logging device that measures and logs groundwater levels four times a day. The data is available to the IRSO in real time by downloading the In-Situ app - "HydroVu". The IRSO should download this app onto their mobile device for easy reference. The OCWD Geology Department maintains all monitoring well data loggers and HydroVu accounts for the District. Because the M-26 groundwater level data is so important to the operation of the Talbert Barrier, the IRSO visits M-26 weekly and measures the water level by hand. If the hand level and the level measured by the data logger do not agree within three tenths of a foot, the IRSO should contact the Hydrogeology Department for assistance.

The IRSO refers to the M-26 groundwater level often to ensure efficient operation of the Talbert Barrier. The IRSO should try to maintain static a static water level at M-26 between 4.86 and 2.86 feet bgs. Exceeding protective elevation range long-term can potentially cause damage to infrastructure near the Talbert Barrier. Injection wells are activated or deactivated to maintain the groundwater level between 4.86 and 2.86 feet bgs.

The groundwater levels captured by the datalogger in M-26 is plotted monthly and presented in a report provided to the California Regional Water Quality Control Board, Santa Ana Region. Figure 49 shows a recent plot of groundwater levels at M-26.

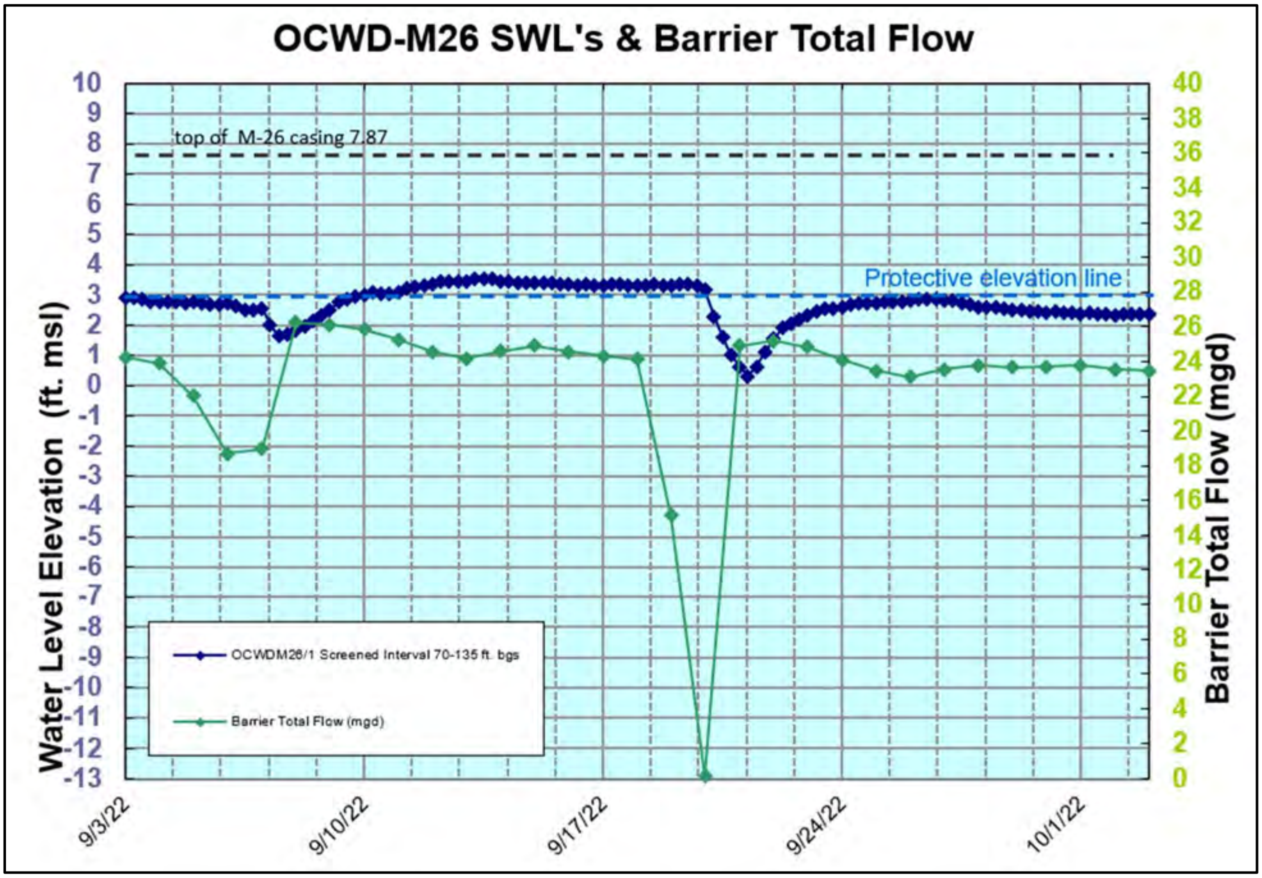


Figure 49 Recent Hydrograph from monitoring well M-26. The protective elevation line is shown as a dashed blue horizontal line at 3 feet above sea level. The dark blue line tracks the M-26 groundwater level with time. The green line indicates total flow to the Talbert Barrier in million gallons per day. Note that the M-26 groundwater level hovers near the protective elevation line except when the GWRS treatment plant slows down (around September 6, 2022) or when the GWRS treatment plant flow temporarily goes to zero (September 21, 2022). This plot demonstrates the relationship in time between Talbert Barrier Injection and the pressure response at M-26. A plot of the M-26 water level is available to the IRSO in real time using the HydroVu app on a mobile devise. *[Interestingly, OCWD hydrogeologists have observed groundwater near the Talbert Barrier moving at a wide range of velocities. The maximum velocity observed to date is 5 feet per day].*

The District has also equipped monitoring well M-25 (Figure 3) near the western end of the Talbert Barrier. Monitoring well M-25 is screened in different geology than M-26. For this reason water levels in monitoring well M-25 are less responsive to Talbert Barrier injection. The IRSO relies on monitoring well M-25 to better understand the historical performance of the Talbert Barrier and to help plan long term operational strategies. Data from monitoring well M-25 is also available to the IRSO on mobile devises using the HydroVu app. The data from monitoring well M-25 is also plotted (Figure 50) and included in the OCWD Water Production Department monthly report. This report is submitted to the California Regional Water Quality Control Board – Santa Ana Region by OCWD's Director of Water Production.

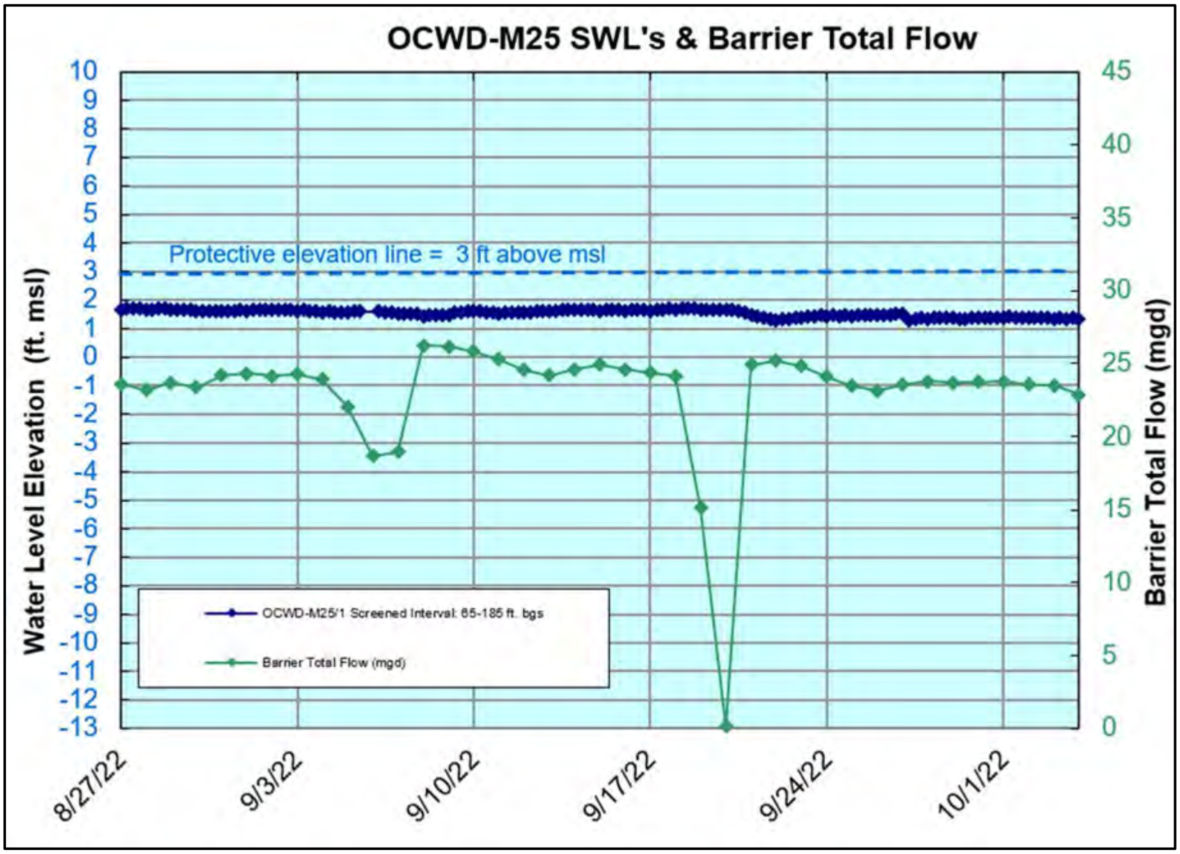


Figure 50 Hydrograph of monitoring well M-25 on the west end of the Talbert Barrier. Water levels in M-25 are much less responsive to injection along the Talbert Barrier.

E. Closing Comment

The Talbert Barrier is a dynamic system that involves a tremendous amount of effort from many different departments at the District. As an IRSO you will likely work with many individuals from various departments. A brief summary of how other departments contribute to the successful operation of the Talbert Barrier is provided below:

<u>I&E Department</u>

I&E staff troubleshoots, maintains, calibrates and repairs injection well electrical equipment and instrumentation and process control software (Delta V).

GWRS Operations Department

GWRS Treatment plant operators provide critical information related to GWRS production and occasionally assists the IRSO with basic injection well operation using Delta V.

GWRS Maintenance Department

Provides fabrication services, vehicle maintenance/repair and equipment transportation support for Legacy Well redevelopment work.

Hydrogeology Department

Designs injection and monitoring wells, provides water level data logger support and interprets water quality data in the Talbert Gap.

Engineering Department

Provides support for pipeline repairs, pipeline modifications and injection well-head modifications. Archives all Talbert Barrier record drawings.

Research and Development Department

Provides support and interpretation for bypass filter study, laser turbidity study, and corrosion study.

Over the course of time the IRSO will work with representatives from each of these departments. When collaborating with staff from other departments it is important to understand their perspective of Talbert Barrier operations will be different than yours. Be patient and try to speak simple language until a mutual understanding is achieved. This will benefit all parties and create a pleasant, positive, and productive working environment.

F. Outside Services

Occasionally the IRSO will need assistance from vendors, outside service providers and contractors. Contractors are selected using a competitive bid process and therefore vary from project to project. A list of important service providers and vendors including contact information is provided as Appendix A-21. Appendix A-21 also contains the most recent version of OCWD’s GWRS + Green Acres Project Emergency Directory.

G. Computerized Maintenance Tracking

The District uses a computerized system called “Maximo” to issue and track maintenance work orders that fall into two categories: 1) preventative maintenance (PM) and 2) corrective maintenance (CM). Preventative maintenance work orders are completed to preserve and extend the life of an asset. Corrective maintenance actions are taken to repair an asset. Work orders are distributed in Maximo from the GWRS Planner/ Scheduler and come with an electronic work plan. Corrective maintenance usually involves repairing something that broke unexpectedly. If something is not working correctly, the IRSO submits a CM work order in Maximo and describes the actions taken to repair the asset in the work order electronically. A list of some common CM and PM activities that the IRSO is likely to encounter include:

Preventative Maintenance	**Corrective Maintenance**
Main valve exercising	Legacy Well sump pump replacement
Lateral valve exercising	Legacy Well ventilation fan replacement
Blow off distribution system mains	Legacy Well pressure transmitter replacement
Legacy Well cathodic anode maintenance	Replace air-vac along distribution system
Injection well profiling / housekeeping	Replace air-vac at injection well site
Modern Well Backwash	Rebuild Legacy Well 3-inch PRV
Coordinate Laser turbidimeter service with manufacturer	Repair minor vandalism at injection facilities

The IRSO can receive Maximo training from the one of the District's two GWRS Planners / Schedulers.

Closing Comment

While OCWD is recognized globally as being both a pioneer and a leader in the water recycling industry, it is important to keep in mind *why* OCWD began recycling water in the first place. The reason OCWD began recycling water back in 1968 was to control seawater intrusion along the coast in Orange County. Without the need to protect the Basin from seawater intrusion, the GWRS treatment plant and its predecessor Water Factory 21 would never have been built.

Being an IRSO is unique, there are very few IRSO's in the world. You are operating the world's largest, fully automated, injection well field. Your work is very important to the community. Try to do your job to the best of your ability and enjoy this opportunity.

Modern Injection Well Site I-32.

9. APPENDIX LIST

A-1 Work Area Traffic Control Handbook

A-2 South East Barrier Pipeline Operating Instructions

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Appendix A-1

Work Area Traffic Control Handbook (WATCH Book)


2019
FOURTEENTH
EDITION
WORK AREA
TRAFFIC
CONTROL
HANDBOOK
Conforms to the Standards and Guidance of the CA MUTCD
CENTER LANE CLOSED AHEAD
STOP
SHARE THE ROAD
WATCHBOOK
BNi Building News
ISBN 978-1-55701-969-1

Work Area Traffic Control Handbook
"WATCH"

PREFACE TO THE 2019 FOURTEENTH EDITION

This handbook is intended to provide standards and guidelines for Temporary Traffic Control zones (TTC zones). The WATCH provides quick reference traffic control guidelines for work activities for contractors, cities, counties, utilities and other agencies responsible for such work.

This handbook is in compliance with current editions of the MUTCD and the CA MUTCD.

Nothing contained in this handbook is intended to establish or create a legal standard of conduct or duty toward the public. The criteria for the position, location, manner of installation and the use of such signs, lights and devices are furnished solely for the purpose of information and guidance. The jurisdictional agency shall determine if a traffic control plan is necessary.

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1 – INTRODUCTION

1-1 GENERAL

This handbook is intended to provide basic principles, standards and guidelines for Temporary Traffic Control zones (TTC zones). The *WATCH* provides quick reference traffic control guidelines for activities for contractors, cities, counties, utilities and other agencies responsible for such work.

The *WATCH* is intended to be used for the following activities:

Short Duration: An activity that occupies a location up to 1 hour.

Short Term Stationary: A daytime activity that occupies a location from 1 to 12 hours.

Intermediate Term Stationary: An activity that occupies a location from overnight to 3 days.

Mobile Operations: An activity that moves intermittently or continuously.

The *WATCH* should not be used for:

Long Term Stationary: An Activity that occupies a location more than 3 days. Long Term Stationary activity sites require the use of long term traffic control devices, extensive planning and detailed coordination with the authorized agency. The agency may require an engineer approved TTC plan. Long Term Traffic Control Plans (TTCP) should be designed by a licensed civil or traffic engineer and be included as part of the complete product design plans.

Uniform Standards:

Nationwide standards, guidance, and options are set forth in the Manual on Uniform Traffic Control Devices (MUTCD) published by the U.S. Department of Transportation, Federal Highway Administration and the California Manual on Uniform Traffic Control Devices (CA MUTCD) published by State of California, California Department of Transportation (Caltrans).

In order to assist road user recognition of traffic control devices in TTC zones, the [California] Department of Transportation shall, after consultation with local agencies, determine specifications for uniform types of warning signs, lights and devices to be placed upon a highway by any person engaged in performing work which interferes with or endangers the safe movement of traffic upon that highway. CVC 21400. This handbook is in substantial compliance with the CA MUTCD.

These principles and standards are intended to provide guidelines for effective Temporary Traffic Control (TTC) activity sites, and to warn, control, protect and expedite vehicular and pedestrian traffic.

Uniform standardized traffic control rules and regulations shall be effectively utilized to:

a. Reduce accidents.
b. Prevent injury to workers and road users.
c. Reduce legal liability to private and public property owners.
d. Minimize the possibility of claims and litigation arising from TTC zone accidents.
e. Reduce confusion to road users, bicyclists and pedestrians.
f. Expedite traffic flow and impede traffic flow as little as possible.
g. Improve public relations.

California Vehicle Code TTC Regulations

The California Vehicle Code lists several regulations regarding road user (vehicles, pedestrian and bicyclist) responsibilities. The road user shall be cautious, not travel at unsafe speeds, not vandalize traffic control devices and shall obey all TTC devices (warning signs, warning lights and other devices).

It is unlawful for any person to disobey the directions of a person authorized to regulate traffic. CVC 21367

Traffic Control Training Requirements:

Each person whose actions affect TTC zone safety from the upper level management through the field workers, should receive training appropriate to the job decisions each individual is required to make. Only those individuals who are trained in proper TTC practices and have a basic understanding of the principles should supervise the selection, placement and maintenance of TTC devices used for TTC zones and for incident management. CA MUTCD 6B.01

2 – CVC TTC REGULATIONS, TRAINING REQUIREMENTS

2-1 TERMS AND DEFINITIONS: Refer to the CA MUTCD, Chapters 1, 5 and 6 for a complete list of Terms and Definitions.

In this handbook, the words "shall," "should" and "may" are used to describe specific conditions. To clarify the meaning intended by these words, the following definitions apply:

Shall: A mandatory condition or specifically prohibitive practice regarding a traffic control device. Exceptions to these conditions can be approved on a case by case basis by the jurisdictional agency or its representative. Documentation shall be provided.

Should: An advisory condition. Where the word "should" is used, it is considered advisable usage and is recommended but not mandatory.

May: A permissive condition that carries no requirement or recommendation.

2-2 ABBREVIATIONS

AB .... Arrow Board
ADA .... Americans with Disabilities Act
CVC .... California Vehicle Code
CA MUTCD ....California Manual on Uniform Traffic Control Devices
TTCP .... Temporary Traffic Control Plan
TTC .... Temporary Traffic Control
USA .... Underground Service Alert
WATCH .... Work Area Traffic Control Handbook

2-4 INSTITUTIONS

FHWA .... Federal Highway Administration
Cal-OSHA ...California Occupational Safety and Health Administration

3 - AUTHORITY

No activity shall be performed in any public right-of-way without permission from the agency. TTC plans shall be in accordance with the provisions of the latest edition of the CA MUTCD, this handbook and the agency's permit for the activity

4 – RESPONSIBILITY

All contractors, permittees, utilities or agencies performing an activity in the public right-of-way shall:

a. Obtain all necessary permits.
b. Provide timely notification and coordinate with all affected agencies, including the following departments and public agencies:
   1) Law Enforcement
   2) Fire Department
   3) Department of Public Works/Transportation
   4) Rail, Bus and Transit Companies
   5) Schools
   6) Trash Collection Services
   7) Emergency Response Services
c. Notify Underground Service Alert (USA) or local one-call center at least 48 hours prior to commencement of excavation.
d. Coordinate the TTC with all affected agencies to check the compatibility of traffic control and to avoid duplicate signing or conflicting activities between adjacent or overlapping activities.
e. Inform occupants of abutting properties, either orally or by written notice, of access limitations made necessary by the activity.
f. Install, inspect and maintain required traffic control devices for the duration of the traffic control activities, both day and night.
g. Provide flaggers when required.
h. Schedule and expedite the activity to cause the least inconvenience to the public.
i. Assure that employees working in or adjacent to activity sites wear all required high visibility safety apparel.
j. Provide adequate safeguards for workers and the general public.
k. Remove traffic control devices when they are no longer needed.

5 - TEMPORARY TRAFFIC CONTROL PLANS and PLANNING

All activities shall be planned in advance to keep traffic obstructions, public inconvenience and lost working time to a minimum.

To properly determine Temporary Traffic Control, those responsible shall visit the activity site to consider the following:

a. Traffic conditions (traffic speed and volume, etc.).
b. Existing traffic controls (signs, striping, traffic signals, etc.).
c. Traffic lane requirements (vehicle & bike lanes, pedestrians, bus stops, etc.).
d. Visibility restrictions (vertical and horizontal sight distance).
e. Physical activity site features.
f. Access to public and private property.
g. Special event activities.
h. The type, number and location of signs, barricades, lights and other traffic devices required for the TTC zone.
i. Pedestrian traffic requirements, including the means of mitigating any adverse effect upon the visually, mobility or other physically challenged persons to comply with ADA.
j. Excavation limits and/or pavement disruptions.

5-1 TTC ZONE COMPONENTS

TTC zones consist of four component elements. They are: Advance Warning Area, Transition Area, Activity Area and Termination Area. Please see the TTC ZONE COMPONENTS illustration on page 21.

6 - TEMPORARY TRAFFIC CONTROL ZONE GUIDELINES

6-1 GENERAL

The primary function of TTC is to provide for the reasonably safe and efficient movement of road users through or around TTC zones while reasonably protecting workers, responders to traffic incidents and equipment.

Of equal importance to the public traveling through the TTC zone is the safety of workers performing the many varied tasks within the work space. TTC zones present constantly changing conditions that are unexpected by the road user. CA MUTCD 6A.01

A TTC zone is typically marked by TTC zone devices that include: signs, channelizing devices, barriers, pavement markings and/or work vehicles used to warn, or guide road users. It extends from the first warning sign or high intensity rotating, flashing, oscillating, or strobe lights on a vehicle to the END ROAD WORK sign or to the last TTC device.

6-2 LOW SPEED (40 MPH OR LESS) TTC ZONES

When the posted or observed speed is 40 MPH or less, the TTC zone is defined as "low speed". TTC safety in low speed TTC zones should not be compromised by using fewer devices simply because the traffic is slower and activity operations are for short durations and/or frequently change locations. The following TTC device guidelines shall be used in "low speed" zones:

a. Flashing warning lights and/or flags may be used to call attention to the advance warning signs.
b. A work vehicle with high intensity rotating, flashing, oscillating, or strobe lights should be used. An arrow board may be used for each lane closed.
c. The minimum height of cones used should be 28 inches, 18-inch high traffic cones may be used during daylight hours.
d. Workers shall wear (minimum) high visibility Class 2 safety apparel.
e. The minimum size for Advance Warning Signs shall be 36 inches by 36 inches.
f. A minimum of two advanced warning signs shall be posted for lane closures.

Typically, short duration mobile activities consist of utility operations, potholing, tree trimming and litter cleanup activities.

On low speed, low volume streets during Short Duration Work, it often takes longer to set up and remove the TTC zone than it takes to perform the work. Considering the fact that workers face hazards in setting up and taking down the TTC zone, simplified TTC procedures may be warranted for short duration work only. A reduction in the number of devices may be offset by the use of more dominant devices such as "high intensity" rotating, flashing, strobe lights, or arrow boards on work vehicles up to one-half hour work duration.

Flaggers may also be used for short duration/mobile operations which often involve frequent short stops.

Vehicle hazard warning signals shall not be used instead of the vehicle's high intensity rotating, flashing, strobe lights or arrow boards.

6-3 HIGH SPEED (GREATER THAN 40 MPH) TTC ZONES

When the posted or observed speed is greater than 40 MPH, the TTC zone is defined as high speed. TTC zones require additional warning signs, devices and safety enhancements. The following TTC device guidelines shall be used in high speed zones:

a. One arrow board shall be used for each closed lane.
b. The minimum height for all traffic cones shall be 28 inches.
c. A minimum of three advance warning signs shall be posted for lane closures.
d. Flashing warning lights and/or flags should be used to call attention to the warning signs.
e. Workers in the roadway shall wear Class 3 high visibility safety apparel.
f. The minimum size for Advance Warning Signs shall be 48 inches by 48 inches.

High speed traffic incidents create the potential for greater impact severity and increased safety vulnerability for workers in the TTC zones. Additional worker safety enhancement measures should be considered.

6-4 TYPICAL TTC ZONE HAZARDS

Work activities can create various hazards in temporary traffic lanes that may not have been considered or included in the work permit or recognized by the contractor or public works personnel. The following examples are common hazards requiring warning signs and/or work activity restrictions.

Visibility: There shall be no activity or storage of materials and equipment that interfere with the travel-way line-of-sight of approaching road users. Approaching road users shall be provided a minimum of 7.5 seconds sight distance.

Work Window Time Restrictions: The activities within or in the vicinity of streets shall be planned and scheduled to minimize interference with peak hour traffic volumes. Except for emergency situations, no activity should encroach into a moving lane of traffic during peak traffic hours as determined by the agency.

Minimum Lane Width: All temporary traffic lanes shall be a minimum of 10 feet in width unless otherwise authorized. The 12-foot minimum lane width, with curb, is essential for the safe movement of buses, trucks and trailers.

Temporary traffic lanes shall have a minimum 5-foot clearance from open excavations and a minimum of 2 feet from vertical obstructions such as curbs and concrete barriers, unless otherwise approved by the agency.

Shoulder Excavations: Road users shall be warned of excavations 2 inches deep or deeper without a 4:1 fillet in the parking lanes or shoulders. LOW SHOULDER (W8-9) or OPEN TRENCH (C27) signs shall be placed to warn the road user that an excavation has been made in the parking lane or shoulder. In addition, edge line channelizer delineation shall be placed every 25 feet to 100 feet for the length of the excavation to warn road users of the excavation.

Pavement Disruptions: Whenever the pavement surface has been disrupted by profiling, paving overlay, temporary trench resurfacing, steel plating, hose placement, etc., warning signs describing the pavement surface shall be installed. Pavement surface disruptions may create an operating problem for automobiles, motorcycles, bicycles or pedestrians. Examples of uneven pavement signing may include the symbol UNEVEN LANES (W8-11), BUMP (W8-1) or STEEL PLATES AHEAD signs. A slope leading to the disruption shall be determined by the agency.

Temporary Surfacing: When traffic is diverted from the existing pavement, temporary surfacing shall be provided and shall be in conformance with specifications for such work issued by the agency.

Activity Site Parking: Equipment not actively engaged in the activity, employee vehicles and official vehicles of the agency shall not be parked in the vicinity of the activity site in such a manner as to further restrict or obstruct traffic flow.

Materials Storage: Construction spoil or materials may be temporarily stored on the nearby parkway or sidewalk area. Pedestrians shall be provided a 4-foot sidewalk clearance.

No Parking on Shoulder Signs: Temporary NO PARKING Tow Away signs shall be installed and removed as directed by the agency. The advanced time line requirements for placing the signs shall be confirmed with the agency.

Road Closures: The ROAD CLOSED (W20-3) sign shall be used in advance of the point where a highway/street is closed to all road users, or to all but local road users except contractors' equipment or officially authorized vehicles. The ROAD CLOSED sign should be accompanied by appropriate warning and detour signing. The ROAD CLOSED sign should be installed at or near the center of the roadway on Type 3 barricades.

Speed Signing: In combination with warning signs, an Advisory Speed sign (W13-1) or a **WORK ZONE (G20-5aP) mounted above a Speed Limit sign (R2-1)** may be used in accordance with the CA MUTCD to indicate a recommended safe speed through the TTC zone. Except in emergencies, an advisory speed sign shall not be mounted until the recommended speed is determined by the agency.

6-5 COVERING OF SIGNS AND TRAFFIC SIGNAL INDICATIONS

If the TTC plans or Temporary Traffic Signal Modification Plans call for the temporary covering of signs or traffic signal indications, agencies shall require the entire sign, signal indication or portions of the indications to be covered with a cover manufactured for that purpose.

The following covering requirements shall be met: The sign and traffic signal indication covers shall be of sufficient size and density to completely block out the message so that it is not visible either during the day or at night. Covers shall be fastened securely to the sign or signal indication.

The material used shall be wind and rain resistant.

In lieu of covering of signs or indications, the agency may allow the signs, indications and/or pedestrian indications to be removed or turned so it may not visible by road users/pedestrians. The covering method and cover material shall be approved by the agency before installation.

The agency may require the associated load switch for that indication to be removed from the traffic control cabinet and traffic signal timing adjusted accordingly. The material/method or the removal or adjustment must be approved by the agency.

7 - TEMPORARY TRAFFIC CONTROL DEVICES

7-1 GENERAL DESCRIPTION OF TTC DEVICES

The application of TTC devices used in TTC zones should consider the needs of all road users (motorists, bicyclists, workers and pedestrians) including those with disabilities.

The most effective system of warning and guidance is provided through the properly planned usage of TTC devices, uniformly placed and well maintained. TTC devices shall conform to the CA MUTCD. They shall be defined as all signs, signals, markings and other devices used to regulate, warn, or to guide road users. The TTC devices shall be approved by the authorized agency having jurisdiction.

TTC devices shall meet the crashworthy performance criteria contained in the National Cooperative Highway Research Program (NCHRP) Report 350. Arrow boards and portable changeable message signs are not included in the NCHRP Report 350 requirement.

7- 2 TEMPORARY TRAFFIC CONTROL SIGNS

7-2.1 GENERAL CHARACTERISTICS OF SIGNS

TTC zone signs convey both general and specific messages by means of words or symbols.

Traffic signs shall meet the requirements of the CA MUTCD sign specifications, Table 6F.1.

7-2.1.1 TEMPORARY TRAFFIC CONTROL SIGN CATEGORY

Sign Category: Traffic signs in TTC zones are classified in the following functional categories:

Warning signs: TTC zone warning signs warn approaching road users of specific situations or conditions on or adjacent to a roadway. Regulatory signs: Existing regulatory signs within or adjacent to the activity site shall be maintained.

If existing signs are not appropriate for traffic conditions, the agency shall be consulted to determine if the signs shall be temporarily covered, replaced, removed or relocated.

7-2.1.2 TEMPORARY TRAFFIC CONTROL SIGN PLACEMENT

The location of the traffic signs shown in the illustrations are guidelines. Actual locations will depend upon the roadway alignment, grade and location of street intersections and posted speed limits. Signs shall be visible to oncoming traffic and be mounted so as to resist displacement.

Warning signs shall be located on the right hand side of traffic lanes. Where special emphasis is needed, signs may be placed on both left and right sides of the roadway.

All TTC signs during the hours of darkness shall be retroreflectorized or illuminated.

Portable signs shall not interfere with vehicular traffic, bicycle traffic or pedestrian movements.

7-2.1.3 TEMPORARY TRAFFIC CONTROL SIGN HEIGHT

Portable Signs: The bottom edge of the sign shall be at least 1-foot above the roadway when the sign is mounted on portable sign supports or barricades.

Post Mounted Signs: Post mounted signs shall breakaway upon impact and have at least a 7-foot vertical clearance in urban locations and 5-foot vertical clearance in rural areas.

7-3 TEMPORARY TRAFFIC CONTROL SIGN ENHANCEMENT DEVICES

7-3.1 GENERAL CHARACTERISTICS SIGN ENHANCEMENT DEVICES

Traffic sign enhancement devices (flags, high level warning devices and warning lights) are used to provide enhanced advance warning to the road user.

7-3.2 FLAGS

Flags shall be a minimum size of 16 inches and fabricated of high visibility fluorescent orange material. Torn, faded or dirty flags shall be immediately replaced.

7-3.3 HIGH LEVEL WARNING DEVICES (Flag Trees)

High level warning devices (Flag Tree) may supplement other devices in TTC zones. A high level warning device (Flag Tree) shall consist of a minimum of two flags.

7-4 TEMPORARY TRAFFIC CONTROL LIGHTING DEVICES

7-4.1 GENERAL DESCRIPTION

Three types of lighting devices are commonly used in TTC zones. They are warning lights, flashing warning beacons and floodlights.

7-4.2 WARNING LIGHTS

There are four types of warning lights: Type A, Type B, Type C and Type D (360 degree). The light weight and portability of the powered, yellow warning lights are advantages that make these devices useful as supplements that provide enhanced road user recognition to the signs, barricades and other channelizing devices. Warning lights are optional. Warning lights may be specified by the agency to provide enhanced advance warning.

Type A: Low intensity flashing warning lights may be mounted on separate portable supports, Type 1 barricades, Type 3 barricades or drums. Type A low intensity flashing warning lights are used to warn road users that they are approaching or adjacent to a hazardous area. They shall not be used for delineation.

Type B: High intensity flashing warning lights may be mounted on advance warning signs or on independent supports. Type B warning lights are used to warn road users during both daylight and nighttime hours that they are approaching or adjacent to a hazardous area. They shall not be used for delineation.

Type C and D: Steady burn lights may be used to delineate the edge of the traveled way and on the outside edge line of a traveled way during nighttime hours.

7- 4.3 FLASHING WARNING BEACONS

A flashing warning beacon shall be a flashing yellow light with a minimum diameter of 12 inches. The mounting height shall be between 6 feet and 10 feet. Flashing warning beacons are often used to supplement a TTC device or to alert drivers to a changing roadway condition and the need to reduce speed and show caution.

7- 4.4 FLOODLIGHTS

When nighttime work is being performed, floodlights shall be used to illuminate the work area including: work activity sites, flagger stations, equipment crossings and other hazardous areas.

Note: *Care shall be exercised to ensure that the floodlights do not shine into the eyes of oncoming road users.* Per CVC

7- 5 PORTABLE CHANGEABLE MESSAGE SIGNS (PCMS)

7- 5.1 PCMS GENERAL GUIDELINES

Portable changeable message signs have applications where work activities, road user routing hazards, incident management, natural disasters or other pertinent conditions require advance warning and real time information. The PCMS shall not be used for advertising.

The primary purpose of portable changeable message signs in TTC zones is to advise road users of unexpected situations:

a. Where the road user speed is expected to substantially be reduced.
b. Where significant traffic flow queuing is expected.
c. Where adverse environmental conditions are present.
d. Where changes in alignment or surface conditions are present.
e. Where advance notice of closures is needed.
f. Areas affected by incident management.
g. Where changes in road user pattern occur.
h. Where unique warning or guidance is needed for the road user.

The portable changeable message signs shall automatically adjust brightness under ambient light conditions to maintain their legibility.

The PCMS shall not be used as a substitute for TTC signs and devices. The PCMS may be placed in advance of or within the TTC zone.

The PCMS shall be delineated when located on a roadway shoulder. The PCMS location shall be delineated with channelizing devices using the standard Shoulder Closure lengths. If the PCMS is not in use, it should be removed.

7-5.2 ARROW BOARDS

An arrow board shall be a sign with a matrix of elements capable of either flashing or sequential displays. This sign shall provide additional warning and directional information to assist in merging and controlling road users through or around a TTC zone.

An arrow board in the arrow or chevron mode should be used to advise approaching traffic of a lane closure along major multi-lane roadways in situations involving heavy traffic volumes, high speeds and/or limited sight distances, or at other locations and under other conditions where road users are less likely to expect such lane closures.

Arrow boards shall have solid rectangular appearances.

The minimum mounting height, measured vertically from the bottom of the board to the roadway below it or to the elevation of the near edge of the roadway, of an arrow board should be 7 feet, except on vehicle mounted arrow boards, which should be as high as practical. Arrow board elements shall be capable of at least a 50 percent dimming from full brilliance. The dimmed mode shall be used for nighttime operation of arrow boards. Full brilliance should be used for daytime operation of arrow boards.

For shoulder work, blocking the shoulder, roadside work near the shoulder, or for temporarily closing one lane on a two-lane, two-way roadway, an arrow board shall be used only in the caution mode. When arrow boards are used to close multiple lanes, a separate arrow board shall be used for each closed lane.

Arrow boards shall only be used to indicate a lane closure. Arrow boards shall not be used to indicate a lane shift.

A portable changeable message sign may be used to simulate an arrow board display.

The arrow board shall be located behind channelizing devices used to transition traffic from the closed lane.

7-5.3 FLASHING DIRECTION BAR (FDB) PANEL - TYPE D

When used, FDBs shall be used with other vehicular mounted warning lights such as flashing strobe lights, rotating flashing beacons and/or vehicular light bars. FDBs may be used to provide traffic control for short duration lane closures. Vehicles displaying an FDB shall be equipped with high intensity rotating, flashing, oscillating, or strobe lights.

7-6 CHANNELIZING DEVICES (See page 27 and 28 for details.)

7-6.1 GENERAL GUIDELINES

The function of channelizing devices is to warn road users of conditions created by work activities in or near the roadway and to guide road users. Channelizing devices include, but are not limited to cones, tubular markers, drums and barricades. All channelizers shall be predominantly orange in color. Their position, size, spacing, form and color determine their effectiveness. All channelizing devices shall be retroreflectorized (during the hours of darkness) and capable of being visible at 1,000 feet during day and night.

Typical examples of channelizing devices are shown in the illustrations. Channelizing devices are used to:

a. Channel and divert traffic.
b. Provide for a smooth gradual transition of traffic flow from one traffic lane to another.
c. Define traffic lanes through the TTC zone.
d. Define a change in the position of the existing traffic lanes around the TTC zone.
e. Define curves and the edges of the roadway on detours.
f. Provide edge line delineation near pavement drop-offs.

Opposing traffic and diverted traffic into a painted median to the left of an existing double yellow centerline or into a left turn lane shall be separated by delineators/barricades.

For low speed situations, channelizers with mounted directional arrows may be used.

7-6.2 CONES

Cones are used on Short Duration and Short Term Stationary TTC zones. Cones, 18 inches high, are only acceptable for use on low speed roadways during daylight hours. High speed cones, a minimum of 28 inches high, are acceptable for use on any roadway at any time when equipped with retroreflective material. 36" or 42" high cones may also be used for improved delineation and visibility. Cones can be ballasted and stabilized by using weighted bases or weighted rings.

7-6.3 PORTABLE DELINEATORS

Portable delineators are typically used where more visibility and stability are required. They are available in two types. One type of portable delineator is a uniform 4 inch in diameter tube and the other type varies from 4 inches in diameter at the top to 8 inches in diameter at the base and is stackable. Both types are typically 36 inches high. Portable delineators greater than 36 inches high are referred to as tall cones and have 4 reflective bands. All portable delineators shall be retroreflectorized.

7-6.4 DRUMS

Drums may be used for Intermediate Term Stationary and Long Term Stationary TTC zones. They provide low maintenance long term edge line delineation. The drum shall be a minimum of 36 inches high and retroreflectorized. Drums shall be constructed of low density polyethylene material and shall be flexible or collapsible upon impact by a vehicle. The drums shall be designed to resist overturning by means of a weighted base. The base shall be of sufficient weight to keep the drum in position and upright.

7-6.5 SURFACE MOUNTED CHANNELIZERS

Surface mounted channelizers are affixed to the pavement using adhesives. They are 2-3/16 inches wide and 36 inches high with a flattened 3-½ inch top to support a retroreflective strip. They are spaced at one-half normal delineator spacing due to their narrow width.

7-6.6 TYPE 1, 2 or 3 BARRICADES

Barricades are portable or fixed devices having from one to three rails that have alternating orange and white retroreflective stripes sloping downward at an angle of 45 degrees in the direction road users are to pass. The predominant color for other barricade components shall be white.

Barricade stability can be achieved by placing sandbags or manufactured weights on the bottom supports. Sandbags or other heavy objects shall not be placed on the upper panels of a barricade. Owner identification shall not be imprinted on the retroreflectorized face of any rail.

Barricades serve the following purposes:

a. To alert the public that a particular area is closed to traffic.
b. To prevent drivers, bicyclists and pedestrians from entering an area.
c. To protect road users and workers.
d. To provide sign supports and warning lights.
e. To channelize traffic.

Barricades shall not be placed in a merging lane transition of traffic without advanced warning. Barricades shall be one of three types: Type 1, Type 2 or Type 3. Type 1 or Type 2 Barricades are intended for use in situations where road user flow is maintained through the TTC zone.

Type 1 Barricades may be used on conventional roads or urban streets.

Type 2 or Type 3 Barricades should be used on freeways and expressways or other high speed roadways.

Type 3 Barricades should be used for road closures and for long term construction activities.

8 -TEMPORARY TRAFFIC CONTROL PAVEMENT STRIPING/MARKINGS

The agency shall determine the need for and extent of striping removal and restriping to supplement devices used for delineation.

Temporary stripe replacement or additional striping shall be considered for construction, maintenance and other activities under the following conditions:

a. When traffic is to be diverted to the left of an existing double yellow centerline for one or more consecutive nights.

b. When the activity site is adjacent to an intersection and results in a transition within the intersection.

c. In other situations where traffic and physical conditions, such as speed or restricted visibility, require special treatment.

When temporary pavement striping or markings are provided, the existing striping or markings shall be completely removed by one of the following methods:

a. Wet abrasive blasting

b. Hydro blasting

c. Vacuum blasting

d. Grinding

All striping removal shall be done with consideration and/or protection of pedestrian and vehicular traffic and surrounding businesses, homes, landscaping, etc. Removal of striping and pavement markings shall be done in a manner that preserves and protects the integrity of the pavement. Covering of striping or markings with black paint shall not be permitted, except as a temporary measure until permanent removal of the striping or marking can be done. Permanent removal shall be done within 24 hours of the application of the black paint.

Detour grade temporary traffic striping tape (matte black only) may be used if approved by the agency.

The agency must approve any striping and marking changes. Responsibility for striping installations and removals shall be by the permittee, contractor, or agency as established by the agency in the permit or specifications.

When stripe delineation has been obliterated, the contractor or permittee shall at all times provide temporary delineation. This delineation shall consist of temporary retroreflectorized raised pavement markers, temporary retroreflectorized lines or other retroreflectorized delineation devices approved by the agency.

9 - FLAGGER TEMPORARY TRAFFIC CONTROL

Flaggers are required when:

a. Workers or equipment intermittently block a traffic lane on a two lane road.

b. Plans or permits allow the use of one lane for two directions of traffic, two flaggers are required, one for each direction of traffic.

c. The safety of the public and/or workers determines there is a need.

d. Signs and barricades alone cannot effectively control the traffic.

Qualifications for Flaggers: Because flaggers are responsible for public safety and make the greatest number of contacts with the public of all highway workers, they shall be trained in safe traffic control practices and public contact techniques.

Flaggers shall be able to satisfactorily demonstrate the following:

a. Ability to receive and communicate specific instructions clearly, firmly and courteously,

b. Ability to move and maneuver quickly in order to avoid danger from errant vehicles,

c. Ability to control signaling devices (such as paddles and flags) in order to provide clear and positive guidance to drivers approaching a TTC zone in frequently changing situations,

d. Ability to understand and apply safe traffic control practices, sometimes in stressful or emergency situations, and

e. Ability to recognize dangerous traffic situations and warn workers in sufficient time to avoid injury.

Flagger Training Requirements: Flaggers shall be trained in the proper fundamentals of flagging moving traffic before being assigned as flaggers. The training and instructions shall be based on the CA MUTCD Part 6E and Cal-OSHA Section 1599, work site conditions and also include the following:

a. flagger equipment which must be used,
b. layout of the work zone and flagging station,
c. methods to signal traffic to stop, proceed or slow down,
d. methods of one way traffic control,
e. trainee demonstration of proper flagging methodology and operations,
f. emergency vehicles traveling through the work zone,
g. handling emergency situations,
h. methods of dealing with hostile drivers,
i. flagging procedures when a single flagger is used (when applicable).

Note: *Documentation of the training shall be maintained as required by Cal-OSHA.*

Flaggers shall be trained by persons with the qualifications and experience necessary to effectively instruct the employee in the proper fundamentals of flagging moving traffic.

The flagger's TTC shall have:

a. An Advance Warning Area.

b. A Flagger Station location. NOTE: Approaching road users shall have an adequate site distance to safely stop at the flagger station.

c. A Work Activity Area (including a buffer space to allow errant vehicles to stop without entering the work space).

d. A Termination Area.

High Visibility Safety Apparel: For daytime activity, flaggers shall wear high visibility safety apparel that meet ANSI "American National Standard for High Visibility Apparel and Headwear" Performance Class 3 requirements.

During the hours of darkness, flaggers shall wear safety apparel ensemble consisting of an ANSI Performance Class 3 vest. Class E pants and Class 3 headware are recommended. Refer to the Flagger Hand Signaling Procedures diagram on page 20).

The apparel background (outer) material color shall be either fluorescent orange-red or fluorescent yellow-green as defined in the standard. The retroreflective material shall be orange, yellow, white, silver, yellow-green, or a fluorescent version of these colors and shall be capable of visibility at a minimum distance of 1,000 feet. The retroreflective safety apparel shall be designed to clearly identify the wearer as a person.

Hand Signaling Devices: Flaggers shall be equipped with an 18-inch by 18-inch STOP/SLOW sign paddle. STOP/SLOW sign paddles 24-inch by 24-inch should be used where greater emphasis is required during the hours of darkness or speeds are in excess of 30 mph. **The bottom of the STOP/SLOW sign portion of the paddle should be a minimum of 6 feet above the pavement when mounted on a rigid staff.**

Restricted Road User Sight Distance: Flaggers shall be located to allow approaching road users sufficient distance to stop at the intended stopping point. Additional space (buffers) should be provided for errant vehicles so they can stop without entering the activity site.

If there is restricted approaching road user sight distance to the primary flagger station, an additional **ADVANCE** flagger, a **PCMS, RUMBLE STRIPS** or a **POLICE OFFICER** may be required to provide early warning for the approaching road users.

The STOP/SLOW paddle may be modified to improve visibility by incorporating red flashing **LED** lights on the STOP face and yellow **LED** flashing lights on the SLOW face.

Flagger Procedures: The proper use of the STOP/SLOW paddle and flaggers hand signal procedures have been uniformly standardized by the FHWA, nationwide. The use of flags to control traffic is restricted to emergency situations only when the STOP/SLOW paddle is not available.

The proper hand signals and equipment to be used by flaggers for controlling and directing traffic are illustrated in this handbook.

Before the flagging activity begins, the flaggers shall agree on the following:

a. The type of safety apparel to be worn.
b. The hand signaling methods to be used.
c. The communication methods and/or equipment to be used.
d. How to respond to approaching emergency vehicles.
e. How to respond to jobsite emergency incidents.
f. How to respond to hostile or frustrated individuals.
g. Identify an emergency escape route to avoid being struck by an errant vehicle.

Flagger Hand Signaling Procedures: The following methods of flagger hand signaling with paddles shall be used as illustrated in this handbook on page 20:

Flaggers are responsible to:

a. Be easily seen by the approaching road users.
b. Protect the activity site from intrusion of pedestrians and vehicles.
c. Always hold the STOP/SLOW sign and not place it in a cone.
d. Not sit, lean, or turn his/her back toward road users.
e. Make eye contact with the approaching road users.
f. Identify a clear lateral escape path to avoid being struck by an errant vehicle.
g. Be courteous at all times and minimize casual conversation.
h. Not engage in arguments with road users.
i. Report extreme hostile actions to your supervisor and/or police.
j. Not socialize with other workers/road users.

During the Hours of Darkness: The flagger stations shall be illuminated so that the flagger station will be clearly visible to approaching traffic. The STOP/SLOW paddle shall be retroreflective and shall be 24" x 24" mounted on a 6-foot rigid staff. The flagger shall wear high-visibility apparel consisting of an ANSI Class 3 garment. Class E pants and Class 3 headware are recommended.

10 - PEDESTRIAN CONSIDERATIONS

When the activity site encroaches upon a sidewalk, walkway or crosswalk area, special consideration must be given to pedestrian safety. Pedestrians shall be provided advance warning if they are detoured away from the activity site. If pedestrians are allowed to pass through or around the activity site, they shall be provided a safe path and shall not be led into direct conflict with the work activities or vehicular traffic.

Advance notification of sidewalk closures shall be provided. It must be recognized that pedestrians are reluctant to retrace their steps to a prior intersection for a crossing or to add distance or out-of-the-way travel to a destination.

Protective barricades, fencing, handrails and bridges, together with warning and guidance devices and signs, shall be utilized so that the passageway for pedestrians, especially visually impaired and other physically disabled persons is safe and well defined.

Wooden railing, fencing and similar systems placed immediately adjacent to motor vehicle traffic shall not be used as substitutes for crashworthy temporary traffic barriers. Tape, rope, or plastic chains strung between devices are not detectable, do not comply with the design standards, and should not be used as a control for pedestrian movements.

All pedestrian routes shall meet the American with Disabilities Act (ADA) requirements. The pedestrian pathway should be 5 feet wide, shall provide an 80-inch high vertical clearance, and may be reduced to 4 feet wide if a 5-foot long, 5-foot wide passing area is provided every 200 feet. The pedestrian pathway surface shall be paved and shall have no vertical displacements greater than 1/2 inch. Any vertical displacements greater than 1/2 inch shall be ramped at a 12:1 slope. ADA compliant pedestrian barriers shall be provided along high risk areas.

At locations where adjacent alternate walkways cannot be provided, devices shall be installed at the limits of the activity and in advance of the closure at the nearest crosswalk or intersection.

11 - BICYCLE CONSIDERATIONS

When performing an activity on any roadway, attention should be directed to the probability of encountering bicycle traffic. Roadways adjacent to activity sites, particularly shoulders or parking lanes, must be kept free of obstructions or other hazards to bicyclists.

When performing work on roadways designated as a bike route or where separate bike lanes are present, special attention shall be given to bicyclists.

There are several considerations in planning for bicyclists in TTC zones:

a. A travel route that replicates the most desirable characteristics of a wide paved shoulder or bikeway through or around the traffic control zone is desirable for bicyclists.
b. If the traffic control zone interrupts the continuity of an existing bikeway system, warning signs directing bicyclists through or around the zone shall be placed in advance of the activity site. All road users shall be warned with a Bike Symbol Sign (W11) mounted above a SHARE THE ROAD (W16) sign.
c. Unless a separate bike path through or around the traffic control zone is provided, adequate roadway lane width to allow bicyclists and motor vehicles to travel side by side through or around the zone is desirable.
d. Bicyclists should not be led into direct conflicts with mainline traffic, work site vehicles, or equipment moving through or around the traffic control zone.

Bicycle routes shall not have any perpendicular vertical displacement greater than ½ inch or parallel vertical displacement greater than 3/8 inch. Any vertical displacement greater than the above shall be ramped at 4:1. There shall be no parallel or skewed gap or slot in the pavement greater than ½ inch.

12 – ACTIVITIES NEAR RAILROADS

Extra care should be exercised not to create conditions, either by lane restrictions, flagging or other operations, where road users may be stopped within railroad right-of-way at street rail grade crossings.

Early coordination with the railroad company should occur before work starts.

When a street rail grade crossing exists either within or in the vicinity of a TTC zone, lane restrictions, flagging, or other operations shall not be performed in a manner that would cause road users to stop on the railroad tracks. Every effort should be made to have in place emergency traffic escape routes on the downstream side of the street rail grade crossing.

DO NOT STOP ON TRACKS (R8-8) signs shall be used on all approaches to a street rail grade crossing within the limits of the TTC zone. Whenever an activity may cause traffic to backup across an active railroad track, a flagger shall be provided.

The safety of bicyclists and pedestrians, including the disabled and the elderly shall be evaluated when the activity site encroaches upon a sidewalk, walkway, crosswalk, or bikeway within or in the vicinity of a street rail grade crossing.

13 – WORKER SAFETY CONSIDERATIONS

Worker safety is as important as that of the road users traveling through the TTC zone. Maintaining TTC zones with TTC signs and devices that get the attention of road users is of particular importance to the safety of workers in the TTC zone.

The FHWA has encouraged all agencies to adopt the following key elements to improve worker safety in TTC zones and provide the following:

a. Training - Workers having specific TTC responsibilities shall be trained in TTC techniques, device usage and placement.
b. Worker safety apparel - all workers shall wear high visibility safety apparel that meets Performance Class 2 or 3 requirements.
c. Provide temporary traffic barriers on long term projects.
d. Speed reduction of vehicular traffic using advisory speed reduction signs.
e. Shadow vehicles equipped with appropriate lights and warning signs, may be used to protect the workers.
f. Temporarily rerouting or detouring traffic around the activity site.
g. Law enforcement units may be stationed to heighten the awareness of passing vehicular traffic and to improve safety through the TTC zone.
h. Lighting for work activities in a TTC zone shall be provided.
i. Special Devices - these include rumble strips, changeable message signs, hazard identification beacons, flags and warning lights.

14 – TEMPORARY TRAFFIC CONTROL INCIDENT MANAGEMENT

A traffic incident is an emergency road user occurrence, a natural disaster, or other unplanned event that affects or impedes the normal flow of traffic.

The traffic incident responders (police, fire and ambulance) are in charge of the incident scene. If a traffic incident should occur during an ongoing TTC operation, emergency services shall be contacted immediately. The agency or contractor responsible for the existing TTC zone shall cooperate with incident responders. The incident responders may ask for further assistance or may request immediate termination of the TTC zone activities.

Flagger Hand Signal Procedures

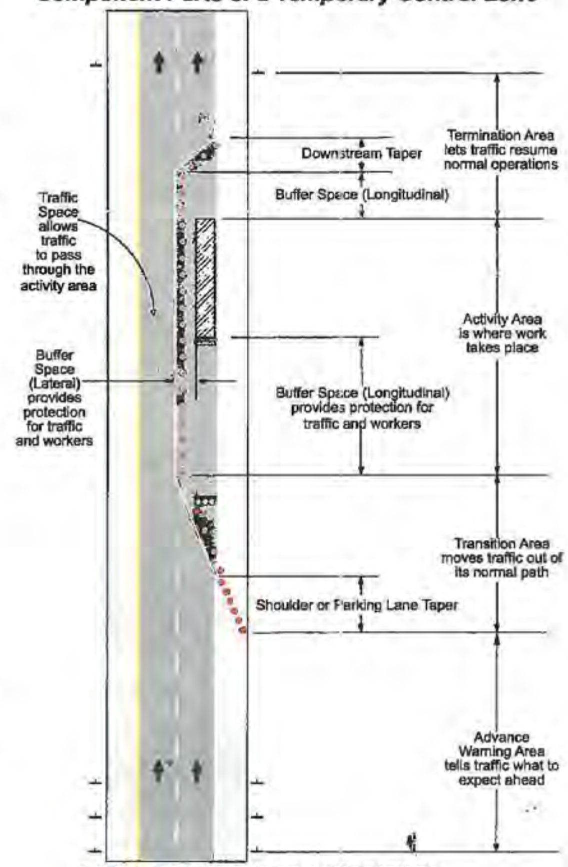
To STOP road users:
To stop road users, the flagger shall face road users and aim the **STOP** paddle face toward road users in a stationary position with the arm extended horizontally away from the body. The free arm shall be held with the palm of the hand above the shoulder level toward the approaching road user.

To direct road users to PROCEED:
To direct stopped road users to proceed, the flagger shall face road users with the **SLOW** paddle face aimed toward road users in a stationary position with the arm extended horizontally away from the body. The flagger shall motion with the free hand for the road user to proceed, moving the free hand horizontally left to right.

To ALERT or SLOW road users:
To alert or slow road users, the flagger shall face road users with the **SLOW** paddle face aimed toward the road users in a stationary position with the motion up and down with the free hand, palm down.

NOTE: The use of hand movements alone without a paddle to control road users shall be prohibited except for law enforcement personnel or emergency responders at incident scenes.

Component Parts of a Temporary Control Zone



CA MUTCD FIGURE 6C-1 (MODIFIED)

NOT TO SCALE

Warning Signs

C9A (CA) | C12 (CA) | C20 (MODIFIED) (CA) (RT, LT, CENT., OR BIKE)

C27 (CA) | C30 (CA) | C30A (CA)

C31A (CA) | C46 (CA) | SC5 (CA)

SC9 (MODIFIED) (CA)

Warning Signs

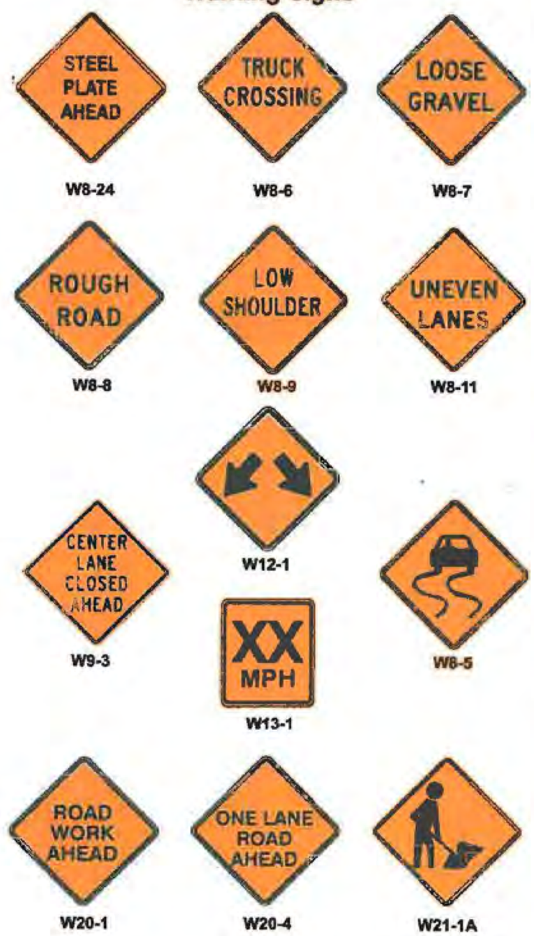
W1-1 (RT) | W1-2 (RT) | W1-3 (RT)

W1-4 (RT) | W1-6 (LT) | W3-1

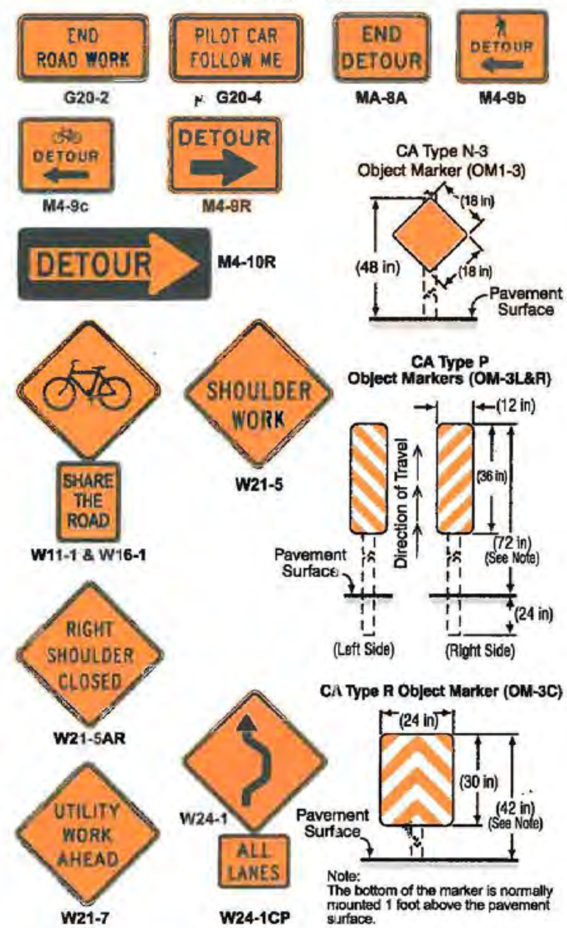
W3-3 | W3-4 | W4-2 (RT)

W4-7 | W6-3 | W6-4 | W8-1

Warning Signs

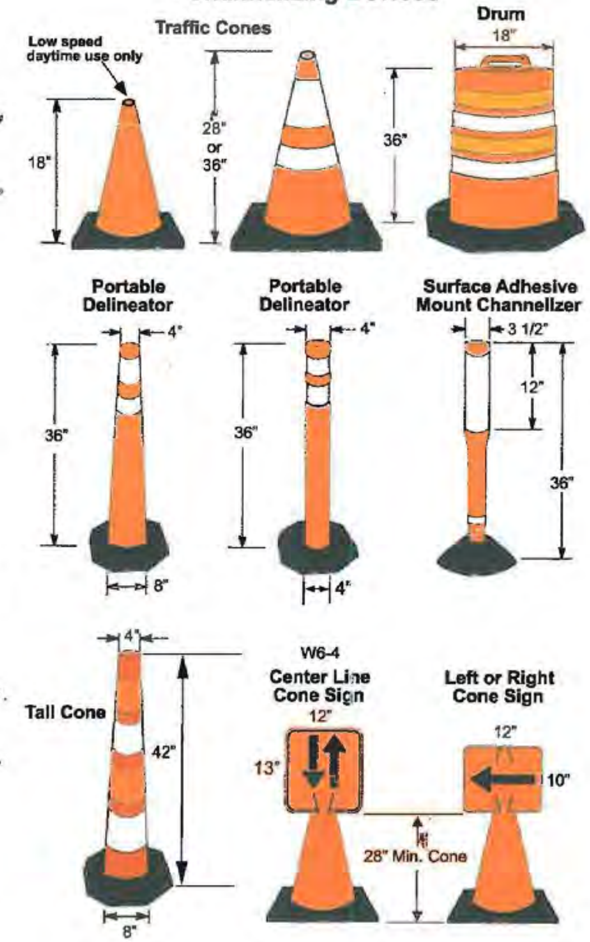


Warning Signs

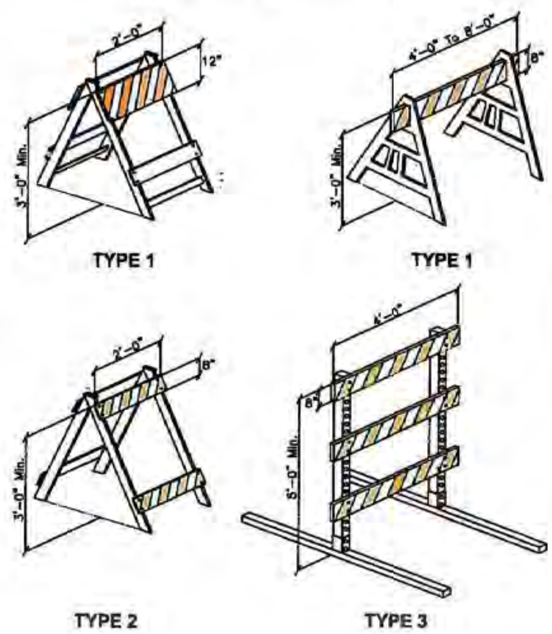


Regulatory Signs

Channelizing Devices



Typical Barricades



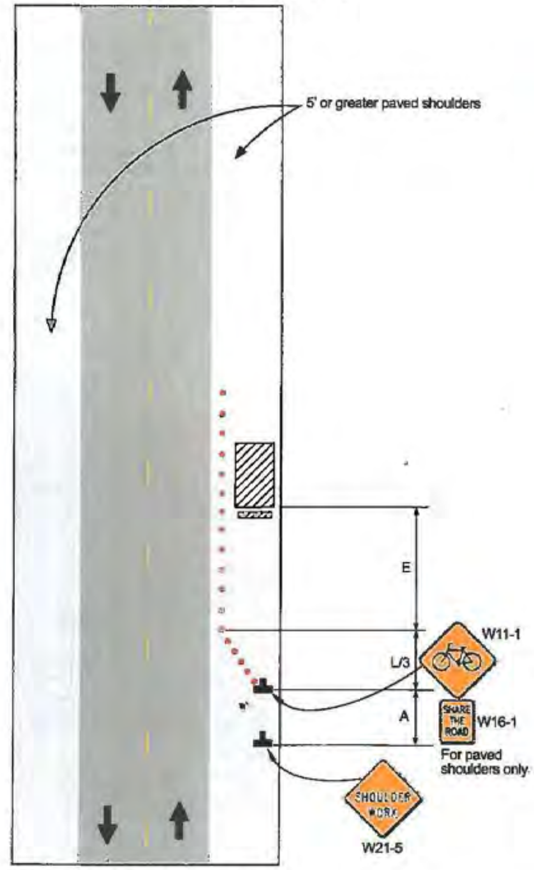
Barricade Striping Orientation

TYPICAL WORK ZONE LAYOUTS

While these Layouts may differ slightly from the Typical Applications shown in the *California MUTCD*, they are in substantial compliance with the Standard and Guidance of The Manual.

The Typical Work Zone Layouts were developed based on actual practices of local agencies in controlling traffic during street work activities. Most of the Layouts are shown as High Speed activities for Short Term or possibly Intermediate Term applications and may be used as initial guidance for engineering Long Term applications. See sections 6-2 and 6-3 for high and low speed requirements.

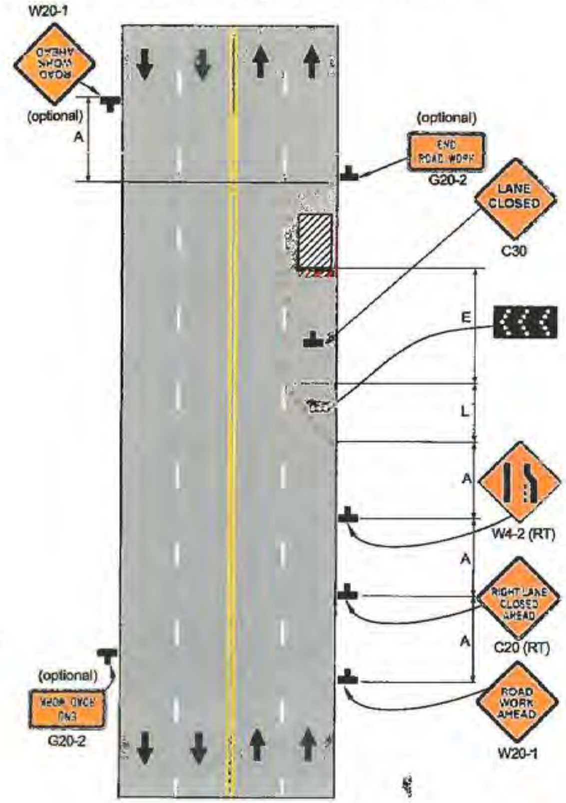
Work On Shoulders



CA MUTCD TA-3 (Modified)

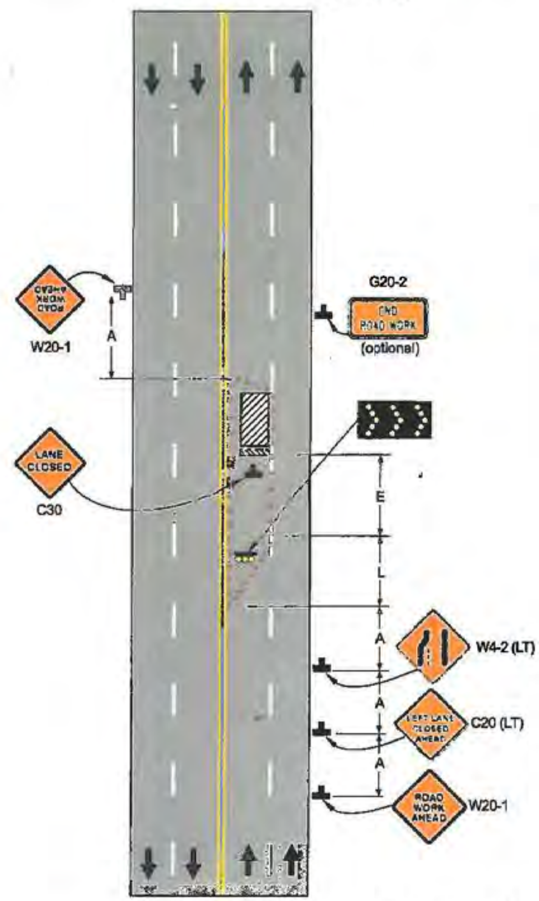
NOT TO SCALE

Mid Block Right Lane Closure



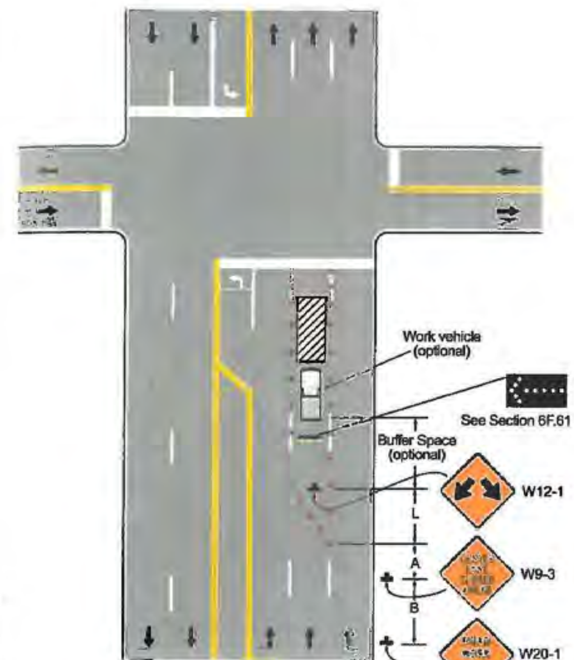
NOT TO SCALE

Mid Block Left Lane Closure



NOT TO SCALE

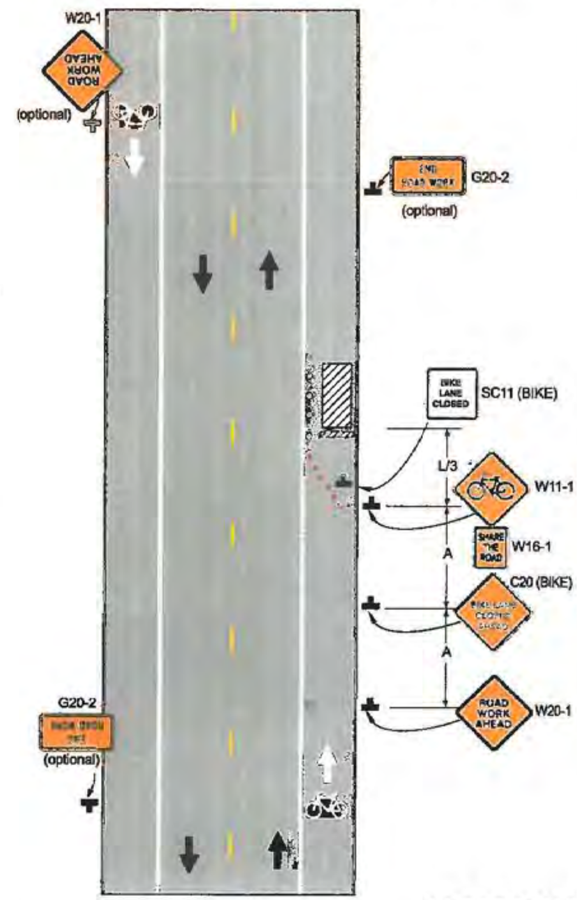
Figure 6H-21 Mid Block Center Lane Closure on the Near Side of an Intersection (TA-21)



Typical Application-21

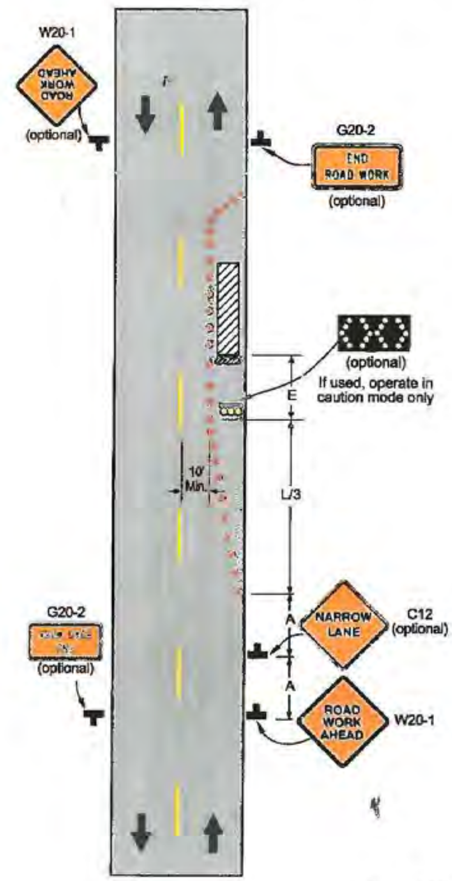
NOT TO SCALE

Mid Block Bike Lane Closure



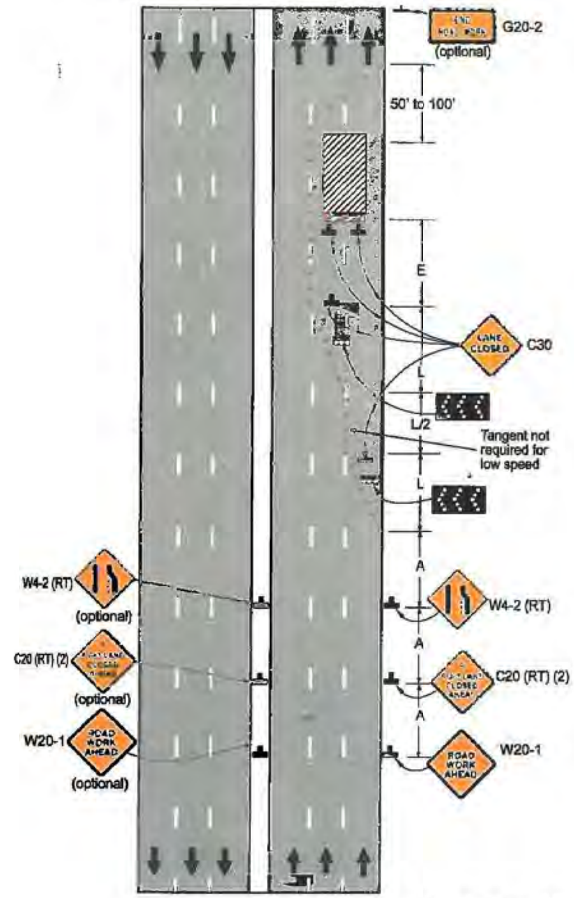
NOT TO SCALE

Mid Block Narrowing of Lane



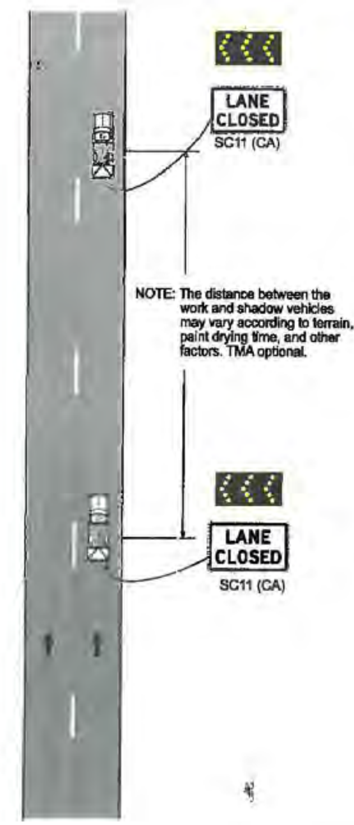
NOT TO SCALE

Mid Block Closure of Two Lanes



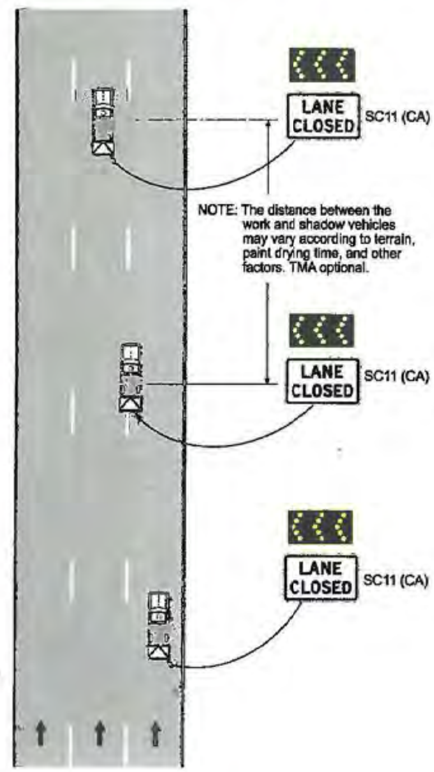
NOT TO SCALE

Single Moving Lane Closure



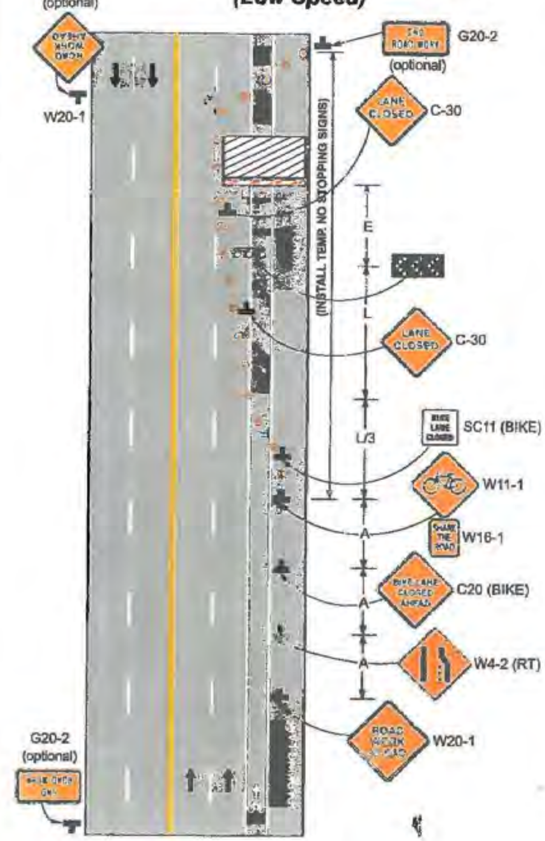
NOT TO SCALE

Multilane Moving Lane Closure



NOT TO SCALE

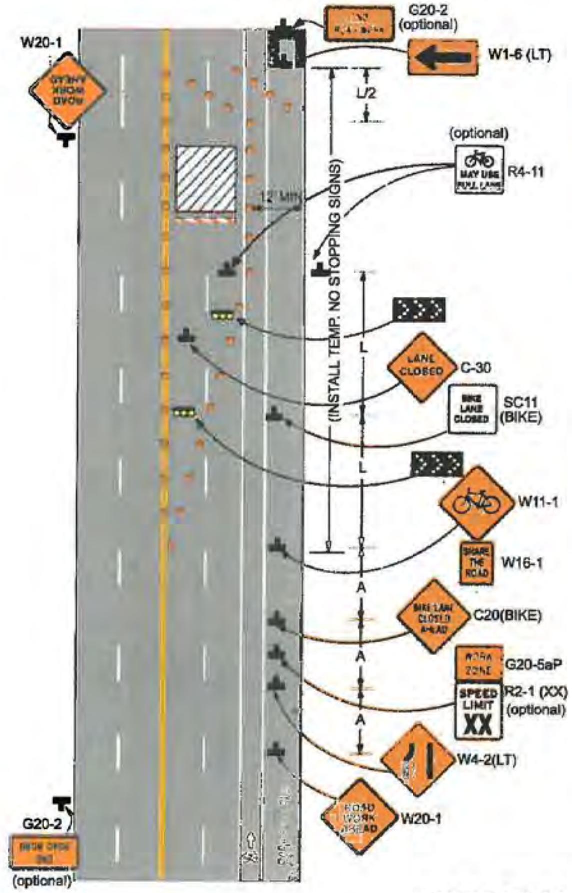
Bike Lane and Adjacent Lane Closure (Low Speed)



NOT TO SCALE

40 Work Area Traffic Control Handbook

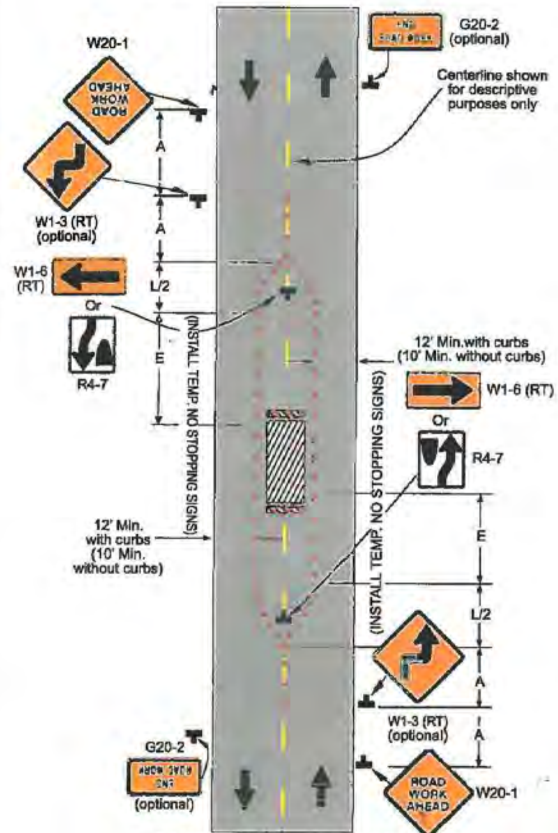
Bike Lane Intrusion (Low Speed)



NOT TO SCALE

Work Area Traffic Control Handbook 41

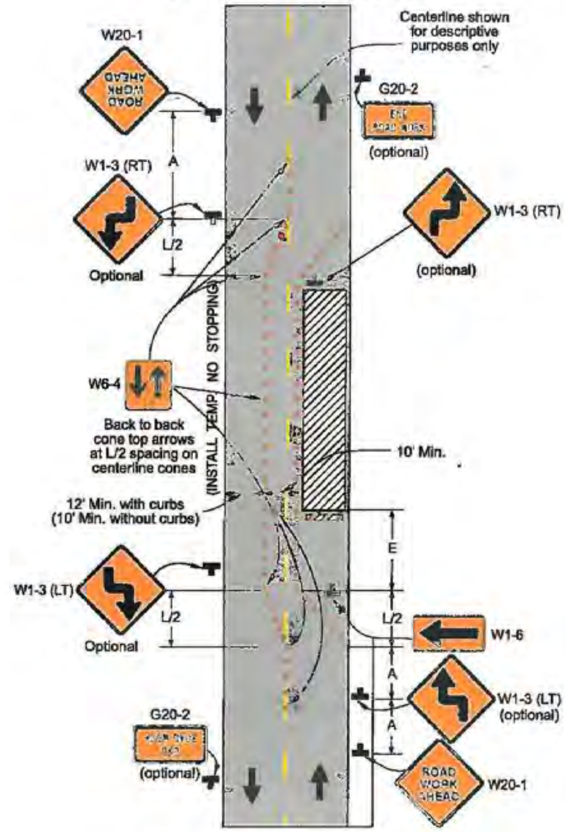
Work in Center of Road with Low Traffic Volumes and Low Speeds



CA MUTCD TA-15 (Modified)

NOT TO SCALE

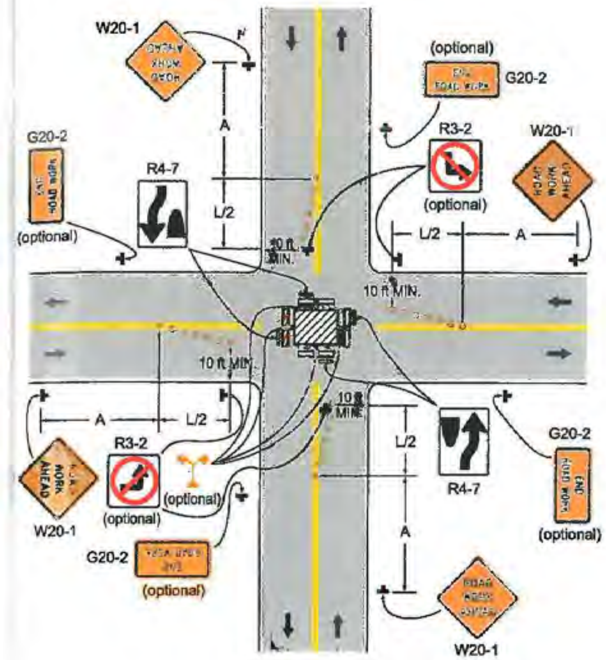
Work on Side of Road With Low Traffic Volumes and Low Speeds



CA MUTCD TA 105 (CA) (Modified)

NOT TO SCALE

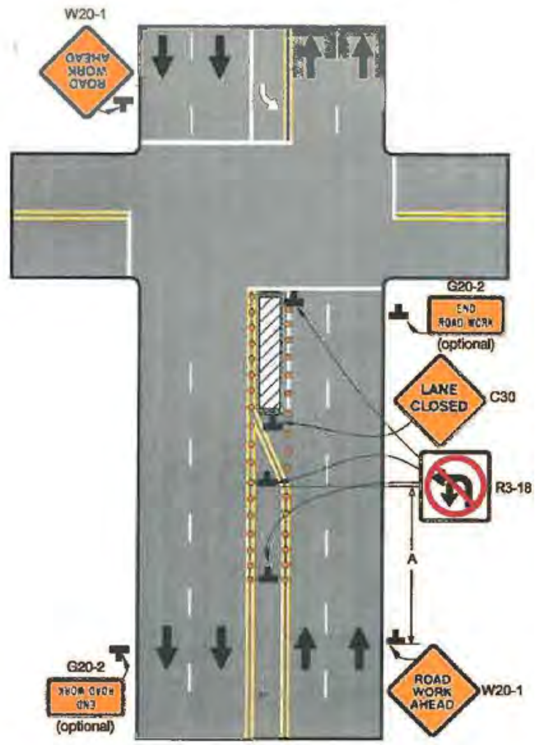
Figure 6H-26 Closure in The Center of an Intersection (TA-26)



TYPICAL APPLICATION 26

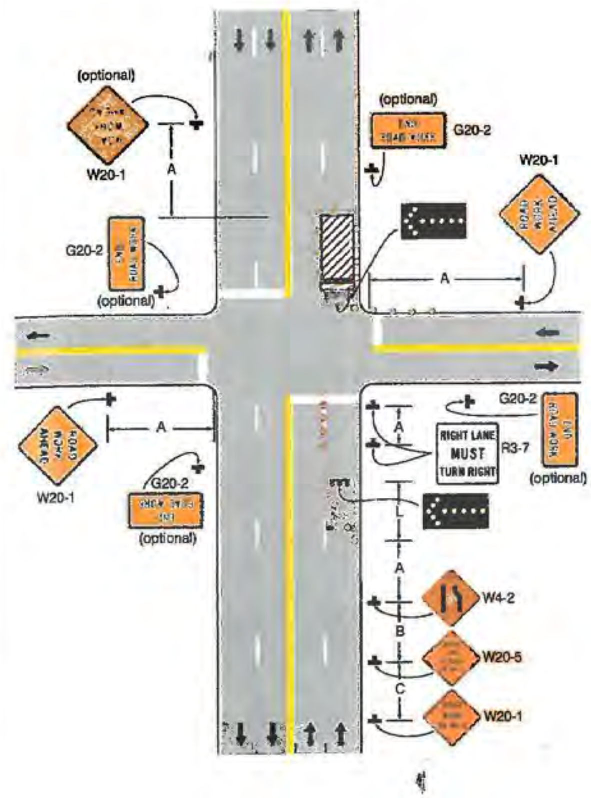
NOT TO SCALE

Closure of a Left Turn Pocket



NOT TO SCALE

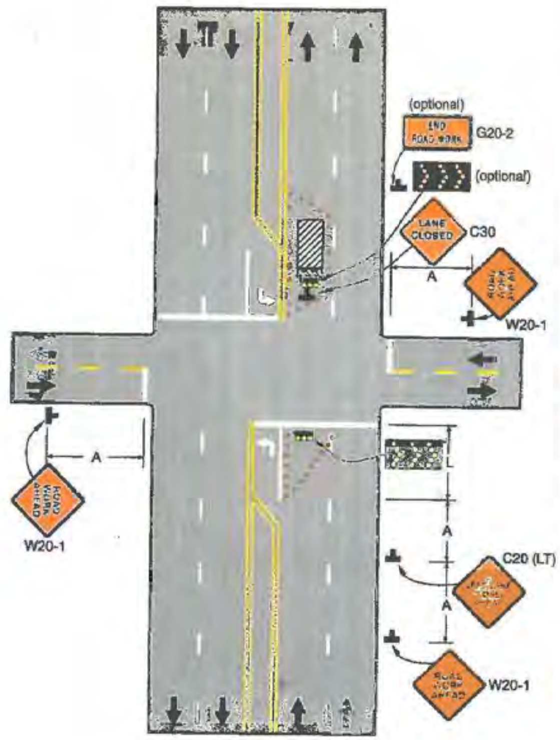
Right Hand Lane Closure on Far Side of Intersection



CA MUTCD TA-22B (CA)

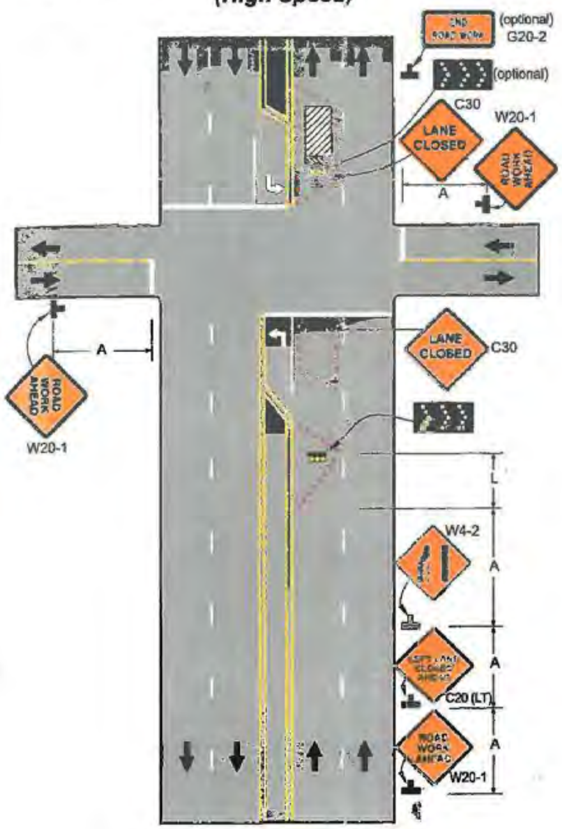
NOT TO SCALE

Left Lane Closure on Far Side of Intersection (Low Speed)



NOT TO SCALE

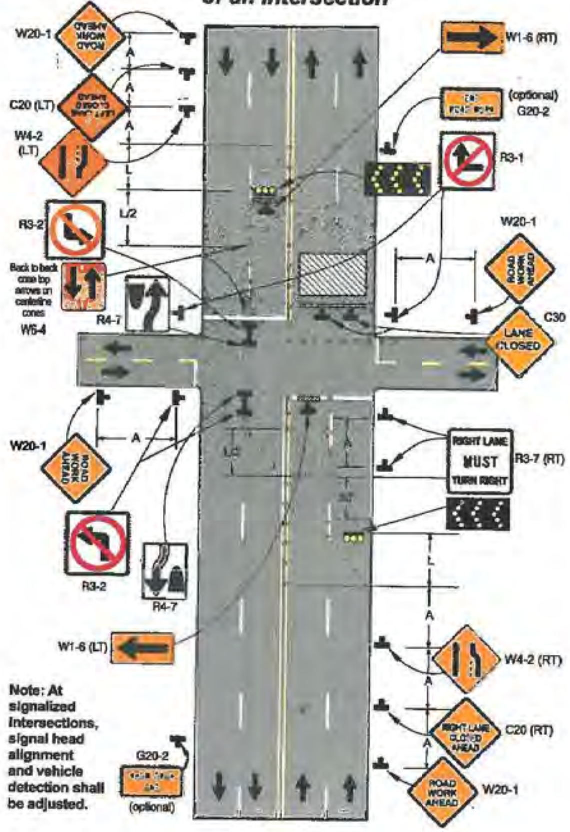
Left Lane Closure on Far Side of Intersection (High Speed)



CA MUTCD TA-25 (Modified)

NOT TO SCALE

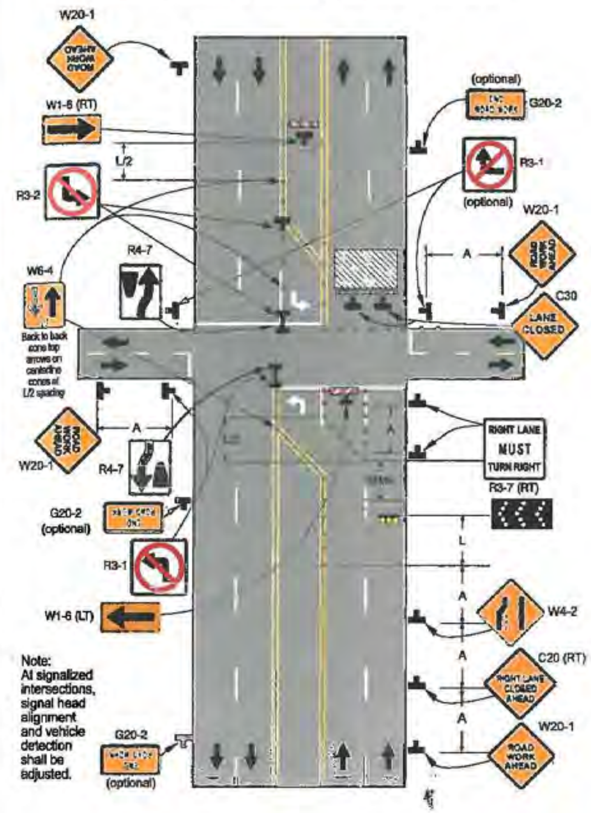
Half Road Closure on the Far Side of an Intersection



CA MUTCD TA-24 (Modified)

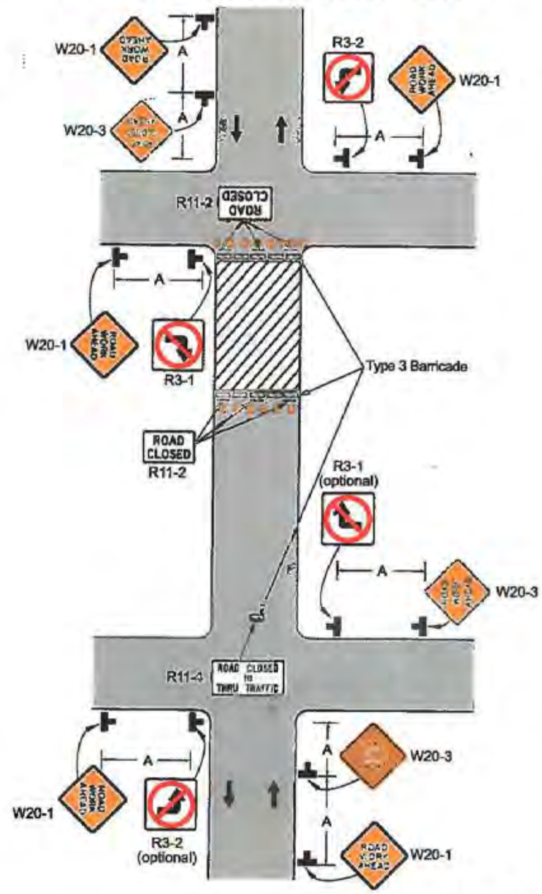
NOT TO SCALE

Half Road Closure on the Far Side of an Intersection Utilizing Painted Median



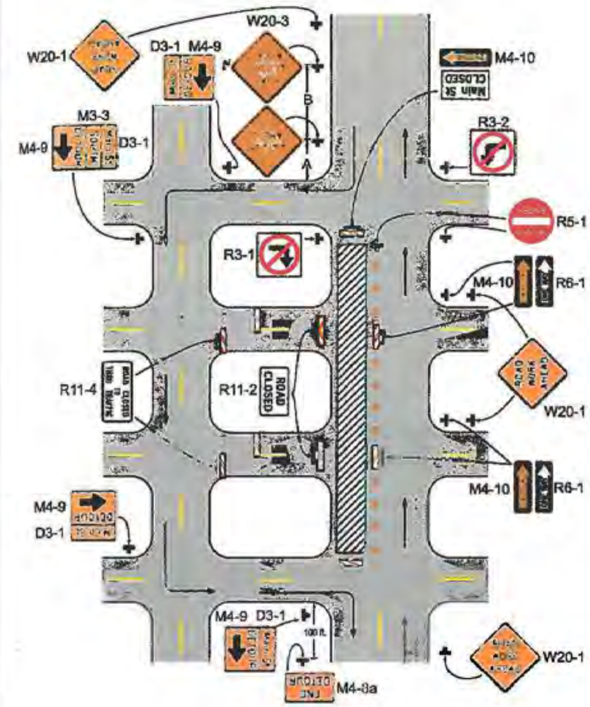
NOT TO SCALE

Closing of Low Speed Local Street



NOT TO SCALE

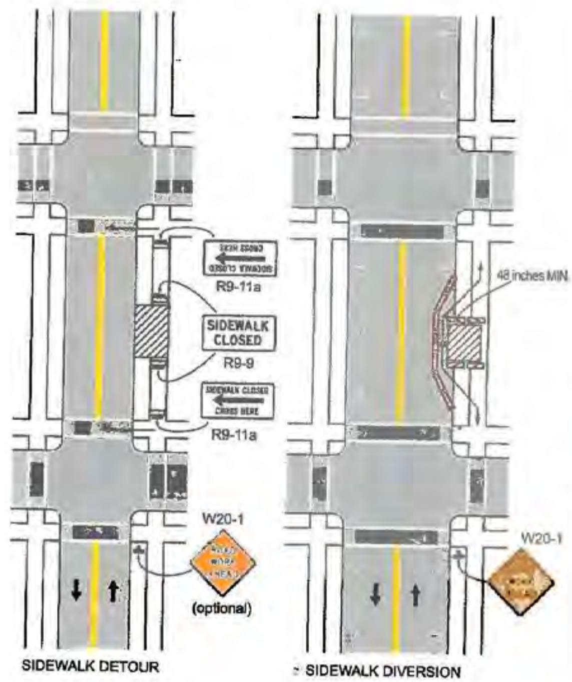
Detour for One Travel Direction



CA MUTCD TA-19

NOT TO SCALE

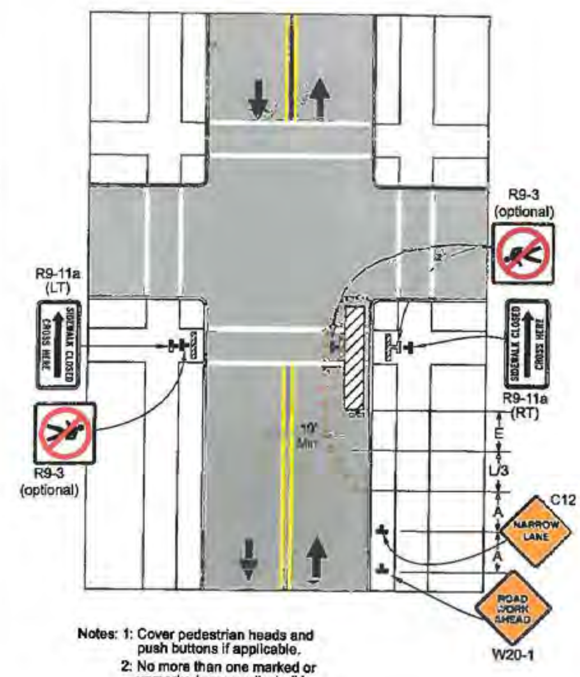
Sidewalk Detour or Diversion



CA MUTCD TA-28

NOT TO SCALE

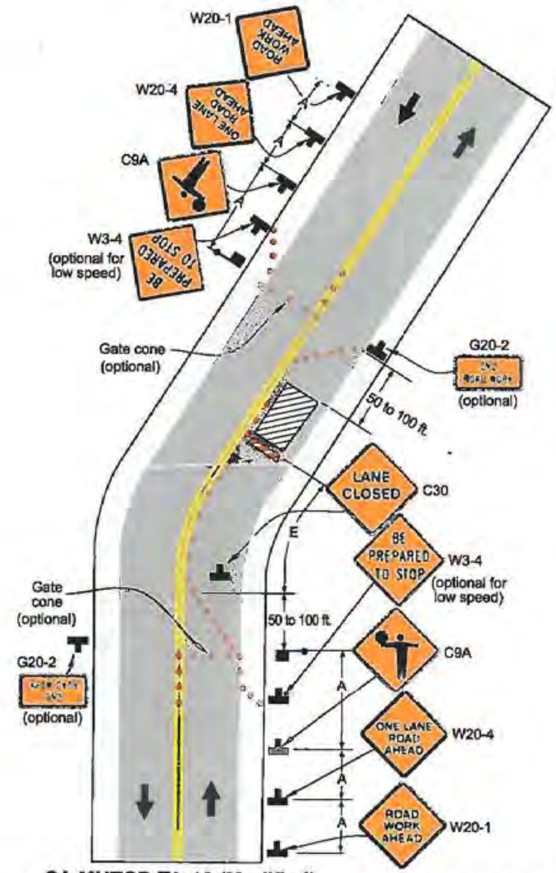
Closure of a Marked or Unmarked Crosswalk



Notes: 1: Cover pedestrian heads and push buttons if applicable.
2: No more than one marked or unmarked crosswalk shall be closed at the same time.

NOT TO SCALE

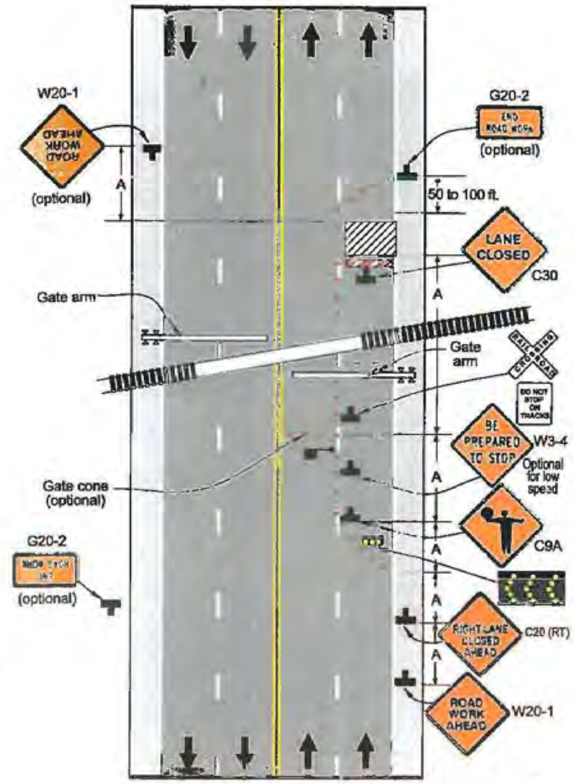
Lane Closure On Two Lane Road Using Flaggers



CA MUTCD TA-10 (Modified)

NOT TO SCALE

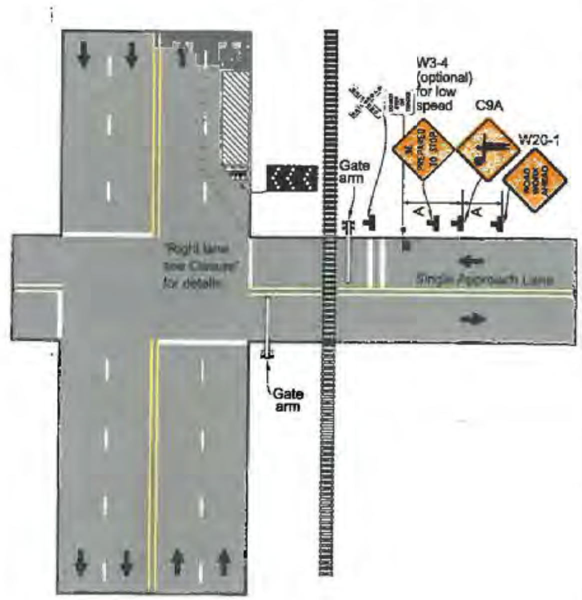
Work in Vicinity of Highway Rail Grade Crossing



CA MUTCD TA-46 (Modified)

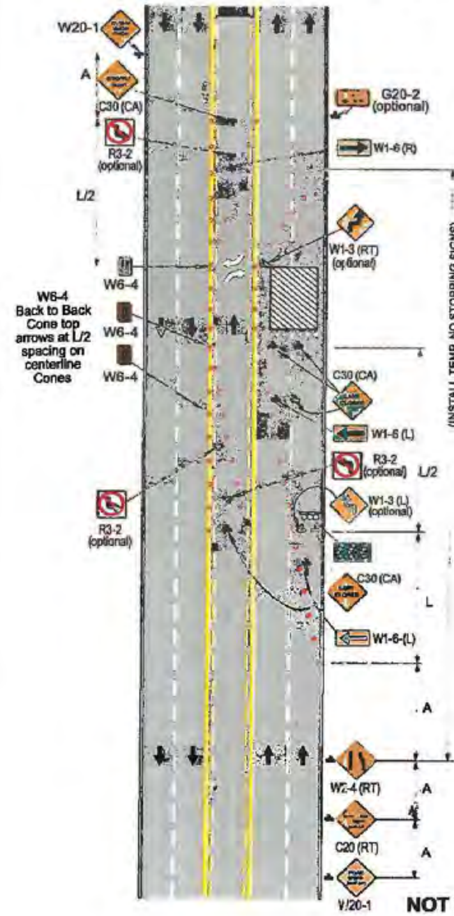
NOT TO SCALE

Flagging for Work on Street Parallel to Railroad Tracks



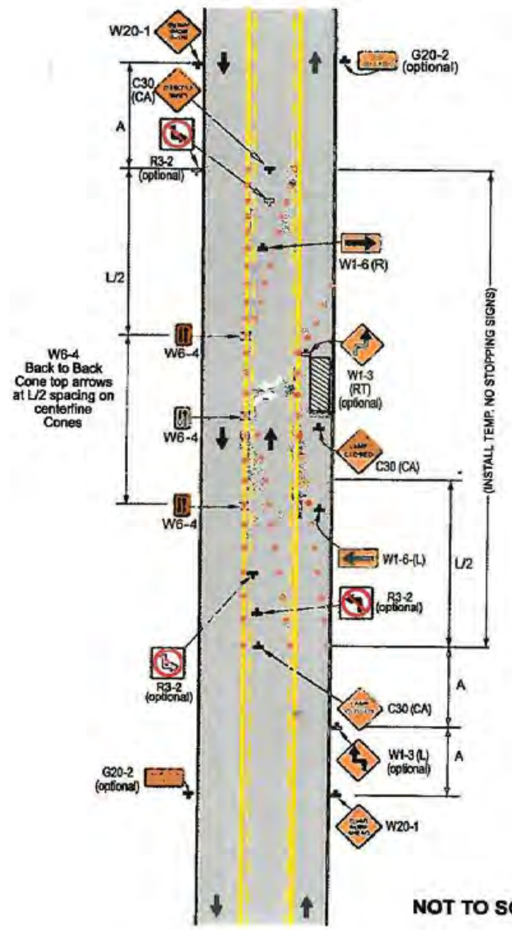
NOT TO SCALE

Work on Side of Road Utilizing Painted Median Multilane for Traffic Flow



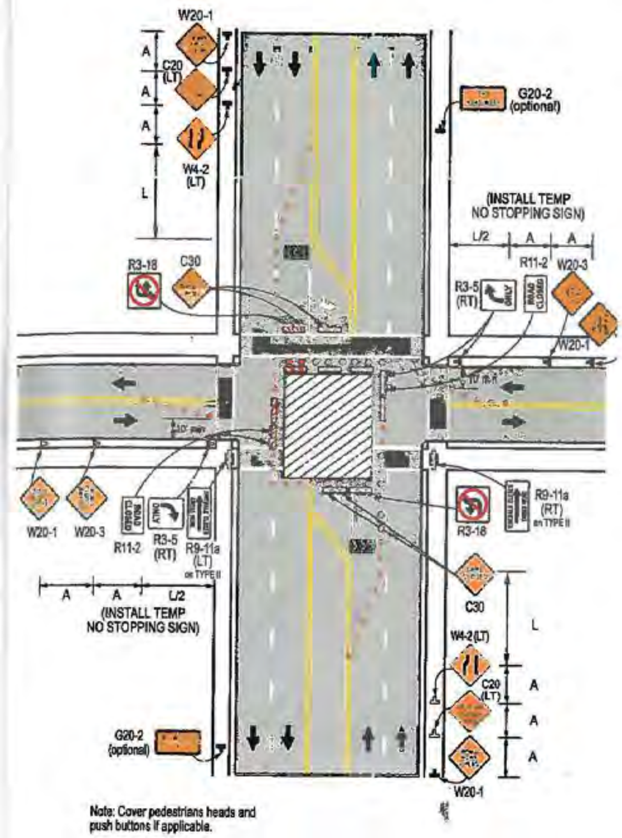
NOT TO SCALE

Work on Side of Road Utilizing Painted Median for Traffic Flow



NOT TO SCALE

Closure in the Center of a Multilane Intersection



Note: Cover pedestrians heads and push buttons if applicable.

NOTES

TEMPORARY TRAFFIC CONTROL PLAN DIMENSION GUIDELINES

SPEED MPH (2)	Dimension A/B/C ADVANCE WARNING SIGN SPACING (5)	Dimension L MERGING TAPER LENGTH	Dimension L/2 SHIFTING TAPER LENGTH	Dimension L/3 MINIMUM SHOULDER TAPER	Dimension "E" BUFFER SPACE (4-A) and FLAGGER STATION STOPPING SIGHT DISTANCE (4-B) (0%) (-3%) (-6%)	MAXIMUM CHANNELIZER TAPER SPACING (3)	MAXIMUM CHANNELIZER TANGENT SPACING (3)	MAXIMUM CHANNELIZER CONFLICT SPACING (6)
MPH	Ft	ft	ft	ft	ft	ft	ft	ft
25	100	125	65	45	(155) (160) (165)	25	50	12
30	250	180	90	60	(200) (205) (215)	30	60	15
35	250	245	125	85	(250) (260) (275)	35	70	17
40	250	320	160	110	(305) (315) (335)	40	80	20
45	350	540	270	180	(360) (380) (400)	45	90	22
50	350	600	300	200	(425) (450) (475)	50	100	25
55	500	660	330	220	(495) (520) (555)	50	100	25
60	500	720	360	240	(570) (600) (640)	50	100	25
65	500	780	390	260	(645) (685) (730)	50	100	25
(1)	Work on Freeways and Expressways shall meet the Caltrans Standard Plans and Standard Specification requirements.							
(2)	Posted Speed or observed operating speed (whichever is greater).							
(3)	Channelizer spacing shall be reduced by half at areas where work is taking place on curves or areas of head-on conflict.							
(4-A)	Buffer space may be inserted in low-speed urban areas and should be inserted in high-speed urban and rural areas.							
(4-B)	The Stopping Sight Distance should enable Road Users to see the Primary Flagger Station and safely stop.							
(5)	Sign spacing in rural areas should be 500 ft.							
(6)	** Table 6F-101(CA)							

Appendix A-2

South East Barrier Pipeline Operating Instructions

South East Barrier Operating Instructions
Version 1 June 28, 2004

The South East Barrier, Figure 1, is presently a domestic water line that ties off of Huntington Beach's domestic water system (OC-44). The OC-44 flow is monitored and controlled by the Mesa Consolidated Water District (MCWD).

Water from the OC-44 line is temporarily being diverted to Water Factory 21's barrier injection line, I-1 – I-28 and future injection wells I-29-I-38. The contracted flow will be between 3 and 8 mgd. The South East Barrier (SEB) line will eventually be fed from Orange County Water District's GWR plant. This line presently supplements injection blends of reverse osmosis, deep well and the City of Fountain Valley's domestic water, into the Talbert Injection Barrier.

The South East Barrier consists of :

- The OC-44 metering vault, located on the North side of Adams Avenue in the median on the frontal road parallel to Adams Blvd, approximately 200 yards west of the Santa Ana River. The service pressure on this line is 150-180 psi. It is recommended that staff conduct a weekly visual check of the meter vault sump at least weekly or until a water infiltration trend is developed. Sump pump can be operated by plugging in a portable generator to plug connection within vault.

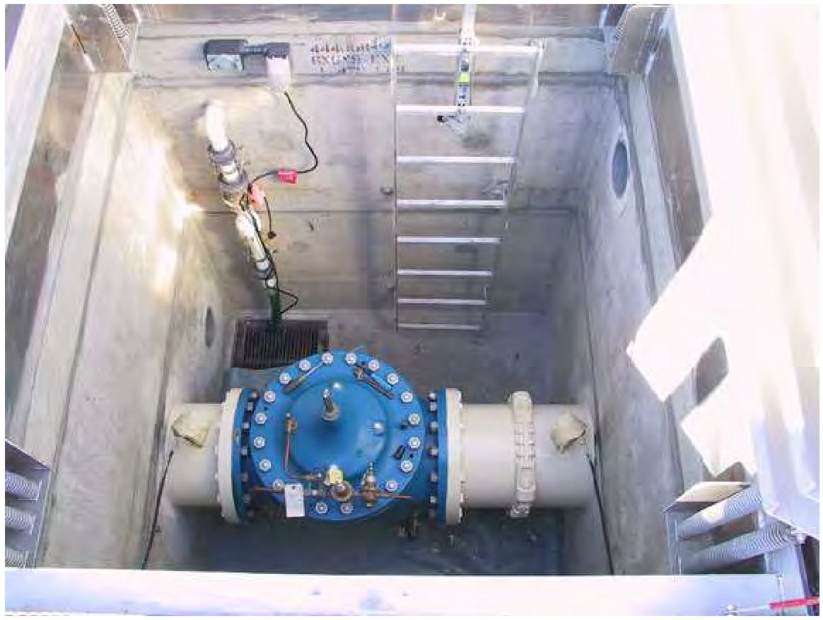
Meter vault is located just east of Mesa Consolidated Water District's chlorination vault. There are two, parallel meters of different sizes located in this vault. The 10-in meter valves are to remain closed during normal operation. If used, flow should be limited to a maximum of 5 mgd. For short term outages, four hours or less, the maximum flow rate could be increased to 6 to 6.5 mgd. Currently this vault has no power or ventilation and should be considered a permit required confined space, unless a portable generator and blower are used.

View down into meter vault.

- Double line - four valve RP back flow prevention valves located approximately 150 yards east and slightly north of the OC-44 metering vault.

Backflow device located north of Adams Frontage Road. Devices are required to be tested and certified annually.

- PRV-1 vault located directly north of the RP system. This valve is set at a sustaining upstream pressure of approximately 100 psi and a reduced downstream pressure of 65 psi. Citect does not receive signals from this vault. Staff should conduct visual check of this facility at least weekly.



View into PRV-1 vault. Sump pump can be operated with portable generator.

- PRV-2 vault is located on OCWD property at the corner of Ward and Ellis and directly south of the I-5 injection vault. This vault is supplied with electrical power and has a ventilation blower system similar to the injection well vaults.

View of PRV-2 vault looking north to Ellis and Ward intersection

- The approximate head loss from PRV-1 to PRV-2 is about 20 psi for a flow rate of 8 mgd. Flow is directed into the PRV-2 pressure/flow control station through a bi-pass valve system. The valve located adjacent (south) of the valve vault should remain closed at all times during normal operation. The valve should only be operated when PRV-2 valves are being serviced and flow is still required. ***Note: PRV-2 was removed after the commissioning of GWRS in 2008.*** This valve should be operated by authorized personnel only. However, PRV-2 will be decommissioned once the AWPF ceases to utilize SEB flow for blending purposes. The PRV-2 vault has two Cla-Val valves, the first is a pressure regulating/pressure sustaining valve and the second is a flow metering valve. The pressure sustaining feature has been disabled while the pressure regulating pilot has been set at 35 psi (downstream pressure). The 35 psi downstream pressure is set slightly higher than the injection pump discharge pressure (P-6 VFD injection pumps) setpoint due to velocity losses through the flow metering valve and overall headloss in the SEB pipeline. It is predicted that the downstream reducing setting would need to be approximately 30 psi when total flow is increased to 8 mgd.

Upstream Pressure Reducing Valve   *Downstream Flow Control Valve*

- The second valve in the PRV-2 vault is currently configured as a flow regulating valve. Currently, all flow changes must be made manually at PRV-2 vault using manual input to the valve's control box. Existing Process Control System, Citect, receives flow, upstream pressure and downstream pressure from PRV-2 vault. These parameters are monitored only and cannot be changed via Citect.

Downstream Flow Control Box   *Pressure transmitters*

- <u>CONTROLLING FLOW CHANGES FROM PRV-2:</u> This flow is regulated and displayed in the vault on the digital display box. To manually increase or decrease flow the display must be in the SP mode which is obtained by pressing the display button until SP is shown on the display screen. Flow changes are made with the up and down arrow and should be made in 200 to 300 gpm increments every 5 minutes.

- <u>CAUTION:</u> Never shutdown flow quickly. When increasing or decreasing flows the injection line VFD system will need to be monitored closely. Whenever the VFD is over 95% (60 Hertz) and you wish to increase Q-10 flow a new line pump must be brought on line from the closed position so that the VFD pump can be lowered into a more tolerable operating range like 60%. Whenever flow is decreased this process occurs in the reverse. Line pumps shall be started in the closed position and brought on-line no quicker than ¼-turm every 5 minutes. Whenever flow changes are made Mesa Consolidated Water District should be contacted by telephone prior to any changes. Current telephone contact numbers are posted in the control room.

EMERGENCY PROCEDURES

- In the event of an emergency remember that great damage can be done to the system if any of the Pressure Reducing Valves or isolation valves are closed too rapidly.

- In case of a SEB line break, the downstream valves on the RP backflow valves located at Adams Avenue should be secured. Secure valves slowly (1/2 turn every 1 minute). As soon as possible, call MCWD and OCWD Barrier Operations staff when securing the SEB.

- Up and downstream pressures at PRV-2 pressure reducing/sustaining valve can be monitored on PCS (Citect AI points: AI0507 and AI0508). If large pressure fluctuations develop on the SEB line, the VFD pumps and valves may need adjusting or maintenance. The Cla-Val valve pilots that control upstream and downstream pressure are to be adjusted by properly qualified and authorized personnel only!

- If fluctuating pressure cannot be controlled, securing of the SEB line may be necessary. Secure pipeline using the downstream isolation valves at the RP backflow valves. As soon as possible, contact MCWD and the OCWD Barrier Operations staff when securing these valves.

Location of Main Line Isolation Valves on SEB Line (Refer to South East Barrier (SEB) Record Drawings for Map and Exact Station Locations)

- At OC-44 metering vault (two valves next to vault on west side and two valves next to vault on the east side). The 10-inch “by-pass” meter valves are to remain closed during normal operation. This side of the metering structure is a “by-pass” line designed for use if the 16-in meter is out of service. The 10-in “by-pass” meter should be limited to a maximum flow rate of 5 MGD. For short term outage (four hours or less), the maximum flow rate could be increased to 6 to 6.5 mgd.
- Reduced Pressure (RP) valves (up and downstream) in nursery directly downstream of OC-44 vault.
- On Ward street where line exits SCE property
- On Ward St. south of Nightingale Circle
- At PRV-2 vault Ward and Ellis (See attached map D-9)
    - West side of vault – this valve will isolate the PRV-2 vault from the SEB line.
    - East side of vault – this valve will isolate the PRV-2 vault from the Ellis Avenue injection line.
    - On the Ellis Avenue Injection supply line at tie-in (separates P-6 VFD/injection pump station from SEB and Ellis).
- On the SEB supply line at Ellis Avenue Injection supply line tie-in point between SEB line and Ellis Avenue line (See attached map D-9).
- There is an additional line valve immediately south of PRV-2 vault located along the main SEB line. This valve will always remain closed when SEB flow is to be routed

through PRV-2 vault. This valve will remain open once PRV-2 vault is decommissioned and the new Barrier Pump Station is brought on-line (See attached map D-9).

Typical valve can installation. All valve lids are marked with GWRS.

Miscellaneous Information:

- All gates crossing the SEB have OCWD American Locks.
- Access into Pegasus School grounds during school hours requires check-in at the school office.
- There is an additional line valve within the Pegasus School grounds. It is recommended that this valve only be operated to help isolate a leak in the SCE property.

Appendix A-3

Exercising Main and Lateral Valves

Appendix A-3

Exercising Main and Lateral Valves

Background

Annually all main line and lateral valves are exercised. This consists of stopping water flow and fully closing and then reopening each valve. Many times, the valve can, and riser needs to be cleaned of debris that block the valve key from contacting the valve nut. A shop vacuum or spring-loaded grabbing device can be used to remove dirt and rocks or asphalt chunks. These tools can be found in the Barrier Shop. Valve exercising procedures are described below. While following the procedures it is important that the IRSO operate all valves *slowly* to prevent the potential for water hammer. When exercising valves in heavy traffic, the IRSO should try to place a pickup truck between the work area and oncoming traffic. *To exercise main line valves pressure on the main must be a zero to prevent water hammer*.

Procedures

- Mobilize to the site, if in heavy traffic try to position a pick-up truck between the work area and oncoming traffic. Remove the valve can lid to access the valve actuator nut.
- Inspect the valve can condition. If debris is present remove with shop vacuum or spring-loaded grabbers.
- Place the “Tee Handle” securely on the valve actuator nut.
- Exercise the main or lateral butterfly valve by *slowly* turning the tee handle in a clockwise direction.
- When the valve operator nut is no longer able to be turned clockwise, the valve is fully closed.
- Once the valve is fully closed, *slowly* turn the Tee Handle on the valve actuator nut in a counterclockwise direction.
- When the valve operator nut is no longer able to be turned counterclockwise, the valve is fully open. Rotate ¼ turn clockwise.
- Remove the Tee Handle from the valve actuator nut and place the valve can lid securely onto the valve can.
- Cautiously demobilize from the site.

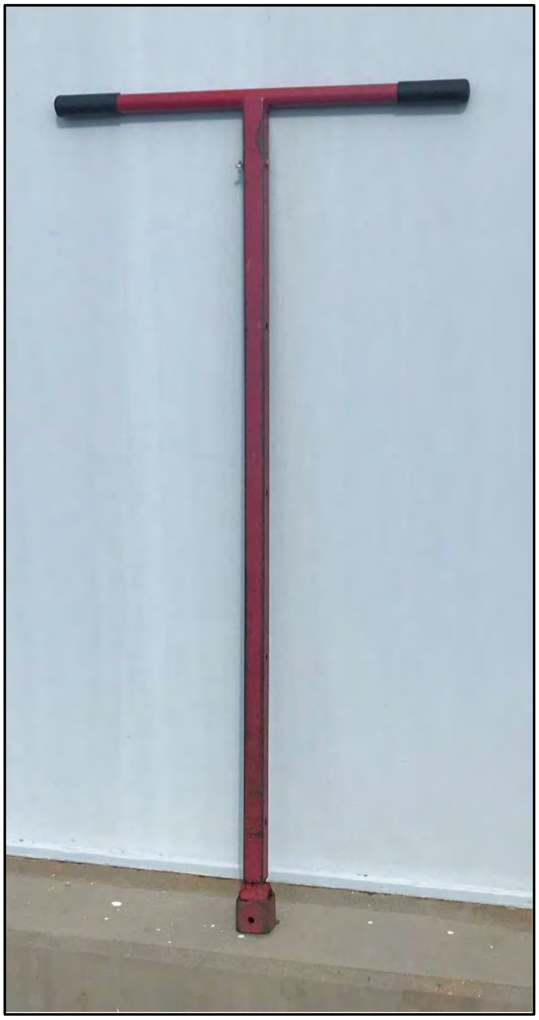


Figure I “Tee Handle” tool that is placed on the valve actuator nut and manually turned to operate the valve. This tool is extendable. The tool is in the shortest position possible for this photograph.

Appendix A-4

Blow Off Valve Operation

Appendix A-4

Blow Off Valve Operation

Background

Annually Blow off valves are partially opened to remove sediment and debris from low lying portions of a distribution pipeline. Valves may be in traffic lanes requiring traffic control to gain access. The IRSO should use the Watchbook for lane closures and try and place a pick-up truck between the work area and oncoming traffic whenever possible. Once the work area is secured a fire hose or standpipe is added to the blow off discharge to divert the flow of water away from traffic or pedestrians. The valve is then opened slightly to allow water and debris to exit the pipeline. The discharge is observed, and the color and type of debris is noted in the IRSO's field book. Dechlorination of GWRS water is typically not necessary prior to discharge, but should be monitored in the field. After the water runs clear the valve is closed the discharge point is sealed and the cover is replaced. If traffic control was used, it is then taken down so the flow of traffic can return to normal.

Procedures

- Carefully mobilize to the blow off valve actuator can. If traffic control is required, work with at least one other IRSO to set-up the lane closure per the Watchbook (Appendix A-1). If possible, place a pick-up truck between the work area and oncoming traffic.
- Remove any debris from the valve can using a shop vacuum or spring-loaded grabbers.
- Remove the discharge vault lid and unthread the cap from the fire hose fitting.
- Thread 2-inch steel pipe riser onto fire hose fitting. Lay flat hose can be threaded onto the 2-inch steel pipe riser to direct discharge longer distances like into nearby vegetation. Ensure that the discharge flow does not affect pedestrians or vehicle traffic.
- Securely place the "Tee Handle" tool (same tool used for main and lateral valve exercising, see Appendix A-3) on the blow off valve actuator nut.
- Slowly begin to turn the "Tee Handle" counterclockwise. The valve will begin to unseat and water will begin discharging out the lay-flat house.
- Continue turning the valve actuator counterclockwise until the velocity of the discharge water is high enough to carry solid material from the pipeline.
- Monitor the discharge color and content. Record the observations in your field book.
- When discharge water becomes clear and particle free, close the blow off valve by slowly turning the "Tee Handle" clockwise. When the "Tee Handle" can no longer be turned clockwise the valve should seat and discharge will stop flowing.
- Remove the "Tee Handle" from the blow off valve actuator nut.

- Unthread the 2-inch steel pipe riser (and lay flat hose, if applicable) from the fire hose fitting. Thread the fire hose cap back onto the fire hose fitting.
- Mobilize back to the discharge vault.
- Securely place the lid back onto the blow off valve discharge vault.
- Clean up any deposits of material that may be on the sidewalk, gutter or street.
- Cautiously remove traffic control (if applicable) and demobilize.
-