SOUTHERN CALIFORNIA GAS COMPANY

AND

SAN DIEGO GAS AND ELECTRIC COMPANY

GAS SYSTEM EXPANSION STUDY:
RECEIPT POINT EXPANSION

DECEMBER 8, 2011

TABLE OF CONTENTS

INTRODUCTION

Pursuant to Decision (D.) 07-12-019, Southern California Gas Company and San Diego Gas and Electric Company ("SoCalGas/SDG&E") hereby submit the following report examining incremental increases in receipt point capacity on its gas transmission system. Incremental increases in storage capacity, and any resulting expansions of the transmission system as a consequence, are examined in a separate report.

D.07-12-019, issued on December 6, 2007, adopted the proposal of SoCalGas, SDG&E, and Southern California Edison that SoCalGas and SDG&E will perform certain system expansion studies. (D.07-12-019, mimeo., at 92.) The testimony regarding these studies provided as follows:

> "Within one year after CPUC approval of the Agreement, and then at least once every three years thereafter, SoCalGas and SDG&E will develop a system expansion study of the SoCalGas and SDG&E interconnect points, backbone system, and storage facilities. The results of these studies will be public, as will key study assumptions, including reliability parameters, but SoCalGas and SDG&E will be able to keep portions of these studies confidential for security reasons. These studies will: (1) address various increments of expansion at each interconnect point on the integrated SoCalGas and SDG&E backbone system, including required system expansions to accommodate an interconnect point expansion (2) address various increments of storage inventory, injection, and withdrawal capacity expansion, including required system expansions to accommodate a storage capacity expansion, and (3) provide data sufficient for any interested party to confirm the reasonableness of the projected costs for all studied expansions. Each study will be reviewed and commented on by a qualified independent third party selected by SoCalGas and SDG&E and approved by the Commission's Energy Division through an advice letter. SoCalGas and SDG&E will recover from customers all reasonable costs related to performing these studies and having the studies reviewed by an independent third party. Interested parties will have the ability to comment on and challenge these studies, including key study assumptions and reliability parameters." Prepared Direct Testimony of Richard Morrow, A.06-08-026, Appendix A, Exhibit B.

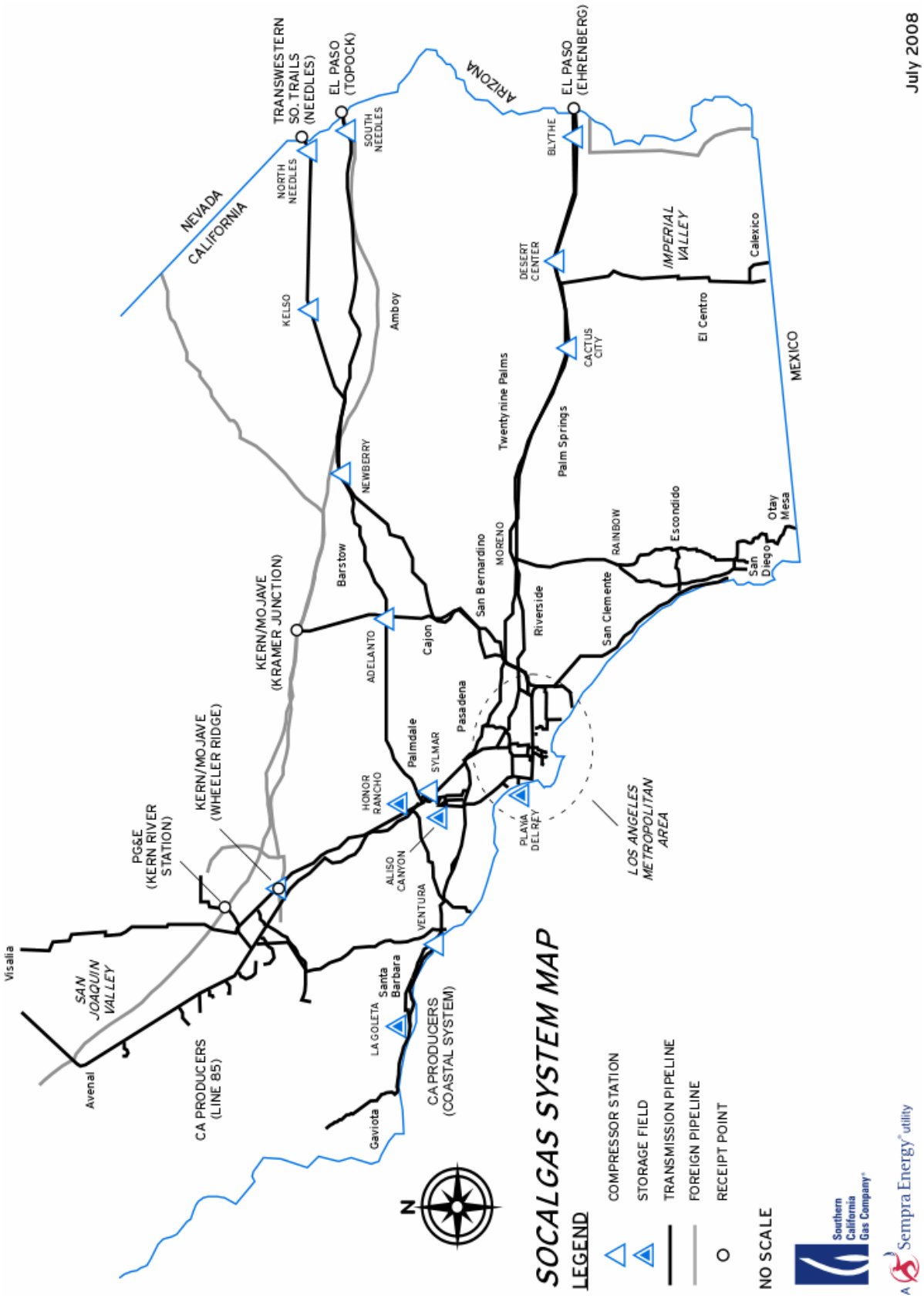
In compliance with this order, SoCalGas/SDG&E performed a series of transient hydraulic simulations which examined two levels of expansion at each of its receipt points.

THE SOCALGAS AND SDG&E GAS TRANSMISSION SYSTEM

SoCalGas owns and operates an integrated transmission system consisting of pipeline and storage facilities. With its network of transmission pipeline and four interconnected storage fields, SoCalGas delivers natural gas to over five million residential and business customers.

A map of the SoCalGas transmission system is shown in Figure 1. The transmission system extends from the Colorado River on the eastern end of SoCalGas' 23,000 square mile service territory, to the Pacific Coast on the western end; from Tulare County in the north, to the U.S./Mexico border in the south (excluding parts of San Diego County).

Figure 1 – SoCalGas Transmission System

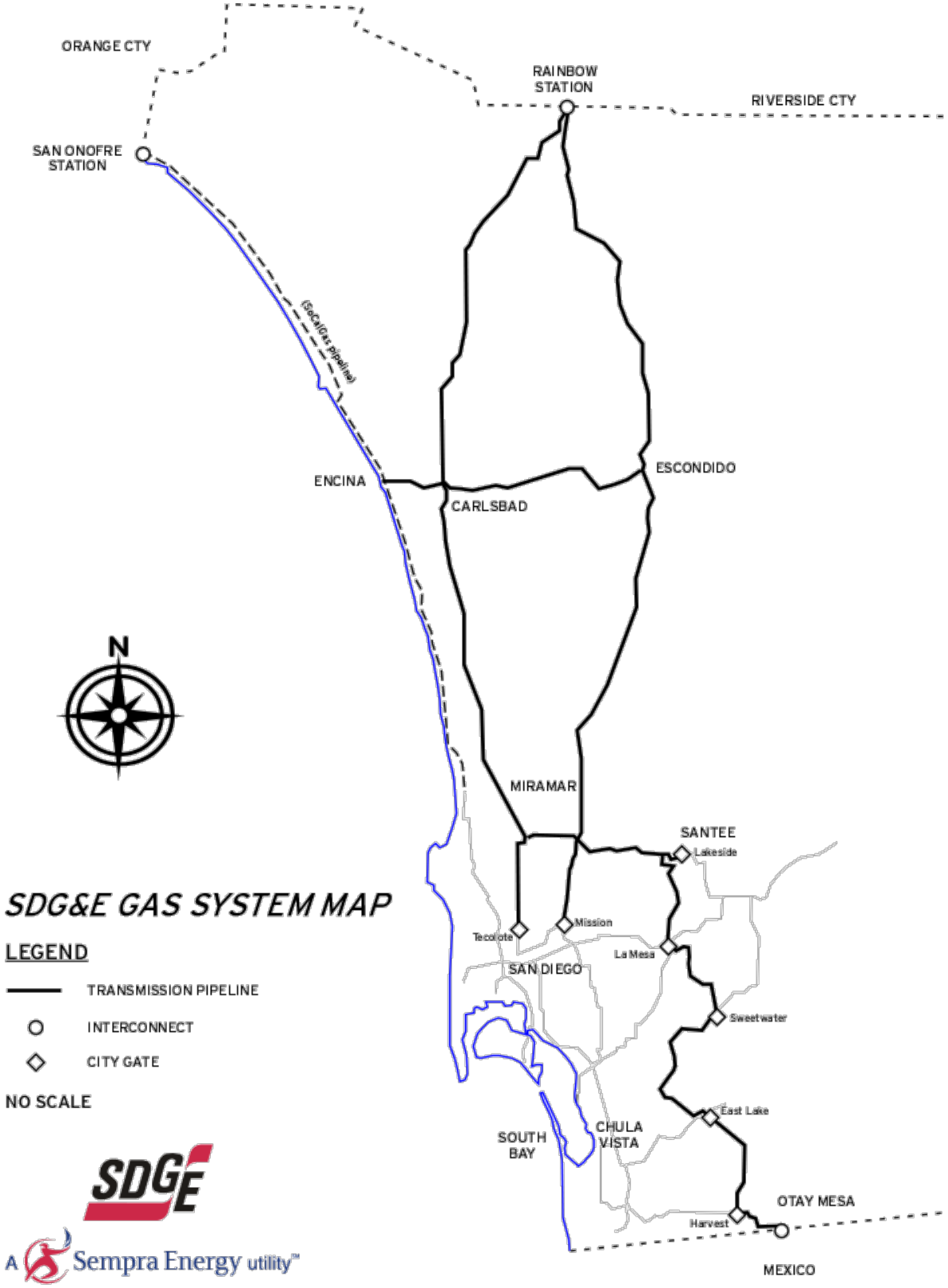


The SoCalGas transmission system was initially designed to receive and redeliver gas from the east to the load centers in the Los Angeles basin, Imperial Valley, San Joaquin Valley, north coastal areas, and San Diego. As our customers sought to access new supply sources in Canada and the Rockies, we modified our system to concurrently accept deliveries from the north. As a result, the system today can accept up to 3,875 million cubic feet per day (MMcfd) of interstate and local California supplies on a firm basis. Primary supply sources are the southwestern United States, the Rocky Mountain region, Canada, and California on- and off-shore production. The pipelines that supply the SoCalGas transmission system are El Paso Natural Gas Company (El Paso), North Baja Pipeline (North Baja), Transportadora de Gas Natural (TGN), Transwestern Pipeline Company (Transwestern), Kern River Gas Transmission Company (Kern River), Mojave Pipeline Company (Mojave), Questar Southern Trails Pipeline Company (Southern Trails), and PG&E's intrastate system (PG&E). The SoCalGas transmission system interconnects at the California border with El Paso at the Colorado River near Needles and Blythe, with North Baja near Blythe, with TGN near Otay Mesa, and with Transwestern and Southern Trails near Needles. SoCalGas also interconnects with the common Kern/Mojave pipeline at Wheeler Ridge in the San Joaquin Valley and at Kramer Junction in the high desert. At Kern River Station in the San Joaquin Valley, SoCalGas maintains a major interconnect with the PG&E intrastate pipeline system, and receives PG&E deliveries at that location. Additionally, SoCalGas receives deliveries from Occidental of Elk Hills Inc. (OEHI) near Kern River Station, and from various local California producers in the San Joaquin Valley and Coastal areas.

SoCalGas' four storage fields – Aliso Canyon, Honor Rancho, La Goleta, and Playa del Rey – are located near the primary load centers of the SoCalGas system. Together they have a combined inventory capacity of 134.1 billion cubic feet (Bcf), a combined firm injection capacity of 850 MMcfd, and a combined firm withdrawal capacity of 3,195 MMcfd.

A schematic of the SDG&E gas transmission system is shown in Figure 2. The SDG&E gas transmission system consists primarily of two high-pressure large diameter pipelines that extend south from Rainbow Station, located in Riverside County. Both pipelines terminate at the SDG&E citygate regulator stations in San Diego.

Figure 2 – SDG&E Transmission System



July 2008

The SDG&E transmission pipelines are interconnected approximately at their midpoint and again near their southern terminus. The northern cross-tie runs between Carlsbad and Escondido, with the southern cross-tie running through Miramar.

A large diameter pipeline extends from the cross tie at Miramar to Santee. At Santee, another large diameter pipeline extends to the Otay Mesa meter station at the U.S./Mexico border.

A smaller diameter pipeline, owned by SoCalGas, extends south from the San Onofre metering station in Orange County to La Jolla, and operates at a lower pressure than the rest of the SDG&E gas transmission system.

Two compressor stations are also part of the SDG&E gas transmission system. SDG&E's Moreno compressor station, located in Moreno Valley, boosts pressure into the SoCalGas transmission lines serving Rainbow Station. A much smaller compressor station is located at Rainbow Station.

KEY STUDY ASSUMPTIONS & PARAMETERS

The following items comprise the key study assumptions and parameters used for this evaluation.

All analyses were preformed on an expansion basis, i.e. all identified improvements expand the system firm receipt capacity beyond the current 3,875 MMcfd.

Receipt point expansion can be evaluated assuming the new supply is allowed to displace existing supplies such that the SoCalGas/SDG&E receipt capacity remains 3,875 MMcfd ("displacement basis"), or assuming the new supply does not displace any existing supplies and instead increases the firm receipt capacity of the entire system ("expansion basis"). For the purposes of this evaluation, all receipt point expansions were evaluated on an expansion basis in order to preserve the current Backbone Transmission Service ("BTS")[1] capacities at each of the existing receipt points.

Receipt point capacities are a function of the interconnect facilities at each receipt point and the take-away piping immediately downstream of the receipt point. The SoCalGas/SDG&E receipt points are grouped into "transmission zones". Each transmission zone also has a defined capacity that is a function of the take-away capacity from that zone. Within each transmission zone, receipt point capacities are interchangeable subject only to the limitations of each individual receipt point capacity and any minimum flow requirement imposed by the SoCalGas Gas Control department.

The following table lists the current firm receipt capacities for each receipt point and transmission zone:

[1] Firm Access Rights was renamed Backbone Transmission Service in Commission decision D.11-04-032.

Name	Receipt Capacity (MMcfd)
Northern Transmission Zone	**1,590**
Transwestern @ North Needles	800
Questar @ North Needles	120
El Paso @ Topock	540
Transwestern @ Topock	190
Kern/Mojave @ Kramer Junction	550
Southern Transmission Zone	**1,210**
El Paso - Ehrenberg	1,210
North Baja Pipeline - Blythe	1,200
TGN - Otay Mesa	400
California Capacity	**310**
Coastal System (Producers)	150
L85 System (Producers)	160
Wheeler Transmission Zone	**765**
Kern/Mojave @ Wheeler Ridge	765
PG&E @ Kern River Station	520
Elk Hills (OEHI) @ Gosford	150

All analyses were performed under minimum demand conditions.

In evaluating access for new supplies, a minimum demand condition represents the "worst case" scenario. It is very easy to receive additional supplies with little or no system improvement if the demand is high, but not so when the demand is low and supplies need to be transported to distant load centers across the transmission system. By evaluating the "worst case" condition, all of the facility improvements are identified such that the new supply can be received under all supply/demand scenarios.

All existing facilities were made available for the analyses.

SoCalGas/SDG&E performs its evaluations assuming all existing facilities are available for use and perform as designed.

Two expansion volumes were examined for each receipt point.

For each interstate pipeline receipt point (and the Occidental Elk Hill's Gosford interconnect since it shares Wheeler Transmission Zone capacity with Kern/Mojave and PG&E), SoCalGas/SDG&E evaluated expansion volumes of 200 and 500 MMcfd, representing both a modest and moderate capacity expansion. For the California producer transmission zones, SoCalGas/SDG&E evaluated smaller expansions of 50 and 100 MMcfd, recognizing the smaller volumes delivered by producers relative to interstate pipelines. Additionally, since there is no single receipt point on the California producer transmission zone systems, SoCalGas/SDG&E performed the evaluation by examining an expansion at a point located the farthest distance from the Los Angeles load center. This represents a "worst case" scenario and provides reasonable assurance that

SoCalGas/SDG&E could accommodate an expansion of these volumes on its California producer transmission zone systems regardless of location without additional facilities beyond those identified herein.

Simultaneous expansions of multiple receipt points were not examined.

All evaluations of expansion are on a "stand alone" basis, and the study results for single points cannot be used to estimate the system improvements or costs needed for the simultaneous expansion of multiple points. The Commission Order did not require the evaluation of simultaneous expansions, and given the number of combinations and permutations that are possible, such an evaluation would be burdensome. However, SoCalGas/SDG&E will examine any combination of simultaneous expansion requested, at the requestor's expense.

Simulations were considered successful when Minimum Operating Pressures (MinOP) and Maximum Allowable Operating Pressures (MAOP) were maintained at all times, and when system linepack was fully recovered at the end of a 24 hour simulated period, with no net pack or draft.

SoCalGas/SDG&E plan the transmission system to operate between the MinOPs and MAOPs, without violating either. By requiring system linepack to fully recover at the end of each simulation for success, SoCalGas/SDG&E gain assurance that the simulated condition could be repeated if necessary and is not dependent upon the state of the transmission system linepack on the day preceding or following the simulated period.

36-inch diameter pipeline was assumed for all pipeline improvements identified, and all additional compression identified was assumed to be gas-fired.

36-inch diameter pipeline was assumed for improvements for expediency. In some situations, a slightly smaller diameter pipeline could be used but at the cost of additional length. Therefore, the material savings resulting from the smaller diameter are offset (or even exceeded) by the increased labor costs of construction. In the rare instance where material savings were significant, SoCalGas/SDG&E relaxed this assumption in its evaluations. Gas-fired compressors were assumed in order to simplify fuel sourcing.

Cost estimates presented herein are preliminary in nature.

SoCalGas/SDG&E have prepared preliminary cost estimates for all system improvements identified in these studies, and have provided sufficient detail regarding these estimates in compliance with the Commission Order. However, SoCalGas/SDG&E have no plans at this time to proceed with any construction, and therefore have not performed a detailed engineering site or route evaluation in the development of these estimates, which take considerable time and expense. Costs which would be estimated as part of a detailed engineering construction estimate and which could be significant, such as those associated with permitting, paving, right-of-way, environmental, gas quality, measurement, regulatory, and land acquisition/development issues; and any unusual

construction costs or facility requirements (e.g. freeway, river, or channel crossings) are unique for each project. SoCalGas/SDG&E have no "rule of thumb" that could be applied for these costs, and so they are explicitly excluded from these preliminary cost estimates. SoCalGas/SDG&E will perform a detailed engineering construction estimate for any expansion scenario presented herein, at the requestor's expense, which will include these costs.

THIRD-PARTY TECHNICAL REVIEW

SoCalGas and SDG&E have selected GL Nobel Denton as the qualified independent third party to review its system expansion studies. SoCalGas and SDG&E sought approval of their selection in Advice Letters 4235and 2029-G, respectively. Both Advice Letters were approved by the Commission in May 2011.

GL Nobel Denton (formerly Advantica Inc.) is a global engineering consultancy, supporting clients in the gas, oil, water and electric industries. With more than 30 years of experience in the energy sector, GL Nobel Denton has a proven track record of providing products, services and consultancy to more than 550 clients in over 60 countries across the globe. SoCalGas and SDG&E have used GL Nobel Denton's software products to evaluate their gas and electric systems for more than 30 years, and GL Nobel Denton is familiar with the SoCalGas and SDG&E systems and hydraulic models.

In its review, GL Nobel Denton found no significant errors in the SoCalGas/SDG&E hydraulic models. Several minor issues were found that did not impact the results of the SoCalGas/SDG&E analyses. These minor issues primarily involved the modeling of the San Diego system. SoCalGas and SDG&E have implemented GL Nobel Denton's recommendations but note that the SDG&E gas system model has been extensively validated with actual operating data for many years.

Other minor issues, such as incorrect gas flowing temperatures, pipeline length, and pipeline diameters for some facilities in the hydraulic models had only a minor effect on the calculation of linepack and did not impact the results of the analyses.

EXPANSION ANALYSES

The following sections present the results of SoCalGas/SDG&E's expansion analyses for each of its receipt points, the detailed cost estimate, and the technical review performed by GL Nobel Denton (formerly Advantica Inc.). Since the preparation of the 2008 expansion study, only the Kramer Junction receipt point was expanded from 500 to 550 MMcfd. Per D.07-12-019, SoCalGas/SDG&E are permitted to leverage past studies

and analyses in the preparation of this expansion report[1]. Accordingly, SoCalGas/SDG&E have performed new hydraulic analyses only for the Kramer Junction receipt point. Since the base conditions for all other receipt points are unchanged from the 2008 analyses, the level of system improvements for the expansion scenarios are also unchanged. For these receipt points, SoCalGas/SDG&E have simply reviewed and updated the cost estimates as necessary.

[1] "To the extent possible, SoCalGas and SDG&E will utilize the results of previous assessments to help reduce the costs and resources requirements for these studies.", Prepared Direct Testimony of Thanathep E. Trinooson, page 4, A.06-08-026; and "We accordingly approve Applicants proposal to develop a system expansion study of the SoCalGas/SDG&E interconnect points, backbone system, and storage facilities.", D07-12-019, page 95.

Blythe Receipt Point

Current capacity: 1210 MMcfd

Expansion of 200 MMcfd (1410 MMcfd receipt capacity): $ 305 million

1. Replace compressor at Desert Center with 10,000 HP, $ 35 million
2. Replace compressor at Cactus City with 10,000 HP, $ 35 million
3. Install 15 miles of 36-inch diameter pipeline between Moreno and Chino, $ 88 million
4. Install 25 miles of 36-inch diameter pipeline between Moreno and Prado, $ 147 million

Refer to Figure B-200 for the location of these facility improvements.

Expansion of 500 MMcfd (1710 MMcfd receipt capacity): $ 662 million

1. Add compression at Blythe at 6,000 HP, $ 21 million
2. Replace compressor at Desert Center with 20,000 HP, $ 70 million
3. Replace compressor at Cactus City with 20,000 HP, $ 70 million
4. Install 20 miles of 36-inch diameter pipeline between Blythe and Desert Center, $ 61 million
5. Install 30 miles of 36-inch diameter pipeline from Moreno to Chino, $ 176 million
6. Install 45 miles of 36-inch diameter pipeline from Moreno to Brea, $ 264 million

Refer to Figure B-500 for the location of these facility improvements.

The existing SoCalGas 30-inch diameter Line 2000, 30-inch Line 2001, and 36-inch Line 5000 from Blythe to Moreno stations become a restriction beyond the 1210 MMcfd capacity of the southern system, resulting in pressures which exceed the MAOPs. The existing compressor stations at Desert Center and Cactus City are single-unit centrifugal stations that are underpowered and not suited for these higher flow rates, and need to be replaced. Installing 10,000 HP (200 MMcfd expansion) or 20,000 HP (500 MMcfd expansion) of new compression at both Desert Center and Cactus City, and for the 500 MMcfd expansion, adding 6,000 HP compression at Blythe and installing 20 miles of 36-inch diameter pipeline in parallel with Line 5000 between Blythe and Desert Center resolves this restriction.

The existing SoCalGas 30-inch diameter Line 2001 from Moreno to Chino stations and 30-inch diameter Line 2000 from Moreno to Brea stations become a restriction beyond the 1210 MMcfd capacity of the southern system, resulting in pressures which exceed the MAOPs. Installing 15 miles (200 MMcfd expansion) or 30 miles (500 MMcfd expansion) of 36-inch diameter pipeline in parallel with Line 2001 between Moreno and Chino and 25 miles (200 MMcfd expansion) or 45 miles (500 MMcfd expansion) of 36-inch diameter pipeline in parallel with Line 2000 between Moreno and Brea resolves this restriction.

Figure B-200

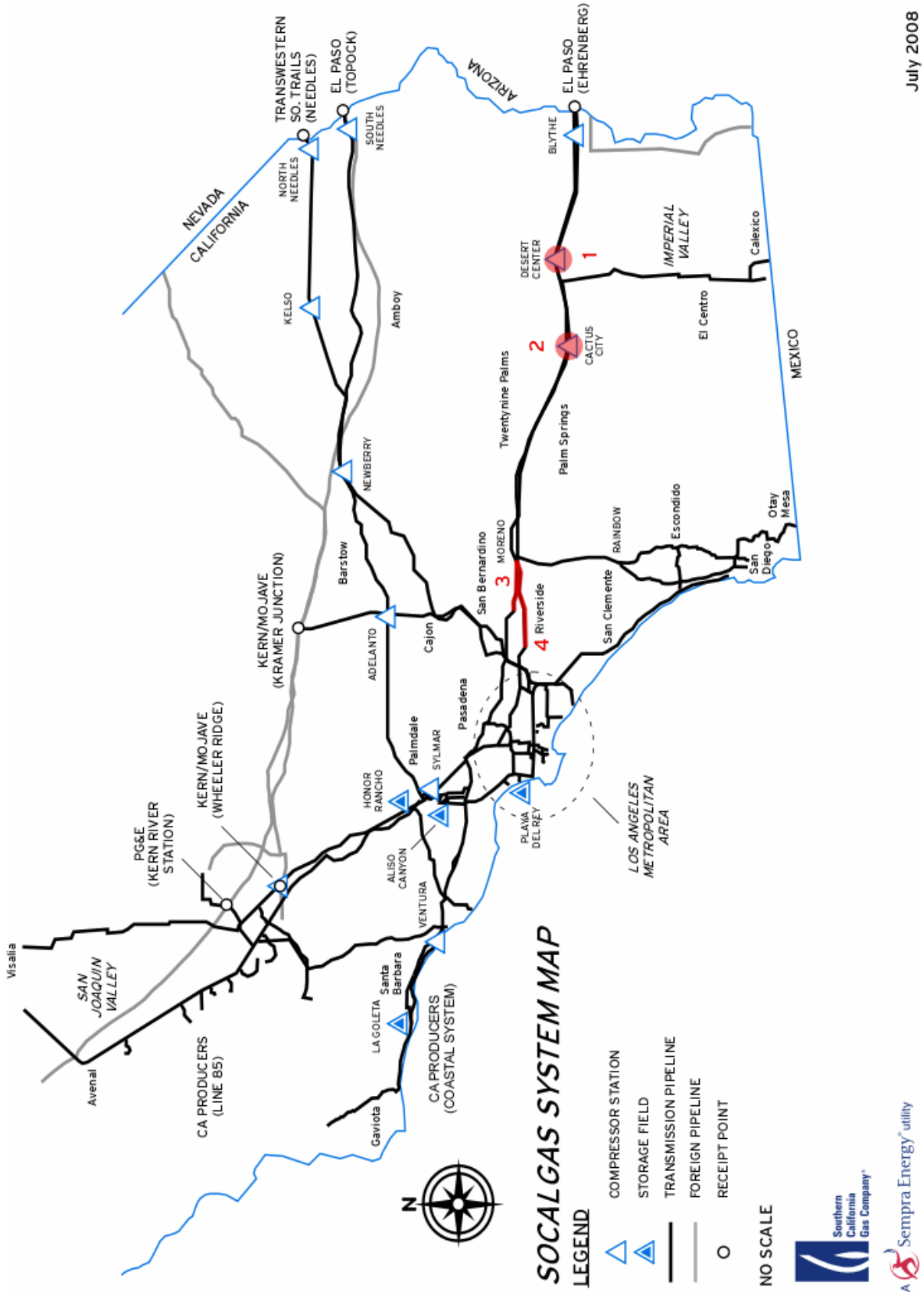
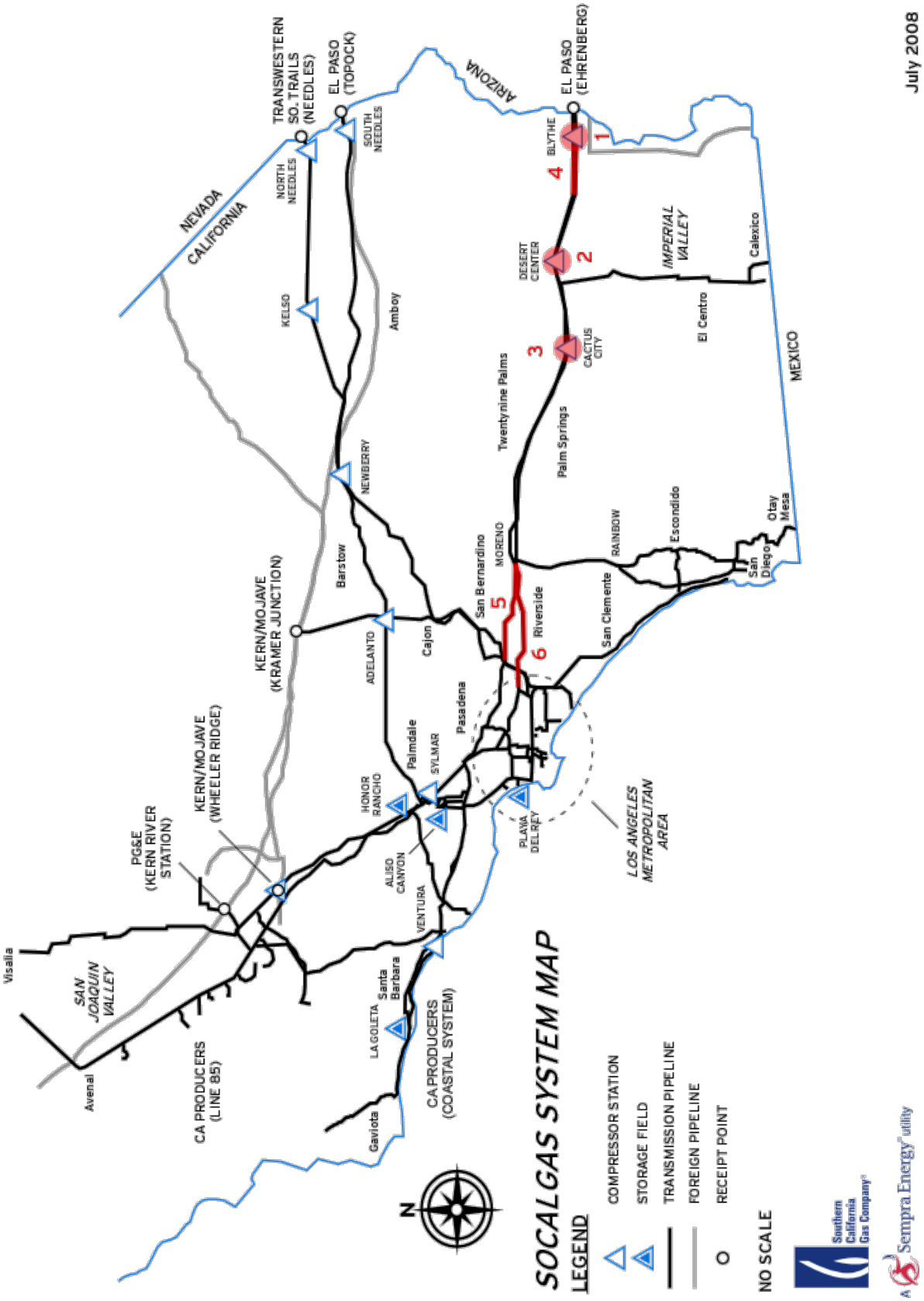

SOCALGAS SYSTEM MAP
July 2008
LEGEND
COMPRESSOR STATION
STORAGE FIELD
TRANSMISSION PIPELINE
FOREIGN PIPELINE
RECEIPT POINT
NO SCALE
N
NEVADA
CALIFORNIA
ARIZONA
MEXICO
TRANSWESTERN SO. TRAILS (NEEDLES)
EL PASO (TOPOCK)
EL PASO (EHRENBERG)
NORTH NEEDLES
SOUTH NEEDLES
BLYTHE
KELSO
Amboy
DESERT CENTER
IMPERIAL VALLEY
Calexico
El Centro
CACTUS CITY
Twentynine Palms
Palm Springs
NEWBERRY
Barstow
KERN/MOJAVE (KRAMER JUNCTION)
ADELANTO
Cajon
San Bernardino
MORENO
Riverside
RAINBOW
Escondido
San Diego
Otay Mesa
San Clemente
Pasadena
Palmdale
SYLMAR
HONOR RANCHO
ALISO CANYON
VENTURA
PLAYA DEL REY
LOS ANGELES METROPOLITAN AREA
KERN/MOJAVE (WHEELER RIDGE)
PG&E (KERN RIVER STATION)
Visalia
SAN JOAQUIN VALLEY
Avenal
CA PRODUCERS (LINE 85)
LA GOLETA
Santa Barbara
Gaviota
CA PRODUCERS (COASTAL SYSTEM)
1
2
3
4

Figure B-500


SOCALGAS SYSTEM MAP
July 2008
LEGEND
COMPRESSOR STATION
STORAGE FIELD
TRANSMISSION PIPELINE
FOREIGN PIPELINE
RECEIPT POINT
NO SCALE
N
NEVADA
CALIFORNIA
ARIZONA
MEXICO
TRANSWESTERN SO. TRAILS (NEEDLES)
EL PASO (TOPOCK)
EL PASO (EHRENBERG)
NORTH NEEDLES
SOUTH NEEDLES
BLYTHE
DESERT CENTER
CACTUS CITY
IMPERIAL VALLEY
Calexico
El Centro
KELSO
Amboy
Twentynine Palms
Palm Springs
NEWBERRY
Barstow
KERN/MOJAVE (KRAMER JUNCTION)
ADELANTO
Cajon
San Bernardino
MORENO
Riverside
RAINBOW
San Clemente
Escondido
San Diego
Otay Mesa
Pasadena
Palmdale
SYLMAR
HONOR RANCHO
ALISO CANYON
VENTURA
PLAYA DEL REY
LOS ANGELES METROPOLITAN AREA
KERN/MOJAVE (WHEELER RIDGE)
PG&E (KERN RIVER STATION)
SAN JOAQUIN VALLEY
Visalia
Avenal
CA PRODUCERS (LINE 85)
LA GOLETA
Santa Barbara
Gaviota
CA PRODUCERS (COASTAL SYSTEM)
1
2
3
4
5
6

Blythe Receipt Point

		Cost	
		Unit	Total
Expansion of 200 MMcfd			
replace compression at Desert Center	10,000 hp	$3,500	$35,000,000
replace compression at Cactus City	10,000 hp	$3,500	$35,000,000
new 36" pipe - Moreno to Chino	15 mi	$5,866,667	$88,000,000
new 36" pipe - Moreno to Prado	25 mi	$5,880,000	$147,000,000
			$305,000,000
Detailed Estimate			
Engineering / design			$18,300,000
Typical permitting			$7,625,000
Material			
compressors	20,000 hp	$1,140	$22,800,000
36" pipe	40 mi	$214	$58,767,264
Other			$0
subtotal			$81,567,264
Construction			
Compressor installation			$38,644,750
Pipe installation	40 mi		$158,862,986
Station work			$0
subtotal			$197,507,736
Total			$305,000,000
Expansion of 500 MMcfd			
add compression at Blythe	6,000 hp	$3,500	$21,000,000
replace compression at Desert Center	20,000 hp	$3,500	$70,000,000
replace compression at Cactus City	20,000 hp	$3,500	$70,000,000
new 36" pipe - Blythe to Desert Center	20 mi	$3,050,000	$61,000,000
new 36" pipe - Moreno to Chino	30 mi	$5,866,667	$176,000,000
new 36" pipe - Moreno to Brea	45 mi	$5,866,667	$264,000,000
			$662,000,000
Detailed Estimate			
Engineering / design			$39,720,000
Typical permitting			$16,550,000
Material			
compressors	46,000 hp	$1,140	$52,440,000
36" pipe	95 mi	$214	$139,572,253
Other			$0
subtotal			$192,012,253
Construction			
Compressor installation			$89,990,900
Pipe installation	95 mi		$323,726,847
Station work			$0
subtotal			$413,717,747
Total			$662,000,000

FINAL REPORT

THE SOUTHERN CALIFORNIA GAS COMPANY EXPANSION SCENARIO REVIEW

BLYTHE SYSTEM

May 27, 2008

This report is written in fulfillment of an agreement between The Southern California Gas Company (SoCal) and Advantica, Inc. SoCal has contracted with Advantica to review supplied expansion scenario models. As stated in the Proposal, each scenario will be examined for the following:

1. Connectivity check limited to orphan pipes and unconnected sections
2. Unknown structure issues
3. Control and constraint issues (not including set point values)
4. Issues related to sonic flow, minimum pressures, and high velocities

If any other issues are subsequently found while searching for the items above, they will be noted as well. This report will address findings regarding the "Blythe" group of models. Along with corresponding results data, the 3 Blythe models received were: 1) blythe 1210 pd/xy; 2) blythe 1410 pd/xy; 3) blythe 1710 pd/xy.

Connectivity check: A connectivity check, which entailed searching for orphan pipes and disconnected subsystems, was performed. For each of the three models submitted, no disconnections were discovered. All systems modeled are tied together as one unit.

Unknown structure issues: No unknown structure messages were generated upon import of the models. A closer inspection of the nodes and facilities did not uncover any unknown structure issues, either.

Control and constraint issues: No constraint or control error messages were generated upon import of the models. A detailed inspection of the control setups did not uncover any areas of suspicion, either.

Issues related to sonic flow, minimum pressures, and high velocities: Some warning messages were encountered after balancing in the steady-state, however the messages were benign. Furthermore, the messages are negated due to the fact that all models undergo "transient initialization" through Procedures and an initialization run period to align the model with known system conditions. All USM models are monitored during the course of the run and manually altered to address any warning conditions. All USM generated messages encountered were benign or addressed through manual intervention during the USM run.

Miscellaneous issues: It was discovered that several pipes are using the FD equation (Fundamental equation with constant friction factor). When used with a valid friction factor, this equation will yield reasonable results. However, the inherent weakness of this equation is the fixed friction factor. As flowing velocities change, so too will the friction factor. If the fixed friction factor differs significantly from the actual friction factor, then a source of error could be introduced. Although the FD equation can yield valid results, Advantica recommends using the FM equation (Fundamental equation with variable friction) for all pipes, due to its adaptability to all flows.

Summary: After reviewing the Blythe system models and the output data provided, no significant issues were discovered, only the minor items already mentioned above. All items observed in the models and output data appear reasonable.

Please contact me if you have questions or concerns regarding any of the items in this document.

Sincerely,

Advantica
Stoner Software

Otay Mesa Receipt Point

Current capacity: 400 MMcfd

Expansion of 200 MMcfd (600 MMcfd receipt capacity): $ 387 million

1. Install 26 miles of 36-inch diameter pipeline from Escondido to Santee, $ 152 million
2. Install 15 miles of 36-inch diameter pipeline from Moreno to Chino, $ 88 million
3. Install 25 miles of 36-inch diameter pipeline from Moreno to Prado, $ 147 million

Refer to Figure OM-200 for the location of these facility improvements.

The existing SDG&E 20-inch diameter pipeline between Miramar and Santee and the 16-inch diameter pipeline between Escondido and Miramar become a restriction beyond 400 MMcfd of receipts at Otay Mesa. The restriction causes pressure at Rainbow to drop below minimum operating pressure (MinOP). Installing 26 miles of 36-inch diameter pipeline from Escondido to Santee resolves this restriction.

The existing SoCalGas 30-inch diameter Line 2001 from Moreno to Chino stations and 30-inch diameter Line 2000 from Moreno to Prado stations become a restriction beyond the 1210 MMcfd capacity of the southern system, resulting in pressures which exceed the maximum allowable operating pressures (MAOPs). Installing 15 miles of 36-inch diameter pipeline in parallel with Line 2001 between Moreno and Chino and 25 miles of 36-inch diameter pipeline in parallel with Line 2000 between Moreno and Prado resolves this restriction.

Expansion of 500 MMcfd (900 MMcfd receipt capacity): $ 932 million

1. Install 84 miles of 36-inch diameter pipeline from Rainbow to the US/Mexico border, $ 492 million
2. Install 30 miles of 36-inch diameter pipeline between Moreno and Chino, $ 176 million
3. Install 45 miles of 36-inch diameter from Moreno to Brea, $ 264 million

Refer to Figure OM-500 for the location of these facility improvements.

The existing SDG&E pipeline system becomes a restriction at 900 MMcfd receipt level at Otay Mesa. The restriction causes pressure at Rainbow to drop below MinOP. Installing 84 miles of 36-inch diameter pipeline from Rainbow to the US/Mexico border resolves this restriction.

The existing SoCalGas 30-inch diameter Line 2001 from Moreno to Chino stations and 30-inch diameter Line 2000 from Moreno to Brea stations become a restriction beyond the 1210 MMcfd capacity of the southern system, resulting in pressures which exceed the MAOPs. Installing 30 miles of 36-inch diameter pipeline in parallel with Line 2001

between Moreno and Chino and 45 miles of 36-inch diameter pipeline in parallel with Line 2000 between Moreno and Brea resolves this restriction.

Figure OM-200

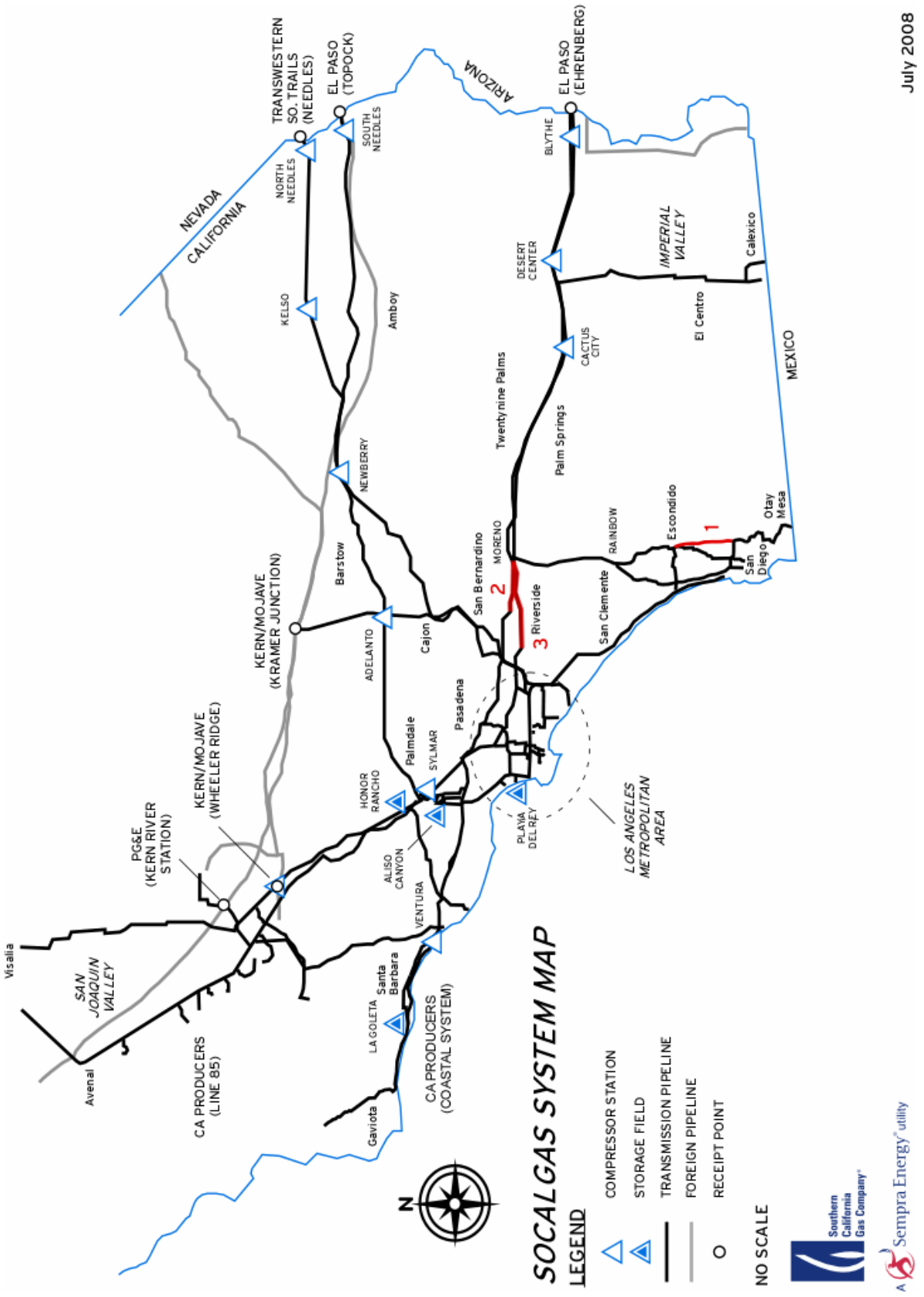
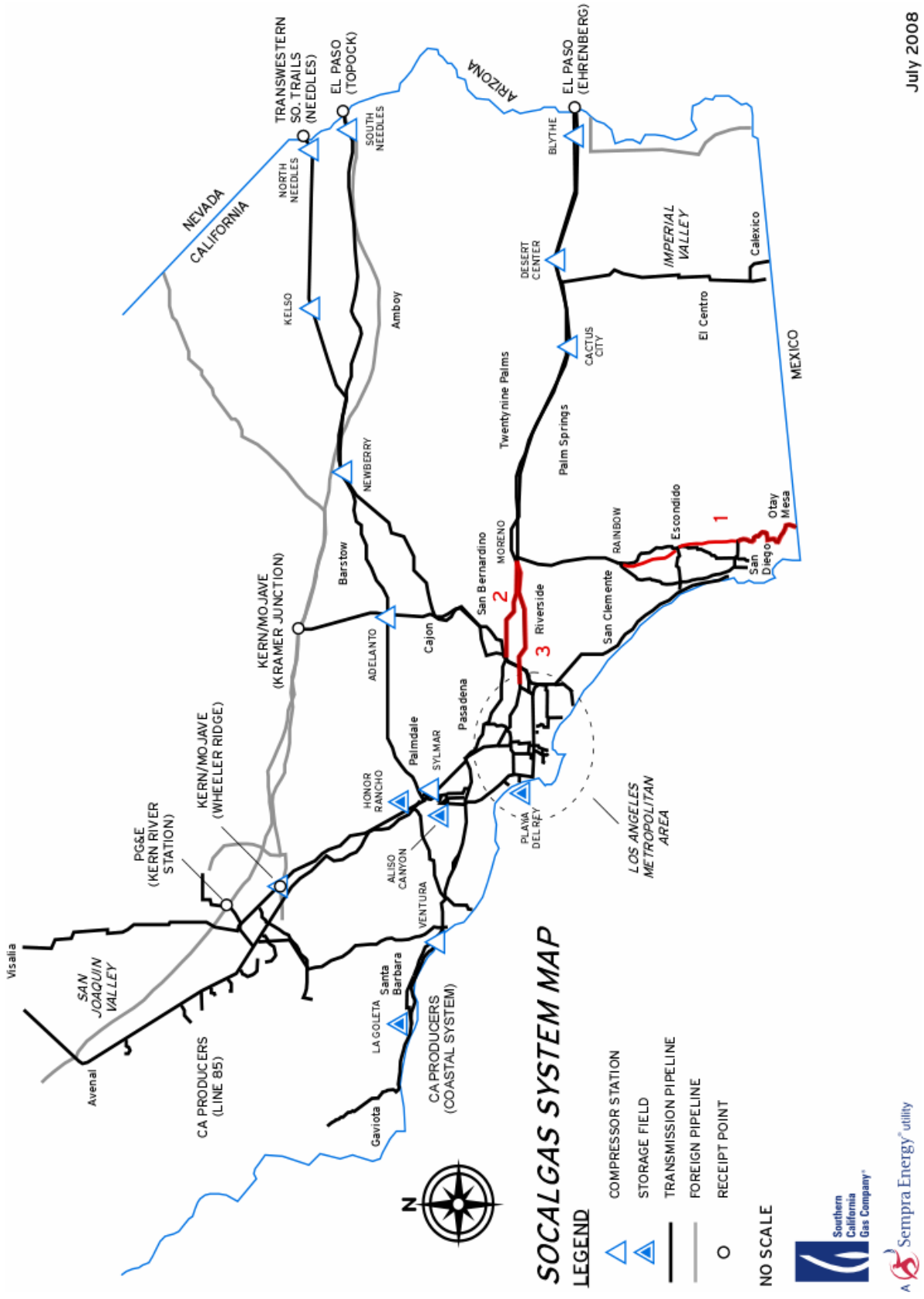


Figure OM-500



Otay Mesa Receipt Point

		Cost	
		Unit	Total
Expansion of 200 MMcfd			
new 36" pipe - Escondido to Santee	26 mi	$5,846,154	$152,000,000
new 36" pipe - Moreno to Chino	15 mi	$5,866,667	$88,000,000
new 36" pipe - Moreno to Prado	25 mi	$5,880,000	$147,000,000
			$387,000,000
Detailed Estimate			
Engineering / design			$23,220,000
Typical permitting			$9,675,000
Material			
compressors			
36" pipe	66 mi	$214	$96,965,986
Other			$0
subtotal			$96,965,986
Construction			
Compressor installation			
Pipe installation	66 mi		$257,139,014
Station work			$0
subtotal			$257,139,014
Total			$387,000,000
Expansion of 500 MMcfd			
new 36" pipe - Rainbow to US/Mex border	84 mi	$5,857,143	$492,000,000
new 36" pipe - Moreno to Chino	30 mi	$5,866,667	$176,000,000
new 36" pipe - Moreno to Brea	45 mi	$5,866,667	$264,000,000
			$932,000,000
Detailed Estimate			
Engineering / design			$55,920,000
Typical permitting			$23,300,000
Material			
compressors			
36" pipe	159 mi	$214	$233,599,876
Other			$0
subtotal			$233,599,876
Construction			
Compressor installation			
Pipe installation	159 mi		$619,180,124
Station work			$0
subtotal			$619,180,124
Total			$932,000,000

FINAL REPORT

THE SOUTHERN CALIFORNIA GAS COMPANY EXPANSION SCENARIO REVIEW

OTAY MESA SYSTEM

May 27, 2008

This report is written in fulfillment of an agreement between The Southern California Gas Company (SoCal) and Advantica, Inc. SoCal has contracted with Advantica to review supplied expansion scenario models. As stated in the Proposal, each scenario will be examined for the following:

1. Connectivity check limited to orphan pipes and unconnected sections
2. Unknown structure issues
3. Control and constraint issues (not including set point values)
4. Issues related to sonic flow, minimum pressures, and high velocities

If any other issues are subsequently found while searching for items above, they will be noted as well. This report will address findings regarding the "Otay Mesa" group of models. Along with corresponding results data, the 3 representative models reviewed were: 1) Otay Mesa 400 pd/xy; 2) Otay Mesa 600 pd/xy; 3) Otay Mesa 900 pd/xy.

Connectivity check: A connectivity check, which entailed searching for orphan pipes and disconnected subsystems, was performed. For each of the models submitted, no disconnections were discovered. All systems modeled are tied together as one unit.

Unknown structure issues: No unknown structure messages were generated upon import of the models. A closer inspection of the nodes and facilities did not uncover any structure issues, either.

Control and constraint issues: No constraint or control error messages were generated upon import of the models. However, a detailed inspection of the control setups revealed that one of the compressors were set up with DEFAULT as the Compressor Operation Switch (DCONTROL and SCONTROL are the other options). DEFAULT is not a recommended setting as it does not provide a clear indicator for which node is the controlling. It introduces the possibility of error under certain Constraint Interchange conditions. For a compressor station that is on discharge control, Advantica recommends using DCONTROL instead. The following compressor station is currently set on DEFAULT:

From-node name	To-node name
MHPS	MHPD

Issues related to sonic flow, minimum pressures, and high velocities: Some warning messages were encountered after balancing in the steady-state, however the messages were benign. Furthermore, the messages are negated due to the fact that all models undergo "transient initialization" through Procedures and an initialization run period to align the model with known system conditions. All USM models are monitored during the course of the run and manually altered to address any warning conditions. All USM generated messages encountered were benign or addressed through manual intervention during the USM run.

Miscellaneous issues: It was discovered that several pipes are using the FD equation (Fundamental equation with constant friction factor). When used with a valid friction factor, this equation will yield reasonable results. However, the inherent weakness of this equation is the fixed friction factor. As flowing velocities change, so too will the friction factor. If the fixed friction factor differs significantly from the actual friction factor, then a source of error could be introduced. Although the FD equation can yield valid results, Advantica recommends using the FM equation (Fundamental equation with variable friction) for all pipes, due to its adaptability to all flows.

Summary: After reviewing the Otay Mesa system models and the output data provided, no significant issues were discovered, only the minor items already mentioned above. All items observed in the models and output data appear reasonable.

Please contact me if you have questions or concerns regarding any of the items in this document.

Sincerely,

Advantica
Stoner Software

North Needles Receipt Point

Current capacity: 800 MMcfd

Expansion of 200 MMcfd (1000 MMcfd receipt capacity): $ 248 million

1. Install 80 miles of 36-inch diameter pipeline from Colorado River crossing westward parallel to existing 34-inch Line 235 to approximately 21 miles west of Kelso compressor station - $245 million
2. Replace Quigley Pressure Limiting Station, $3 million

Refer to Figure NN-200 for the location of these facility improvements.

Simulation results show that the existing 34-inch diameter Line 235 from the Colorado River crossing to Newberry becomes a restriction causing MAOP violations along the pipeline. To resolve this, a new 80-mile, 36-inch diameter pipeline from Colorado River crossing westward paralleling the existing Line 235 is required. Simulations also show that flows at the Quigley pressure limiting station exceed that of the current rated flow capacity. Thus, a rebuild of the Quigley Station with a higher flow rate capacity is necessary.

Expansion of 500 MMcfd (1,300 MMcfd receipt capacity): $ 511 million

1. Install 116 miles of 36-inch diameter pipeline from Colorado River crossing westward parallel to existing 34-inch Line 235 to Newberry compressor station plus 50 miles of 36-inch diameter pipeline from Newberry compressor station parallel to existing 36-inch Line 4000 - $508 million
2. Replace Quigley Pressure Limiting Station, $3 million

Refer to Figure NN-500 for the location of these facility improvements.

Similar to the 200 MMcfd expansion scenario, results show that Line 235 and Line 4000 become a restriction causing MAOP violations along the pipelines. To resolve this restriction, 36-inch diameter pipeline from the Colorado River crossing westward paralleling the existing Line 235 to Newberry compressor station and from Newberry compressor station paralleling the existing Line 4000 is necessary. A rebuild of the Quigley Station is also required for increased flow capacities since simulations show flows at Quigley pressure limiting station exceed the current rated flow capacity.

Figure NN-200

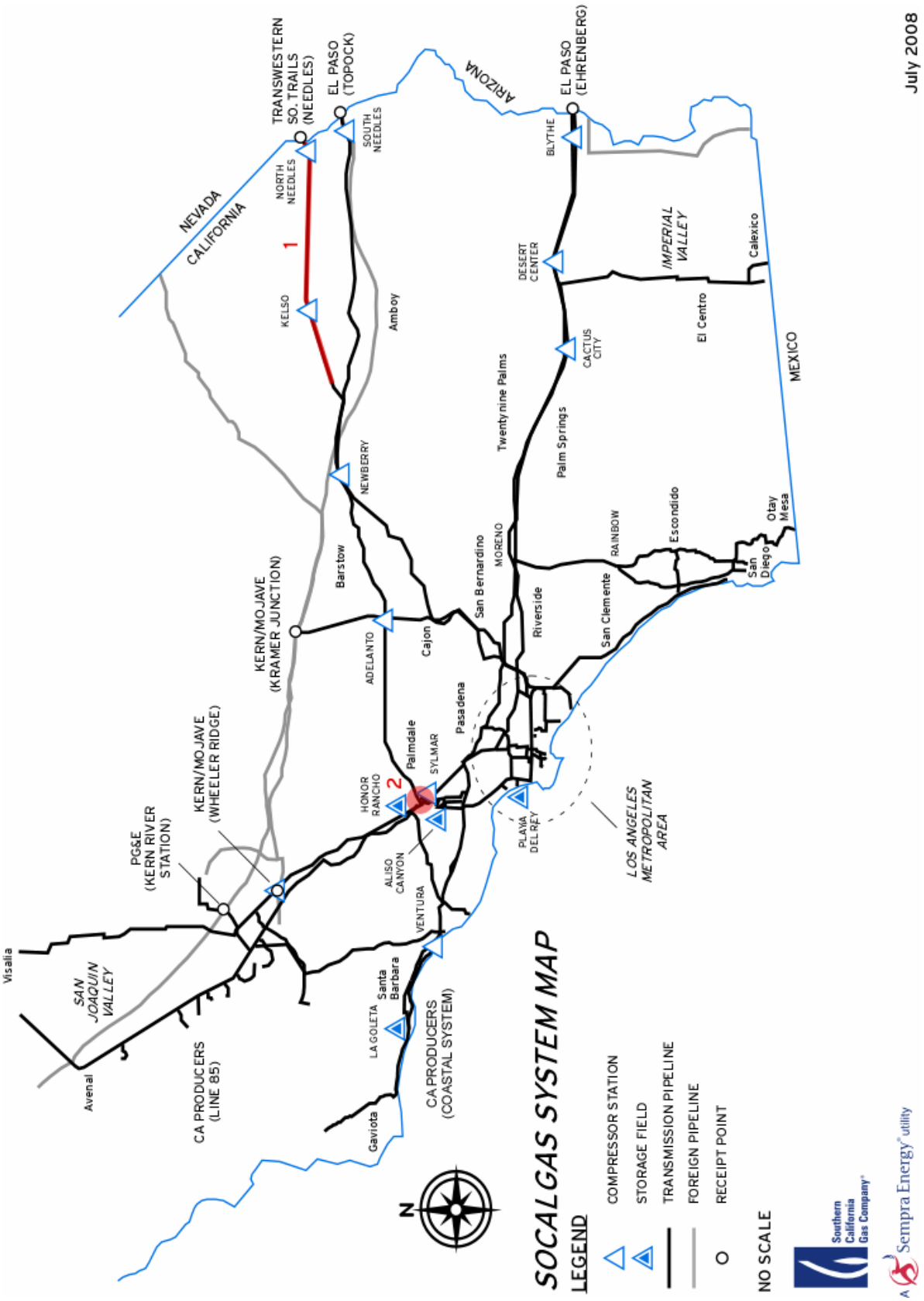
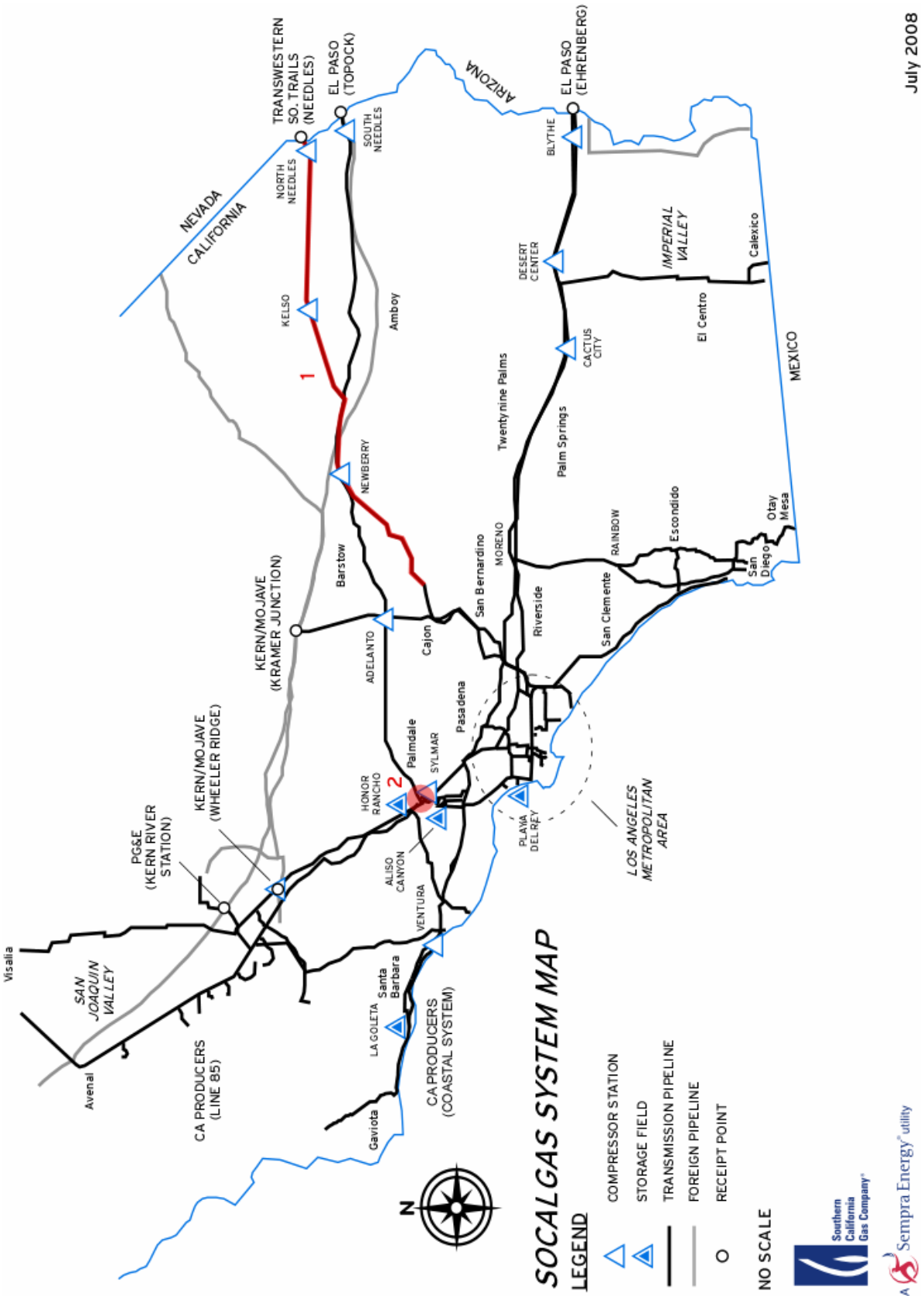


Figure NN-500



North Needles Receipt Point

		Cost	
		Unit	Total
Expansion of 200 MMcfd			
new 36" pipe - Colorado River to 21 mi west of Kelso	80 mi	$3,062,500	$245,000,000
replace Quigley PLS			$3,000,000
			$248,000,000
Detailed Estimate			
Engineering / design			$14,880,000
Typical permitting			$6,200,000
Material			
compressors			
36" pipe	80 mi	$214	$117,534,529
Other			$1,000,000
subtotal			$118,534,529
Construction			
Compressor installation			
Pipe installation	80 mi		$106,385,471
Station work			$2,000,000
subtotal			$108,385,471
Total			$248,000,000
Expansion of 500 MMcfd			
new 36" pipe - Colorado River to 50 mi west of Newberry	166 mi	$3,060,241	$508,000,000
replace Quigley PLS			$3,000,000
			$511,000,000
Detailed Estimate			
Engineering / design			$30,660,000
Typical permitting			$12,775,000
Material			
compressors			
36" pipe	166 mi	$214	$243,884,147
Other			$1,000,000
subtotal			$244,884,147
Construction			
Compressor installation			
Pipe installation	166 mi		$220,680,853
Station work			$2,000,000
subtotal			$222,680,853
Total			$511,000,000

FINAL REPORT

THE SOUTHERN CALIFORNIA GAS COMPANY EXPANSION SCENARIO REVIEW

NORTH NEEDLES SYSTEM

July 17, 2008

This report is written in fulfillment of an agreement between The Southern California Gas Company (SoCal) and Advantica, Inc. SoCal has contracted with Advantica to review supplied expansion scenario models. As stated in the Proposal, each scenario will be examined for the following:

1. Connectivity check limited to orphan pipes and unconnected sections
2. Unknown structure issues
3. Control and constraint issues (not including set point values)
4. Issues related to sonic flow, minimum pressures, and high velocities

If any other issues are subsequently found while searching for items above, they will be noted as well. This report will address findings regarding the "North Needles" group of models. Along with corresponding results data, the following models were received: 1) 1810_BASE pd/xy; 2) NN_1000 pd/xy; 3) NN_1000_CA pd/xy; 4) NN_1000_HR pd/xy 5) NN_1000_SOUTH pd/xy; 6) NN_1000_WHLR pd/xy; 7) NN_1300 pd/xy; 8) NN_1300_CA pd/xy; 9) NN_1300_HR pd/xy 10) NN_1300_SOUTH pd/xy 11) NN_1300_WHLR pd/xy.

Connectivity check: A connectivity check, which entailed searching for orphan pipes and disconnected subsystems, was performed. For each of the models submitted, no disconnections were discovered. All systems modeled are tied together as one unit.

Unknown structure issues: No unknown structure messages were generated upon import of the models. A closer inspection of the nodes and facilities did not uncover any structure issues, either.

Control and constraint issues: No constraint or control error messages were generated upon import of the models. However, a detailed inspection of the control setups revealed that multiple compressors were set up with DEFAULT as the Compressor Operation Switch (DCONTROL and SCONTROL are the other options). DEFAULT is not a recommended setting as it does not provide a clear indicator for which node is controlling. It introduces the possibility of error under certain Constraint Interchange conditions. For a compressor station that is on discharge control, Advantica recommends using DCONTROL instead. The following compressor stations are currently set on DEFAULT for all models:

From-node name	To-node name
MHPS	MHPD
MCBS	MCBD
MCLS	MCLD
MSOS	MSOD

Issues related to sonic flow, minimum pressures, and high velocities: After a steady-state balance, several higher velocities were noted in the "CA" (NN_1300 only), "HR", "SOUTH", and "WHLR" models. Note that the velocity values and pipes affected can vary depending upon which of the 11 models is imported. Below is a sample list of affected pipes from model NN_1300_HR:

Name	From-node	To-node	Velocity	Diameter	Length	P From	P To
EQ000497	SC1	MCBS	474.2	5.000	4.000	461.82	443.57
EQ000495	SC1	MSOS	398.7	4.000	4.000	461.82	445.58
EQ000499	SC1	MHPS	360.7	4.000	4.000	461.82	448.40
EQ000493	SC1	MCLS	357.0	4.000	4.000	461.82	448.65

Some warning messages were encountered after balancing some of the models in the steady-state. However, the messages are negated due to the fact that all models undergo "transient initialization" through Procedures and an initialization run period to align the model with known system conditions. All USM models are monitored during the course of the run and manually altered to address any warning conditions. All USM generated messages encountered were benign or addressed through manual intervention during the USM run.

Miscellaneous issues: It was discovered that several pipes are using the FD equation (Fundamental equation with constant friction factor). When used with a valid friction factor, this equation will yield reasonable results. However, the inherent weakness of this equation is the fixed friction factor. As flowing velocities change, so too will the friction factor. If the fixed friction factor differs significantly from the actual friction factor, then a source of error could be introduced. Although the FD equation can yield valid results, Advantica recommends using the FM equation (Fundamental equation with variable friction) for all pipes, due to its adaptability to all flows.

During import, the models generated the following sampling of errors:

*** SAI468 - WARNING - MISSING SUPER KEYWORD FOR COMPRESSOR MHPS MHPD - DEFAULT PARAMETER USED.

*** SAI468 - WARNING - MISSING SUPER KEYWORD FOR COMPRESSOR MCBS MCBD - DEFAULT PARAMETER USED.

*** SAI468 - WARNING - MISSING SUPER KEYWORD FOR COMPRESSOR MCLS MCLD - DEFAULT PARAMETER USED.

*** SAI468 - WARNING - MISSING SUPER KEYWORD FOR COMPRESSOR MSOS MSOD - DEFAULT PARAMETER USED.

The messages above indicate that no supercompressibility equation was indicated for these two compressors. SynerGEE used the default equation instead. The messages are generally not problematic but should be noted in case a different supercompressibility equation is desired.

Summary: After reviewing the North Needles system models and the output data provided, no significant issues were discovered, only the minor items already mentioned above. All items observed in the models and output data appear reasonable.

Please contact me if you have questions or concerns regarding any of the items in this document.

Sincerely,

Advantica
Stoner Software

South Needles Receipt Point

Current capacity: 540 MMcfd

Expansion of 200 MMcfd (740 MMcfd receipt capacity): $ 255 million

1. Install additional 12,000 HP at South Needles compressor station - $ 42 million
2. Install 65 miles of 36-inch diameter pipeline from South Needles compressor station westward parallel to existing 30-inch Line 3000 - $199 million
3. Install additional 3,000 HP at Newberry compressor station - $ 11 million
4. Replace Quigley Pressure Limiting Station, $ 3 million

Refer to Figure SN-200 for the location of these facility improvements.

Simulation results show that the existing 30-inch diameter Line 3000 from South Needles to Newberry become a restriction causing MAOP violations along the pipeline. To resolve this, additional compression of 12,000 HP and 3,000 HP at South Needles and Newberry compressor stations, respectively, and a new 65-mile, 36-inch diameter pipeline from South Needles station westward paralleling the existing Line 3000 are required.[2] Simulations also show that flows at the Quigley pressure limiting station exceed that of the current rated flow capacity. Thus, a rebuild of the Quigley Station with a higher flow rate capacity is necessary.

Expansion of 500 MMcfd (1,040 MMcfd receipt capacity): $ 623 million

1. Install additional 12,000 HP at South Needles compressor station - $ 42 million
2. Install 125 miles of 36-inch diameter pipeline from Colorado River crossing to Newberry compressor station - $383 million
3. Reconfigure piping, valving and controls at Newberry compressor station - $ 5 million
4. Install 62 miles of 36-inch diameter pipeline from Newberry compressor station to Cajon - $190 million
5. Replace Quigley Pressure Limiting Station, $ 3 million

Refer to Figure SN-500 for the location of these facility improvements.

Similar to the 200 MMcfd expansion scenario, results show that Line 3000 becomes a restriction causing MAOP violations along the pipeline. To resolve this restriction, additional 12,000 HP of compression at South Needles station and a new 125-mile, 36-inch diameter pipeline from the Colorado River crossing to Newberry compressor station are necessary. Once at Newberry Station, flow restrictions occur along existing 36-inch

[2] Alternatively, a new 36-inch pipeline can be installed from South Needles to Newberry stations to resolve this restriction. No additional compression would be required with this option. However, this would total approximately 120 miles of new pipeline installation and would greatly increase the costs.

diameter Line 4000 from Newberry Station to Cajon. This again causes pressures to exceed the MAOPs on Line 3000. A new 62-mile, 36-inch diameter pipeline from Newberry Station to Cajon is required to remove this restriction. Finally, new piping, valving and controls at Newberry compressor station and a rebuild of the Quigley Station are both required for increased flow capacities.

Figure SN-200

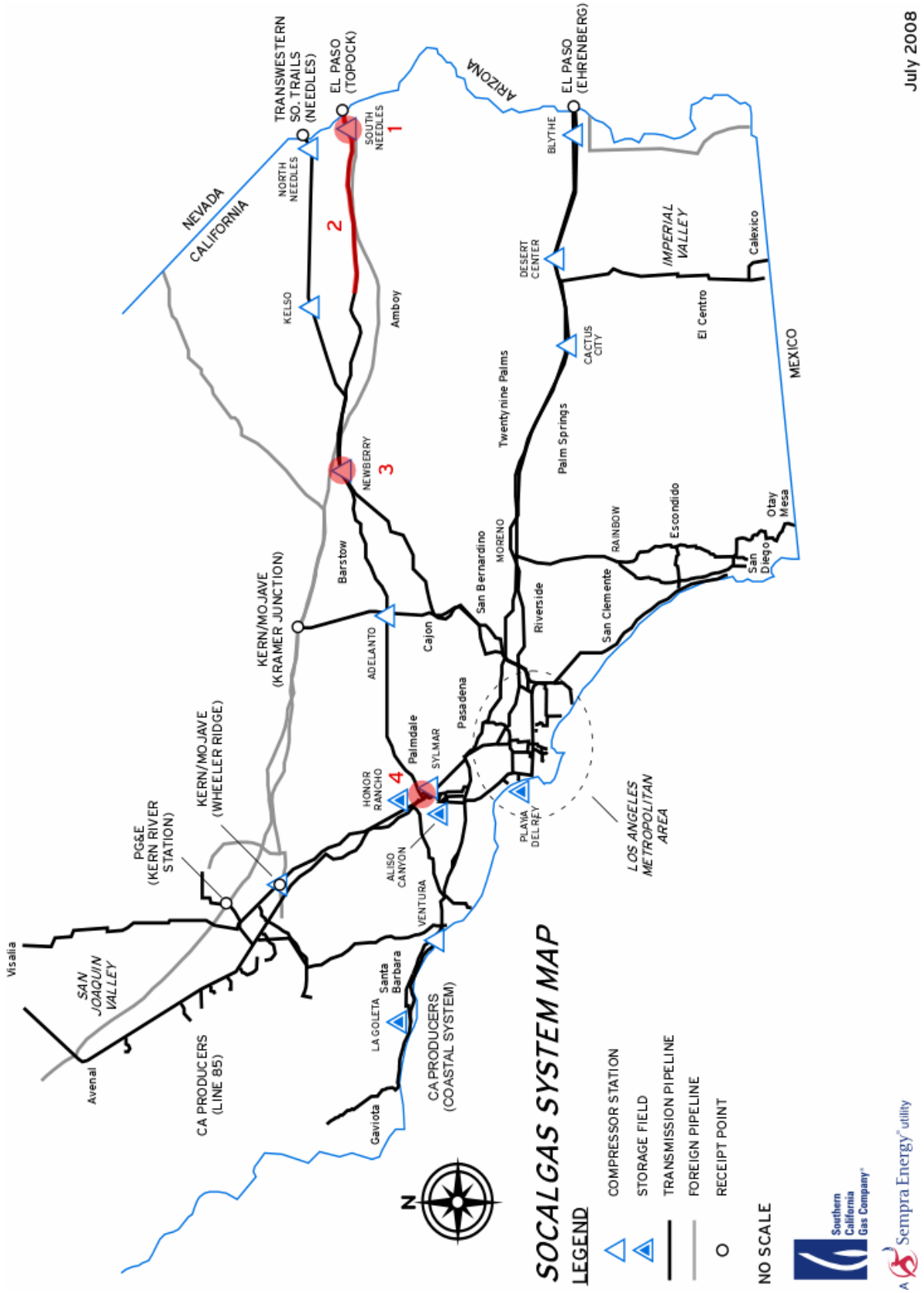
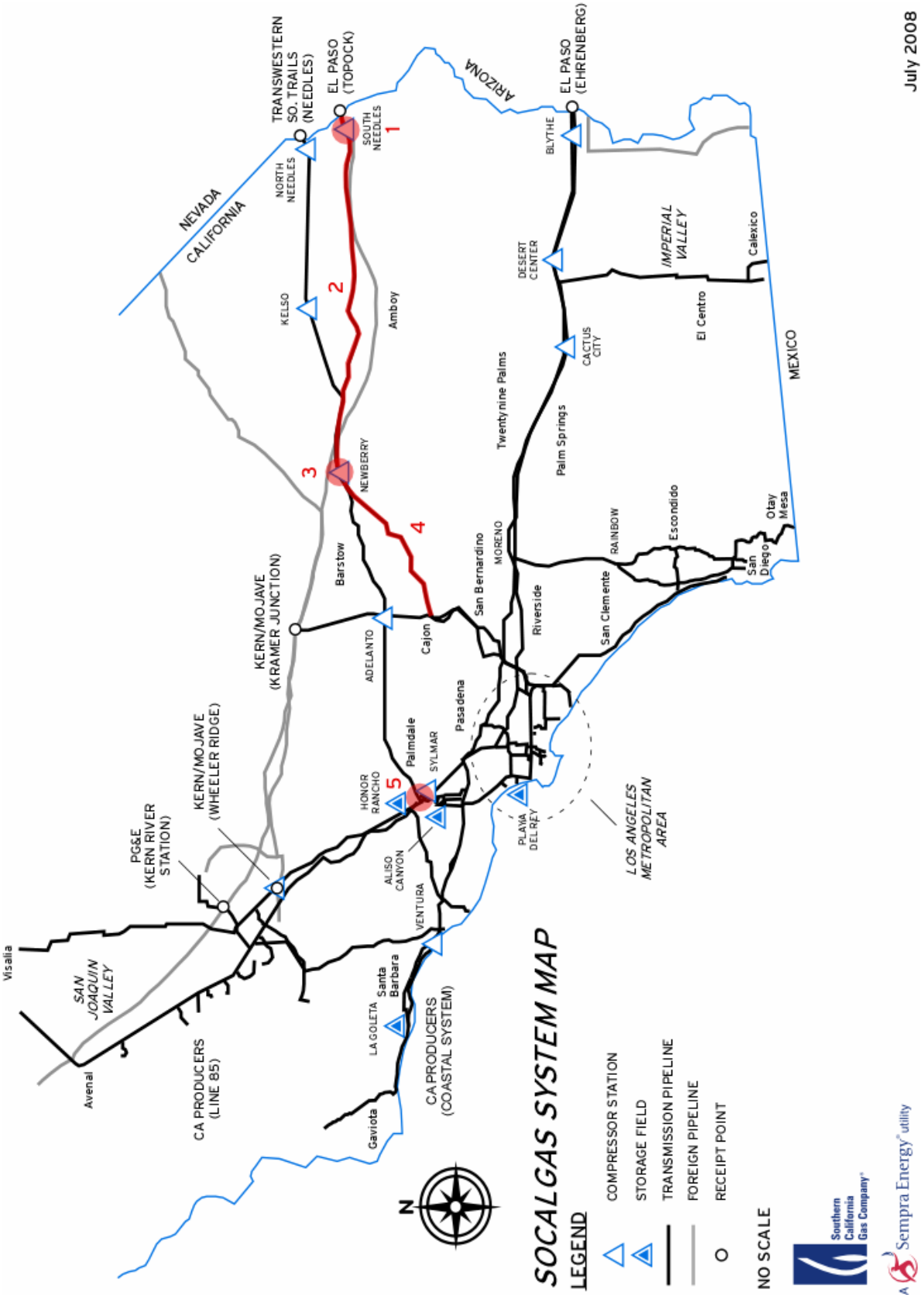


Figure SN-500



South Needles Receipt Point

		Cost	
		Unit	Total
Expansion of 200 MMcfd			
add compression at South Needles	12,000 hp	$3,500	$42,000,000
new 36" pipe west of South Needles	65 mi	$3,061,538	$199,000,000
add compression at Newberry Springs	3,000 hp	$3,667	$11,000,000
replace Quigley PLS			$3,000,000
Total			$255,000,000
Detailed Estimate			
Engineering / design			$15,300,000
Typical permitting			$6,375,000
Material			
compressors	15,000 hp	$1,140	$17,100,000
36" pipe	65 mi	$214	$95,496,805
Other			$1,000,000
subtotal			$113,596,805
Construction			
Compressor installation	15,000 hp		$28,747,250
Pipe installation	65 mi		$88,980,945
Station work			$2,000,000
subtotal			$119,728,195
Total			$255,000,000
Expansion of 500 MMfcd			
add compression at South Needles	12,000 hp	$3,500	$42,000,000
new 36" pipe - Colorado River to Newberry	125 mi	$3,064,000	$383,000,000
reconfigure Newberry Springs compressor station			$5,000,000
new 36" pipe - Newberry to Cajon	62 mi	$3,064,516	$190,000,000
replace Quigley PLS			$3,000,000
			$623,000,000
Detailed Estimate			
Engineering / design			$37,380,000
Typical permitting			$15,575,000
Material			
compressors	12,000 hp	$1,140	$13,680,000
36" pipe	187 mi	$214	$274,736,961
Other			$3,000,000
subtotal			$291,416,961
Construction			
Compressor installation	12,000 hp		$10,844,850
Pipe installation	187 mi		$262,783,189
Station work			$5,000,000
subtotal			$278,628,039
Total			$623,000,000

FINAL REPORT

THE SOUTHERN CALIFORNIA GAS COMPANY EXPANSION SCENARIO REVIEW

SOUTH NEEDLES SYSTEM

July 16, 2008

This report is written in fulfillment of an agreement between The Southern California Gas Company (SoCal) and Advantica, Inc. SoCal has contracted with Advantica to review supplied expansion scenario models. As stated in the Proposal, each scenario will be examined for the following:

1. Connectivity check limited to orphan pipes and unconnected sections
2. Unknown structure issues
3. Control and constraint issues (not including set point values)
4. Issues related to sonic flow, minimum pressures, and high velocities

If any other issues are subsequently found while searching for the items above, they will be noted as well. This report will address findings regarding the "South Needles" group of models. Along with corresponding results data, the South Needles models received were: 1) 1810_BASE pd/xy; 2) sn_740 pd/xy; 3) sn_740_FULL pd/xy; 4) sn_740_HR pd/xy; 5) sn_740_SOUTH pd/xy; 6) sn_740_WHLR pd/xy; 7) sn_1040 pd/xy; 8) sn_1040_FULL pd/xy; 9) sn_1040_HR pd/xy; 10) sn_1040_SOUTH pd/xy; 11) sn_1040_WHLR pd/xy.

Connectivity check: A connectivity check, which entailed searching for orphan pipes and disconnected subsystems, was performed. For each of the models submitted, no disconnections were discovered. All systems modeled are tied together as one unit.

Unknown structure issues: No unknown structure messages were generated upon import of the models. A closer inspection of the nodes and facilities did not uncover any unknown structure issues, either.

Control and constraint issues: No constraint or control error messages were generated upon import of the models. A detailed inspection of the control setups did not uncover any areas of suspicion, either.

Issues related to sonic flow, minimum pressures, and high velocities: Some warning messages were encountered after balancing some of the models in the steady-state. However, the messages are negated due to the fact that all models undergo "transient initialization" through Procedures and an initialization run period to align the model with known system conditions. All USM models are monitored during the course of the run and manually altered to address any warning conditions. All USM generated messages encountered were benign or addressed through manual intervention during the USM run.

Miscellaneous issues: It was discovered that several pipes are using the FD equation (Fundamental equation with constant friction factor). When used with a valid friction factor, this equation will yield reasonable results. However, the inherent weakness of this equation is the fixed friction factor. As flowing velocities change, so too will the friction factor. If the fixed friction factor differs significantly from the actual friction factor, then a source of error could be introduced. Although the FD equation can yield valid results, Advantica recommends using the FM equation (Fundamental equation with variable friction) for all pipes, due to its adaptability to all flows.

Additionally, all proposed 36” pipe are using a 35” internal diameter. If a heavier wall is being used, this may be correct. However, schedule 40 36” pipe has a 35.25” internal diameter. Although calculated linepack differences will be relatively small, it is noted here for thoroughness.

Summary: After reviewing the South Needles system models and the output data provided, no significant issues were discovered, only the minor items already mentioned above. All items observed in the models and output data appear reasonable.

Please contact me if you have questions or concerns regarding any of the items in this document.

Sincerely,

Advantica
Stoner Software

Kramer Junction Receipt Point

Current capacity: 550 MMcfd

Expansion of 200 MMcfd (750 MMcfd receipt capacity): $ 74 million

1. Install new compressor at Kramer Junction with 8,000 HP, $ 30 million
2. Replace compressor at Adelanto Station with 10,000 HP, reconfigure piping, valving and controls, $ 41 million
3. Replace Quigley Pressure Limiting Station, $ 3 million

Refer to Figure KJ-200 for the location of these facility improvements.

Kern River Transmission currently has a delivery pressure obligation of 700 psig at the Kramer Junction receipt point. Analyses show that at 750 MMcfd delivery volume and 700 psig delivery pressure at Kramer Junction, pressures drop to below the MinOP on Line 6905 between Kramer Junction and Adelanto Station. To resolve this violation, higher delivery pressures are required from Kern River Transmission up to the MAOP of Line 6905 (1200 psig). Alternatively, should Kern River Transmission not be able to deliver higher pressures, the installation of a new 8,000 HP compressor station at Kramer Junction can boost pressures to the MAOP of the pipeline.

Evaluation results also show flow restrictions at Adelanto Station. The existing Adelanto Station is a single unit compressor and existing piping, valves and controls allow for limited flexibility of flow directions. With this flow restriction at Adelanto Station, MAOP violations occur at Kramer Junction and at other points in the North Desert System. To resolve this, replacement of Adelanto Station is required with a horsepower rating of 10,000. Piping, valves, and controls at the station will also need to be reconfigured to allow compression eastward, westward and southward.

Lastly, simulations show that flows at the Quigley pressure limiting station exceed that of the current rated flow capacity. Thus, a rebuild of the Quigley Station with a higher flow rate capacity will allow the receipt of 750 MMcfd at Kramer Junction.

Expansion of 500 MMcfd (1,050 MMcfd receipt capacity): $ 172 million

1. Install 32 miles of 36-inch diameter pipeline from Kramer Junction to Adelanto Station - $128 million
2. Replace compressor at Adelanto Station with 10,000 HP, reconfigure piping, valving and controls, $ 41 million
3. Replace Quigley Pressure Limiting Station, $ 3 million

Refer to Figure KJ-500 for the location of these facility improvements.

At 1,050 MMcfd total receipt capacity, Line 6905 from Kramer Junction to Adelanto Station becomes a restriction causing MinOP violations at Adelanto Station. Unlike the

200 MMcfd expansion scenario, compression to the MAOP of the pipeline alone cannot resolve this restriction and pipeline improvement is required. As a result, installation of 32 miles of 36-inch diameter pipeline from Kramer Junction to Adelanto Station parallel to the existing 30-inch pipeline is required. The pipeline improvement will allow the receipt of 1050 MMcfd delivery volume at Kramer Junction.

Finally, both Adelanto and Quigley Stations will require replacement to resolve flow restrictions for the same reasons as discussed in the 750 MMcfd delivery volume.

Figure KJ-200

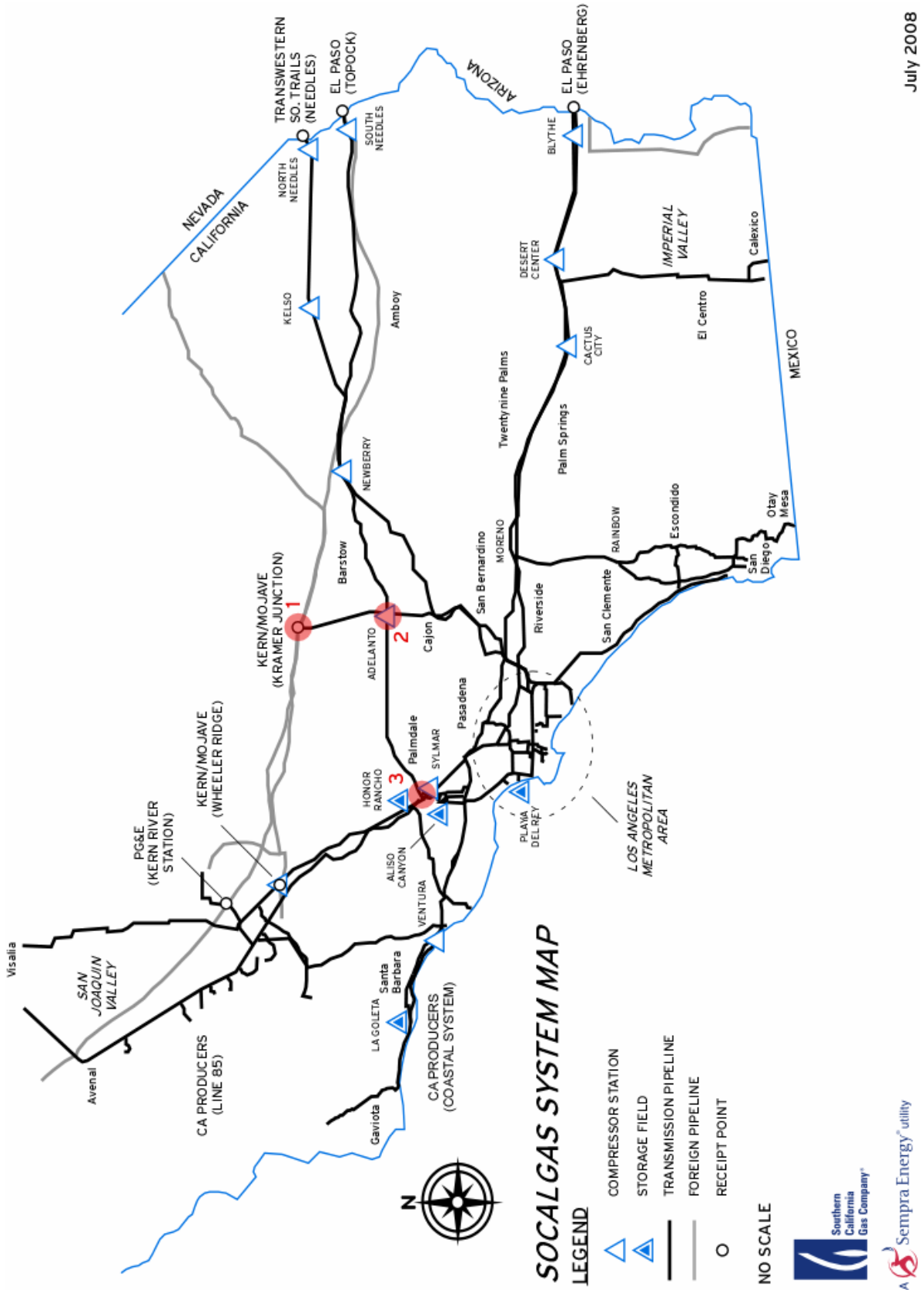
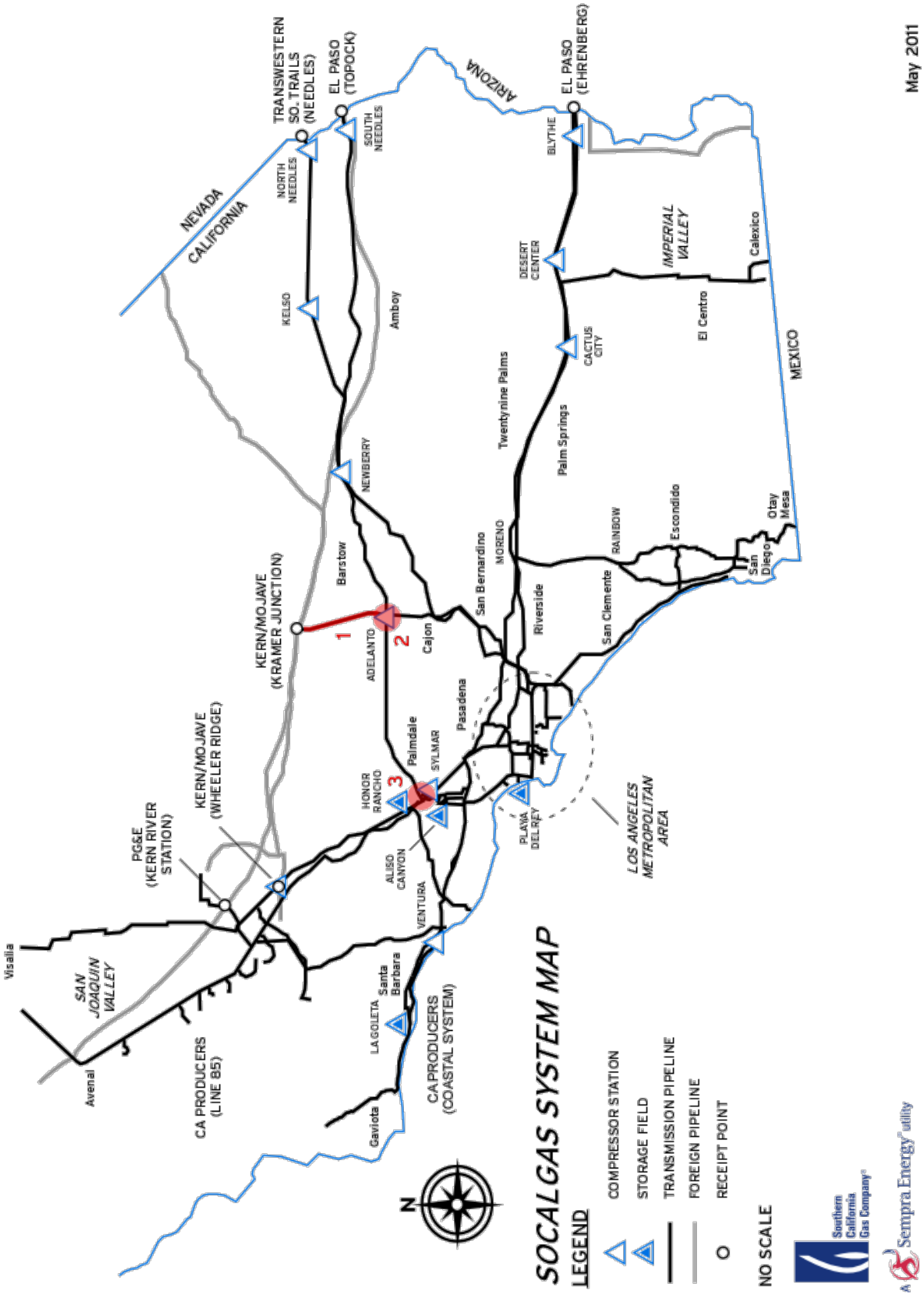


Figure KJ-500



Kramer Junction Receipt Point

		Cost	
		Unit	Total
Expansion of 200 MMcfd			
new compression at Kramer Junction	8,000 hp	$3,750	$30,000,000
replace compression at Adelanto, modify piping	10,000 hp	$4,100	$41,000,000
replace Quigley PLS			$3,000,000
			$74,000,000
Detailed Estimate			
Engineering / design			$4,440,000
Typical permitting			$1,850,000
Material			
compressors	18,000 hp	$1,140	$20,520,000
36" pipe			$0
Other			$1,000,000
subtotal			$21,520,000
Construction			
Compressor installation			$44,190,000
Pipe installation			
Station work			$2,000,000
subtotal			$46,190,000
Total			$74,000,000
Expansion of 500 MMcfd			
new 36" pipe - Kramer Junction to Adelanto	32 mi	$4,000,000	$128,000,000
replace compression at Adelanto, modify piping	10,000 hp	$4,100	$41,000,000
replace Quigley PLS			$3,000,000
			$172,000,000
Detailed Estimate			
Engineering / design			$10,320,000
Typical permitting			$4,300,000
Material			
compressors	10,000 hp	$1,140	$11,400,000
36" pipe	32 mi	$214	$47,013,812
Other			$1,000,000
subtotal			$59,413,812
Construction			
Compressor installation			$24,775,400
Pipe installation	32 mi		$71,190,788
Station work			$2,000,000
subtotal			$97,966,188
Total			$172,000,000

Report Number: Final *9 September 2011*

Expansion Scenario Review

Prepared for:

Southern California Gas Company
555 W. Fifth St.
Los Angeles, CA 90013

Prepared by:

GL Noble Denton
Suite 100
600 Bent Creek Boulevard
Mechanicsburg, PA 17050
USA

Customer Reference: ADV-SOCAL1150

Executive Summary

This report is written in fulfillment of an agreement between The Southern California Gas Company (SoCal) and GL Noble Denton. SoCal has contracted with GL to review supplied expansion scenario models. As stated in the Proposal, each scenario was examined for the following:

1. Connectivity check limited to orphan pipes and unconnected sections
2. Unknown structure issues
3. Control and constraint issues (not including set point values)
4. Issues related to sonic flow, minimum pressures, and high velocities

Other issues subsequently found while searching for the items above were noted as well.

This report addresses findings regarding the expansion scenarios of the SoCal Kramer Junction receipt point and transmission system improvements necessary for an expansion of storage services.

Contents

1 Introduction

GL used SynerGEE Gas version 4.5.2.7 to review the following 6 models:

- ss base Line 6905_550 MMcfd.mdb
- ss Line 6905_750_MMcfd compr.mdb
- ss Line 6905_1050_MMcfd 36-in.mdb
- transient 1.8 bcfd.mdb
- transient 2.0 bcfd.mdb
- transient 2.3 bcfd.mdb

2 Model Review

2.1 ss base Line 6905_550 MMcfd

The following items were reviewed and the following observations were made:

- Import Log – no errors or warnings issued
- Connectivity Check – no orphan pipes or disconnected systems were discovered
- Unknown Structure – no issues were discovered with the model structure
- Control/Constraint Issues – no issues were discovered
- Analysis Log – no errors issued upon balancing (steady-state) the model
- Miscellaneous
    - Reviewed Facilities Tab – no issues discovered

2.2 ss Line 6905_750_MMcfd compr

The following items were reviewed and the following observations were made:

- Import Log – no errors or warnings issued
- Connectivity Check – no orphan pipes or disconnected systems were discovered
- Unknown Structure – no issues were discovered with the model structure
- Control/Constraint Issues – no issues were discovered
- Analysis Log – no errors issued upon balancing (steady-state) the model
- Miscellaneous
    - Reviewed Facilities Tab – no issues discovered

2.3 ss Line 6905_1050_MMcfd 36-in

The following items were reviewed and the following observations were made:

- Import Log – no errors or warnings issued
- Connectivity Check – no orphan pipes or disconnected systems were discovered
- Unknown Structure – no issues were discovered with the model structure
- Control/Constraint Issues – no issues were discovered
- Analysis Log – no errors issued upon balancing (steady-state) the model
- Miscellaneous
    - Reviewed Facilities Tab – new 36” pipe that was added has a 0.98 efficiency (all other pipes in the model have 1.0); roughness value is 0.0018 (all other pipes in the model have 0.0025)

2.4 transient 1.8 bcfd

- Import Log – no errors or warnings issued
- Connectivity Check – no orphan pipes or disconnected systems were discovered

- Unknown Structure – no issues were discovered with the model structure
- Control/Constraint Issues – no issues were discovered
- Analysis Log
    - The following warnings were issued upon balancing (steady-state) the model
        - As a result of valve closures, the following region(s) have been isolated and removed from the calculations
            - Valve Name: EQ000147, Type: shut, Region Valve Node: SDG42A, Pressures: 414.31 S 235.00 S
            - Valve Name: EQ000145, Type: shut, Region Valve Node: ENCSOUTH, Pressures: 602.50 S 235.00 S
        - Warning - regulator Re155 has a negative flow of -68.97137. The regulator has a from node pressure of 400.8481 and a to node pressure of 400.8741
        - Warning - regulator DELAMOREG has a negative flow of -98.82274. The regulator has a from node pressure of 406.2022 and a to node pressure of 406.2548
        - The following facilities have negative flows:
            - Facility: WHEELER Type: CS Flow: -73.1798 Valve Constant: 30.0000 Upstream Pressure: 426.061 Downstream Pressure: 426.074
    - The following errors/warnings were issued upon balancing (slow transient – 30 hours) the model
        - Warning: Compressor CACTUS suction pressure, 579.42, fell below its soft minimum suction pressure limit, 580.00, at 0.10 hours.
        - Error: Compressor WHEELER suction pressure, 426.06, fell below its minimum suction pressure limit, 605.00, at 0.10 hours.
        - Warning: Continuity error of 2.71 reached 0.1% at 1.90 hours.
        - Warning: Continuity error of -0.122 lowered to 0.1% at 3.80 hours.
        - Warning: Compressor BLYTHE suction pressure, 566.85, fell below its soft minimum suction pressure limit, 575.00, at 3.90 hours.
        - Warning: Continuity error of 2.78 reached 0.1% at 4.00 hours.
        - Warning: Compressor DESERT discharge pressure, 753.06, rose above its soft maximum discharge pressure limit, 750.00, at 4.00 hours.
        - Warning: Continuity error of 2.01 lowered to 0.1% at 4.10 hours.
        - Error: Compressor DESERT discharge pressure, 775.12, rose above its maximum discharge pressure limit, 770.00, at 4.30 hours.
        - Warning - balance not obtained.
        - Warning Node L300313A has flow imbalance of 1.0701 at time: 6.000.
        - Warning Node L1181END has flow imbalance of -1.7373 at time: 6.000.
        - Warning Minimum Allowable Pressure Soft Limit Violated at node BCHINOX at 6.70 hours.
        - Error Minimum Allowable Pressure Violated at node BCHINOX at 6.70 hours.
        - Error: Compressor DESERT discharge pressure, 770.18, rose above its maximum discharge pressure limit, 770.00, at 12.20 hours.
        - Warning - balance not obtained.
        - Warning Node L300313A has flow imbalance of -47.2732 at time: 24.300.
        - Warning Node L300313B has flow imbalance of 47.2732 at time: 24.300.

        The above warning messages are all temporary, immediately resolve themselves, and therefore negligible.
- Miscellaneous
    - Reviewed Facilities Tab – pipe ‘Pi248’ has a roughness value of 0.25, which is a factor of 100 higher than the typical pipe roughness of 0.0025

2.5 transient 2.0 bcfd

- Import Log – no errors or warnings issued
- Connectivity Check – no orphan pipes or disconnected systems were discovered
- Unknown Structure – no issues were discovered with the model structure
- Control/Constraint Issues – no issues were discovered
- Analysis Log
    - The following warnings were issued upon balancing (steady-state) the model
        - As a result of valve closures, the following region(s) have been isolated and removed from the calculations
            - Valve Name: EQ000147, Type: shut, Region Valve Node: SDG42A, Pressures: 414.08 S 235.00 S
            - Valve Name: EQ000145, Type: shut, Region Valve Node: ENCSOUTH, Pressures: 602.50 S 235.00 S
        - Warning - regulator Re155 has a negative flow of -69.44050. The regulator has a from node pressure of 400.7458 and a to node pressure of 400.7722
        - Warning - regulator DELAMOREG has a negative flow of -98.53707. The regulator has a from node pressure of 406.0604 and a to node pressure of 406.1128
        - The following facilities have negative flows:
            - Facility: WHEELER Type: CS Flow: -73.1798 Valve Constant: 30.0000 Upstream Pressure: 425.886 Downstream Pressure: 425.899
    - The following errors/warnings were issued upon balancing (slow transient – 30 hours) the model
        - Warning: Compressor CACTUS suction pressure, 579.42, fell below its soft minimum suction pressure limit, 580.00, at 0.10 hours.
        - Error: Compressor WHEELER suction pressure, 425.89, fell below its minimum suction pressure limit, 605.00, at 0.10 hours.
        - Warning: Compressor CACTUS suction pressure, 579.89, fell below its soft minimum suction pressure limit, 580.00, at 1.10 hours.
        - Warning Minimum Allowable Pressure Soft Limit Violated at node BCHINOX at 6.70 hours.
        - Error Minimum Allowable Pressure Violated at node BCHINOX at 6.70 hours.
        - Error: Compressor CACTUS suction pressure, 559.72, fell below its minimum suction pressure limit, 560.00, at 8.10 hours.

        The above warning messages are all temporary, immediately resolve themselves, and therefore negligible.

- Miscellaneous
    - Reviewed Facilities Tab – pipe 'Pi248' has a roughness value of 0.25, which is a factor of 100 higher than the typical pipe roughness of 0.0025

2.6 transient 2.3 bcfd

- Import Log – no errors or warnings issued
- Connectivity Check – no orphan pipes or disconnected systems were discovered
- Unknown Structure – no issues were discovered with the model structure
- Control/Constraint Issues – no issues were discovered
- Analysis Log
    - The following warnings were issued upon balancing (steady-state) the model
        - As a result of valve closures, the following region(s) have been isolated and removed from the calculations
            - Valve Name: EQ000147, Type: shut, Region Valve Node: SDG42A, Pressures: 421.10 S 235.00 S
            - Valve Name: EQ000145, Type: shut, Region Valve Node: ENCSOUTH, Pressures: 602.50 S 235.00 S

- Warning - regulator Re155 has a negative flow of -213.8428. The regulator has a from node pressure of 374.6901 and a to node pressure of 374.9566
- Warning - regulator L115REG has a negative flow of -5.002192. The regulator has a from node pressure of 363.7047 and a to node pressure of 363.7049
- Warning - regulator DELAMOREG has a negative flow of -169.2943. The regulator has a from node pressure of 385.2589 and a to node pressure of 385.4213
- The following facilities have negative flows:
    - Facility: WHEELER Type: CS Flow: -73.1798 Valve Constant: 30.0000 Upstream Pressure: 388.627 Downstream Pressure: 388.641

- The following errors/warnings were issued upon balancing (slow transient – 30 hours) the model
    - Warning: Compressor CACTUS suction pressure, 579.37, fell below its soft minimum suction pressure limit, 580.00, at 0.10 hours.
    - Error: Compressor WHEELER suction pressure, 388.63, fell below its minimum suction pressure limit, 605.00, at 0.10 hours.
    - Warning: Continuity error of 2.72 reached 0.1% at 2.00 hours.
    - Warning: Continuity error of -0.163 lowered to 0.1% at 3.40 hours.
    - Warning: Compressor BLYTHE suction pressure, 564.63, fell below its soft minimum suction pressure limit, 575.00, at 3.50 hours.
    - Warning: Continuity error of 2.83 reached 0.1% at 3.60 hours.
    - Warning: Continuity error of 2.28 lowered to 0.1% at 3.70 hours.
    - Warning: Compressor DESERT discharge pressure, 753.99, rose above its soft maximum discharge pressure limit, 750.00, at 4.00 hours.
    - Error: Compressor DESERT discharge pressure, 770.81, rose above its maximum discharge pressure limit, 770.00, at 4.20 hours.
    - Warning Minimum Allowable Pressure Soft Limit Violated at node BCHINOX at 6.70 hours.
    - Error Minimum Allowable Pressure Violated at node BCHINOX at 6.70 hours.
    - Error: Compressor DESERT discharge pressure, 770.11, rose above its maximum discharge pressure limit, 770.00, at 11.30 hours.

    The above warning messages are all temporary, immediately resolve themselves, and therefore negligible.

- Miscellaneous
    - Reviewed Facilities Tab – pipe 'Pi248' has a roughness value of 0.25, which is a factor of 100 higher than the typical pipe roughness of 0.0025

3 Summary

After reviewing the SoCal Kramer Junction system models and the output data provided, no significant issues were discovered other than the minor items already mentioned above. All items observed in the models and output data appear reasonable.

Kern/Mojave Wheeler Ridge Receipt Point

Current capacity: 765 MMcfd

Expansion of 200 MMcfd (965 MMcfd receipt capacity): $ 80 million

1. Install 25 miles of 36-inch diameter pipeline from Wheeler Ridge to Gorman Post, $ 77 million
2. Replace Quigley Pressure Limiting Station, $ 3 million

Refer to Figure KM-200 for the location of these facility improvements.

The existing SoCalGas 34-inch diameter pipeline between Wheeler Ridge and Gorman Post becomes a restriction beyond 765 MMcfd of receipts at Wheeler Ridge. The restriction causes pressure upstream of the wheeler ridge compressor station to rise above the maximum operating pressure (MAOP). Installing 25 miles of 36-inch diameter pipeline from Wheeler Ridge to Gorman Post resolves this restriction.

Simulations show that flows at the Quigley pressure limiting station exceed that of the current rated flow capacity. A rebuild of the Quigley Station with a higher flow rate capacity will allow the receipt of 965 MMcfd at Wheeler Ridge.

Expansion of 500 MMcfd (1265 MMcfd receipt capacity): $ 162 million

1. Install 52 miles of 36-inch diameter pipeline from Wheeler Ridge to Honor Rancho, $ 159 million
2. Replace Quigley Pressure Limiting Station, $ 3 million

Refer to Figure KM-500 for the location of these facility improvements.

The existing SoCalGas 34-inch diameter pipeline between Wheeler Ridge and Honor Rancho becomes a restriction beyond 765 MMcfd of receipts at Wheeler Ridge. The lower MAOP from Gorman Post to Honor Rancho causes a restriction in the pipeline section which causes pressure upstream of the wheeler ridge compressor station to rise above the maximum operating pressure (MAOP). Installing 52 miles of 36-inch diameter pipeline from Wheeler Ridge to Honor Rancho resolves this restriction.

Simulations also show that flows at the Quigley pressure limiting station exceed that of the current rated flow capacity. A rebuild of the Quigley Station with a higher flow rate capacity will allow the receipt of 1265 MMcfd at Wheeler Ridge.

Figure KM-200

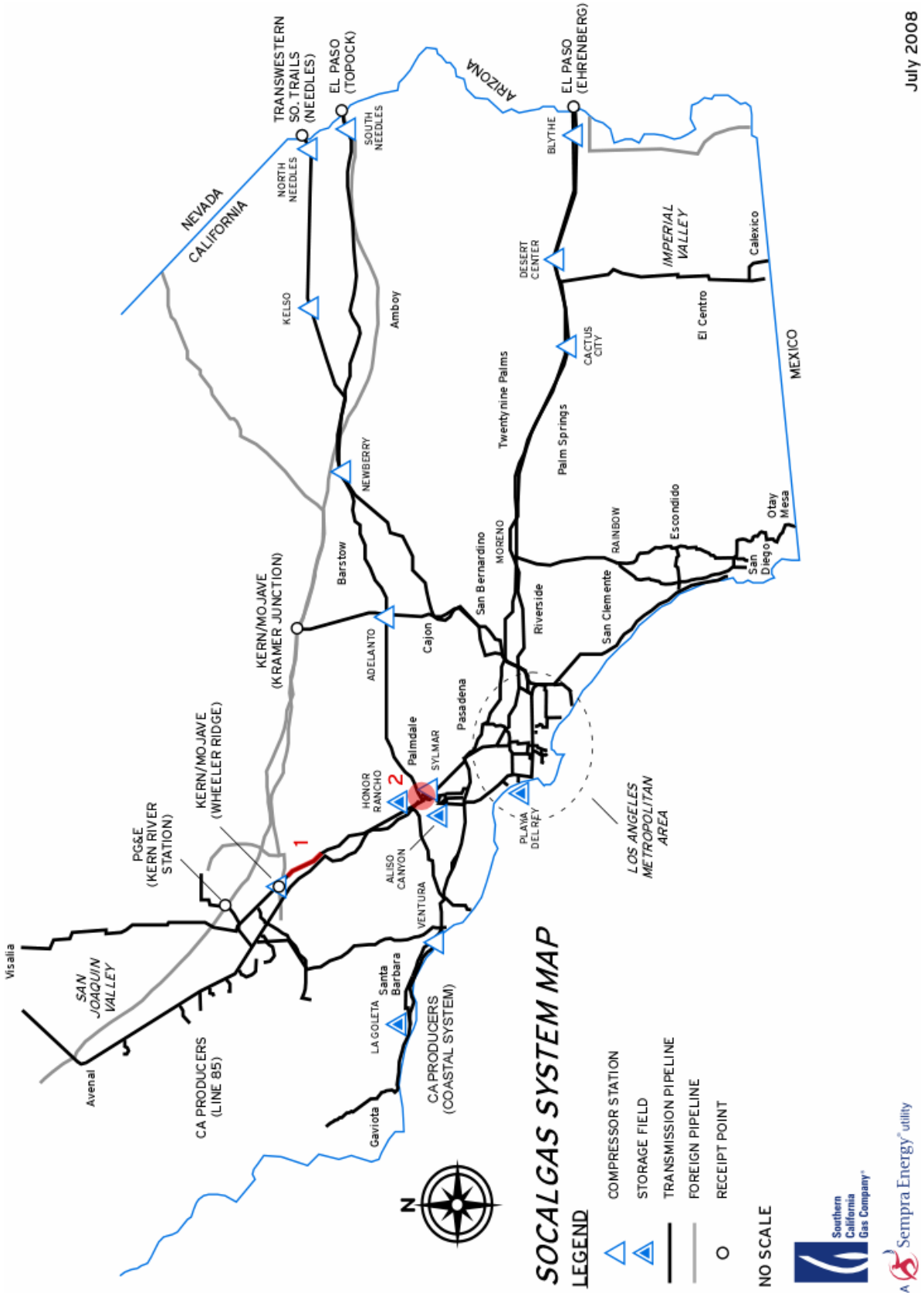
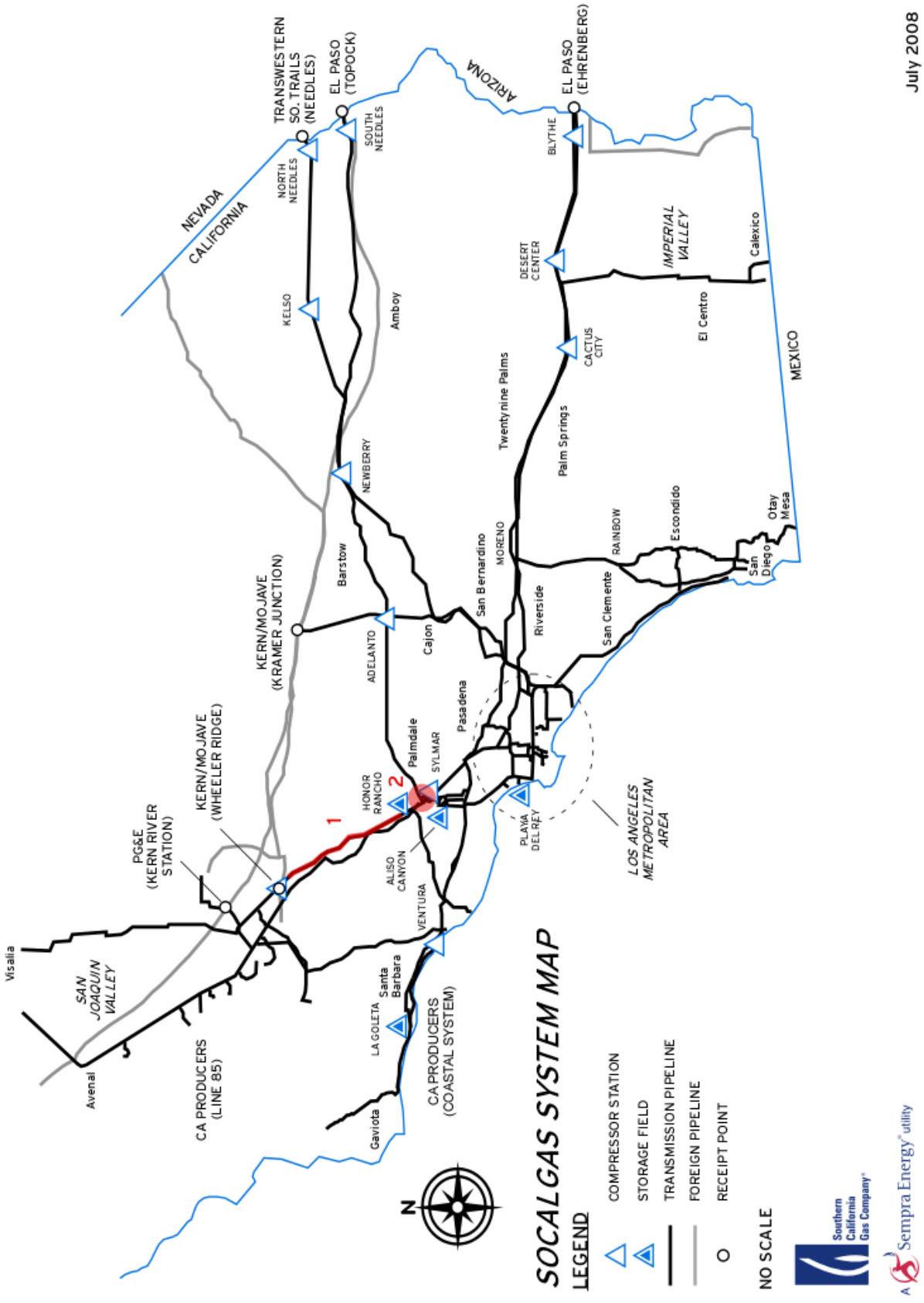


Figure KM-500



Kern Mojave Wheeler Ridge Receipt Point

		Cost	
		Unit	Total
Expansion of 200 MMcfd			
new 36" pipe - Wheeler to Gorman Post	25 mi	$3,080,000	$77,000,000
replace Quigley PLS			$3,000,000
			$80,000,000
Detailed Estimate			
Engineering / design			$4,800,000
Typical permitting			$2,000,000
Material			
compressors			
36" pipe	25 mi	$214	$36,729,540
Other			$1,000,000
subtotal			$37,729,540
Construction			
Compressor installation			
Pipe installation	25 mi		$33,470,460
Station work			$2,000,000
subtotal			$35,470,460
Total			$80,000,000
Expansion of 500 MMfcd			
new 36" pipe - Wheeler to Honor Ranch	52 mi	$3,057,692	$159,000,000
replace Quigley PLS			$3,000,000
			$162,000,000
Detailed Estimate			
Engineering / design			$9,720,000
Typical permitting			$4,050,000
Material			
compressors			
36" pipe	52 mi	$214	$76,397,444
Other			$1,000,000
subtotal			$77,397,444
Construction			
Compressor installation			
Pipe installation	52 mi		$68,832,556
Station work			$2,000,000
subtotal			$70,832,556
Total			$162,000,000

PG&E Kern River Station Receipt Point

Current capacity: 520 MMcfd

Expansion of 200 MMcfd (720 MMcfd receipt capacity): $ 80 million

1. Install 25 miles of 36-inch diameter pipeline from Wheeler Ridge to Gorman Post, $ 77 million
2. Replace Quigley Pressure Limiting Station, $ 3 million

Refer to Figure PG-200 for the location of these facility improvements.

The existing SoCalGas 34-inch diameter pipeline between Wheeler Ridge and Gorman Post becomes a restriction beyond 765 MMcfd of receipts at Wheeler Ridge. The restriction causes pressure upstream of the wheeler ridge compressor station to rise above the maximum operating pressure (MAOP). Installing 25 miles of 36-inch diameter pipeline from Wheeler Ridge to Gorman Post resolves this restriction.

Simulations show that flows at the Quigley pressure limiting station exceed that of the current rated flow capacity. A rebuild of the Quigley Station with a higher flow rate capacity will allow the receipt of 965 MMcfd at Wheeler Ridge.

Expansion of 500 MMcfd (1020 MMcfd receipt capacity): $ 251 million

1. Install 52 miles of 36-inch diameter pipeline from Wheeler Ridge to Honor Rancho, $ 159 million.
2. Install 29 miles of 36-inch diameter pipeline from Kern River Station to Wheeler Ridge, $ 89 million.
3. Replace Quigley Pressure Limiting Station, $ 3 million

Refer to Figure PG-500 for the location of these facility improvements.

The existing SoCalGas 34-inch diameter pipeline between Wheeler Ridge and Honor Rancho becomes a restriction beyond 765 MMcfd of receipts at Wheeler Ridge. The lower MAOP from Gorman Post to Honor Rancho causes a restriction in the pipeline section which causes pressure upstream of the wheeler ridge compressor station to rise above the maximum operating pressure (MAOP). Installing 52 miles of 36-inch diameter pipeline from Wheeler Ridge to Honor Rancho resolves this restriction.

The existing SoCalGas 34-inch diameter pipeline between Kern River station and Wheeler Ridge compressor station becomes a restriction beyond 520 MMcfd receipts at Kern River Station. Installing 29 miles of 36-inch diameter pipeline from Kern River Station to Wheeler Ridge compressor station resolves this restriction.

Simulations show that flows at the Quigley pressure limiting station exceed that of the current rated flow capacity. A rebuild of the Quigley Station with a higher flow rate capacity will allow the receipt of 1265 MMcfd at Wheeler Ridge.

Figure PG-200

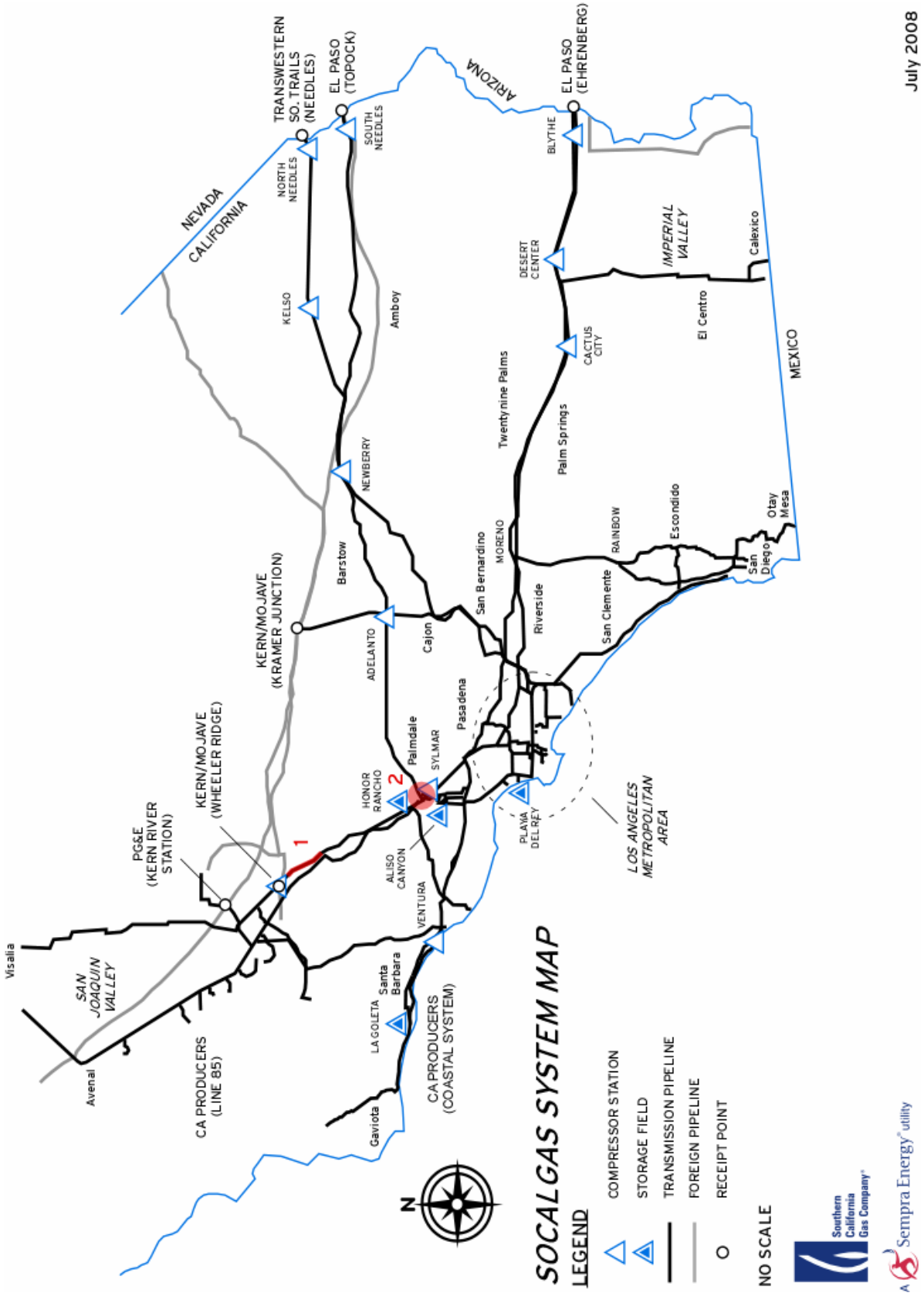
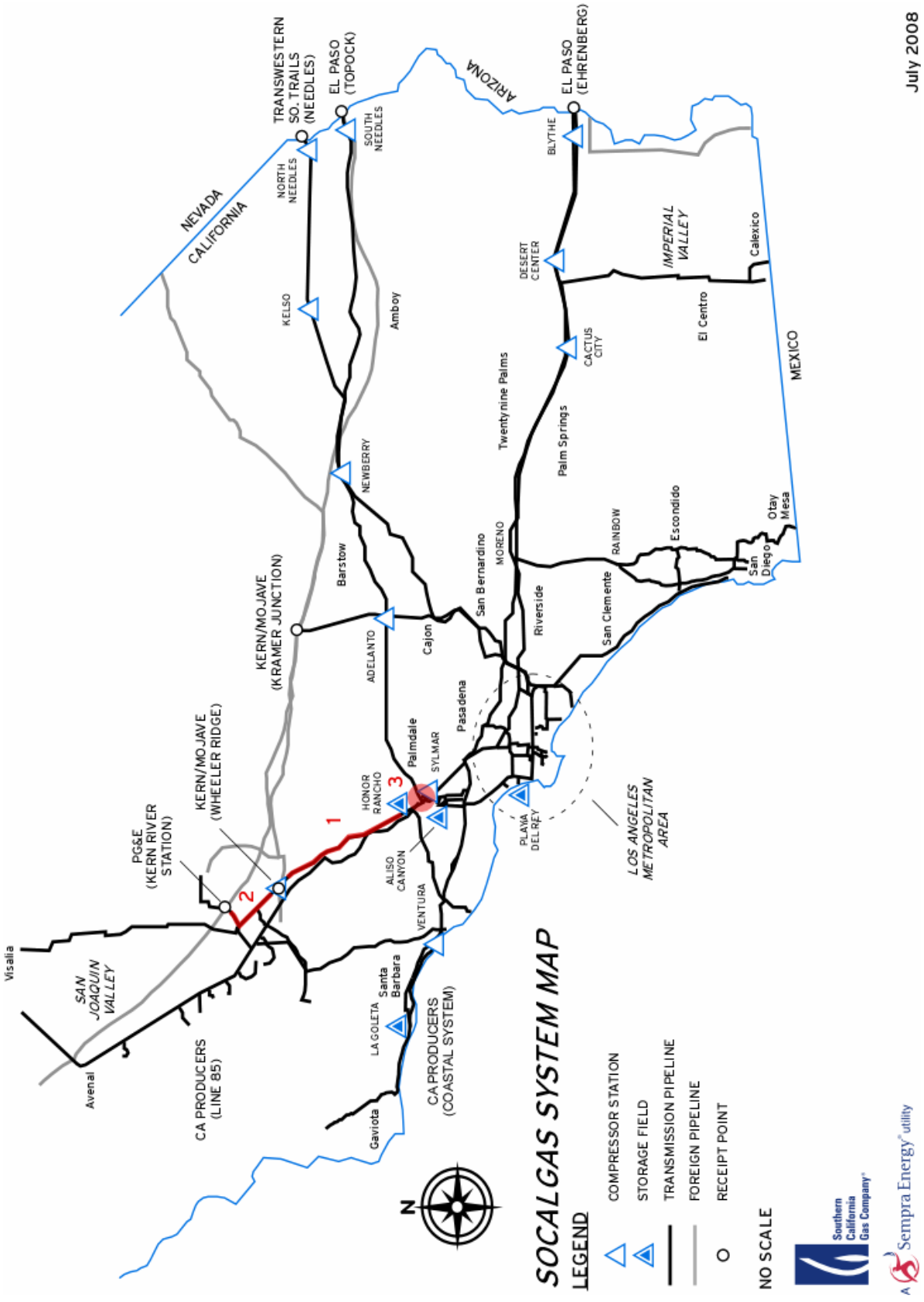


Figure PG-500



PG&E Kern River Receipt Point

		Cost	
		Unit	Total
Expansion of 200 MMcfd			
new 36" pipe - Wheeler to Gorman Post	25 mi	$3,080,000	$77,000,000
replace Quigley PLS			$3,000,000
			$80,000,000
Detailed Estimate			
Engineering / design			$4,800,000
Typical permitting			$2,000,000
Material			
compressors			
36" pipe	25 mi	$214	$36,729,540
Other			$1,000,000
subtotal			$37,729,540
Construction			
Compressor installation			
Pipe installation	25 mi		$33,470,460
Station work			$2,000,000
subtotal			$35,470,460
Total			$80,000,000
Expansion of 500 MMfcd			
new 36" pipe - Wheeler to Honor Ranch	52 mi	$3,057,692	$159,000,000
new 36" pipe - Kern River Station to Wheeler	29 mi	$3,068,966	$89,000,000
replace Quigley PLS			$3,000,000
			$251,000,000
Detailed Estimate			
Engineering / design			$15,060,000
Typical permitting			$6,275,000
Material			
compressors			
36" pipe	81 mi	$214	$119,003,710
Other			$1,000,000
subtotal			$120,003,710
Construction			
Compressor installation			
Pipe installation	81 mi		$107,661,290
Station work			$2,000,000
subtotal			$109,661,290
Total			$251,000,000

Elk Hills (OEHI) Gosford Receipt Point

Current capacity: 150 MMcfd

Expansion of 200 MMcfd (350 MMcfd receipt capacity): $ 80 million

1. Install 25 miles of 36-inch diameter pipeline from Wheeler Ridge to Gorman Post, $ 77 million
2. Replace Quigley Pressure Limiting Station, $ 3 million

Refer to Figure OX-200 for the location of these facility improvements.

The existing SoCalGas 34-inch diameter pipeline between Wheeler Ridge and Gorman Post becomes a restriction beyond 765 MMcfd of receipts at Wheeler Ridge. The restriction causes pressure upstream of the wheeler ridge compressor station to rise above the maximum operating pressure (MAOP). Installing 25 miles of 36-inch diameter pipeline from Wheeler Ridge to Gorman Post resolves this restriction.

Simulations show that flows at the Quigley pressure limiting station exceed that of the current rated flow capacity. A rebuild of the Quigley Station with a higher flow rate capacity will allow the receipt of 965 MMcfd at Wheeler Ridge.

Expansion of 500 MMcfd (650 MMcfd receipt capacity): $ 223 million

1. Install 52 miles of 36-inch diameter pipeline from Wheeler Ridge to Honor Rancho, $ 159 million.
2. Install 20 miles of 36-inch diameter pipeline from South Coles Levee to Wheeler Ridge, $ 61 million.
3. Replace Quigley Pressure Limiting Station, $ 3 million

Refer to Figure OX-500 for the location of these facility improvements.

The existing SoCalGas 34-inch diameter pipeline between Wheeler Ridge and Honor Rancho becomes a restriction beyond 765 MMcfd of receipts at Wheeler Ridge. The lower MAOP from Gorman Post to Honor Rancho causes a restriction in the pipeline section which causes pressure upstream of the wheeler ridge compressor station to rise above the maximum operating pressure (MAOP). Installing 52 miles of 36-inch diameter pipeline from Wheeler Ridge to Honor Rancho resolves this restriction.

The existing SoCalGas 34-inch diameter pipeline between OEHI (Gosford) and Wheeler Ridge compressor station becomes a restriction beyond 520 MMcfd receipts at Kern River Station and OEHI combined. Installing 20 miles of 36-inch diameter pipeline from South Coles Levee to Wheeler Ridge compressor station resolves this restriction.

Simulations show that flows at the Quigley pressure limiting station exceed that of the current rated flow capacity. A rebuild of the Quigley Station with a higher flow rate capacity will allow the receipt of 1265 MMcfd at Wheeler Ridge.

Figure OX-200

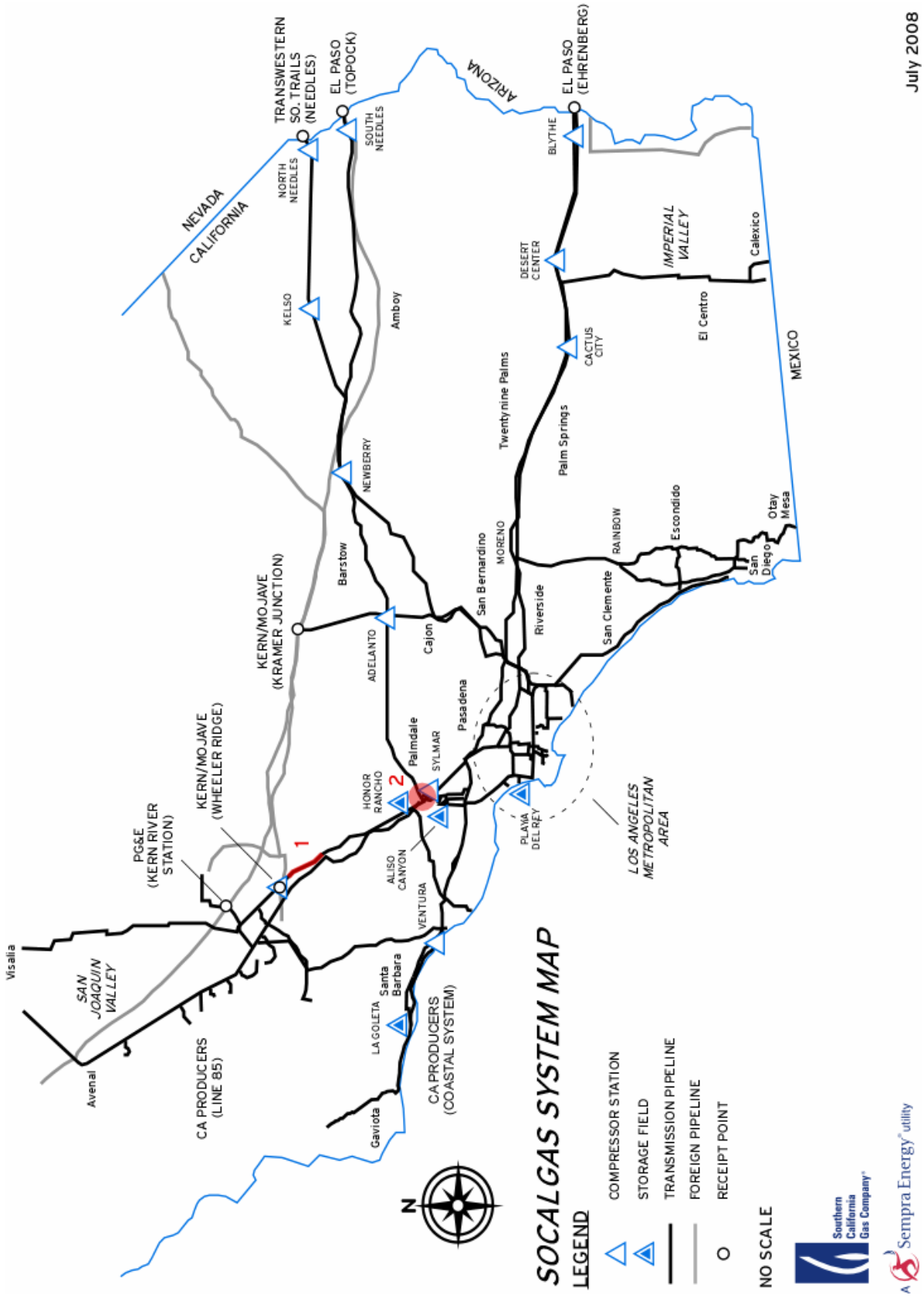
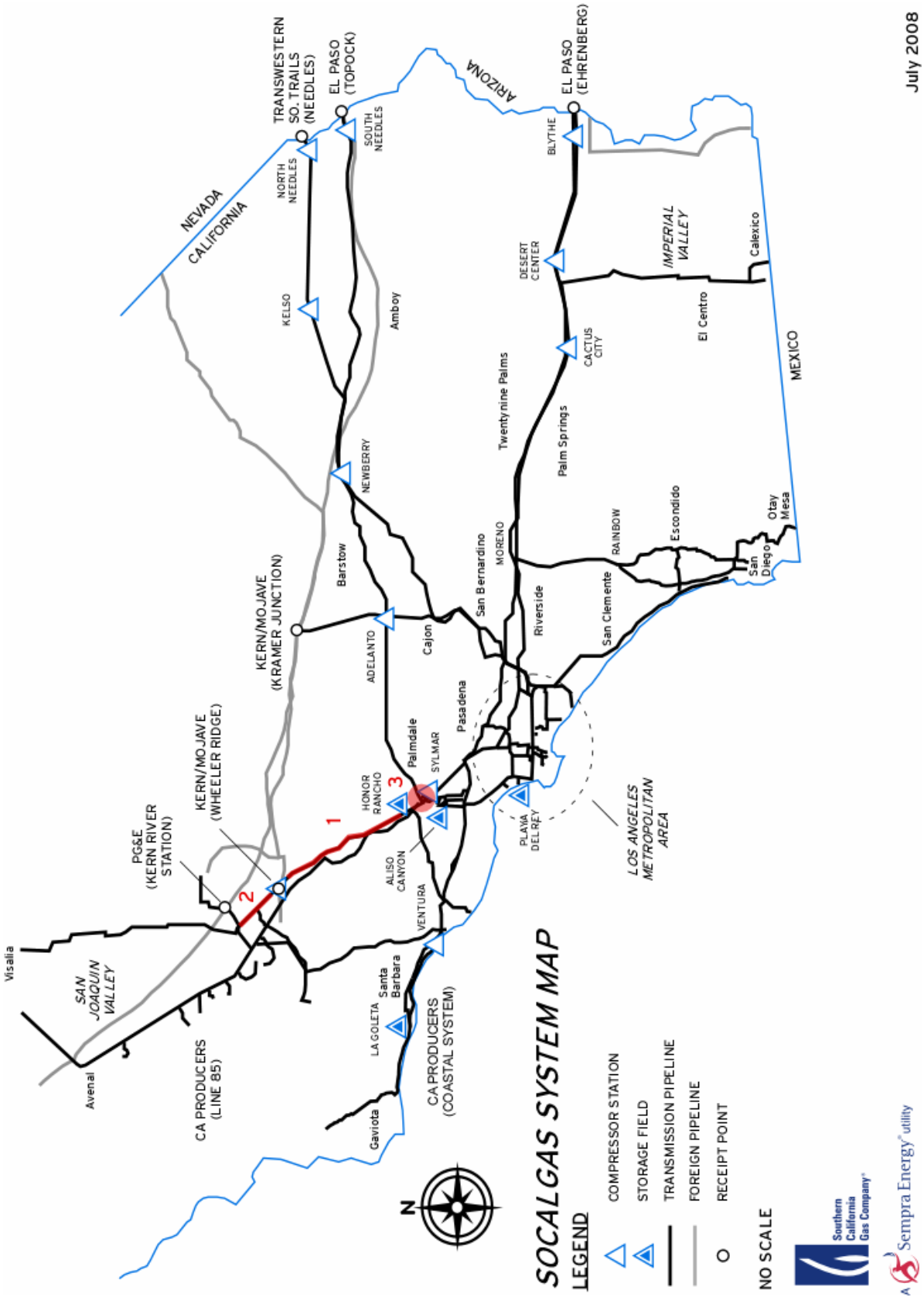


Figure OX-500



OEHI (Gosford) Receipt Point

		Cost	
		Unit	Total
Expansion of 200 MMcfd			
new 36" pipe - Wheeler to Gorman Post	25 mi	$3,080,000	$77,000,000
replace Quigley PLS			$3,000,000
			$80,000,000
Detailed Estimate			
Engineering / design			$4,800,000
Typical permitting			$2,000,000
Material			
compressors			
36" pipe	25 mi	$214	$36,729,540
Other			$1,000,000
subtotal			$37,729,540
Construction			
Compressor installation			
Pipe installation	25 mi		$33,470,460
Station work			$2,000,000
subtotal			$35,470,460
Total			$80,000,000
Expansion of 500 MMfcd			
new 36" pipe - Wheeler to Honor Ranch	52 mi	$3,057,692	$159,000,000
new 36" pipe - South Coles Levee to Wheeler	20 mi	$3,050,000	$61,000,000
replace Quigley PLS			$3,000,000
			$223,000,000
Detailed Estimate			
Engineering / design			$13,380,000
Typical permitting			$5,575,000
Material			
compressors			
36" pipe	72 mi	$214	$105,781,076
Other			$1,000,000
subtotal			$106,781,076
Construction			
Compressor installation			
Pipe installation	72 mi		$95,263,924
Station work			$2,000,000
subtotal			$97,263,924
Total			$223,000,000

FINAL REPORT

THE SOUTHERN CALIFORNIA GAS COMPANY EXPANSION SCENARIO REVIEW

WHEELER RIDGE SYSTEM

July 9, 2008

ADVANTICA

This report is written in fulfillment of an agreement between The Southern California Gas Company (SoCal) and Advantica, Inc. SoCal has contracted with Advantica to review supplied expansion scenario models. As stated in the Proposal, each scenario will be examined for the following:

1. Connectivity check limited to orphan pipes and unconnected sections
2. Unknown structure issues
3. Control and constraint issues (not including set point values)
4. Issues related to sonic flow, minimum pressures, and high velocities

If any other issues are subsequently found while searching for items above, they will be noted as well. This report will address findings regarding the "Wheeler Ridge" group of models. Along with corresponding results data, the following models were received: 1) 1810Base pd/xy; 2) 3160Base pd/xy; 3) KM965 pd/xy; 4) KM1265 pd/xy 5) OXY350 pd/xy; 6) OXY650 pd/xy; 7) PGE720 pd/xy; 8) PGE1020 pd/xy;

Connectivity check: A connectivity check, which entailed searching for orphan pipes and disconnected subsystems, was performed. For each of the models submitted, no disconnections were discovered. All systems modeled are tied together as one unit.

Unknown structure issues: No unknown structure messages were generated upon import of the models. A closer inspection of the nodes and facilities did not uncover any structure issues, either.

Control and constraint issues: No constraint or control error messages were generated upon import of the models.

Issues related to sonic flow, minimum pressures, and high velocities: All issues related to sonic flow, minimum pressures, and high velocities were valid.

Some additional warning messages were encountered after balancing in the steady-state, however the messages were benign. Furthermore, the messages are negated due to the fact that all models undergo "transient initialization" through Procedures and an initialization run period to align the model with known system conditions. All USM models are monitored during the course of the run and manually altered to address any warning conditions. All USM generated messages encountered were benign or addressed through manual intervention during the USM run.

Miscellaneous issues: It was discovered that several pipes are using the FD equation (Fundamental equation with constant friction factor). When used with a valid friction factor, this equation will yield reasonable results. However, the inherent weakness of this equation is the fixed friction factor. As flowing velocities change, so too will the friction factor. If the fixed friction factor differs significantly from the actual friction factor, then a source of error could be introduced. Although the FD equation can yield valid results, Advantica recommends using the FM equation (Fundamental equation with variable friction) for all pipes, due to its adaptability to all flows.

During import, the models generated the following sampling of errors:

Model 1810_Base only:

*** SAI468 - WARNING - MISSING SUPER KEYWORD FOR COMPRESSOR MCBS MCBD - DEFAULT PARAMETER USED.

*** SAI468 - WARNING - MISSING SUPER KEYWORD FOR COMPRESSOR MCLS MCLD - DEFAULT PARAMETER USED.

*** SAI468 - WARNING - MISSING SUPER KEYWORD FOR COMPRESSOR MHPS MHPD - DEFAULT PARAMETER USED.

*** SAI468 - WARNING - MISSING SUPER KEYWORD FOR COMPRESSOR MSOS MSOD - DEFAULT PARAMETER USED.

The messages above indicate that no supercompressibility equation was indicated for these compressors. SynerGEE used the default equation instead. The messages are generally not problematic but should be noted in case a different supercompressibility equation is desired.

Models 3160_Base, KM965, KM1265, OXY350, OXY650, PGE720, and PGE1020:

The Temperature for pipe EQ000529 was 60.0 degrees F instead of the 65.0 degree temperature used on all other pipes. Since this is only a 2 mile stretch of 8 inch pipe, the difference in calculated linepack should be relatively small but should be noted none the less. Also note that model 1810Base is missing this pipe and source node.

Wheeler Ridge Enhancements:

Model KM1265:

The Kern/Mojave Wheeler Ridge receipt point system enhancements include 25 mile and 52 mile 36” pipe loops. The internal diameters used in the models for the 52 mile loop are 36.0” pipes. Schedule 40 36” steel has an internal diameter of 35.25” so this difference will produce slightly more liberal linepack calculations.

Model OXY650:

Similar to the 52 mile loop as noted above, the 20 miles of 36-inch diameter pipeline from South Coles Levee to Wheeler Ridge is shown as a 36” internal diameter. Schedule 40 36” steel has an internal diameter of 35.25” so this difference will produce slightly more liberal linepack calculations.

Model PGE1020:

The 29 miles of 36-inch diameter pipeline from Kern River Station to Wheeler Ridge is also shown as a 36” internal diameter. Schedule 40 36” steel has an internal diameter of 35.25” so this difference will produce slightly more liberal linepack calculations.

Summary: After reviewing the Wheeler Ridge system models and the output data provided, no significant issues were discovered, only the minor items already mentioned above. All items observed in the models and output data appear reasonable.

Please contact me if you have questions or concerns regarding any of the items in this document.

Sincerely,

Advantica
Stoner Software

L85 Zone

Current capacity: 160 MMcfd

Expansion of 50 MMcfd (210 MMcfd receipt production): $ 25 million

1. Install a 1700 hp compressor to compress into line 225 from line 7053, $ 6 million
2. Replace Quigley Pressure Limiting Station, $ 3 million.
3. Install 5 miles of 36-inch diameter pipeline southward from Wheeler Ridge compressor station $ 16 million.

Refer to Figure L85-50 for the location of these facility improvements.

The additional production becomes a restriction on Line 800. The restriction causes pressure at Lemoore to rise above the maximum operating pressure (MAOP). Installing a 1700 hp compressor at North Coles to facilitate flow into line 225 resolves this restriction.

Simulations show that flows at the Quigley pressure limiting station exceed that of the current rated flow capacity. A rebuild of the Quigley Station with a higher flow rate capacity will allow the receipt of 815 MMcfd at Wheeler Ridge.

The existing SoCalGas 34-inch diameter pipeline downstream from Wheeler Ridge compressor station becomes a restriction beyond 765 MMcfd of receipts at the Wheeler Ridge zone. Installing 5 miles of 36-inch diameter pipeline southward from Wheeler Ridge compressor station resolves this restriction.

Expansion of 100 MMcfd (260 MMcfd receipt production): $ 203 million

1. Install a 3300 hp compressor to compress into line 225 from line 7053, $ 12 million
2. Install 19 miles of 36-inch diameter pipeline from North Coles to Elk Hills, $ 59 million.
3. Install 27 miles of 36-inch diameter pipeline from Avenal to Lemoore, $ 83 million.
4. Install 15 miles of 36-inch diameter pipeline southward from Wheeler Ridge compressor station $ 46 million.
5. Replace Quigley Pressure Limiting Station, $ 3 million

Refer to Figure L85-100 for the location of these facility improvements.

The additional production becomes a restriction on Line 85. The restriction causes pressure at Elk Hills to rise above the maximum operating pressure (MAOP). Installing a 3300 hp compressor at North Coles to facilitate flow into line 225 as well as 19 miles of 36-inch diameter pipeline from North Coles to Elk Hills resolves this restriction.

The additional production also becomes a restriction on line 800. The restriction causes pressure at Lemoore to rise above the MAOP. Installing 27 miles of 36-inch diameter pipeline from Avenal to Lemoore resolves this restriction.

The existing SoCalGas 34-inch diameter pipeline southward from Wheeler Ridge compressor station becomes a restriction beyond 765 MMcfd of receipts north of the Wheeler Ridge compressor. Installing 15 miles of 36-inch diameter pipeline southward from Wheeler Ridge compressor resolves this restriction.

Simulations also show that flows at the Quigley pressure limiting station exceed that of the current rated flow capacity. A rebuild of the Quigley Station with a higher flow rate capacity will allow the receipt of 865 MMcfd at Wheeler Ridge.

Figure L85-50

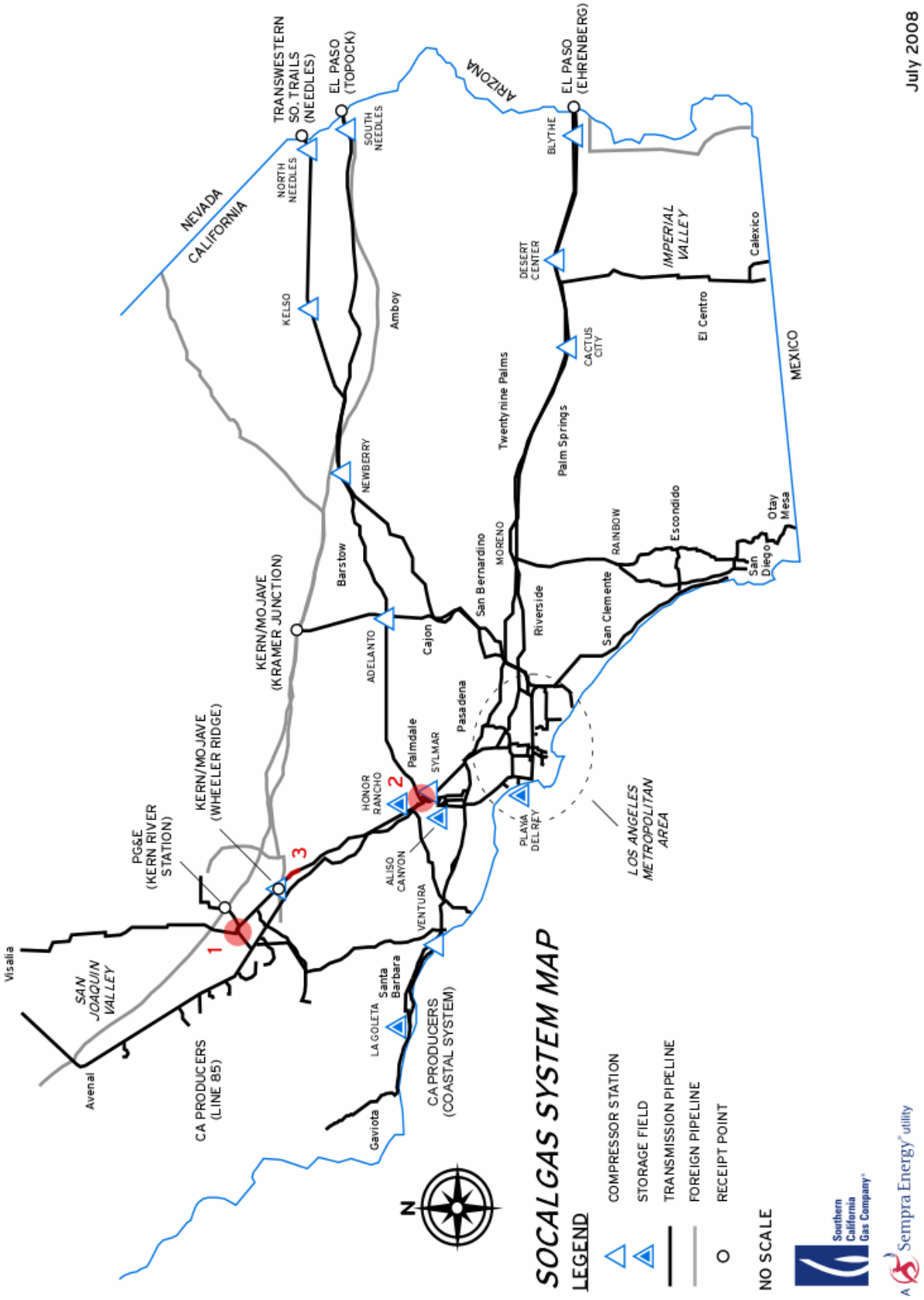
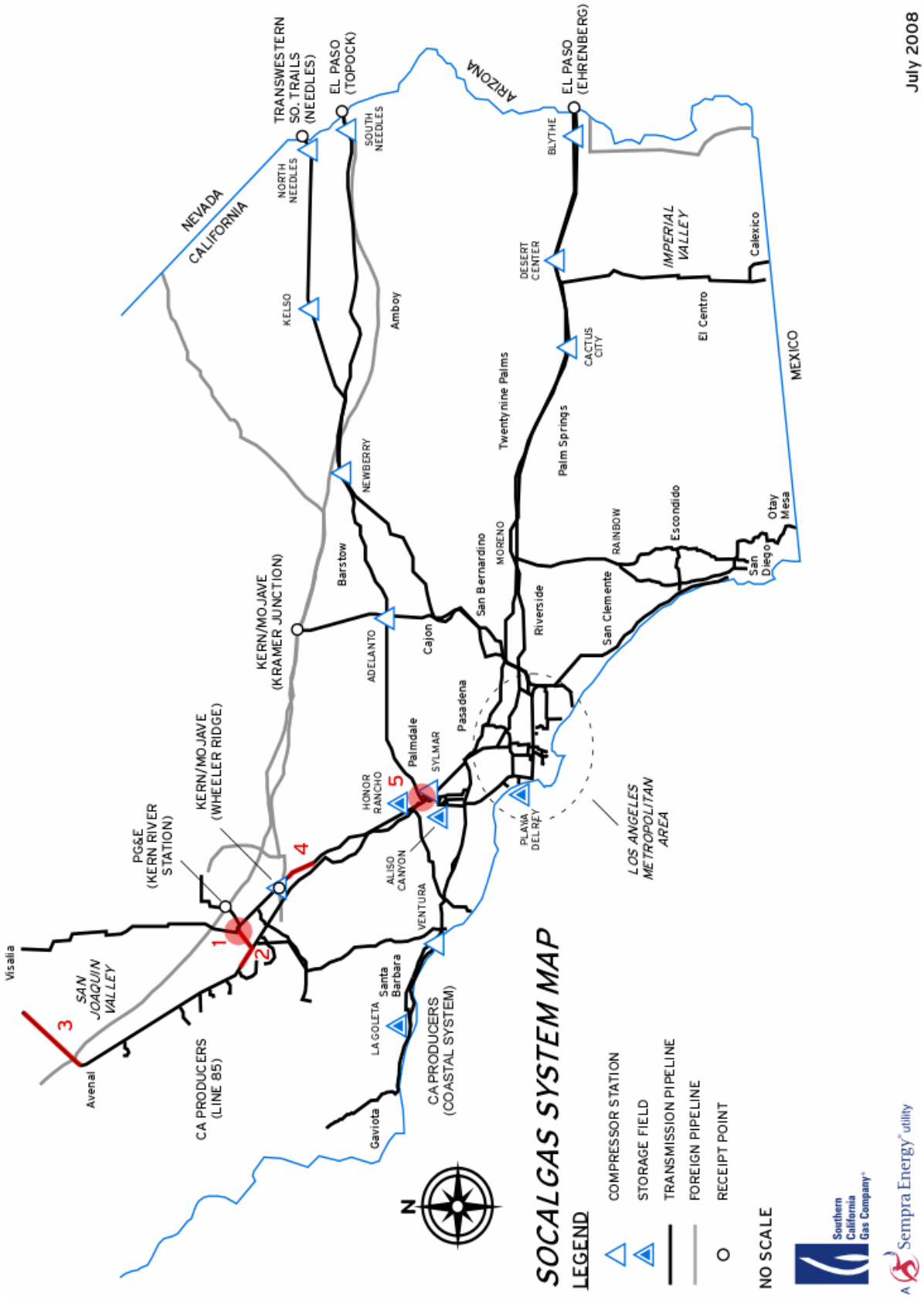


Figure L85-100



San Joaquin Valley Line 85 Receipt Point

		Cost	
		Unit	Total
Expansion of 50 MMcfd			
new 36" pipe - southward from Wheeler Ridge sta	5 mi	$3,200,000	$16,000,000
new compressor - Line 103 into Line 225	1,700 hp	$3,529	$6,000,000
replace Quigley PLS			$3,000,000
			$25,000,000
Detailed Estimate			
Engineering / design			$1,500,000
Typical permitting			$625,000
Material			
compressors	1,700 hp	$1,140	$1,938,000
36" pipe	5 mi	$214	$7,345,908
Other			$1,000,000
subtotal			$10,283,908
Construction			
Compressor installation	1,700 hp		$3,360,750
Pipe installation	5 mi		$7,230,342
Station work			$2,000,000
subtotal			$12,591,092
Total			$25,000,000
Expansion of 100 MMfcd			
new 36" pipe - North Coles to Elk Hills	19 mi	$3,105,263	$59,000,000
new 36" pipe - Avenal to Lemoore	27 mi	$3,074,074	$83,000,000
new compressor - Line 103 into Line 225	3,300 hp	$3,636	$12,000,000
new 36" pipe - southward from Wheeler Ridge sta	15 mi	$3,066,667	$46,000,000
replace Quigley PLS			$3,000,000
			$203,000,000
Detailed Estimate			
Engineering / design			$12,180,000
Typical permitting			$5,075,000
Material			
compressors	3,300 hp	$1,140	$3,762,000
36" pipe	61 mi	$214	$89,620,078
Other			$1,000,000
subtotal			$94,382,078
Construction			
Compressor installation	3,300 hp		$2,543,850
Pipe installation	61 mi		$86,819,072
Station work			$2,000,000
subtotal			$91,362,922
Total			$203,000,000

FINAL REPORT

THE SOUTHERN CALIFORNIA GAS COMPANY EXPANSION SCENARIO REVIEW

Line 85 SYSTEM

August 1, 2008

This report is written in fulfillment of an agreement between The Southern California Gas Company (SoCal) and Advantica, Inc. SoCal has contracted with Advantica to review supplied expansion scenario models. As stated in the Proposal, each scenario will be examined for the following:

1. Connectivity check limited to orphan pipes and unconnected sections
2. Unknown structure issues
3. Control and constraint issues (not including set point values)
4. Issues related to sonic flow, minimum pressures, and high velocities

If any other issues are subsequently found while searching for items above, they will be noted as well. This report will address findings regarding the "Line 85" group of models. Along with corresponding results data, the following models were received: 1) 3160Base pd/xy; 2) L85whlr815 pd/xy; 3) L85whlr865 pd/xy; 4) SJVbase08 pd/xy 5) SJVbase08and50 pd/xy; 6) SJVbase08and100 pd/xy;

Connectivity check: A connectivity check, which entailed searching for orphan pipes and disconnected subsystems, was performed. For each of the models submitted, no disconnections were discovered. All systems modeled are tied together as one unit.

Unknown structure issues: No unknown structure messages were generated upon import of the models. A closer inspection of the nodes and facilities did not uncover any structure issues, either.

Control and constraint issues: No constraint or control error messages were generated upon import of the models.

Issues related to sonic flow, minimum pressures, and high velocities: Some warning messages were encountered after balancing some of the models in the steady-state. However, the messages are negated due to the fact that all models undergo "transient initialization" through Procedures and an initialization run period to align the model with known system conditions. All USM models are monitored during the course of the run and manually altered to address any warning conditions. All USM generated messages encountered were benign or addressed through manual intervention during the USM run.

Miscellaneous issues:

1. It was discovered that several pipes are using the FD equation (Fundamental equation with constant friction factor). When used with a valid friction factor, this equation will yield reasonable results. However, the inherent weakness of this equation is the fixed friction factor. As flowing velocities change, so too will the friction factor. If the fixed friction factor differs significantly from the actual friction factor, then a source of error could be introduced. Although the FD equation can yield valid results, Advantica recommends using the FM equation (Fundamental equation with variable friction) for all pipes, due to its adaptability to all flows.

2. For the SJVbase08 model, an isolated region was found containing non-zero flows. This may be intentional but is being noted here for precaution. The following closed valves bound this isolated region and left a neglected flow of 1.679:

4702NCOL	WESTKERN	shut	4702NCOL	650.02	S	381.85	S
LAKEU	LAKED	shut	LAKEU	650.02	S	375.17	S
WHEELERD	1	shut	1	650.00		650.02	S
D1642	ID1642A	shut	ID1642	650.02	S	388.01	S
7000REG	V50406A	shut	7000REG	650.02	S	366.04	S

L85 Enhancements

A detailed inspection of the control setups revealed that the new 1700 HP and 3300 HP compressors were set up with DEFAULT as the Compressor Operation Switch (DCONTROL and SCONTROL are the other options). DEFAULT is not a recommended setting as it does not provide a clear indicator for which node is controlling. It introduces the possibility of error under certain Constraint Interchange conditions. For a compressor station that is on suction control such as this, Advantica recommends using SCONTROL instead.

Summary: After reviewing the L85 system models and the output data provided, no significant issues were discovered, only the minor items already mentioned above. All items observed in the models and output data appear reasonable.

Please contact me if you have questions or concerns regarding any of the items in this document.

Sincerely,

Advantica
Stoner Software

Coastal Zone

Current capacity: 150 MMcfd

Expansion of 50 MMcfd (200 MMcfd receipt capacity): $ 137 million

1. Install 35 miles of 16-inch diameter pipeline between La Goleta Storage Field and Ventura Compressor Station: $ 90 million
2. Install 15 miles of 20-inch diameter pipeline between Ventura Compressor Station and Center Rd Station: $ 47 million

Refer to Figure CO-50 for the location of these facility improvements.

16-inch diameter Line 1004, 22-inch diameter Line 1005, 18-inch diameter Line 404 and 22-inch Line 406 provide insufficient capacity to expand coastal production and to maintain full withdrawal at La Goleta Storage Field. This results in pressures exceeding MAOP on Line 247. Installing 50 miles of 16- and 20-inch pipeline parallel to Lines 1004, 1005, 404 and 406 avoids MAOP violations.

Expansion of 100 MMcfd (250 MMcfd receipt capacity): $ 294 million

1. Install 35 miles of 36-inch diameter pipeline between La Goleta Storage Field and Ventura Compressor Station: $ 206 million
2. Install 15 miles of 36-inch diameter pipeline between Ventura Compressor Station and Center Rd Station: $ 88 million

Refer to Figure CO-100 for the location of these facility improvements.

The 50 miles of additional 16- and 20-inch pipeline identified as necessary for increasing the receipt capacity of the Coastal System by 50 MMcfd is undersized for an expansion of 100 MMcfd, resulting in pressures exceeding MAOP on Line 247. Increasing the diameter of the additional pipeline to 36-inch resolves this restriction.

Figure CO-50

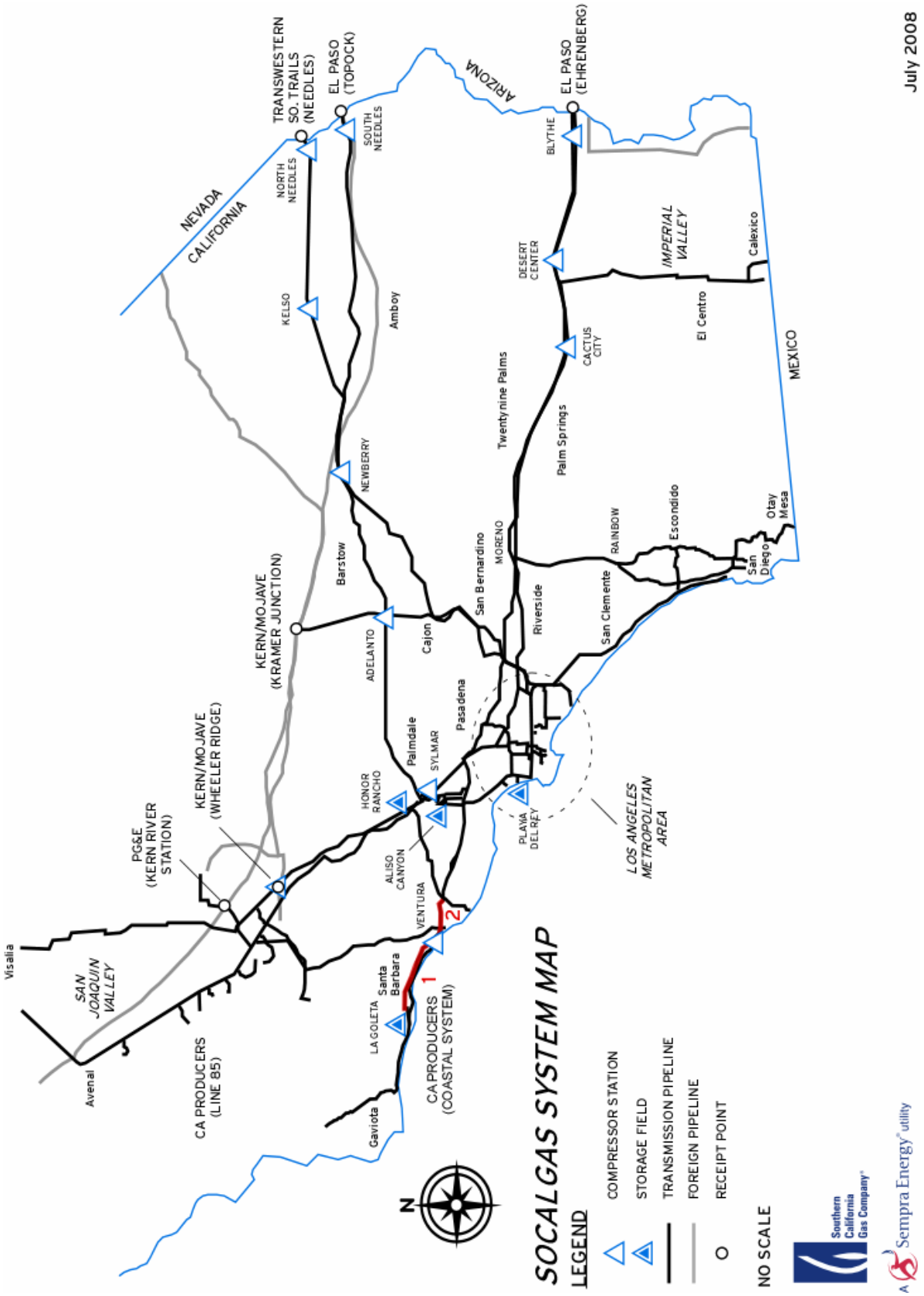
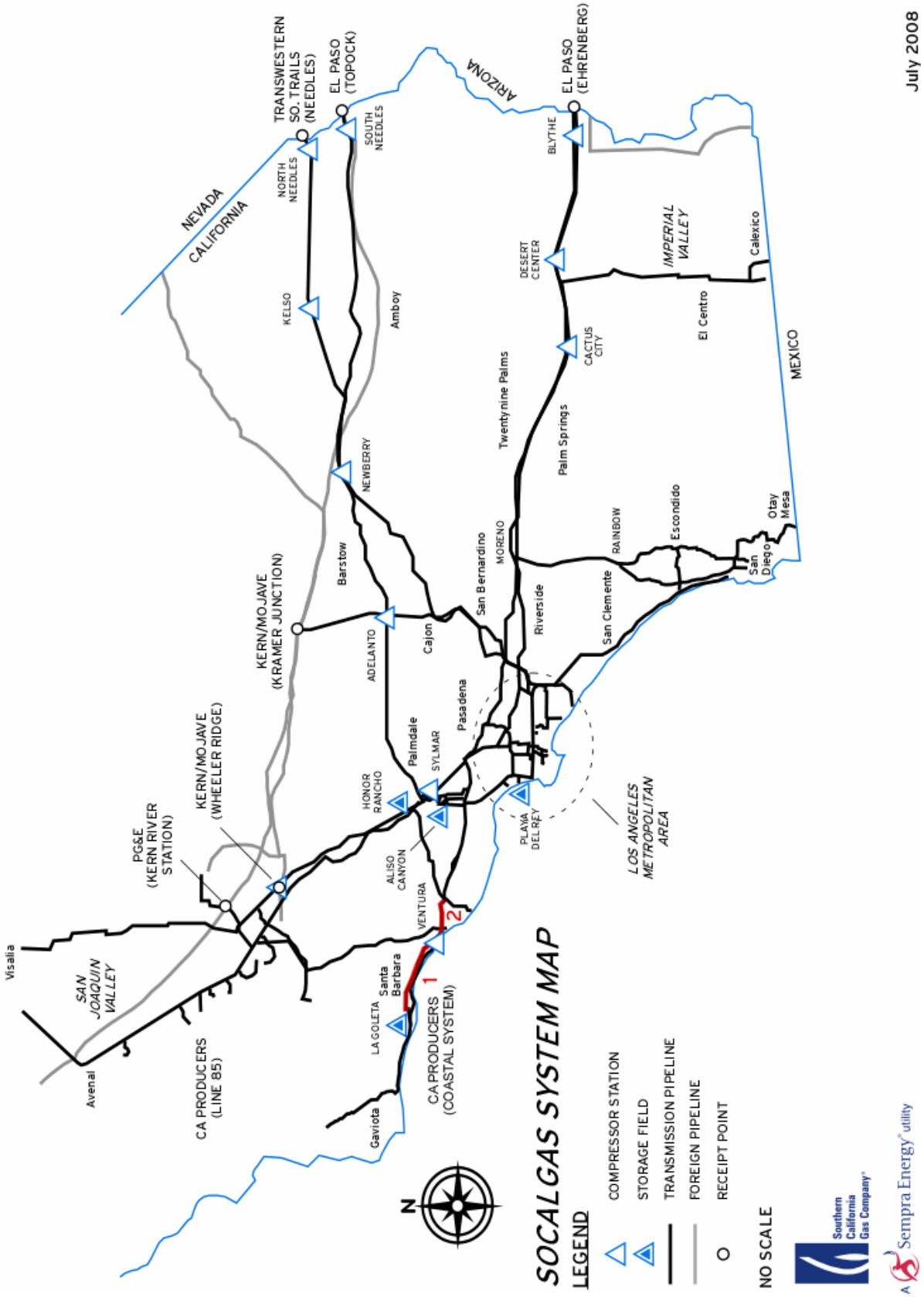

SOCALGAS SYSTEM MAP
July 2008
LEGEND
COMPRESSOR STATION
STORAGE FIELD
TRANSMISSION PIPELINE
FOREIGN PIPELINE
RECEIPT POINT
NO SCALE
N
NEVADA
CALIFORNIA
ARIZONA
MEXICO
TRANSWESTERN SO. TRAILS (NEEDLES)
EL PASO (TOPOCK)
EL PASO (EHRENBERG)
NORTH NEEDLES
SOUTH NEEDLES
BLYTHE
KELSO
Amboy
DESERT CENTER
IMPERIAL VALLEY
Calexico
El Centro
CACTUS CITY
Twentynine Palms
Palm Springs
NEWBERRY
Barstow
KERN/MOJAVE (KRAMER JUNCTION)
ADELANTO
Cajon
San Bernardino
MORENO
Riverside
RAINBOW
San Clemente
Escondido
San Diego
Otay Mesa
PG&E (KERN RIVER STATION)
KERN/MOJAVE (WHEELER RIDGE)
HONOR RANCHO
Palmdale
SYLMAR
Pasadena
PLAYA DEL REY
LOS ANGELES METROPOLITAN AREA
ALISO CANYON
VENTURA
Visalia
SAN JOAQUIN VALLEY
Avenal
CA PRODUCERS (LINE 85)
LA GOLETA
Santa Barbara
Gaviota
CA PRODUCERS (COASTAL SYSTEM)
1
2
Southern California Gas Company
A Sempra Energy utility

Figure CO-100



Coastal Zone Expansion

		Cost	
		Unit	Total
Expansion of 50 MMcfd			
new 16" pipe - Goleta to Ventura	35 mi	$2,571,429	$90,000,000
new 20" pipe - Ventura station to Center Rd stati	15 mi	$3,133,333	$47,000,000
			$137,000,000
Detailed Estimate			
Engineering / design			$8,220,000
Typical permitting			$3,425,000
Material			
compressors			
16" pipe	35 mi	$60	$14,336,861
20" pipe	15 mi	$94	$9,714,012
Other			
subtotal			$24,050,873
Construction			
Compressor installation			
Install pipe	50 mi		$101,304,127
Station work			
subtotal			$101,304,127
Total			$137,000,000
Expansion of 100 MMfcd			
new 36" pipe - Goleta to Ventura	35 mi	$5,885,714	$206,000,000
new 36" pipe - Ventura station to Center Rd stati	15 mi	$5,866,667	$88,000,000
			$294,000,000
Detailed Estimate			
Engineering / design			$17,640,000
Typical permitting			$7,350,000
Material			
compressors			
36" pipe	50 mi	$214	$73,459,081
Other			
subtotal			$73,459,081
Construction			
Compressor installation			
Pipe installation	50 mi		$195,550,919
Station work			
subtotal			$195,550,919
Total			$294,000,000

FINAL REPORT

THE SOUTHERN CALIFORNIA GAS COMPANY EXPANSION SCENARIO REVIEW

COASTAL ZONE SYSTEM

July15, 2008

This report is written in fulfillment of an agreement between The Southern California Gas Company (SoCal) and Advantica, Inc. SoCal has contracted with Advantica to review supplied expansion scenario models. As stated in the Proposal, each scenario will be examined for the following:

1. Connectivity check limited to orphan pipes and unconnected sections
2. Unknown structure issues
3. Control and constraint issues (not including set point values)
4. Issues related to sonic flow, minimum pressures, and high velocities

If any other issues are subsequently found while searching for items above, they will be noted as well. This report will address findings regarding the "Coastal Zone" group of models. Along with corresponding results data, the following models were received: 1) 50Exp_Nee_Coast_Zones_Gol_Prof pd/xy; 2) 50Exp_Southern_Coast_Zones_Gol_Prof pd/xy; 3) 50Exp_Whee_L85_CoastZones_Gol_Prof pd/xy; 4) 100Exp_Nee_Coast_Zones_Gol_Prof pd/xy 5) 100Exp_Southern_Coast_Zones_Gol_Prof pd/xy; 6) 100Exp_Whee_L85_CoastZones_Gol_Prof pd/xy; 7) Base_Coastal Expansion pd/xy; 8) 16&20in_50Exp_Whee_L85_CoastZones pd/xy

Connectivity check: A connectivity check, which entailed searching for orphan pipes and disconnected subsystems, was performed. For each of the models submitted, no disconnections were discovered. All systems modeled are tied together as one unit.

Unknown structure issues: No unknown structure messages were generated upon import of the models. A closer inspection of the nodes and facilities did not uncover any structure issues, either.

Control and constraint issues: No constraint or control error messages were generated upon import of the models. However, a detailed inspection of the control setups revealed that several compressors were set up with DEFAULT as the Compressor Operation Switch (DCONTROL and SCONTROL are the other options). DEFAULT is not a recommended setting as it does not provide a clear indicator for which node is the controlling. It introduces the possibility of error under certain Constraint Interchange conditions. For a compressor station that is on discharge control, Advantica recommends using DCONTROL instead. The following compressor stations are currently set on DEFAULT for all models:

From-node name	To-node name
MHPS	MHPD
MCBS	MCBD
MCLS	MCLD
MSOS	MSOD

Issues related to sonic flow, minimum pressures, and high velocities: Some additional warning messages were encountered after balancing in the steady-state, however the messages were benign. Furthermore, the messages are negated due to the fact that all models undergo "transient initialization" through Procedures and an initialization run period to align the model with known system conditions. All USM models are monitored during the course of the run and manually altered to address any warning conditions. All USM generated messages encountered were benign or addressed through manual intervention during the USM run.

Miscellaneous issues: It was discovered that several pipes are using the FD equation (Fundamental equation with constant friction factor). When used with a valid friction factor, this equation will yield reasonable results. However, the inherent weakness of this equation is the fixed friction factor. As flowing velocities change, so too will the friction factor. If the fixed friction factor differs significantly from the actual friction factor, then a source of error could be introduced. Although the FD equation can yield valid results, Advantica recommends using the FM equation (Fundamental equation with variable friction) for all pipes, due to its adaptability to all flows.

During import, the models generated the following sampling of errors:

*** SAI468 - WARNING - MISSING SUPER KEYWORD FOR COMPRESSOR MHPS MHPD - DEFAULT PARAMETER USED.

*** SAI468 - WARNING - MISSING SUPER KEYWORD FOR COMPRESSOR MCBS MCBD - DEFAULT PARAMETER USED.

*** SAI468 - WARNING - MISSING SUPER KEYWORD FOR COMPRESSOR MCLS MCLD - DEFAULT PARAMETER USED.

*** SAI468 - WARNING - MISSING SUPER KEYWORD FOR COMPRESSOR MSOS MSOD - DEFAULT PARAMETER USED.

The messages above indicate that no supercompressibility equation was indicated for these two compressors. SynerGEE used the default equation instead. The messages are generally not problematic but should be noted in case a different supercompressibility equation is desired.

Several pipes were found in all but the Base_Coastal model to have a temperature of 60 degrees Fahrenheit instead of the 65 degrees value used. This would result in a slight increase in calculated linepack for each of the 60 degree pipes.

The Coastal Zone enhancement documentation indicates a proposed enhancement of 15 miles 36-inch or 20-inch pipeline from Ventura to Center Road Station. The actual mileage for this enhancement in the model is 13.61 miles.

Summary: After reviewing the Coastal Zone system models and the output data provided, the most potentially significant item was the pipelength noted immediately above. All other items observed in the models and output data appear reasonable.

Please contact me if you have questions or concerns regarding any of the items in this document.

Sincerely,

Advantica
Stoner Software