MAGELLAN
MIDSTREAM PARTNERS, L.P.

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Via Certified Mail - Hardcopy Requested

February 14, 2012

Mr. R.M. Seeley, Director
Southwest Region, Pipeline Hazardous Materials and Safety Administration
8701 South Gessner, Suite 1110
Houston, TX 77074

Re: Longhorn Pipeline Reversal – LMP Changes

Dear Mr. Seeley,

As previously communicated, Magellan Midstream Partners is developing a project, which is currently under NEPA review, to reverse the Longhorn Pipeline from Crane to Houston, Texas to transport crude oil. As part of this Proposed Project, Magellan has evaluated the Longhorn Mitigation Plan (LMP) requirements and proposes the following changes to the LMP contingent upon approval of the Proposed Project:

1. Mitigation Appendix – Item 13. This item currently outlines a leak detection performance commitment for the hydrocarbon sensing leak detection cable that was installed and currently functional over the Edwards Aquifer Recharge Zone and the Slaughter Creek watershed in the Edwards Aquifer Contributing Zone. The current commitment does not contain a performance specification for crude oil. Magellan is proposing to add the performance commitment for crude oil as follows (red text):

Leak Detection Performance Commitment:

Longhorn is committed to implementing the best available leak detection systems with the following design specifications:

LOCATION	SYSTEM DESIGN SPECIFICATIONS
Tier I	• *1% of flow detected within one-half hour.*
Tier II	• *1% or more of flow detected within one-half hour.* • *0.5% - 1% of flow detected within one hour.*
Tier III	• *Same as Tier II, except Edwards Aquifer Recharge Zone.*
Edwards Aquifer Recharge Zone and Contributing Zone (Slaughter Creek watershed)	• *Same as Tier II, and sensor-based detection of 0.0030467 barrel/hour from contact for the following products:* • *Gasoline – 12 minutes* • *Diesel Fuel – 60 to 120 minutes* • *Jet Fuel – 50 to 70 minutes* • Crude Oil – 100 to 200 minutes

Magellan contracted with Tyco Thermal Controls to conduct tests of the sensitivity of the existing TT-5000 leak cable on two different types of crude oil currently anticipated to be transported on the Longhorn System. See Report # TT 1106-006 (Attachment #1). These tests confirmed the cable sensitivity as published by TraceTek. See Attachment #2. Additionally, Magellan contracted with Spartan Engineering Inc. to evaluate the existing systems capabilities in crude oil compared to other direct detection methods. Spartan determined that the existing leak detection cable is the best available technology for crude oil. The Spartan report is contained herein as Attachment #3.

2. Mitigation Appendix – Item 22. – This item was completed prior to original start-up in 2005 and required the installation or relocation of check valves to mitigate potential drain down volumes. Due to the elevation profile of the line, check valves would not effectively mitigate a leak when flowing in the reverse direction. Therefore, as part of the proposed project, Magellan is proposing to replace currently installed check valves specified by Mitigation Item 22 with remotely controlled valves (RCV). Both devices are considered Emergency Flow Restricting Devices (EFRD's) in accordance with 49 CFR 195.450. In some cases RCV's will be relocated for greater accessibility to power utilities and for maintenance and thus minimize the environmental impact of the change. Potential drain down volumes affected by these modifications will remain below maximum drain volumes as specified within Mitigation Appendix Item 22. All RCV's will be in place and functional prior to initiating crude flow from Crane to Houston.

River Basin	Approximate Current Station Location (Check Valve)	Approximate Proposed Station Location (RCV)	Location Description	Notes
Pedernales River (maximum drain down volume of 200,000 gallons)	10210+24	10210+24	Near Flat Creek	No change in location
	10263+24	10263+24	Ulrich Rd and Co Rd 301	No change in location
	10503+95	10503+95	Near the Pedernales River	No change in location
	10538+00	10538+00	West Side of Pedernales R.	No change in location
	10742+50	10742+50	Near Cottonwood Creek	No change in location
	10850+40	**10810+80**	**Near Hwy 281**	**Relocated**
	11192+24	11192+24	Near FM 1323 and Sandy School Rd	No change in location
	11310+24	**11267+52**	**Near White Oak**	**Relocated**
Colorado River between Austin and Bastrop (maximum drain down volume of 300,000 gallons)	**7110+58**	**7154+40**	**Near Colorado River**	**Relocated**
	7357+15	**7386+72**	**Near Bastrop, TX**	**Relocated**
	7877+23	**7824+96**	**Close to Jenkins Road**	**Relocated**
Llano River (maximum drain down volume of 250,000 gallons)	**14606+59**	**14612+40**	**Near the Llano River**	**Relocated**
	14834+24	14834+24	Hwy 377 near London, TX	No change in location
	15014+74	**14988+86**	**London, TX**	**Relocated**
San Saba River (maximum drain down volume of 350,000 gallons)	17143+24	17143+24	Co. RD 245	No change in location
	17886+00	**17946+72**	**Eldorado, TX**	**Relocated**
	18299+24	18299+24	Hwy 190 W. of Eldorado, TX	No change in location

See Attached Drain down Summary (Attachment #4) and Drain Down profiles (Attachment #5) illustrating changes to drain down associated with the new locations of some of the required EFRD's.

3. Section 2.1 – System Description – This language will replace section 2.1 and 2.2 in its entirety.

The pipeline system covered under the Longhorn Mitigation Plan is made up of two distinct systems. The first system transports refined products from Odessa to El Paso, Texas.

The refined product system with an initial capacity of 64,000 bpd is made up of the following segments:

- A 29 mile, 8" pipeline from Odessa, Texas to a station in Crane County (Crane Station).
- A 237 mile, 18" pipeline from Crane Station to El Paso Terminal. Pumping units could potentially be added at an existing site called Cottonwood Station to assist with expansion of capacity.
- Four, 9.4 mile, lateral pipelines connecting El Paso Terminal to El Paso Junction (also known as the El Paso Laterals).
    - i. El Paso to Kinder Morgan, 12"
    - ii. El Paso to Kinder Morgan, 8"
    - iii. El Paso to Chevron, 8"
    - iv. Kinder Morgan 8" Flush Line

The crude oil system with an initial capacity of 135,000 barrels per day is made up of the following segments:

- A 424 mile, 18" pipeline from Crane Station to Satsuma Station with the following intermediate pumping stations
    - o Kimble County – Kimble County, TX
    - o Cedar Valley – Hays County, TX
- A 32 mile, 20" pipeline from Satsuma Station to East Houston Terminal.
- A 9 mile, 20" pipeline from East Houston Terminal to 9th street junction.
- A 1 mile inactive and purged section of 20" pipeline from 9th street junction to Galena Park Terminal.

Based upon shipper demand, Magellan may increase capacity of the crude system to 225,000 bpd. To reach this capacity, Magellan may, in the future, build the following pump stations:

- Texon
- Barnhart
- Cartman
- James River
- Eckert (existing scraper trap site)
- Bastrop (existing site)
- Warda (existing scraper strap site)
- Industry
- Buckhorn
- Satsuma (existing scraper trap site)

Per Mitigation Commitment Item 39, this change to the LMP is submitted for PHMSA review and approval. The proposed change in the form of this letter is made available to the public by posting on the Magellan website. Copies of this letter are made available to the General Manager of the Lower Colorado River Authority (LCRA) and to the Mayors of Houston, Austin, and El Paso at the addresses shown below. If you have any questions or need additional information, please contact me at your convenience.

Sincerely,

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Cc:

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Attachment 1

Tyco Thermal Controls
Report # TT 1106-006

tyco
Thermal Controls

TraceTek

Magellan West Texas Crude Oil (Intermediate & Sour)
TT-5000 Response Time

Tyco Thermal Controls
307 Constitution Drive
Menlo Park, CA

Report # TT 1106-006

(7/21/2011)

Prepared by: ______________________
Neil Bednar

Approved by: ______________________
Ken McCoy

TEST: TT5000 Response Time to WTI and WTS

1. Applicable Standards

None

2. Test Description

The test measured response time of TraceTek TT5000 sensor cable to two different crude oil samples supplied by customer (WTI and WTS). Three segments of TT5000 were tested with each type of crude oil, six segments total. A Fluke Hydra, with attached computer was used to monitor the electrical resistance of each segment, so that the elapsed time to reach 10 kΩ (alarm threshold) could be measured.

The segments of sensor cable were inserted into clear plastic tubing and then gently depressed to form a low spot in the center of each test cable. 5 ml of crude oil was injected into the open end of each tube and allowed to form a pool in the low spot. Tests were conducted at ambient lab temperature which averaged 20.3 °C during the test period for samples #1 #2, #4, and #5. The ambient temperature was 21.2 °C during the test period for samples # 3 and # 6

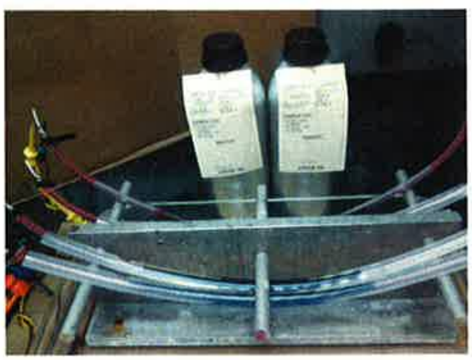

Fig. 1 TT5000 WTI and WTS detection time test setup.

Fig. 1 Crude oil pooling in specimen tubes.

The resistance between the two internal sensor electrodes in the center of the cable core is monitored to determine sensor cable response. The beginning resistance value is essentially an open circuit and remains a very high resistance until the cable jacket has absorbed sufficient oil to cause the cable to 'trip'. The detection time is indicated by a very precipitous drop in the resistance between the electrodes from greater than 50 MΩ to less than 10 kΩ.

We noted the start time at the moment when the cable was exposed to the crude oil and the ending time as the point where the resistance between electrode wires drops below 10k. Electrical resistance and time were measured by a Fluke Data Logger and computer.

3. Test Responsibility

Neil Bednar

4. Test Results

All samples reached alarm threshold of less than 10 kΩ in less than four hours. The WTI was detected in an average of 92 minutes and the WTS was detected in an average of 184 minutes at room temperature. As temperature rises, the detection time will decrease on the order of approximately one half the reaction time for every 10°C as a rule of thumb.

Specimen Number (#)	Type of Crude Oil	Time to Alarm (min)	Average Time to Alarm (min)
1	WTI	99	
2	WTI	94	92
3	WTI	83	
4	WTS	186	
5	WTS	189	184
6	WTS	177	

5. Equipment Used

Description	Manufacturer	Model	Software rev	Serial No.
Datalogger	Fluke	Hydra	NA	6095601

6. References

Neil Bednar's Lab book 1344-30

Attachment #2

Trace Tek Chemical Response

TraceTek Chemical Response

*NOTE: **This data is provided for general reference only and is not guaranteed.** Values are nominal response times at 20 deg C under laboratory test conditions. For critical applications, customers should confirm response times based on application specific installation parameters. Contact Tyco Thermal Controls for more information.*

Group	Chemical	TT3000	TT5000	TT5001	TT7000	Notes
Acid	Acetic Acid 25% / CH3CO-OH	Yes			Yes	
	Acetic acid 50%~99.4% / CH3COOH	Yes			Yes	
	Ferric Chloride / FeCl3	Yes				
	Hydrochloric acid 9.5~37% / HCl	Yes			Yes	
	Hydrofluoric acid 49% / HF	Yes				
	Nitric acid 15~65%	Yes			Yes	
	Sulfuric acid 25~98% / H2SO4	Yes			Yes	
Alcohol	Ethanol (95% in H2O) / CH3-CH2-OH	Yes		60 min		
	Ethanol 100% / CH3-CH2-OH			60 min		*aka Ethyl Alcohol; fit for human consumption, not likely to be considered an environmental hazard*
	isopropanol	Yes		90 min		
	Isopropyl Alcohol (IPA) / (CH3)2 CHOH			90 min		
	Methanol (100%) / CH4O			45 min		*a.k.a. wood spirit, wood alcohol, methyl alcohol*
	Methanol (up to 95% in H2O)	Yes				*Up to 150 mm of TT3000 must be wetted for detection at 95% concentration. Sensitivity increases (less cable must be wet) for lower concentrations.*
Caustic	Sodium hydroxide (concentrated) / NaOH	Yes				*Also known as Caustic Soda*
	Sodium Hypochlorite / NaOCl	Yes				
Fuel	Diesel #1		60 min			
	Diesel #2		120 min			
	Fuel oil #6		*			** no response @ 20 C, 41~64 hrs @ 40 C, 9~11 hrs @ 60 C*
	gasoline		9~20 min*	48 min		** depends on grade and type of gasoline*
	gasoline vapor		3 days	5 days		
	Jet A		50 min	4~11 hrs		
	Jet B		Yes	Yes		
	JP-10		40 min			
	JP-4		15 min	<5 hrs		
	JP-5		70 min	<4 hrs		
	JP-7		25 min	10 hrs		

TraceTek Chemical Response

*NOTE: **This data is provided for general reference only and is not guaranteed.** Values are nominal response times at 20 deg C under laboratory test conditions. For critical applications, customers should confirm response times based on application specific installation parameters. Contact Tyco Thermal Controls for more information.*

Group	Chemical	TT3000	TT5000	TT5001	TT7000	Notes
Fuel	kerosene		47 min			
	Light Sweet Crude		3 hrs			
Hydraulic fluid	Automotive transmission fluid		4~8 hrs			*Dextron II brand ~8.3 hrs Ford brand 4.1 hrs Response time may vary considerably by brand and type.*
	brake fluid (DOT 3)			~30 hrs*		
	hydraulic oil		3~8 days*			** depends on type*
Lubricant	SAE 20 motor oil		<1 day			
	SAE 30 motor oil		2 days			
Other	Aliphatic hydrocarbon (generic)		Varies			*Fuels and oils are typically aliphatic (long chain) HC's, with some aromatics blended in. Length of chain translates into viscosity (longer = heavier) and hence into longer response times.*
	Ammonium Hydroxide / NH4OH	Yes				*must be in solution; will not detect dry form*
	anisole	Yes	1.7 hrs	33 min		
	carbon disulfide			3 min		
	chloroform		12 min	10 min		
	dimethylformamide	Yes		2 hrs		
	Dowtherm A		10 hrs	90 min		*Dowtherm A = diphenyl oxide / biphenyl blend Dowtherm J = alkylated aromatic*
	ethyle acetate			20 min		
	ethylene glycol	Yes				
	Formaldehyde					*See Formalin. Formaldehyde is a gas at room temperature. (Boiling Point -21C) When it is dissolved in water (remember the frogs in your biology class) it is called formalin. Usually the commercial concentration is 40% in H2O.*
	Formalin	Yes				*This is the typical liquid form of Formaldehyde (dissolved in H2O, typically 40% solution).*
	Freon TF		22 min	42 min		
	gum turpentine		10 min	20 min		
	heptane		10 min	60 min		
	Hydrogen Peroxide / H2O2	Yes				
	mineral spirits		20 min			
	Mobiltherm 603		<9 hrs	<4 hrs		
	Naptha		15 min			
	PCB		<9 hrs			

TraceTek Chemical Response

*NOTE: **This data is provided for general reference only and is not guaranteed.** Values are nominal response times at 20 deg C under laboratory test conditions. For critical applications, customers should confirm response times based on application specific installation parameters. Contact Tyco Thermal Controls for more information.*

Group	Chemical	TT3000	TT5000	TT5001	TT7000	Notes
Other	Prestone antifreeze	Yes				
	Shell Diala X transformer oil		13 hrs			*Transformer oils vary considerably.*
	styrene monomer		20 min	8 min		
	tetrahydrothiophene		25 min	27 min		
Solvent	50/50 methylene chloride /methanol			< 10 min		*Blend of methylene chloride and methanol*
	acetone			10 min		
	Acetone (30% in H2O)	Yes				
	Acetone (50% in H2O)	Yes		80 min		
	butyl acetate			20 min		
	carbon tetrachloride		20 min	20 min		
	chlorobenzene		21 min	10 min		
	cyclohexane			32 min		
	dichloromethane		13 min	5 min		
	Ethyl benzene		Yes			
	Methyl Ethyle Ketone (MEK)			10 min		*Avoid exposure to TT1000 or TT3000*
	Methylene Chloride			~5 min		
	N-methyl pyrrolodone			60 min		*Will damage TT3000 / TT1000 (dissolves kynar)*
	toluene		18 min	10 min		
	trichloroethane			20 min		
	trichloroethylene			8 min		
	xylene		20 min	35 min		

Attachment #3

Pipeline Leak Detection Systems Direct Detection

Spartan Engineering, Inc.

Pipeline Leak Detection Systems – Direct Detection

Prepared for:

MAGELLAN MIDSTREAM PARTNERS, L.P.

October 18, 2011
(R3)

By:

SPARTAN
ENGINEERING INC.

<u>CONTENTS</u>

1.0 Overview

Magellan is interested in currently available technology for early detection of pipeline leaks that can be employed on the section of the Longhorn pipeline traversing the Edwards Aquifer. Additionally, because the Longhorn Reversal project will introduce crude oil to the line, there is interest in the capability of these systems to adequately detect crude oil.

This report focuses on the direct sensing style of pipeline leak detection systems that are most capable of detecting small leaks. The direct methods include liquid sensing cables, fiber optic cables, vapor sensing tubing, and ultrasonic sensing. Information on these direct sensing methods (and companies that can provide them) has been compiled from an extensive search and is included in appendices of this report.

2.0 Executive Summary

Each of the four direct pipeline leak detection technologies investigated will detect crude oil. Direct detection methods are best at detecting leaks that are less than about 0.5% of the pipeline flow rate, while computational methods are best at detecting leaks that are greater than about 0.5% of the pipeline flow. Therefore, to cover all circumstances, it is recommended Magellan maintain both types of systems. For the direct sensing method, it is recommended to retain the existing Tyco TraceTek TT5000 system. It has the advantage of already being in place, it has the ability to detect leaks as small as 0.01 GPH, it can locate leaks accurately, and it has proven to be reliable.

The liquid sensing cable systems are the most sensitive for detecting small leaks with a 2-3 hour response time. The existing Tyco TraceTek TT5000 is extremely robust and reliable and capable of detecting leaks as low as 0.01 GPH and is not impacted as much because of soil porosity, soil temperature and low vapor pressure as the other systems reviewed. See Section 3.2 under Tyco TraceTek TT5000 for a detailed discussion.

Vapor sensing systems are not as sensitive to small leaks or to leaking materials with very low vapor pressures, such as heavy oils. Additionally, response time is more dependent on soil porosity and soil temperature than the liquid sensing systems. The minimum detectable leak size is 0.04 GPH, in high-sensitivity mode. See Section 3.4 under Nitor Technologies for a detailed discussion.

Fiber-optic cable systems and acoustic sensing systems are very poor at detecting small leaks. These units rely on either a change in temperature or an acoustic footprint to detect leaks. These systems are very reliable when detecting leaks of highly volatile liquids but they are not suitable for crude oil since the leak does not develop a sufficient differential temperature (essentially ground temperature) nor does it develop enough acoustic energy to allow the system to reliably detect a small leak. Additionally, the reliability decreases as the vapor pressure of the material to be detected approaches zero. See Section 3.4 Fiber Optic Leak Detection and Section 3.5 Ultrasonic/Acoustical Leak Detection for a brief discussion.

3.0 Types of Leak Detection Systems

3.1 General

The available pipeline leak detection systems (LDS) fall, generally, into two broad classes; 1) Direct detection, and 2) Computational/Statistical. Computational/Statistical will not be discussed because this topic is beyond the scope of this report.

API Publication 1149 outlines methods for calculating the size of a leak in terms of the total pipeline flow rate. This leak rate is often described as a percent of the total pipeline flow with the total flow given to estimate the leak size.

The direct detection methods are associated with efforts to detect leaks with sensing systems that can locate the leak within a few meters of its origin. These include: 1) Liquid Sensing leak detection, 2) Vapor sensing leak detection, 3) Fiber-optic leak detection, and (4) Ultrasonic/Acoustical leak detection.

Direct leak detection depends upon a sensing system in the area around the location that has been deemed to be most sensitive to the effects of a pipeline leak. These detection techniques depend upon a change in some physical property associated with the pipeline, the pipeline surroundings, or changes to a sensor based on some characteristic of the leaking fluid. These can be summarized as: 1) the conductivity (or electrical resistance) of the cable; 2) localized temperature changes; 3) some characteristic physical effect that is always associated with a leak, such as the presence of vapor, or the sound associated with a leak.

3.2 Liquid Sensing Leak Detection

Liquid sensing cables are buried beneath or adjacent to a pipeline and are specifically designed to detect changes in transmitted energy pulses as a result of impedance differentials induced by contact with hydrocarbon liquids. Safe energy pulses are continuously sent by a microprocessor through the cable. The pulses are reflected and returned to the micro-processor. Based on the specific installation of the cable, a baseline reflection map is stored in the memory of the microprocessor. When a leak occurs, a portion of the cable is saturated with fluid. The fluid alters the impedance of the sensing cable, which in turn alters the reflection pattern returning to the microprocessor. The change in signal pattern causes the microprocessor to register a leak alarm that also locates the position of the altered impedance. Controller interface software is available to provide real-time information on leak detection and record keeping. Cable types are chosen for each application based on the specific type of fluid being monitored.

The cable detects a leak independently of the leak rate and thus is a good choice for small leaks, which are more difficult to detect than large leaks. The sensor cable responds directly to the presence of the liquid and not to the rate at which it arrived. Additionally, the leak detection cable can report the spill location to an accuracy of a few feet.

Liquid sensing leak detection is typically marketed as a self-contained leak detection and location system, including all hardware and software. Advantages include relatively high accuracy in determining leak location, no modifications to existing pipeline, and simple software configuration and maintenance.

A system that detects oil leaks based on a change in electrical resistance is the Tyco TraceTek TT5000. The Tyco system can locate leaks to within a few feet of their source. An analysis of the Tyco TraceTek TT5000 leak detection cable currently used on the Longhorn Pipeline System is provided to determine its applicability to a crude oil pipeline.

Tyco TraceTek TT5000 Leak Detection Cable

The Tyco TraceTek TT5000 leak detection cable currently in use on the Longhorn Pipeline System is usable for detecting crude oil leaks, as demonstrated by Tyco (see Table below). The minimum detectable leak size is 0.01 GPH. The TraceTek cable system is apparently the only electrical conductivity cable available. It should be noted that after a leak is detected by the cable, the portion of the cable that was exposed to the leak must be replaced.

Tyco Thermal Controls has performed testing on three different oils, West Texas Intermediate (WTI), West Texas Sour (WTS) and ARCO North Slope Oil. The results of these tests are summarized in the table below.

Oil Type	TT5000 Response Time	
	Temperature 68°F	Temperature 104°F
WTI	92 to 93 minutes	15-20 to 22 min
WTS	184 to 190 minutes	42 to 45 min
ARCO North Slope	180 minutes	42 minutes

The results indicate that the TT5000 will respond to the presence of a WTS oil leak within about 3-hours after the sensor cable has been in contact with the oil. In other words, for very small leaks the TT5000 will always set off an alarm.

3.3 Vapor Sensing Leak Detection

The Leak Alarm System for Pollutants (LASP) consists of a vapor sensing tube installed along the entire length of the pipeline. This tube is impervious to water but allows petroleum vapors to pass and accumulate. A vacuum pump periodically draws the air from the tube and passes the air stream through a sensor which detects the presence of petroleum vapors. Detectable substances include a wide range of gases, hydrocarbon liquids and vapors, halogenated hydrocarbons, landfill gases, water vapor, and many others. This vapor sensing system has the potential to detect leaks of all sizes; however, very small leaks can take 30 hours or more to detect.

The detection tube is manufactured in the form of a cable and is highly permeable to the substances to be detected in the particular application. If a leak occurs, the substances to be measured come into contact with the tube in the form of vapor, or gas dissolved in water. In the event of a leak, some of the leaking substance diffuses into the tube. After a period of time has passed, enough vapor will accumulate inside the tube so that when the air in the tube is pulled past the detector there will be enough vapor to produce an accurate identification of the substances surrounding the tube. The detector unit at the end of the sensor tube is equipped with gas sensors so that an increase in gas concentration results in a pronounced "leakage peak," which is proportional to the concentration of the vapor from the leaking medium at the sensor tube surface.

A disadvantage of the LASP technology is that the time required to draw a vapor slug to the detector will vary substantially because of diurnal and seasonal changes causing decreased leak location accuracy.

Nitor Technologies, Inc. PROWLER LDS

Nitor Technologies, Inc. carries the PROWLER system and has upgraded the LASP system technology. The published minimum detectable leak size is 0.04 GPH. However, this leak rate is not referenced with a statement about the volatility and temperature of the leaking substance was not specified in the literature.

Vapors emitted by the leaking crude oil diffuse into the PROWLER tubing and reach a steady state or equilibrium concentration. The PROWLER pump is then activated to move the vapors in the tubing to the detector, where measurements are made. Depending on soil porosity and oil vapor pressure, several hours may be required for gases and vapors to migrate from the leak site to the PROWLER tubing. To see a change from the baseline condition, a minimum of two runs is needed, each taking as long as 15 minutes.

The PROWLER can locate the position of the leak to within 1% of the length of the pipeline. For a twenty mile long section of pipeline, the accuracy would be less than 1100 feet. Using secondary test points, the location of the leak can be determined to within 50 feet. More precise leak location requires that a spike of tracer gas, such as Hydrogen or Ethane, be injected at the front end near the inlet-air dryer unit.

For sizeable leaks, the density of the crude oil has little impact on response time. However, at very low leak rates the crude oil and the vapors emitted by the crude oil require more time to move through soil. Very small leaks of a heavy crude oil, as well as the vapors emitted by that oil, will move through the soil much slower than the rates observed for lighter refined products and their vapors to move through the soil.

The reliability of vapor sensing systems is lower than the liquid sensing cable systems. The system is prone to set point drift and requires chromatographs that can lose sensitivity unless properly calibrated and maintained.

A second sensor tube can be installed that continuously draws a vacuum. This option allows for a more rapid detection of large leaks (greater than 0.5% to 1.00% of flow) while still enabling the detection of small leaks by the periodic removal of the tubing air from the other tube. Operating with two tubes in this manner is recommended by the manufacturer.

3.4 Fiber Optic Leak Detection

The fiber-optic sensing leak detection method involves the installation of a fiber-optic cable along the entire length of the pipeline. The substances to be measured come into contact with the cable when a leak occurs, changing the temperature of the cable. The distributed fiber-optical temperature-sensing technique offers the possibility to measure temperature along the pipeline. Scanning the entire length of the fiber, the temperature profile along the fiber is determined, leading to leak detection.

Optical fiber sensor cables have been demonstrated to be useful for the measurement of a wide variety of physical and chemical parameters because they have: 1) an immunity to electromagnetic interference, 2) avoidance of ground loops, 3) capability of responding to a wide variety of measured quantities, 4) avoidance of electric sparks, 5) resistance to harsh environments, 6) remote operation, 7) capability of multiplexing, and 8) ease of integration into large-scale fiber networking and communication systems. The reliability of the optical fiber cables is questionable for long-term use because of their fragility and the possibility of false positive signals caused by the presence of groundwater. For small crude oil leaks under low pressure, the leaking substance will have adequate time to thermally equilibrate with the material that surrounds the pipeline and the thermal sensor. Since the liquids and sensor will be at the same temperature there will be little or no differential temperature for the fiber-optic sensor to determine. This makes the fiber-optic LDS less desirable for crude oil applications. In fact, no reference has been found where fiber optic cable has been used in the determination and location of crude oil leaks from pipelines.

Two of the companies that supply fiber-optic based LDS's are Sensornet and Westminster, Intl.

The Sensornet Fiber-Optic Based LDS

The Sensornet fiber-optic cable system allows the inference of a leak by detecting the change in temperature of the fiber-optic cable when it becomes exposed to the leaking fluid or a change in temperature of the space around the cable caused by the nearby presence of the leaking fluid. To date, the use of Sensornet's leak detection system has been for the detection of leaks on and around highly pressurized natural gas liquid products such as ethane, ethylene, propane, Y-grade products, and ammonia.

Westminster, International Fiber-Optic Based LDS

Westminster International appears to be in the private sector security business. They propose that their fiber-optic cable systems be used to detect temperature changes caused by NGL's leaking from pipelines and storage tanks.

3.5 Ultrasonic/Acoustical Leak Detection

Leak detection in pipelines using acoustic emission technology is based on the principle that an escaping liquid creates an acoustic signal as it passes through a perforation in the pipe. When a leak occurs, the resulting low frequency acoustic signal is detected and analyzed by system processors. Deviations from the baseline acoustic profile would signal an alarm. The received signal is stronger near the leak site, thus enabling leak location.

Asel-Tech

Asel-Tech has developed an acoustic/mass-balance/computational LDS that holds the possibility of improving the computational technology. Response time can be as short as a minute for leaks that are large enough to be acoustically detectable; however, the system's ability to detect small leaks is greatly reduced in low vapor pressure liquids that cannot generate sufficient acoustic energy to be detected over background noise.

3.6 Comparison

The following table summarizes the properties of the various direct leak detection systems:

Leak Detection System	Response Time	Detectable Leak Size
Tyco TraceTek TT5000 Leak Detection Cable	The detection response time is not dependent upon the leak rate. It is dependent upon the soil porosity and the substance temperature. From the data supplied by Tyco for Magellan: the response time for the WTS heavy crude is about 45 minutes at 104°F and 190 minutes at 68°F; and for WTI light crude about 22 minutes at 68°F and 93 minutes at 68°F. As a comparison, response times for data done by Tyco for Arco on their North Slope crude: 42 minutes at 104°F and 180 minutes at 68°F. Leak location is typically within "a few meters" of the leak.	Leak rates lower than 0.01 GPH are detectable over a long period of time. The cable is responsive to both small and large leaks. Response is not dependent on the leak rate. The TT5000 is immune to the presence of water.
Nitor Vapor Sensing System – High Speed Mode	The detection response time is dependent upon the leak rate, the soil porosity, and the oil volatility. In the high speed mode the system can detect leaks of 600 to 1300 GPH within a few hours. Large leaks, 12600 GPH or larger, can be detected in less than 30 minutes. Additional response time factors include calibration frequency and the type and sensitivity of the chromatograph. The maximum detectable leak has no upper limit. The system is immune to the presence of water.	
Nitor Vapor Sensing System – High Sensitivity Mode	As with the high speed mode, the detection response time is dependent upon the leak rate, the soil porosity, calibration frequency, and the oil volatility. In the high sensitivity mode detection time for the PROWLER is determined by the system's setup parameters but is often given as 12 hours. While the published minimum detectible leak rate is about 0.04 GPH the response time for this small leak rate may be as long or longer than 30 days. The system is immune to the presence of water.	
Fiber Optic Leak Detection – Sensornet and West-minster	The leak detection time for a fiber optic system depends upon the time required for the leak to cause a temperature change in the cable. Response times are very fast for high volatility fluids like ethane, but for small low pressure crude oil leaks there may not be a response.	Fiber optic LDS is responsive to both small and large leaks. Response time is dependent on the vapor pressure of the leaking material and on the leak rate.

Leak Detection System	Response Time	Detectable Leak Size
Hybrid Computa-tional LDS - Asel-Tech	Asel-Tech has developed an acoustic/mass-balance/computational LDS that holds the possibility of improving the computational technology. Response time can be as short as a minute for leaks that are large enough to be acoustically detectable.	Leaks less than about 0.1% of total flow may not be detected. Leaks that are greater than 0.5% to 1% of total flow can be detected.

4.0 Conclusions and Recommendations

Each of the four direct pipeline leak detection technologies investigated will detect crude oil. For small leaks that are less than about 0.1% to 0.5% of the total pipeline flow rate, the TraceTek TT5000 is the most sensitive to crude oil. The Prowler vapor sensing system can also detect oil but its response time will be slower than the TT5000 because the loss of sensitivity associated with low vapor pressure crude oil. For leaks that are greater than 0.5% to 1% of the total pipeline flow rate, the fiber-optic cable and acoustic detection systems provide the fastest response time, giving indication of a leak in less than a minute after being contacted by the leaking substance. However, the Sensornet and Westminster fiber-optic systems may be less sensitive to crude oil than the other three leak detection systems because there will be little if any temperature change associated with a leak from a low pressure crude oil pipeline. Acoustic leak detection systems are also hampered by crude oil at low pressures because small leaks will not generate enough acoustic energy to be detected over the background noise.

Because direct detection methods are best at detecting leaks that are less than 0.5% of the pipeline flow rate, and while computational methods are best at detecting leaks that are greater than about 0.5% of the pipeline flow, it is recommended that Magellan maintain both types of systems. For the direct sensing method, it is recommended to retain the existing Tyco Trace-Tech system. It has the advantages of already being in place, it can pinpoint the leak accurately, and has been proven to be reliable. The Nitor system is not recommended for detecting small leaks because the response time due to the low volatility crude oil is too great to detect them in a timely manner. The Sensornet, Westminster, and Asel-Tech systems are not recommended for use in detecting small leaks from low pressure crude oil applications for the reasons noted in section 3.4, above.

5.0 Appendix

5.1 Corporate Contact Information

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alan.sanderson@tendeka.com
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Attachment #4

Drain Down Summary

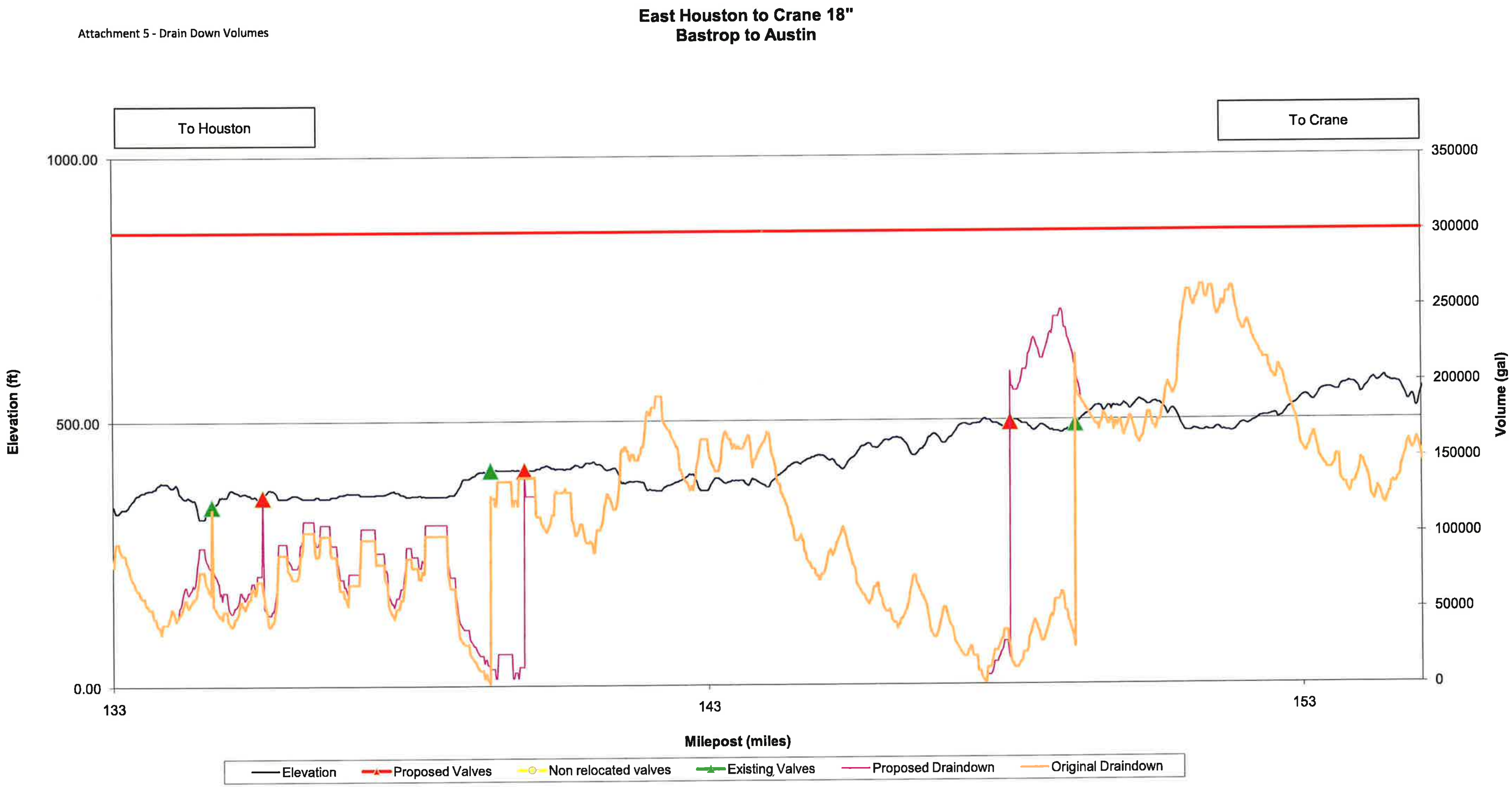
	Location	Existing MP	Proposed MP	Existing Station	Proposed Station
Colorado Basin	Valve 1	134.67	135.51	7110+58	7154+93
	Valve 2	139.34	139.91	7357+15	7387+25
	Valve 3	149.19	148.08	7877+23	7818+62
Pedernales Basin	Valve 4	205.49	204.75	10849+87	10810+80
	Valve 5	214.21	213.41	11310+29	11268+05
Llano Basin	Valve 6	276.64	276.82	14606+59	14616+10
	Valve 7	284.37	283.86	15014+74	14987+81
San Saba Basin	Valve 8	338.75	339.91	17886+00	17947+25

		Existing Max drain down (gal)	Proposed Max Drain down (gal)	Settlement Max Drain down (gal)
Colorado	Between Bastrop and Valve 1	99,253	99,253	300,000
	Between Valve 1 and Valve 2	116,622	120,344	300,000
	Between Valve 2 and Valve 3	191,061	191,061	300,000
	Between Valve 3 and Austin	263,689	263,689	300,000
Pedernales				
	Between MP 203.44 and Valve 4	80,634	43,423	200,000
	Between Valve 4 and MP 211.97	84,365	131,510	200,000
	Between MP 211.97 and Valve 5	55,830	37,220	200,000
	Between Valve 5 and End of Basin	136,472	136,472	200,000
Llano				
	Between MP 276.46 and Valve 6	23,573	23,573	250,000
	Between Valve 6 and MP 280.94	107,937	107,937	250,000
	Between MP 280.94 and Valve 7	94,290	83,124	250,000
	Between Valve 7 and End of Basin	126,547	140,194	250,000
San Saba				
	Between MP 324.68 and Valve 8	181,136	241,928	350,000
	Between Valve 8 and MP 346.57	275,426	270,463	350,000

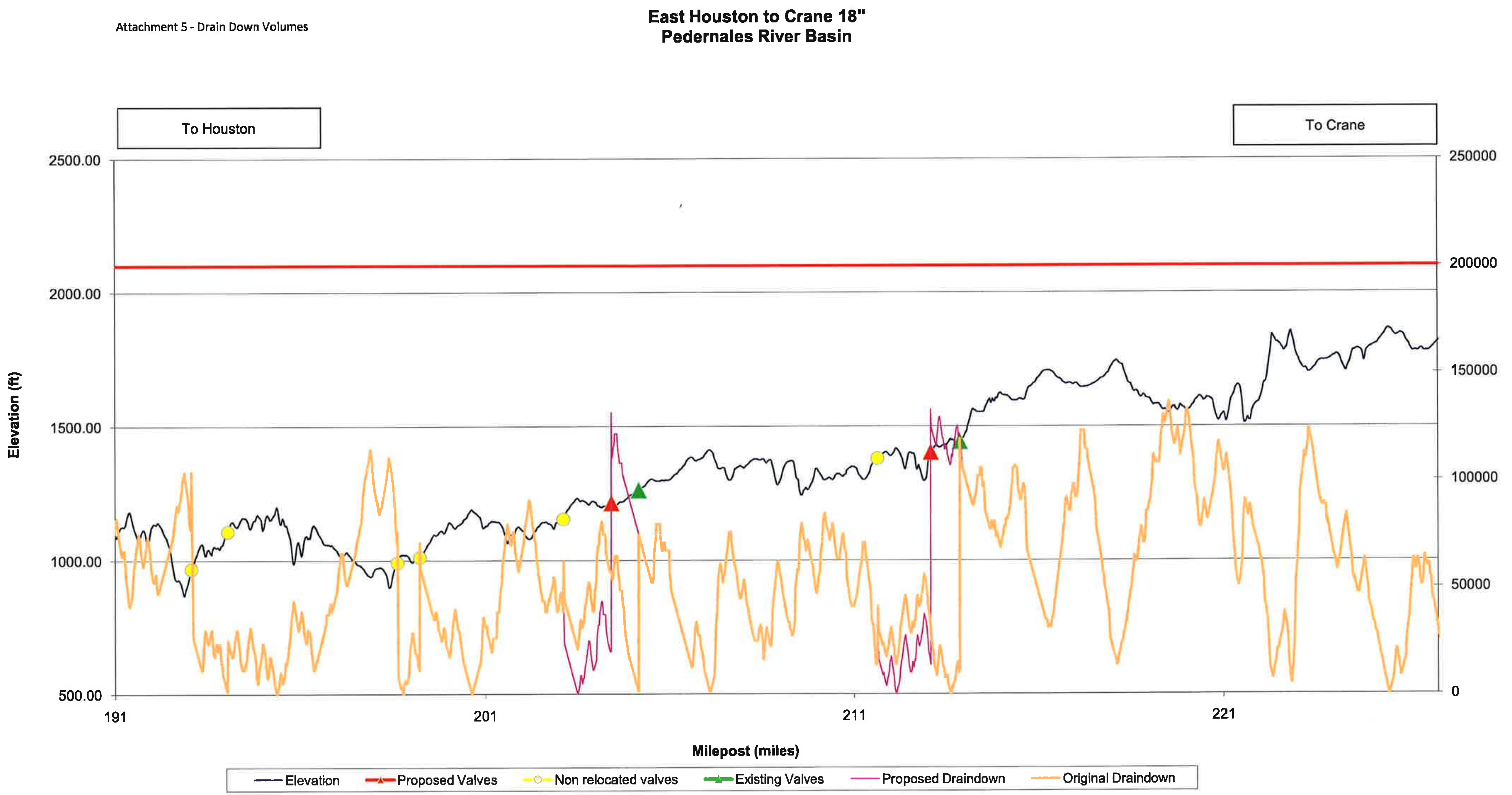
Attachment #5

Drain Down Volumes

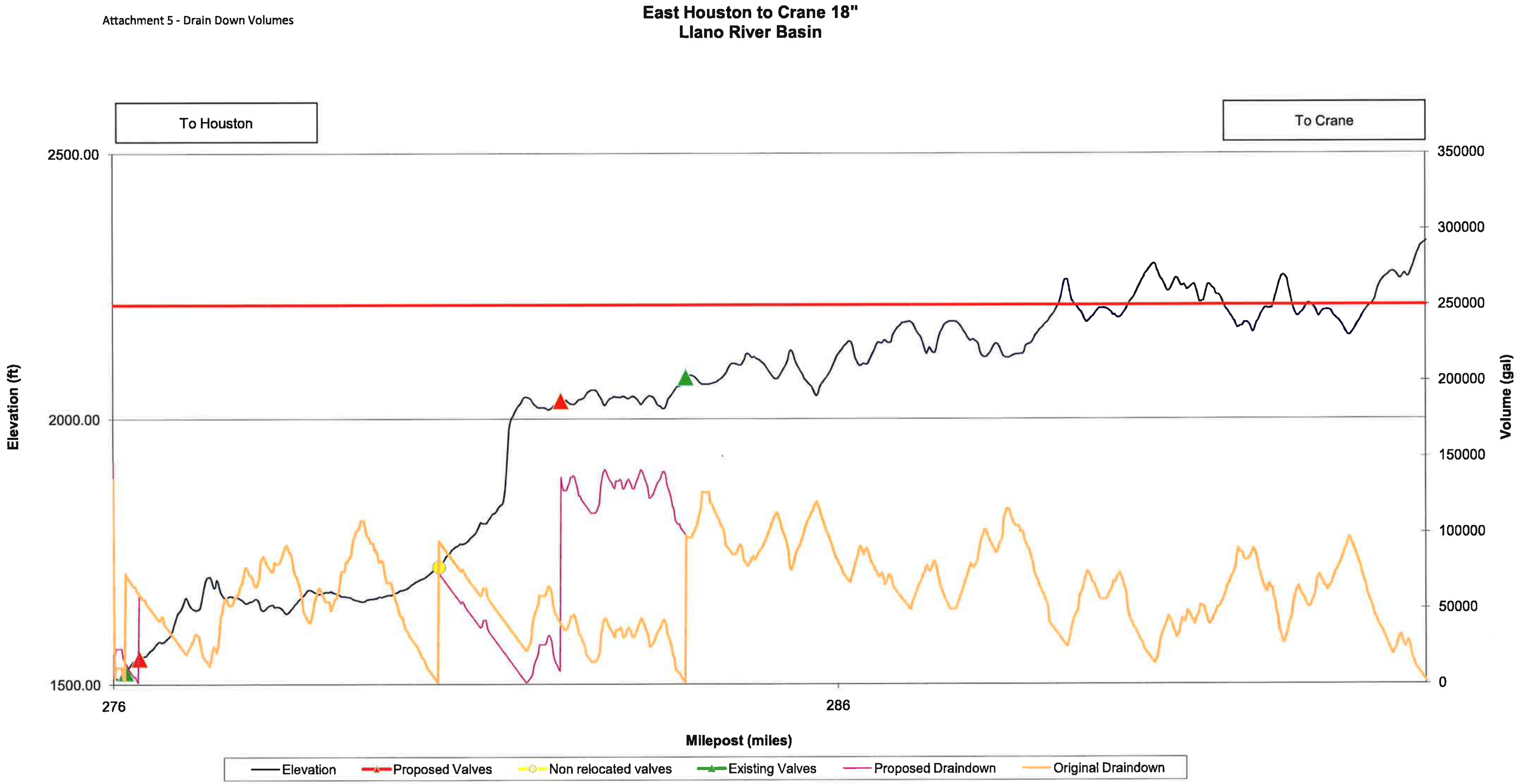
Attachment 5 - Drain Down Volumes



Attachment 5 - Drain Down Volumes



Attachment 5 - Drain Down Volumes



Attachment 5 - Drain Down Volumes