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Flood Control Authority

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December 15, 2011

To: See distribution
Re: Pipeline Grant Report; Agreement DTPH56-10-G-PHPT03

Attached is the final report, in either hard copy or electronic form, as appropriate or prescribed. It is comprised of the following sections:

I. Executive Summary
II. Conclusions/Recommendations [Technical Memorandum]
III. History/background
IV. The Process
V. References
VI. Acknowledgements

If further information is needed, please contact Mike Castillo at mcastillo@escafca.com, and me at blairylar@hotmail.com or 505-249-1035.

Sincerely,

Larry A. Blair P.E.
ESCAFCA Consultant

Distribution:
USDOT Pipeline and Hazardous Materials Safety Administration-2 [electronically]
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I. Pipeline Grant Report-Executive Summary

In 2007-2008, residents of Placitas, NM, requested that the safety of several pipelines in and crossing Las Huertas Creek be investigated, especially because some lines had been exposed during a 2006 storm event. They also requested that the Creek be kept as natural as possible.

In response, the Board of Directors of the Eastern Sandoval County Arroyo Flood Control Authority [ESCAFCA] commissioned an engineering study to determine how the creek would behave over a 30-year period of typical storm events, plus a 100-year event. This so-called "Prudent Line Study" predicted the vertical and lateral migration likely to occur.

Concern had been raised in other forums and documents, but this study, using an analytical approach, predicted that the pipelines could indeed be exposed by stormwater scour, thus increasing the danger of rupture or damage.

The Grant received from USDOT Pipeline and Hazardous Material Safety Administration [PHMSA] enabled work to continue, both to inform the public about the study results, and to continue further engineering analysis aimed at identifying specific concerns, and recommending possible solutions.

A major purpose of this entire study effort was to demonstrate that engineering analysis can, and should be used to predict scour and lateral migration when pipelines and watercourses are to occupy the same space.

This Report documents the entire process used for Las Huertas Creek. The final component, entitled "Technical Memorandum: Recommendations for Channel Stability Measures in Las Huertas Creek, Sandoval County, New Mexico", recommends the construction of four grade control structures, installation of bank protection in four locations, and monitoring of existing pipeline protection. This Technical Memorandum is Section II, Conclusions/Recommendations [next under].

Because Las Huertas Creek and Placitas are no longer in ESCAFCA jurisdiction, this report is provided to other government and regulatory agencies, to the affected pipeline companies, and to the community of Placitas, for whatever action is deemed appropriate.

Technical Memorandum: Recommendations for Channel Stability Measures in Las Huertas Creek, Sandoval County, New Mexico

December 8, 2011

1. INTRODUCTION AND BACKGROUND

In October 2010, Tetra Tech, Inc. completed a channel stability analysis and prudent line assessment for portions of Las Huertas Creek in Sandoval County, New Mexico (Tetra Tech, 2010) that was conducted for Wilson and Company, Inc. (Wilson). As part of this work, Tetra Tech provided recommendations for channel stabilization measures for the project reach, a number of which were developed to protect the buried pipelines in the portion of the project area between the Camino de Las Huertas culvert crossing and the eastern boundary of the Placitas Open Space. During the field reconnaissance for that study, a number of existing channel stabilization measures were identified, including articulated concrete mat bed and bank protection and gabion basket bank protection. While these items were used to estimate the location of the buried pipelines, no information was available to determine neither the exact location nor the burial depth of the pipelines; thus, that study recommended a more detailed field investigation with representatives from the pipeline companies (Enterprise and Kinder-Morgan) to determine the location and burial depth of the pipelines. This field investigation was subsequently carried out by representatives from Wilson, East Sandoval County Flood Control Authority (ESCAFCA), and Enterprise during August 2011. Information collected during the investigation was provided to Tetra Tech to develop updated recommendations for channel stabilization measures that may be necessary to protect the pipelines. This memorandum summarizes the findings from the field investigation and the updated recommendations for grade control and bank protection in the portion of the project area where the buried pipelines were identified.

2. FIELD INVESTIGATION SUMMARY

Four buried pipelines are located along the valley bottom of Las Huertas Creek from about 900 feet upstream (east) from the Camino de Las Huertas Culvert Crossing to near the eastern boundary of the Placitas Open Space in Subreaches 8 and 9 as defined in the previous study. The pipelines include an 8-inch refined petroleum product line installed by Enterprise in 1972, two 12-inch natural gas lines installed by Enterprise in 1980 and 1995, and a 30-inch CO2 line installed by Kinder Morgan in 1982. The field investigation was carried out by representatives from Wilson, ESCAFCA, and Enterprise to identify the specific location of the pipelines, the burial depth, and locations where existing bed and bank protection have been installed (**Figure 1**). The alignment of the pipelines was determined using an electronic locater, and the burial depth to the top of the Enterprise pipelines was measured at four specific locations, and estimated at one additional location (Figure 1).

3. UPDATED RECOMMENDATIONS

Because no additional bed-material data were collected for this updated study, and because the previously developed hydraulic model include s sufficient resolution to evaluate the hydraulic conditions in the vicinity of the burie d pipelines that were identified during the August 2011 field investigation, the previo usly developed hydrau lic models a nd associated sediment-continuity and equilibrium slope analyses were used in conjunctio n with the findings from the fiel d investigation to update the recommendations for channel stability measures necessary to protect the pipelines. T hese recommendations include measures to insure the verti cal stability of the channel (grade-control struct ures) and measures to protect against bank erosion and lateral migration (bank protection), as discussed in the following sections. **It should be noted that, because the depth of the pipelines is not known at a number of locations, a burial depth of 3 feet was assumed at these locations for this analysis, since that depth appears to be consistent with most of the measured burial depths. If additional information becomes available that indicates the assumed burial depth of 3 feet is larger than the actual burial depth, it may be necessary to re-evaluate the recommended stabilization measures.**

3.1. Location of Grade-control Structures

Four locations were ide ntified where grade co ntrol may b e necessary to protect t he pipeline crossings. The identified grade control was primarily located downstream from areas where the ultimate equilibrium slope profile (i.e., the anticipated channel bed profile after channel incision) would be below the top of the pi pelines, and could therefore threaten the stability of the pipelines. The existing bed protection (articulated concrete mats) and natural grad e control, as identified during the 2010 and 2011 field investigations, was considere d in the development of the recommendations. A profile of the existing channel bed , the field-identified or estimated top of pipeline that is buried beneath the channel bed, the existing bed protection, and the ultimate equilibrium slope profile with the recommended grade control is shown in **Figure 2**. A summary of the recommended grade-control structures is presented in **Table 1**, and are also shown on the aerial photograph in Figure 1. Downstream scour protection for the grade-control structures is discussed in the design considerations section, below.

The first recommended grade-control structure (GCS#1) is located at Station 85+00 about 700 feet downstream from Arroyo del Ojo del Orno. The Enterprise pipeline just upstream from this grade control structure is buried t o a depth of 26 in ches, and the dirt road crossing at th is location could destabilize the channel bed. For these reasons, an approximately 2-foot grade-control structure is recommended, even though the equilibrium slope analysis indicates less than 1-foot of degradation is anticipated at this location.

GCS #2 is located at Station 98+50 at the d ownstream limit of the existing bed protection (articulated concrete mat) to prote ct the Kind er Morgan lines that run parallel to the channe l beneath the channel bed and the Enterprise lin e that crosses the channel bed a short distance upstream. This grade control stru cture would also assist in preservi ng the stability of the existing articulated concrete mat along the channel bed and banks upstream from the structure, thereby eliminating the need for additional grade control through the matted reach. During the 2011 field investigation, the top of th e Enterprise line crossing could not be located, but it was estimated to be buried to a depth of 6 feet near 100+00 (150 feet upstream from GCS #2).

Table 1. Summary of recommended grade-control structures in Subreaches 8 and 9.									
Grade-control Structure	Station (ft)	Crest Elev @ Existing Ground (ft)	Elev after Incision (ft)[1]	Predicted Drop Height (ft)	Estimated Plunge Scour (ft)	Recommended Drop Height (ft)	Top of Pipeline Elev (ft)	Existing Dist to Top of Pipeline (ft)	Dist to Top of Pipeline After Incision[1]
GCS #1[2]	85+00	5495.2	5494.5	0.7	2.5	2.0	5493.1	2.2	1.5
GCS #2[2,3]	98+50	5521.2	5518.8	2.4	7.0	3.0	5517.3	3.9	1.5
GCS #3[4]	105+70	5546.3	5540.2	6.1	6.5	6.1	NA	NA	NA
GCS #4[4,5]	120+50	5580.4	5574.0	6.3	4.3	-	NA	NA	NA

[1]Based on the equilibrium slope analysis in Tetra Tech, 2010.

[2]Riprap to be installed below crest to protect against plunge scour since estimated scour depth exceeds distance to pipeline.

[3]Based on estimated pipeline burial depth at Station 100+00.

[4]Recommended drop height assumes measures to protect against plunge scour will be installed.

[5]Not recommended unless existing culvert foundation depth is less than the 6.3 feet of predicted incision; no drop height recommended because foundation depth unknown.

Assuming this estimated burial depth is correct, this grade-control structure should have a tota l drop height of 3 feet to account for the 2.4 feet of downstream incision that is predicted by the equilibrium slope analysis. However, because the measured burial depths are mu ch shallower at up- and downstream locations, the 6-foot b urial depth at Station 1 00+00 could be over-estimated, so the depth to the top of the pipeline at GCS #2 could be less than the estimated depth of 3.9 feet. If th is is determined to be the case, it may be necessary to adjust the height of the drop to be less than the distance to the top of the line but still sufficient to account for the 2.4 feet of predicted downstream incision.

The majority of the reach between GCS #2 an d the existing 6-foot headcut at Station 98+50 is currently protected with articulated concrete mat, and this mat will be stabilized by GCS #2. It is therefore unlikely that significant incision will occur in this reach, provided that the mat is sufficiently keyed in to prevent undermining of the upstream limit of the mat (as discussed in the considerations for design section, below). While the existing headcut is composed of erosion-resistant Santa Fe Formation and appears to be relatively stable at the current time, disturbance of the formation during large flood s could re sult in upstr eam migration of the h eadcut. To prevent this migration from reaching a point whe re it could threaten the pipeline crossings near Station 111+00, which have burial depths of as little as 3 feet, GCS#3 should be installed at this location. To reduce the amount of trenching that would b e necessary for keying down, this structure could be located immediately downstream from th e headcut at Station 105+70 with a crest elevation equal to the eleva tion of the existing headcut crest, provided t hat the voi d between the structure and existing crest is filled with soil cement. Because the anticipate d incision along the reach between GCS #3 and the Camino de Las Huertas culverts is less than the measured or estimated burial depths of t he pipelines in this rea ch, no additional grade control is re commended in this reach. Howe ver, if the estimated burial depths of 3 feet are determined to be too high, it may be necessary to install additional grade control in this reach.

The estimated incision at the downstream face of the Camino de Las Huertas culvert crossing (Station 120+70) is ab out 6.3 feet. While th e key-down depth of t he culvert foundation is unknown, if it is determined to be less than the predicted depth of incision, some form of grade control is recommended at Station 120+70 to protect the culverts. Because the key-down depth of the culvert foundation is not known, the details (type, d rop height, etc.) of this grade control cannot be determined at this time. However, if the vertical distance to be protected is relatively small, some form of lat eral trenchfill riprap may be a viable and less costly solu tion than a cement-based structure at this location. The lo w-elevation portion of th e roadway grade to the south of the culvert crossing in the left overbank was apparently designed to be a sacrificia l washout section. If this section were to fail during a large flood event, significant d owncutting in the vicinity of upstream pipelines could occur. It is therefore recommended that this section of the roadway be repla ced with a no n-sacrificial grade that is equipped with a hardened spillway on the downstream (west) face of the embankment.

Although Tetra Tech did not conduct any analys is along Arroyo del Ojo del Orno, i nformation collected during the 2011 field investigation indicated that active incision downstream from the Cedar Creek Road culvert crossing of this arroyo could thre aten the Enterprise lines that cross the arroyo a short dist ance downstream from the road. Based on this observation, a grade control structure should be located a short dist ance downstream from the pipeline crossing to protect pipeline. However, the structure drop he ight and other structural details such as plung e pool scour protection will need to be determined at a later date, since the depth of the pipeline is not known and since estimates of the depth of incision are not available in this arroyo.

3.2. Location of Bank Protection

A number of locations were identified where the pipelines are buried in the channel banks and could be threatened by bank erosion or lateral migration. To protect the pipelines in these areas, riprap bank protection is recommended, as shown in Figure 1 and summarized in **Table 2**. The recommended bank protection on the left bank between Station 58+80 and Station 60+50 would protect both the structures on the top of this bank and the pipelines buried in this vicinity. The bank protection that was recommended in Tetra Tech (2010) on the right bank between Station 61+00 and Station 63+20 was intended to protect the residential buildings just north of the bank, and is still recommended even though it would not protect any pipelines. About 370 feet of bank protection is recommended to protect the pipeline buried in the left bank between Station 110+80 and Station 114+30. In addition to the bank protection recommended in Las Huertas Creek, about 370 feet of bank protection is also recommended on the left bank of Arroyo del Ojo del Orno near its mouth to protect the Enterprise line that is buried to the south of this tributary. In addition, if the burial depth of the Kinder Morgan line that runs parallel to the channel along the north bank between Station 82+00 and Station 92+70 is determined and the top-of-pipeline elevations are higher than the channel invert, bank protection may also be required on the right bank to prevent lateral migration that could endanger this line.

Table 2. Summary of recommended bank protection in Subreaches 8 and 9.

Downstream Station (ft)	Upstream Station (ft)	Length (ft)	Bank	Comment
58+80	62+80	360	Left	Protect residential structures and buried pipelines in active bank erosion reach.
61+00	63+20	230	Right	Protect residential structures in active bank erosion reach.
92+00	95+70	390	Left	Protect Enterprise line buried along outside of actively eroding reach of Arroyo del Ojo del Orno.
110+80	114+30	370	Left	Protect Enterprise line buried on outside of bend.

3.3. Design Considerations for Stabilization Measures

A number of items sh ould be considered in the more detailed design of the grade-control structures and bank protection, as presented in the following sections. The scour estimates that were used to develop a number of these recommendations are based o n guidelines presented in the SSCAFCA Sediment and Erosion Design Guide (Design Guide; MEI, 2008).

3.3.1. Grade Control Structures

The potential for plu nge scour that typically occurs downstream from the crest of grade control structures is a primary consideration in the d esign of the structures. P reliminary estimates of the plunge scour were made using the Veronese equation (Equation 3.57 in the Design Guide) and the hyd raulic conditions predicted by the Tetra Tech (2010) hydraulic model f or the 100-year future development conditions peak flow. These estimates indicate the predicted plunge scour depths range fro m 2.5 feet at GCS #1 to about 7 .0 feet at GCS #2. Because th e estimated scour depths at GCS #1 and #2 exceed the pipeline burial depth after incision (Table 1), it will be necessary to install so me form of scour protection in the plunge pool of these two structures. While a number of measures could be employed in the plunge pools, either riprap or articulated concrete mats will likely be the most effect ive considering the relati vely shallow pipeline burial depths below the structures. The scour protection should extend for a distance of at least 1.5 times the crest with the downstream end matching the existing profile, and the downstream end should be toed-down to a depth that matches the e quilibrium slope profile (**Figure 3**). The area e xcavated to install the protection should be b ackfilled to the existing grade after construction. The protection measures at GCS #1 and GCS #2 should be designed and installed in a manner that safeguards the pipelines that run parallel to the channel bed. No buried pipelines were identified at the upstream two structures (GCS #3 and GCS #4), so scour protection is not necessary at these two structu res. However, because the estimated plunge scour depths are relatively large at these two locations (Table 1), the scour protection measures that are recommended for GCS #1 and GCS #2 could also be imple mented at the upstrea m structures.

The recommended grade-control structure GCS#2 is locat ed near the downstream limit of the existing bed protection, where the mat transitions from bed protection t o bank protection. To insure that this structure protects the upstream mat in the bed as well a s the downstream mat along the right bank, the existing mat should be "broken" at the structure crest. This would allow for tying the upstream s egment of t he mat that protects the channel bed into the crest of the structure, and the downstream segment of the mat that protects the rig ht bank into the bank at the structure outlet.

As noted above, GCS #4 may not be necessary if the existing key-down depth of the Camino de Las Huertas Culvert foundation exceeds the predicted incision depth of 6.3 feet. Regardless of whether the structure is deemed necessar y, the sacrificia l washout section of the road embankment should be hardened to prevent failure of this section, which would like ly result in upstream incision that could threaten the buried pipelines in the upstream channel bed. The roadway hardening should include some form of protection on the downstream side of th e embankment (i.e., the "spillway"). Although more detailed modeling of this area would be required to determine t he hydraulic conditions and potential for scour, results from the e xisting hydraulic modeling indicate that this section of the roadwa y, as currently configured, conveys about 2,400 cfs of the 11,300-cfs discharge at the 10 0-year peak (future development

conditions hydrology), at velocities of up to 3 fps. Because these velocities are relatively low, it is likely that riprap revetment would be a suitable form of protection for the embankment spillway.

3.3.2. Bank Protection

Riprap revetment is recommended for the areas where bank protection is necessary because it is more flexible than gabion structures and, therefore, is more suitable for the minor channel adjustments (i.e., incision) that are expected along the project reach. In addition, in coarse bed material systems such as the project reach of Las Huertas Creek, gravels and cobbles that are transported during flood events tend to damage the gabion baskets. Based on results from the hydraulic modeling (Tetra Tech, 2010) and using the future developed conditions 100-year peak flow as the design discharge, the median size of the riprap should be 20 inches with a D_{30} of 16 inches. The riprap should extend to an elevation that is equal to the 100-year (developed conditions hydrology) water-surface elevation plus 2 feet of freeboard, except in locations where this water-surface elevation exceeds the top of bank, in which case the revetment should extend to the top of bank (**Table 3**; **Figure 4**). [The hydraulic model of Las Huertas Creek that was developed for Tetra Tech (2010) should be modified to represent design conditions in order to determine the 100-year water-surface elevation and the necessary height of the revetment. A similar model should be developed to determine these design parameters for the recommended riprap in Arroyo del Ojo del Orno.] The riprap should also be keyed down into the bed to a depth equal to the estimated scour, which includes long-term scour and bend scour (Table 3), since no antidune scour is likely due to the relatively coarse bed material in these areas. The riprap should have a minimum thickness equal to 30 inches based on a $1.5*D_{50}$ criteria.

Table 3. Summary of estimated scour depths and the resulting toe-down for the recommended riprap revetments along Las Huertas Creek.

Downstream Station (ft)	Upstream Station (ft)	Average 100-yr WSE (ft)	Avg. Recommended Top Elev. (ft)	Length (ft)	Bank	Long-term Scour (ft)	Bend Scour (ft)	Recommended Toe-Down (ft)
58+80	62+80	5461.3	5459.0	360	Left	2.3	3.0	5.3
61+00	63+20	5463.6	5461.3	230	Right	0.7	3.2	3.9
110+80	114+30	5574.0	5576.0	370	Left	0.5	3.2	3.7

3.4. Recommendations for Monitoring and Additional Evaluation

In addition to the recommendations for monitoring that were presented in Tetra Tech, 2010, a number of additional recommendations were developed during this updated study to protect the pipelines. The depth of the Kinder Morgan lines is not known along the project reach, so it was not possible to develop recommendations for protecting these lines at locations where there are no Enterprise Lines. As such, every effort should be made to determine the burial depths of these lines. As discussed above, if the burial depth of the Kinder Morgan line that runs parallel to the channel along the north bank between Station 82+00 and Station 92+70 is determined

and the top-of-pipeline elevations are higher than the channel invert, bank protection may also be required on the right bank to prevent lateral migration that could endanger this line.

The existing articulated concrete mats could fa il due to a variety of different mechanisms, the most common of which involve either (1) downcutting of the reach downstream from the mat s such as headcut migration that results in destabilization of the downstream face of the mat, and (2) undermining of the upstream face of the mats due to scour associated with impinging flows. Because the recommended grade control str uctures were located in a manner that sho uld prevent incision at the downstream face of the mats, this mode of failure is not a nticipated at any of the mats upstream from GCS #1 at Stat ion 85+00. However, because no grade-control structure was recommended downstream from the recently installed mat near Station 59+50 , this mat should be mo nitored periodically to insure the downstream face of the mat is not i n danger of failure. In general, the most common method for protecting the upstream face of the mats against impinging flow scour involves proper key down of the mat into the chan nel bed. A field evaluation to determine the d egree of key down alo ng the upstream face of the mats should be carried out, and if the key down is determined to be insufficient to protect against the impinging flow scour, the mats should be refurbished with properly designed burial depths.

The depth of key-down for the fou ndation of the Camino de Las Hue rtas culverts should be determined by either re viewing as-built drawings or through a field investigation. As discussed previously, this information is important bec ause GCS #4 is only recommend if th e predicted depth of incision (6.3 feet) exceeds the foundation key-down. If it is determined that GCS #4 is necessary to protect the culvert crossing, this structure should be designed with a crest elevation that is suf ficiently high to protect the foundation, while minimizing the dro p height to reduce costs.

The very high right (no rth) bank of the arroyo along the o utside of the bend between Station 73+00 and Station 77+00 appears to be relatively stable at the current time, and the estimated bank erosion rates are relatively low, so no ba nk protection was recommended to protect the Enterprise lines that are buried a short distance beyond the top of the bank. However, this area should be monitored to insure that future bank erosion d oes not threaten the pipelines. The existing gabion bank pr otection in Subreaches 8 and 9 should be monitored to insure the baskets are intact and the bank protection is functioning as intended. For the reach of Arroyo del Ojo del Orno where bank protection (and possibly grade control) is recommended, hydraulic and channel stability analyses similar to those conducte d for Las H uertas Creek should b e carried out to properly design the stabilization measures.

4. SUMMARY

Previously developed hydraulic models and the associated sediment-transport and channel stability analyses were used in conjunctio n with pipeline location information to update recommendations for channel stabilization mea sures that were originally developed by Tetra Tech (2010). These re commendations generally include g rade-control structures to provide vertical controls that will limit down cutting, bank protection in areas w here the pipelines ar e buried in the banks along the outside of bends or where re sidential structures are at risk, and a number of items that should be ev aluated in the future after additional information becomes available. The following list of items is a summary of the specific reco mmendations that were developed for the reach between t he Camino de Las Hue rtas road crossing and the eastern boundary of the Placitas Open Space that was considered in this study:

1. Three grade-control structures are recommended in the reach downstream from the Camino de Las Huertas road crossing to protect the buried pipelines (Figure 1 and Table 1). These structures should be designed with drop heights that are large enough to protect against the predicted incision, and should be designed with proper scour protection to protect the buried lines against plunge scour (Table 1). A fourth grade-control structure may be necessary to protect the Camino de Las Huertas culverts if the key-down depth of the culvert foundation is less than the predicted depth of incision at this location.
2. About 1,100 lineal feet of bank protection is recommended at three locations to safeguard pipelines that are buried in the left (south) bank of Las Huertas Creek and Arroyo del Ojo del Orno (Table 2). An additional 230 feet of bank protection was recommended at one location in Tetra Tech (2010) to protect residential structures on the right (north) bank. The bank protection should be designed based on guidelines presented in the Design Guide with the general dimensions outlined in Table 3.
3. Because the burial depth of the Kinder Morgan lines is unknown at most locations along the project reach, the grade control and bank protection is primarily recommended to protect the Enterprise pipelines. The burial depth of the Kinder Morgan pipelines should be determined, and these recommendations should be updated to ensure the safety of all pipelines.
4. The degree to which the existing articulated concrete mats are keyed down should be determined, since this key-down safeguards the upstream face of the mats against impinging flow scour. If this key-down is determined to be insufficient or non-existent, the mats should be refurbished with properly designed key-down.
5. The existing articulated concrete mats and gabion structures should be periodically monitored to insure that these elements are functioning as designed, and bank erosion should be monitored at select locations where pipelines are buried along the outside of bends, but the estimated bank erosion rates were deemed to be insufficient to warrant bank protection.

5. REFERENCES

Mussetter Engineering, Inc., 2008. Sediment and Erosion Design Guide. Prepared for the Southern Sandoval County Arroyo Flood Control Authority, Rio Rancho, New Mexico, November, 246 p.

Tetra Tech, Inc., 2010. Channel Stability Analysis and Prudent Line Assessment for Las Huertas Creek, Sandoval County, New Mexico. Prepared for Wilson and Company, Inc., Rio Rancho, New Mexico, October 15.

III. Pipeline Grant Report-History/Background

New Mexico's oil and gas industries are located in the northwest and southeast corners of the state. Several pipelines carry products between these areas, as well as to/from out-of state sources.

The Sandia and Manzano Mountains in the north central part of the state, form a barrier around which pipelines must pass. One such pipeline corridor goes through the village of Placitas, and a portion of this corridor lies in the watershed of Las Huertas Creek [arroyo], the major watercourse which drains the village.

"The Sandia Mountains have been occupied by human beings for thousands of years.
Settled in 1767 when Governor Pedro Fermin de Mendinueta made the land grant known as La Merced de San Antonio de Las Huertas. The area is known as 'Las Placitas' because it contains several villages, also known as 'plazas'.

Descendants of the stockmen and farmers who first settled the grant still live in the vicinity." [From Historic marker, Highway 165 in Placitas].

The older portion of the village is built on the north slope of the Sandia Mountains.It is irrigated by acequias [ditches] which draw their water from springs and Las Huertas Creek , and is drained by several tributary arroyos which flow northerly to Las Huertas Creek. These arroyos and Las Huertas Creek comprise a drainage area of some 29 square miles, and are subject to snowmelt runoff and summer flash floods. Newer portions of Placitas generally drain elsewhere.

In the last 50 years, the community has grown, first with an influx of "hippies", and more recently, with upscale subdivisions and pricey homes. Included in that growth were the installation of petroleum, natural gas, and CO2 lines between 1972 and 1995. Currently, in and adjacent to Las Huertas Creek are two 12-inch liquid natural gas lines, installed in 1980 and 1995; an 8-inch refined products line, installed in 1972 [gasoline, diesel, jet fuel]; and a 30-inch CO2 line installed in 1986.

Along a two-mile portion of Las Huertas Creek, pipelines were buried in, and crossed, the Creek bottom. Homes, structures, corrals, and yards also were built in desirable locations along the Creek, sometimes on or near the pipelines. This juxtaposition of uses inevitably raised concerns about safety.

In 2006, a major rainstorm caused damage along Las Huertas Creek, including the exposure of pipelines where high flows had scoured away the creek bottom and/or banks. This event heightened concerns of residents, and led, at least to some degree, to the formation of the Eastern Sandoval County Arroyo Flood Control Authority [ESCAFCA].

Responding to community concerns, ESCAFCA commissioned an engineering study to predict how the Las Huertas Creek would behave over a 30-year period of typical storms, coupled with a 100-year storm. The study identified the expected vertical and lateral migration of the creek, and established a line on each side of the creek, within which it would not be prudent to build [the "Prudent Line"]. It also identified areas of potential scour which could expose the buried pipelines and subject them to damage or failure.

It was at this juncture that ESCAFCA applied for, and received, a grant from the US Department of Transportation [USDOT] Pipeline and Hazardous Materials Safety Administration [PHMSA] to conduct further engineering analysis and public outreach to determine which, if any, measures might be advisable. The overall effort and resulting reports are also intended to demonstrate that analytical engineering can be of value in determining how deep and in what locations pipelines should be buried, when a watercourse is involved.

This report is the final product of that grant effort.

IV. Pipeline Grant Report-The Process

This section documents the process used to accomplish the objectives of the USDOT grant. Certain documents, as noted , are not included in this report, because of their volume, and because they have been previously distributed to involved or interested parties. Hard copies are available in ESCAFCA files, and can be provided electronically on request. Those documents will be so noted , but will be summarized for understanding.

A. The area of concern is along Las Huertas Creek [arroyo] in the village of Placitas, NM, as depicted on the map, Reference 1, attached.

B. The Las Huertas Canyon Watershed Restoration Action Strategy [WRAS] , September 30, 2005, identified " the pipeline corridors a major environmental and human health and safety concern of local residents [LPA 2005a]" [page 7].Attached Reference 2,also on file.

C. In the summer of 2006, major storm events in the Las Huertas watershed caused significant damage to the streambed and road crossings, and exposed pipelines in the creek bottom. Although estimated flows were significant [6,000 to 8,000 cfs], they were not as large as the predicted 100-year event [10,000 cfs]. Repairs were made by the pipeline companies. See photos in Reference 3, attached.

D. Before ESCAFCA was voted into existence in November 2008, it received funds from the State Legislature and other government agencies to determine flood control needs. ESCAFCA contracted with HDR Engineering Inc. to conduct a needs assessment. This study effort included public meetings in the three affected communities, during which attendees were asked to identify concerns. The HDR Interim Preliminary Needs Assessment, July 12, 2007, stated that in Placitas "several residents noted strong safety concerns about the existing pipelines adjacent to and crossing arroyos in the area. Residents were also concerned about the adequacy of current repairs on arroyo crossings." [p.4]. The report also recommended to "perform a thorough hydraulic and scour analysis of pipeline crossings in the area" [p. 6]. Reference 4, on file.

E. Upon receipt of the HDR study, ESCAFCA than contracted with Wilson and Company, Inc. to develop a Drainage Master Plan. This plan identified as a Documented Drainage Problem " Erosion of arroyos resulting in damage to roadway embankments and exposure of natural gas pipelines" [p.8], and stated "Of the issues affecting Placitas residents, the issue of erosion and exposed natural gas and exposed pipelines within arroyos is by far the most serious" [p. 18], and

recommended "that channel stabilizing structures are constructed within arroyos containing pipeline infrastructure" [p. 19]. It also "recommended that one of ESCAFCA's priorities in the Placitas area be to establish erosion limits of existing major arroyos (i.e., the maximum anticipated extent of erosion within an arroyo)"[p. 18], [a so-called 'prudent line']. [Reference 5, on file].

F. In November, 2008, ESCAFCA was voted into existence, along with approval of a $3 million bond issue, thus giving ESCAFCA the ability to begin engineering studies and projects.

G. Responding to the concerns of Placitas residents, one of ESCAFCA's first projects was to conduct an engineering study of Las Huertas Creek [arroyo] to predict how it would behave over a 30-year period of typical storm flows, coupled with a 100-year event. The study was to predict vertical and horizontal movement of the streambed, and thus establish lines along each side of the creek within which it would not be prudent to build [so-called "prudent lines"]. A second major component of the study was also to identify potential scour in areas where pipelines were located. This study was authorized by Task Order No. 11 "Las Huertas Creek Prudent Line Assessment and Letter of Map Revision (LOMR)" , dated 10/20/09, and Amendment 1, dated 1/6/2011, for a total appropriation of $195,000. Reference 6, attached.

H. On August 17, 2009, the Cedar Creek Homeowners Association hosted a meeting in Placitas, at which residents expressed concerns to Federal and State regulators and pipeline company representatives over the possibility of damage or failure during storm events. The ESCAFCA Board Chairman informed all present that ESCAFCA had initiated a study [Reference 6, above] which would address this very issue. A committee was formed to assist and advise [but never did anything]. Minutes of this meeting are attached as Reference 7.

I. In the fall of 2009, ESCAFCA learned of the availability of USDOT grants for pipeline safety issues. On December 8, 2009, the Board authorized expenditure of $5,913.72 to prepare a grant application [Task Order No.12, Reference 8, attached] and in January, 2010, ESCAFCA submitted a request for a Technical Assistance Grant for $50,000.00. The Grant Agreement was subsequently executed on September 30, 2010 [Reference 9, on file].

J. On October 19, 2010, the ESCAFCA Board of Directors approved Task order No. 15, the ESCAFCA Pipeline Grant Work Plan, and appropriated up to $50,000.00, to be reimbursed by the USDOT under the Grant Agreement [Reference 10, attached]

K. The "Channel Stability Analysis and Prudent Line Assessment for Las Huertas Creek, Sandoval County, New Mexico", was completed on October 15, 2010 [Reference 11, on file]. Using recognized engineering techniques, the study established erosion risk limits along Las Huertas Creek [prudent lines], and predicted scour depths along the creek where pipelines are buried. At some pipeline locations, scour predictions were 6 to 8 feet. Assuming pipelines were buried at least 30 inches deep, as specified by 42 CFR 192.139-327, it was apparent that some pipelines might be at risk. Accordingly, the two pipeline companies were asked to field identify location and depths, so that a more exact analysis of risk could be performed. Only Enterprise Products responded.

L. As part of the work plan, public meetings were to be held to inform residents of the study results, solicit comments, and recommend solutions. The first meeting, scheduled for December 16, 2010, was cancelled because of snow. Subsequent meetings were scheduled for January 11, January 26, and February 22, 2011. Pipeline companies and government regulators were invited by letter, and Placitas residents were invited via flyers and newspaper ads. Attendance was dismal at the first two meetings, and no one attended the February 22 meeting. Especially obvious was the lack of attendance by the Cedar Creek homeowners. To help remedy this, the New Mexico Public Regulation Commission sponsored a third meeting on April 28,2011,at which some 30 people attended, 15 of which were pipeline company representatives. Copies of the meeting notices and meeting minutes are at Reference 12, attached.

M. On May 5, 2011, a time extension was granted, allowing the Final report and final financial report to be submitted by December 31, 2011. A copy of that document is at Reference 13.

N. In order to complete the engineering analysis of the scour potential on the pipelines, the two affected pipeline companies were repeatedly asked to provide field crews to ascertain pipeline location and depth within and along the creek. Because the ground was frozen January through March, this effort was delayed. Ultimately, only Enterprise personnel participated in this effort, and on July 29, 2011, a productive field reconnaissance was made, during which the Enterprise lines [2-12 inch NGL lines and one 8 inch refined product line] were located and plotted. The field notes and map resulting from this effort are at Reference 14, attached.

O. The field notes were transmitted to the consulting engineers for final analysis and a report. This report is entitled "Technical Memorandum: Recommendations for Channel Stability Measures in Las Huertas Creek, Sandoval County, New Mexico", and is included in this Pipeline Grant Report as Section II, Conclusions/Recommendations. The Technical Memorandum recommends construction of four [4] grade control structures, additional bank protection at four [4] locations along Las Huertas Creek to help protect the pipelines, and monitoring of existing protection. This Technical Memorandum represents the culmination of the work to be done under this grant.

P. The thrust of this grant-funded project is to demonstrate that engineering analysis can be used to determine appropriate depth [or bank setback] for buried pipelines in or adjacent to watercourses, especially those in ephemeral streams. Rather than simply following" guidelines", there may be many instances where engineering analysis of the type done here might prevent serious consequences, such as happened on the Yellowstone and Missouri Rivers in 2011. See attached news articles at Reference 15.

Q. Because Placitas and Las Huertas Creek are no longer under ESCAFCA jurisdiction [by Legislative action-HB306, April 6, 2011]. ESCAFCA will not take any further action to implement the recommendations contained in the Technical Memorandum. However, copies of this entire Pipeline Grant Report will be provided to pipeline companies, regulatory agencies, the Placitas

library and Community Center, and government agencies for whatever action is deemed appropriate. The distribution list is listed below.

USDOT Pipeline and Hazardous Materials Safety Administration- 2 [electronically]
Enterprise Products-1
Kinder Morgan-1
NM Public Regulatory Commission-Pipeline Safety Bureau-1
Sandoval County-2
Placitas Library-2
Placitas Community Center-1
ESCAFCA-3
Wilson and Co.Inc-1

V. Pipeline Grant Report-References

1. Area Map, National Pipeline Mapping System
2. Las Huertas Canyon Watershed Restoration Action Strategy, Version 2.0, September 30, 2005, Reid Bandeen, P.G., Principal Author
3. Photographs, 2006
4. Interim Preliminary Needs Assessment, July 12, 2007, HDR Engineering, Inc, prepared for ESCAFCA
5. Drainage Master Plan and Needs Assessment, Wilson and Company, Inc, for ESCAFCA, June 27, 2008
6. Task Order No. 11 Las Huertas Creek prudent Line Assessment and Letter of Map Revision(LOMR), 10/20/09, and Amendment 1, 1/6/2011
7. Pipeline Meeting Minutes—August 17, 2009, submitted by Larry A. Blair, Executive Engineer, ESCAFCA
8. Task Order No. 12,Pipeline and Hazardous Material Safety Administration Grant Assistance, 12/8/09
9. GRANT AGREEMENT between ESCAFCA and U. S. Department of Transportation, dated Sep 30,2010, with Pipeline Grant Work Plan [10/14/2010], and modification to AGREEMENT, dated 5/5/11
10. Task Order No. 15 Pipeline Grant Administration, 10/19/10
11. Channel Stability Analysis and Prudent Line Assessment for Las Huertas Creek, Sandoval County, New Mexico, by Wilson & Company, Inc. and Tetra Tech for ESCAFCA, dated October 15, 2010
12. Public Meeting notices, minutes, and notes
13. Executed Grant Agreement #DTPH56-10-G-PHPT03, Modification #0001 [Time Extension],5/5/11
14. Field notes and map from August 29,2011 reconnaissance
15. News Articles on Yellowstone and Missouri Rivers, 2011

VI. Pipeline Grant Report- Acknowledgements

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