TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES
(See Volume 2)

9.0 MITIGATED PROJECT AND COMPARISON OF ALTERNATIVES

The first eight chapters of this Environmental Assessment (EA) focus primarily on the proposed System without the implementation of additional mitigation measures that have been agreed to by Longhorn Partners Pipeline, L.P. (Longhorn). In Chapter 9, the EA considers those mitigation measures and their effect on potential impacts.

9.1 PROPOSED PROJECT AS MITIGATED

The Lead Agencies have determined that there are potential impacts associated with the project as originally proposed that arise from the risk of pipeline failure. The Lead Agencies have determined that mitigation measures are necessary to reduce the potential impacts of the proposed project to a level of insignificance. These mitigation measures, in many cases, go substantially beyond the legal requirements that apply to US hazardous liquid pipelines.

Section 9.1 includes an introduction (9.1.1) in which the organization and content of the section are summarized. The proposed project is summarized in Section 9.1.2. Section 9.1.3 contains a more detailed discussion of the approach used in selecting mitigation measures to reduce the impacts of the Longhorn pipeline. This section begins with an overview of the approach, with more detailed descriptions following in Sections 9.1.3.1 through 9.1.3.4. Section 9.1.3.1 describes how Index Sums are derived through the EA Risk Model. The methodology used in defining sensitive and hypersensitive areas along the pipeline route is discussed in Section 9.1.3.2. The establishment of risk target levels, which guide the selection of mitigation measures to be applied to pipeline segments, is described in Section 9.1.3.3. Section 9.1.3.4 contains a discussion of the residual risk model and the relationship between failure probability and Index Sum values.

The Longhorn Mitigation Plan (LMP) is a collection of detailed commitments that Longhorn has made to address environmental and safety concerns raised by the Lead Agencies, other federal agencies, and the general public. Major elements of the LMP are briefly described and interpreted in Section 9.1.4. In Section 9.1.4.1, the LMP Project Description, the reader is directed to sources of more detailed information about the LMP and the Project. Two major elements of the LMP, the System Integrity Plan (SIP) and the Operational Reliability Assessment (ORA) are discussed in Sections 9.1.4.2 and 9.1.4.3, respectively. Section 9.1.4.4 contains a description and discussion of the annotated alignment sheets, which graphically show the mitigation measures applied along the pipeline.

9.1.1 Introduction

This EA concludes that the proposed project does not pose significant impacts when the System is operating in a routine manner. That is, there are no significant impacts that are certain to occur at any given location, such as unacceptable noise from pump stations; routine releases of unacceptably high levels of air contaminants from valves, flanges, or product tanks; hazardous liquid effluent discharges or solid waste generation; or disturbance of threatened or endangered species.

However, there are varying probabilities that accidents could occur along the System. Should these accidents occur, impacts to the environment and human health and safety could be significant. The mitigation measures reduce the probabilities of failure with the greatest risk reductions in those areas along the pipeline where environmental sensitivities and population densities are highest. The mitigation measures also reduce the impacts of a spill should they occur.

As required by the Settlement Agreement (Settlement), the Lead Agencies developed a draft list of general mitigation measures necessary to reduce the impacts to a level of insignificance. The draft mitigation measures allowed Longhorn some flexibility in selecting specific mitigation commitments that collectively reduce spill probabilities and consequences, with additional and more stringent mitigation measures for sensitive and hypersensitive areas, as well as enhanced opportunities for public awareness of Longhorn's activities associated with implementing the LMP.

Certain mitigation measures were developed in parallel with the risk assessment. This was possible because it was apparent even in early stages of the EA process that issues such as pipeline integrity verification and enhanced leak detection would be necessary to manage risks appropriately. Other mitigation measures were selected after the risk assessment identified specific concerns. Alternative mitigation measures were received as comments to the draft EA. These were carefully considered and, in some cases, modifications have been made to the LMP to incorporate the suggestions. Many appropriate and reasonable mitigation measure suggestions were added to the LMP following publication of the draft EA. Additional mitigation measures for protection of the Barton Springs Salamander are the results of direct discussions between Longhorn and the US Fish and Wildlife Service (FWS) as part of the Endangered Species Act Section 7 consultation process.

All mitigation measures specified are technically feasible. In most cases, they add to normal industry practices by increasing thoroughness and frequency, but they do not introduce new technical challenges. In a few cases, newer technologies are specified, but these also have been demonstrated to be technically feasible. Examples of the latter include direct burial leak detection cables and transverse wave in-line inspection (ILI) or "crack tools." These are described in the LMP.

9.1.2 Proposed Project (with Mitigation)

The proposed project, as originally proposed, is described generally in Chapter 3. The Settlement includes the consideration of alternative routes in addition to several types of pollution prevention measures[1] required to be evaluated as a part of this EA. These mitigation measures listed in the Settlement include: enhanced leak detection; enhanced ground surveillance; replacement of pipe sections with new and stronger pipe; increased depth of buried sections; enhanced emergency response capability; additional block or check valves and remote operation capability; berms or other containment for certain portions; increased integrity verifications; special studies and recommendations; and other mitigation measures that arise from integrity analysis or from risk assessment. These pollution prevention measures, along with many additional ones, are included in the LMP.

Table 9-1 lists the main mitigation measures detailed in the LMP. As discussed in Section 9.2, the LMP is estimated to result in at least a twenty-fold reduction in frequency and probability of spills compared to an unmitigated Longhorn pipeline. The LMP also includes several measures that would reduce the consequences of a spill as compared to an unmitigated Longhorn pipeline. These are discussed in Section 9.2.2.

The Lead Agencies' approach to the development of mitigation measures focuses on reducing the probability and consequences of potential leaks and spills through application of mitigation measures over the entire System with increasingly more stringent measures over sensitive and hypersensitive areas. In the draft EA, approximately 102 miles of the 731-mile System were designated as sensitive, of which 22 were hypersensitive. Based on comments from the public, this final EA designated approximately 129 miles as sensitive of which 22 miles are hypersensitive areas. Appendix 7A contains the description of sensitive and hypersensitive areas.

[1] The Settlement refers to these measures as "pollution control alternatives." This EA uses the term "pollution prevention measures" because pollution prevention best describes the intent of the measures. Pollution control suggests a response to a spill or a leak rather than prevention of the release.

9.1.3 Approach to Mitigation

The types and sizes of leaks from pipelines are quite variable. This variability makes it difficult to formulate explicit models or relationships relating leak occurrences to pipeline operating and mechanical parameters. At the same time, the frequency of leak occurrence is generally low. As a result, the small data sets make it difficult, if not impossible, to develop implicit or empirical models with a reasonable degree of certainty that directly relate leak rates to pipeline operating variables. Since neither implicit nor explicit models are available, the approach to developing mitigation measures and estimating their effectiveness is to rely on the best professional judgement of pipeline and environmental experts combined with the use of a relative risk model of the pipeline.

The relative risk model (EA Risk Model) based on the Muhlbauer model (Muhlbauer, 1996) was used to estimate the relative probability of spills associated with the operation of the Longhorn pipeline. The pipeline was divided into several thousand linear segments based on many individual risk factors for each segment. The many factors that can cause or contribute to spill probabilities were incorporated into the EA Risk Model to develop a single score, or "Index Sum," for each individual pipeline segment. In developing the Index Sums, a variety of sources were used to provide the data needed in the EA Risk Model. These sources included maintenance records, construction documents, design documents, employee interviews, expert testimonies, and inspection of facilities. In the absence of data, more aggressive conditions were conservatively used for default values. The individual segment Index Sums were used to guide the selection and estimate the relative impact of mitigation measures on the failure probabilities. Index Sums are discussed in more detail in Section 9.1.3.1, below.

In the original model formulated by Muhlbauer (Muhlbauer, 1996), risk assessment includes a Leak Impact Factor (LIF) to incorporate the consequences of a leak into the final evaluation of risk. The impact of a leak depends on (1) the product and transport conditions in the pipeline; (2) the reaction to the leak; and (3) the pipeline surroundings. It is important to understand that the original purpose of the Muhlbauer model was to assist industry in analyzing their pipeline vulnerabilities, not to conduct an environmental review. A more appropriate means for the purpose of an environmental review to evaluate the potential impacts from a pipeline was a methodology that included consideration of NEPA categories. This method allowed for each segment along the pipeline to be designated as hypersensitive (Tier 3), sensitive (Tier 2), or less sensitive (Tier 1). The tiering methodology incorporated a more comprehensive consideration of the sensitivity level of each area along the pipeline as a function of the potential receptors (drinking water supplies, population density, socioeconomics, threatened and endangered species, and recreational areas). The level of mitigation proposed for each segment was greatest for the Tier 3 areas and lowest for the Tier 1 areas. The identification of sensitive and hypersensitive areas is described in Section 9.1.3.2 and Appendix 7A.

Minimum Index Sum (relative probability of failure from the EA Relative Risk Model)targets were proposed for each of the three tier levels. The target levels were developed by using best professional judgement, combined with the calculated average Index Sum score of 195 for the entire pipeline prior to adding further mitigation measures. Mitigation measures were selected and applied to each pipeline segment or groups of segments until the target levels were reached or exceeded, as determined with the EA Risk Model. The target levels are discussed further in Section 9.1.3.3. (See Appendix 9A for more information on risk modeling process and post-mitigation results.)

In addition to applying the relative risk model, a probabilistic risk assessment was also conducted to provide a measure of the absolute risk of leaks for selected locations and segments along the pipeline. The probabilities of leaks were developed using historical leak data for the Exxon Pipeline Company (EPC) operations and assuming a Poisson probability distribution function. The absolute leak probabilities were used to estimate the number of leaks that might be expected along the mitigated pipeline over the expected 50-year life of the project. The probabilities calculated in this manner have a high level of uncertainty, however, due to the limited data set.

Although there are insufficient data to precisely quantify the effect of mitigation on the overall probability of leak occurrences, it appears reasonable to assume there exists a strong relationship between leak probability and Index Sum score and that reductions in failure rates would occur when mitigation measures are applied. This reduction was quantified by assuming a conservative functional form or equation relating leak probabilities with Index Sum scores. This relationship was developed from two key Index Sums and leak probabilities (pre- and post-mitigation) associated with the Longhorn pipeline, and from the assumed leak probabilities of 1 and 0 at Index Sums of 0 and 400 (maximum Index Sum), respectively. Using the relationship, the average reduction in System-wide leak probabilities was estimated to be over twenty-fold after mitigation. Details and results of this effort are provided in Section 9.1.3.4.

9.1.3.1 Index Sum

The most effective way to mitigate risks is to reduce spill probability. The alternative of reducing spill consequences involves the reaction to a leak, which is usually less effective in avoiding impact. Risks along the pipeline are assessed in Chapter 6 using the EA Risk Assessment Model. As explained in detail in Chapter 6, the EA Risk Model provides an objective means of incorporating the many factors that can cause pipeline failure into a single score for a segment of pipeline. The relative probability of pipeline failure is quantified in a variable called the Index Sum. The Index Sum is a summary number that includes all variables that affect spill probability. These variables are grouped into the four categories of third-party damage, corrosion, design, and incorrect operation—each of which corresponds to a historical cause of pipeline accidents. For the pre-mitigation assessment, the model produced relative probability of failure scores for about 8,000 segments of the System along the entire 731-mile route based on many individual risk factors.

As noted in Chapter 6, the higher the Index Sum, the lower the risk of pipeline failure. Therefore, the Index Sum can be viewed as a relative "safety scale," whereby increasing points mean increasing safety—lower failure probability. Unfavorable conditions around the pipeline, inadequate operator activities, and increasing uncertainty (about existing conditions) all tend to reduce Index Sum scores—indicating a higher failure probability. Mitigation measures that improve pipeline conditions increase the Index Sum score. The extreme ends of Index Sums produce a theoretical range of scores from 0 to 400 (although the extremes can only be approached in theory). The risk formula produces higher scores for pipeline segments with lower risks (i.e., a "400" score is a hypothetical pipeline segment with near zero risk; a "0" score is a hypothetical pipeline segment at risk of imminent failure).

9.1.3.2 Identification of Sensitive and Hypersensitive Areas

The selection of sensitive and hypersensitive areas along the pipeline is based on the vulnerability of the existing environment (Chapter 4) to potential impacts (Chapter 7). Areas were identified as sensitive based upon proximity and density of population, ground water (with an emphasis on drinking water supplies), surface water, presence of threatened and endangered species habitats, and proximity to recreational areas. Appendix 7A explains how these areas were identified.

Of the total 731 miles on the Longhorn pipeline, 112 miles are designated as sensitive. Within these 129 miles, 22 miles are hypersensitive areas. Appendix 7A provides tables showing the exact locations by mileposts (MP) of the sensitive and hypersensitive areas along with notes describing why these areas are sensitive and hypersensitive.

Figures 9-1 and 9-2 are large foldout maps of the entire pipeline with enlargements of the Houston and Austin areas. These maps show the location of the sensitive and hypersensitive areas as well as pipeline risk conditions. These sensitive and hypersensitive areas are shown as green strips that are located above and parallel to the pipeline. The light green portion of the strips depicts sensitive areas; the dark green portion of the strips embedded within the light green strips depicts hypersensitive areas. The text boxes in the figures generally identify the sensitive and hypersensitive areas. Figure 9-1 presents the Index Sum scores before mitigation; Figure 9-2 presents the Index Sum scores after mitigation.

9.1.3.3 EA Risk Target Levels

Risk target or tier levels were established by the Lead Agencies as guidelines for determining the mitigation measures necessary to reduce impacts to a level of insignificance along the entire pipeline, recognizing that additional and more stringent mitigation measures are required in the more sensitive areas.

As discussed in Section 9.1.3.4, a direct correlation between all points on the two relative scales of Index Sums and accident rates does not exist due to data limitations. However, there is sufficient knowledge and experience of hazardous liquid pipeline operations to establish relative target levels based on the use and effectiveness of mitigation measures.[2] Appendix 9B describes some links between the relative measure of risk and leak frequency.

The first Index Sum target level established by the Lead Agencies is termed Tier 1 and sets a minimum guideline for mitigation measures required for the entire pipeline. The Tier 1 level was nominally set at 200 points. Based on the relative correlation between the Index Sum and the historical accident rates, the Tier 1 target level reflects a failure rate lower than the national average for similar systems operated by other companies in the United States.

Based on DOT's experience with similar pipeline systems, the mitigation measures required to achieve this target level exceed DOT requirements and are at a level comparable with common industry practices. For these purposes, "common industry practice" means practice consistent with reasonable and prudent operations in the industry, including, as applicable,

[2] Each measure that affects spill probability has an associated point score in the EA Risk Assessment. By accumulating points with application of mitigation measures the target levels can be attained, and hence, risk reduction is demonstrated. In all cases of complying with the tier requirements, the components of the Index Sum, the four indexes that each correspond to a specific failure mode, must be in reasonable "balance." An excess in any individual index can mask a deficiency in another, when only the Index Sum is considered. For example, if the target score were obtained by solely focussing on corrosion control, neglecting protection from third-party damage, or from incorrect operation (human error), the apparent reduction in failure rate is less than what could occur if all failure modes share in the improvement.

compliance with API provisions, NACE provisions, ASME provisions, and company standards. This is a reasonable minimum standard for the entire pipeline.

The second target level is called Tier 2. It is the minimum level for all segments of the pipeline that are in “sensitive areas,” as defined in Appendix 7A. That is, no portion of the pipeline in a sensitive area should have a score lower than this value, set nominally at 240. The mitigation measures required to achieve this target level are equivalent to meeting or exceeding common industry practices applied to pipelines in a benign environment. A benign environment means a lack of threats to pipeline integrity, such as landslide potential, third-party construction activities, highly corrosive soils, crossings by other buried utilities, etc.

The third target level, called Tier 3, is the minimum level for all segments of the pipeline which are in “hypersensitive” areas. That is, no portion of the pipeline in any hypersensitive area should have an Index Sum score lower than 280 points using the EA Risk Model. This Tier 3 target number is the Index Sum that can only be achieved by implementing a combination of mitigation measures that generally corresponds to the advantages of a new pipeline in a “very” favorable (benign) environment. This level of mitigation is more stringent and comprehensive than is currently in practice by similar pipeline systems.

It is important to reiterate that the Tier 1, 2, and 3 Index Sum target levels are used as a starting point in determining appropriate means of reducing risks associated with the pipeline. All portions of the pipeline exceed target levels as is discussed elsewhere in this chapter. Although achieving the applicable EA Risk Model target score was treated as a minimum requirement for all segments of the pipeline, achieving that target score was not treated as sufficient to establish that failure-related risks had been adequately mitigated. Instead, after ensuring that the target scores were achieved, the Lead Agencies’ focus shifted to ensuring that appropriate combinations of protective measures were in place with respect to each pipeline segment. For example, the LMP contains numerous mitigation measures intended to reduce the consequences of a spill, should it occur. Examples are described in Section 9.2.2. Because the Index Sum relates only to pipeline failure probability, rather than to the consequence of a spill, mitigation measures of this kind do not result in improved Index Sums.

9.1.3.4 Residual Risk Analysis

The Index Sum value is thought to generally correlate with failure probability as is shown graphically in Figure 9-3 and described in the following paragraphs. The two scales in this figure show qualitatively how the Index Sum relates to failure frequencies.[3] A more rigorous analyses of the relationship between the relative and absolute scales is in Appendix 9B.

The relationship proposed in Figure 9-3 was developed from incremental Index Sum scores derived for the Longhorn pipeline and from published pipeline accident rates. Index Sum scores for certain segments of the pipeline are shown on a linear scale (the upper scale shown in Figure 9-3). Pipeline accident rates for several companies and groups, as discussed in Chapter 5, are shown on a second scale (the lower scale). While these accident rates are shown as points, the number actually represents the average of some distribution of accident rates—the company would have pipelines with both higher and lower accident rates than the company's average.

A single connection point between the two scales was developed from the length-weighted Index Sum score of 189 (pre-mitigation risk assessment) for the average recent operation from Valve J1 (Houston) to Crane. This score is estimated to be comparable to the accident rate of 0.77 reportable accidents per 1,000 miles per year experienced by the EPC pipeline (excluding stations) during the last 29 years of EPC operation (1964 to 1995). Coincidentally, the accident rate for the entire Williams Energy Company from 1990 to 1997 was 0.71 accidents per 1,000 miles per year.

A second connection point between the two scales is the theoretical link between the highest theoretical Index Sum score of 400 with a near zero accident rate. Since the model is designed to measure all risk variables, even less reasonable mitigation measures can be included. For example, the highest possible Index Sum is 400 points and represents virtually no chance of failure in any failure mode. To achieve the highest score for third-party damage potential, for example, an operator could theoretically take measures such as burying the pipeline 20 ft deep in concrete, install high fences along a specially purchased ROW, and have watch towers and guard patrols 24-hour per day all along the ROW. Such a scenario is not realistic, but the risk model nonetheless has an upper range of point values to capture such aspects of risk reduction. Using only these two data points, the accident rate scale was then compressed so that the two connection points overlaid with the connecting Index Sum scores. This compression resulted in the nonlinear accident rate scale shown in Figure 9-3. These two relative scales reflect several

[3] A definitive correlation between the two scales is very difficult because of the absence of data relating relative risk assessments with leak rates nationwide. One key assumption underlies the displayed correlation, namely, that the failure statistics quantified by the sources cited reflect pipeline systems that are comparable to the Longhorn pipeline. This conceptual linkage between the accident rates and risk scores, reflecting pipeline conditions, is used here because of the limitations of available pipeline industry data. There is no known database correlating accident rates to pipeline characteristics and conditions. However, Appendix 9B presents an estimated correlation for this system.

propositions that the Lead Agencies believe are accurate with respect to hazardous liquid pipelines:

- Most pipelines in the United States have a risk level lower (i.e., higher EA Risk score) than the minimum DOT compliance level;
- The risk level of the Longhorn pipeline, while under EPC operation, was relatively high as is evidenced by the relatively high accident rate;
- As safety improves, it becomes increasingly difficult to further reduce spill frequency; and
- The most effective way to mitigate risks is to reduce spill probability. The alternative of reducing spill consequences involves the reaction to a leak, which is usually less effective in avoiding impact.

Figure 9-4 shows how the three tier levels correspond to the top portion of Figure 9-3.

9.1.4 Description and Interpretation of the Longhorn Mitigation Plan

Longhorn has developed the LMP, which contains the detailed descriptions of measures that would be implemented to reduce risks of leaks and spills during the pipeline operation. The complete LMP is provided in Appendix 9C.

In the LMP, Longhorn has made a number of specific commitments that address the four leading causes of pipeline failures: outside force damage (including third-party damage), corrosion, material defects , and incorrect operations. In addition, Longhorn makes several commitments that address the detection and containment of pipeline leaks as well as enhanced public involvement. The Longhorn Mitigation Commitments (LMCs) are summarized in Table 9-1. Detailed descriptions of the individual commitments are included in the LMP.

In addition to the list and description of the 40 specific mitigation measures, other sections of the LMP include the Project Description and the Longhorn Partners System Integrity Plan (LPSIP). The Longhorn Integrity Management System (LIMS) and the Operational Reliability Assessment (ORA) are both parts of the LPSIP. The entire set of WES operations and maintenance procedures, policies, and manuals that relate to the Longhorn System, fall under the LIMS program. The ORA is a set of processes and calculations that establishes integrity verification intervals. Longhorn has adopted the LMP for all future years of operation. A graphical depiction of the LMP is shown in the approximately 200 annotated alignment sheets that comprise Volume 3 of this EA. These sheets illustrate mitigation measures to be implemented at particular locations.

9.1.4.1 LMP Project Description

The LMP Project Description section contains a brief description of the System, including a listing of the major subsystems. An overview of the project and a description of the planned operation are also provided in the LMP. A more comprehensive description of originally proposed System and its operation is provided in Chapters 3 and 5 of this EA.

9.1.4.2 LMP Longhorn Pipeline System Integrity Plan

The major section of this LMP is the Longhorn Pipeline System Integrity Plan (SIP). The Longhorn SIP is the core organizational driver for Longhorn management initiatives and operational priorities. It is charged with making improvements based on system integrity analyses and performance metrics. The SIP also has the responsibility for resource allocation (time, talent, and money) targeted at risk mitigation.

The SIP consists of certain specific "Process Elements," which, together with the LMC, reflect Longhorn's commitments in the areas of human health and safety and the environment. These process elements include:

- Corrosion Management Plan;
- In-Line Inspection and Rehabilitation Program;
- Identification and Assessment of Key Risk Areas;
- Damage Prevention Program;
- Encroachment Procedures;
- Incident Investigation Program;
- Management of Change;
- Depth-of-Cover Program;
- Fatigue Analysis and Monitoring Program;
- Scenario Based Risk Mitigation Analysis;
- Incorrect Operations Mitigation; and
- System Integrity Plan Scorecarding and Performance Metrics Plan.

Detailed descriptions of each of these process elements, and the manner in which they are incorporated into the mitigation measures, are included in the LMP.

The goals of the SIP encompass a variety of activities. Some of the major goals are associated with adaptability and continuous improvement of the program. The SIP is designed to adapt to change, respond to unique requests, and to monitor, evaluate, and implement new technologies. With the SIP, Longhorn is providing a method to validate or improve the effectiveness, efficiency, and adaptability of the program by continuously measuring, evaluating, and upgrading the program.

Longhorn would perform an annual self-audit of the SIP. This self-audit would provide the means for overall SIP feedback and continual improvement. Longhorn would share its self-audit results and SIP information with the US Department of Transportation (DOT). The DOT would be provided with an increased understanding of the entire Longhorn System, including pipeline maintenance, operation, and emergency response programs.

9.1.4.3 Operational Reliability Assessment

The ORA provides a technical evaluation of the System's integrity and provides specific recommendations to preserve the integrity. A conventional ORA uses the results of previous integrity verifications along with conservatively-applied crack-growth and corrosion-rate calculations to determine safe intervals between integrity re-verifications. This ORA has been expanded to also consider third-party damage potential, earth movements, and other threats to pipeline integrity. The ORA is therefore a key mechanism for determining the timing of integrity re-verifications in response to things like changes in operations; environmental changes along the pipeline route; new data collected from integrity testing; results of new root cause analyses; and input from other programs of the SIP. A summary of the preliminary ORA calculations and results is located in Appendix 9D, "Results of Preliminary Operational Reliability Assessment."

The ORA is to be conducted at least annually, and would include the line pipe, pump stations, terminals, and any other associated System equipment. The ORA may be conducted on a more frequent basis, at least for some segments or components of the Longhorn Pipeline System. Events that could lead to adjustments in ORA frequency include new inspection or test data affecting previous estimates, a significant change in pipeline operation, a pipeline accident, a significant industry or government advisory regarding pipeline integrity, or new or enhanced technologies that could produce significant reductions in pipeline risk. Knowledge, gained through testing or operations, of component conditions or equipment attributes that could affect pipeline risk would be included in the ORAs. Literature reviews are to be periodically conducted and the plan specifics reviewed by independent experts to ensure that the best knowledge and practices are incorporated into the analysis. ORA processes are to be updated as needed.

The results of all elements of the SIP would be incorporated into the ORA as part of the overall assessment of the System. A reputable third-party independent technical company or companies, with demonstrated capabilities in the analyses of mechanical integrity, metallurgy, and components of pipelines would be selected and employed to perform the ORAs. This contractor(s) would be subject to the review and approval of the DOT. Recommendations from the ORA would be implemented by Longhorn, with the approval of the DOT.

9.1.4.4 LMP Monitoring and Enforcement of Public Information

Longhorn would submit quarterly progress reports on the mitigation plan to DOT during the first two years of operation and annually thereafter. These progress reports, which Longhorn would make available to the public on its website, would address the status of each mitigation commitment, results of mitigation related studies and analyses, and any problems anticipated in meeting the LMP. Examples of these studies and analyses include summaries of the annual damage prevention program meetings (see LMP Section 3.5.4), annual risk assessments and updating of population density and environmental sensitivity (see LMP Section 3.5.3), and results of the ORA contractor's report (see LMP Section 3.5.9). These progress reports, the results of the self audit and the ORA review, would assist DOT in ensuring that implementation of the LMP is fully achieved and would assist the public in understanding the progress being made in implementing and maintaining the LMP.

It is DOT's policy to enforce each pipeline against DOT regulations and each company's own operating procedures. Because the LMP is part of Longhorn's operating procedures, it would be enforceable under DOT's current enforcement process. The monitoring and enforcement process is described in more detail in Volume 4, Responsiveness Summary, Section 9.7.1.

The public would be able to track progress in LMP implementation through publication of the progress reports on the Internet at Longhorn's website. LMC 39 in the LMP also assures that any proposed changes to the LMP would be made available to the public. Results of DOT inspections of Longhorn facilities and remaining construction on the pipeline would be on file and available for the public at DOT OPS regional office in Houston.

In addition, Volume 3 of this EA is designed to assist the public in understanding what mitigation measures are being undertaken at specific locations. The annotated alignment sheets in Volume 3 present strips of aerial photography along the entire pipeline, including the Odessa lateral. Each of the approximately 200 sheets shows the pipeline alignment, mileposts, geographical features (such as dwellings, streams, roads, etc), and tier designations. Below each strip of annotated aerial photography are EA Risk Assessment Index Sum scores (before and after mitigation) for the segment of pipeline portrayed in the photograph. The bottom portion of each page lists the specific mitigation measures being conducted along that segment of the pipeline. The annotated alignment sheets therefore provide a complete visual representation of the LMP and its application at every point along the pipeline.

9.2 EFFECTIVENESS OF MITIGATION MEASURES—ELIMINATING SIGNIFICANT IMPACTS

Federal regulations governing the preparation of NEPA documents do not set out objective and explicit guidelines as to what constitutes a threshold separating impact "significance" and "insignificance." There are no quantitative limits, such as acceptable risk levels or acceptable concentrations of discharges. The regulations (40 CFR §1508.27) do identify considerations that Lead Agencies take into account in making this judgment call. These include qualitative factors, such as the "degree to which the action affects public health or safety," the degree to which the action may affect historic, cultural, or scientific resources, or "whether the action threatens a violation of federal, state, or local law or requirements imposed for the protection of the environment."

The Lead Agencies have determined that the proposed project, as originally planned, had the potential for significant impacts. The mitigation measures, to which Longhorn has committed, reduce the potential impacts to a level of insignificance through their collective effect. The collective effect can be seen through looking at Tables 9-1 and 9-2 and is described in this section.

Table 9-1 lists each of the 40 separate mitigation measures (or Longhorn Mitigation Commitments).

Table 9-2 shows how individual measures listed in Volume 3 for Tier 1, 2, and 3 areas address several categories of impacts typically addressed under NEPA. The table shows at a glance that most measures address several impact categories simultaneously and that each impact category is addressed by multiple measures.

Discussion of the mitigation effectiveness is also presented in the following section. Within each of the four failure modes described in the EA Risk Model (Chapter 6), mitigation measures are identified that address that failure mode. Some mitigation measures are addressing more than one failure mode. Mitigation measures intended to reduce spill consequences are also shown.

9.2.1 Mitigation Measures by Failure Mode

While no guarantees of leak-free operation over many years can be made, the LMP should greatly reduce the failure potential of this pipeline. This is accomplished via three steps that, while not unique to the Longhorn pipeline, go significantly beyond common practice in their thoroughness as specified in the LMP. These three steps are:

1. Verify current pipeline integrity;
2. Identify and prioritize all possible failure mechanisms using risk assessment techniques; and
3. Adopt extensive measures to address each failure mechanism.

The comprehensiveness of these three steps provides assurance that very few pipeline failures should occur when the LMP is fully implemented. Long stretches of US pipelines can be found operating for several decades with no failures (see 9.2.5) and while probably not employing nearly as much mitigation as is called for in the LMP. This provides at least some evidence that very low failure rates are possible in the real world. The way in which the LMP addresses all aspects of the three steps noted above is the topic of the rest of this section.

The following discussion shows how failure modes in general are addressed in the LMP. These lists are intended to show where the LMP specifies measures that exceed minimum regulatory compliance and common industry practice. Since the latter is difficult to gauge, some items are noted when it is not certain how widespread the practice is being followed.

9.2.1.1 Third-Party Damage

This failure mode involves damages caused by human activities near the pipeline. The most common damages arise from various forms of excavations including digging, boring, and drilling. Third-party damage is a category of failures that is often viewed as the most random and hence, the least controllable through mitigation. A third-party related pipeline failure requires several conditions. Each condition represents an opportunity to interrupt a series of events that would otherwise precipitate a pipeline failure. Since most third-party damage involves excavation activities, the following discussion focuses on those. A sequence of events leading to a third-party related pipeline failure requires several conditions:

- Excavation equipment operating near to the pipeline;
- An equipment operator who is unaware of the location of the pipe;
- A pipeline that is vulnerable to the activity; and

- Damages that are undetected by the pipeline owner.

Each condition represents an opportunity to prevent a failure by altering the condition and interrupting the event sequence. Attachment B to Appendix 9B is a scenario-based evaluation providing greater details of these interruption opportunities.

Seven out of 26 historical leaks on this pipeline (under EPC operation) were categorized as being caused by "third-party damage." It is useful to characterize these accidents based on some situation specifics. At least six of the accidents involved heavy equipment such as backhoe, bulldozer, bulldozer with ripper/plow, and ditching machine (the seventh is not listed). Five of the accidents suggest that a professional contractor was probably involved since activities are described as cable installations, water line installations, excavations for an oil/gas company, land clearing, etc. At least four of these events occurred before a One-Call system was available in Texas (a system was available in the early 1990s and mandated in late 1997). So, the opportunities for advance knowledge of the presence of the pipeline was limited to signs, right-of-way (ROW) indications, and perhaps some public records if the excavator was exceptionally diligent in a pre-job investigation. Contractor and public education efforts, ROW condition, and actual patrol frequency at the times of these accidents are unknown. Based on current survey information, depth of cover at these sites varies from 19 inches to over 48 inches, although depths at the time of the accidents are unknown. Many of these conditions have been improved through the years or would be specifically improved under the LMP.

LMP provisions to reduce the potential for future third-party failures include the following:

Higher frequency patrols—daily, every 2.5 days, or weekly, depending on tier. Increased surveillance should eliminate a large portion of potential damage scenarios since the patrol would also be looking for indications such as approaching activity and recently completed activity.

Concrete cap in specific areas. A red-colored reinforced concrete slab should offer a physical barrier against excavations as well as a visual alert to excavators. Such slabs are to be installed in conjunction with the pipe replacements through the Edwards Aquifer area as well as wherever Longhorn's on-going risk management program identifies the need for such additional protection.

New pipe with increased safety factor, in specific areas. Heavier walled pipe offers additional strength to resist external forces. Damages to this pipe are less likely to result in loss of containment. New, heavier walled pipe will replace existing pipe over a 19-mile segment of pipeline through the Edwards Aquifer area and contributing zone. Other areas for potential installation of new pipe may be identified through Longhorn's on-going risk management program.

Increased depth of cover in specific areas. Additional depth of cover puts the pipeline out of reach of certain excavation activities, and the depth of cover will be increased in selected areas. New, heavier walled pipe will replace existing pipe over a 19-mile pipeline segment across the Edwards Aquifer and contributing zone and would be buried to a depth of 7 ft. Other selected areas where increased depth of cover would be potentially needed might be identified from Longhorn's on-going risk management program.

Annual door-to-door visits to adjacent residents in Tier 2 and Tier 3. Regular personal contact with neighbors should increase the number of "pipeline-aware" individuals, thus reducing the number of damaging activities and perhaps even enlisting the support of such individuals in reporting potentially damaging activities when observed.

Placement of more ROW markers. Additional signs and markers in Spanish and English should increase the chances of an excavator becoming aware of the pipeline's presence and contacting Longhorn or the One-call center.

ROW kept in "excellent" condition. Although a clear ROW might invite unintended use, it also offers an additional indication of the pipeline's presence, enhances surveillance, and increases accessibility to the pipeline in the event of a spill.

Annual mailings. Regular contact via mailed pamphlets and promotional materials should increase the number of "pipeline-aware" individuals, thus reducing the number of damaging activities and perhaps even enlisting the support of such individuals in reporting potentially damaging activities when observed.

The planned larger radius of mailings (1/4 mile to 1 mile, urban to rural, respectively) should increase the number of people receiving such mail which should increase the number who are made aware of pipeline issues. This in turn, should increase the chances of avoidance of or intervention during a potentially damaging activity.

Depth-of-cover program—risk based. This program should preferentially increase depth of cover where it is most beneficial to do so. This is in consideration of both probability of third-party damage and consequences of a spill.

Integrity verifications (hydrostatic test). Verifying a defect-free pipe and establishing a margin of safety between the System strength and its intended operation increases the likelihood that the System would operate leak-free under normal operations and can also tolerate some unintended forces.

Integrity verifications (ILI). Regularly ensuring a defect-free pipe increases the likelihood that the System would operate leak-free.

Integrity re-verifications based on ORA including third-party considerations. Conservatively re-verifying System integrity ensures that defects not prevented or detected by other means are found before they cause a loss of containment. Conservative assumptions in the ORA ensure more frequent verifications.

When notification is received, continuous on-site supervision of third-party activities while pipeline is exposed. Direct supervision of a potentially damaging excavation ensures that minor damages such as coating scratches or metal scrapes are avoided or at least repaired before re-burial.

Annual public education, contractor, public officials meetings. Regular direct contact via meetings and presentations should increase the number of "pipeline-aware" individuals, thus reducing the number of damaging activities and perhaps even enlisting the support of such individuals in reporting potentially damaging activities when observed.

Close interval pipe-to-soil surveys (CIS) to find coating damages from previous strikes. CIS is primarily a corrosion-control measure, but can also help detect previous coating damages from third-party activities. Such minor damages can lead to more serious threats to pipeline integrity if not detected and addressed. They might indicate more severe damage that should be immediately investigated and impact the ORA-driven integrity verification schedule.

Surge pressure limitations to reduce chance of undetected previous damage leading to leak. In association with integrity verifications, the surge pressure limitations ensure that the System is not exposed to internal pressure-induced stresses and "shocks" that it cannot withstand. Until previous third-party damage is detected and addressed, the System could be more vulnerable to failure from unintended stresses.

Root cause analyses to identify special situations. Investigations of previous leaks and repairs that lead to identification of underlying causes and procedural shortcomings should help prevent similar scenarios in the future.

Many other parts of the LMP also address third-party damage potential. These include measures that are not "new" or "extra" mitigation but are part of the O&M plans and/or already required by regulations. Most of the third-party damage related measures address prevention of any third-party activities near the pipeline. The remaining measures address protection of the pipeline when such activities are nearby. All of the measures are thought to be interrelated and, when combined, should prevent almost all third-party failures. The objective is to interrupt any sequence of events that could lead to a pipeline failure.

The current LMP is judged to have a high degree of effectiveness since it capitalizes on opportunities to interrupt a failure event sequence. A first line of defense is the mandated one-call system that should prevent many episodes of unsupervised, nearby activity that would otherwise occur. The one-call system was not available before the early 1990s and is believed to be gaining more acceptance and hence, effectiveness, every year even where not mandated. This alone should decrease failure potential.

Supplementing and overlapping the one-call system are the public education program and excavator education program as described in the LMP. The public education program is especially robust since it includes door-to-door visits—the face-to-face contact with ROW "neighbors" who not only often control access to the pipeline, but who also may serve as additional observers (using sight, smell, and hearing) to help monitor conditions along the ROW. Annual mailings should also keep pipeline issues more immediate in the minds of neighbors. Both programs should reach more people than the one-call system alone and hence increase the chances of a pipeline-aware individual interrupting an event sequence.

If, despite efforts to alert potential excavators, activity commences near the pipeline, then at least two more prevention opportunities exist. The first is the signs, markers, and cleared ROW. Together these present a scene that can prompt an excavator to pause and investigate further. The second is the scheduled patrol that detects not only activity near the pipeline, but also activity that is either progressing towards the ROW or has recently occurred near the ROW. The shortened time-between-patrols is thought to greatly reduce the number of activities that could go undetected. This is further discussed in Attachment B of Appendix 9B. Patrol also affords the opportunity to detect recent disturbances over the pipeline. Since third-party activities can cause damages that do not immediately lead to failure, this ability to inspect evidence of recent activity is important. Such minor damages can be repaired before they become integrity threatening.

If these measure fail to prevent the activity, several elements offering direct protection are called for in the LMP. Increased depth of cover reduces the types of equipment and excavations that could be potentially harmful to the pipeline. A concrete cap, red in color, should prevent virtually any excavator from accidentally damaging the pipeline in areas where such a cap is installed. Finally, where extra wall thickness is specified, the pipe is more tolerant of additional stresses.

Even minor excavation contact with the pipeline can cause coating damages and pipe wall scratches that could become integrity threatening over time due to corrosion and/or fatigue stresses. The additional mitigation measures related to these time-dependent failure mechanisms, such as future integrity verifications and cathodic protection (CP) effectiveness surveys, should reduce these failure potentials. In addition, all measures intended to reduce stresses, such as the surge limitations, also have the benefit of making the pipe more tolerant to any third-party damages that might, despite all mitigation measures, still occur. These are described in the following sections.

9.2.1.2 Corrosion

This failure mode involves the various forms of metal deterioration including atmospheric, internal, and buried-metal (galvanic) corrosions. Corrosion is of concern because any metal loss invariably means a reduction in structural integrity with an associated increase in the risk of failure. The potential for pipeline failure caused either directly or indirectly by corrosion is perhaps the most familiar hazard associated with steel pipelines. Only 2 of the 26 historical leaks on the EPC were attributed to corrosion, however, the causes of 9 of the 26 leaks were not identified. Based on general US pipeline leak experience and assumptions regarding past leak reporting practices, it is reasonable to assume that many of the unspecified leak causes were corrosion related. Therefore, corrosion prevention measures are warranted. LMP provisions to reduce the potential for corrosion-related failures include the following:

Integrity verifications (hydrostatic test). Verifying a defect-free pipe and establishing a margin of safety between the System strength and its intended operation increases the likelihood that the System would operate leak-free under normal operations and can also tolerate some unintended forces.

Integrity verifications (ILI). Regularly ensuring a defect-free pipe increases the likelihood that the System would operate leak-free.

Integrity re-verifications based on ORA including corrosion considerations. Conservatively re-verifying System integrity ensures that defects not prevented or detected by other means are found before they cause a loss of containment. Conservative assumptions in the ORA ensure more frequent verifications.

Reburials, if coating repair, replacement is involved. In many cases, the older external coating would be damaged by the handling required in a lowering or reburial process. This would require a re-coating or repair-of-coating of the section, improving the corrosion-resistance.

Close interval pipe-to-soil surveys. These surveys are among the best tools to ensure that adequate CP is reaching all portions of the System.

Additional test lead readings. While not as complete a survey as CIS, the test lead reading surveys also help detect CP deficiencies. The more frequent surveys specified shorten the time period between detection opportunities.

Internal corrosion coupons. As a third line of defense behind product corrosion specifications and inhibitor injection, the corrosion coupon program should detect any potential internal corrosion problems before they can threaten the pipe integrity. (A corrosion coupon is sacrificial metal placed inside the pipeline used to measure corrosion activity.)

Surge pressure limitations to reduce chance of undetected previous damage leading to leak. In association with integrity verifications, the surge pressure limitations ensure that the System is not exposed to internal pressure-induced stresses and "shocks" that it cannot withstand. Until previous corrosion damages are detected and addressed, the System could be more vulnerable to failure from unintended stresses.

Root cause analyses to identify special situations. Investigations of previous leaks and repairs that lead to identification of underlying causes and procedural shortcomings should help prevent similar scenarios in the future.

Studies/remediation—stress corrosion cracking. While a very rare phenomenon for this type of pipeline in this climate, the study provides assurance that stress corrosion cracking issues have been considered and operating personnel have been alerted to those issues.

New pipe with increased safety factor, in certain locations. Heavier walled pipe offers additional strength to resist external forces and extends the pre-failure detection opportunity for possible metal loss from corrosion. Damages to such pipe are less likely to result in loss of containment. Nineteen miles of existing pipe in the Edwards Aquifer and contributing zone will be replaced with heavier walled pipe. Other selected segments where new pipe might be considered for replacing existing pipe may be identified through Longhorn's ongoing risk management program.

Most corrosion mechanisms are well understood and therefore, preventive measures can be appropriately designed. Regulations and industry standards specify many corrosion control measures. Corrosion is a time-dependent phenomenon. With a strong program of inspection, there is usually sufficient time to detect and respond to corrosion before it becomes integrity threatening.

The LMP recognizes that one of the two primary defenses against corrosion of buried metal, the coating system, is old in some portions of the pipeline and not as effective as a modern coating system would be. Coating replacement is an imperfect solution since field-applied coatings are generally not as good as those applied under the controlled conditions of a coating yard. The planned re-coatings and pipe replacements (which include new coating) reduce the amount of older coating and reduce risks proportionally. The reduced effectiveness of the remaining old coating is offset by more attention to the other line of defense—the impressed current CP system. CP alone can prevent corrosion, but is normally not cost efficient without a coating that reduces the amount of steel that must be protected. Ensuring that adequate levels of CP are always applied eliminates a large part of the corrosion concern, even when occasionally poor coating is present. The additional pipe-to-soil potential surveys planned, especially the closer interval variety, offer more complete assurance that sufficient CP is present. If CP levels are inadequate or otherwise prevented from protecting the steel (for example due to shielding effect of disbonded coating), then corrosion could occur. This would be a characteristically slow-acting corrosion. Reliance is on the integrity re-verification program (ORA) to detect such mitigation gaps before corrosion progresses.

Internal corrosion is prevented by programs to control product specifications, inject inhibitors, and use monitoring coupons. This represents several lines of defense. In order for internal corrosion to occur, an off-specification product would have to be delivered into the pipeline, the inhibitor injection would have to be ineffective, and the coupon monitoring program would have to fail to detect the corrosion. The chances of all of these mitigations failing are very remote.

More exotic forms of corrosion involving mechanisms such as interference or microbial activity are addressed through the LMP's corrosion control provisions, which are more industry standard. The study to effectively rule out the potential for stress-corrosion cracking (SCC) addresses in detail one of these more rare corrosion mechanisms. All forms of corrosion, even the more rare forms, are further addressed by integrity re-verifications, which are driven by the ORA. This, coupled with the more rigorous attention to the common mechanisms, fosters the belief that leak potential from corrosion is very unlikely.

9.2.1.3 Design

Another significant element in the risk evaluation is the relation between the original design of the pipeline and the proposed operation of the pipeline. This failure mode involves issues related to stress levels, naturally occurring external forces, and safety margins. All original design calculations contain some assumptions, including material strengths and the use of simplifying models. Many of the factors included in the assessment of design-related risks are dependent upon operating conditions such as normal pressures and surge pressure potential.

Failures in this category are possible only where system weaknesses—inconsistent with design limits—exist or unanticipated stresses are encountered. As the chances for either of these elements are reduced, so too is the probability of failure in this category. The LMP reduces these integrity threats by first verifying current pipe integrity and then by identifying and responding to potential failure initiators. Some of the failure initiators of concern in this case are related to external forces (but not third-party damage potential which is addressed elsewhere) such as those caused by seismic activity, scour, landslides, and other earth movements.

LMP provisions to reduce the potential for failures related to "design" issues, as defined herein, include the following:

Stopple removals. A stopple is a specialized fitting installed in a pipeline to allow work to be done on the pipeline without completely clearing it of product. The fittings are often left in the pipeline after the work is completed. Historically, older stopple fittings have been leak prone. Removal of these eliminates a potentially problematic pipeline component.

New pipe with increased safety factor. Heavier walled pipe offers additional strength to resist external forces. Damages to such pipe are less likely to result in loss of containment.

Integrity verifications (hydrostatic test). Verifying a defect-free pipe and establishing a margin of safety between the System strength and its intended operation increases the likelihood that the System would operate leak-free under normal operations and can also tolerate some unintended forces.

Integrity verifications (ILI). Regularly ensuring a defect-free pipe increases the likelihood that the System would operate leak-free.

Fatigue monitoring program as part of ORA. Fatigue cycles are a mechanism by which cracks in metal can grow larger due to many loadings, eventually reaching an integrity-threatening size. Measuring pressure cycles allows calculations to be performed so that new integrity tests or inspections can be more accurately scheduled.

Surge pressure limitations to reduce chance of undetected previous damage leading to leak. In association with integrity verifications, the surge pressure limitations ensure that the System is not exposed to internal pressure-induced stresses and "shocks" that it cannot withstand. Until all defects are detected and addressed, the System could be more vulnerable to failure from unintended stresses.

Integrity re-verifications based on ORA including crack considerations. Conservatively re-verifying System integrity ensures that defects not prevented and undetected by other means are found before they cause a loss of containment. Conservative assumptions in the ORA ensure more frequent verifications.

Studies/remediation—span. This is an engineering assessment of all pipeline spans to determine if the pipe is overstressed or likely to become overstressed due to additional loadings or loss of support. Analyses and subsequent remediation ensure that the likelihood of such overstressing is greatly reduced.

Studies/remediation—landslide. While a very rare failure mode for this type of pipeline in the topography, this study provides assurance that landslide issues have been considered and operating personnel have been alerted to those issues.

Studies/remediation—seismic. While a very rare failure mode for this type of pipeline in this region, the study provides assurance that seismic issues have been considered and operating personnel have been alerted to those issues.

Studies/remediation—scour. This is an engineering assessment of scour-susceptible pipeline stretches (e.g., at a river or stream crossing) to determine if the pipe is likely to become unsupported. Analyses and subsequent remediation ensures that the likelihood of this failure mode is greatly reduced.

Studies/remediation—subsidence. This is an engineering assessment of the possibility for some portions of the pipeline to lose support due to soil subsidence. Analyses and subsequent remediation ensures that the likelihood of this failure mode is greatly reduced.

Monitoring of aseismic faulting in Houston area. This is an engineering assessment of all portions of the pipe near to active aseismic faults to determine if the pipe is likely to be overstressed from additional loadings or lack of support. Analyses, monitoring, and subsequent remediation ensures that the likelihood of this failure mode is greatly reduced.

Root cause investigation program. Investigations of previous leaks and repairs that lead to identification of underlying causes and procedural shortcomings should help prevent similar scenarios in the future.

Current integrity is verified by overlapping tests and inspections as described in the LMP. This eliminates system weaknesses. Until such verifications are complete, operating pressures are reduced to account for the uncertainty, thereby increasing the margin of safety. Removal of historically problematic components (cause of leaks in other pipelines—similar problems have not been seen in this pipeline) such as stopple fittings, eliminates another potential system weakness. Increased inspections and/or tests for low frequency electric resistance weld seam weaknesses and continuous monitoring of fatigue cycles offsets yet another potential susceptibility.

The possibility of high stresses due to unusual external forces is next addressed. Potential sources of such unusual forces have been identified through analyses of past pipeline failures and consideration of all reasonable external-loading scenarios. These possible failure contributors were assessed in detail in a route-specific manner for this pipeline. The LMP-mandated studies (see Appendix 9E) therefore offer assurances that the covered failure mechanisms, already rare in the experience of most pipelines, present virtually no threat to this pipeline.

Under these measures, first the system strength is confirmed to a high degree of confidence. That strength is then protected by addressing possible future external force threats. Additional assurances of on-going system integrity are obtained from the ORA-driven re-verification program and surge pressure limitations. Surge pressure limitations ensure lower stress levels in the pipeline as an added safety factor against possible future undetected weaknesses from any cause.

9.2.1.4 Incorrect Operations

This failure mode involves human error as a prime cause of a failure and is perhaps the most difficult to quantify. Safety professionals are emphasizing behavior as possibly the key to a breakthrough in accident prevention. Of the failure causes listed for the 26 historical leaks on this pipeline, only one was directly attributed to human error. Although human error can play a role in every other failure mode, it is examined here as a primary initiator. LMP provisions to reduce the potential for failures relating to human error include the following:

Surge limitations. In association with integrity verifications, the surge pressure limitations ensure that the System is not exposed to internal pressure-induced stresses and "shocks" that it cannot withstand. Human actions can often precipitate a surge event; therefore, this is a risk-reducer for human error issues.

Risk management program. Identification of hazards and assessment of risks should help to focus resources appropriately to reduce leaks, especially in higher consequence areas.

Hazard and Operability Studies (HAZOPS) for hazard identification. The very structured and comprehensive nature of HAZOPS ensures that complex systems, such as a pump station and its associated control logic, are thoroughly assessed. Hazards, complications, or inadequacies related to operations sequencing and shutdown systems should be identified and addressed through this program.

Training Program. Training is viewed as the first line of defense against human error and accident reduction. A Longhorn training program will be developed that contains the following components: product characteristic awareness, pipeline material stresses and associated component mechanical design limitations, pipeline corrosion awareness, pipeline control devices and operating knowledge, and maintenance awareness. This training should mitigate potential errors in operations.

Management of Change program. This process forces an evaluation for any proposed change to a system. This should ensure that a desired change does not lead to an unintended consequence.

Root cause investigation program. Investigations of previous leaks and repairs that lead to identification of underlying causes and procedural shortcomings should help prevent similar scenarios in the future.

Camera surveillance of pump stations. This provides the ability to visually inspect the pump station grounds for signs of abnormal conditions. It should also provide opportunities for control room personnel to better coordinate with field personnel in performing station activities.

Heavier walled pipe. Heavier walled pipe offers additional strength to resist unintended stresses from operational upsets. Such pipe is less likely to be damaged and is therefore also less likely to result in loss of containment.

Integrity verifications (hydrostatic test). Verifying a defect-free pipe and establishing a margin of safety between the System strength and its intended operation increases the likelihood that the System would operate leak-free under normal operations and can also tolerate some unintended forces.

Integrity verifications (ILI). Regularly ensuring a defect-free pipe increases the likelihood that the System would operate leak-free.

Human error by the pipeline operator is not often a direct cause of pipeline failure. It is however, a likely contributing factor to many failures and an important element in leak consequences where rapid and correct reactions greatly influence the event outcome. Eliminating human error as a direct cause of pipeline failure is similar to the third-party damage prevention in that event sequences that could precipitate a failure must be interrupted. The interruption opportunities in this case are provided primarily through training, procedures, redundant safety systems, and operational safety margins. These interruption opportunities themselves are protected by administrative systems such as management of change. Safety margins are protected by the ORA integrity-verification program, surge pressure limitations, and, in some cases, higher pipe strength. Therefore, a human error event sequence that leads to a pipeline leak requires the failures of all of the prevention opportunities as well as the exceedance of safe operating parameters. Prevention opportunities include employee training; use of accurate and complete procedures; and safety systems. Even an inadequately trained employee can be prevented from precipitating a failure if he correctly follows a detailed procedure. If he is both ill-trained and fails to follow a procedure (or he uses an inadequate procedure), then an error must still be of the type that could cause a design limit to be exceeded and not be prevented by safety systems designed to prevent such exceedances. A further consideration is the margin of safety between design limits and strength limits--so the error must lead to an exceedance of the margin of safety as well. The LMP specified processes should make such scenarios very unlikely.

It is conservatively assumed that a human error could occur at any phase of the pipelining process—design, construction, operations, or maintenance. Since integrity verifications address most potential human errors that may have occurred during design and construction, the operations and maintenance aspects of the pipeline become the focus for human error prevention. The most important consideration is the susceptibility of the pipeline to fail from human error. The first line of defense is therefore the identification and minimization of system vulnerabilities. The risk assessment efforts including periodic HAZOPS and the management of change program are the means for identification of hazards and also serve as training and risk-sensitizing opportunities for operating personnel. The Longhorn pipeline does have pressure sources—the overpressuring the line. However, several redundant levels of safety devices exist to prevent failure even when a human error sets into motion a chain of events that could lead to overpressure. These safety systems include independent devices that react to unusual pressure, temperature, or vibration conditions at various locations along the pipeline (see Chapter 5 for more discussion of safety systems). They are protected by the maintenance and calibration program as well as the commitment to perform additional HAZOPS and management of change procedures, as specified in the LMP. While these actions are now seen more often in the pipeline industry, such commitments are believed to still be unusual and should reduce error potential.

Surge pressure limitations, coordination of field activities through the use of two-way communications and camera surveillance of pump stations, and the training program described in WES documents (see Chapter 5) combine to further support the belief that potentially dangerous human errors would be greatly reduced in this system.

9.2.2 Mitigation Measures to Reduce Impact Severity

While it is obviously preferable to prevent leaks from occurring, the potential for such an occurrence must be recognized, and methods to reduce the impacts of leaks must be implemented. In studying the impacts of leaks and devising methods for mitigating the impacts, the distinction between chronic and acute hazards should be recognized. Hazards such as fire, explosion, or contact toxicity are considered to be acute hazards. Hazards such as ground water contamination, carcinogenicity, and other long-term health effects are considered to be chronic hazards. Product properties such as flammability, reactivity, and toxicity must all be considered in evaluating the severity of impact of a leak. The characteristics of the area at and around the spill area must also be factored into the impact determination. These characteristics include soil properties, vegetation, ground slope, population density, ground water and surface water flow patterns, proximity to ground water and surface water, product solubility in water, etc.

Several mitigation measures have been developed to reduce the potential consequences of a spill from the pipeline. These are listed and described below:

Leak detection—hydrocarbon-sensing cable. Leak detection offers the opportunity to react to a spill and thereby reduce the severity of consequences. The sensing cable adds the capability to detect very small leaks, undetectable by other means. Such leaks, if allowed to continue, could otherwise result in large volume spills with far-ranging impacts.

Leak detection—transient model, Supervisory Control and Data Acquisition (SCADA) based. The transient model adds the capability to detect smaller leaks than conventional SCADA equipment alone can detect. This reduces the number of leak scenarios that could continue undetected for long periods of time.

Methyl tertiary-butyl ether (MTBE) removal. At very low concentrations, MTBE makes drinking water non-potable, and it is one of the most difficult product components to remediate. Its removal from the pipeline reduces the potential long-term impact associated with many spill scenarios. Additionally, due to its unique properties, MTBE in a release complicates the emergency response effort. Its removal would simplify the situation in the field and expedite the remediation.

Leak detection—increased patrol. A shortened time between surveillance actions provides the opportunity to more rapidly detect a leak and thereby reduce spill volumes.

Leak detection—increased public awareness program. Increased public education should increase the number of pipeline-aware individuals among the public. This has the potential benefit of enlisting many observers in the leak detection process, thereby increasing the chances of early reporting of a leak.

Pipeline shutdown at flood levels. To reduce the likelihood of a catastrophic spill and contamination of the City of Austin drinking water supplies, Longhorn will monitor stream levels and will cease pipeline operations when flow rates on the Pedernales River reach 100,000 cfs.

Secondary containment along certain stretches of ROW. Design provisions to capture and retain spilled product (not allowing it to migrate from the ROW) should reduce the chances of spills reaching any sensitive receptors along these stretches of the ROW.

Additional check valve installations. The potential spill volume is often heavily influenced by the draindown potential. Fast-acting valves such as check valves can greatly reduce the amount of product spilled from a pipeline.

Enhanced emergency response plan. This should provide the plans and procedures to ensure that an optimum response to a spill is conducted. This plan exceeds common practice.

New emergency response center. This should decrease the response time to a spill, thereby increasing the opportunities to take consequence-reducing actions such as evacuation and containment.

Risk management program to direct resources in proportion to area sensitivities. Identification of hazards and assessment of risks should help to focus resources appropriately to reduce leaks, especially in higher consequence areas.

Leak detection—water quality monitoring. This measure adds the capability to detect very small leaks, undetectable by other means. Such leaks, if allowed to continue, could otherwise eventually result in large volume spills with far-ranging impacts.

Surveillance personnel all trained to Occupational Health and Safety Administration Hazardous Waste Operations and Emergency Response (OSHA HAZWOPER) first responder level. This training ensures that personnel (other than control room personnel) who are most likely to detect an abnormal condition know what actions should be immediately taken to reduce potential consequences.

Secondary containment at Cedar Valley pump station. Preventing movement of spilled product away from the pipeline is the intent of this mitigation. This should prevent offsite receptors from being impacted by a spill.

Camera surveillance of pump stations. This provides the ability to visually inspect the pump stations grounds for signs of abnormal conditions. It is also another diagnostic tool to assist the control room in identifying leaks or determining the need to halt product movements.

Contingency plans for alternate water supplies. As a means of reducing the impact of a spill, the LMP specifies the providing of alternate water supplies to affected communities and private well owners until cleanup is completed and permanent water supplies are restored.

Pollution Liability Insurance. Longhorn would maintain pollution legal liability insurance of no less than $15 million to cover claims arising from spills. This is a means of assuming compensation for losses and cleanup costs (see Appendix 9H).

9.2.3 Barton Springs Salamander and Edwards Aquifer Protection

The following discussion describes how a multi-layered array of mitigation measures would protect a segment of the pipeline over a very sensitive area along the pipeline route that includes habitat of the vulnerable Barton Springs Salamander population in the Austin area. The potential threat is from a pipeline spill within the approximately 19 miles of the recharge zone and contributing zone of the Edwards Aquifer. Such a spill could migrate to the aquifer or to surface streams and then into Barton Creek resulting in contamination of the aquatic habitat of this threatened and endangered species. The extraordinary degree of mitigation over this segment was developed in part by the Lead Agencies recommendations and, in part, through discussions between Longhorn and FWS as part of the Endangered Species Act Section 7 consultation process. The mitigation measures here are atypical of the pipeline as a whole and reflect measures proffered by Longhorn to address concerns raised by FWS. The details of this mitigation as it relates FWS concerns are provided in the Phase II BA (see summary in Appendix 4E). A list of mitigation measures, which cumulatively provide protection of the Edwards Aquifer, Barton Springs, and the Barton Springs Salamander are shown below:

- LMC 1 would demonstrate that the pipeline is capable of withstanding 125 percent of the pipeline's maximum operating pressure (MOP) through hydrotesting before System startup.
- Nevertheless, LMC 9 states that Longhorn would not allow maximum allowable surge pressures (allowed by regulations to be 110 percent of MOP) to exceed MOP over all sensitive and hypersensitive areas.
- Over approximately 3-miles of this stretch, Longhorn would install new, heavier-walled pipe with 5-ft minimum depth of cover and a protective concrete cap (LMC 3). Collectively, the new pipe with its thicker walls and new coating and the increased protection from third-party damages, sharply reduce the probability of pipeline failure. See also additional commitments from the endangered species consultation.
- Longhorn's FRP has been revised to show pre-planned response locations to enable response personnel to optimize emergency response and recovery operations along the recharge and contributing zones of the Edwards Aquifer.
- To reduce the likelihood of third-party damage to the pipeline, Longhorn would conduct enhanced public education/damage prevention programs (LMC 25).
- Longhorn would increase the frequency of CP surveys to reduce likelihood of corrosion (LMC 32).
- While most pipelines have weekly surveillance, Longhorn has committed to a patrol frequency of once every 2.5 days (LMC 20) for sensitive and hypersensitive areas. However, in the three-mile crossing of the recharge zone, Longhorn would have daily patrols.
- To allow these daily patrols to more readily spot signs of leakage, Longhorn would maintain the ROW to excellent condition across the entire line (LMC 17).
- To detect small leaks over the Edwards Aquifer Recharge Zone that may otherwise escape notice, Longhorn would install a state-of-the-art sensor-based leak detection system along 3 miles of this stretch (LMC 13).

- Longhorn has committed to being able to shut down the System within five minutes of detecting a leak in this section (LMC 13).
- Once a leak has been discovered, Longhorn would implement measures to enable a response to a spill in less than two hours.
- In measures specific to the preservation of the Salamander (LMC 28 and 33), Longhorn has agreed to revise its Facility Response Plan to make it consistent with the City of Austin's Barton Springs oil spill contingency plan and the US Fish and Wildlife Services Barton Springs Salamander Recovery Plan and would provide funding for a refuge and captive breeding program
- Although not listed as a separate measure, Longhorn has isolated a 9-mile portion of the pipeline, including portions of this stretch, through remote controlled valves that would automatically shut off and limit the quantity of product that would be lost to the environment should a leak occur.
- Should a leak result in environmental damage, Longhorn has obtained a $15 million insurance policy for pollution legal liability (LMC 37).

In addition to the mitigation measures identified above, several measures were added based on the endangered species consultations with FWS. Many of these measures go beyond those that were needed to meet the Lead Agencies' concerns.

- Longhorn would install 16 miles (in addition to the original 3 miles discussed previously, for a total of 19 miles) of new, heavier-walled pipe with 5-ft minimum depth of cover and a protective concrete cap (LMC 3). Collectively, the new pipe with its thicker walls and new coating and the increased protection from third-party damages, sharply reduce the probability of pipeline failure.
- The new pipeline segment would be placed in a trench that would be designed to serve as secondary containment in the event of a leak in the pipeline. The trench would be in limestone and cracks and karst features would be sealed off by grouting.
- Surface retention areas would be constructed to assure containment in the event of a release that results in a flow out of the trench (e.g., a leak that occurs during a rainfall event and/or a large spill).
- To detect small leaks over the Slaughter Creek watershed in the Edwards Aquifer Contributing Zone that may otherwise escape notice, Longhorn would install a 5-mile-long, state-of-the-art, sensor-based leak detection system. This results in a total of 8 miles of sensor cable in this area (LMC 13).

Nevertheless, the measures illustrate the principle, found in varying degrees across the entire System, of implementing overlapping means of reducing the probability of failure, improving the detection of leaks and spills, and enhancing the capability to respond to leaks if they should occur.

9.2.4 Comparison of the Condition of the Pipeline before and after Mitigation

Figures 9-1 and 9-2 generally illustrate with color codes how mitigation measures reduce the impacts on pipeline segments based on the EA Risk Model Index Sum scores. The annotated alignment sheets in Volume 3 show the before and after scores for site-specific segments along the pipeline.

Table 9-3 shows the before and after scores for specific pipeline segments and for the entire pipeline. The top row of figures shows that, before mitigation, the average score for the entire pipeline was 195 and, following mitigation, the average increases to 295 (289 on a length-weighted basis). This top row also indicates that the minimum score for the entire pipeline was 139 before mitigation. After mitigation, the lowest score is 237. This is well above the Tier 1 target level of 200 and near the Tier 2 level of 240. Table 9-3 also shows minimum, average, and maximum scores for various tier levels in the two large urban counties, Harris County and Travis County. The table indicates that the hypersensitive areas in Harris County (mostly due to population density) were exposed to pipe segments with minimum scores of 164 prior to mitigation. Following mitigation, the minimum score in Harris County sensitive areas is 280, while the average score is 297. The table also illustrates a major improvement in the risk scores for Travis County, where the minimum score in hypersensitive areas before mitigation is 168. Following mitigation, the lowest score in a Travis County hypersensitive area is 282.

Figures 9-5 and 9-6 depict these same data (minimums and averages, but not maximums) in bar charts.

9.2.5 Post-Mitigation Residual Risks

Residual risks remaining after implementation of the LMP cannot be precisely quantified. The Lead Agencies believe that proposed mitigation measures would result in a significant reduction in risk from the pre-mitigation levels. Over the proposed 50-year operation, the mitigation contained in the LMP should result in three or fewer pipeline leaks, including 1 to 2 DOT reportable leaks of 50 barrels or more. Support for this estimate is provided by the following factors:

- Very low leak frequencies over long periods of time are being experienced by US pipeline operators on hazardous liquid systems of similar length, but without the extraordinary level of mitigation as proposed in the LMP. DOT (Little, 2000) has provided data on reportable leak frequencies from hazardous liquid pipelines over a reporting period from 1986 to 2000. This study focused only on DOT reportable leaks, which are generally 50 barrels or more in volume. Over half of the nearly 300 companies in the database did not report any leaks over the reporting period. Also provided in the database was a subset of 16 companies operating total lengths (600-800 miles) of pipelines similar to the total length of the Longhorn pipeline. Of the 16 operators in this subset, 4 had no reportable leaks over the 14-year period. The median leak frequency for the 16 operators is 0.00024 reportable leaks/mile/year, compared to the estimated post-mitigation leak frequency of 0.00007 total leaks/mile/year for the Longhorn pipeline. The DOT data are discussed in greater detail in Attachment E of Appendix 9B. This suggests that the estimated leak frequency is possible, especially with increased mitigation.

- The LMP reflects levels of mitigation unprecedented in the industry. This suggests that extraordinary leak rate reduction is possible, even if not commonly observed.
- The correlation as described in Attachment A to Appendix 9B, although limited in terms of statistically valid data quantity and quality, offers a semi-quantitative linkage that supports the estimate.
- Appendix D in the Responsiveness Summary (EA Volume 4) and Attachment E to Appendix 9B show leak rate estimates for approximately 60 US liquid pipeline operators. The range of leak rates, presumably achieved under industry standard mitigation levels, suggests that many different leak rates are possible. This includes company-wide leak rates that are approaching the estimated post-mitigation leak frequency for Longhorn.
- The scenario-based analyses detailed in Attachment B in Appendix 9B suggests that the estimated leak rate reductions can be achieved with reasonable assumptions regarding mitigation effectiveness, even for the more problematic challenge of reducing third-party damage.

Independent of the judgment that a twenty-fold or greater reduction in risk would result from application of the LMP, the issue has been approached through mathematical calculations (see second bullet item above) and exercises based on available data and conservative assumptions. The results are well within the range estimated through professional judgment and are used here to provide specific estimates of residual risk.

Calculations have been performed to estimate frequencies of nine different potential impacts along the Longhorn pipeline length. Impact frequencies are calculated for numerous scenarios involving various combinations of leak frequencies, spill sizes, and receptor vulnerabilities. Probabilities are also calculated, using the leak frequencies and assuming a Poisson distribution of events—a common statistical distribution for rare events. These calculations are summarized here and detailed in Appendix 9B. The calculations offer some quantitative support to the findings of the EA; but, due to the uncertainties involved in such calculations, they are not the primary basis of the EA findings.

For the purposes of this analysis, “overall risk” is analogous to “societal risk” commonly seen in other risk assessments and is defined as the risks to receptors along the entire pipeline length over a period of 50 years. “Segment-specific risk” is analogous to “individual risk” commonly seen in risk assessments and is defined as the risk to a point receptor that is presented by 2,500 ft of the pipeline, over a period of 50 years. This definition is based on a 1,250-ft radius from any potential leak point on the pipeline, resulting in 2,500 linear ft of pipeline. In this usage, the segment-specific risk is essentially the overall risk normalized to a length of 2,500 ft. Except in special circumstances, a point receptor is exposed to risks from leaks occurring along a maximum length of 2,500 ft. The basis for this “impact zone” is described in Section 6.2.4 of the EA. Longer receptors such as aquifers are exposed to multiples of the segment-specific risks, in proportion to their lengths. Since risks are not uniform along the pipeline, this length-normalization can be viewed more as an average of the overall risks. It is useful to examine a shorter length of pipeline in order to show risks that are more representative of individual receptor risks and to be more comparable to other published risk criteria.

“Index Sum” refers to the EA relative risk model's measure of relative failure probability, as detailed in Chapter 6 and earlier in this chapter. "Post-mitigation" means the condition of and risks to the pipeline after full and complete achievement of all aspects of the LMP. This includes the establishment of specified on-going operation and maintenance activities. “Receptors” refer to the sites or organisms that are threatened by a spill of refined products. Receptors in this study include humans, drinking water supplies, and wetlands. Each impact potentially damages one or more receptors.

9.2.5.1 Leak Frequencies

Two additional “frequency of leak” cases are examined in this analysis as a continuation of the analysis described in Chapter 6. Case numbers are consistent between Chapter 6, Appendix 9B, and this section. Each case represents a different estimated accident rate and is used independently to perform an impacts assessment. The first case examined here, Case 3, uses only historical data with no consideration given to possible benefits of mitigation. This is included for reference and represents impact frequencies that would be seen on an unmitigated Longhorn pipeline whose leak experience is equal to the previous EPC experience. The second case examined is Case 4, which estimates leak frequencies considering effects of mitigation. The two leak frequencies used are generally described as follows:

Case 3 (former EPC pipeline, overall leak rate):

The overall accident rate, regardless of spill size, on the 450 miles of pipeline (not stations) under EPC operation in 29 years. (Incident rate) = (26 leaks) / (450 miles x 29 years).

Case 4 (uses an estimate of mitigation effects plus historical data):

Cases 1 through 3 (see Chapter 6 or Appendix 9B) use leak frequencies that do not consider Index Sums and hence do not consider effects of mitigation. In Case 4, impact distinctions are made between the various tier categories or for a specific geographic area and the corresponding Index Sum is used to predict a leak frequency. The leak rate estimated by correlating the Index Sum scale to an absolute leak frequency is described in Attachment A of Appendix 9B. The equation used represents the curve that best fits the following points:

Index Sum	Probability of Leak (estimated by frequency in number of leaks per mile-year)
0	1.0 (100 percent chance of a leak)
189	0.00199 (historical EPC leak rate on this pipeline)
400	0 (virtually no chance of a leak)

The leak frequency estimates have a high degree of uncertainty, primarily due to the limited amount of data available. However, no data that would better refine these estimates are known to be available. It is also important to note that frequencies and probabilities like these are statistically valid only over long periods of time. Short time periods can have radically different experience and still be appropriately represented by these frequencies. Therefore, the short-term predictive power of these probabilities is very limited.

9.2.5.2 Leak Probabilities

Leak probabilities are calculated in addition to leak frequencies. These are obtained by calculating the Poisson probability estimate of "one or more" impacts over the life of the project. The equations used are as follows:

$$P(X)SPILL = [(f * t)^X / X!] * \exp(- f * t)$$

where: P(X)SPILL = probability of exactly X spills

f = the average spill frequency for a segment of interest, spills /year

t = the time period for which the probability is sought, years

X = the number of spills for which the probability is sought, in the pipeline segment of interest.

The probability for one or more spills is evaluated as follows:

P(probability of one or more)SPILL = 1 - P(X)SPILL; where X = 0.

The results of these calculations are shown in Tables 9-4 through 9-7.

9.2.5.3 Spill Size Distribution

In addition to overall leak frequencies, spill size frequency also plays a role in many of the impacts. A spill size distribution for spills larger than 50 bbl was derived from DOT hazardous liquid pipeline reportable spills from 1975 to early 2000. The fraction of spills smaller than 50 bbl was estimated from the 29-year EPC leak experience on the 450-mile segment from Valve J1 to Crane. EPC leak experience contains too few larger-sized spills to create a meaningful profile.

Embedded in this approach is the assumption that the national spill size distribution (DOT data) is representative of the Longhorn’s future spill size distribution. This implies that the following variables are also representative:

- Topography;
- Failure mechanisms that determine hole size;
- Leak detection capabilities; and
- Leak reaction capabilities.

Since the national pipeline system is not characterized in these terms, the similarities cannot be confirmed. However, since the LMP specifies several state-of-the-art spill size reduction measures not typically seen in other pipelines, it is reasonable to assume that the national data would not underestimate the spill size potential and very probably would overestimate the potential.

A second assumption is that the < 50 bbl spill size fraction seen under EPC operations is representative of Longhorn’s future spill size distribution. Since the < 50 bbl size triggers few impacts and since > 50 bbl spill fraction can be separated from the “all size” distribution, the absolute validity of this assumption is not critical to this analysis.

9.2.5.4 Risk of Impacts to Environmental Features

Potential impacts considered in this analysis were mostly described in Chapters 6 and 7 and can be found in Appendix 9B. Potential impacts considered for leak frequency Cases 3 and 4, examined here, include three special receptors not discussed in Chapter 6. These are described as follows:

Edwards Aquifer (Balcones Fault Zone) contamination. This is a special case of “drinking water contamination,” focused specifically on the 3 miles MP 170.5 and MP 173.5 (all new pipe as proposed in LMP). This case has the following assumptions in addition to the general drinking water impacts (see Chapter 6 or Appendix 9B).

- The spill size threshold is 500 bbl. Spills of this size and larger are assumed to be equally harmful.
- The enhanced leak detection system in this area is credited with reducing the potential frequency of larger sized spills. Specifically, the types of potential large spills reduced are those created by a slow leak, below the detection capabilities of normal leak detection, which may continue for long periods of time.
- The Index Sum represents the additional leak prevention measures proposed in these 3 miles.

Further discussion of how this receptor is modeled can be found in Appendix 9B.

Lake Travis drinking water contamination. This is a special case of “drinking water contamination,” which focuses on spills in the Pedernales watershed that could impact drinking water supplies drawn from Lake Travis areas. The analysis involves 1.54 miles of pipeline located in Tier 2 areas and 2.74 miles in Tier 3 areas. The spill size threshold is assumed to be 1,500 bbl. Spills of this size and larger are assumed to be equally harmful, and spills below this threshold would not cause the impact.

Further discussion of how this receptor is modeled can be found in Appendix 9B.

Drinking water contamination—no MTBE. The drinking water contamination scenarios discussed in earlier chapters assumed 15 percent MTBE would be transported in the pipeline. Without MTBE present, impacts are assumed to be one-half of the previous case. Rationale for this is presented in Appendix 9B.

A threshold spill size of 1,500 bbl is assumed before any impact is significant. Above that threshold, impacts are judged to be equally likely, regardless of spilled volume. This is conservative, since even the spill volumes closer to the threshold are modeled to be as harmful as the largest spill volumes.

9.2.5.5 Results of Residual Risk Calculations

Post-mitigation impact frequencies and probabilities are calculated to be at least 20 times lower than pre-mitigation and industry average frequencies. The frequency reduction is not constant since different permutations of leak frequencies, spill size frequencies, and lengths-impacted are combined.

Tables 9-4 through 9-7 show the results of all frequency and probability estimates for all impacts, for the two leak frequency cases. Case 4 in all tables shows the estimate for post-mitigation results. Case 3 is included for comparison and represents the estimate for an unmitigated Longhorn pipeline whose leak experience is equal to the previous EPC experience.

9.3 ALTERNATIVES TO THE PROPOSED PROJECT

The Settlement identifies alternatives to the originally proposed project that must be considered in this EA. These alternatives are described in Chapter 3, “Description of Proposed Project and Alternatives” and analyzed in detail in Chapter 7, “Potential Impacts Analysis.” Briefly, these are as follows:

- The No-Action Alternative;
- Resumption-of-Crude-Oil-Shipments Alternative;
- Re-routing alternatives; and
- Pollution prevention (or control) alternatives.

9.3.1 Evaluation of the No-Action Alternative

The No-Action Alternative provides a basis for comparison with the proposed project and other alternatives. Based on public comments and further legal analysis following the publication of the draft EA, the Lead Agencies have determined that the No-Action Alternative is no operation of the Longhorn pipeline.

The No-Action Alternative would arise through a DOT decision not to approve Longhorn's facility response plan.[4] Under the No-Action Alternative, Longhorn would have several options it could pursue. One of these is to idle the pipeline and related infrastructure following DOT regulations that pertain to decommissioning. Another option is to salvage all or some of the pipe and aboveground infrastructure and sell it to other pipeline operators. By salvaging the equipment, Longhorn would be able to recoup some of its investment costs. Impacts to the environment would be largely confined to the temporary impacts of digging and operation of the heavy equipment related to pipe and aboveground infrastructure removal.

9.3.1.1 Environmental Benefits of the No-Action Alternative

If the Longhorn pipeline were left idled, (1) there would be no construction-related impacts since there would be no need for the remaining new construction of the System (pipe and pump stations) and (2) there would be no impacts from pipeline operation. Specifically, there would be no impacts and zero risks to receptors and resources along the route of the pipeline resulting directly from the Longhorn pipeline operations, maintenance, and remaining construction. These include:

- No direct impacts and zero risks to human health from spills resulting in fires, short or long-term exposure to hazardous vapors from contaminated soils, or ingestion of hazardous constituents from spilled product;
- No direct impacts and zero risks to human health from product spills that could result in contamination of drinking water supplies in surface water or ground water;
- No direct impacts and zero risks to recreational resources, including use of rivers and lakes for fishing, boating, and swimming;
- No direct impacts and zero risks from spills to wetlands and other habitats for aquatic and terrestrial biota, including threatened and endangered species;
- No direct impacts and zero risks from routine leaks and accidental spills along the Longhorn pipeline resulting in release of hydrocarbon vapors and diminished air quality;
- No direct impacts and zero risks from Longhorn to transportation resources, such as roads, railroads, and other pipelines;
- No direct impacts and zero risks to land use, such as parks, farmland, housing and retail developments, from operation and maintenance activities; and
- No direct impacts and zero risks to archaeological and historic resources resulting from spills along the Longhorn pipeline.

[4] The draft EA had defined the No-Action Alternative as the resumption of crude oil transport through the former Exxon Pipeline Company (EPC) pipeline between Crane and Houston (Valve J1).

9.3.1.2 Environmental Drawbacks and Limitations to the No-Action Alternative

The No-Action Alternative would not provide the direct economic benefits to gasoline and other refined product consumers that would logically be expected from additional competition in the El Paso Gateway Market.

The benefits of the No-Action Alternative listed above would only result in incremental benefits to human and environmental receptors along the route of the Longhorn pipeline. The majority of the population and environmentally sensitive areas along the route is already exposed to multiple hazardous liquid pipelines in the same general pipeline corridor. (See discussion of cumulative impacts in Section 7.12.) In parts of the Houston area, the Longhorn pipeline is one of approximately 15 hazardous liquid pipelines sharing a common corridor. Through central and west central Texas there are two parallel pipelines—one transporting crude oil and one transporting natural gas liquids.

These adjacent pipelines pose similar risks to those posed by the Longhorn pipeline. Therefore, it is reasonable to conclude that the health and safety risks to those living along the pipeline and the potential impacts to the environment along the route of the Longhorn pipeline would only be partially reduced from the idling of the Longhorn pipeline. The Longhorn pipeline contribution to the total environmental and health risks from all of the pipelines in a given corridor was not quantified but is generally proportional to the number of pipelines in the corridor. A fully mitigated Longhorn pipeline would pose a small fraction of the current total risk from all pipelines along the route that do not incorporate the various features of the LMP. Also, there would not be the added inspection/surveillance that would have been available to the other pipeline operations due to the increased frequency of patrols and other various activities by Longhorn.

There is a third potential drawback to the No-Action Alternative. If the No-Action Alternative were to be implemented, the increasing demand for refined products in the El Paso Gateway Market would be satisfied through some means other than the Longhorn pipeline. Any of these could pose environmental risks and potential impacts that could equal or surpass those of the mitigated Longhorn pipeline. These other means to substitute for the absence of the Longhorn pipeline include one or more of the following:

- Expanded refining capacity in these markets;

- Construction and operation of new pipelines (i.e., connecting the Gulf Coast with the El Paso area); and/or
- Alternative transportation modes connecting the refined product supply points and these markets.

Expanding refining capacity in these markets could result in environmental and health impacts that occur with constructing or expanding and operating large refineries. In particular, refinery operation in the air basins of El Paso, Phoenix, Tucson, and Albuquerque would increase emissions of volatile organic compounds (VOCs), oxides of nitrogen, particulate matter, and carbon monoxide in air sheds that already exceed or threaten to exceed federal and state air quality standards.

Constructing new pipelines to replace refined product supply that would have been provided by the proposed project would pose impacts from construction that would not occur with the already constructed System. Impacts from new construction are addressed in Chapter 7 and in the discussion of the alternative routes in Section 9.3.3 in this chapter. Operation of any new pipelines would result in similar risks posed by the proposed project, except that location of the risks would be different. Whether these locations involve more or less environmental and population-related sensitivity would only be known when potential new routes and operational plans are assessed.

Because new pipelines would have new coatings and pipe materials from modern manufacturing and construction processes, aspects of pipeline integrity would be expected to be better than that of the approximately 450 miles of the older pipe of the System. This comparative advantage of a new pipeline over the older portion of the Longhorn pipeline is partially offset by the mitigation measures provided in the LMP. A mitigated Longhorn pipeline could result in less risk than a new pipeline, depending upon the extent to which the new pipeline adopts measures and designs that exceed DOT requirements.

A third means of meeting the refined product demand in the absence of the System is transporting refined product from refining centers, such as the Texas and Louisiana Gulf Coast, to the El Paso Gateway Market. The most common non-pipeline mode of transporting refined product from refineries to demand centers is via large tanker trucks (approximately 8,000 to 10,000-gallon capacity). More than 2,000 tanker trucks per day (counting empty trucks returning to the refining centers) would be required to transport the 225,000 barrels per day (bpd) that would be transported by the Longhorn pipeline at full capacity.

As described in Chapter 6, the risks of non-pipeline transport modes are higher than those for pipelines. In particular, the number of deaths from tanker truck accidents is more than 80 times greater than the number of deaths from pipeline accidents based on an equivalent number of gallon-miles shipped. Although the probabilities of tanker truck spills are higher than for pipelines, the quantity of product released to the environment would be limited to 8,000 to 10,000 gallons per tank truck size, while a maximum spill from the Longhorn pipeline could reach 1.5 million gallons in west Texas.

9.3.2 Evaluation of Resumption-of-Crude-Oil-Shipments Alternative

According to Longhorn, if the company were not allowed to operate its already constructed pipeline, its next best economic return would result from the resumption of crude oil shipments from west-to-east on the Crane-to-Houston former EPC pipeline, including use of the Crane-to-El Paso newly constructed segment and the Crane-to-Odessa lateral (see Appendix 3A).

A return to crude oil shipment operation is feasible and it is unlikely that valuable pipeline infrastructure would be abandoned. The following section is a comparison of the Resumption-of-Crude-Oil-Shipments Alternative to the proposed project. The Resumption-of-Crude-Oil Shipments Alternative represents the most likely scenario if for any reason the proposed project does not occur (see Appendix 3A).

Because some of the mitigation measures in the LMP have already been implemented by Longhorn during the EA process and because Longhorn has indicated its intention to adopt others, the comparison discussed below is between a mitigated Longhorn gasoline pipeline from Houston to El Paso and a partially mitigated crude oil pipeline from El Paso to Houston. This list of partial measures is presented in a letter from Longhorn in Appendix 3A.

9.3.2.1 Proposed Project versus Resumption-of-Crude-Oil-Shipments Alternative: Comparative Probabilities of a Spill

A risk assessment has been performed for the scenario of Longhorn resuming crude oil shipments from west to east with partial mitigation (see Appendix 9I). The probability of leaks and spills along the partially mitigated west-to-east crude oil pipeline would exceed those of the fully mitigated proposed project (east-to-west gasoline transport).

The risk factors that would contribute to loss of containment are similar in both the proposed project and the Resumption-of-Crude-Oil-Shipments Alternative. There are some probability-of-failure differences between a crude oil pipeline and a refined products pipeline transportation scenario. These are related to operational differences as well as physical and chemical properties of the two fluids and would affect the pressure profile, surge potential, and internal corrosion potential. The pressure profile and surge potential would be affected by flow rates, pump configurations, and other hydraulic considerations. Throughput for the crude oil pipeline would most likely be less than for the refined products pipeline (see Section 9.3.2.3). However, as discussed in Chapter 5, the pressures on some portions of the Longhorn products pipeline would be less than the operating pressures were on those same portions of the former EPC pipeline. Lower pressures may produce lower stress level and result in lower probabilities of a spill. The internal corrosion potential on the crude oil pipeline could be greater because of the chemical constituents in crude oil.

The mitigation measures of the LMP go beyond compliance with DOT requirements and common industry practices. As discussed, the reduction in spill frequency and probability between an unmitigated Longhorn pipeline and the mitigated Longhorn pipeline is estimated to be more than twenty fold. This level of risk reduction benefit would not occur in the case of a partially mitigated crude oil pipeline.

9.3.2.2 Proposed Project versus Resumption-of-Crude-Oil-Shipments Alternative: Comparative Consequences of a Spill

As discussed in Chapter 6, the risk of a spill is the product of the probability and the consequence of a spill. The differences in consequences of a spill between the proposed project and the partially mitigated Resumption-of-Crude-Oil-Shipments Alternative are a function of both the properties of crude oil versus refined products and how well the spill is detected, responded to, and cleaned up.

Gasoline is used to represent other refined products in this discussion because gasoline would be the primary refined product shipped and because a gasoline spill results in greater consequences than would a diesel or jet fuel spill, for example. As discussed in Chapter 7, the differences in impacts due to differences in properties between gasoline (without MTBE) and crude oil are as follows:

- Gasoline may have higher impacts to drinking water for both ground water and surface water, due to the effects of toxic constituents and because transport characteristics make it more likely to reach a drinking water source in the event of a release. The removal of MTBE from gasoline greatly reduces the magnitude of these consequences, however.
- Crude oil may have slightly higher impacts to long-term water quality in ground water, because the higher viscosity, sorbability, and specific gravity make a crude

oil release more likely than gasoline to sink deeper into the ground water column, to resist natural dilution and transport through flushing, and to be less likely to volatilize. This difference in impact varies by aquifer type. The toxicity of crude oil may be lower, but this may be overcome by the persistence of heavier fractions in the crude.

- Except in scenarios involving ignition, crude oil may have greater long-term potential impacts to land use than gasoline. In the absence of an ignition, a large crude oil release would result in more severe long-term impacts to land use because of the slower movement rates and lower volume removal effects of volatilization.
- Gasoline is more likely to ignite than crude oil, and because of the rapid heat release and the wider area of spread from a comparable volume released, a gasoline fire would be expected to result in greater damage than a fire involving crude oil. If ignition occurs, gasoline would impact a larger radius and potentially cause more damage to land use.
- Through vaporization, gasoline quantities would be reduced much faster than crude oil, generally resulting in shorter duration of impacts to soil and water. Because of its volatility, gasoline spills can cause immediate inhalation risks not posed by a crude oil spill.

In general, gasoline spills (without MTBE) potentially create more acute consequences while crude oil spills potentially present more chronic impacts. These differences are situation and location specific.

Several of the mitigation measures in the LMP would result in more rapid leak detection and response than would occur under the partially mitigated Resumption-of-Crude-Oil-Shipments Alternative. These consequence-reduction measures tend to partially offset the differences in impacts due to differences in properties of crude oil versus refined products.

9.3.2.3 Proposed Project versus Resumption-of-Crude-Oil-Shipments Alternative: Comparative Quantities of Liquid Shipped

The comparison of consequences described above assumes an equal transport volume of both liquids. For any given spill site, the level of consequences of a large spill are greater than for a small spill. The market data provided by Longhorn projecting a growth from 72,000 bpd of refined product shipped increasing to 225,000 bpd exceeds the historical trend of diminishing quantities of crude oil shipped over the last decade of EPC operations over the Crane-to-Houston EPC pipeline. This decrease in crude oil transport is from approximately 44 million barrels per year [bpy] (120,000 bpd) in 1986 to approximately 27 million bpy (74,000 bpd) in 1995.

Longhorn estimates that it could transport between 70,000 and 130,000 bpd or 25 million barrels per year to 47 million bpy of crude oil as shown in Appendix 3A.

Therefore, for some parts of the pipeline it would appear that the quantity of liquid spilled would be greater for the refined products pipeline compared to a crude oil pipeline because of the larger flow rates. However, only a fraction of the maximum spill volume at most points along the pipeline is due to the flow rates. On average, 12 percent of the maximum spill would occur from pumping losses with a 5-minute response time, and 22 percent would result from a 10-minute response time. The majority of spill volume would be due to draindown of product based on valve locations and topography. The addition of check valves along the particularly sensitive portions of the mitigated pipeline would tend to reduce spill sizes in these areas. Also, with mitigation measures set forth in the LMP that reduce the time for leak detection and response (e.g., shut-down of the pumps and closing of valves), the differences between the proposed project with its assumed larger flow rates and the resumption of crude oil shipments alternative tend to favor the proposed project.

9.3.2.4 Proposed Project versus Resumption-of-Crude-Oil-Shipments Alternative: Comparison of Need for Future New Pump Stations

The greater the number of pump stations, the greater the potential impacts of pump station construction on natural and cultural resources and the greater the opportunity for leaks from valves, flanges, pumps, tanks, and other equipment associated with the pump stations.

The proposed project would require more pump station construction than would the Resumption-of-Crude-Oil-Shipments Alternative. The EPC pipeline used six pump stations to transport crude oil from Crane to Houston and would presumably require 1 or 2 more pump stations for an El Paso to Houston crude oil pipeline. Longhorn proposes to ultimately use 19 stations to transport 225,000 bpd of refined products from Houston to El Paso.

The difference in the number of pump stations for the proposed project as compared to the EPC pipeline is the result of hydraulic differences in the two scenarios. The quantity of crude oil shipped by EPC was less than the quantity of refined products that would be transported under the proposed project. Less flow rate generally requires fewer pump stations. Furthermore, the west-to-east transport of crude oil results in a largely “down-hill” flow from approximately 4,000 feet (ft) above mean sea level to near sea level. An east-to-west pipeline results in a 4,000-ft climb. A pipeline moving liquid uphill requires more pumping energy than one moving liquid downhill.

The Resumption-of-Crude-Oil-Shipments Alternative would not require any new pump stations; the proposed project requires eight future pump stations to be constructed for full build-out of the System. The exact sites of these stations are not known. Depending upon where the new pump stations are constructed, there may be impacts to biological and cultural resources. A supplemental EA would need to be prepared for each new series of stations associated with a proposed increase in System throughput. This would ensure that environmental impacts of new station construction are considered and addressed. Also, some of the mitigation measures set forth in the LMP address pump stations. These measures in the proposed project tend to partially offset the advantage of fewer pump stations required for the Resumption-of Crude Oil Shipments Alternative.

9.3.2.5 Summary of Comparison between the Proposed Project and Resumption-of-Crude-Oil-Shipments Alternative

The comparison between the proposed project and the Resumption-of-Crude-Oil-Shipments Alternative is summarized below.

<u>Advantages of the Mitigated Proposed Project over the Partially Mitigated Resumption-of-Crude-Oil-Shipments Alternative</u>:

- Lower probability of spills over the entire pipeline with much lower probabilities of spills on the Houston-to-Crane segment (i.e., the majority of the pipeline and its most sensitive areas) due to the more comprehensive mitigation measures.
- Reduced long-term soil and water contamination consequences because crude oil is more persistent in the environment than gasoline, and because the leak detection and emergency response mitigation measures would tend to limit spill size.
- Reduced need for construction of new refining capacity to serve the El Paso Gateway Market (west Texas, northern Mexico, New Mexico, and Arizona). The construction and operation of the new or expanded refineries would result in air, water, and solid waste impacts.
- Reduced need for new refined product pipeline construction and operation to serve the El Paso Gateway Market. New pipelines would pose greater construction impacts because the proposed project is 99 percent constructed, whereas new pipelines would need to be sited, the ROW cleared and constructed.
- Operational impacts from a new pipeline could be equal, greater, or less than operational impacts of the proposed project, depending upon the degree of mitigation measures applied to any new pipeline and the sensitivity of the affected environment.

- Reduced risk to health and safety if the demand for petroleum products in the market areas to be served by the Longhorn pipeline were to be met by trucking of refined products. In particular, more than 2,000 gasoline tanker trucks per day would be required to transport the 225,000 bpd capacity of the Longhorn pipeline resulting in more traffic congestion, air pollution, noise, and higher costs of transport.

Advantages of the Partially Mitigated Resumption-of-Crude-Oil-Shipments Alternative over the Fully-Mitigated Proposed Project:

- Considering the likelihood that the proposed project would probably transport larger quantities than would the Resumption-of-Crude-Oil-Shipments Alternative, the consequences of a large spill would be somewhat less for the Resumption-of-Crude-Oil-Shipments Alternative assuming equal leak detection, valve closure time, and response time.
- In the event of a spill, probability of a fire or explosion from spilled crude oil shipments under the Resumption-of-Crude-Oil-Shipments Alternative is less than would be the case for a gasoline under the proposed project because gasoline is more likely to be ignited than crude oil.
- In the event of a spill, short-term impacts to surface and ground water would be less under the Resumption-of-Crude-Oil-Shipments Alternative than they would be under the proposed project because gasoline, with its higher concentrations of benzene, poses a greater risk to drinking water quality and spreads more rapidly than an equal amount of crude oil.
- Depending on the flow rate and hydraulic profile, portions of the pipeline could have lower pressure levels. This would mean lower stress levels and corresponding reduced failure probabilities.

9.3.3 Route Alternatives to the Proposed Project

As noted in Section 1.2, the Lead Agencies do not have statutory authority to prescribe the location or routing of pipeline facilities. However, that does not preclude consideration of alternative routes as part of the National Environmental Policy Act (NEPA) process. There are three alternatives to the route of the proposed project. The LMP applies only to the proposed project, not to alternative routes.

9.3.3.1 Evaluation of the Aquifer Avoidance/Minimization Alternative Route

The Settlement requires that the EA evaluate a route that avoids the following: Edwards Aquifer, Edwards-Trinity Aquifer, Colorado River Alluvium, Carrizo-Wilcox Aquifer, and Gulf Coast Aquifer. As discussed in Chapter 3 of this final EA, the Aquifer Avoidance/Minimization (AA/M) Alternative Route is not an economically feasible (i.e., not a reasonable) alternative and, therefore, did not meet the project purpose and need. For this reason, it was not assessed in the same degree of detail as the proposed project route.

The discussion of aquifers crossed by the Longhorn pipeline in Chapter 4 shows that it is not possible to completely avoid several of these aquifers because they cross the state in wide, sweeping bands that parallel the Gulf of Mexico from northeast to southwest. It is possible to avoid some critical aquifers and minimize exposure to others via a route that was developed more than a decade ago as the "Northern Alternative" to a proposed extension to the All American Pipeline.

The All American Pipeline is a 1,247-mile, 30-inch diameter, crude oil pipeline that was constructed in the mid-1980s to carry California crude oils to McCamey, Texas (near Crane). Before construction began on this California-to-west Texas route began, All American Pipeline Company proposed an additional 486-mile extension that would have utilized a ROW parallel and 10 to 30 miles to the south of Longhorn's 458-mile Crane-to-Galena Park Station segment. The final 486-mile segment of the All American Pipeline was subject to a federal lawsuit that also resulted in a Settlement Agreement requiring development of a Supplemental Environmental Impact Statement (SEIS) with the US Bureau of Land Management (BLM) as the Lead Agency. BLM evaluated two alternative routes to the route proposed by the project proponent. BLM selected the “Northern Alternative” as the preferred alternative (BLM, SEIS, 1987) in large part because it avoided impacts to sensitive aquifers.

In particular, the Northern Alternative would completely avoid the Edwards Aquifer Balcones Fault Zone (BFZ). The Northern Alternative was not constructed and operated. However, because of the similarities between the Longhorn pipeline route and the proposed route by All American Pipeline and because both proposed projects involve similar issues, the Northern Alternative Route in the BLM SEIS was selected as the alternative to be considered in this EA to satisfy the objectives of the Settlement.

One major difference between the Longhorn proposed project and the All American Pipeline proposed project is that the Longhorn System is already built, while the All American Pipeline would have required completely new construction for any of the three routes that BLM could have selected. The Lead Agencies in this EA, which involves an already constructed pipeline, face a completely different decision than did BLM with regard to the All American Pipeline, which did not involve an already constructed pipeline.

As shown in Figure 3-1, the AA/M Route Alternative would replace 313 miles of the 458 miles of the existing Galena Park Station-to-Crane segment of the System with a new pipeline that would avoid and reduce possible impacts to several aquifers. This alternative could not have been examined in the same degree of detail as the proposed project because detailed construction plans and alignments had not been developed. Nevertheless, based on information that Longhorn has provided and on analyses drawn from the 1987 All American SEIS, a comparative analysis of this alternative is provided below.

The impacts of construction and operation of the AA/M Route are discussed in Chapter 7. Table 9-8 summarizes the comparative environmental impacts of the proposed project and the AA/M Route Alternative.

The principal advantages and disadvantages of the AA/M Route Alternative are listed below:

The advantages of the AA/M Route:

- It would avoid the Edwards Aquifer, Colorado Alluvium and three other minor aquifers (Hickory, Ellenburger-San Saba, and Marble Falls) and therefore eliminate the possibility of spills to these aquifers and to surface waters along the route.
- It would avoid the entire Austin area with attendant risks to population and natural resources.
- Because of the installation of new pipe for the entire route, the higher uncertainties associated with the integrity of the older pipe would be eliminated. Additionally, associated improvements in pipe strength, corrosion prevention (new coating system), ROW (cleared with no encroachments), and greater depth of cover would reduce risks of pipeline operation.

The disadvantages of the AA/M Route Alternative:

- It would require 370 miles of new construction with attendant construction-related and short-term impacts to the following resources: ground water, surface water, topographic alterations and karst terrain, aquatic and terrestrial biology, threatened and endangered species, cultural and historic resources, land use and recreation, and transportation. Also the acquisition of the AA/M Route Alternative ROW could result in condemnation proceedings.
- It would pose risks of spills and leaks to surface water and other rural and small town populations that are not now subject to these risks (by contrast, the elimination of the Longhorn pipeline does not remove the risks from the other pipelines that lie in the same pipeline corridor as the Longhorn pipeline).
- It would be proximal to and could potentially affect planned City of San Antonio well fields in the Carrizo-Wilcox Aquifer in Bastrop and Lee counties.

9.3.3.2 Evaluation of the Austin Re-route Alternative

The Settlement requires the evaluation of an alternative route that would avoid "populated areas in and around the City of Austin." Longhorn identified a route that would minimize population exposure and that would take into account environmental concerns and other factors that would normally be considered in siting a new pipeline. The route departs from the existing Longhorn pipeline southwest of the Austin-Bergstrom International Airport and extends south of the existing Longhorn pipeline into northern Hays County before heading north and rejoining the existing pipeline west of Austin.

The Austin Re-route Alternative would replace a 12-mile segment in south Austin with a 21-mile segment that loops further south. This alternative route is shown in Figure 3-1 and in Figures 9-1 and 9-2**.** Its purpose is to avoid populated areas in and around Austin. In accordance with the Settlement, Longhorn developed a route that minimized population exposure. It is estimated that the 12-mile segment of the existing pipeline that would be replaced by the Austin Re-route Alternative lies within 1,250 ft of 8,750 residents. By comparison, the Austin Re-route would come within 1,250 ft of only 550 residents, more than a 90 percent reduction. Following is a comparative evaluation of the Austin Re-route compared to the proposed route:

<u>The advantages to the Austin Re-route Alternative</u>:

- It accomplishes the goal of substantially avoiding population.
- It would use new pipeline (possibly heavier walled) with new coating with increased depth of cover and other risk reductions associated with new pipeline.
- It would be easier to re-establish a clear ROW given that there are several encumbrances that have been allowed to develop over the existing pipeline ROW.
- It would provide increased contaminant travel distances to Barton Springs Pool, a valuable resource for drinking water, endangered species habitat, and recreation. This would allow more time to respond to spills and possibly greater dilution of contamination.

<u>The disadvantages to the Austin Re-route Alternative</u>:

- Northern Hays County is undergoing rapid growth. Capitol Area Planning Council cites a 3 percent per annum growth in Hays County since 1997, and the same growth rate is predicted for the town of Buda, which is within 0.5 mile of the Austin Re-route. This puts the pipeline in the path of development with increased risk of third-party damage and creates the possibility that at some point in the future the population along the Austin Re-route would equal or exceed the current population along the pipeline.[5] Approximately one-half of the Re-route lies in the City of Austin's "Desired Development Zone" under the City's Smart Growth Initiative.

- Many pipeline risks are directly proportional to length of a pipeline. The Austin Re-route is 9 miles longer than the portion of the proposed project route.
- Establishing new ROW for the Austin Re-route would require clearing of approximately 15 miles through potential Golden-cheeked Warbler habitat; a maximum of 180 acres of wildlife habitat would be affected during construction, and 45 acres would be permanently lost through ROW maintenance.
- The Austin Re-route does not reduce the number of pipeline miles crossing hypersensitive leached/collapsed and Kirschberg Evaporite members of Edwards Aquifer (BFZ). Also, by increasing the number of crossings of creeks in the recharge zone (new crossings of Little Bear Creek and Bear Creek would occur), there is increased potential for damages to the Edwards Aquifer from a release.
- Since the Austin Re-route would pass approximately 5 miles south of the proposed project route through the Edwards Aquifer (BFZ), and since ground water movement in this zone is south to north, the Re-route would greatly increase the number of private and public wells at risk of contamination from a release.

In summary, the Austin Re-route Alternative raises several new environmental issues. Compared to a fully mitigated (including some pipe replacement) pipeline over the existing route, the net environmental impacts of the construction and operation of the Austin Re-route are questionable.

9.3.3.3 El Paso Lateral Alternatives: Proposed Fort Bliss Route and Montana Avenue Alternative

Longhorn's proposed route for the yet-to-be constructed 8.3-mile-long laterals connecting the El Paso Terminal to the Kinder Morgan and Chevron pipelines would pass through Fort Bliss. Longhorn has developed an alternative route that would be used if the US Army were not to approve the use of Fort Bliss property for a ROW. This alternative to the Fort Bliss route, the Montana Avenue Alternative, runs west from the El Paso Terminal to the Kinder Morgan and Chevron pipelines along Montana Avenue. Both the Fort Bliss and the Montana Avenue routes are described in Chapter 3 of this EA and depicted in Figure 3-1.

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[5] Between the time that the Austin Re-route was mapped in the spring of 1999 and this EA was developed in the summer of 2000, several major residential and commercial developments were announced that would conflict with this route.

As described in Chapter 3, construction on the Longhorn pipeline is complete with the exception of an 8.3-mile segment between the El Paso Terminal through Fort Bliss property to the tie-in points with three interstate pipelines that would transport refined products to New Mexico and Arizona.

The Settlement requires that the EA compare the proposed Fort Bliss Route with the Montana Avenue Alternative. Both routes are compared below.

Both routes would entail temporary impacts associated with pipeline construction. These include short-term noise, dust, and interruption of traffic flow. However, because the Montana Avenue Alternative would be constructed along a busy El Paso arterial, it would have greater impacts.

The Montana Avenue Alternative would require construction along an 8-mile portion of Montana Avenue to an industrial area near the El Paso International Airport. Approximately 1.5 miles of the western portion of the route would be on the south side of Montana Avenue; the remainder of the alignment would be along the north side of the road. Montana Avenue would be crossed at two locations by directional drilling. Loop 375 would be crossed at one location by directional drilling. Access to a mobile home park (Quail Run), several industrial/commercial sites, and county administration facilities would be crossed by trenching.

The Fort Bliss Route would require construction within Fort Bliss to a proposed tie-in site along Loop 375 (Joe Battle Boulevard). A gravel road that is used as access along the south side of the Fort Bliss property line would be crossed by trenching; Loop 375 would be crossed by directional drilling. The Fort Bliss Route would avoid developed areas as shown in the land use map and descriptions in Chapter 4.

Because the Montana Avenue Route Alternative lies along an area that is partially developed and is likely to develop more as El Paso expands to the east, it is subject to greater potential for third-party damage to the pipelines. Moreover, the City of El Paso water and wastewater pipelines lie along Montana Avenue. Work on these pipelines in the future pose the risk of third-party damage to the pipeline laterals. The proposed Fort Bliss Route would be on undeveloped federal property that is off-limits to development and therefore poses minimal third-party risks.

Furthermore, should an accident occur on the three laterals, there would be more persons at risk along the Montana Avenue Alternative. An estimated 3,755 persons live within 1,250 ft of the Montana Avenue Alternative as compared to 232 persons within 1,250 ft of the Fort Bliss

Route. The residents within 1,250 ft of the Montana Avenue Route Alternative are in 12 subdivisions, apartment complexes, and mobile home parks. Additional persons at risk include those in vehicles on the busy Montana Avenue. Along the Fort Bliss Route, residents within 1,250 ft are in the Butterfield Square colonia.

In addition to the residences, the Montana Avenue Alternative would pass within 1,250 ft of other sensitive receptors including two churches, a new Ysleta Independent School District elementary school, and several businesses. No such sensitive receptors were identified along the Fort Bliss Route.

The Fort Bliss Route poses no impacts to protected biological resources. The alignment across Fort Bliss was modified to avoid construction-related impacts to identified archeological sites.

Similar studies have not been conducted along the Montana Avenue Route Alternative. However, because much of the area along the route has been previously disturbed for development, any cultural resources and biological resources that would have been impacted would have already been affected by road and infrastructure construction.

In summary, the Fort Bliss Route is superior to the Montana Avenue in reducing risks to the public. It also poses fewer impacts from construction.

9.4 SUMMARY AND CONCLUSIONS

9.4.1 Construction

Most of the remaining construction would occur in relatively non-sensitive areas, some of which have been previously disturbed, e.g., the Fort Bliss pipeline corridor. Replacement of pipeline in the Barton Springs recharge zone for mitigation purposes would occur in a hypersensitive area, but only within the previously disturbed ROW of the existing pipeline. Since the specific locations are not presently known, a supplemental EA would be required prior to construction of the additional pump stations needed to incrementally increase the delivery capacity of the pipeline. The construction may also require consultation under the National Historic Preservation Act and Endangered Species Act and imposition of additional air quality controls on the El Paso Terminal.

9.4.2 Operation

Ordinary routine operation of the pipeline would not significantly affect environmental quality because it would entail no significant routine emissions of air contaminants or discharges of pollutants, nor would it significantly increase ambient noise levels. ROW maintenance activities in areas where threatened or endangered species may be present would be scheduled and conducted in a manner that would not harm the species.

9.4.3 Potential Risks

Potential risks posed by the proposed project are primarily associated with the possibility of a serious impact resulting from a spill. Determining whether such risks are significant requires consideration of two elements: (1) probability of occurrence and (2) consequences or degree of harm which could result from an occurrence. The Lead Agencies employed a process designed to identify and reduce both the risk of spills and their potential consequences and conclude that the combination of mitigation measures developed through that process would adequately mitigate the risks.

A risk assessment model based on known causes of pipeline failure was developed to evaluate the probability of a pipeline failure. Three sensitivity levels or tiers, relating to potential consequences of spills, were established as targets for failure-potential reductions. The goal is to provide ample protection for the entire length of the pipeline, but also provide greater protection in more sensitive areas. Progressively higher model target levels were set in areas with higher sensitivities to assure the probability of accidents would be lowest in areas where the human and natural environment is most vulnerable.

9.4.4 Mitigation

The Lead Agencies requested that Longhorn develop a mitigation plan, based on guidance from the Lead Agencies and on extensive comments from the public that would address the specific causes contributing to the risk of spills in each pipeline segment and the consequences of spills. Longhorn developed and submitted a mitigation plan that met or exceeded the Lead Agencies' risk reduction goals in every area. In addition to decreasing the frequency of spills, the mitigation plan includes measures which would limit spill consequences, rendering their effects more temporary and localized.

After verifying the current pipeline integrity, Longhorn would increase the frequency of many inspections and maintenance activities designed to protect that integrity. They would also install enhanced leak detection capabilities, reducing the chances of smaller leaks going undetected for long periods of time. Longhorn has agreed not to ship MTBE in the pipeline, thus removing the greatest threat to drinking water supplies. Longhorn would also prepare a contingency plan to provide alternate water supplies to municipalities with sensitive water resources along the pipeline ROW as well as to ensure a supply of non-contaminated water to any private well-owners who might be impacted by a release. The cumulative effect of all the mitigation measures, including those listed above, substantially reduces the likelihood that damaging spills would occur and are fully described in Section 9.2. Additionally, Longhorn has committed to these measures unless authorized to modify them by DOT. This restriction on their operating control is not placed on any other pipeline in the country. Longhorn, through the LMP, has greatly expanded the public nature of its business through public disclosure of information related to the LMP and its implementation. Through these actions, the probability of a spill between the unmitigated and mitigated project is estimated to be reduced by twenty fold or more.

9.4.5 Potential Impacts

The combination of proposed mitigation measures when implemented is expected to dramatically reduce the potential impacts of the proposed project. The proposed project would avoid the potentially more significant effects of a partially mitigated pipeline that would return the former EPC crude oil pipeline to crude oil service. Resumption of crude oil transport between Crane and Houston and extension to El Paso and Odessa could result in less overall protection to the human and natural environment because DOT could not require implementation of most of the specified mitigation measures, which exceed the requirements of substantive law.

Also, transportation of the refined products from the Texas and Louisiana Gulf Coast to the El Paso Gateway Market by large tanker trucks would introduce higher risks than those of pipelines, as discussed in Section 9.3 and Chapter 6. In particular, the number of deaths from tanker truck accidents is more than 80 times greater than the number of deaths from pipeline accidents based on an equivalent number of gallon-miles shipped. Although the probabilities of tanker truck spills are higher than for pipelines, the quantity of product released to the environment per spill is limited to the 8,000 to 10,000-gallon capacity of the tanker trucks.

The proposed project is compatible with the existing land uses in the area. The Longhorn pipeline shares the ROW with several other pipelines and would not result in a major change in land use, nor would its addition elevate adverse conditions to a level that is significant. If Longhorn operates the pipeline in accordance with its mitigation plan, the enhanced activities surrounding its own pipeline may also enable detection of problems on other pipelines in the ROW and enable reduction of potential risks to the environment.

9.4.6 Conclusions

Pipeline experts, within the Lead Agencies' staff and on the Contractor team, have determined that the LMP represents a combination of pipeline pollution control and response measures that is unprecedented in the pipeline industry. This final EA and final LMP are markedly different than the October 1999 draft EA and the previous LMP, reflecting many minor and several substantive changes—some in response to public comments and outside expertise. These changes make the final LMP more protective than the October 1999 LMP.

The Lead Agencies' staff and expert advisors believe the mitigation measures meet or exceed best industry practices and embody state-of-the-art techniques.

As described in Section 9.2 above, each of the causes of pipeline failure has been addressed by multiple mitigation measures that collectively are comprehensive and often overlapping. In other words, there are many measures to guard against a single failure mode. Section 9.2.2 addresses measures that include actions and equipment that would reduce the consequences of a spill.

To further support the professional judgment of the pipeline experts, the EA project team has developed an estimate of the spill probability of selected impacts for the pipeline as mitigated by the LMP. This analysis was also conducted in response to several public comments requesting a comparison of pre- and post-mitigation spill probabilities. The method, assumption, and results of this quantitative analysis are provided in Appendix 9B.

9.5 REFERENCES

Muhlbauer, W. Kent, "Pipeline Risk Management Manual, 2nd Edition" Gulf Publishing Company, Houston, Texas 1996.