09.12.07

Operating Plan

Draft

STATE OF COLORADO
OIL & GAS
CONSERVATION COMMISSION

DEPARTMENT OF NATURAL RESOURCES
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September 12, 2007

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Mr. Larry D. Kennedy
Manager, Reservoir Services
Colorado Interstate Gas Company
P.O. Box 1087
Colorado Springs, CO 80944

Re: Conditions to Operations Plan for the Fort Morgan Gas Storage Field

Dear Larry,

The staff of the Colorado Oil and Gas Conservation Commission ("COGCC") has reviewed the operations plan for the Fort Morgan gas storage field. The operations plan was submitted to COGCC in February 2007 as part of the abatement action required by Notice of Alleged Violation #1175591 ("NOAV") issued to Colorado Interstate Gas ("CIG") on December 18, 2006.

The COGCC staff finds the operations plan acceptable, with the following conditions:

1) COGCC staff accepts the Fort Morgan operations plan on a temporary basis. New rules and regulations concerning gas storage fields passed by the COGCC in the future could require this plan to be altered.

2) Although the NOAV required that CIG include semi-annual bradenhead testing as part of the operations plan, the COGCC staff now believes that bradenhead pressures throughout the Fort Morgan field should be measured and recorded every 48 hours. This requirement supersedes the semi-annual bradenhead testing requirement of the NOAV.

3) In the event any bradenhead pressure exceeds a value of 0.25 psi/ft multiplied by the depth of the surface casing in the well, CIG shall, as soon as practicable, isolate the entire well bore from the injection zone in a manner that will contain natural gas in the storage reservoir and also isolate the well bore from the gas injection/withdrawal system.

4) This well shall be immediately tested and repaired or shall remain shut-in and isolated until the cause of the high bradenhead pressure can be determined and repaired, or until CIG can present evidence, to COGCC staff's satisfaction, that the high bradenhead pressure does not present a threat to public health, safety, and welfare.

Please submit an amended operations plan incorporating the above requirements.

Sincerely,

David K. Dillon
Engineering Manager
Colorado Oil and Gas Conservation Commission
303-894-2100 x 104

Operating Plan for the Fort Morgan Gas Storage Field Morgan County, Colorado

Introduction

On or about October 9, 2006, Colorado Interstate Gas Company ("CIG") experienced a leak in one of the natural gas injection/withdrawal wells located in its Fort Morgan, Colorado underground natural gas storage facility (the "Facility"). As a result of this incident, CIG received a Notice of Alleged Violation ("NOAV") dated December 18, 2006 from the Colorado Oil and Gas Conservation Commission ("COGCC"). Included in the Abatement or Corrective Action required to be performed by CIG was the receipt of COGCC's final approval of the Work Plan submitted by CIG on November 17, 2006, collection of soil samples to determine any soil impacts, additional analyses on water samples, and submittal of information contained in the NOAV's supplemental sheet. Included in the supplemental sheet was a request by the Director of the COGCC for CIG to submit a draft Operating Plan defining operating and regulatory oversight of the Facility, and this Draft Operating Plan for the Fort Morgan Gas Storage Field, Fort Morgan County, Colorado (the "Plan") is submitted pursuant to this latter request.

Statement of Storage Field Operating Plan Purpose:

CIG's gas storage fields provide peak day gas volumes to its customers when they need it. The gas in the storage fields belongs to CIG and its customers and is injected, stored, and withdrawn as required. Gas storage performance must be safe and reliable. CIG has developed this Operating Plan to protect the public, environment, and company personnel and to provide a means to verify that the gas stored in the Facility remains contained in the reservoir and protected from migration due to breaches in the reservoir or in the wells.

Regulatory Jurisdiction for the Fort Morgan Gas Storage Field

CIG's natural gas storage fields are subject to the jurisdiction of the Federal Energy Regulatory Commission ("FERC"), which have issued Certificates of Public Convenience and Necessity, which state that the facilities have been found to be needed for public necessity and convenience. Additionally, the surface facilities (lines, compression, processing, dehydration units, etc.) are under the exclusive jurisdiction of the Department of Transportation (49 C.F.R Part 192). CIG drills, constructs, and operates its storage wells included in a FERC-designated storage field according to the rules and regulations of the Colorado Oil and Gas Commission's rules and regulations.

Operating Plan Accountability

CIG's Reservoir Services department is responsible for the operating, monitoring, and maintaining of the company's storage wells and field (sub-surface) integrity. These responsibilities include, but are not limited to, the following:

- Drilling, construction, and operation of the storage wells
- Routine monitoring of annulus pressures to identify potential wellhead and well bore leaks.
- Conducting casing inspection and/or monitor logging programs to characterize casing condition and abnormal gas accumulations behind pipe.
- Performing Mechanical Integrity Tests ("MIT") of brine disposal wells and documenting the results.
- Developing and implementing programs/procedures to repair leaks/maintain or restore well bore integrity.
- Performing annual wellhead valve maintenance to confirm proper valve operation and implement repairs as necessary.
- Storage Inventory Verification:
  - Annually review and verify stored gas volumes.
  - Ongoing routine monitoring of field pressure/inventory relationship.
  - Coordinate investigations into storage-related Loss, Fuel, and Usage ("LAUF") and storage measurement errors.
  - Coordinate and schedule semi-annual field shut-in tests with CIG's Gas Control and Field Operations Departments. The testing periods are scheduled at times

intended to minimize their impacts on customer needs and the pipeline system requirements.
  - Prepare reports summarizing results of storage inventory investigations and recommended actions to maintain reservoir integrity. Conduct review of the results with outside engineering consultant.
- Identify and acquire necessary storage/mineral rights to maintain adequate buffer acreage and operational integrity.
- Maintenance of Gas Storage Data Base as a central repository of data collected from fields.

Operating Plan Process
This Operating Plan is divided into two parts: Field Integrity and Well Integrity. While the parts may be separated, they are not mutually exclusive. Following is a list of tasks performed to monitor field and well integrity:

Field Integrity/Inventory Verification	Well Integrity
Bottom Hole Pressure Surveys	Downhole Logging
Observation Well Monitoring	Mechanical Integrity Tests of Disposal Wells
Monitor Third Party Wells	Annular Pressure Monitoring
LAUF	Gas Sampling
Measurement Correlation	Safety Valve Maintenance/Testing
Annual Inventory Verification Study	Wellhead Maintenance
Audit of Inventory report by Consultant	Remedial Action and Well Construction
	Well Pressure and Flow Monitoring

Field Integrity:

Inventory Bottom Hole Pressure ("BHP") Surveys
Annual storage field inventory studies verify the volume of gas in the storage field compared to the company-booked volumes. Gas volumes that need reconciliation consist of native base gas, injected base gas, injected and withdrawn working gas (less fuel) and other losses, both measured and estimated. These studies consist of conducting a production pressure-decline analysis for each storage field/reservoir as described below. A detailed description of the methodology, terms, and definitions related to inventory studies is included in **Appendix 1**.

The production pressure-decline analysis involves the following steps:
- Individual wellhead pressures are recorded during the semi-annual field shut-in periods which take place every spring (low inventory) and fall (high inventory);
- Well pressures are reviewed for evidence of leaks (Pressure data is contoured to help identify if any low pressures are observed);
- Surface pressures are converted to bottom-hole pressures ("BHP") by adding the weight of the gas column, as determined by direct bottom-hole pressure measurements and/or by calculation;
- Gas compressibility factor ("Z") is computed using the properties of the stored gas from analyses of field and/or well samples;
- BHP/Z pressure values are calculated for each well and an average BHP/Z is determined or a single BHP/Z is calculated from a field average wellhead pressure;
- The average field pressures are evaluated through the semi-annual shut-in period to establish a field stabilization trend;
- The average BHP/Z is then plotted versus the company book volumes (Gas-In-Place).

Observation Well Monitoring

Observation wells are utilized to monitor gas movement within a storage zone and to monitor the potential for gas migration away from the storage zone or movement to other porous zones above or below the storage zone. Some observation wells were originally oil/gas production wells that were obtained with the acquisition of the field. Others were drilled as part of the development of the field.

Gas samples are obtained and analyzed from observation wells to determine if changes in gas composition occur over time. The samples may be taken from edge observation wells completed in the storage zone and/or observation wells completed in porous zones above or below the storage zone. This information is recorded in the Gas Storage Data Base and a gas sample analysis table included in the annual inventory report. Changes in gas composition may indicate movement of the gas toward storage boundaries. This information is valuable for identification of potential storage gas migration.

Some injection/withdrawal ("I/W") wells that are connected to the gathering systems of the respective storage fields are not utilized to flow gas into or out of the reservoirs but are utilized for reservoir monitoring purposes similar to Observation wells

The following is a summary of questions CIG attempts to answer in its evaluation of the pressure response and gas sample data from an observation well or an I/W well:

- What is the fluid observed in the well - gas or brine? If gas, does the gas sample reflect native or storage gas?
- Which formation is the observation well monitoring - the storage zone, fringe area of the storage zone or potential porous zones above or below the storage zone into which gas could migrate?
- Are pressure changes observed at the surface or bottom hole?
- Status of nearby wells – what does the data from offsetting wells provide?
- Well integrity history –
  - Does annular pressure monitoring data confirm the integrity of tubing or casing?
  - Are casing corrosion defects present on Vertilogs; if so, what is the rate of change of casing defects?
- Well location – is the well near houses, buildings, roads or waterways?
- Does the pressure of this well track closely with the reservoir pressure?
- Is this well being used for gas injection and/or gas withdrawal?
- Is the drainage area from this well a low percentage?
- Is the gas analysis from this well similar to the gas analysis from the remainder of the reservoir?

Monitor Third-Party Existing and New Wells

An important part of maintaining storage field integrity is verifying that any third party wells penetrating the storage reservoir are adequately designed to prevent the leakage of gas from the reservoir. CIG also attempts to periodically monitor these wells to detect leaks if they develop later.

The following criteria are used to evaluate existing and new third party wells drilled through CIG's gas storage reservoirs:

CIG seeks to obtain written access agreements with the operators of existing and new third-party wells to prevent misunderstandings and future problems. CIG also seeks assurances that all planned third-party wells that will penetrate its storage reservoirs comply with state regulations; CIG does not waive any state regulation nor accept attempts to lessen any requirement. If allowed by the operator, CIG monitors the drilling, cementing and logging of any third party well.

Existing Wells

- Thoroughly review the state regulations for third party wells penetrating gas storage reservoirs and specific state regulations pertaining to individual reservoirs and verify that these rules are strictly followed.
- Identify well location, serial and state permit or API number, production interval, TD and operator.
- Obtain available well data, schematics and logs and conduct thorough review of state files.
- Obtain gas, oil and water production data from the state and/or well data service companies.
- Monitor production data annually and look for anomalies.
- Sample the storage reservoir gas and, if necessary, obtain a gas analysis from the existing well to be used for comparison purposes.
- Open dialogue with outside operator and obtain written permission to perform the following, if practicable:
  - Routinely monitor all annular and tubing pressures.
  - Sample the gas streams including the tubing and the tubing-casing annulus and perform a gas analysis at least once, but more often if anomalies are identified. Resample if the producing horizon changes.

New Wells

- Review the design of the well, and verify that the storage zone will be properly isolated by cement, and that the casing design is adequate for the storage field's pressures.
- To the extent practicable, monitor the drilling, cementing, and logging and perforating operation of the third-party wells.
- Review all available logs and identify any anomalies.
- If CIG suspects that the integrity of its storage reservoir has been breached by a new well, CIG contacts the operator and attempts to negotiate a plan for remedial action.

Measurement Correlation and LAUF Studies:
Metering errors and fuel/station gas usage for underground gas storage operations represent gas "losses" from inventory and are accounted for monthly. The following potential gas losses are considered to verify gas inventory:

- Engine starting gas utilized (number of starts times the volume of a typical start);
- Venting volume of compressor piping each time a unit is shut down and the number of times it is shut down each month;
- Emergency Shut Down ("ESD") blow down volumes each month;
- Other equipment depressurizing each month (volume of each);
- Station fuel;
- Well blow downs (number of wells, starting pressure and volume of each);
- Gathering system header blow downs;
- Relief valve discharge occurrences and estimate of volume;
- Flash gas from atmospheric tanks;
- Flare gas, where applicable;
- Diffuse gas losses from leaking valves, flanges and screwed pipe.

Well Integrity

Gas storage wells may be in service for 50 or more years. It is prudent to design the wells to remain intact for that time period, and to monitor and maintain the integrity to prevent well leakage. Methods utilized to assess and prevent future casing failures and gas releases include:

- Well Logging and Cathodic Protection Monitoring;

- Mechanical Integrity Testing (MIT);
- Annular Pressure Monitoring.

Storage Well Logging
Wells are logged to identify potential problems, including the following (type of log run identified in parenthesis):

- Reductions to casing wall thickness (Vertilog);
- Identification of gas presence behind the casing (Gamma Ray Neutron (GRN));
- Presence of a corrosion cell (Casing Protection Profile ("CPP"));
- Temperature logs;
- Noise Logs.

In addition, for future drilled storage wells the following list of logs shall be considered to be run during drilling and completion; the principle (how the log works) and the identification (purpose of the log) are presented in **Appendix 2**, along with the list of logs:

- Open Hole Logs:
  - Caliper
  - Density
  - Compensated Neutron
  - Spontaneous Potential
  - Gamma Ray
  - Resistivity Logs

- Cased Hole Logs
  - Casing Inspection Logs (i.e. Vertilog)
  - Cement Bond Log/Cement Mapping Tool with Gamma Ray and Casing Collar Locator
  - Base line TDT/PDK with Gamma Ray and Casing Collar Locator or Gamma Ray Neutron with Casing Collar Locator.

Vertilogs, Logging, and Cathodic Protection

Vertilogs and Casing Potential Profiles ("CPP") are beneficial to get a baseline on the condition of the casing and the following criteria summary (See **Appendix 3** for further details) should be used:

- Run baseline logs (Vertilogs and/or GRN) on every well (See **Appendix 4**);
- Follow-up Vertilogs are required on casing-completed wells to assess the rate of change in pipe corrosion at time intervals to be determined by the condition of the pipe (See **Appendix 5** for current logging schedule);
- Follow-up Vertilogs on tubing and packer-completed wells are required when tubing is pulled for other remedial work and with consideration of the time interval between the remedial work and the last Vertilog run;
- Follow-up GRN logs will be run on tubing and packer-completed wells that do not have baseline Vertilogs to identify changes in gas accumulation behind pipe;
- Coordination and communication with the Operations Department to verify that wells are protected by a cathodic protection system.

Casing Pressure Tests and Annulus Monitoring:

Mechanical Integrity Tests ("MIT")
Wellbore Mechanical Integrity Tests ("MIT") are hydro-tests that demonstrate that the well casing is capable of holding a pressure at the time the test was conducted. Performing MIT's on wells

TUBING & PACKER WELLS ONLY.

completed with tubing and packer is relatively simple due to the nature of the completion. A pump-truck is connected to the casing valve and fluid is slowly pumped until the annular pressure reaches the desired pressure, normally 300 to 500 psig. The casing valve is closed and the pressure is monitored for 15 to 30 minutes. Normally, the well passes the MIT if the pressure holds for 15 minutes with zero drawdown or 30 minutes with a 10% drawdown. Such tests are to be performed on wells that are completed with tubing and packers at the rate of not less than one test every five years. If, during the five years the tubing and packer is removed and replaced, an MIT will be conducted prior to returning the well to service.

ONLY TWICE PER YEAR

Annulus Monitoring (Bradenhead Tests)
Monitoring of well surface casing annuli ("SCA") and tubing casing annuli ("TCA") should be completed at a minimum of twice per year, during the semi-annual bottom-hole pressure surveys. SCA's identified as having elevated gas pressures should be sampled to determine if storage gas is present. Wells that exhibit pressure anomalies should be investigated immediately and blown down to determine if corrective action is required. SCA's and TCA's will normally be shut-in. To minimize corrosion in the surface casing and casing, for wells with the surface casing not cemented to surface, the SCA should be liquid filled and shut-in to prevent atmospheric corrosion in the annular space.

APPENDIX 1
INVENTORY STUDIES

Definitions

Terms included in this Appendix are specific to gas inventory verification studies. The terms relate specifically to formal accounting treatment and disposition of gas which may no longer reside within the storage reservoir or which may not be recoverable upon abandonment of the storage field. These terms are as follows:

Inventory: "Inventory" means**:** All gas molecules in the reservoir expressed in volume at standard temperature and pressure.

Adjustment(s): "Adjustment(s)" means**:** A volume of gas that impacts storage Inventory deriving from meter errors, fuel usage, diffuse gas losses and/or other operational factors.

Non-Recoverable Gas: "Non-Recoverable Gas" means: A volume of gas which supports the storage cycle under stabilized pressure conditions but can not be recovered economically upon field abandonment. The initial determination of Non-Recoverable Gas will be made at or after the abandonment of the storage reservoir begins excluding volumes previously deemed non-recoverable and written down. Any Identified gas volume which is deemed Non-Recoverable shall be written down at the time a determination of such volume is made (pursuant to Section V in Corporate Policy).

Migrated Gas: "Migrated Gas" means: a volume of gas believed to have been present in a storage reservoir, which subsequently has left the reservoir and no longer supports its cyclic storage operation. Any Identified gas volume which is deemed Migrated Gas shall be written down.

Identified: "Identified" means: The nature or the origin of the Adjustment, Non-Recoverable or Migrated Gas volume(s) is known to a Reasonable Engineering Certainty; no further research is required.

Inconsequential: "Inconsequential" means: To a reasonable person that there is lack of worth or importance; trivial in relation to the lowest level of external financial reporting. (Or, Lacking in worth or importance as deemed by a reasonable person)

Consequential: "Consequential" means: To a reasonable person it has magnitude or importance. (or Having magnitude or importance as deemed by a reasonable person)

Unresolved/Loss Contingency: "Unresolved/Loss Contingency" means: Items that require further research and/or additional data to determine proper classification as to a possible gain or loss and whose ultimate resolution depends upon whether one or more future events occur or fail to occur. The occurrence of such events can range from Probable to Remote as follows:

1. *Probable.* The future event or events are likely to occur.
2. *Reasonably Possible.* The chance of the future event or events occurring is more than Remote but less than Probable.
3. *Remote.* The chance of the future event or events occurring is slight.

Annual Inventory Report: "Annual Inventory Report" is: An annual analysis of the gas storage Inventory including, Adjustments, Migrated Gas, and Non-Recoverable Gas where applicable, in each gas storage reservoir owned and/or operated, or in which an interest is owned, by El Paso Corporation, based on operating data and engineering studies.

Reasonable Engineering Certainty: "Reasonable Engineering Certainty" means: A conclusion arrived at by a qualified engineer using all the pertinent available information and employing industry accepted engineering techniques and scientific concepts.

In addition to the terms identified above, a number of practical terms are used to describe operational issues related to management of storage inventory. These terms identify portions of the booked gas volume which do not exhibit a pressure response in the reservoir during the semiannual spring and fall shut-in periods. The terms and their definitions are as follows:

Non-Effective Gas

The volume of gas that does not exhibit a pressure response in the reservoir when a pressure decline analysis (PDA) is performed based on the fall and spring shut-in pressure data which, in general, are not indicative of fully stabilized reservoir conditions.

> **Impounded Gas:** That portion of the non-effective gas which supports the storage cycle under stabilized pressure conditions but is not readily producible during the operating withdrawal cycle.

Non-Effective Gas Calculation

The volume of non-effective gas for an operating cycle is determined graphically by performing a PDA. The analysis involves measuring the volume of gas withdrawal from a storage field and well shut-in pressures before and after withdrawal takes place. After plotting the starting and ending total inventory with the corresponding bottom hole pressures (corrected to account for the departure from the ideal gas law), a straight line is drawn through the points and extrapolated to zero psi. This line is used to determine the non-effective gas volume for the operating cycle.

The PDA involves the following steps:

1. Individual bottom-hole pressures and/or wellhead pressures are recorded during the semiannual field shut-in periods which take place every spring and fall. If inconsistencies are observed for individual pressures, estimates are made or excluded.
2. The wellhead pressures are converted to absolute.
3. These pressures are converted to bottom hole pressure (BHP) by adding the weight of the gas column using the well bore gas gradient.
4. Wells with measured bottom hole pressures are used in place of converting wellhead pressure to bottom hole pressures.
5. The compressibility factor (Z) is computed using the properties of the stored gas.
6. The BHP/Z pressure values are calculated for each well.
7. The BHP/Z values are weighted to obtain a weighted average field BHP/Z. The weighting factors are arithmetical for Fort Morgan and Washington Ranch. The remaining fields are volumetrically weighted.
8. The weighted average field pressures are evaluated through the semiannual shut-in period to establish a stabilization trend. The pressures will tend to build up or fall off depending on storage activity prior to the shut-in.
9. The final spring and fall BHP/Z pressure values are plotted vs. the total field inventory for those days.
10. The non-effective gas volume is determined at 0 psi rather than the bottom hole pressure at abandonment.

Gas-Per-Pound or Apparent Pore Volume ("PV")

Reservoir gas-per-pound ("GPPr") or Apparent Pore Volume ("PV") is the slope of the line connecting an individual BHP/Z vs. total field content and zero psi vs. zero total field content. This is done for both spring and fall points.

Cyclic gas-per-pound ("GPPc") or Effective Pore Volume ("PVe") is the slope of the line that connects the current shut-in point and the previous shut-in point.

Gas-Per-Pound Calculations

GPPr or PV is calculated using the following steps (note that steps 1-8 in the non-effective gas calculation have previously been performed):

1. For each semiannual shut-in point calculate total content divided by BHP/Z
2. Graphically connect all calculated points.

GPPc or PVe is calculated using the following steps (note that steps 1-8 in the non-effective gas calculation have previously been performed):

1. After each semiannual shut-in calculate previous total field content less the current total field content divided by the previous BHP/Z less the current BHP/Z.
2. All calculations that are performed using a spring shut-in as the current shut-in generate one set of data (the slope of all fall-spring cycle lines). Calculations performed using the fall shut-in as the current shut-in generates a second set of data (the slope of all spring-fall cycle lines).
3. Graphically connect calculated points of the same cycle, for example all of the calculated slopes for the fall-spring cycle are connected.

Pore Volume Ratio

Pore volume ratio ("PVR") is the ratio of current pore volume compared to the original pore volume.

Pore Volume Ratio Calculation

PVR is calculated using the following steps (note that steps 1-8 in the non-effective gas calculation have previously been performed):

1. Calculate the original BHP/Z times the current total content divided by the original total content times the current BHP/Z for each semiannual shut-in.
2. Graphically connect all calculated points.

Appendix 2

Well Logging Criteria for New wells

The following list of logs shall be run on newly drilled storage wells (vertical).

- **Open hole logs:**
  - Array induction
  - Density
  - Compensated Neutron
  - Spontaneous Potential
  - Gamma Ray
  - Resistivity Logs - Microlog or equivalent

Type of Log	Principal	Identification
Array Induction	A high frequency current of constant intensity is sent through a transmitter coil. The magnetic field induces currents in the formation surrounding the borehole. The currents are proportional to the conductivity of the formation.	Deep formation investigation to minimize borehole influences and measure resisitivities. Fluid Contacts. Water Saturation.
Density	Medium energy gamma rays are emitted to the formation and scattered, if the formation is very dense the more scattering takes place and more gamma rays are absorbed, less dense formation the less scattering and less absorption.	Primarily used to measure bulk density. Can be related to porosity when lithology is known, gas detection, hydrocarbon density, and evaluation of shaly sands.
Compensated Neutron Logs (CNL)	Neutron logs measure the formation's ability to slow the movement of neutrons through the formation. This measurement reflects the amount of hydrogen in the formation indicating the porosity of the formation. This log requires a fluid filled hole.	The compensated neutron log is recorded as apparent limestone, sandstone or dolomite porosity. It has the advantage of reduced borehole influences and is used to evaluate formation porosity and identify gas zones and gas/liquid contacts.
Spontaneous Potential (SP)	The SP curve records the electrical potential produced by the interaction of formation water, conductive drilling fluid, shales.	The SP is used to identify permeable beds, locate boundaries of permeable beds, aid in determining water resistivity and as an indicator of formation shaliness.
Resistivity Logs	Electric current is passed through the formation, and voltages are measured between electrodes. The measured voltages provide the resistivity.	Various formation resistivities are calculated: flush zone, uninvaded zones, fluid contacts and water saturation.
Micro log	Electric current is passed through	Comparison of the curves

	the formation, and voltages are measured between two short-spaced electrodes with different depths of investigation. The measured voltages provide the resistivity	identifies mudcake which indicates invaded zones, thus permeable formations

- **Cased Hole Logs**
  - Vertilog
  - Cement Bond Log/Cement Mapping Tool with Gamma Ray and Casing Collar Locator
  - Base line Gamma Ray Neutron with Casing Collar Locator to be used in the analysis of gas migration.

Type of Log	**Principal**	**Identification**
Vertilog	The log uses magnetic flux leakage measurements to identify corrosion and defects in casing	Evaluation of casing metal loss or gain and internal or external corrosion defects
CBL-VDL (casing bond and variable density log)	The principle of the measurement is to record the transit time and attenuation of an acoustic signal after moving though the borehole fluid and the casing wall. This log requires a fluid filled hole.	The CBL is used to evaluate hydraulic seal, cement to casing bond and coverage. The VDL is used to assess the cement to formation bond and to detect the presence of channels and gas intrusion.
CMT or CET (cement mapping or cement evaluation tool) or SBT	The tool uses the casing resonance in its thickness mode to give a very fine resolution.	The tool is used to evaluate cement in eight directions 45° apart.
CCL (casing collar log)	The CCL is a magnetic device which is sensitive to the increased metal at a casing collar.	It is run with cased hole logs and is primarily used for depth control.
GRN (gamma ray neutron)	Gamma ray logs record the natural radioactivity of the formation, less dense formations will appear to be slightly more radioactive.	The GR is used for correlation and gives lithology control. Neutron identifies gas behind pipe, porosity and fluid contacts.

APPENDIX 3

Casing Inspection Decision Tree Spreadsheet

Casing Inspection Program

1. Review logs when they arrive in office. Check for large defects that should be addressed immediately, confirm log header information and casing information is correct, confirm that all logs run have been received

2. The MVisro vertilog interpretation program is present on every CD. It starts automatically when the CD is inserted. Instructions, if needed, are in the Microline manual.

3. Review hard copy log and electronic log. Confirm OD vs. ID, GC vs. IP (consider calling any defect affecting >30% of the channels GC, and definitely it should be called GC when appearing on >40% of the channels), and whether defect is truly metal loss. At the very least, confirm metal loss on all Class 3 & 4 defects. Check metal loss for all Class 3 & 4 defects on repeat log pass as well (this is usually only present electronically).

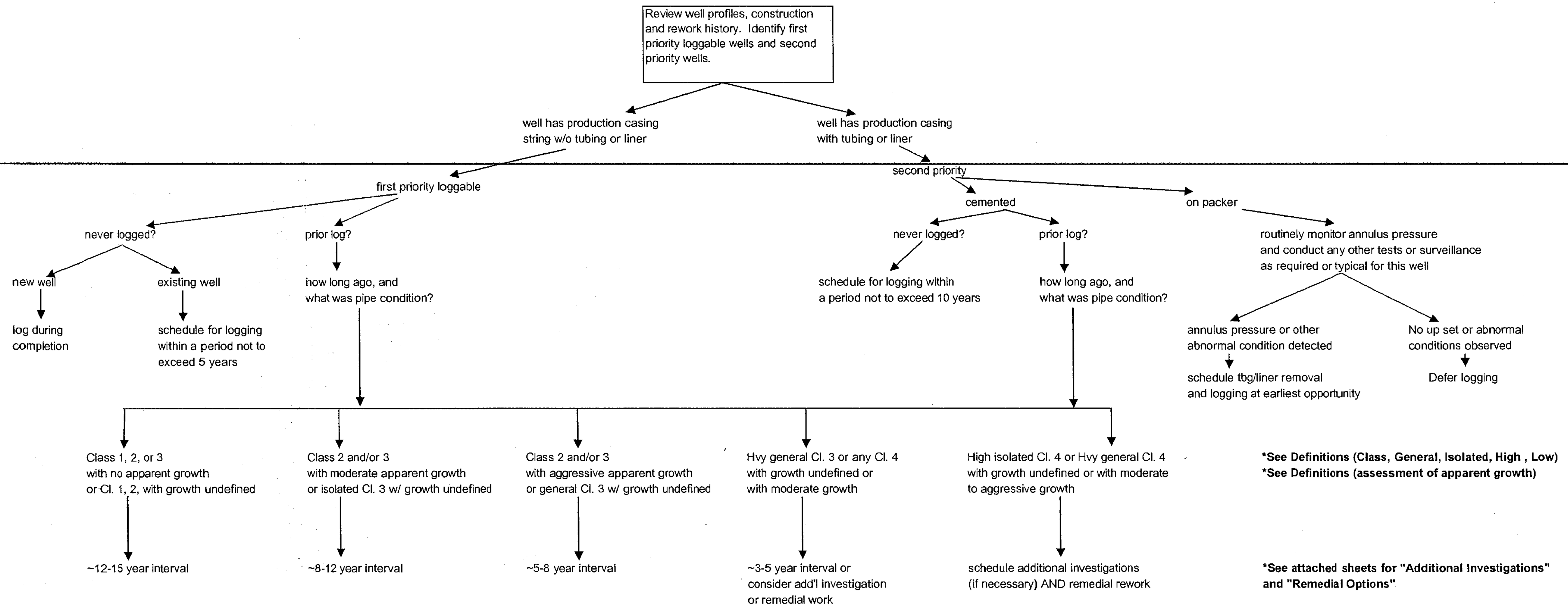
4. Compare defects with earlier logs. Determine if defects are growing circumferentially and vertically as well as degree of metal loss. Calculate apparent % metal loss / year ((% metal loss current log - % metal loss previous log)/# of years) if defects are significantly different.

5. For large ID defects, check well files to determine if there is a mechanical reason for the defect (i.e. drilling cement, set packer, etc). If an ID defect has not been previously investigated or appears to have grown significantly since the previous survey, recommend additional investigations such as caliper logging or downhole camera surveys to confirm the presence and severity of internal defects.

6. Prepare a summary report (one report per field) documenting results of casing inspection efforts; if necessary, follow this report with a supplemental report which describes findings of any additional logging investigations conducted in response to the casing inspection survey. Review draft report with Reservoir Services manager and field engineer to discuss findings and incorporate their input, then finalize the report and save in the Reservoir Services common drive or group folder specific to the area.

7. Select wells for next years logging program based on a specific recommendation that had been made at the time of the previous review, or according to the "Casing Inspection Survey Frequency Decision Tree".

CASING INSPECTION SURVEY FREQUENCY DECISION TREE



Definitions

Class
defect rating based on interpreted percentage of pipe wall thickness lost;
Class 1: <= 20% wall loss
Class 2: > 20% wall loss and <=40% wall loss
Class 3: > 40% wall loss and <=60% wall loss
Class 4: > 60% wall loss

High
in the upper 50% of the Class

Low
in the lower 50% of the Class

General
many defects along the axis and/or circumference of the casing; Baker/Atlas generally considers defect clusters appearing in nearly 40% or more of sensors to be "general corrosion"

Isolated
single flux leakage anomalies found by individual sensors or at most on less than 30-40% of sensors (which may be adjacent defects or single larger defects)

Internal
anomalies on the internal wall of the casing, identified by eddy current anomalies corresponding to flux leakage anomalies on the same sensor pads; generally the eddy current anomaly should have a signature or response level beyond background noise for any joint of casing

Outer or External
anomalies on the external or outside wall of the casing, identified by lack of eddy current anomalies on the same sensor pads

Assessment of Apparent Growth

To be used when comparing a survey log to prior survey logs

1. Pit Depth: Interpretations of metal loss from flux leakage measurements are at best within +/-10-15% of actual metal loss (this could be closer to 10-15% for isolated pitting and 15-20% for general corrosion)

   Therefore, let WTp=pct metal loss in present survey
   WTn=pct metal loss in earlier survey
   Yp=year of present survey
   Yn=year of earlier survey

   Then,

   Maximum Rate of Apparent Change is:

   [(WTp + 15%) - (WTn - 15%)]/(Yp - Yn)

   and Minimum Rate of Apparent Change is:

   [(WTp - 15%) - (WTn + 15%)]/(Yp - Yn)

   Rates of Change >3-4%+ wall thickness per year = AGGRESSIVE

   Rates of Change in the 1-3% wall thickness per year ranges = MODERATE

   Rates of Change <1% wall thickness per year = LOW

2. Holistic Qualitative Review of Anomaly Occurrence and Density
   - in comparing the present survey to an earlier survey, does there appear to be a greater number of defects, a greater density of defects, or a growth in the circumferential or axial extent of defects?
   - how does the present survey compare to prior surveys in regard to eddy current anomalies or response to casing jewelry (scratchers, centralizers, etc)?

Additional Investigations

Check well's cement bond log - top of cement and bond quality
- if no bond log exists, consider cost/benefit to obtaining one;
- have there been any squeeze efforts or related cement improvement or remediation efforts; any temperature surveys?

Check well's nuclear log history
- gamma-neutron, pulsed neutron or other nuclear log
- noise, temperature, flowlog, or other production/problem assessment log
- obtain annular fluid levels (AFL) and AFL history
- review logs for any prior history of annular gas or gas out of zone
  - (occurrences adjacent to collars or to DV tools; correspondence to areas of inspection survey defects)

Check well's casing inspection history
- type of survey, compare survey results to present log
- have there been other integrity surveys run (magnelog, cathodic profile logging?)

Review well records for construction and rework history
- when was casing installed; scratchers or centralizers, other external or internal tools applied
- any milling/drilling/spudding/cabling inside the casing
- any casing pressure tests or mechanical integrity tests
- cementing operations
- size, cement, problems on surface and intermediate casing strings
- natural hydrocarbon zones encountered while drilling
- other fluid flow or lost circulation zones encountered while drilling
- perforations
- stimulation treatments
- position of well in gathering system; position relative to cathodic protection system rectifiers and anodes

Review well's annulus pressure history
- occurrences of pressure or flow
- other external evidence of problems (water well surveys, vegetation stress issues, odors, audible leaks reported, regulatory citations)

If a well's file is deficient in a number of items listed above and the well's inspection survey shows defects increasing in magnitude and/or extent, appropriate logs should be run or tests and offset data should be obtained to help assess the problem and promote solution.

If internal corrosion is evident from survey, mechanical caliper and/or video camera surveys should be run at earliest possible convenience to confirm presence and magnitude of internal metal loss.

Remedial Options

Note: Any pipe recovered in remedial operations should be inspected and selected pieces set aside for delivery to El Paso Metallurgical Labs for detailed metallographic analysis and pit depth measurement. The EP Lab will:

1) clean and photograph the pipe
2) measure pit depth and geometry
3) measure unaltered pipe wall thickness
4) perform tensile tests on unaltered pieces of casing

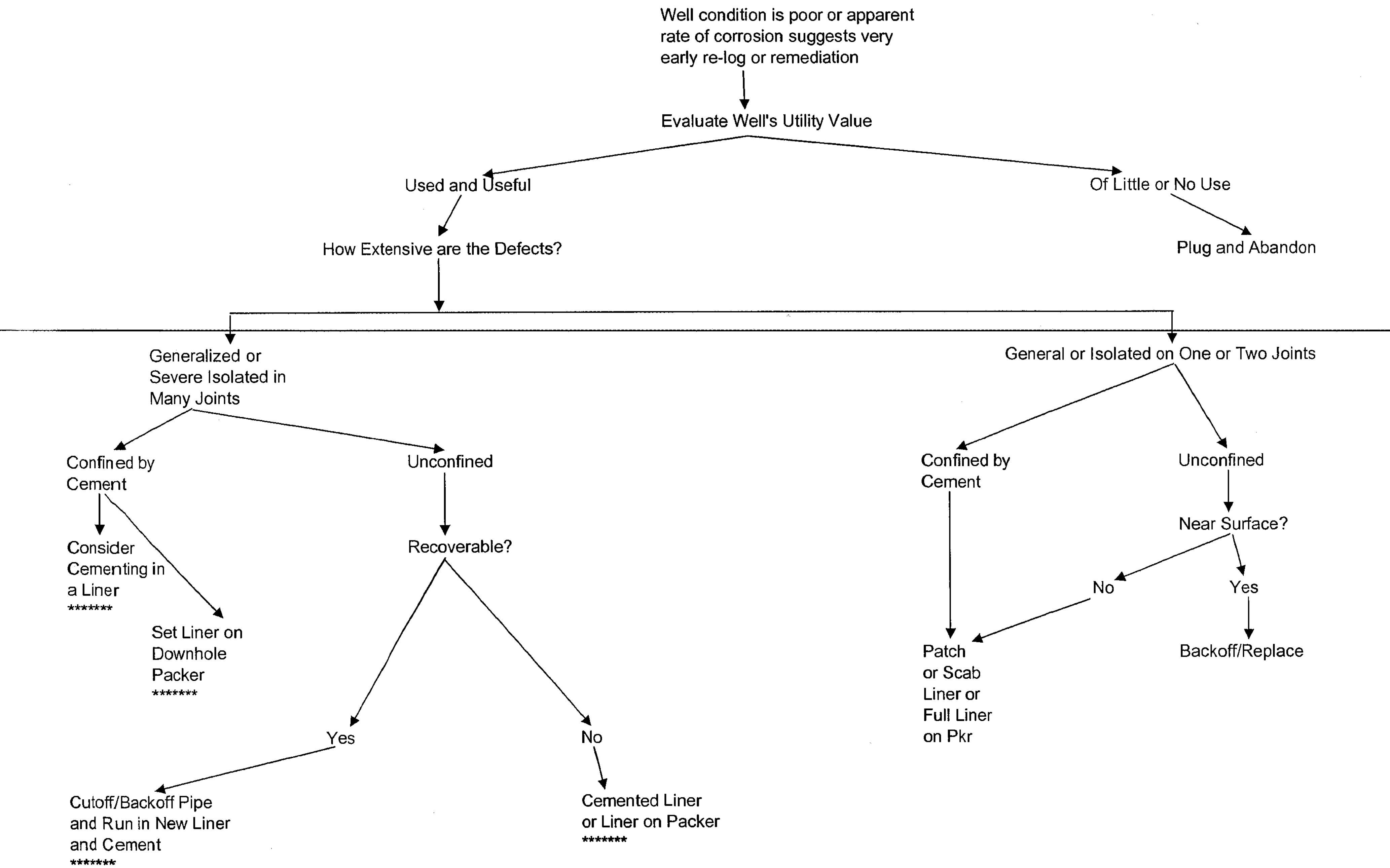
Also Note: Make sure that casing conditions have been properly assessed to remove the influence of conditions on log interpretation:

1) does casing need to be washed prior to logging? (past history may indicate a need)
2) were significant defect areas repeated?
3) were all background checks and cross checks made against well construction data and rework records? (see "Additional Investigations" tab)

Remediation Decisions:

1) Based on metal loss and geometry interpretations from casing inspection logs
2) Compared to previous survey to establish rough approximate metal loss rate
3) Hydrostatic testing program had established confidence in fairly high threshold for failure pressure of typical pipe sizes and pitting geometries
    a) typical failure pressure of unconfined, corroded pipe, especially isolated pits, was at or in excess of API minima for unaltered pipe
    b) failure pressure of unconfined, corroded pipe exceeded calculated failure pressure based on NG-18 formula for line pipe
4) Remediation or shorter-frequency re-log depends on approximate metal loss rate and on nature of the defect patterns (geometry and location), and a complete review of the well's operating history

REMEDIATION DECISION TREE



*******If lining or tubing the well will have a significant and adverse impact to well and field deliverability, consideration can be given to drilling additional or replacement wells with or without plugging of the well with corroded casing**

APPENDIX 4

Summary of Baseline Casing Inspections

2/4/2007

Fort Morgan Storage Field, Fort Morgan County, Colorado Baseline Casing Inspection Log Summary

Well #	FERC Class	(1/17/07) Comp. Type	Spud/ Respud Date	Initial Vertilog Run Date	Initial Microvert Run Date	GR/N Run Date	Installed Packer	0%-20% Class 1 Joints	21%-40% Class 2 Joints	41%-60% Class 3 Joints	61%-100% Class 4 Joints	Maximum Apparent % Loss	Maximum % Loss Depth	Approx. TOC	Class 2 Average % Metal Loss	Class 3 Average % Metal Loss	Class 4 Average % Metal Loss	MicroVert Deepest Reading	PBTD	Surf. Csg.
FM # 1	I / W	T/P	05/06/54	N/A	07/19/01	07/18/01		6	75	50	5	85	1,576	4,764	38	56	82	5,312	5,589	125
FM # 2	I / W	T	05/19/54	N/A	07/18/01	07/18/01		44	86	2	0	47	5,214	5,124	30	N/A	N/A	5,465	5,702	175
FM # 3	OBS	T/P	08/27/54	N/A	07/05/01	07/05/01	02/20/02	49	90	31	5	71	762	5,138	35	59	N/A	5,455	5,669	194
FM # 4	I / W	C	09/13/54	N/A	07/16/01	07/16/01		112	60	1	0	41	2,696		29	N/A	N/A	5,460	5,567	179
FM # 5	SWD	T/P	10/26/54	N/A	SWD State Tested	N/A												N/A	5,835	213
FM # 6	OBS	T/P	11/10/54	N/A	07/06/01	07/06/01	02/22/02	42	82	49	5	77	3,891		35	58	77	5,460	5,533	178
FM # 7	I / W	T/P	11/28/54	N/A	07/27/01	06/26/01		6	92	33	4	76	1008'-1044'	4,406	35	56	76	5,487	5,627	220
FM # 8	I / W	C	01/24/55	N/A	07/23/01	07/23/01		45	108	16	0	55	1,860	5,078	33	54	N/A	5,430	5,578	140
FM # 9	I / W	T/P	02/09/55	N/A	06/23/01	06/28/01		1	104	28	1	73	3,678	4,670	35	58	N/A	5,419	5,700	201
FM #10	OBS- J	T/P	03/07/55	N/A		05/11/98												N/A	5,712	205
FM #11	I / W	T	09/04/59	N/A	07/20/01	07/20/01		140	24	0	1	66	3,493		27	66	N/A	5,462	5,558	161
FM #12	OBS	T/P	07/16/62	N/A	07/24/01	07/24/01		106	31	2	0	52	4912'-4949'	4,195	31	52	N/A	5,450	5,552	156
FM #13	OBS	T/P	07/27/62	N/A	07/26/01	07/25/01		160	5	1	0	45	3612'-3643'	3,600	34	N/A	N/A	5,364	5,495	161
~~FM #14~~	~~I / W~~	~~C~~	~~08/03/62~~	~~N/A~~	~~07/19/01~~	~~07/19/01~~		~~60~~	~~105~~	~~2~~	~~0~~	~~44~~	~~10~~	~~4,007~~	~~29~~	~~N/A~~	~~N/A~~	~~5,402~~	~~5,533~~	~~158~~
FM #15	OBS	C	08/10/62	12/16/99	N/A	12/16/99		176	0	0	0	<20	N/A	3,958	<20	N/A	N/A	5,524	5,553	198
FM #16	I / W	T/P	12/03/64	N/A	07/21/01	07/21/01		66	100	2	0	46	5308'-5341'	4,046	30	N/A	N/A	5,480	5,563	229
FM #17	I / W	T	04/01/65	N/A	06/18/01	06/18/01		140	29	0	0	40	5,217	3,829	30	N/A	N/A	5,468	5,531	182
FM #18	SWD	T/P	06/09/69	N/A	06/27/01	06/27/01		105	40	12	11	95	5011'-5043'	3,950	32	61	86	5,450	5,559	202
FM #19	I / W	C	09/15/69	N/A	06/19/01	06/19/01		135	31	0	1	70	4,442	4,275	29	70	N/A	5,444	5,518	194
FM #20	I / W	C	06/01/71	N/A	06/04/01	06/04/01		126	41	2	0	52	14		29	52	N/A	5,424	5,548	223
FM #21	I / W	T	06/07/71	N/A	08/03/01	08/03/01		135	33	1	0	48	124		28	N/A	N/A	5,470	5,553	218
FM #22	I / W	C	06/13/71	N/A	06/25/01	06/25/01		112	55	1	0	47	96		29	N/A	N/A	5,430	5,544	219
FM #23	I / W	C	06/17/71	N/A	07/01/01	07/01/01		105	62	0	0	39	740'-773'		29	N/A	N/A	5,434	5,534	217
FM #24	I / W	C	06/24/71	N/A	07/03/01	07/03/01		135	33	1	0	60	3,007		30	60	N/A	5,409	5,532	214
FM #25	I / W	T/P	06/05/72	N/A	07/17/01	07/17/01		146	24	2	0	44	5,014		29	N/A	N/A	5,478	5,596	214
FM #26	I / W	C	06/16/72	N/A	07/26/01	07/25/01		142	27	1	0	48	5432'-5465'		28	N/A	N/A	5,450	5,564	215
FM #27	I / W	C	06/26/72	N/A	06/26/01	06/25/01		125	45	0	0	37	5151'-5182'		28	N/A	N/A	5,410	5,542	213
FM #28	I / W	C	07/03/73	N/A	06/21/01	06/21/01		149	26	0	0	37	5018'-5050'		29	N/A	N/A	5,520	5,552	219
FM #29	I / W	C	07/10/73	N/A	06/21/01	06/20/01		111	63	0	0	36	1000'-1032'/3712'-3745'		28	N/A	N/A	5,508	5,545	189
FM #30	I / W	C	07/16/73	12/18/99	N/A	12/18/99		172	1	0	0	30	5100'-5116'		30	N/A	N/A	5,520	5,540	219
FM #31	I / W	C	07/21/73	N/A	06/20/01	06/20/01		158	15	0	0	30	577'-609'		27	N/A	N/A	5,523	5,561	219
FM #32	I / W	C	07/27/73	12/17/99	N/A	12/17/99		173	0	0	0	<20	N/A		<20	N/A	N/A	5,504	5,543	216
FM #33	I / W	C	08/01/73	N/A	06/22/01	06/21/01		157	16	0	0	36	1950'-1982'		32	N/A	N/A	5,512	5,555	216
FM #34	I / W	T-2-7/8"	07/15/01	N/A	08/04/01	08/05/01		103	19	1	0	41	1596'-1606'	Circ.	30	N/A	N/A	5,646	5,654	312

APPENDIX 5

Well Work Plan Spreadsheet

Fort Morgan Storage Field, Fort Morgan County, Colorado Well Work Schedule

Field	Well No.	Formation	Type	Comp Type	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Previous Log Results	Survey Freq
Ft Morgan	1	D	I/W	T/P			Vert												T/P-Monitor
Ft Morgan	2	D	I/W	T			Vert					GRN,Vert			Vert			Two Class 3 - Max=47% .	5-8 Years
Ft Morgan	3	D	OBS	T/P			Vert					GRN,Noise							T/P-Monitor
Ft Morgan	4	D	I/W	C			Vert					GRN,Vert,T, Noise,Video			Vert			One Class 3 - Max=41% (Gen.)	5-8 Years
Ft Morgan	5	J	SWD	T/P					Acidize	Acidize	Acidize	Acid	Acid	Acid	Acid	Acid	Acid		T/P-Monitor
Ft Morgan	6	D	OBS	T/P			Vert					GRN, Noise							T/P-Monitor
Ft Morgan	7	D	I/W	T/P			Vert												T/P-Monitor
Ft Morgan	8	D	I/W	C			Vert						Vert					Sixteen Class 3 - Max=55% (Gen.)	5-8 Years
Ft Morgan	9	D	I/W	T/P			Vert					GRN,Noise							T/P-Monitor
Ft Morgan	10	J	OBS	T/P															T/P-Monitor
Ft Morgan	11	D	I/W	T			Vert					GRN,Temp,Nois e	Install Pkr Only					One Class 4 - Max=66% (Gen.)	3-5 Years
Ft Morgan	12	D	OBS	T/P			Vert					GRN,Noise							T/P-Monitor
Ft Morgan	13	D	OBS	T/P			Vert					GRN,T,Noise							T/P-Monitor
Ft Morgan	14	D	I/W	C			Vert							Vert				Two Class 3 - Max=44% (Gen.)	5-8 Years
Ft Morgan	15	D	OBS	C	Vert							GRN,Vert,T,Noi se, Video						Zero Class 2 - Max<20%.	12-15 Years
Ft Morgan	16	D	I/W	T/P			Vert												T/P-Monitor
Ft Morgan	17	D	I/W	T			Vert			Wellhead O&M								Zero Class 3 - Max=40%.	12-15 Years
Ft Morgan	18	D	SWD	T/P			Vert					GRN,Noise							T/P-Monitor
~~Ft Morgan~~	~~19~~	~~D~~	~~I/W~~	~~C~~			~~Vert~~					~~GRN, T, Noise~~	~~Hvert, CPP~~					~~One Class 4 - Max=70% (Gen.)~~	~~3-5 Years~~
Ft Morgan	20	D	I/W	C			Vert					GRN,Vert,T,Vid eo		Vert				Two Class 3 - Max=52% (Gen.)	5-8 Years
Ft Morgan	21	D	I/W	T			Vert							Vert				One Class 3 - Max=48% (Gen.)	5-8 Years
Ft Morgan	22	D	I/W	C			Vert					GRN,T,Noise		Vert				One Class 3 - Max=47% (Gen.)	5-8 Years
Ft Morgan	23	D	I/W	C			Vert					GRN,Vert,T,Noi se,Video						Zero Class 3 - Max=39%. (Gen.)	12-15 Years
Ft Morgan	24	D	I/W	C			Vert					GRN,Vert,T,Noi se,Video				Vert		One Class 3 - Max=60% (Iso.)	8-12 Years
Ft Morgan	25	D	I/W	T/P			Vert					GRN							T/P-Monitor
Ft Morgan	26	D	I/W	C			Vert					GRN,Vert,T,Noi se,Video	Hvert,SBT	Vert				One Class 3 - Max=48% (Gen.)	5-8 Years
Ft Morgan	27	D	I/W	C			Vert					GRN,Vert,T,Noi se,Video						Zero Class 3 - Max=37%. (Gen.)	12-15 Years
Ft Morgan	28	D	I/W	C			Vert						CPP					Zero Class 3 - Max=37%. (Gen.)	12-15 Years
Ft Morgan	29	D	I/W	C			Vert											Zero Class 3 - Max=36%. (Gen.)	12-15 Years
Ft Morgan	30	D	I/W	C	Vert							GRN,Vert,T,Vid eo						Zero Class 3 - Max=30%. (Iso.)	12-15 Years
Ft Morgan	31	D	I/W	C			Vert											Zero Class 3 - Max=30%. (Gen.)	12-15 Years
Ft Morgan	32	D	I/W	C	Vert													Zero Class 3 - Max<20%.	12-15 Years
Ft Morgan	33	D	I/W	C			Vert					GRN,Vert,T,Noi se,Video						Zero Class 3 - Max=36%. (Iso.)	12-15 Years
Ft Morgan	34	D	I/W	T			Vert					GRN, T,Noise			Vert			One Class 3 - Max=41% (Gen.)	5-8 Years

Well Completion Abbreviations

- C - Well Completed on Casing
- D - Well Completed in "D" Sand
- I/W - Injection/Withdrawal Well
- J - Well Completed in "J" Sand
- OBS - Observation Well
- SWD - Salt Water Disposal Well
- T - Well Completed with no Tubing
- T/P - Well Completed with Tubing on a Packer

Well Work Abbreviations

- GRN - Gamma Ray/Neutron Log
- Hvert - High Resolution Casing Inspection Log
- N - Noise Log
- T - Temperature Log
- Vert - Casing Inspection with Microvertilog
- Video - Downhole Video