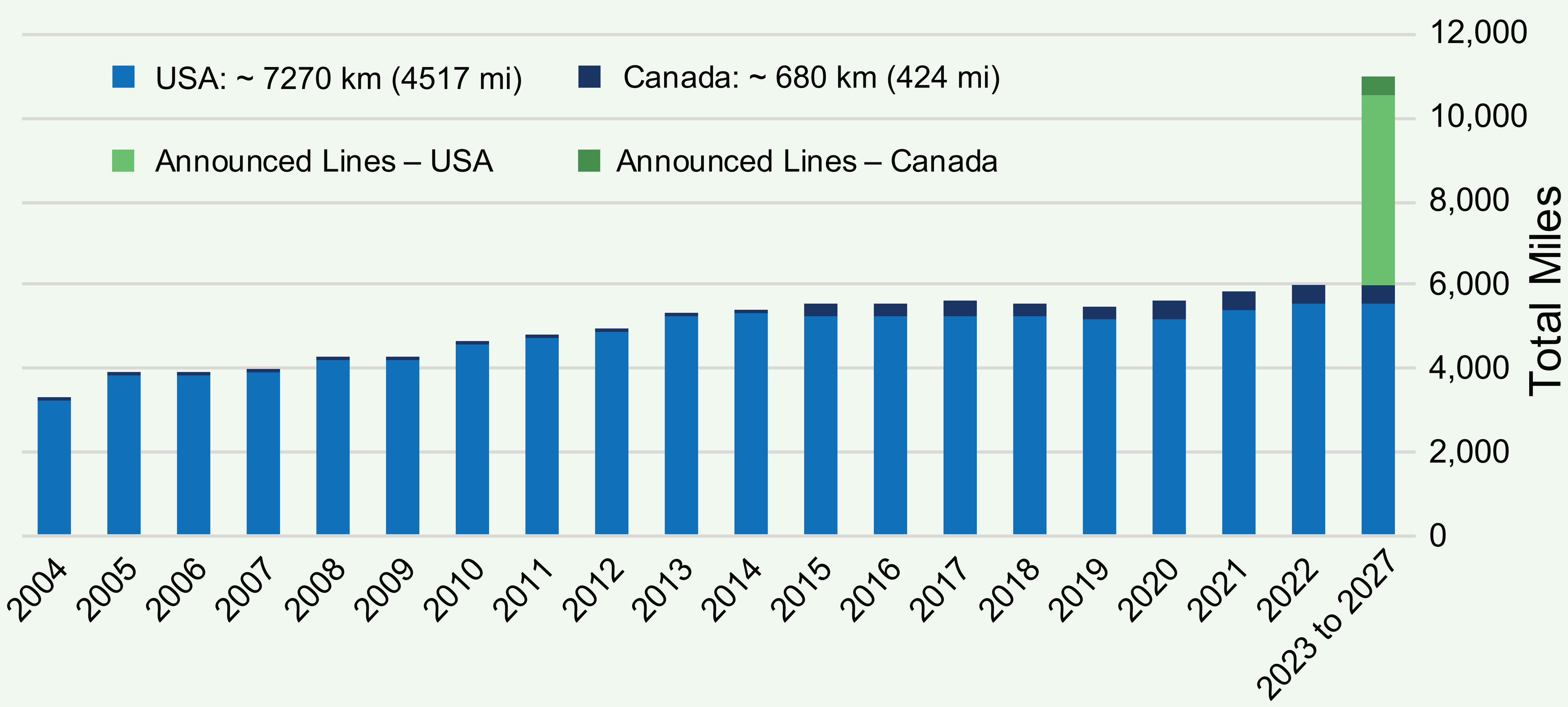
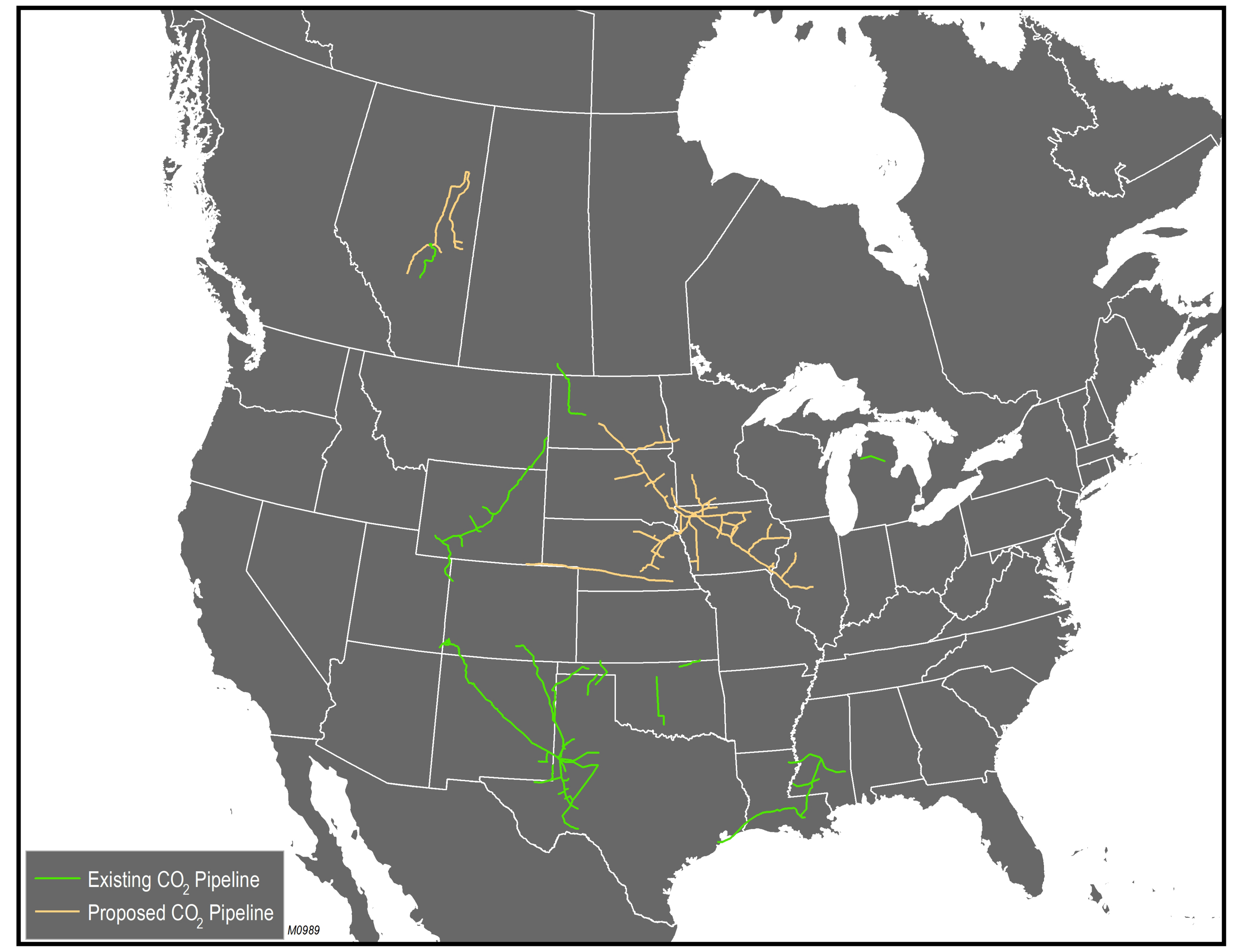
CO_2 TRANSPORTATION INFRASTRUCTURE WITHIN THE UNITED STATES AND CANADA

EERC
UNIVERSITY OF NORTH DAKOTA
PCOR Partnership

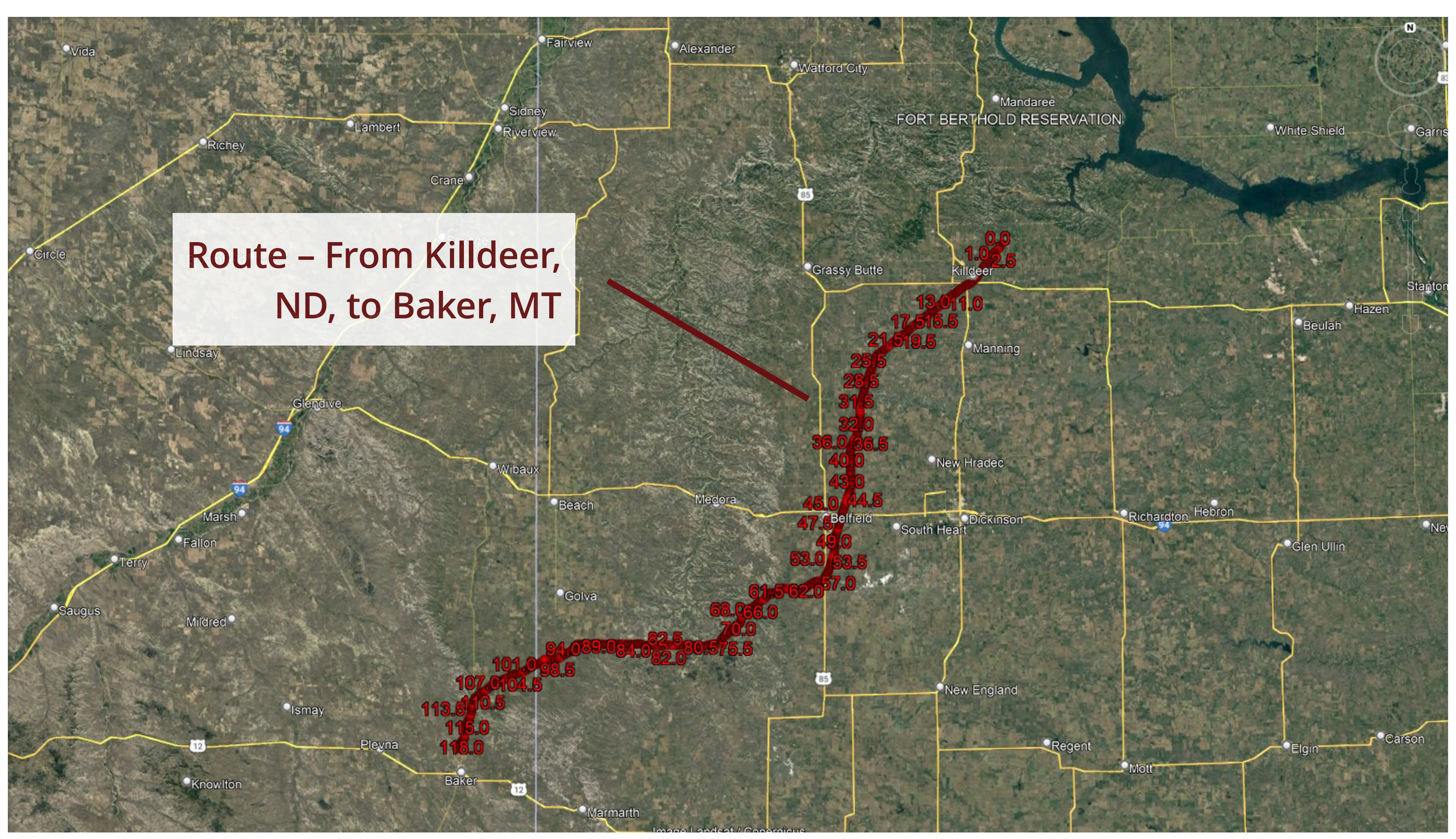


ADDING PIPELINES AS THE NUMBER OF CCS PROJECTS CONTINUES TO GROW



There is >9630 km (5985 mi) of CO_2 pipeline in North America, touting a maximum capacity >225 Mt/yr:

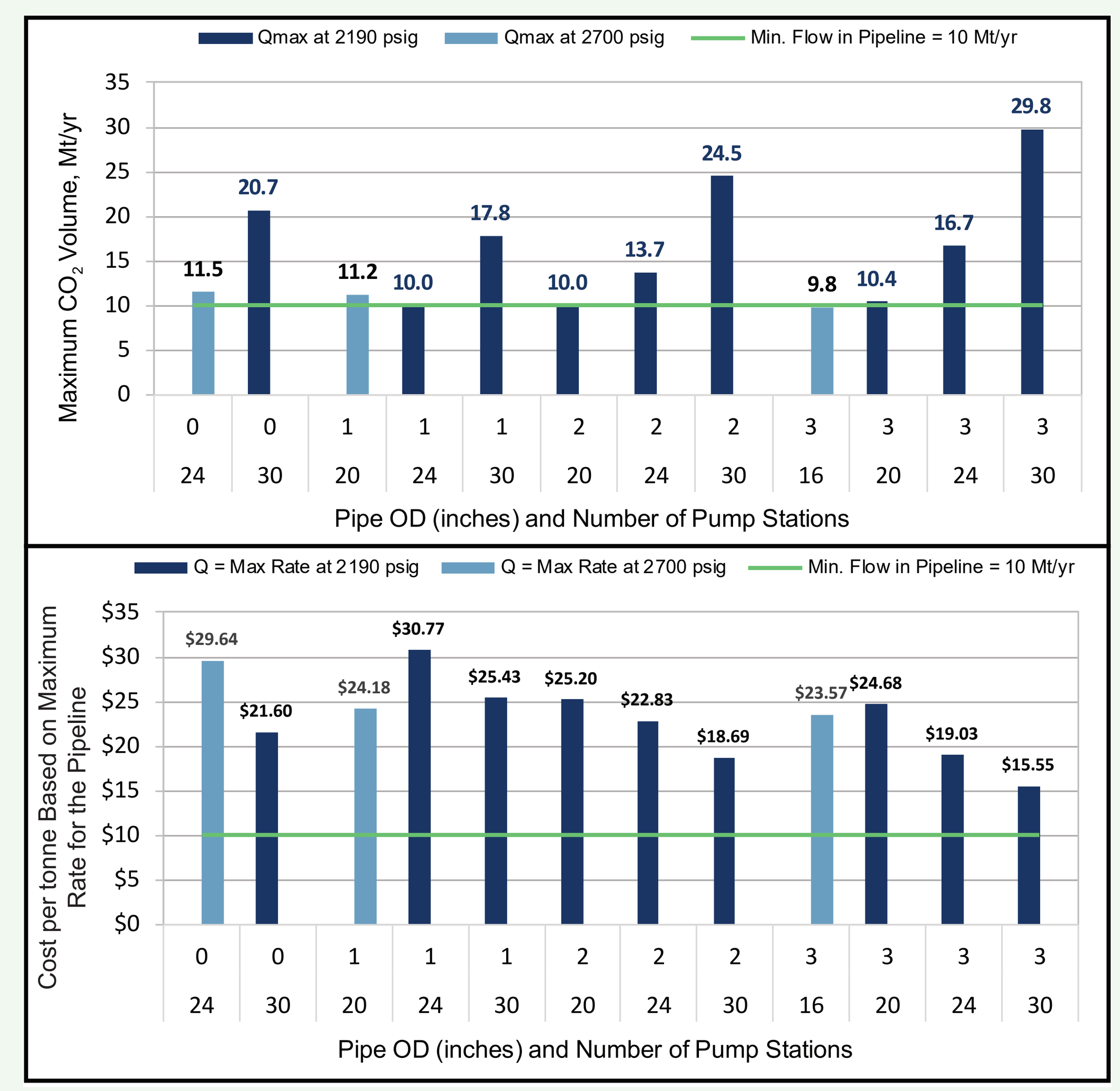
- Additional pipelines are planned in the United States and Canada but are not shown on this map.
- CO_2 flowlines are not shown on this map.
- The current network of existing CO_2 pipelines is primarily used to transport CO_2 for use in EOR.



PIPELINE INVESTIGATION – REVIEW OF LINE SIZING AND EFFECT OF PUMP STATIONS ON A THEORETICAL CO_2 PIPELINE

Pipeline Design Conditions:

- 10 million tonnes/year (Mt/yr)
- 115°F into pipeline
- Line pressures
  – 2190 and 2700 psig
- Net elevation change = 825′



RESULTS

Increasing the size of pipe provided more flow rate through pipeline:

- Some pipelines may require higher pipe and flange pressure ratings (ANSI 1500 vs. ANSI 900) for the desired flow rate and limiting the OD of the pipeline.

Adding pump stations increased the capacity of the pipeline and downsized the OD of the pipeline:

- The addition of pump stations along the pipeline can reduce the OD of the pipeline while increasing flow.
- However, the purchase cost and the operating cost of the pumps over the life of the project need to be reviewed to determine if the addition of pumps are economically justified with the reduction of line OD.

Steel pricing, cost of pumps, and delivery time can drive the decision on how the pipeline is constructed.

EFFECTS ON PIPELINES AND OTHER AREAS OF SOME SPECIFIC IMPURITIES WITHIN CO_2 STREAMS

- Subject matter experts (SMEs) should be used to review the CO_2 stream and provide a recommendation for the material requirements for all parts of the system. Additionally, the SMEs should provide an assessment on whether testing is required to confirm which alloy would best withstand the effects of the CO_2 stream in an aqueous environment for the duration of the project.
- Because of the lack of available information of stainless steels in high CO_2/water/impurity environments, testing may be required to determine the best alloy to use for the CO_2 stream being considered.
- If testing is required, a lead time of 4–12 months may be needed to perform the testing and present results. The length of time for the testing is dependent on the complexity of the analysis with the CO_2 stream.

H_2S

H_2S is toxic and is limited to 10 ppmv for health and safety reasons. When present in CO_2, the corrosion mechanism changes from general or pitting corrosion to cracking, requiring resistant steel and appropriate welds.

CH_4

CH_4 will decrease the saturation water content of CO_2 and increases the potential for hydrate formation.

O_2

O_2 worsens the corrosiveness of a CO_2 stream when free water is present. O_2 can react under certain conditions with H_2S to form sulfuric acid or elemental sulfur. It affects CO_2 infrastructure (in addition to pipelines) and the geologic subsurface if the CO_2 stream is used for enhanced oil recovery (EOR) or storage.

GLYCOL

Glycol (when carried over from the dehydration process) can damage seals and other components.

IMPURITIES

The impurities within the CO_2 stream need to be evaluated for the entire process: from source, through the pipeline/flowline and injection well tubulars, and within the injection zone.

N_2

N_2 decreases the saturation water content of CO_2, increasing the potential for free water formation. It also increases the potential for hydrate formation and can require increased pipe strength because of ductility issues.

MINERAL OIL

Compressor cylinder lubricant (mineral oil) can cause asphaltene plugging issues in injection wells.

H_2O

Free water corrodes the interior of the pipeline Because of the formation of carbonic acid with CO_2.