5.4 Fracturing Fluid
The fluid used for slickwater fracturing is typically comprised of more than 98% fresh water and sand, with chemical additives comprising 2% or less of the fluid. The Department has collected compositional information on many of the additives proposed for use in fracturing shale formations in New York directly from chemical suppliers and service companies. This information has been evaluated by the Department’s Air Resources and Water Divisions as well as the Bureaus of Water Supply Protection and Toxic Substances Assessment in the New York State Department of Health. It has also been reviewed by technical consultants contracted by NYSERDA to conduct research related to the preparation of this document. Discussion of potential environmental impacts and mitigation measures in Chapters 6 and 7 of this SGEIS reflect analysis and input by all of the foregoing entities. Six service companies and twelve chemical suppliers have provided additive product compositional information to the Department that includes more complete information than is available on product Material Safety Data Sheets (MSDSs). Altogether, some compositional information is on file with the Department for 197 products, with complete compositional information on file for 152 of those products. Within these products are approximately 260 unique chemicals whose CAS Numbers have been disclosed to the Department and an additional 40 compounds which require further disclosure since many are mixtures. Table 5.3 is an alphabetical list of all products for which complete chemical information has been provided to...
the Department. Table 5.4 is an alphabetical list of products for which only partial chemical composition information has been provided to the Department. Any product whose name does not appear within Table 5.3 or Table 5.4 was not evaluated in this SGEIS either because no chemical information was submitted to the Department or because the product was not proposed for use in fracturing operations at Marcellus shale wells or other wells targeting other lowpermeability gas reservoirs. MSDSs are on file with the Department for most of the products listed. The Department considers MSDSs to be public information ineligible for exception from disclosure as trade secrets or confidential business information.

Table 5-3 Fracturing Additive Products – Full Composition Disclosure Made to the Department

<table>
<thead>
<tr>
<th>Product Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABF</td>
</tr>
<tr>
<td>Acetic Acid 0.1-10%</td>
</tr>
<tr>
<td>Acid Pensurf / Pensurf</td>
</tr>
<tr>
<td>Activator W</td>
</tr>
<tr>
<td>AGA 150 / Super Acid Gell 150</td>
</tr>
<tr>
<td>AI-2</td>
</tr>
<tr>
<td>Aldacide G</td>
</tr>
<tr>
<td>Alpha 125</td>
</tr>
<tr>
<td>Ammonium Persulfate/OB Breaker</td>
</tr>
<tr>
<td>APB-1, Ammonium Persulfate Breaker</td>
</tr>
<tr>
<td>AQF-2</td>
</tr>
<tr>
<td>ASP-820</td>
</tr>
<tr>
<td>B315 / Friction Reducer B315</td>
</tr>
<tr>
<td>B317 / Scale Inhibitor B317</td>
</tr>
<tr>
<td>B859 / EZEFL0 Surfactant B859</td>
</tr>
<tr>
<td>EZEFL0 F103 Surfactant</td>
</tr>
<tr>
<td>B867 / Breaker B867 / Breaker J218</td>
</tr>
<tr>
<td>B868 / EB-CLEAN B868 LT Encapsulated Breaker / EB-Clean J479 LT Encapsulated Breaker</td>
</tr>
</tbody>
</table>
B869 / Corrosion Inhibitor B869 / Corrosion Inhibitor A262
B875 / Borate Crosslinker B875 / Borate Crosslinker J532
B880 / EB-CLEAN B880 Breaker / EB-CLEAN J475 Breaker
B890 / EZEFLO Surfactant B890 / EZEFLO F100 Surfactant
B900 / EZEFLO Surfactant B900 / EZEFLO F108 Surfactant
B910 / Corrosion Inhibitor B910 / Corrosion Inhibitor A264
B916 / Gelling Agent ClearFRAC XT B916 / Gelling Agent ClearFRAC XT J590
BA-2
BA-20
BA-40L
BA-40LM
BC-140
BC-140 X2
BE-3S
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BE-6
BE-7
BE-9
Bentone A-140
BF-1
BF-7 / BF-7L
BioClear 1000 / Unicide 1000
Bio-Clear 200 / Unicide 2000
Breaker FR
BXL-2, Crosslinker/ Buffer
BXL-STD / XL-300MB
Carbon Dioxide
CL-31
CLA-CHEK LP
CLA-STA XP
Clay Treat PP
Clay Treat TS
Clay Treat-3C
Clayfix II
Clayfix II plus
Cronox 245 ES / CI-14
CS-250 SI
CS-650 OS, Oxygen Scavenger
CS-Polybreak 210
CS-Polybreak 210 Winterized
EB-4L
Enzyme G-NE
FE-1A
FE-2
FE-2A
FE-5A
Ferchek
Ferchek A
Ferrotrol 300L
Flomax 50
Flomax 70 / VX9173
FLOPAM DR-6000 / DR-6000
FLOPAM DR-7000 / DR-7000
Formic Acid
FR-46
FR-48W
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FR-56
FRP-121
FRW-14
GasPerm 1000
GBL-8X / LEB-10X / GB-L / En-breaker
GBW-20C
GBW-30 Breaker
Green-Cide 25G / B244 / B244A
H015 / Hydrochloric Acid 15% H15
HAI-OS Acid Inhibitor
HC-2
High Perm SW-LB
HPH Breaker
HPH foamer
Hydrochloric Acid
Hydrochloric Acid (HCl)
HYG-3
IC 100L
ICA-720 / IC-250
ICA-8 / IC-200
ICI-3240
Inflo-250
Inflo-250W / Inflo-250 Winterized
Iron Check / Iron Chek
Iron Sta IIC / Iron Sta II
Isopropyl Alcohol
J313 / Water Friction-Reducing Agen J313
J534 / Urea Ammonium Nitrate Solution J534
J580 / Water Gelling Agent J580
K-34
K-35
KCl
L058 / Iron Stabilizer L58
L064 / Temporary Clay Stabilizer L64
LGC-35 CBM
LGC-36 UC
LGC-VI UC
Losurf 300M
M003 / Soda Ash M3
MA-844W
Methanol
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MO-67
<table>
<thead>
<tr>
<th>Product Name</th>
<th>Partial Composition Disclosure to the Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mophlo III</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>MSA-II</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>Muriatic Acid 36%</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>Musol A</td>
<td>Nitrogen</td>
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<tr>
<td>NOO2 / Nitrogen N2</td>
<td>Nitrogen</td>
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<tr>
<td>NCL-100</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>Para Clear D290 / ParaClean II</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>Paragon 100 E+</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>PLURADYNE TDA 6</td>
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</tr>
<tr>
<td>PSA-2L</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>PSA-720</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>PSI-7208</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>SAS-2</td>
<td>Nitrogen</td>
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<tr>
<td>Scalecheck LP-55</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>Scalecheck LP-65</td>
<td>Nitrogen</td>
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<tr>
<td>Scalehib 100 / Super Scale Inhibitor / Scale Clear SI-112</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>SGA II</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>Shale Surf 1000</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>Shale Surf 1000 Winterized</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>Sodium Citrate</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>SP Breaker</td>
<td>Nitrogen</td>
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<tr>
<td>STIM-50 / LT-32</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>Super OW 3</td>
<td>Nitrogen</td>
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<tr>
<td>Super Pen 2000</td>
<td>Nitrogen</td>
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<td>SuperGel 15</td>
<td>Nitrogen</td>
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<tr>
<td>U042 / Chelating Agent U42</td>
<td>Nitrogen</td>
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<tr>
<td>U066 / Mutual Solvent U66</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>Unicode 100 / EC6116A</td>
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<tr>
<td>Unifoam</td>
<td>Nitrogen</td>
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<tr>
<td>Unigel 5F</td>
<td>Nitrogen</td>
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<td>UniHibA / SP-43X</td>
<td>Nitrogen</td>
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<td>UnihibG / S-11</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>Unisilik ST 50 / Stim Lube</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>Vicon NF</td>
<td>Nitrogen</td>
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<td>WG-11</td>
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<td>DRAFT SGEIS 9/30/2009, Page 5-38</td>
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<tr>
<td>WG-36</td>
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<tr>
<td>WLC-6</td>
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<tr>
<td>XL-1</td>
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</tr>
<tr>
<td>XL-8</td>
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</tr>
<tr>
<td>XLW-32</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>Xylene</td>
<td>Nitrogen</td>
</tr>
</tbody>
</table>

Table 5-4 Fracturing Additive Products - Partial Composition Disclosure to the Department

Product Name
20 Degree Baume Muriatic Acid
AcTivator / 78-ACTW
AMB-100
B885 / ClearFRAC LT B885 / ClearFRAC LT J551A
B892 / EZEFLO B892 / EZEFLO F110 Surfactant
CL-22UC
Clay Master 5C
Corrosion Inhibitor A261
FAW-5
FDP-S798-05
FDP-S819-05
FE ACID
FR-48
FRW-16
FRW-18
FRW-25M
GA 8713
GBW-15C
GBW-15L
GW-3LDF
HVG-1, Fast Hydrating Guar Slurry
ICA 400
Inflo-102
J134L / Enzyme Breaker J134L
KCLS-2, KCL Substitute
L065 / Scale Inhibitor L065
LP-65
Magnacide 575 Microbiocide
MSA ACID
DRAFT SGEIS 9/30/2009, Page 5-39
Multifunctional Surfactant F105
Nitrogen, Refrigerated Liquid
OptiKleen-WF
Parasperse Cleaner
Product 239
S-150
SandWedge WF
Scalechek SCP-2
SilkWater FR-A
Super Sol 10/20/30
Unislick 30 / Cyanaflo 105L
WC-5584
WCS 5177 Corrosion Scale Inhibitor
WCW219 Combination Inhibitor
WF-12B Foamer
WF-12B Salt Inhibitor Stix
WF-12B SI Foamer/Salt Inhibitor
WF12BH Foamer
WFR-C
Information in sections 5.4.1-3 below was compiled primarily by URS Corporation, under contract to NYSERDA.

5.4.1 Properties of Fracturing Fluids

Additives are used in hydraulic fracturing operations to elicit certain properties and characteristics that would aide and enhance the operation. The desired properties and characteristics include:

• Non-reactive
• Non-flammable
• Minimal residuals
• Minimal potential for scale or corrosion.
• Low entrained solids
• Neutral pH (pH 6.5 – 7.5) for maximum polymer hydration
• Limited formation damage
• Appropriately modify properties of water to carry proppant deep into the shale
• Economical to modify fluid properties
• Minimal environmental effects

5.4.2 Classes of Additives

Table 5.5 lists the types, purposes and examples of additives that have been proposed to date for use in hydraulic fracturing of gas wells in New York State.

Table 5-5 - Types and Purposes of Additives Proposed for Use in New York State

Additive Type Description of Purpose Examples of Chemicals

Proppant “Props” open fractures and allows gas / fluids to flow more freely to the well bore.

Sand
[Sintered bauxite; zirconium oxide; ceramic beads]

Acid Cleans up perforation intervals of cement and drilling mud prior to fracturing fluid injection, and provides accessible path to formation.

Hydrochloric acid (HCl, 3% to 28%)

Breaker Reduces the viscosity of the fluid in order to release proppant into fractures and enhance the recovery of the fracturing fluid.

Peroxydisulfates

Bactericide / Biocide

Inhibits growth of organisms that could produce gases (particularly hydrogen sulfide)
that could contaminate methane gas. Also prevents the growth of bacteria which can reduce the ability of the fluid to carry proppant into the fractures.

Glutaraldehyde; 2-Bromo-2-nitro-1,2-propanediol

Clay Stabilizer / Control

Prevents swelling and migration of formation clays which could block pore spaces thereby reducing permeability.

Salts (e.g., tetramethyl ammonium chloride) [Potassium chloride (KCl)]

Corrosion Inhibitor

Reduces rust formation on steel tubing, well casings, tools, and tanks (used only in fracturing fluids that contain acid).

Methanol

Crosslinker The fluid viscosity is increased using phosphate esters combined with metals. The metals are referred to as crosslinking agents. The increased fracturing fluid viscosity allows

Potassium hydroxide

Additive Type Description of Purpose Examples of Chemicals

the fluid to carry more proppant into the fractures.

Friction Reducer Allows fracture fluids to be injected at optimum rates and pressures by minimizing friction.

Sodium acrylateacrylamide copolymer; polyacrylamide (PAM)

Gelling Agent Increases fracturing fluid viscosity, allowing the fluid to carry more proppant into the fractures.

Guar gum

Iron Control Prevents the precipitation of metal oxides which could plug off the formation.

Citric acid; thioglycolic acid

Scale Inhibitor Prevents the precipitation of carbonates and sulfates (calcium carbonate, calcium sulfate, barium sulfate) which could plug off the formation.

Ammonium chloride; ethylene glycol; polyacrylate

Surfactant Reduces fracturing fluid surface tension thereby aiding fluid recovery.
5.4.3 Composition of Fracturing Fluids

The composition of the fracturing fluid used may vary from one geologic basin or formation to another in order to meet the specific needs of each operation; but the range of additive types available for potential use remains the same. There are a number of different chemical compositions for each additive type; however, only one product of each type is typically utilized in any given gas well. The selection may be driven by the formation and potential interactions between additives. Additionally not all additive types will be utilized in every fracturing job.

A sample composition by weight of fracture fluid is provided in Figure 5.3; this composition is based on data from the Fayetteville Shale. Based on this data, approximately 90 percent of the fracture fluid is water; another approximately 9 percent is proppant (see Photo 5.17); the remainder, typically less than 0.5 percent consists of chemical additives listed above.

Similar to the Marcellus Shale, the Fayetteville Shale is a marine shale rich in unoxidized carbon (i.e. a black shale). The two shales are at similar depths, and vertical and horizontal wells have been drilled/fractured at both shales.

Barnett Shale is considered to be the first instance of extensive high-volume hydraulic fracture technology use; the technology has since been applied in other areas such as the Fayetteville Shale and the Haynesville Shale. URS notes that data collected from applications to drill Marcellus Shale wells in New York indicate that the typical fracture fluid composition for operations in the Marcellus Shale is similar to the provided composition in the Fayetteville Shale.

Even though no horizontal wells have been drilled in the Marcellus Shale in New York,
applications filed to date indicate that it is realistic to expect that the composition of fracture fluids used in the Marcellus Shale would be similar from one operation to the next. One potential exception is that additional data provided separately to the Department indicates that biocides have comprised up to 0.03% of fracturing fluid instead of 0.001% as noted in Figure 5.3.

Each product within the twelve classes of additives may be made up of one or more chemical constituents. Table 5.6 is a list of chemical constituents and their CAS numbers, that have been extracted from complete product chemical compositional information and Material Safety Data Sheets submitted to the NYSDEC for nearly 200 products used or proposed for use in hydraulic fracturing operations in the Marcellus Shale area of New York. It is important to note that several manufacturers and suppliers provide similar chemicals (i.e. chemicals that would serve the same purpose) for any class of additive, and that not all types of additives are used in a single well. Table 5.6 represents constituents of all hydraulic-fracturing-related chemicals submitted to NYSDEC to date for potential use at shale wells in the State, only a handful of which would be utilized in a single well. Data provided to NYSDEC to date indicates similar fracturing fluid compositions for vertically and horizontally drilled wells.
Table 5-6 - Chemical Constituents in Additives/Chemicals

<table>
<thead>
<tr>
<th>CAS Number</th>
<th>Chemical Constituent</th>
</tr>
</thead>
<tbody>
<tr>
<td>2634-33-5</td>
<td>1,2 Benzisothiazolin-2-one / 1,2-benzisothiazolin-3-one</td>
</tr>
<tr>
<td>95-63-6</td>
<td>1,2,4 trimethylbenzene</td>
</tr>
<tr>
<td>123-91-1</td>
<td>1,4 Dioxane</td>
</tr>
<tr>
<td>3452-07-1</td>
<td>1-ecicosene</td>
</tr>
<tr>
<td>629-73-2</td>
<td>1-hexadecene</td>
</tr>
<tr>
<td>112-88-9</td>
<td>1-octadecene</td>
</tr>
<tr>
<td>1120-36-1</td>
<td>1-tetradecene</td>
</tr>
<tr>
<td>10222-01-2</td>
<td>2,2 Dibromo-3-nitrilopropionamide</td>
</tr>
<tr>
<td>27776-21-2</td>
<td>2,2'-azobis-[2-(imidazlin-2-yl)propane]-dihydrochloride</td>
</tr>
<tr>
<td>73003-80-2</td>
<td>2,2-Dobromomalonamide</td>
</tr>
<tr>
<td>15214-89-8</td>
<td>2-Acrylamido-2-methylpropanesulphonic acid sodium salt polymer</td>
</tr>
<tr>
<td>46830-22-2</td>
<td>2-acryloyloxyethyl(benzyl)dimethylammonium chloride</td>
</tr>
<tr>
<td>52-51-7</td>
<td>2-Bromo-2-nitro-1,3-propanediol</td>
</tr>
<tr>
<td>111-76-2</td>
<td>2-Butoxy ethanol</td>
</tr>
<tr>
<td>1113-55-9</td>
<td>2-Dibromo-3-Nitrilopronamide (2-Monobromo-3-nitrilopropionamide)</td>
</tr>
<tr>
<td>104-77-6</td>
<td>2-Ethyl Hexanol</td>
</tr>
<tr>
<td>67-63-0</td>
<td>2-Propanol / Isopropyl Alcohol / Isopropanol / Propan-2-ol</td>
</tr>
<tr>
<td>26062-79-3</td>
<td>2-Propan-1-aminium, N,N-dimethyl-N-2-propenyl-chloride, homopolymer</td>
</tr>
<tr>
<td>9003-03-6</td>
<td>2-propenoic acid, homopolymer, ammonium salt</td>
</tr>
<tr>
<td>25987-30-8</td>
<td>2-Propenoic acid, polymer with 2 p-propenamide, sodium salt / Copolymer of acrylamide and sodium acrylate</td>
</tr>
<tr>
<td>71050-62-9</td>
<td>2-Propenoic acid, polymer with sodium phosphinate (1:1)</td>
</tr>
<tr>
<td>66019-18-9</td>
<td>2-propenoic acid, telomer with sodium hydrogen sulfite</td>
</tr>
<tr>
<td>107-19-7</td>
<td>2-Propyn-1-ol / Propargyl Alcohol</td>
</tr>
<tr>
<td>51229-78-8</td>
<td>3,5,7-Triaza-1-azoniatricyclo[3.3.1.13,7]decane, 1-(3-chloro-2-propenyl)-chloride,</td>
</tr>
<tr>
<td>115-19-5</td>
<td>3-methyl-1-butyn-3-ol</td>
</tr>
<tr>
<td>127087-87-0</td>
<td>4-Nonylphenol Polyethylene Glycol Ether Branched / Nonylphenol ethoxylated / Oxyalkylated Phenol</td>
</tr>
<tr>
<td>64-19-7</td>
<td>Acetic acid</td>
</tr>
<tr>
<td>68442-62-6</td>
<td>Acetic acid, hydroxy-, reaction products with triethanolamine</td>
</tr>
<tr>
<td>108-24-7</td>
<td>Acetic Anhydride</td>
</tr>
<tr>
<td>67-64-1</td>
<td>Acetone</td>
</tr>
<tr>
<td>79-06-1</td>
<td>Acrylamide</td>
</tr>
</tbody>
</table>

28 Table 5.6 is a list of chemical constituents and their CAS numbers that have been extracted from complete chemical compositions and Material Safety Data Sheets submitted to the NYSDEC.

29 These are the chemical constituents of all chemical additives proposed to be used in New York for hydraulic fracturing operations at shale wells. Only a few chemicals will be used in a single well; the list of chemical constituents used in an individual well will be correspondingly smaller.

30 Chemical Abstracts Service (CAS) is a division of the American Chemical Society. CAS assigns unique numerical identifiers to every chemical described in the literature. The intention is to make database searches more convenient, as chemicals often have many names. Almost all molecule databases today allow searching by CAS number.
Acrylamide - sodium 2-acrylamido-2-methylpropane sulfonate copolymer
Acrylamide - Sodium Acrylate Copolymer or Anionic Polyacrylamide
Acrylamide polymer with N,N,N-trimethyl-2[1-oxo-2-propenyl]oxy
Ethenaminium chloride
Acrylamide-sodium acrylate copolymer
Alcohols, C12-C16, Ethoxylated (a.k.a. Ethoxylated alcohol)
Aliphatic Hydrocarbon / Hydrotreated light distillate / Petroleum Distillates / Isoparaffinic Solvent / Paraffin Solvent / Naphthenic Solvent
Alkenes
Alkyl (C14-C16) olefin sulfonate, sodium salt
Alkylphenol ethoxylate surfactants
Aluminum chloride
Amines, C12-14-tert-alkyl, ethoxylated
Amines, Ditallow alkyl, ethoxylated
Amines, tallow alkyl, ethoxylated, acetates
Ammonia
Ammonium acetate
Ammonium Alcohol Ether Sulfate
Ammonium bisulfate
Ammonium Bisulphite
Ammonium Chloride
Ammonium citrate
Ammonium Cumene Sulfonate
Ammonium hydrogen-difluoride
Ammonium nitrate
Ammonium Persulfate / Diammonium peroxidisulphate
Ammonium Thiocyanate
Aqueous ammonia
Bentonite, benzyl(hydrogenated tallow alkyl) dimethylammonium stearate complex / organophilic clay
Benzene
Benzene, 1,1'-oxybis, tetratpropylene derivatives, sulfonated, sodium salts
Benzenemethanaminium, N,N-dimethyl-N-[2-[(1-oxo-2-propenyl)oxy]ethyl]-, chloride, polymer with 2-propenamide
Boric acid
Boric oxide / Boric Anhydride
Butan-1-ol
C10 - C16 Ethoxylated Alcohol
C12-15 Alcohol, Ethoxylated
Calcium chloride
Carbon Dioxide
Carboxymethylhydroxypropyl guar
Cellulase / Hemicellulase Enzyme
Cellulose
Chlorine Dioxide
Citric Acid

CAS Number 30 Chemical Constituent
Citrus Terpenes
Cocamidopropyl Betaine
68155-09-9 Cocamidopropylamine Oxide
68424-94-2 Coco-betaine
7758-98-7 Copper (II) Sulfate
31726-34-8 Crissanol A-55
14808-60-7 Crystalline Silica (Quartz)
7447-39-4 Cupric chloride dihydrate
1120-24-7 Decyldimethyl Amine
2605-79-0 Decyl-dimethyl Amine Oxide
3252-43-5 Dibromoacetonitrile
25340-17-4 Diethylbenzene
111-46-6 Diethylene Glycol
22042-96-2 Diethylenetriamine penta (methyleneephonic acid) sodium salt
28757-00-8 Diisopropyl naphthalenesulfonic acid
68607-28-3 Dimethylcocoamine, bis(chloroethyl) ether, diquaternary ammonium salt
7398-69-8 Dimethylallylammonium chloride
25265-71-8 Dipropylene glycol
139-33-3 Disodium Ethylene Diamine Tetra Acetate
5989-27-5 D-Limonene
123-01-3 Dodecylbenzene
27176-87-0 Dodecylbenzene sulfonic acid
42504-46-1 Dodecylbenzenesulfonate isopropanolamine
50-70-4 D-Sorbitol / Sorbitol
37288-54-3 Endo-1,4-beta-mannanase, or Hemicellulase
149879-98-1 Erucic Amidopropyl Dimethyl Betaine
89-65-6 Erythorbic acid, anhydrous
54076-97-0 Ethanaminium, N,N,N-trimethyl-2-[(1-oxo-2-propenyl)oxy]−, chloride, homopolymer
107-21-1 Ethane-1,2-diol / Ethylene Glycol
9002-93-1 Ethoxylated 4-tert-octylphenol
68439-50-9 Ethoxylated alcohol
126950-60-5 Ethoxylated alcohol
67254-71-1 Ethoxylated alcohol (C10-12)
68951-67-7 Ethoxylated alcohol (C14-15)
68439-46-3 Ethoxylated alcohol (C9-11)
66455-15-0 Ethoxylated Alcohols
84133-50-6 Ethoxylated Alcohols (C12-14 Secondary)
68439-51-0 Ethoxylated Alcohols (C12-14)
78330-21-9 Ethoxylated branch alcohol
34398-01-1 Ethoxylated C11 alcohol
61791-12-6 Ethoxylated Castor Oil
61791-29-5 Ethoxylated fatty acid, coco
61791-08-0 Ethoxylated fatty acid, coco, reaction product with ethanolamine
68439-45-2 Ethoxylated hexanol
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**CAS Number30 Chemical Constituent**
9036-19-5 Ethoxylated octylphenol
9005-67-8 Ethoxylated Sorbitan Monostearate
9004-70-3 Ethoxylated Sorbitan Trioleate
64-17-5 Ethyl alcohol / ethanol
100-41-4 Ethyl Benzene
97-64-3 Ethyl Lactate
9003-11-6 Ethylene Glycol-Propylene Glycol Copolymer (Oxirane, methyl-, polymer with oxirane)
75-21-8 Ethylene oxide
5877-42-9 Ethyloctynol
68526-86-3 Exxal 13
61790-12-3 Fatty Acids
68188-40-9 Fatty acids, tall oil reaction products w/ acetophenone, formaldehyde & thiourea
9043-30-5 Fatty alcohol polyglycol ether surfactant
7705-08-0 Ferric chloride
7782-63-0 Ferrous sulfate, heptahydrate
50-00-0 Formaldehyde
29316-47-0 Formaldehyde polymer with 4,1,1-dimethylethyl phenolmethyl oxirane
153795-76-7 Formaldehyde, polymers with branched 4-nonylphenol, ethylene oxide and propylene oxide
75-12-7 Formamide
64-18-6 Formic acid
110-17-8 Fumaric acid
65997-17-3 Glassy calcium magnesium phosphate
111-30-8 Glutaraldehyde
56-81-5 Glycerol / glycerine
9000-30-0 Guar Gum
9000-30-01 Guar Gum
64742-94-5 Heavy aromatic petroleum naphtha
9025-56-3 Hemicellulase
7647-01-0 Hydrochloric Acid / Hydrogen Chloride / muriatic acid
7722-84-1 Hydrogen Peroxide
79-14-1 Hydroxy acetic acid
35249-89-9 Hydroxyacetic acid ammonium salt
9004-62-0 Hydroxyethyl cellulose
5470-11-1 Hydroxylamine hydrochloride
39421-75-5 Hydroxypropyl guar
35674-56-7 Isomeric Aromatic Ammonium Salt
64742-88-7 Isoparaaffinic Petroleum Hydrocarbons, Synthetic
64-63-0 Isopropanol
98-82-8 Isopropylbenzene (cumene)
68909-80-8 Isoquinoline, reaction products with benzyl chloride and quinoline
8008-20-6 Kerosene
64742-81-0 Kerosine, hydrodesulfurized
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**CAS Number**

30 Chemical Constituent

63-42-3 Lactose
64742-95-6 Light aromatic solvent naphtha
1120-21-4 Light Paraffin Oil
14807-96-6 Magnesium Silicate Hydrate (Talc)
1184-78-7 methanamine, N,N-dimethyl-, N-oxide
67-56-1 Methanol
68891-11-2 Methyloxirane polymer with oxirane, mono (nonylphenol) ether, branched
8052-41-3 Mineral spirits / Stoddard Solvent
141-43-5 Monoethanolamine
44992-01-0 N,N,N-trimethyl-2[1-oxo-2-propenyl]oxy Ethanaminium chloride
64742-48-9 Naphtha (petroleum), hydrotreated heavy
91-20-3 Naphthalene
38640-62-9 Naphthalene bis(1-methylethyl)
93-18-5 Naphthalene, 2-ethoxy-
68909-18-2 N-benzyl-alkyl-pyridinium chloride
68139-30-0 N-Cocoamidopropyl-N,N-dimethyl-N-2-hydroxypropylsulfobetaine
7727-37-9 Nitrogen, Liquid form
68412-54-4 Nonylphenol Polyethoxylate
121888-66-2 Organophilic Clays
64742-65-0 Petroleum Base Oil
64741-68-0 Petroleum naphtha
70714-66-8 Phosphonic acid, [(phosphonomethyl)imino]bis[2,1-ethanediyl]initrilobis(methylene)]tetrakis-, ammonium salt
8000-41-7 Pine Oil
60828-78-6 Poly(oxy-1,2-ethanediyl), α-[3,5-dimethyl-1-(2-methylpropyl)hexyl]-ω-hydroxy-
25322-68-3 Poly(oxy-1,2-ethanediyl), α-hydro-w-hydroxy / Polyethylene Glycol
24938-91-8 Poly(oxy-1,2-ethanediyl), α-tridecyl-ω-hydroxy-
51838-31-4 Polyepichlorohydrin, trimethylamine quaternized
56449-46-8 Polyethylene glycol oleate ester
62649-23-4 Polymer with 2-propenoic acid and sodium 2-propenoate
9005-65-6 Polyoxyethylene Sorbitan Monooleate
61791-26-2 Polyoxylated fatty amine salt
127-08-2 Potassium acetate
12712-38-8 Potassium borate
1332-77-0 Potassium borate
20786-60-1 Potassium Borate
584-08-7 Potassium carbonate
7447-40-7 Potassium chloride
590-29-4 Potassium formate
1310-58-3 Potassium Hydroxide
13709-94-9 Potassium metaborate
24634-61-5 Potassium Sorbate
112926-00-8 Precipitated silica / silica gel
57-55-6 Propane-1,2-diol, or Propylene glycol

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CAS Number30 Chemical Constituent
107-98-2 Propylene glycol monomethyl ether
68953-58-2 Quaternary Ammonium Compounds
62763-89-7 Quinoline, 2-methyl-, hydrochloride
15619-48-4 Quinolinium, 1-(phenylmethl), chloride
7631-86-9 Silica, Dissolved
5324-84-5 Sodium 1-octanesulfonate
127-09-3 Sodium acetate
95371-16-7 Sodium Alpha-olefin Sulfonate
532-32-1 Sodium Benzoate
144-55-8 Sodium bicarbonate
7631-90-5 Sodium bisulfate
7647-15-6 Sodium Bromide
497-19-8 Sodium carbonate
7647-14-5 Sodium Chloride
7758-19-2 Sodium chlorite
3926-62-3 Sodium Chloroacetate
68-04-2 Sodium citrate
6381-77-7 Sodium erythorbate / isoascorbic acid, sodium salt
2836-32-0 Sodium Glycolate
1310-73-2 Sodium Hydroxide
7681-52-9 Sodium hypochlorite
7775-19-1 Sodium Metaborate .8H2O
10486-00-7 Sodium perborate tetrahydrate
7775-27-1 Sodium persulphate
9003-04-7 Sodium polyacrylate
7757-82-6 Sodium sulfate
1303-96-4 Sodium tetraborate decahydrate
7772-98-7 Sodium Thiosulfate
1338-43-8 Sorbitan Monooleate
57-50-1 Sucrose
5329-14-6 Sulfamic acid
112945-52-5 Synthetic Amorphous / Pyrogenic Silica / Amorphous Silica
68155-20-4 Tall Oil Fatty Acid Diethanolamine
8052-48-0 Tallow fatty acids sodium salt
72480-70-7 Tar bases, quinoline derivs., benzyl chloride-quaternized
68647-72-3 Terpene and terpenoids
68956-56-9 Terpene hydrocarbon byproducts
533-74-4 Tetrahydro-3,5-dimethyl-2H-1,3,5-thiadiazine-2-thione (a.k.a. Dazomet)
55566-30-8 Tetrakis(hydroxymethyl)phosphonium sulfate (THPS)
75-57-0 Tetrakis(hydroxymethyl)phosphonium sulfate (THPS)
64-02-8 Tetrasodium Ethylenediaminetetraacetate
68-11-1 Thioglycolic acid
62-56-6 Thiourea
68527-49-1 Thiourea, polymer with formaldehyde and 1-phenylethanolone
108-88-3 Toluene

**CAS Number**

81741-28-8 Tributyl tetradecyl phosphonium chloride
68299-02-5 Triethanolamine hydroxyacetate
112-27-6 Triethylene Glycol
52624-57-4 Trimethylolpropane, Ethoxylated, Propoxylated
150-38-9 Trisodium Ethylenediaminetetraacetate
5064-31-3 Trisodium Nitrilotriacetate
7601-54-9 Trisodium ortho phosphate
57-13-6 Urea
25038-72-6 Vinylidene Chloride/Methylacrylate Copolymer
7732-18-5 Water
1330-20-7 Xylene

**Chemical Constituent**

Aliphatic acids
Aliphatic alcohol glycol ether
Alkyl Aryl Polyethoxy Ethanol
Alkylaryl Sulfonate
Aromatic hydrocarbons
Aromatic ketones
Oxyalkylated alkylphenol
Petroleum distillate blend
Polyethoxylated alkanol
Polymeric Hydrocarbons
Salt of amine-carbonyl condensate
Salt of fatty acid/polyamine reaction product
Sugar
Surfactant blend

Chemical constituents are not linked to product names in Table 5.6 because a significant number of product composition and formulas have been justified as trade secrets as defined and provided by Public Officers Law §87.2(d) and the Department’s implementing regulation, 6 NYCRR 616.7.

5.4.3.1 Chemical Categories and Health Information

DEC requested assistance from NYSDOH in identifying potential exposure pathways and constituents of concern associated with high-volume hydraulic fracturing for low-permeability gas reservoir development. DEC provided DOH with fracturing additive product constituents based on Material Safety Data Sheets (MSDSs) and product-composition disclosures for hydraulic fracturing additive products that were provided by well-service companies and the chemical supply companies that manufacture the products.

Compound-specific toxicity data are very limited for many chemical additives to fracturing fluids, so chemicals potentially present in fracturing fluids were grouped together into categories according to their chemical structure (or function in the case of microbiocides) in Table 5.7, compiled by NYSDOH. As explained above, any given individual fracturing job will only involve a handful of chemicals and may not include every category of chemicals.

Table 5-7 - Categories based on chemical structure of potential fracturing fluid constituents. Chemicals are grouped in order of ascending CAS Number by category.
Chemical CAS Number

Amides
Formamide 75-12-7
acrylamide 79-06-1

Amines
urea 57-13-6
thiourea 62-56-6
tetramethyl ammonium chloride 75-57-0
monoethanolamine 141-43-5
Decyldimethyl Amine 1120-24-7
methanamine, N,N-dimethyl-, N-oxide 1184-78-7
Decyl-dimethyl Amine Oxide 2605-79-0
dimethyldiallylammonium chloride 7398-69-8
polydimethyl dially ammonium chloride 26062-79-3
dodecylbenzenesulfonate isopropanolamine 42504-46-1
N,N,N-trimethyl-2[(1-oxo-2-propenyl)oxy]ethanaminium chloride 44992-01-0
2-acryloyloxyethyl(dimethyl)dimethylammonium chloride 46830-22-2
ethanaminium, N,N,N-trimethyl-2-[(1-oxo-2-propenyl)oxy]-, chloride, homopolymer 54076-97-0
Cocamidopropyl Betaine 61789-40-0
polyoxylated fatty amine salt 61791-26-2
quinoline, 2-methyl, hydrochloride 62763-89-7
N-cocamidopropyl-N,N-dimethyl-N-[2-[(1-oxo-2-propenyl)oxy]ethyl]-, chloride, polymer with 2-propenamide 74153-51-8

Chemical CAS Number

Quaternary ammonium compounds, bis(hydrogenated tallow alkyl) dimethyl, salts with bentonite 68953-58-2
amines, ditallow alkyl, ethoxylated 71011-04-6
amines, C-12-14-tert-alkyl, ethoxylated 73138-27-9
benzenemethanaminium, N,N-dimethyl-N-[2-[(1-oxo-2-propenyl)oxy]ethyl]-, chloride, polymer with 2-propenamide 74153-51-8
Erucic Amidopropyl Dimethyl Betaine 149879-98-1

Petroleum Distillates
light paraffin oil 1120-21-4
kerosene 8008-20-6
stoddard solvent 8052-41-3
petroleum naphtha 64741-68-0
Multiple names listed under same CAS#:
LVP aliphatic hydrocarbon,
ydrotreated light distillate,
low odor paraffin solvent,
paraffin solvent,
paraffin napthenic solvent,
isoparaffinic solvent,
distillates (petroleum) hydrotreated light,
petroleum light distillate,
aliphatic hydrocarbon,
petroleum distillates
naphtha, hydrotreated heavy 64742-48-9
petroleum base oil 64742-65-0
kerosine (petroleum, hydodesulfurized) 64742-81-0
kerosine (petroleum, hydodesulfurized) 64742-88-7
Multiple names listed under same CAS#:
heavy aromatic petroleum naphtha,
light aromatic solvent naphtha
64742-94-5
light aromatic solvent naphtha 64742-95-6
alkenes, C> 10 α - 64743-02-8

Aromatic Hydrocarbons
benzene 71-43-2
naphthalene 91-20-3
naphthalene, 2-ethoxy 93-18-5
1,2,4-trimethylbenzene 95-63-6
cumene 98-82-8
ethyl benzene 100-41-4
toluene 108-88-3
dodecylbenzene 123-01-3
xylene 1330-20-7

Chemical CAS Number
diethylbenzene 25340-17-4
naphthalene bis(1-methylethyl) 38640-62-9

Alcohols
sorbitol (or) D-sorbitol 50-70-4
Glycerol 56-81-5
propylene glycol 57-55-6
ethanol 64-17-5
isopropyl alcohol 67-63-0
methanol 67-56-1
isopropyl alcohol 67-63-0
butanol 71-36-3
2-ethyl-1-hexanol 104-76-7
propargyl alcohol 107-19-7
ethylene glycol 107-21-1
Diethylene Glycol 111-46-6
3-methyl-1-butyne-3-ol 115-19-5
Ethyl octynol 5877-42-9

Glycol Ethers & Ethoxylated Alcohols
propylene glycol monomethyl ether 107-98-2
ethylene glycol monobutyl ether 111-76-2
triethylene glycol 112-27-6
oxylated 4-tert-octylphenol 9002-93-1
ethoxylated sorbitan trioleate 9005-70-3
Polysorbate 80 9005-65-6
ethoxylated sorbitan monostearate 9005-67-8
Polyethylene glycol-(phenol) ethers 9016-45-9
Polyethylene glycol-(phenol) ethers 9036-19-5
<table>
<thead>
<tr>
<th>Chemical CAS Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>ethoxylated alcohols 66455-15-0</td>
</tr>
<tr>
<td>ethoxylated alcohol 67254-71-1</td>
</tr>
<tr>
<td>Ethoxylated alcohols (9 – 16 carbon atoms) 68002-97-1</td>
</tr>
<tr>
<td>ammonium alcohol ether sulfate 68037-05-8</td>
</tr>
<tr>
<td>Polyethylene glycol-(alcohol) ethers 68131-39-5</td>
</tr>
<tr>
<td>Polyethylene glycol-(phenol) ethers 68412-54-4</td>
</tr>
<tr>
<td>ethoxylated hexanol 68439-45-2</td>
</tr>
<tr>
<td>Polyethylene glycol-(alcohol) ethers 68439-46-3</td>
</tr>
<tr>
<td>Ethoxylated alcohols (9 – 16 carbon atoms) 68439-50-9</td>
</tr>
<tr>
<td>C12-C14 ethoxylated alcohols 68439-51-0</td>
</tr>
<tr>
<td>Exxal 13 68526-86-3</td>
</tr>
<tr>
<td>Ethoxylated alcohols (9 – 16 carbon atoms) 68551-12-2</td>
</tr>
<tr>
<td>alcohols, C-14-15, ethoxylated 68951-67-7</td>
</tr>
<tr>
<td>Ethoxylated Branched C11-14, C-13-rich Alcohols 78330-21-9</td>
</tr>
<tr>
<td>Ethoxylated alcohols (9 – 16 carbon atoms) 84133-5-6</td>
</tr>
<tr>
<td>alcohol ethoxylated 126950-60-5</td>
</tr>
<tr>
<td>Polyethylene glycol-(phenol) ethers 127087-87-0</td>
</tr>
</tbody>
</table>

**Microbiocides**

<table>
<thead>
<tr>
<th>Chemical CAS Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>bronopol 52-51-7</td>
</tr>
<tr>
<td>glutaraldehyde 111-30-8</td>
</tr>
<tr>
<td>2-monobromo-3-nitrilopropionamide 1113-55-9</td>
</tr>
<tr>
<td>1,2-benzisothiazolin-3-one 2634-33-5</td>
</tr>
<tr>
<td>dibromoacetanitrile 3252-43-5</td>
</tr>
<tr>
<td>dazomet 533-74-4</td>
</tr>
<tr>
<td>Hydrogen Peroxide 7722-84-1</td>
</tr>
<tr>
<td>2,2-dibromo-3-nitrilopropionamide 10222-01-2</td>
</tr>
<tr>
<td>tetrakis 55566-30-8</td>
</tr>
<tr>
<td>2,2-dibromo-malonamide 73003-80-2</td>
</tr>
</tbody>
</table>

**Organic Acids and Related Chemicals**

<table>
<thead>
<tr>
<th>Chemical CAS Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>tetrasodium EDTA 64-02-8</td>
</tr>
<tr>
<td>formic acid 64-18-6</td>
</tr>
<tr>
<td>acetic acid 64-19-7</td>
</tr>
<tr>
<td>sodium citrate 68-04-2</td>
</tr>
<tr>
<td>thiglycolic acid 68-11-1</td>
</tr>
<tr>
<td>hydroxyacetic acid 79-14-1</td>
</tr>
<tr>
<td>erythorbic acid, anhydrous 89-65-6</td>
</tr>
</tbody>
</table>

**Chemical CAS Number**

<table>
<thead>
<tr>
<th>Chemical CAS Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>ethyl lactate 97-64-3</td>
</tr>
</tbody>
</table>
acetic anhydride 108-24-7
fumaric acid 110-17-8
potassium acetate 127-08-2
sodium acetate 127-09-3
Disodium Ethylene Diamine Tetra Acetate 139-33-3
Trisodium Ethylenediamine tetraacetate 150-38-9
sodium benzoate 532-32-1
potassium formate 590-29-4
ammonium acetate 631-61-8
Sodium Glycolate 2836-32-0
Sodium Chloroacetate 3926-62-3
trisodium nitrilotriacetate 5064-31-3
sodium 1-octanesulfonate 5324-84-5
Sodium Erythorbate 6381-77-7
ammonium citrate 7632-50-0
tallow fatty acids sodium salt 8052-48-0
quinolinium, 1-(phenylmethyl), chloride 15619-48-4
diethylenetriamine penta (methylenephonic acid) sodium salt 22042-96-2
potassium sorbate 24634-61-3
dodecylbenzene sulfonic acid 27176-87-0
diisopropyl naphthalenesulfonic acid 28757-00-8
hydroxyacetic acid ammonium salt 35249-89-9
isomeric aromatic ammonium salt 35674-56-7
ammonium cumene sulfonate 37475-88-0
Fatty Acids 61790-12-3
fatty acid, coco, ethoxylated 61791-29-5
2-propenoic acid, telomer with sodium hydrogen sulfite 66019-18-9
carboxymethylhydroxypropyl guar 68130-15-4
fatty acids, tall oil reaction products w/ acetophenone, formaldehyde & thiourea 68188-40-9
triethanolamine hydroxyacetate 68299-02-5
alkyl (C14-C16) olefin sulfonate, sodium salt 68439-57-6
triethanolamine hydroxyacetate 68442-62-6
N-benzyl-alkyl-pyridinium chloride 68909-18-2
phosphonic acid, [(phosphonomethyl)imino]bis[2,1-ethanediylnitrilobis (methylene)]tetrafisammonium
salt 70714-66-8
tributyl tetradecyl phosphonium chloride 81741-28-8
sodium alpha-olefin sulfonate 95371-16-7

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**Chemical CAS Number**
benzene, 1,1’-oxybis, tetratpropylene derivatives, sulfonated, sodium salts 119345-04-9

**Polymers**
guar gum 9000-30-0
guar gum 9000-30-01
2-propenoic acid, homopolymer, ammonium salt 9003-03-6
low mol wt polyacrylate 9003-04-7
Low Mol. Wt. Polyacrylate 9003-04-7
Multiple names listed under same CAS#: oxirane, methyl-, polymer with oxirane,
Ethylene Glycol-Propylene Glycol Copolymer
cellulose 9004-34-6
hydroxyethyl cellulose 9004-62-0
cellulase/hemicellulase enzyme 9012-54-8
hemicellulase 9025-56-3
acrylamide-sodium acrylate copolymer 25085-02-3
Vinylidene Chloride/Methacrylate Copolymer 25038-72-6
polyethylene glycol 25322-68-3
copolymer of acrylamide and sodium acrylate 25987-30-8
formaldehyde polymer with 4,1,1-dimethylethyl phenolmethyl oxirane 29316-47-0
hemicellulase 37288-54-3
acrylamide - sodium 2-acrylamido-2-methylpropane sulfonate copolymer 38193-60-1
oxiranemthanaminium, N,N,N-trimethyl-, chloride, homopolymer (aka: polyepichlorohydrin, trimethylamine quaternized) 51838-31-4
polyethylene glycol oleate ester 56449-46-8
polymer with 2-propenoic acid and sodium 2-propenoate 62649-23-4
modified thiourea polymer 68527-49-1
methyloxirane polymer with oxirane, mono (nonylphenol) ether, branched 68891-11-2
acrylamide polymer with N,N,N-trimethyl-2[1-oxo-2-propenyl]oxy ethanaminium chloride 69418-26-4
2-propenoic acid, polymer with sodium phosphinate (1:1) 71050-62-9
formaldehyde, polymers with branched 4-nonylphenol, ethylene oxide and propylene oxide 153795-76-7

Minerals, Metals and other Inorganics

carbon dioxide 124-38-9
sodium bicarbonate 144-55-8
Sodium Carbonate 497-19-8
Potassium Carbonate 584-08-7
Boric Anhydride (a.k.a. Boric Oxide) 1303-86-2
sodium tetraborate decahydrate 1303-96-4
Potassium Hydroxide 1310-58-3

Chemical CAS Number

sodium hydroxide 1310-73-2
aluminum chloride, basic 1327-41-9
sodium tetraborate decahydrate 1332-77-0
aqua ammonia 29.4% 1336-21-6
ammonium hydrogen-difluoride 1341-49-7
ammonium thiocyanate 1762-95-4
sulfamic acid 5329-14-6
hydroxylamine hydrochloride 5470-11-1
ammonium nitrate 6484-52-2
cupric chloride dihydrate 7447-39-4
potassium chloride 7447-40-7
Trisodium ortho phosphate 7601-54-9
Non-Crystaline Silica 7631-86-9
sodium bisulfate 7631-90-5
hydrochloric acid 7647-01-0
sodium chloride 7647-14-5
sodium bromide 7647-15-6
aqueous ammonia 7664-41-7
sodium hypochlorite 7681-52-9
ferric chloride 7705-08-0
nitrogen 7727-37-9
ammonium persulfate 7727-54-0
water 7732-18-5
sodium sulfate 7757-82-6
sodium chlorite 7758-19-2
sodium thiosulfate 7772-98-7
Sodium Metaborate.8H2O 7775-19-0
Sodium Persulphate 7775-27-1
ammonium bisulfate 7783-20-2
boric acid 10043-35-3
Calcium Chloride 10043-52-4
Chlorine Dioxide 10049-04-4
ammonium bisulphite 10192-30-0
sodium perborate tetrahydrate 10486-00-7
ammonium chloride 12125-02-9
potassium borate 12714-38-8
potassium metaborate 13709-94-9
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Chemical CAS Number
Magnesium Silicate Hydrate (Talc) 14807-96-6
crystalline silica (quartz) 14808-60-7
glassy calcium magnesium phosphate 65997-17-3
silica gel 112926-00-8
synthetic amorphous, pyrogenic silica 112945-52-5
synthetic amorphous, pyrogenic silica 121888-66-2

Miscellaneous
formaldehyde 50-00-0
Sucrose 57-50-1
lactose 63-42-3
acetone 67-64-1
ethylene oxide 75-21-8
1-octadecene 112-88-9
1,4-dioxane 123-91-1
1-hexadecene 629-73-2
1-tetradecene 1120-36-1
sorbitan monooleate 1338-43-8
1-eicosene 3452-07-1
D-Limonene 5989-27-5
Pine Oil 8000-41-7
2,2’-azobis-(2-(imidazolin-2-yl)propane)-dihydrochloride 27776-21-2
3,5,7-triaza-1-azoniatricyclo[3.3.1.13,7]decane, 1-(3-chloro-2-propenyl)-chloride 51229-78-8
alkenes 64743-02-8
Cocamidopropyl Oxide 68155-09-9
terpene and terpenoids 68647-72-3
terpene hydrocarbon byproducts 68956-56-9
tar bases, quinoline derivs., benzyl chloride-quaternized 72780-70-7
citrus terpenes 94266-47-4
organophilic clays 121888-68-4

**Listed without CAS Number**

**belongs with amines**
proprietary quaternary ammonium compounds NA
quaternary ammonium compound NA

**constituents listed without CAS #’s** were tentatively placed in chemical categories based on the name listed on the MSDS or within confidential product composition disclosures. Many of the constituents reported without CAS #s, are mixtures which require further disclosure to DEC.

**Chemical CAS Number**

triethanolamine (tea) 85%, drum NA
Quaternary amine NA
Fatty amidoalkyl betaine NA **belongs with petroleum distillates**
petroleum distillate blend NA **belongs with aromatic hydrocarbons**
aromatic hydrocarbon NA
aromatic ketones NA **belongs with glycol ethers and ethoxylated alcohols**
Acetylenic Alcohol NA
Aliphatic Alcohols, ethoxylated NA
Aliphatic Alcohol glycol ether NA
Ethoxylated alcohol linear NA
Ethoxylated alcohols NA
aliphatic alcohol polyglycol ether NA
alkyl aryl polyethoxy ethanol NA
mixture of ethoxylated alcohols NA
nonylphenol ethoxylate NA
oxyalkylated alkylphenol NA
polyethoxylated alkanol NA
Oxyalkylated alcohol NA **belongs with organic acids**
Aliphatic acids derivative NA
Aliphatic Acids NA
hydroxy acetic acid NA
citric acid 50%, base formula NA
Alkylaryl Sulfonate NA **belongs with polymers**
hydroxypropyl guar NA
2-acrylamido-2-methylpropanesulphonic acid sodium salt polymer NA **belongs with minerals, metals and other inorganics**
precipitated silica NA
sodium hydroxide NA **belongs with miscellaneous**
epa inert ingredient NA
non-hazardous ingredients NA
proprietary surfactant NA
salt of fatty acid/polyamine reaction product NA
Although exposure to fracturing additives would require a failure of operational controls such as an accident, a spill or other non-routine incident, the health concerns noted by NYSDOH for each chemical category are discussed below. The discussion is based on available qualitative hazard information for chemicals from each category. Qualitative descriptions of potential health concerns discussed below generally apply to all exposure routes (i.e., ingestion, inhalation or skin contact) unless a specific exposure route is mentioned. For most chemical categories, health information is available for only some of the chemicals in the category. More specific assessment of health risks associated with a contamination event would entail an analysis based on the specific additives being used and site-specific information about exposure pathways and environmental contaminant levels. Potential human health risks of a specific event would be assessed by comparison of case-specific exposure data with existing drinking standards or ambient air guidelines. If needed, other chemical-specific health comparison values would be developed, based on a case-specific review of toxicity literature for the chemicals involved. A case-specific assessment would include information on how potential health effects might differ (both qualitatively and quantitatively) depending on the route of exposure.

**Petroleum Distillate Products**

Petroleum-based constituents are included in some fracturing fluid additive products. They are listed in MSDSs as various petroleum distillate fractions including kerosene, petroleum naphtha, aliphatic hydrocarbon, petroleum base oil, heavy aromatic petroleum naphtha, mineral spirits,
Hydrotreated light petroleum distillates, stoddard solvent or aromatic hydrocarbon. These can be found in a variety of additive products including corrosion inhibitors, friction reducers and solvents. Petroleum distillate products are mixtures that vary in their composition, but they have similar adverse health effects. Accidental ingestion that results in exposure to large amounts of petroleum distillates is associated with adverse effects on the gastrointestinal system and central nervous system. Skin contact with kerosene for short periods can cause skin irritation, blistering or peeling. Breathing petroleum distillate vapors can adversely affect the central nervous system.

**Aromatic Hydrocarbons**

Some fracturing additive products contain specific aromatic hydrocarbon compounds that can also occur in petroleum distillates (benzene, toluene, ethylbenzene and xylene or BTEX; naphthalene and related derivatives, trimethylbenzene, diethylbenzene, dodecylbenzene, cumene). BTEX compounds are associated with adverse effects on the nervous system, liver, kidneys and blood-cell-forming tissues. Benzene has been associated with an increased risk of leukemia in industrial workers who breathed elevated levels of the chemical over long periods of time in workplace air. Exposure to high levels of xylene has damaged the unborn offspring of laboratory animals exposed during pregnancy. Naphthalene is associated with adverse effects on red blood cells when people consumed naphthalene mothballs or when infants wore cloth diapers stored in mothballs. Laboratory animals breathing naphthalene vapors for their lifetimes had damage to their respiratory tracts and increased risk of nasal and lung tumors.

**Glycols**
Glycols occur in several fracturing fluid additives including crosslinkers, breakers, clay and iron controllers, friction reducers and scale inhibitors. Propylene glycol has low inherent toxicity and is used as an additive in food, cosmetic and drug products. High exposure levels of ethylene glycol adversely affect the kidneys and reproduction in laboratory animals.

**Glycol Ethers**
Glycol ethers and related ethoxylated alcohols and phenols are present in fracturing fluid additives, including corrosion inhibitors, surfactants and friction reducers. Some glycol ethers (e.g., monomethoxyethanol, monoethoxyethanol, propylene glycol monomethyl ether, ethylene glycol monobutyl ether) can affect the male reproductive system and red blood cell formation in laboratory animals at high exposure levels.

**Alcohols**
Alcohols are present in some fracturing fluid additive products, including corrosion inhibitors, foaming agents, iron and scale inhibitors and surfactants. Exposure to high levels of some alcohols (e.g., ethanol, methanol) affect the central nervous system.

**Amides**
Acrylamide is used in some fracturing fluid additives to create polymers during the stimulation process. These polymers are part of some friction reducers and scale inhibitors. Although the reacted polymers that form during fracturing are of low inherent toxicity, unreacted acrylamide may be present in the fracturing fluid, or breakdown of the polymers could release acrylamide back into the flowback water. High levels of acrylamide damage the nervous system and reproductive system in laboratory animals and also cause cancer in laboratory animals. Formamide may be used in some corrosion inhibitors products. Ingesting high levels of formamide adversely affects the female reproductive system in laboratory animals.

**Amines**
Amines are constituents of fracturing fluid products including corrosion inhibitors, cross-linkers, friction reducers, iron and clay controllers and surfactants. Chronic ingestion of mono-, di- or tri-ethanolamine adversely affects the liver and kidneys of laboratory animals. Some quaternary ammonium compounds, such as dimethyldiallyl ammonium chloride, can react with chemicals used in some systems for drinking water disinfection to form nitrosamines. Nitrosamines cause genetic damage and cancer when ingested by laboratory animals.

**Organic Acids, Salts and Related Chemicals**

Organic acids and related chemicals are constituents of fracturing fluid products including acids, buffers, corrosion and scale inhibitors, friction reducers, iron and clay controllers, solvents and surfactants. Some short-chain organic acids such as formic, acetic and citric acids can be corrosive or irritating to skin and mucous membranes at high concentrations. However, acetic and citric acids are regularly consumed in foods (such as vinegar and citrus fruits) where they occur naturally at lower levels that are not harmful.

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Some foaming agents and surfactant products contain organic chemicals included in this category that contain a sulfonic acid group (sulfonates). Exposure to elevated levels of sulfonates is irritating to the skin and mucous membranes.

**Microbiocides**

Microbiocides are antimicrobial pesticide products intended to inhibit the growth of various types of bacteria in the well. A variety of different chemicals are used in different microbiocide products that are proposed for Marcellus wells. Toxicity information is limited for several of the microbiocide chemicals. However, for some, high exposure has caused effects in the respiratory and gastrointestinal tracts, the kidneys, the liver and the nervous system in laboratory animals.

**Other Constituents**
The remaining chemicals listed in MSDSs and confidential product composition disclosures provided to DEC are included in Table 5.7 under the following categories: polymers, miscellaneous chemicals that did not fit another chemical category and product constituents that were not identified by a Chemical Abstract Service (CAS) number. Readily available health effects information is lacking for many of these constituents, but two that are relatively well studied are discussed here. In the event of environmental contamination involving chemicals lacking readily available health effects information, the toxicology literature would have to be researched for chemical-specific toxicity data.

Formaldehyde is listed as a constituent in some corrosion inhibitors, scale inhibitors and surfactants. In most cases, the concentration listed in the product is relatively low (< 1%) and is listed alongside a formaldehyde-based polymer constituent. Formaldehyde is irritating to tissues when it comes into direct contact with them. The most common symptoms include irritation of the skin, eyes, nose, and throat, along with increased tearing. Severe pain, vomiting, coma, and possible death can occur after drinking large amounts of formaldehyde. Several studies of laboratory rats exposed for life to high amounts of formaldehyde in air found that the rats developed nose cancer. Some studies of humans exposed to lower amounts of formaldehyde in workplace air found more cases of cancer of the nose and throat (nasopharyngeal cancer) than expected, but other studies have not found nasopharyngeal cancer in other groups of workers exposed to formaldehyde in air.

1,4-dioxane may be used in some surfactant products. 1,4-Dioxane is irritating to the eyes and nose when vapors are breathed. Exposure to very high levels may cause severe kidney and liver
effects and possibly death. Studies in animals have shown that breathing vapors of 1,4-dioxane, swallowing liquid 1,4-dioxane or contaminated drinking water, or having skin contact with liquid 1,4-dioxane affects mainly the liver and kidneys. Laboratory rats and mice that drank water containing 1,4-dioxane during most of their lives developed liver cancer; the rats also developed cancer inside the nose.

Conclusions
The hydraulic fracturing product additives proposed for use in NYS and used for fracturing horizontal Marcellus shale wells in other states contain similar types of chemical constituents as the products that have been used for many years for hydraulic fracturing of traditional vertical wells in NYS. Some of the same products are used in both well types. The total amount of fracturing additives and water used in hydraulic fracturing of horizontal wells is considerably larger than for traditional vertical wells. This suggests the potential environmental consequences of an upset condition could be proportionally larger for horizontal well drilling and fracturing operations. As mentioned earlier, the 1992 GEIS addressed hydraulic fracturing in Chapter 9, and NYSDOH’s review did not identify any potential exposure situations associated with horizontal drilling and high-volume hydraulic fracturing that are qualitatively different from those addressed in the GEIS.