

**Watershed Conservation Practices Handbook (FSH 2509.25, 5/5/06)
sections relative to fens:**

Main focus: Best Management Practices (BMP's) – *ways of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals.* Fens are very sensitive to changes in water quantity and quality. Water quality goals for fens would be different from wetlands and streams and highly complex. Iron fen groundwater flows through pyrite and becomes very acidic at the surface. Some iron fens also have calcareous groundwater from other sources deep in the peat (Cooper et al. 2002).

11 – **HYDROLOGIC FUNCTION** (pg. 5 of 29)

The ability of a watershed to infiltrate and naturally regulate runoff so streams are in dynamic equilibrium with their channels and floodplains. *Watershed focus*, although it does mention, *the ability of a particular stream to be able to accommodate increases in runoff and sediment transport without being damaged depends upon stream type, past disturbances and current stream condition.* No mention of the hydrologic function of wetlands or fens. *Fens do not act as “sponges & filters” like wetlands do. They have a large living peat mass ecosystem that needs a consistent source of groundwater flowing through them. Moving groundwater slows reduction processes and allows the peat mass to accumulate organic material rather than decompose. Fens evolved as systems with little water table fluctuation and little incoming sediment. A man-induced pollutant, sediment (Ohlson 2006), can alter fens and fen plant communities (Bedford et al. 1974, Cooper et al. 1998, Cooper & MacDonald 2000, Galatowitsch et al. 2000, Werner & Zedler 2002, USDA Forest Service 2004b).

12- **RIPARIAN AREAS AND WETLANDS** (pg. 7 of 29)

Management Measure – no mention of wetlands or fens in regards to the “water influence zone (WIZ)” but assume they are included in the 100 feet or mean height of mature dominant late-seral vegetation = WIZ. A buffer of 100 feet may not be enough for the protection of the source of water to a fen (Jones 2003, Houlahan & Findlay 2004, Houlahan et al. 2006, Kate Dwire per. com.). The source(s) of water to a fen may seep through a nearby hillside(s) or toeslope(s) into the fen or discharge to the surface from beneath the fen. In areas where there is a geologic unit that restricts groundwater flow (ie. clay layer), a fen may be supported by a local perched water table. This type of site may be under hydraulic pressure and easily drained via ground disturbance from above, below, or the sides. The chemical components of the groundwater nourishing the fen are critical for maintaining the local water and carbon balance of fen plant communities. Some fen communities may be limited in certain nutrients; adding nutrients to the system may alter plant communities in the fen (Charman 2002).

12.1b. Design Criteria – *allow no action that will cause long-term change away from desired condition in any riparian or wetland vegetation community. In degraded systems, progress toward desired condition within the next plan period.* Again, fens are very sensitive to changes in water chemistry and quantity. By the time one has detected

long-term change in a fen, it is often too late to reverse the impacts. In the Rocky Mountains and R2 there is no published documentation of fen function restoration once a fen has been heavily disturbed (Cooper & MacDonald 2000). That is why the USFWS is recommending no mitigation for loss of fens (USFWS 1999). Loss or severe damage to a GMUG fen may cause “irreversible or irretrievable commitment of resources” because of the thousands of years it takes to form a fen (40 CFR Part 1502.14, National Environmental Policy Act, 1992).

12.1c. *Keep heavy equipment out of streams, swales, and lakes... Include wetlands and fens included in this!*

12.1d. *Keep log landings and skid trails out of the WIZ, including swales. Include wetlands and fens included in this! Again – if skid trails are disturbing the soil and having potential for altering groundwater into a fen, 100’ may not be enough distance from the fen to prevent impacts (Jones 2003, Houlahan & Findlay 2004, Houlahan et al. 2006, Kate Dwire per. com.).*

12.1e. *...Armor or reclaim existing sites in the WIZ to prevent detrimental soil and bank erosion. May be OK for wetlands but not good for fens if the groundwater connection is altered during backhoe/cat work.*

12.1k(1.) pg. 10 of 29. NOTE: *Hummocking and platy surface soil structure are good indicators of soil compaction if more detailed sampling is not available (BLM 1993, 1994; FSH 2509.18). Hummocks may also be an indicator of fen conditions. Fens found in Wager Gulch Fen, Taylor River Fen, Hobbs Fen, and Upper Taylor River Fen in the Gunnison Basin all have large hummocks developed by hummock-forming plants (ie. *Kobresia myosuroides*, *Kobresia simpliciuscula*, *Betula glandulosa*, *Thalictrum alpinum*, etc..*

12.1m. *Do not excavate earth material from, or store excavated earth material in, any stream, swale, lake, wetland, or WIZ. Again, 100 feet may not be enough for the protection of the source of water to a fen (Jones 2003, Houlahan & Findlay 2004, Houlahan et al. 2006, Kate Dwire per. com.).*

12.3. Restoration pg. 10 of 29. *...Disconnect or armor disturbed areas. May be OK for wetlands but not good for fens if the groundwater connection is altered during backhoe/cat work.*

12.2 – Management Measure (4) pg. 10 of 29. *Design and construction of stream crossings and other instream structures. May be OK for wetlands but not good for fens if the groundwater connection is altered during backhoe/cat work.*

12.3 – Management Measure (5), pg. 12 of 29.

1a. Design Criteria - *Add or remove rocks, wood, or other material in streams or lakes only if such action maintains or improves stream and lake health. Adding or removing rocks, wood, or other material from fens will not maintain or improve the health of a fen.*

12.4 – Management Measure (6), pg. 13 of 29. *Executive Order 11990 directs that impacts to wetlands should be avoided, minimized or mitigated where practicable. The Corps of Engineers protects wetlands under Section 404 regulations, which may permit wetland impacts if mitigation measures are applied to replace wetland values in-kind. Current Clean Water Act (Corps of Engineers) regulations do not protect isolated fens unconnected to navigable waters of the U.S. There are no known methods in the southern Rocky Mountains for restoration/replacement of heavily impacted fens that are thousands of years old (Cooper & MacDonald 2000) and thus, no mitigation (USFWS 1999).*

1a. Design Criteria, pg. 13 of 29 – *keep ground vehicles out of wetlands unless protected by at least 1 foot of packed snow or 2 inches of frozen soil. Do not disrupt water supply or drainage patterns into wetlands. On-going research by Cooper (2001) in Prospect Basin Fens above Telluride is showing impacts to fens from heavy equipment snow compaction. USDA Forest Service literature (2004b) indicates compaction of snow over fens and the increased thermal conductivity in the snow permits peatland soil to freeze, thus, changing the thermal environment in the fen. In mountainous alpine areas, soil underneath deep undisturbed snow is insulated from cold air temperatures in the winter and does not usually freeze (Stadler et al. 1996, Pomeroy & Brun 2001). In contrast, under compacted snow, researchers found that thermal conductivity increases, soil heat balance changes, and soil temperatures decrease (Rixen et al. 2004). In research in alpine ski areas, snow compaction on ski runs altered soil nutrients, decreased the number of species and canopy cover of early flowering plant species, and changed plant community composition in comparison to undisturbed snow plots (Wipf et al. 2005).*

1b. *Keep roads and trails out of wetlands unless there is no other practicable alternative. Regarding fens – find other alternatives to placing a road or trail through a fen. Impacting a fen may lead to irreversible and irretrievable commitment of resources (NEPA 1992).*

1c. *Avoid long-term reduction in organic ground cover and organic soil layers in any wetland (including peat in fens). NOTE: Field studies show this measure protects vital ecological functions. Regarding fens and disturbances, a change in organic ground cover will occur first and alteration of organic soil layers later. Both may occur very slowly over time, depending on the disturbance. Changes in organic ground cover and organic soil layers may be so gradual that they will be difficult to detect until it is too late. Peat accumulation is a critical part of fen function. Just protecting organic ground cover and organic soil layers is not necessarily going to protect the fen, protection of the fen source of groundwater is needed first.*

1d. *When practicable, keep buried utility and pipelines out of wetlands. If such a line must enter a wetland, use measures that sustain long-term wetland function. May be OK for wetlands but not good for fens if the groundwater connection/water chemistry is altered during backhoe/cat work.*

1e. *Avoid any loss of rare wetlands such as fens and springs. NOTE: These wetlands cannot be replaced in-kind.*

1.f. *Do not build firelines in or around wetlands unless needed to protect life, property, or wetlands. Regarding fens – better to let fen burn than to build fireline*

around/through it with the risk of altering the fen groundwater connection/water chemistry.

3. Restoration, pg. 14 of 29. *Reclaim wetlands to restore physical and biological functions. Revegetate using certified local native plants as practicable; avoid persistent or invasive exotic plants. Regarding fens - research is on-going regarding restoration of moderately to lightly impacted fens in Colorado. In most cases on the GMUG it would be better to let natural recolonization of local native plants occur in fens rather than reseed.*

13 – **SEDIMENT CONTROL**, pg. 18 of 29. *Most sediment delivered from slopes to streams (include wetlands and fens!) comes from roads and similar disturbed sites.*

13.1 – Management Measure (9). *Keep the number of stream crossings and the extent of sediment sources to a practicable minimum. Avoid sediment loads that damage stream (add fen) health. Sediment is especially harmful to fens as it allows oxygen into the peat which initiates decomposition of the peat mass.*

1a. Design Criteria, pg. 18 of 29. – *Construct roads on ridge tops, stable upper slopes, or wide valley terraces if practicable. End-haul soil if full-bench construction is used. In areas with fens – know where the fen’s groundwater is coming from. If it is coming from the hillside above the fen, it would be better to avoid the ridge above the fen. End-haul soil brought in from off-site should be inspected and weed-free.*

1c. *Install cross drains to disperse runoff into filter strips and minimize connected disturbed areas. Make cuts, fills, and road surfaces strongly resistant to erosion between each stream crossing and at least the nearest cross drain. May be OK for wetlands but not good for fens if the groundwater connection/water chemistry is altered during backhoe/cat work. Assuming that erosion resistance is encouraged with Magnesium or sodium chloride: spraying cuts, fills, and road surfaces with MgCl or NaCl for resistance to erosion may be OK with wetlands but may negatively impact the water chemistry in fens. Dust with these chemicals may also blow with prevailing winds into nearby fens, causing further impacts (Forman & Alexander 1998).*

1d. *Construct roads where practicable, with outslope and rolling grades instead of ditches and culverts. May be OK for wetlands but not good for fens if the groundwater connection/water chemistry is altered during backhoe/cat work.*

1h. *NOTE: Uncontrolled OHV and other recreational use, especially in wet conditions, can severely damage streams and riparians. Include wetlands and fens!*

13.2 – Management Measure (10) – *Construct roads and other disturbed sites to minimize sediment discharge into streams, lakes, wetlands. Avoid sediment discharge into fens!*

1. Design Criteria

1f. *Design road ditches and cross drains to limit flow to ditch capacity and prevent ditch erosion and failure. May be OK for wetlands but not good for fens if the groundwater connection/water chemistry is altered during backhoe/cat work.*

13.3 – Management Measure (11) – *stabilize and maintain roads and other disturbed sites during and after construction to control erosion.*

1c. Design Criteria, pg. 21 of 29. *Do not disturb ditches during maintenance unless needed to restore drainage capacity or repair damage. Do not undercut the cut slope. Ditches may be OK in areas with wetlands but not good for fens if the groundwater connection/water chemistry is altered during backhoe/cat work.*

1d & 1 e. Construction of cross drains... Cross drains may be OK in areas with wetlands but not good for fens if the groundwater connection/water chemistry is altered during backhoe/cat work.

1h. Building firelines... Firelines OK in areas with wetlands but not good for fens if the groundwater connection/water chemistry is altered during fireline construction.

1i. *Use the minimum amount of sand, salt, and/or other de-icing substances (Magnesium Chloride) as necessary to provide safe winter travel conditions. De-icing substances such as Magnesium chloride or sodium chloride may be OK with wetlands but could potentially negatively impact the water chemistry and fen plant communities in fens. Dust with these chemicals may also blow with prevailing winds into nearby fens, causing further impacts (Forman & Alexander 1998).*

2. Monitoring. ...cuts, fills, and ditches...cross drains. Cuts, ditches, and cross drains may be OK in areas with wetlands but are not good for fens if the groundwater connection/water chemistry is altered during backhoe/cat work.

3. Restoration. *Stabilize fills, ditches, and cross drains. Add cross drains. Ditches and cross drains may be OK in areas with wetlands but are not good for fens if the groundwater connection/water chemistry is altered during backhoe/cat work.*

13.4 – Management Measure (12), pg. 23 of 29. *Reclaim roads and other disturbed sites when use ends, as needed, to prevent resource damage.*

2. Restoration. *Provide stable drainage that disconnects as much disturbed area as practicable. Careful with fens here! May be OK for wetlands but not good for fens if the groundwater connection is altered during backhoe/cat work. Do not disconnect groundwater from the fen.*

14 – **SOIL QUALITY**, pg. 24 of 29. *Nothing on inspecting till from off-site locations for noxious weeds.*

1b. Design Criteria. *Operate heavy equipment for land treatments only when soil moisture is below the plastic limit, or protected by at least 1 foot of packed snow or 2 inches of frozen soil. NOTE: This measure limits compaction. Regarding fens: This measure does not limit compaction on snow in fens. On-going research by Cooper (2001) is showing impacts to fens and fen plant community phenology from heavy equipment snow compaction. USDA Forest Service literature (2004b) indicates compaction of snow over fens and the increased thermal conductivity in the snow permits peatland soil to freeze, thus, changing the thermal environment in the fen. In mountainous alpine areas, soil underneath deep undisturbed snow is insulated from cold air temperatures in the winter and does not usually freeze (Stadler et al. 1996, Pomeroy & Brun 2001). In contrast, under compacted snow, researchers found that thermal conductivity increases, soil heat balance changes, and soil temperatures decrease (Rixen et al. 2004). In research in alpine ski areas, snow compaction on ski runs altered soil nutrients, decreased the number of species and canopy cover of early*

flowering plant species, and changed plant community composition in comparison to undisturbed snow plots (Wipf et al. 2005).

1d. *Allow dispersed winter motorized recreation when snow depths are sufficient to protect soils. Specify a minimum unpacked snow depth of 12 inches unless a site-specific analysis shows a different snow depth is adequate to protect soils. Allow use of snowcats or grooming machines when unpacked snow depths equal or exceed 18 inches. Regarding fens: On-going research by Cooper (2001) is showing impacts to fens from heavy equipment snow compaction. USDA Forest Service literature (2004b) indicates compaction of snow over fens and the increased thermal conductivity in the snow permits peatland soil to freeze, thus, changing the thermal environment in the fen. In mountainous alpine areas, soil underneath deep undisturbed snow is insulated from cold air temperatures in the winter and does not usually freeze (Stadler et al. 1996, Pomeroy & Brun 2001). In contrast, under compacted snow, researchers found that thermal conductivity increases, soil heat balance changes, and soil temperatures decrease (Rixen et al. 2004). In research in alpine ski areas, snow compaction on ski runs altered soil nutrients, decreased the number of species and canopy cover of early flowering plant species, and changed plant community composition in comparison to undisturbed snow plots (Wipf et al. 2005).*

15 – **WATER PURITY**, pg. 27 of 29.

15.1 – **Management Measure** (15). *Place new sources of chemical and pathogenic pollutants where such pollutants will not reach surface or ground water.*

Chemicals and pathogens can travel long distances in water (and air). Pollutants must be filtered out before they reach surface or ground water.

15.2 – **Management Measure** (16). *Apply runoff controls to disconnect new pollutant sources from surface and ground water.*

1a. Design Criteria, pg. 28 of 29. *Install contour berms and trenches around vehicle service and refueling areas, chemical storage and use areas, and waste dumps to fully contain spills. Again – know where your source of groundwater supplying the fen is located. In general, trenches, digging with heavy equipment, and ditches around fens is not a good idea because of their close connection with groundwater. A buffer of 100 feet may not be enough for the protection of the source of water to a fen (Jones 2003, Houlahan & Findlay 2004, Houlahan et al. 2006, Kate Dwire per. com.).*