Climate Change – Extreme Conditions: Do Plans of Operations Need to Include an Ark?

20th Annual
Mine Design, Operations & Closure Conference
April 29 – May 3, 2012

Fairmont Hot Springs

R. David Williams
Bureau of Land Management
Butte, MT

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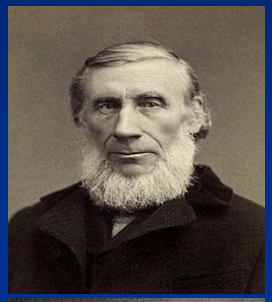
Forward Looking Statement!

- I'd like to thank you for attending the NRDP meeting held in Butte, September 30. As you could see from both the number of attendees and the nature of the questions, there are very strong feelings about the Parrott Tailings. I'd also like to thank EPA for organizing the Conceptual Site Model public meeting, which was moved to the Arco facilities at the Kelly due to the turnout.
- As I mentioned in my September 14th letter I would be preparing a more detailed response to your May 24th letter after I'd had a chance to review EPA's responses to our 2005 letter and prepare a detailed evaluation using some of the additional groundwater monitoring efforts required under section 12.3.2.3 of the BPSOU ROD which resulted in the MBMG aquifer test report as well as some of the additional information that has been generated this summer.
- As I mentioned in my September letter, even without a detailed review I and the other signatories to the 2005 letter believe that our conclusions in the 2005 letter have been substantially validated by the recent work and neither the 2006 Responsiveness Summary nor your letter of May 24, 2010 change that conclusion. Neither the Parrott Tailings nor the alluvial aquifer system were adequately characterized prior to the BPSOU ROD. The additional work that's been performed in the last couple years, some of which was performed in response to involvement of the Butte Restoration Alliance, Environmental Subcommittee, has been invaluable in developing a more detailed understanding of the entire range of contamination issues inherent in the "left in place" remedy. This information and characterization of the entire system is what should have been performed prior to BPSOU ROD, particularly given the treatment in perpetuity that WILL result from chosen remedy. Perpetuity is a long time. As we noted in our 2005 letter; "*Removal of the Parrott Tailings waste material would at the least assure that the aquifer might clean itself up over some measurable unit of time. Leaving the acid generating material in place assures the aquifer will clean itself up over geologic time*".
- Detailed review of some EPA's responses to our 2005 letter.
- 2005 EPA response: *If the most conservative estimates of typical retardation coefficients are used (i.e., allowing for the fastest travel of contaminants in the aquifer matrix), contaminant travel times are in the hundreds of years. EPA believes that site specific tests to develop retardation coefficients representative of the aquifer would have shown even greater retardation (i.e., even slower contaminant travel times). The groundwater flow rates EPA used to analyze the potential for groundwater quality to be restored in a reasonable period of time were based on the pump tests results for the MSD area.*
- Results from MBMG OFR 590 and 592: **The average hydraulic conductivity estimated in the current study for the middle gravel layer in the MSD area was 609 feet/day.**
- **The hydraulic conductivities estimates obtained in this report are larger than previous findings by 1 to 2 orders of magnitude.**
- 2005 EPA Response: *Focused Feasibility Study that the plume associated with the Parrott Tailings is stagnant and has a low hydraulic gradient. In addition, the predominant flow path is downward. Due to these characteristics, the plume associated with the Parrott Tailings has not expressed itself in surface water in MSD .*
- *Even though the volume of water from MSD is approximately 400 gpm, this is still a relatively low flow rate and even if the flow rate doubles, it will not be a significant change to operate and maintain the system .*
- *The alluvial aquifer is heterogeneous. Lithologic, hydrogeologic, and chemical data are available from approximately 60 monitoring wells located within the MSD Area. These wells are distributed across the MSD area and range in depth from 11 feet to 268 feet below ground surface (bgs). These wells on numerous occasions dating back to the mid-1980s and, as a result, sufficient hydrogeologic and chemical data are available to understand flow paths and contaminant distribution and to make remedial decisions regarding the potential to cleanup the shallow and deeper portions of the aquifer. Further, lithologic data obtained from borings in the MSD area clearly show that the aquifer is heterogeneous.*
- Results from MBMG OFR 590 and 592: **Average linear velocities based on the estimates from this report for the aquifer above Harrison Avenue ranged from 580 to 3,100 feet per year (assuming a gradient of 0.004 and a porosity of 30 percent). For the aquifer below Harrison Avenue, the average linear velocities ranged from 2,300 to 4,800 feet per year (assuming a gradient of 0.004 and a porosity of 30 percent), compared to 80 feet per year below Harrison Avenue estimated by EPA (2004).**
- **Furthermore, the alluvial aquifer is not as heterogenous as originally characterized by the EPA. MBMG OFR 507 describes three locally continuous and homogenous gravel zones (upper, intermediate, and lower), which act as zones of preferential groundwater flow in the alluvial aquifer. These gravel units correlate lithologically between wells completed throughout the MSD area. MBMG OFR 590 describes similar degraded water quality in the intermediate alluvial aquifer, and MBMG OFR 592 shows a hydrologic connection between all wells completed in the intermiate zone throughout the MSD area. This evidence weighs overwhelmingly against the EPA's assertion that the aquifer is entirely heterogenous.**
- 2005 EPA Response: *The comment implies that characteristics of the higher permeability units are representative of all or most of the alluvial aquifer within the MSD. This is not the case. In fact, hydraulic conductivity (permeability) values estimated from nine pumping tests performed on wells completed in the alluvial aquifer within the MSD area range from 1.34 to 32 feet per day (ft/day), with a median of 3.9 ft/day and an average value of 8.8 ft/day. This suggests that the aquifer is heterogeneous and, more significantly, the aquifer as a whole has low permeability and little capacity to yield significant quantities of groundwater to wells. Further, severely contaminated groundwater is not limited to preferential flow paths within the aquifer (higher permeability zones) and zones of preferential flow within a heterogeneous system exacerbate the problems associated with aquifer remediation. Aquifer cleanup times are controlled by diffusion-limited transport of contamination from lower permeability zones to more permeable units. In other words, the time required for aquifer cleanup will be controlled by the lower permeability units and not the higher permeability units.*
- Results from MBMG OFR 590 and 592: **Conversely, water-level responses to pumping and downward gradients suggest that the confining layer separating the shallow alluvial aquifer and the middle alluvial aquifer is less continuous in the Parrot Complex area. Again, this hypothesis is supported by the highly contaminated groundwater observed in both shallow and middle alluvial aquifers in the Parrot Complex area (Tucci, 2010). Contaminated water entering the middle alluvial aquifer in the Parrot Complex area will likely travel to at least GS-09 before encountering an area where it might disperse to the shallow aquifer or discharge to the surface. In fact, water samples collected from wells completed in the middle alluvial aquifer throughout the MSD have degraded water quality with elevated metal concentrations that decrease down gradient from the Parrot complex (Tucci, 2010). The hydrogeologic evaluation discussed in the current study and the groundwater quality discussed in Tucci (2010) both suggest that the source of metal loading to the middle alluvial aquifer (as far away as MSD-05 and GS-09) is the tailings associated with the Parrot Complex.**
- 2005 EPA Response: *EPA agrees with the findings of the MBMG study that there are areas of preferential groundwater flow in the upper limits of the alluvial aquifer. In fact, EPA recognized the heterogeneous nature of the alluvial aquifer in the Remedial Investigation Report and predicted areas of higher groundwater flow. Nevertheless, pump tests still suggest a relatively low rate of groundwater movement. EPA disagrees with the conclusion reached by the MBMG that the more rapid movement of groundwater in the coarser members of the alluvial aquifer will lead to restoration of groundwater quality in a short period of time because it totally ignored the recovery of groundwater quality in the finer grained members of the aquifer. In fact, EPA believes that the data from MBMG further support EPA's position that it will require in excess of 100 years for groundwater quality to be restored. Specifically, EPA believes that the preferential flows in the coarser materials will lead to more limited flow in the finer materials that will result in contaminants remaining in the finer grained members of the aquifer for a longer period.*
- Results from MBMG OFR 590 and 592: **Additionally, recent monitoring activities in the area suggest a worsening of water quality in the plume, suggesting that leaching from one to several lithological units is active, and that equilibrium with respect to contaminants in the plume has not yet been established.**
- **Water-level and water-quality data suggests that conditions in this area are not stable, and that both of these parameters have fluctuated in recent history, based on a number of possible factors. These factors have led to water-quality and water-level fluctuations throughout the area surrounding the Parrot complex. Unfortunately, monitoring to the southwest of the Parrot complex (down gradient) is insufficient, and trends in this area cannot be ascertained.**
- To be blunt, it is clear that EPA essentially blew off our criticism of their earlier studies. Now five years later it is obvious our concerns and technical criticisms of EPA's earlier work have been completely vindicated. Is it any wonder there is no confidence among many of the specialists familiar with the technical issues that EPA will start making good decisions now?
- Just to re-focus, here are the bulleted concerns from our 2005 letter:

Climate Change: Some Basics



Al Gore did not discover “Global Warming”, these guys did: Joseph Fourier, 1824, 1827, John Tyndall, 1872 and Arvid Högbom and Svante Arrhenius, 1896

Guy Callendar

More basics…

- There is little scientific dispute about the physics by which “global warming” occurs: carbon dioxide in the atmosphere absorbs long wave radiation that would otherwise escape into space, thus warming the lower atmosphere and respective temperatures worldwide.

Who is working on it now?

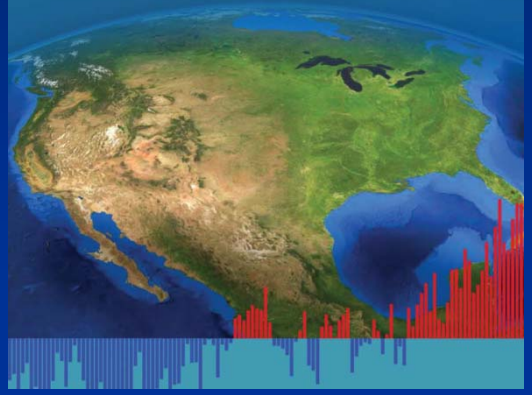
JRC Scientific and Technical Reports

Impacts of climate change in agriculture in Europe. PESETA-Agriculture study

Ana Iglesias, Luis Garrote, Sonia Quiroga, Marta Moneo

Global Climate Change Impacts in the United States

U.S. GLOBAL CHANGE RESEARCH PROGRAM

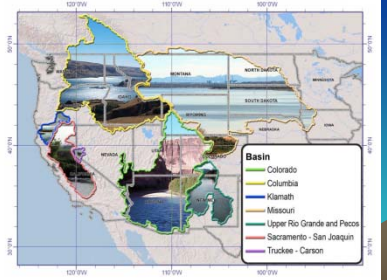


climatechange in Australia

technical report 2007

RECLAMATION
Managing Water in the West

SECURE Water Act Section 9503(c) – Reclamation Climate Change and Water 2011



U.S. Department of the Interior
Policy and Administration
Bureau of Reclamation
Denver, Colorado

April 2011

USGS
science for a changing world

Changes in Streamflow Timing in the Western United States in Recent Decades

... from the National Streamflow Information Program

JRC

STRATOS

Climate Change and Acid Rock Drainage – Risks for the Canadian Mining Sector

DATE OF SUBMISSION:
August 11, 2011

SUBMITTED TO:
Gilles A. Tremblay
Manager, Mine Closure and Ecosystem Risk Management
Secretariat MEND
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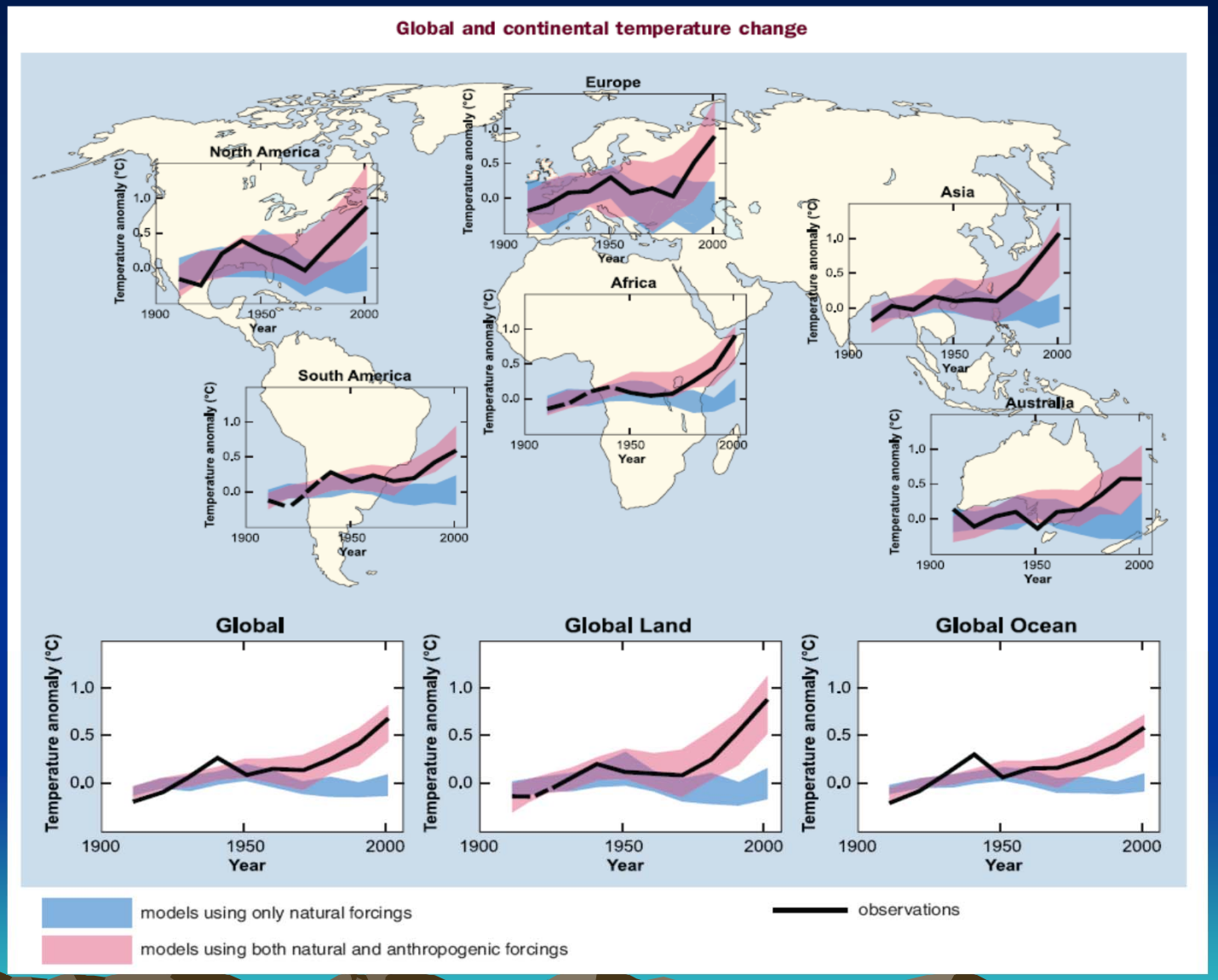
Does it matter for mines??

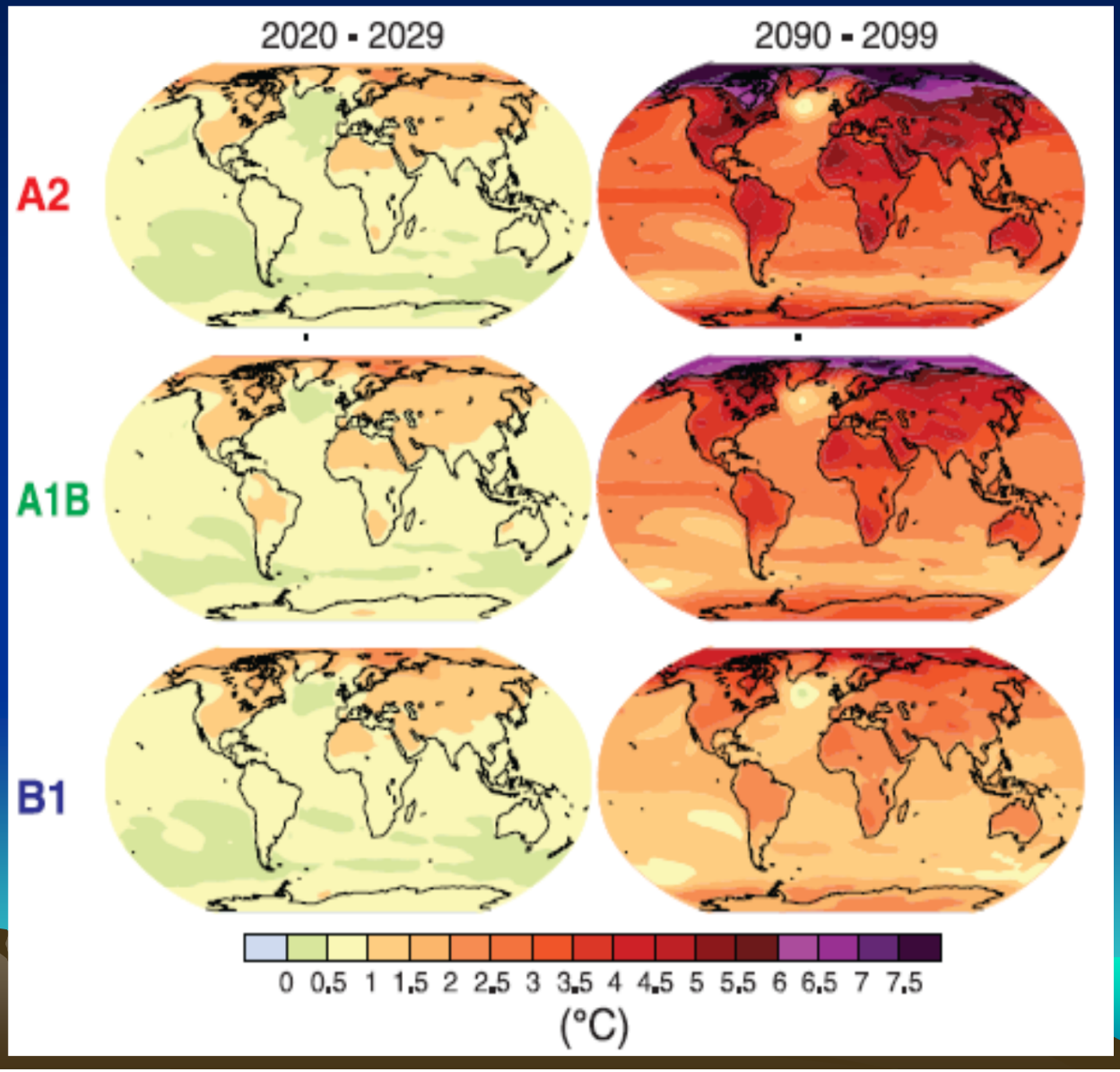
It might….

What have temperatures done?



Global temperatures through 2007

IPCC Temperature Projections



What are the risk drivers for potential impacts to mines throughout the life-of-mine?

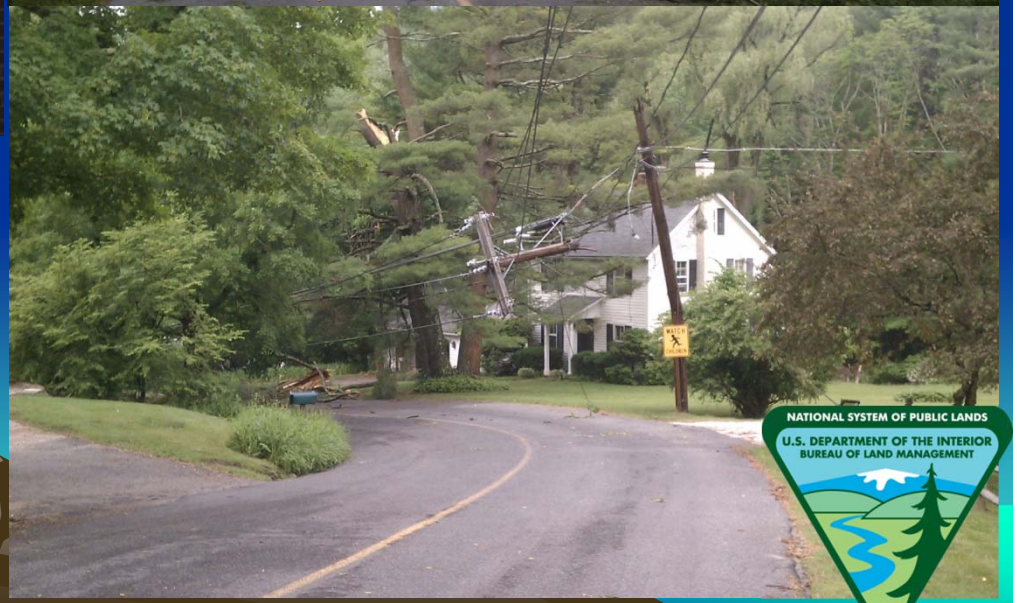
- Warmer temperatures (NRTEE 2010, Stratos 2009)
- More precipitation (IPCC2007, Karl *et al.* 2009, NRTEE 2010, Stratos 2009)
- More frequent drought conditions (IPCC 2007, Karl *et al.* 2009, NRTEE 2010)
- More extreme weather events (IPCC 2007, 2011, Karl *et al.* 2009, NRTEE 2010
- For northern climates, loss of permafrost (NRTEE 2010, Stratos 2009)
- For coastal operations, higher sea levels (IPCC2007, Karl *et al*. 2009)

What matters most for mines?

- More frequent drought conditions (IPCC 2007, Karl *et al.* 2009, NRTEE 2010)
- More extreme weather events (IPCC 2007, 2011, Karl *et al.* 2009, NRTEE 2010

Extreme Weather Events

- What are they?



More dramatic examples…

The IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation

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ipcc
INTERGOVERNMENTAL PANEL ON climate change

A changing climate leads to changes in extreme weather and climate events

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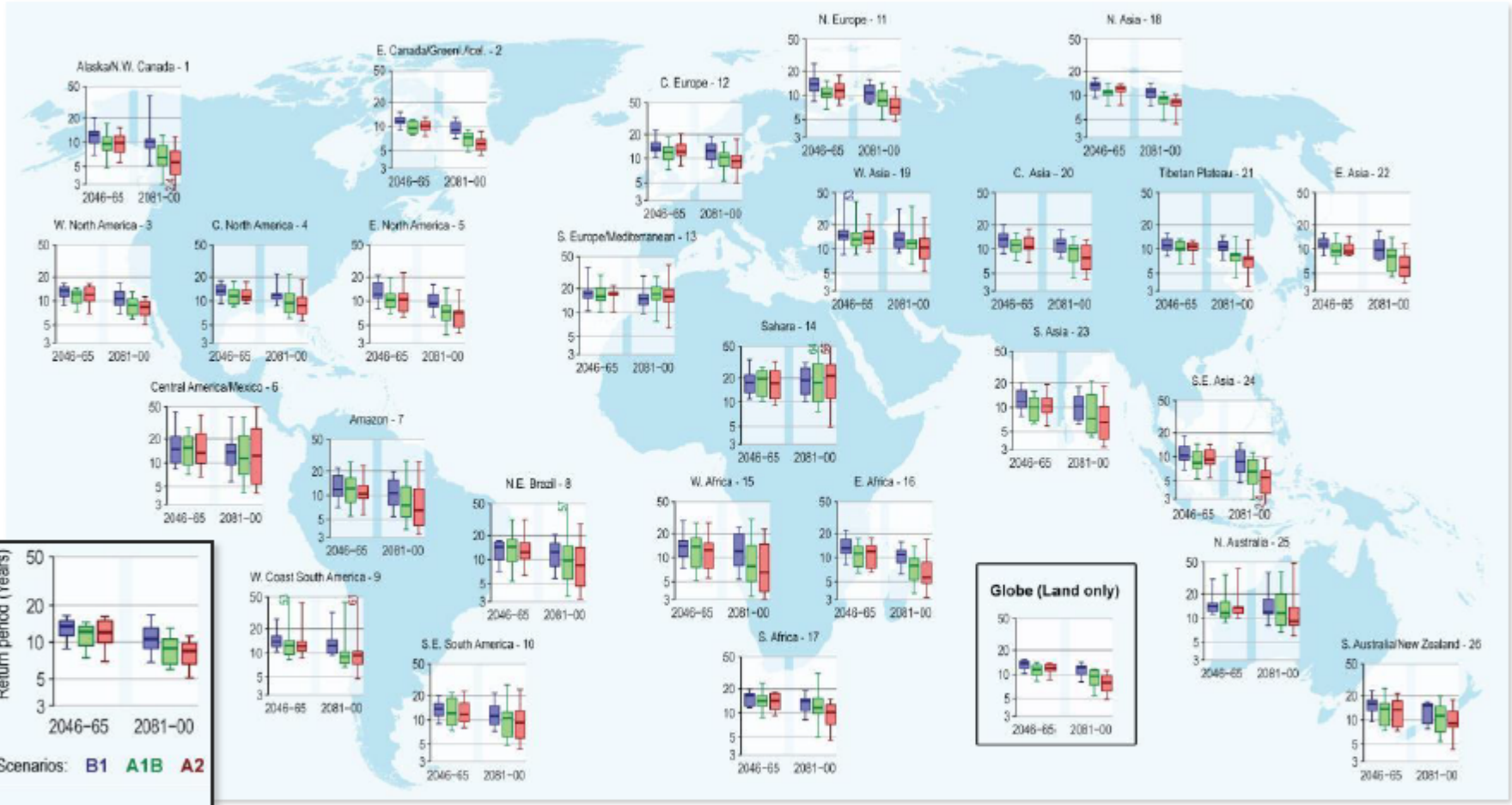
INTERGOVERNMENTAL PANEL ON climate change

Climate models project there will be more heavy rain events throughout the 21st century



In many regions, the time between "20-year" (unusually intense) rainstorms will decrease

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Open Mind | Science, Politics, I
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Channel Guide
Free Hotmail
Google
Internet Explorer News
Internet Start
RealPlayer
Bookmarks
News
Climate
Skiing
Other bookmarks
Browse
Video
Photos
Shortcuts
Corrections
Comics
Crosswords
Horoscopes
Lottery
NewsTools
Sudoku
Newsletters & alerts
FirstPerson
Actress decries 'botched' plastic surgery
Tide detergent a hot commodity on
The Week in Sports Pictures
Today's best news pictures
MSNBC: March 13th
New! Share what you're watching & see what your friends are viewing
Allow
What's this?
Follow us on Facebook
Like
497k
Sign Up
Create an account or log in to see what your friends are recommending.
Homeless people used as mobile Wi-Fi hotspots
630 people recommend this.
Rick Perry more open to probe label that Virginia's ultrasound governor
226 people recommend this.
Local news & weather
change
Show 0 4 8 items
Move box
Local headlines for Denver, CO from Bing
NFLPA unhappy with Broncos' suspensions
9News: Manpower survey: Hiring on upward track ...
9News: Resurgent Cavs entertain Raptors
9News: Hawks continue road trip at Denver
Forecast for Denver, CO via weather.com
Today
Wednesday
Thursday
70°F / 44°F
69°F / 44°F
70°F / 44°F
Detailed
Hourly
Weather news
US & world
Show 0 5 10 15 stories
Move box
Top headlines
School demands middle-schooler's Facebook login
A 12-year-old girl was reduced to tears while school officials and a police officer looked at her Facebook postings after forcing her to surrender her password, an ACLU lawsuit alleges.
Will Afghan massacre soldier get death penalty?
Warmth records falling across Northeast, Midwest
Afghan shooter: Chain of command failure
Strip club donates $1,200 to save city's Little League
'Hero' bus driver staves off irate passenger
Closing arguments in Rutgers webcam spying trial
15 inches of rain floods Louisiana homes, roads
Multimedia
Video
Unseasonably warm weather across US
TODAY
Video
Alleged killer soldier's troubled base
TODAY
Topics
Powerwall
Open Channel
Behind the Wall
World Blog
Field Notes
Wonderful World
Politics
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Cloudy outlook for Southern primaries
UPDATED US, EU, Japan challenge China on trade
A new GOP foreign policy tone: pessimism
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MineClosure2012 ...
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US & world

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Top headlines

School demands middle-schooler's Facebook login

A 12-year-old girl was reduced to tears while school officials and a police officer looked at her Facebook postings after forcing her to surrender her password, an ACLU lawsuit alleges.

- Will Afghan massacre soldier get death penalty?
- Warmth records falling across Northeast, Midwest
- Afghan shooter: Chain of command failure
- NEW Strip club donates $1,200 to save city's Little League
- 'Hero' bus driver staves off irate passenger
- Closing arguments in Rutgers webcam spying trial
- 15 inches of rain floods Louisiana homes, roads

Multimedia

Video

Unseasonably warm weather across US

TODAY

Video

Alleged killer soldier's troubled base

TODAY

Topics

- Powerwall
- Open Channel
- Behind the Wall
- World Blog
- Field Notes
- Wonderful World

Politics

Show 0 5 10 15 stories Move box

Top headlines

Cloudy outlook for Southern primaries

- UPDATED US, EU, Japan challenge China on trade
- A new GOP foreign policy tone: pessimism
- Michelle Obama to lead US Olympic delegation

Multimedia

Video

NEW Mississippi and Alabama: Expectations and implications

Topics

- Primaries
- BLTWY

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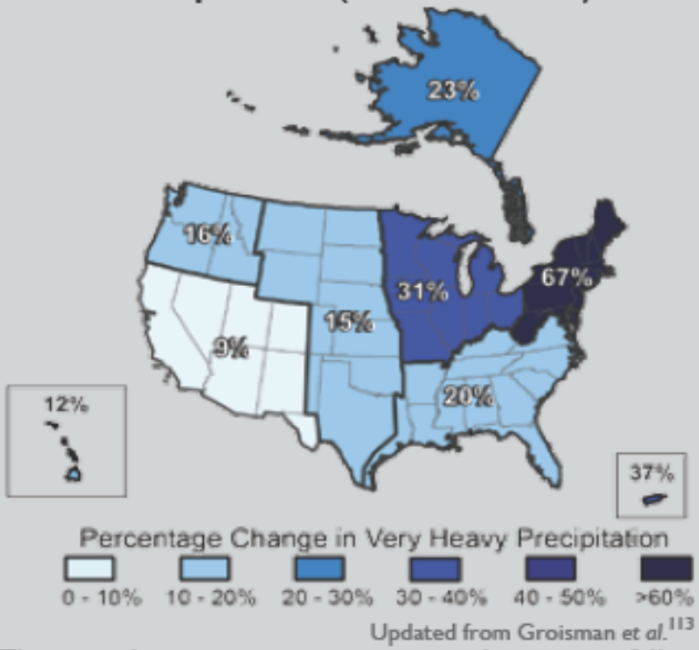
Precipitation Intensity

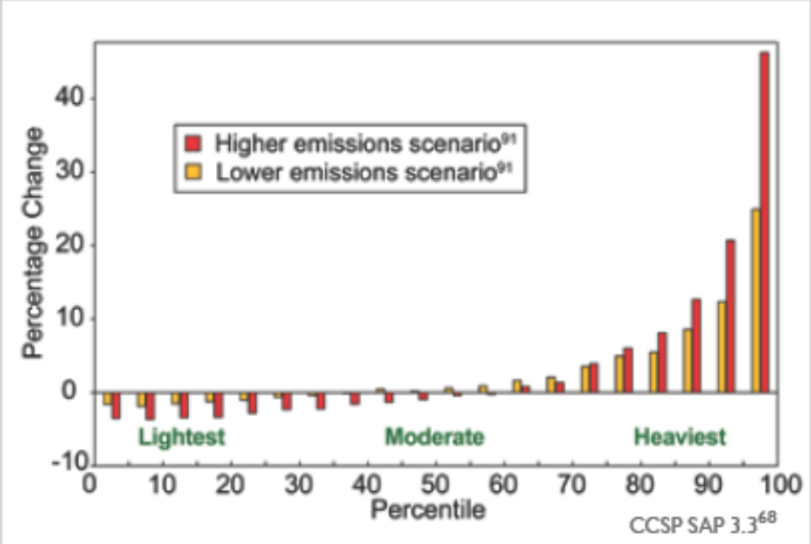
Increases in Amounts of Very Heavy Precipitation (1958 to 2007)



Updated from Groisman *et al.*[113]

The map shows percent increases in the amount falling in very heavy precipitation events (defined as the heaviest 1 percent of all daily events) from 1958 to 2007 for each region. There are clear trends toward more very heavy precipitation for the nation as a whole, and particularly in the Northeast and Midwest.

Projected Changes in Light, Moderate, and Heavy Precipitation (by 2090s)



The figure shows projected changes from the 1990s average to the 2090s average in the amount of precipitation falling in light, moderate, and heavy events in North America. Projected changes are displayed in 5 percent increments from the lightest drizzles to the heaviest downpours. As shown here, the lightest precipitation is projected to decrease, while the heaviest will increase, continuing the observed trend. The higher emission scenario[91] yields larger changes. Projections are based on the models used in the IPCC 2007 Fourth Assessment Report.

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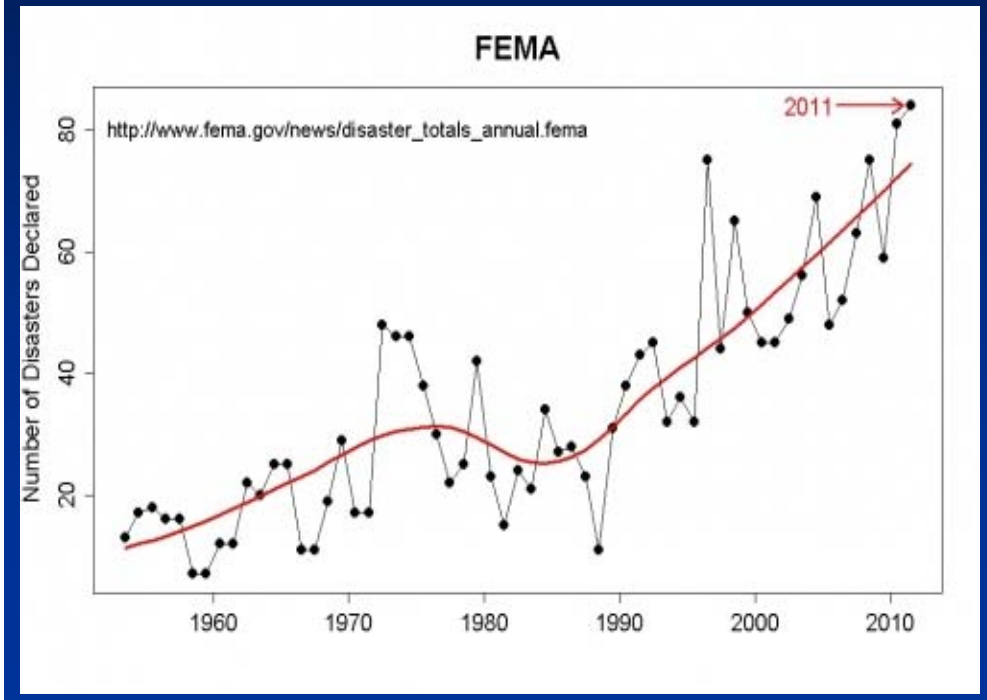
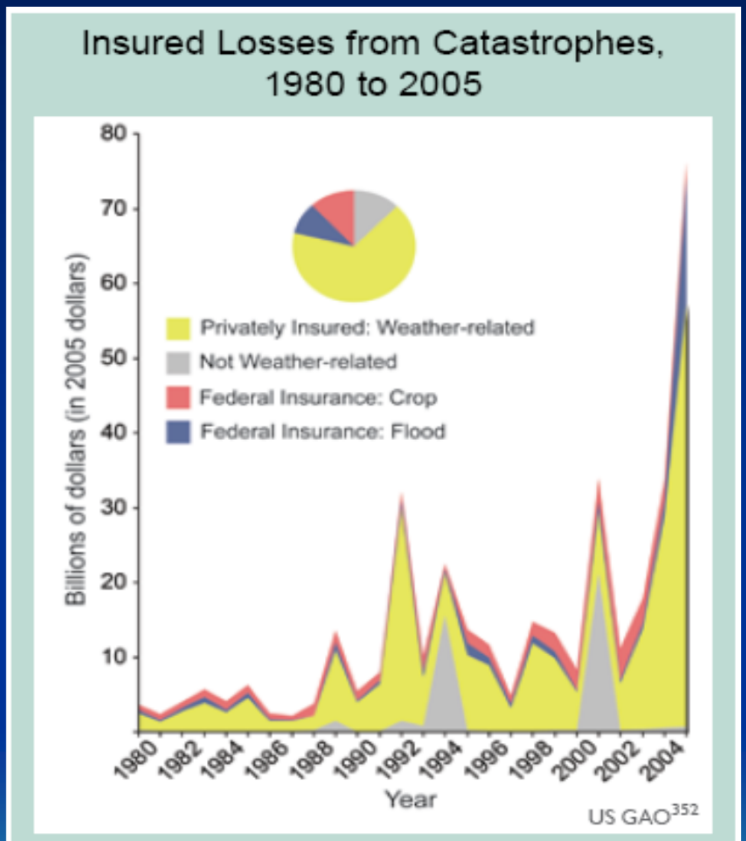
Other metrics…





Weather-related insurance losses in the United States are increasing. Typical weather-related losses today are similar to those that resulted from the 9/11 attack (shown in gray at 2001 in the graph). About half of all economic losses are insured, so actual losses are roughly twice those shown on the graph. Data on smaller-scale losses (many of which are weather-related) are significant but are not included in this graph as they are not comprehensively reported by the U.S. insurance industry.

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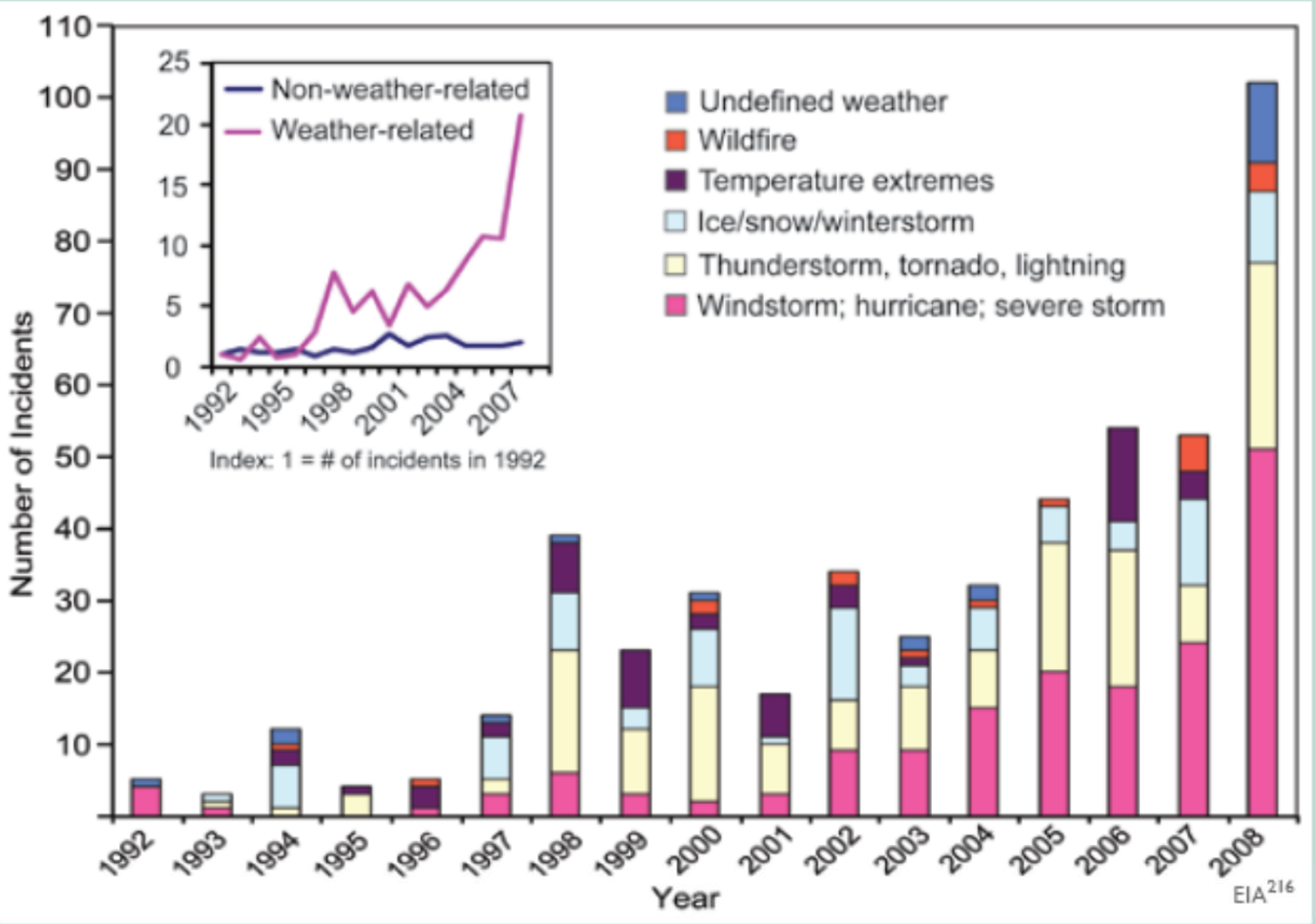
Significant Weather-Related U.S. Electric Grid Disturbances

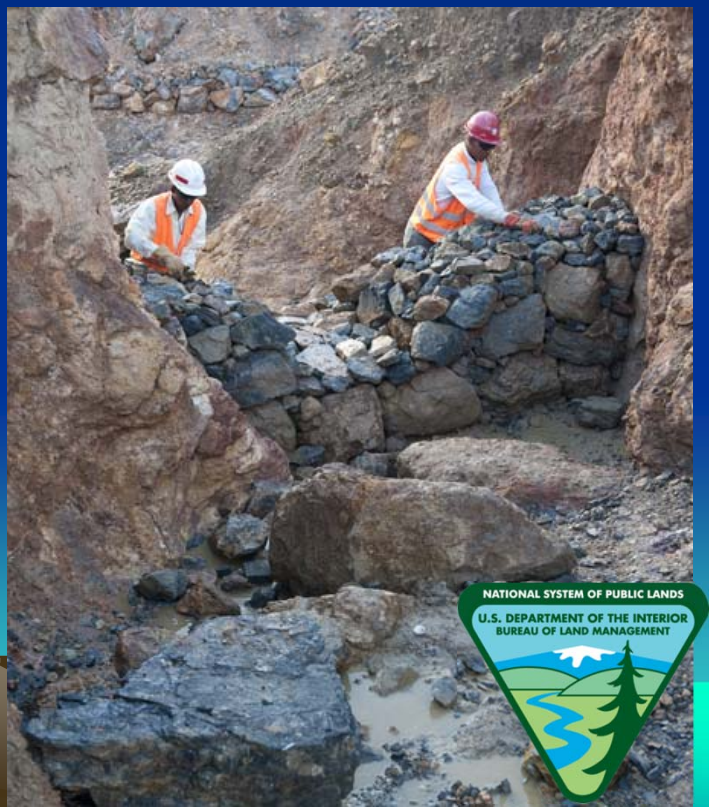


The number of incidents caused by extreme weather has increased tenfold since 1992. The portion of all events that are caused by weather-related phenomena has more than tripled from about 20 percent in the early 1990s to about 65 percent in recent years. The weather-related events are more severe, with an average of about 180,000 customers affected per event compared to about 100,000 for non-weather-related events (and 50,000 excluding the massive blackout of August 2003).[201] The data shown include disturbances that occurred on the nation's large-scale "bulk" electric transmission systems. Most outages occur in local distribution networks and are not included in the graph. Although the figure does not demonstrate a cause-effect relationship between climate change and grid disruption, it does suggest that weather and climate extremes often have important effects on grid disruptions. We do know that more frequent weather and climate extremes are likely in the future,[68] which poses unknown new risks for the electric grid.

The following mine life cycle events are evaluated for relative risk:

- Exploration: Features at risk include roads and drill pads. Equipment at risk is generally mobile.

Development: Features at risk include all areas under construction; mill and office facilities, transportation infrastructure, and tailing impoundments (if included). Facilities and equipment at risk are less mobile and could be exposed depending on the nature of severe weather



Operations: Facilities at risk include all mine structures and facilities. The risks are likely lower than during development, because all erosion and water management infrastructure is in place, functional and maintained. Facilities are at risk. Equipment may have less flexibility for mobility than during exploration and development.

Closure/Post-Closure

- Virtually all constructed features are at risk
- Risk is highest before reclamation is complete and facilities may be in salvage

Longer Term Risk:

- Counter-balanced by longer time frames –
- Perpetuity…for extreme weather events
- Foreseen or unforeseen changes in temperature or precipitation may dramatically impact vegetation and cover performance

Longer Term Risk:

- Changes in cover performance may impact water management and other costs
- Equipment at the site is generally mobile

What would an extreme weather event look like?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Features at risk:

Hmm…might be “Mine influenced water”?

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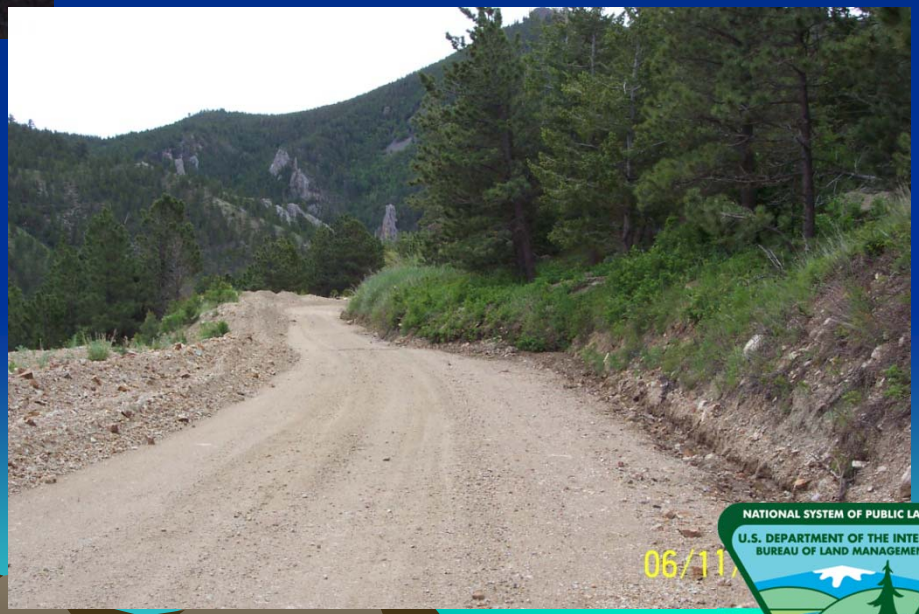
Water control features

Roads



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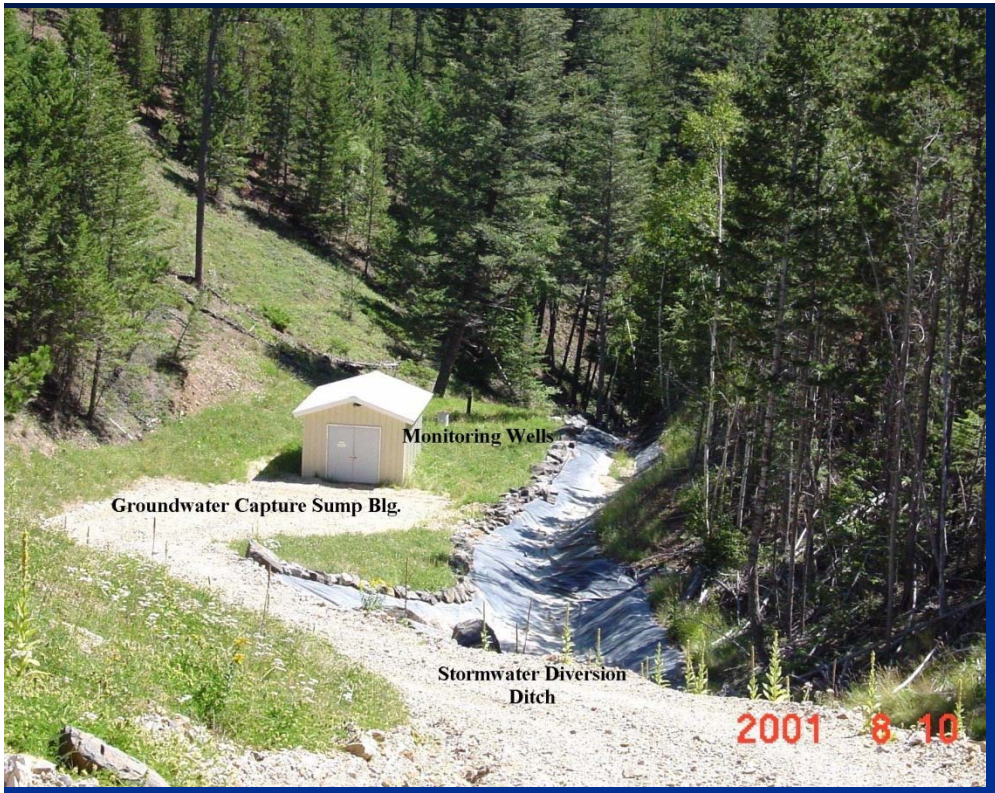

Water treatment plants

ARD Seepage Capture Systems

Ouch…

Carter/Alder Gulch Storm Damage

Approximately 43,000 cubic M

Repair costs - $300,000 – 14M

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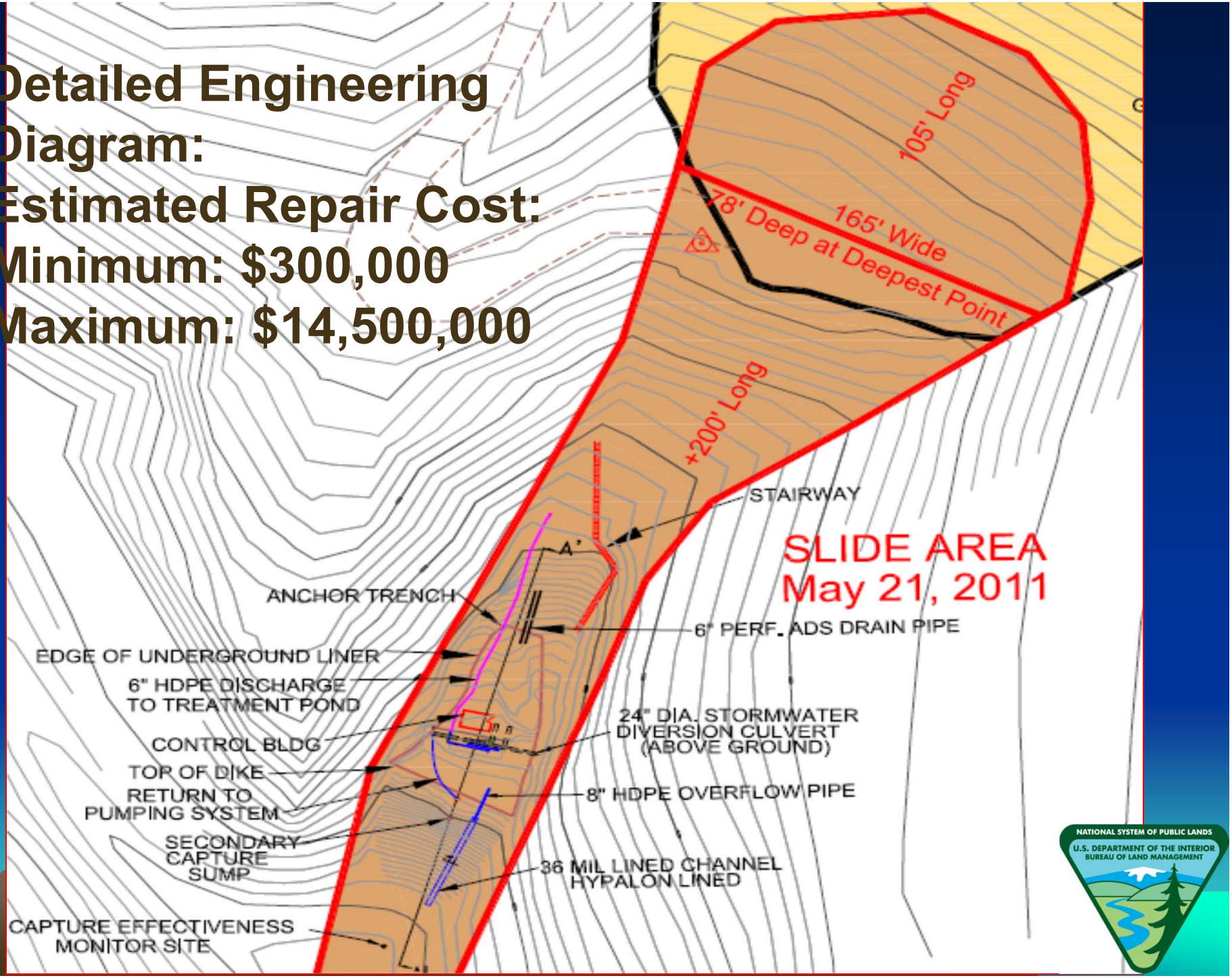
Detailed Engineering Diagram:
Estimated Repair Cost:
Minimum: $300,000
Maximum: $14,500,000



Swift Gulch water treatment plant


Repair Cost Estimate: $ 252,000
Approximately 3.5 m
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Various examples of site-wide road/infrastructure damage


Site-wide Miscellaneous Repair Costs: ≈ $100,000
CAT
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Close Call…


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ARD Seepage Capture Systems

- 7 Capture Systems in 6 Drainages
- Routes seepage to WTP
- Sized for 100-year, 24-hour event


..the reality is the industry is making closure, reclamation and drainage treatment predictions based on a historic climate that no longer exists.
Swift Gulch
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It will be important for mining companies to plan for extreme weather events as a contingency throughout the mine life and design their operations and closure plans to survive them.
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A couple other things to think about

- To what extent will operators be responsible for long term effects, which may impact water management that can be “clearly” projected, but are outside the range of normal longer term effects?
- What are the potential legal implications of these collective uncertainties?

Slide left blank to confuse you…

THE END

Any Questions??