Climate Change Resilience at the Rocky Flats Site, Colorado

U.S. Department of Energy
Office of Legacy Management

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Ecosystem Overview

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Climate change is a HOT topic these days

- Extreme events happen regardless of climate change

Presentation Agenda

- Potential changes that may occur from climate change
- Climate model predictions for the Front Range of Colorado
- Potential climate effects at the Rocky Flats Site
- Potential ecosystem responses at the Rocky Flats Site
- Potential adaptive ecosystem management responses for the Rocky Flats Site
- Effects on groundwater
- Groundwater collection and treatment systems
- Surface water monitoring and operations
- Questions

2018 National Climate Assessment Conclusions (U.S. Global Change Research Program)

- Climate change impacts expected to be widely distributed across the U.S.
- Impacts will affect various regions of U.S. differently
- Assessment identifies increased frequency of extreme events:
  - Flooding
  - Drought
  - Intense precipitation or windstorms
  - Wildland fires
  - Erosion
  - Vegetation mortality

Climate Model Predictions for the Colorado Front Range

- Temperatures are expected to increase (2 to 6.5 degrees Fahrenheit by 2050)
- Precipitation may or may not change (real change unknown — depends on model)
- Storm intensities are likely to increase

Potential Climate Effects at the Rocky Flats Site

- Some of the potential changes include:
  - Increased drought
  - Increased storm intensities
  - Increased wildland fire potential
  - Climate zone shifts — up in elevation and northward
  - Warmer summer temperatures (increased potential for heatwaves)
  - Milder winter temperatures

Ecosystems Are Dynamic

- Ecosystems constantly change and respond to changes in environmental conditions
- Any long-term changes in the plant communities are not likely to happen overnight
    - May take years or decades to be evident

Wetlands

- Wetland plant species are dependent on water
- Under normal environmental variability, wetland margins expand and contract
- Warmer temperatures and reduced precipitation (drought conditions) may result in reduced wetland areas in Central Operable Unit (COU)
- Warmer temperatures and increased precipitation may result in no change in wetland areas or perhaps a smaller decrease in area
- Decrease in wetlands could lead to shift to upland grassland areas as grasses replace wetland plant species adapted to drier conditions

Riparian Areas

- Reduced water flows due to increased temperatures and decreased precipitation may result in:
  - Smaller or narrower riparian areas at the site
  - Increase in grasslands along streams
  - Loss or reduced abundance of certain plant species along the streams
  - Increase of abundance of species adapted to drier conditions along the streams
  - Shift in species composition (e.g., coyote willow and wild indigo)
- Increased precipitation may result in no change or less of a change

Grassland Ecosystems

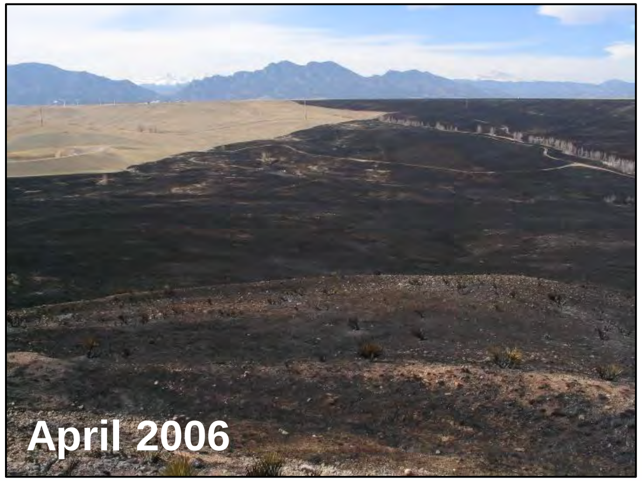
- Potential shifts in species composition
- Potential for increased weed infestations
- Potential reduction in the amount of xeric tallgrass prairie because tallgrass species require more moisture than mid-grass and short-grass prairie species
- Potential shift from C3 (cool season species) to more C4 (warm season species)
- Could benefit the site by reducing abundance of smooth brome (a non-native C3 species)
- Our seed mixes incorporate both C3 and C4 species for revegetation areas

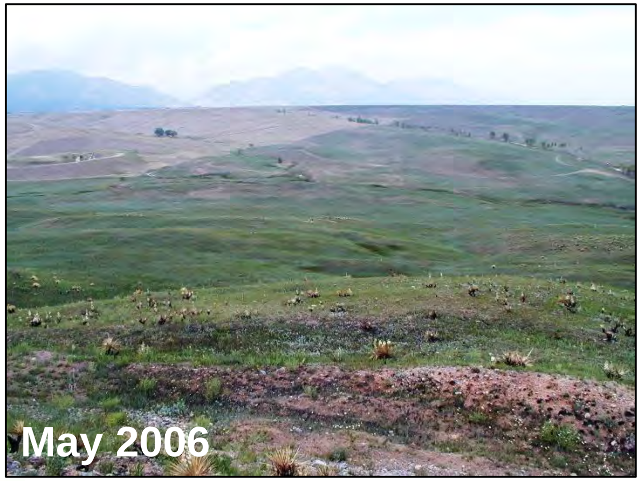
Will the Rocky Flats Site Become a Dust Bowl?

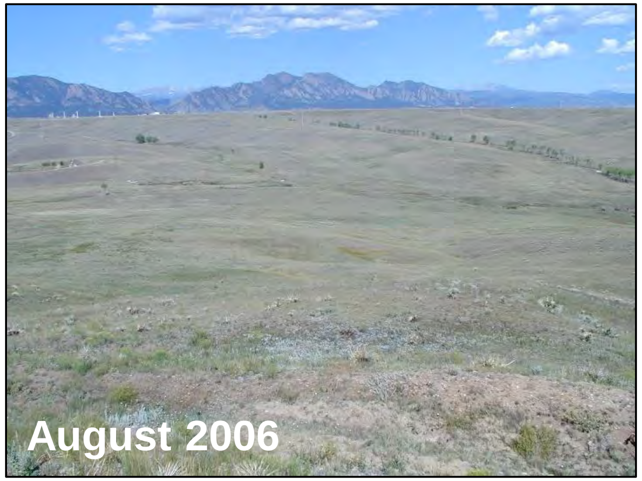
- Severe drought and unsustainable farming practices caused the 1930s Dust Bowl
  - Plowing the native prairie destroyed native plant root systems that held soil in place
- This is not likely at the Rocky Flats Site
  - We have planted a diverse mix of deep-rooted native grasses, mimicking the surrounding native undisturbed prairie
  - We are not plowing up the grassland
  - Abundance of plant material available with a wide range of tolerance and genetic variability

Increased Wildland Fire Potential

- Increased wildland fire potential would benefit the grassland ecosystem
  - Grassland species are adapted to fire and need it to maintain a healthy plant community
  - For the past 70+ years, wildland fires have been extinguished in the Rocky Flats area
  - Unnaturally large accumulation of plant litter is now present, which stresses the grassland ecosystem at the site
  - Could cause problems with neighborhoods at the boundaries of the refuge
  - Accumulation of plant litter at the site potentially creates conditions that would result in a large fire when one happens — natural or human caused







Ecosystem Management

- Climate change will probably not affect ecosystem management at the Rocky Flats Site
  - We cannot stop potential climate change effects on ecosystems
  - Rocky Flats Site is a small piece in the larger ecosystems of the Front Range
  - Change will occur across the entire area, and it will be gradual
  - Trying to prevent ecosystem responses to climate change is not a realistic option

Ecosystem Management (continued)

- So, how do we respond to climate change?
  - Continue to do what we already do
  - Plant native seed mixes that mimic the native prairies, which have a high range of tolerance and genetic variability
  - Install and manage erosion/sediment controls during and after projects to prevent/reduce erosion potential
  - Conduct weed control and vegetation management as needed to maintain diverse native habitat and for operations and safety
  - Continue monitoring plant communities

Questions?

Groundwater Overview

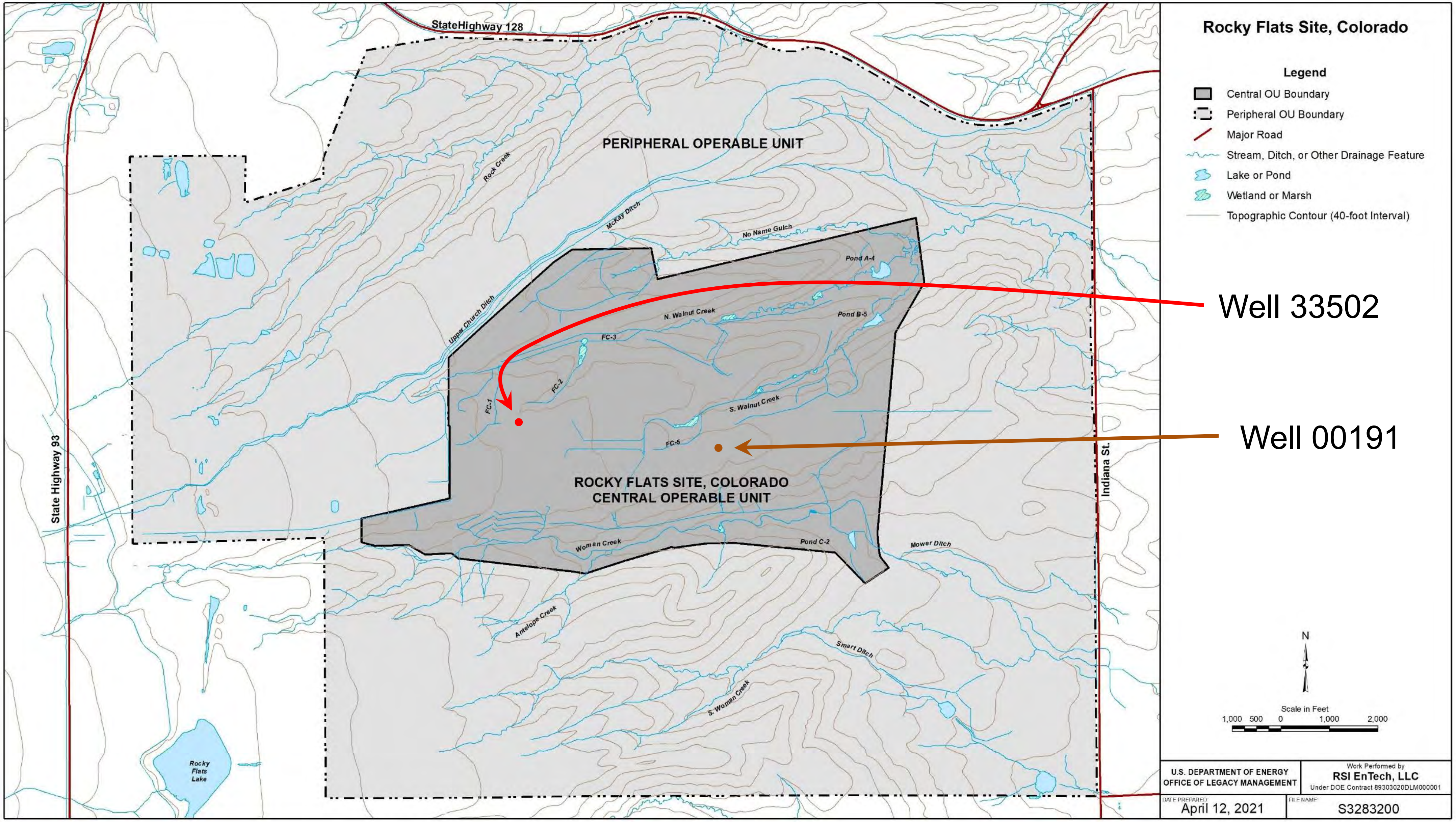
John Boylan

Rocky Flats Site Groundwater Lead

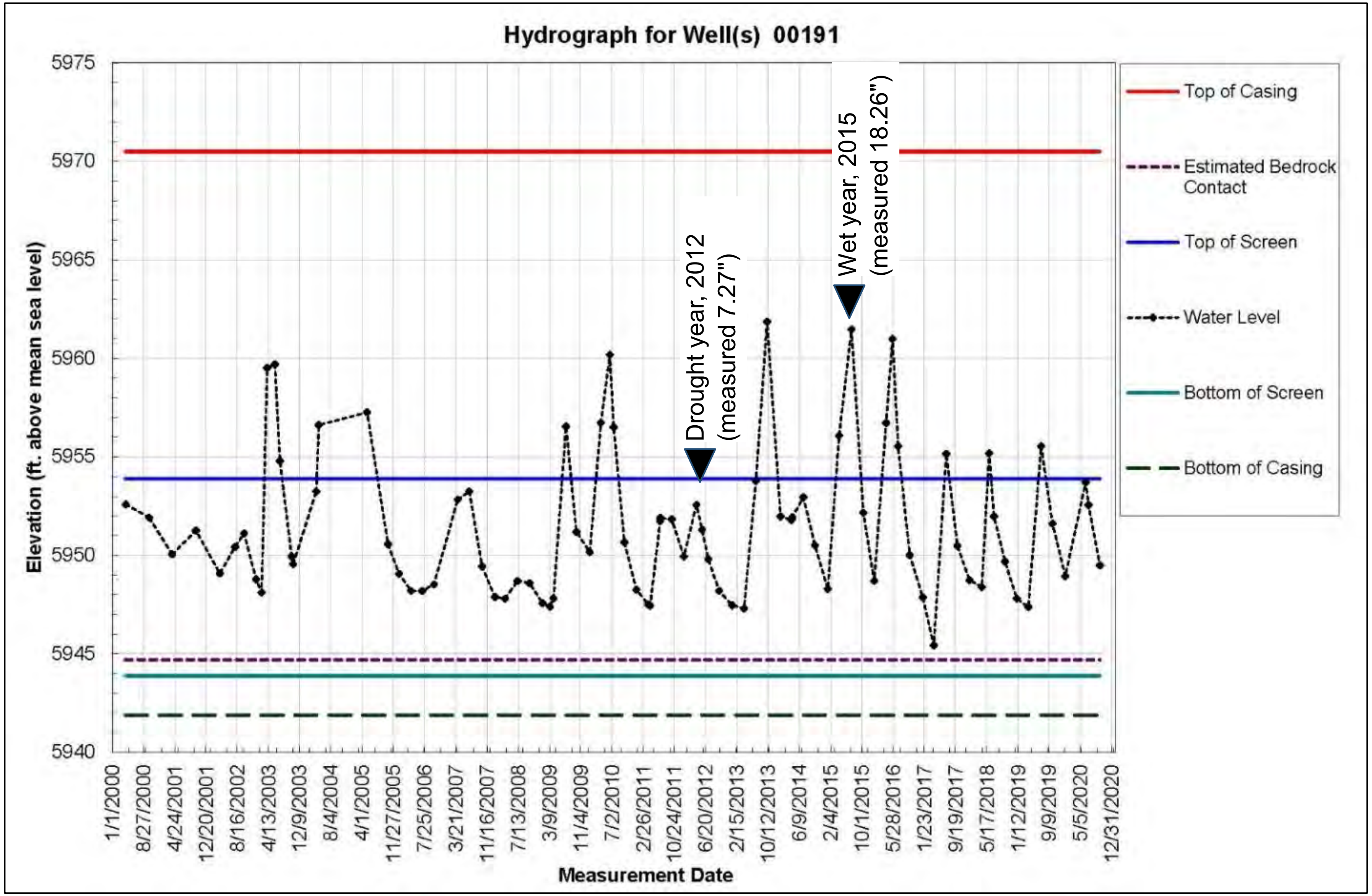
RSI EnTech, LLC

Effects of Climate Change on Groundwater

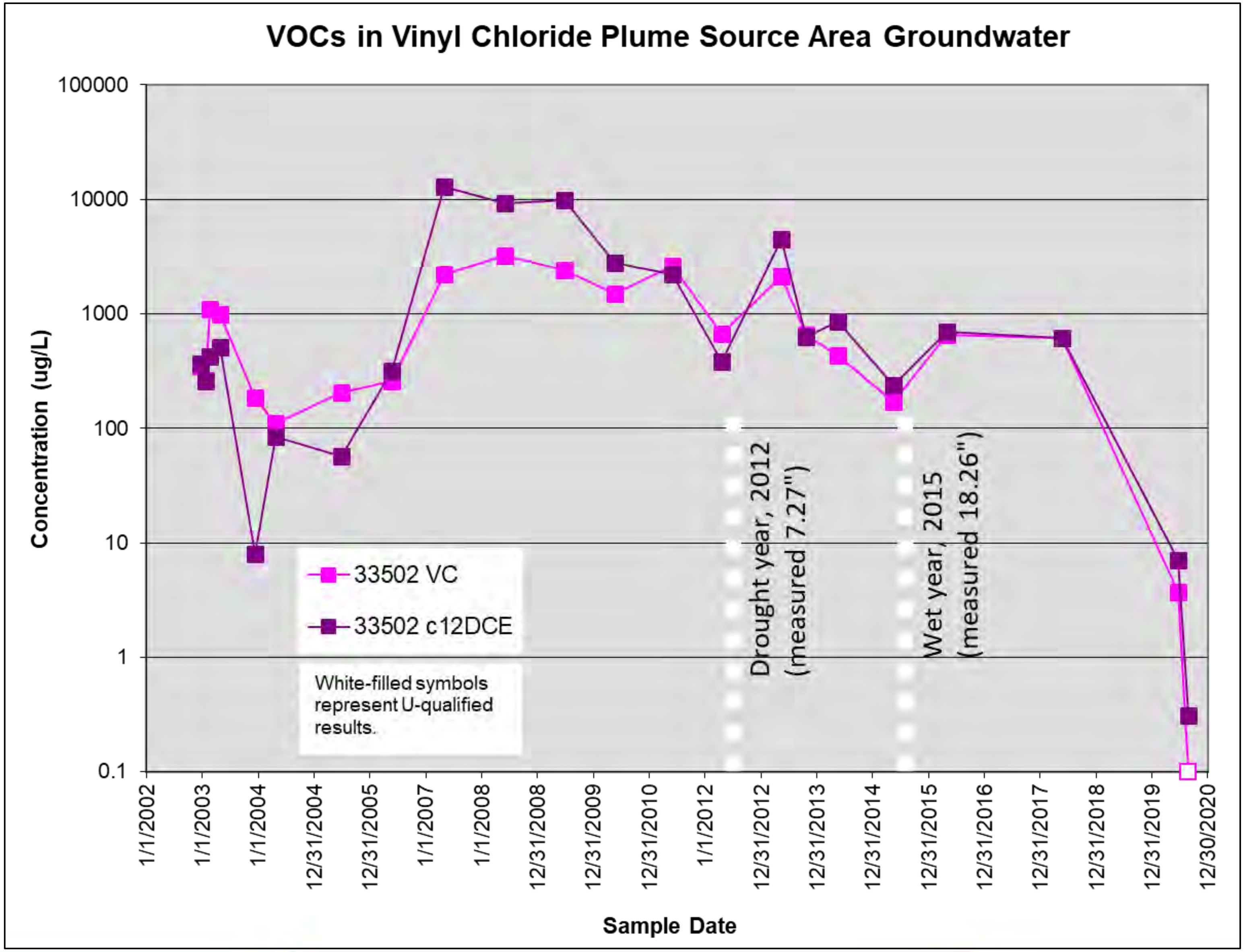
- Effects on groundwater regime will be gradual and episodic, not sudden
- *Rocky Flats Legacy Management Agreement* (RFLMA) protocols and processes, including consultation to discuss observations and events, will continue
- Groundwater volume is highly variable — see hydrographs in annual reports
- Groundwater quality is also highly variable — see time-series plots in annual reports
- Network of monitoring wells on pediment surface and along flowpaths or in drainages adequately monitors the site
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) five-year review reports will continue
    - Groundwater models are updated, checked for each five-year review report


StateHighway 128
PERIPHERAL OPERABLE UNIT
Rock Creek
McKay Ditch
No Name Gulch
Pond A-4
Upper Church Ditch
N. Walnut Creek
Pond B-5
FC-3
FC-2
FC-1
S. Walnut Creek
FC-5
ROCKY FLATS SITE, COLORADO
CENTRAL OPERABLE UNIT
Woman Creek
Pond C-2
Mower Ditch
Antelope Creek
Smart Ditch
S. Woman Creek
State Highway 93
Indiana St.
Rocky Flats Lake
Rocky Flats Site, Colorado
Legend
Central OU Boundary
Peripheral OU Boundary
Major Road
Stream, Ditch, or Other Drainage Feature
Lake or Pond
Wetland or Marsh
Topographic Contour (40-foot Interval)
N
Scale in Feet
1,000 500 0 1,000 2,000
U.S. DEPARTMENT OF ENERGY
OFFICE OF LEGACY MANAGEMENT
Work Performed by
RSI EnTech, LLC
Under DOE Contract 89303020DLM000001
DATE PREPARED:
April 12, 2021
FILE NAME:
S3283200
Well 33502
Well 00191

Example Hydrograph



Example Time-Series Plot



(note logarithmic concentration scale)

Groundwater Collection and Treatment Systems

- Being off the grid forces a much deeper consideration of “what ifs” than might otherwise be the case — water volumes, concentrations, power and backup power requirements, ability to monitor operations and conditions remotely, etc.
- Maintain supply of replacement components (e.g., pumps) to enable quick replacement
- Power supplies are flexible
  - Power is supplied by solar/battery system
  - Each has generator backup connection
- Designs incorporate wind loading requirements of 130 miles per hour
  - If wind speeds indicate strengthening is necessary, will consider options (e.g., hurricane straps, jersey barriers/weight, other anchoring)

Groundwater Collection and Treatment Systems (continued)

- Treatment systems are designed for flexibility
  - Can accommodate large range in flows
  - Existing variability in flow rates and water volumes is huge
  - Can accommodate increased variability or overall increase/decrease
    - Solar Ponds Plume Treatment System (SPPTS) uses about one quarter of its available capacity
    - East Trenches Plume Treatment System (ETPTS) air stripper runs for less than 8 hours each day (average is less than 6 hours each day)

SPPTS and ETPTS have additional capacity, if needed

Groundwater Collection and Treatment Systems

- Treatment system flexibility (continued)
  - Power systems are designed with excess capacity
    - Helps deal with long periods of cloudy conditions
    - Accommodates wide range of flows
    - Adding capacity is not difficult, whether more solar panels, more batteries, or both
  - Less precipitation would mean existing systems are oversized — not a serious problem (in some respects they are already oversized)
  - More precipitation would be accommodated by existing designs
    - If more capacity is needed, would follow RFLMA protocols to resolve
  - Systems are automated, do not require manual operation
  - System conditions and operations are monitored remotely, and some operations can be adjusted remotely

Former Landfills

- Conduct routine and weather-related inspections
  - Monitor for potential issues
  - Similar inspections are conducted in several other parts of the former Industrial Area
- Original Landfill recently received structural reinforcements
  - Response to continuing hillside instability and slumping
  - RFLMA protocols include inspections, reporting, issue evaluation, design development, and maintenance, with frequent regulatory consultation and stakeholder updates
- Present Landfill has not needed reinforcement
  - Completely different setting – fills a valley rather than being on a hillside
  - Incorporates structural enhancements installed prior to closure
    - French drain to divert groundwater (Groundwater Intercept System)
    - Slurry wall to minimize groundwater encroachment
    - Surface water diversion to minimize run-on
  - Different cover design reduces infiltration

OFFICE OF LEGACY MANAGEMENT
Commitment to Stewardship

Surface Water Overview

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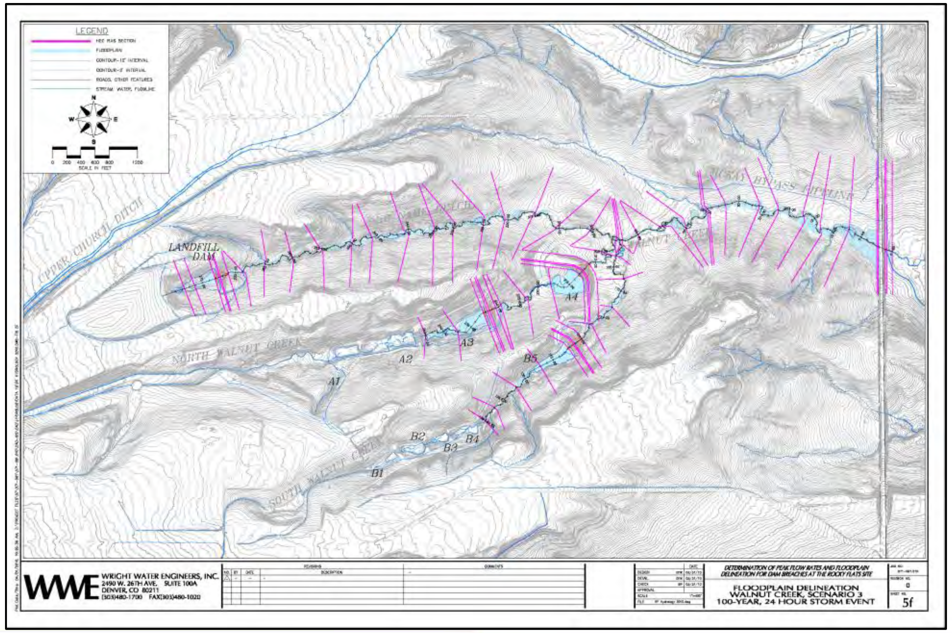
Surface Water Monitoring and Operations

- Design of surface water infrastructure and management of monitoring programs have always considered the probability and effects of weather variability

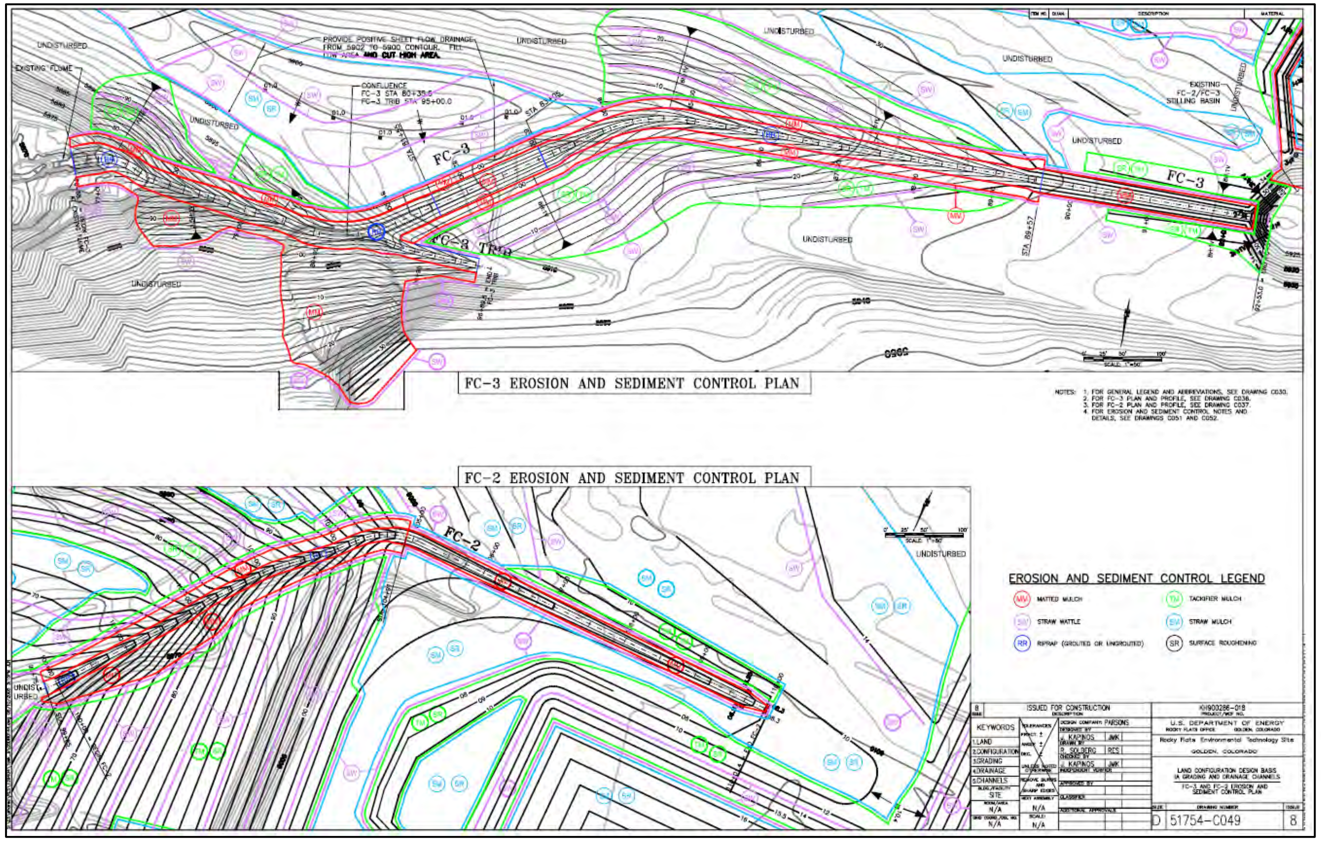
Dams

- Dams are not part of the CERCLA remedy and will be breached at some point in the future
- Designed to withstand extreme events by passing high flows through emergency spillways without damage
  - Design used basin characteristics from the former Rocky Flats Plant when there were significant impervious areas that would generate much more runoff and higher peak flow rates than the current grassland environment
  - During the September 2013 event, the dams retained the water and spillways did not flow
  - Dam breaches have similar design criteria to withstand extreme events



COU Functional Channels

- Functional Channels were designed to adequately convey the 100-year event runoff flows with adequate freeboard according to the *Urban Storm Drainage Criteria Manual*
- During the September 2013 event, the Functional Channels sustained no damage



Surface Water Monitoring

- Flow measurement structures can measure a wide range of flow rates
  - For example, flumes at the Points of Compliance (POCs) can measure peak flow rates that are more than 1,000 times higher than baseflow

Surface Water Monitoring (continued)

- Flow measurement structures can be modified or reconstructed at moderate cost to handle larger events

Surface Water Monitoring (continued)

- Secondary automated samplers were added to both POCs and POE SW027 after the September 2013 flood.
- These samplers trigger when the primary flow-paced sample carboy fills due to high flow rates
  - Secondary sampler is programmed at a higher flow pace so that samples are collected more slowly during the extremely high flow rates
    - Gives the field team time to collect the full carboys, start new carboys, and prevent interruptions in sampling

Surface Water Monitoring (continued)

- Monitoring network uses automated equipment that is programmable to adapt to changes in water quantity and quality
  - Annual evaluation performed to assess water quality variability at each location
    - Used to determine appropriate number of samples to ensure confidence in decision-making
  - Flow-pacing of automated composite samples is continuously updated using current flow records. As average flow rates change, either increasing or decreasing, sample flow pacing adjusts accordingly

Conclusions

- Large-scale effects of climate change will be gradual
- Extreme weather events occur regardless of overall climate trend
- As conditions change, adjustments will be made in accordance with the RFLMA
- Quarterly, annual, and five-year review reports, together with associated briefings, will continue to communicate and inform stakeholders
- CERCLA five-year reviews will continue to be performed

The environment is dynamic - LM's stewardship is constant.

Questions?

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