



Know No Boundaries: Creative Use of Storage for Transboundary Water Management in the Klamath Basin

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Acknowledgements



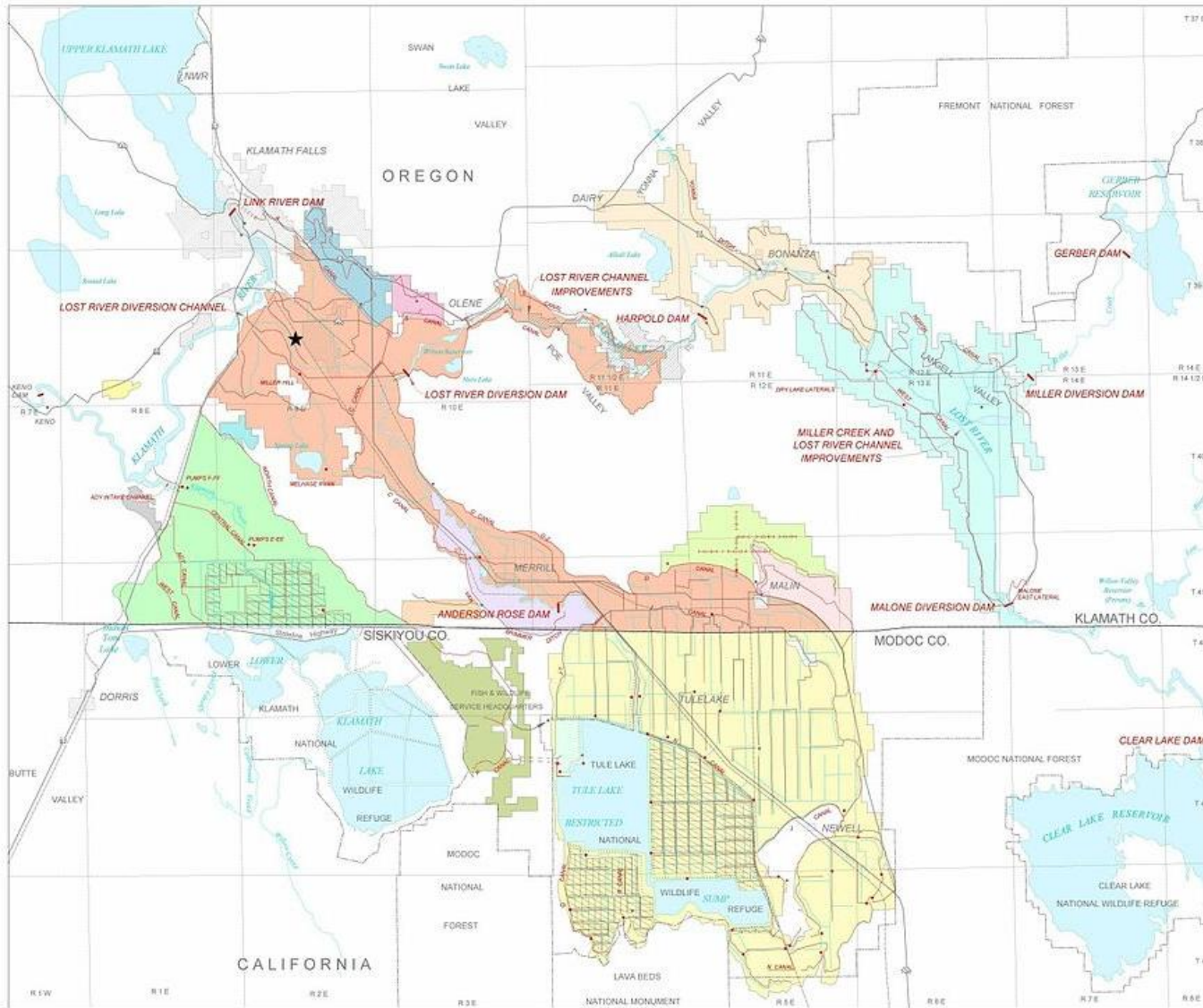
Presentation Outline

- Klamath Basin water issues
- Water storage – a part of the solution
- Key factors affecting feasibility
- Potential opportunities
- Summary and what's next

Klamath Basin Water Issues

- Tribal claims
- Federal water management
 - Bureau of Reclamation
 - Wildlife Refuges
 - Federal lands
- Off- and On-Project irrigation
- Dams and hydropower
- ESA, CWA
- State adjudication
- State scenic waterways



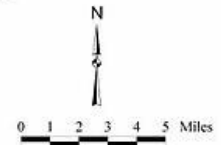


- FEATURES:**
- Hydrography
 - Canal
 - Drain
 - Dike
 - Tunnel
 - Flume
 - Siphon
 - Pipeline
 - Drop
 - Pumping Plant
 - Irrigation District Pumping Plant
 - Private Utility Powerplant
 - Project Headquarters
 - Project Land Lease Area

- MAJOR WATER DISTRICTS:**
- Ady Dist. Improv. Co.
 - Enterprise I.D.
 - Horsefly I.D.
 - Klamath Drain. Dist.
 - Klamath I.D.
 - Langell Valley I.D.
 - Malin I.D.
 - Midland Dist. Improv. Co.
 - P Canal Mutual Water Co.
 - Pine Grove I.D.
 - Pioneer Dist. Improv. Co.
 - Pievna Dist. Improv. Co.
 - Poe Valley Improv. Dist.
 - Shasta View I.D.
 - Sunnyside I.D.
 - Tulelake I.D.
 - Van Brimmer Ditch Co.
 - Westside Improv. Dist.

KLAMATH PROJECT

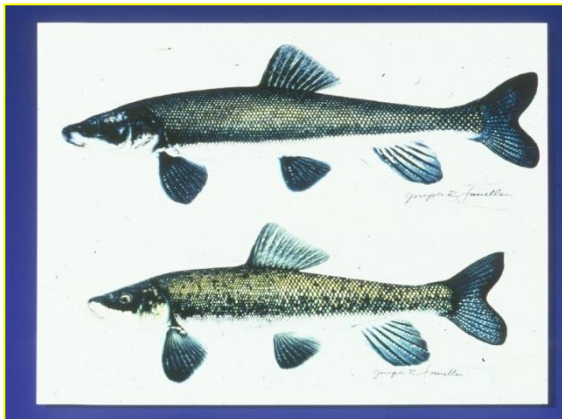
Oregon - California



Prioritization of Water in the Klamath Basin

Based on Federal Solicitor's Opinion dated July 25, 1995
This is further "supported" by 2013 Biological Opinion for Klamath River
Water operations

- Endangered and threatened species
- Tribal trust
- Agriculture
- National Wildlife Refuges



Klamath Basin Water Issues

Klamath Basin has a long history of competing water demands from environmental, tribal, federal, state and private landowner entities, and has resulted in entrenched positions...

Klamath Basin Water Issues

Klamath Basin has a long history of competing water demands from environmental, tribal, federal, state and private landowner entities, and has resulted in entrenched positions...

...but collaboration and opportunities for incremental progress persist.

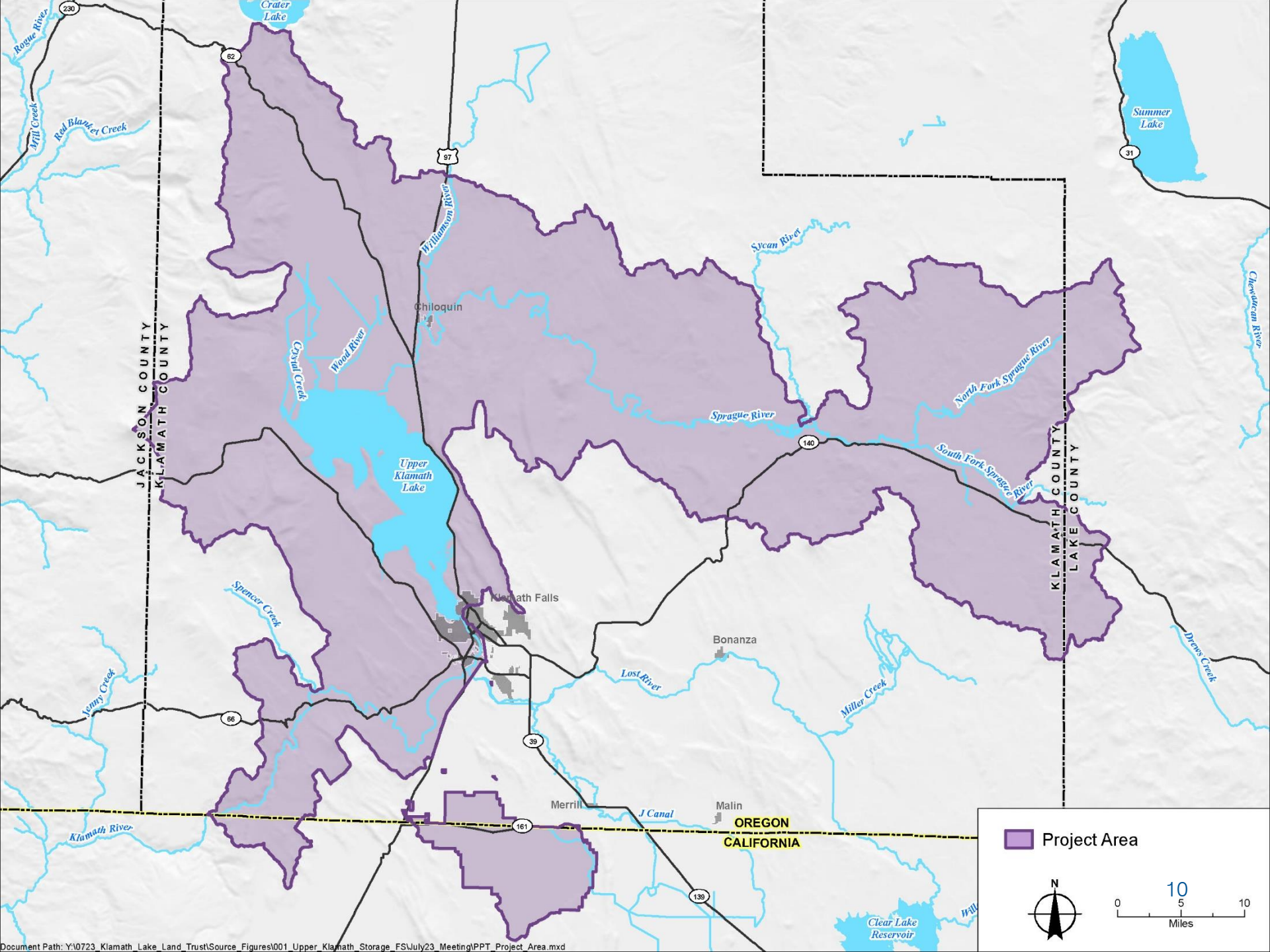
Project Overview

Klamath Basin Feasibility Study to Identify Supplemental (Water) Sources

Project Goals:

Assess above- and below-ground storage options to assist in the potential for instream flow augmentation to:

1. Address instream needs for federally listed aquatic species
2. Allow more water to be available for out of stream use



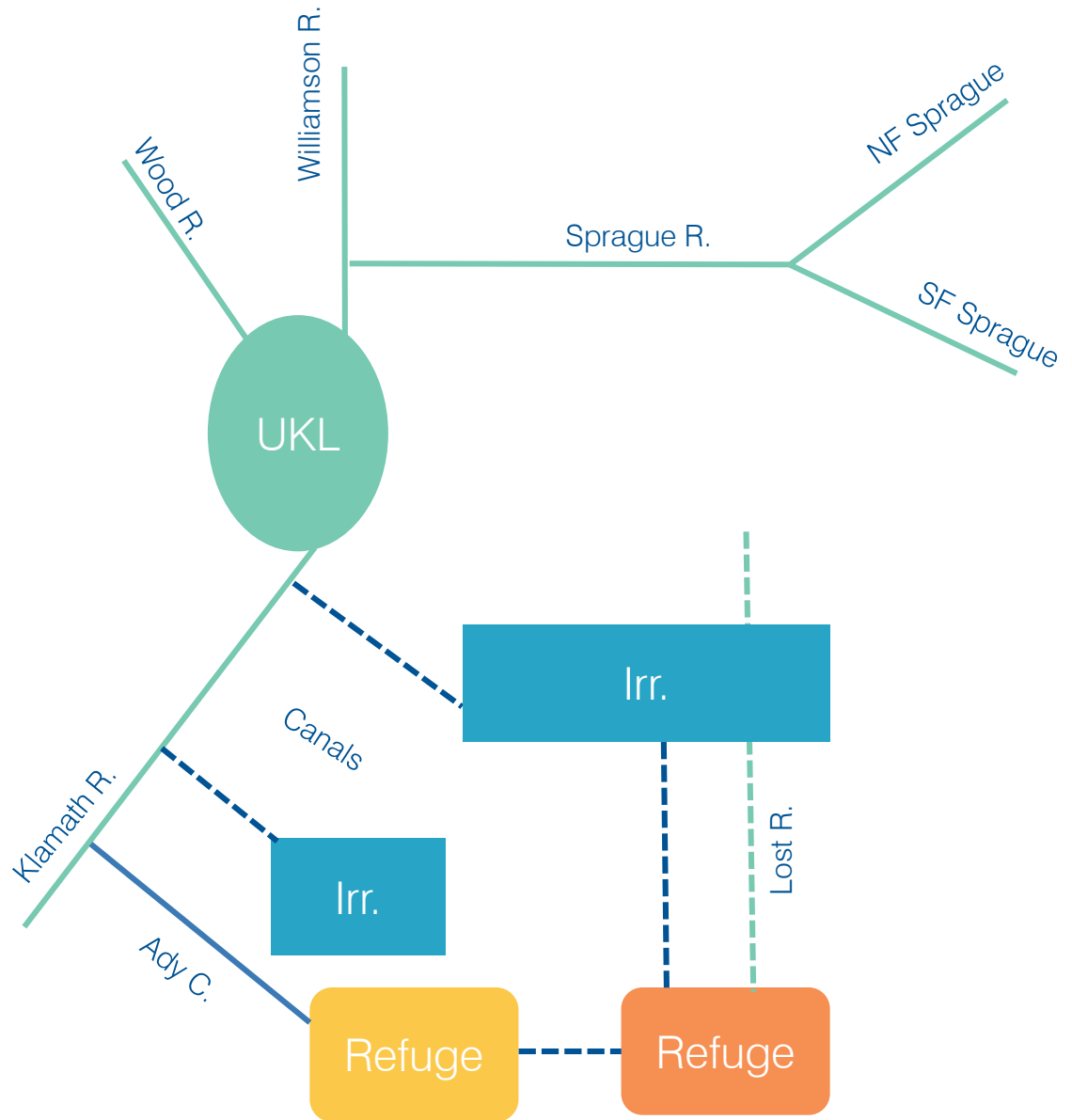
Storage Feasibility Criteria

- Topography (surface storage)
- Hydrogeology (subsurface)
- **Net benefits** (location, timing)
- **Water availability** (quantity, reliability)
- Infrastructure (existing, needed)
- Permitting (complexity, certainty)
- Relative cost
- Data gaps and uncertainty

Storage Concepts and Benefits

- Storage
 - Store available winter high flows
 - Release during summer high demand period
- Benefits
 - Release stored water for direct flow augmentation
 - Exchange live streamflow for stored water
 - Stored groundwater:
 - Cooler temperature when released
 - Increase GW levels

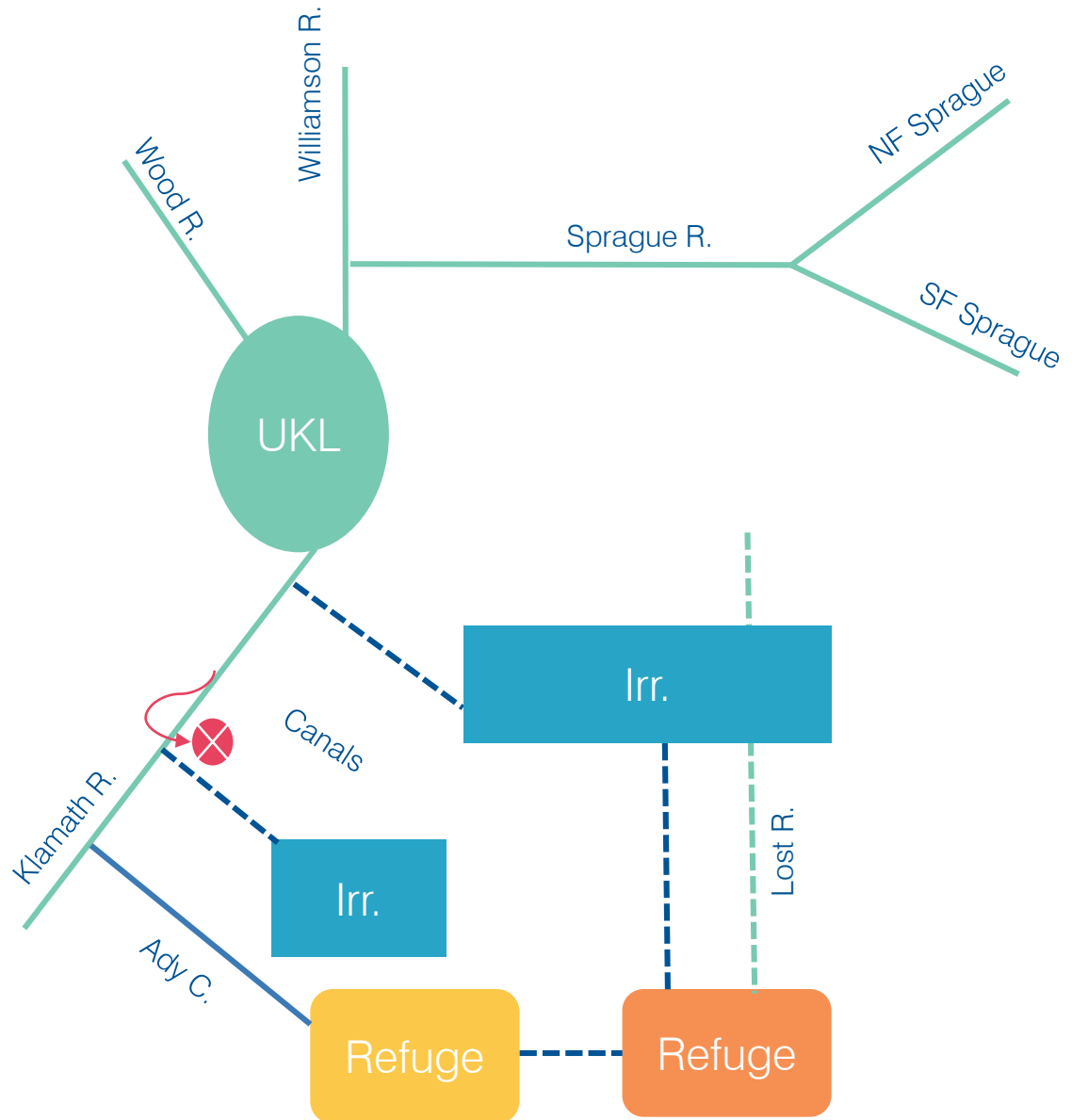
Storage Concepts and Benefits



Storage Concepts and Benefits

Winter/Early Spring:

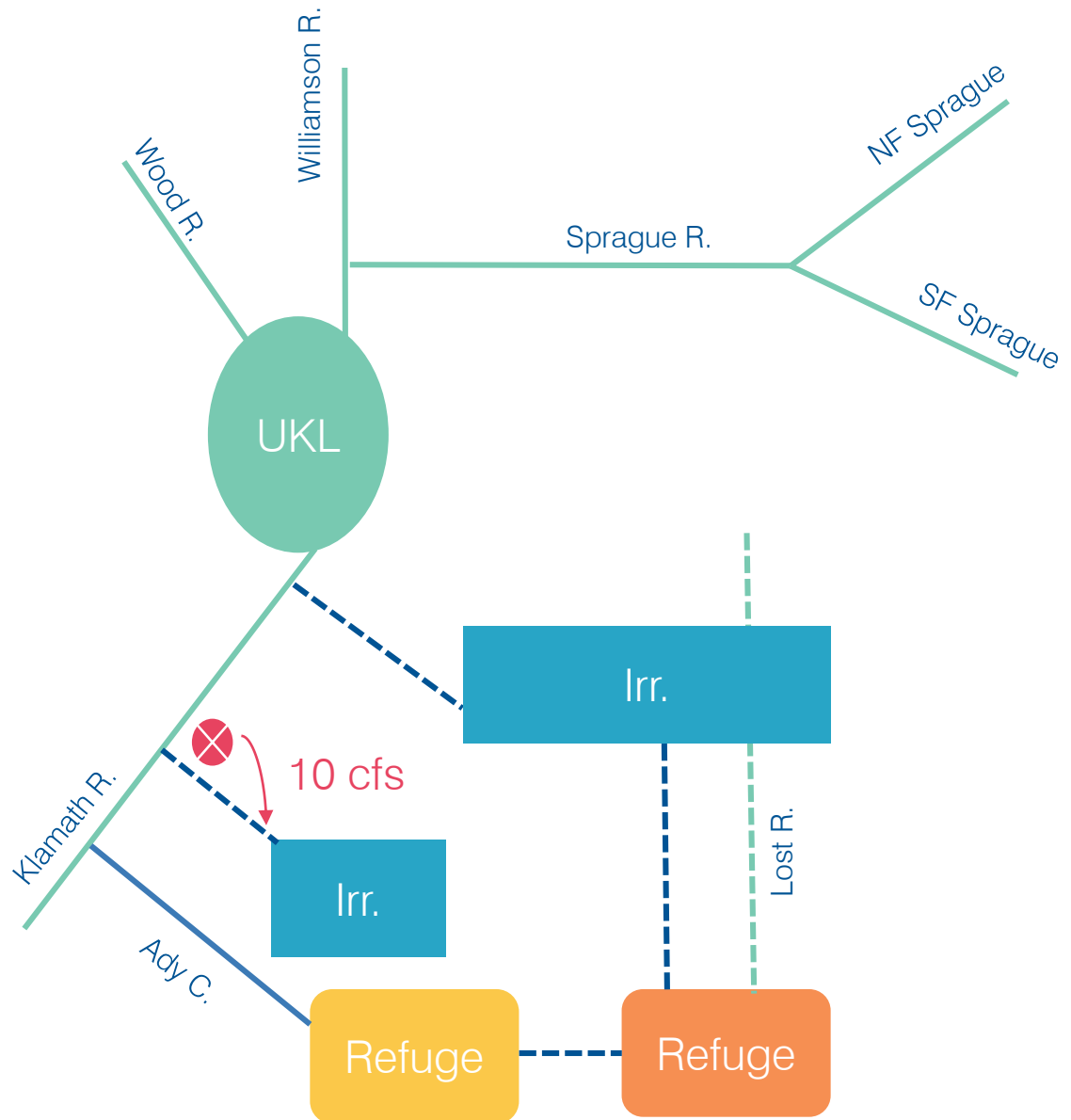
Divert from Klamath River and store water using surplus streamflow



Storage Concepts and Benefits

Late Summer:

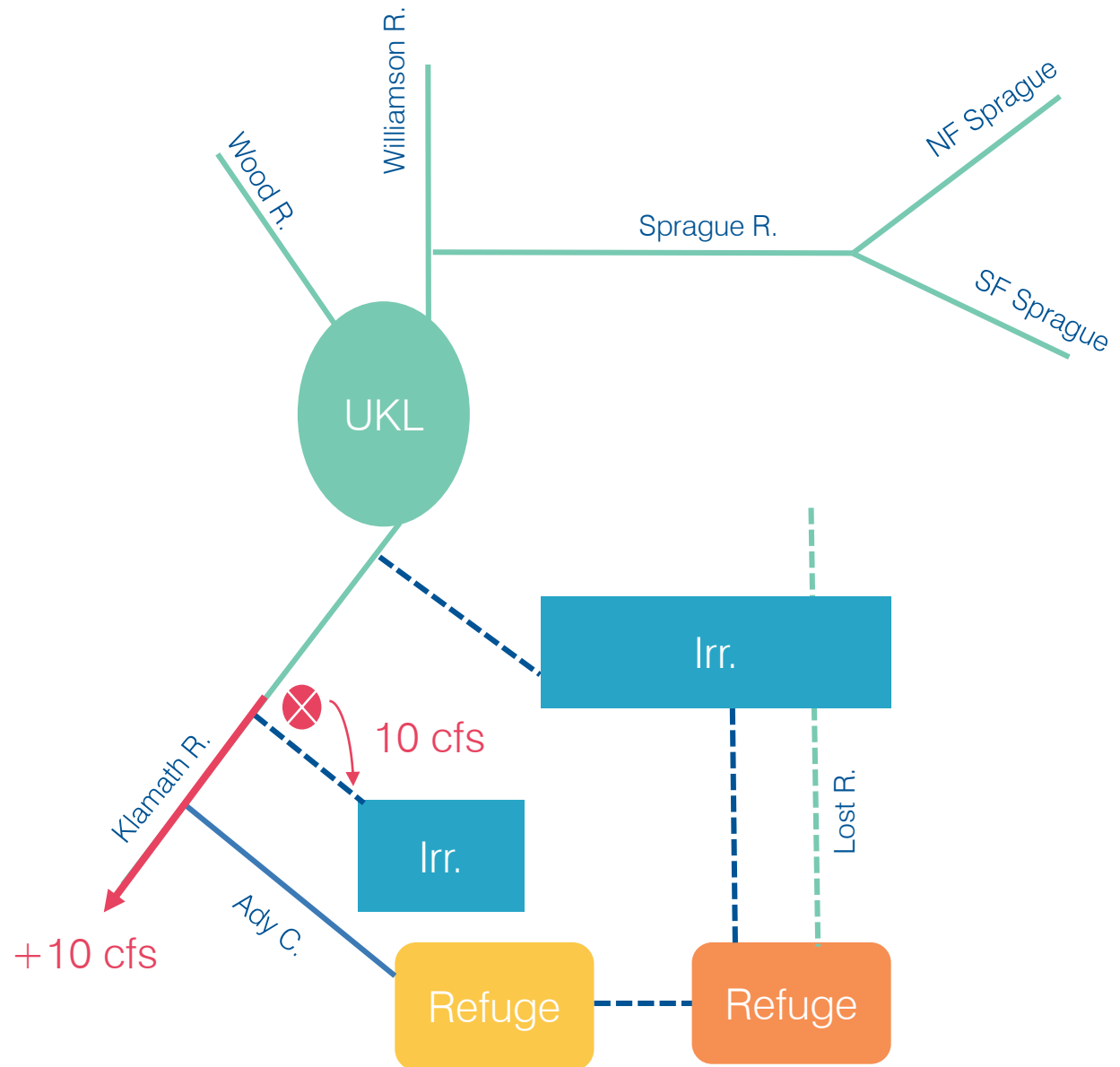
Recover water from storage and use water to meet irrigation demand



Storage Concepts and Benefits

Late Summer:

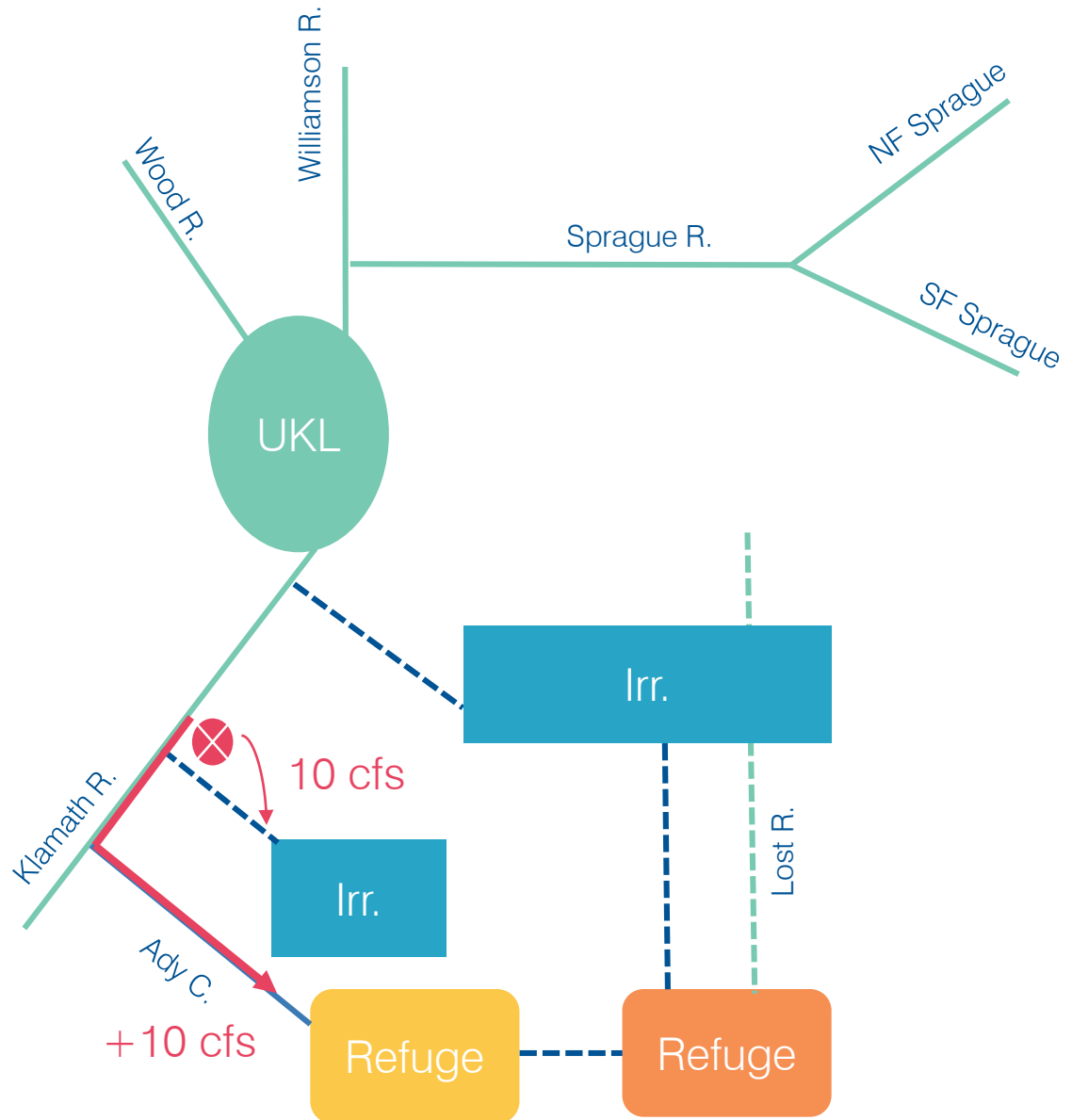
Allow water that would have been used for irrigation to remain instream in Klamath River



Storage Concepts and Benefits

Late Summer:

Or allow water that would have been used for irrigation to divert into the Refuge



Water Availability

- Regulatory: OWRD Water Availability (WARS)
 - 50% exceedance natural flow (for storage)
 - Consumptive uses + instream flow requirements
 - Bi-Op not considered
- Physical: surplus streamflow
 - Gaged flow from 2014-2018
 - Instream claims
 - Bi-Op flows
 - Scenic Waterway flows

Water Availability

Browser address bar: https://apps.wrd.state.or.us/apps/wr/klamath_sif_dashboard/Charts.aspx

Navigation tabs: Klamath Regulation Dashbo, Watermaster Basin Status, Water Resources Department K..., WR Map Tool- Intranet

Search bar: Search...

Navigation menu: WR Map Tool- Intranet, Google, iLearn, Klamath Assessor, Mapper with TL, Misc MMT, Near Realtime Streamflow..., Oregon Secretary of State ..., ORmap, OWRD GIS

Oregon Water Resources Department
Klamath Tribal Instream Claim Dashboard

Main | Help | Return | Contact Us

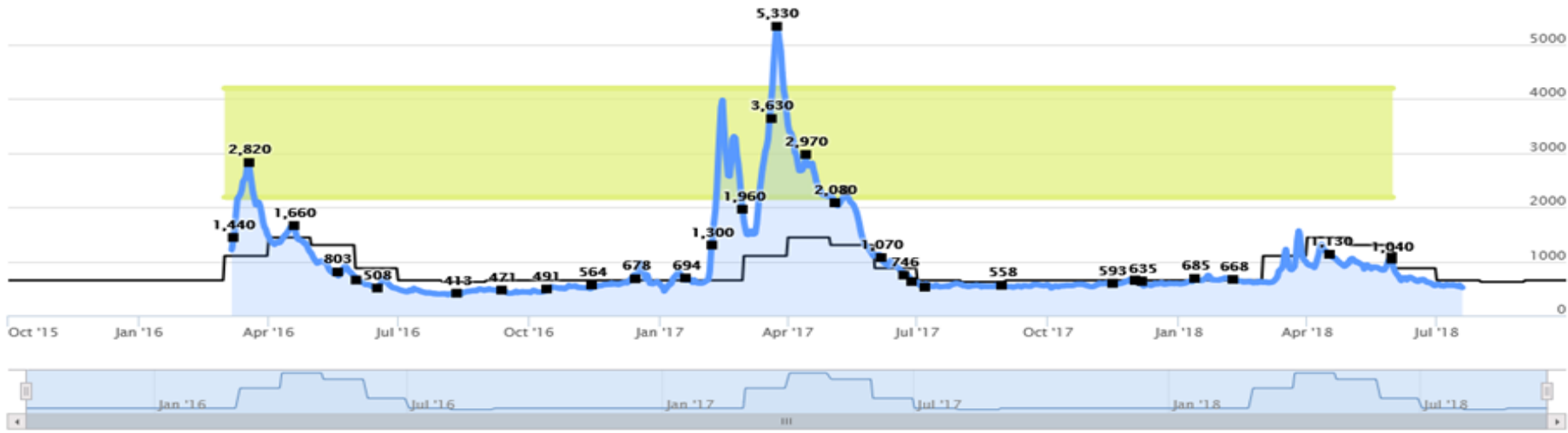
Search Records

Claim Char: Claim Nbr: Start Date: End Date:

Tool Tips Off:

Lower Williamson River (KA-625, Gaging Station: 11502550)

Zoom From To



Source: Oregon Water Resources

Water Availability

Sprague River – Gage Data

Upper Sprague - Surplus Streamflow Available (AF)
Gage 11497500; Claim KA-647

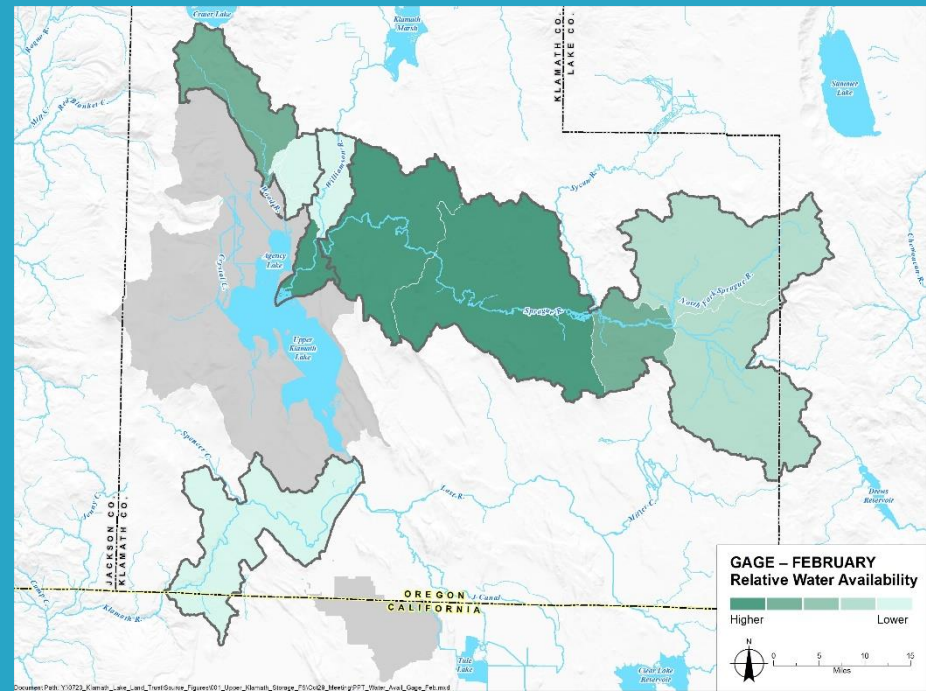
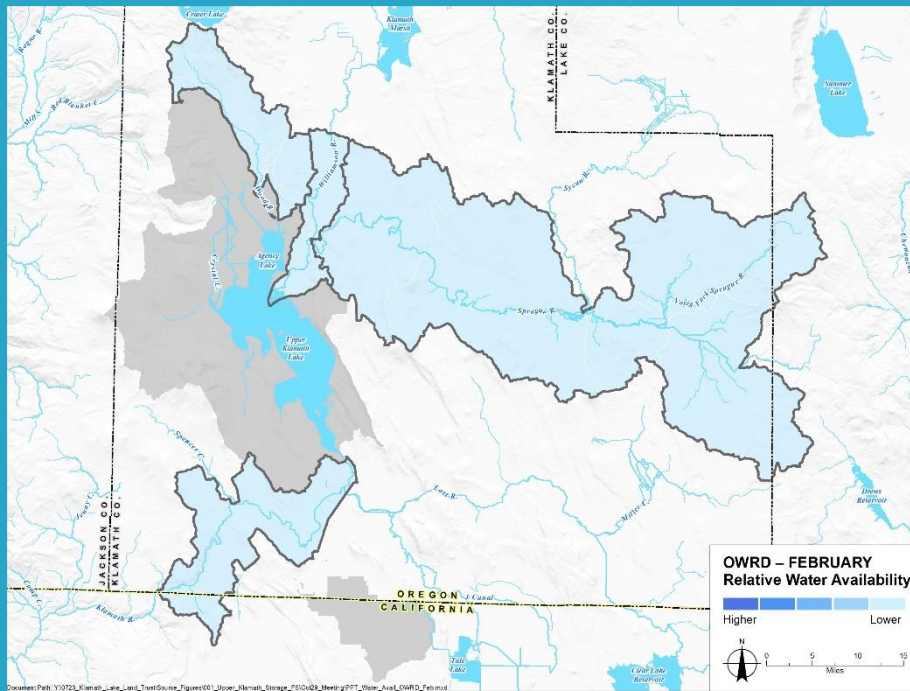
		2014	2015	2016	2017	2018
10/1	10/15	0	0	0	0	0
10/16	10/31	0	0	0	0	0
11/1	11/15	0	0	0	0	0
11/16	11/30	0	0	0	0	0
12/1	12/15	0	84	10	0	0
12/16	12/31	0	8337	80	3010	0
1/1	1/15	0	5291	0	100	0
1/16	1/31	0	4327	7952	1178	689
2/1	2/15	6	7636	9655	6100	654
2/16	2/29	6927	8832	10778	10314	0
3/1	3/15	327	0	6579	9521	0
3/16	3/31	2073	0	3967	4891	1648
4/1	4/15	0	0	2839	782	0
4/16	4/30	0	0	4318	0	0
5/1	5/15	0	0	283	1587	0
5/16	5/31	0	0	0	7937	0
6/1	6/15	0	20	0	6047	630
6/16	6/30	0	0	0	652	0
7/1	7/15	0	0	0	25	0
7/16	7/31	0	0	0	0	0
8/1	8/15	0	0	0	0	0
8/16	8/31	0	0	0	0	0
9/1	9/15	0	0	0	0	0
9/16	9/30	0	0	0	0	0
Total AF (Nov - May)		9334	34507	46461	45419	2991

Upper Sprague - Surplus Flow Days
Gage 11497500; Claim KA-647

		2014	2015	2016	2017	2018
10/1	10/15	0%	0%	0%	0%	0%
10/16	10/31	0%	0%	0%	0%	0%
11/1	11/15	0%	0%	0%	0%	0%
11/16	11/30	0%	0%	0%	0%	0%
12/1	12/15	0%	13%	7%	0%	0%
12/16	12/31	0%	100%	44%	75%	0%
1/1	1/15	0%	100%	0%	13%	0%
1/16	1/31	0%	100%	88%	69%	94%
2/1	2/15	7%	100%	100%	67%	93%
2/16	2/29	100%	100%	100%	100%	0%
3/1	3/15	13%	0%	100%	80%	0%
3/16	3/31	38%	0%	31%	44%	31%
4/1	4/15	0%	0%	73%	13%	0%
4/16	4/30	0%	0%	93%	0%	0%
5/1	5/15	0%	0%	20%	13%	0%
5/16	5/31	0%	0%	0%	75%	0%
6/1	6/15	0%	7%	0%	100%	33%
6/16	6/30	0%	0%	0%	40%	0%
7/1	7/15	0%	0%	0%	7%	0%
7/16	7/31	0%	0%	0%	0%	0%
8/1	8/15	0%	0%	0%	0%	0%
8/16	8/31	0%	0%	0%	0%	0%
9/1	9/15	0%	0%	0%	0%	0%
9/16	9/30	0%	0%	0%	0%	0%
Total Surplus Days (Nov - May)		22	77	99	83	34

*Capacity limitation of 40 cfs.

Water Availability – February



Storage: Part of the Answer

Storage of water in the basin can provide added flexibility in managing water for all stakeholders...

Storage: Part of the Answer

Storage of water in the basin can provide added flexibility in managing water for all stakeholders...

...the key is to understand the benefits and come to a common agreement on how to utilize surplus water.

Surface Storage Sites

On-channel

Pros

- Recreation
- Provides wildlife habitat
- Flood control
- No inflow conveyance

Cons

- Flood riverside wildlife habitat
- Difficult to permit
- Fish passage barrier

Off-channel

Pros

- Recreation
- Provides wildlife habitat
- Maintains fish passage

Cons

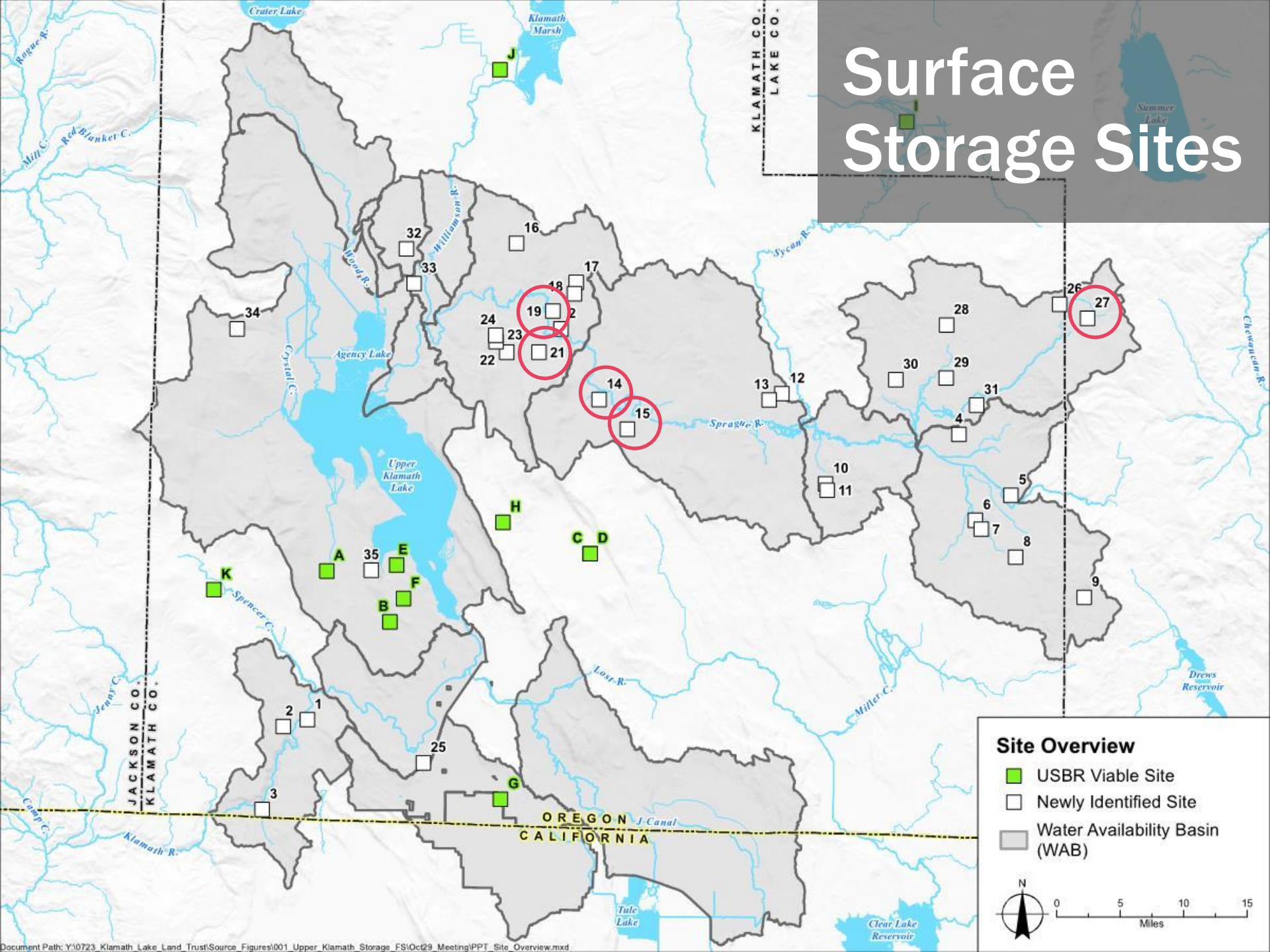
- Diversion and conveyance from water source needed

Surface Storage Sites

Key Criteria:

- Water availability assessment
- Site topography and geology
- Potential to use existing infrastructure or cost-effectively construct new infrastructure
- Cost-benefit analysis (cost per AF)
- “Unique” siting benefits/constraints

Surface Storage Sites



Surface Storage Sites

Site	Name	On- or Off-Channel?	Potential Storage Capacity (AF)	Water Availability Basin (WAB)	Earthwork (CY)	Potential Annual Storage Available in WAB (AF)	Nearest Reach/Water Body	Operational Category	Diversion
14	Trout Creek	Off	4,400	70805	185,667	30,869	Trout Creek & Sprague River	B, D	Gravity
15	Expand Riddle Field Reservoir	Off	2,400	70805	177,840	30,869	Sprague River	A	Gravity
19	East of Kamkaun Spring No. 1	Off	3,000	70806	54,833	39,416	Sprague River	A	Pump
21	Dockney Flat	Off	26,400	70806	589,708	39,416	Sprague River	A	On-channel /gravity
27	Lee Thomas Meadow	Off	2,400	70816	132,444	15,368	North Fork Sprague River	A	Pump

Subsurface Storage Sites

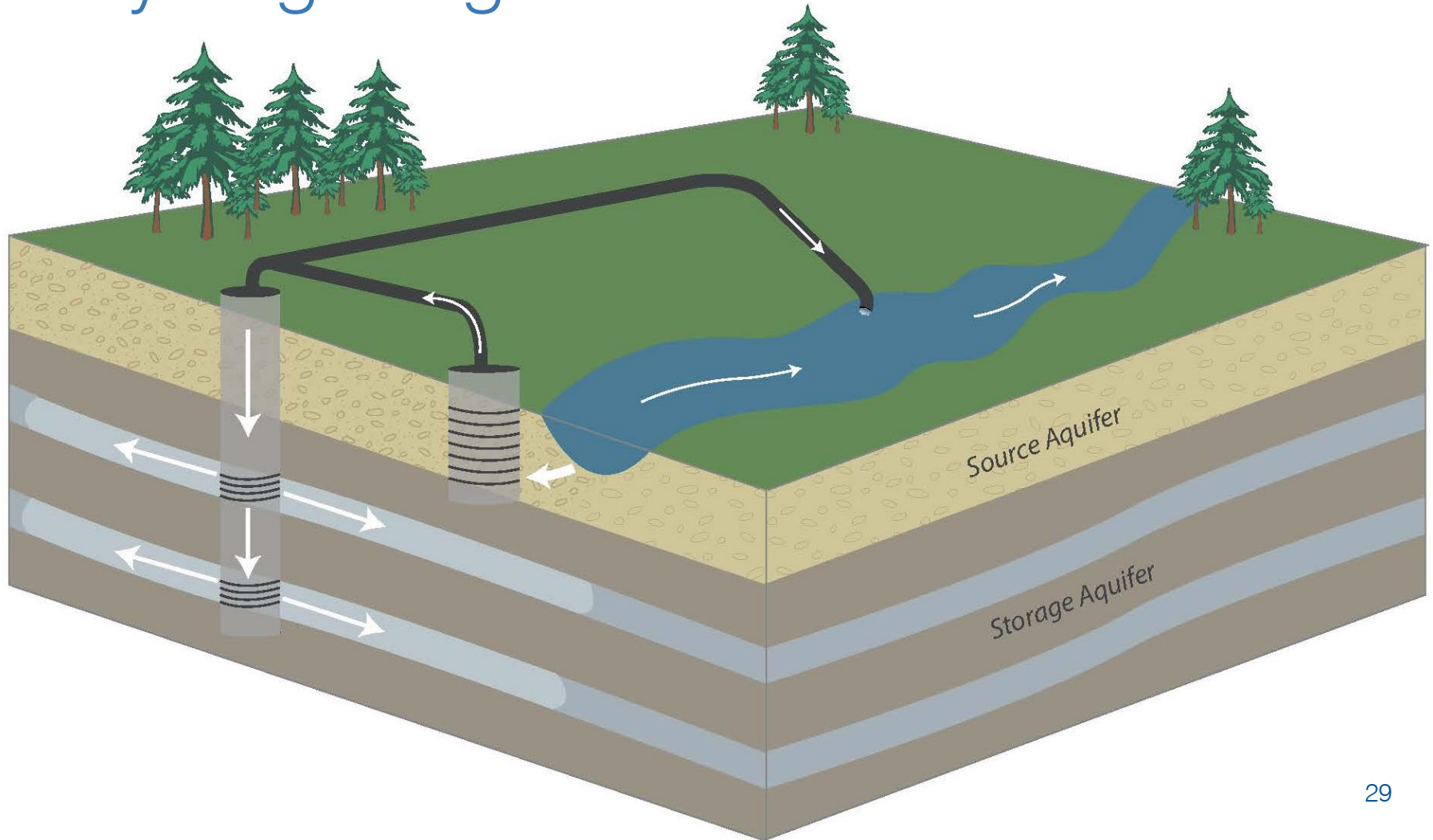
Key Criteria:

Hydrogeologic Characteristics:

- Source Aquifer
 - Productivity (transmissivity) – Rate (volume/time)
 - 10 cfs or 4,500 gallons per minute
 - Period of water availability determines volume
 - 90 days at 10 cfs = 1,800 acre-foot (587 MG)
- Storage Aquifer
 - Productivity (transmissivity)
 - Groundwater level relative to ground surface or storage space
 - Storage Volume
 - Municipal ASR projects in Oregon – 1,500 AF

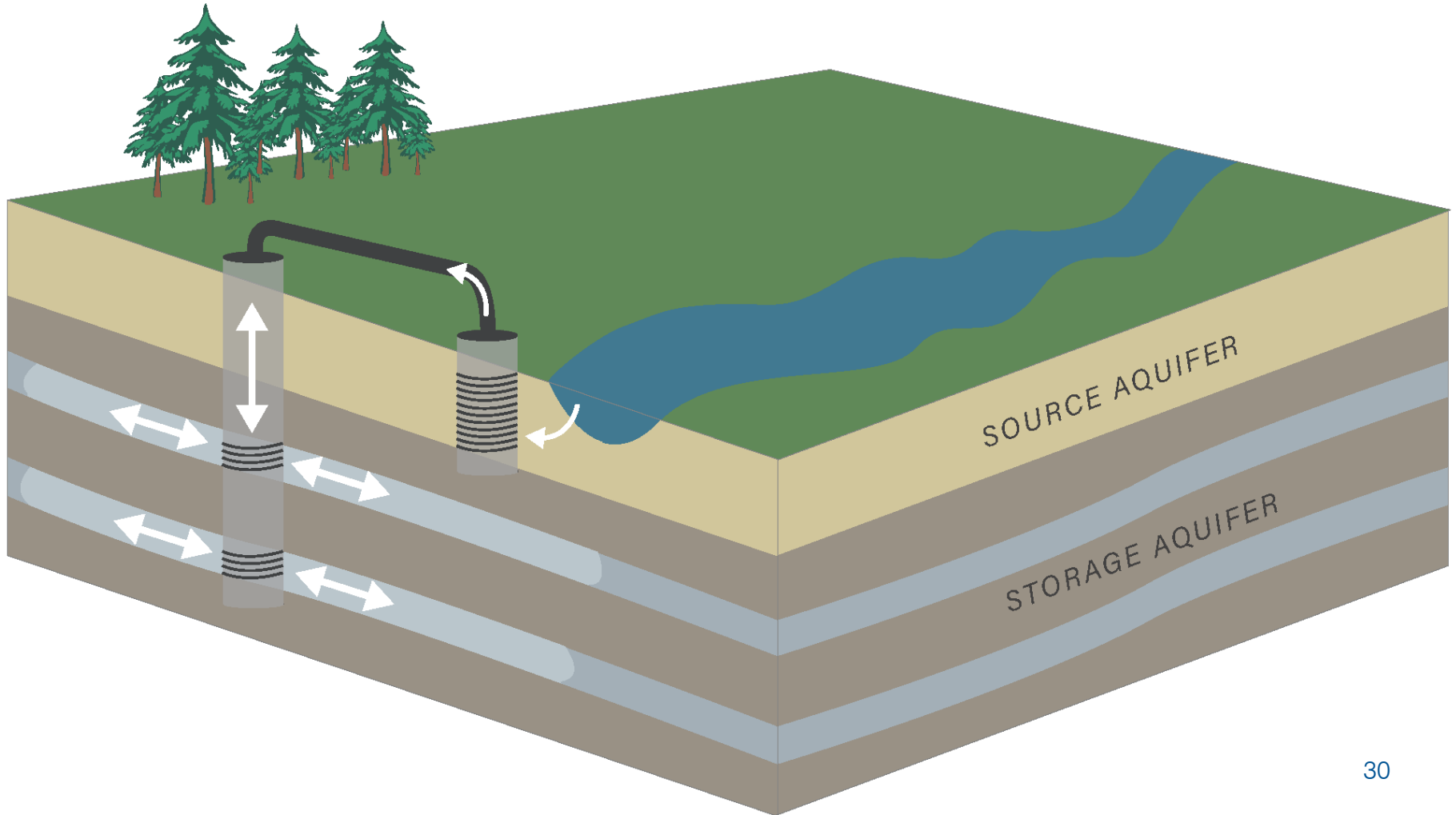
Subsurface Storage Sites

Hydrogeologic Characteristics

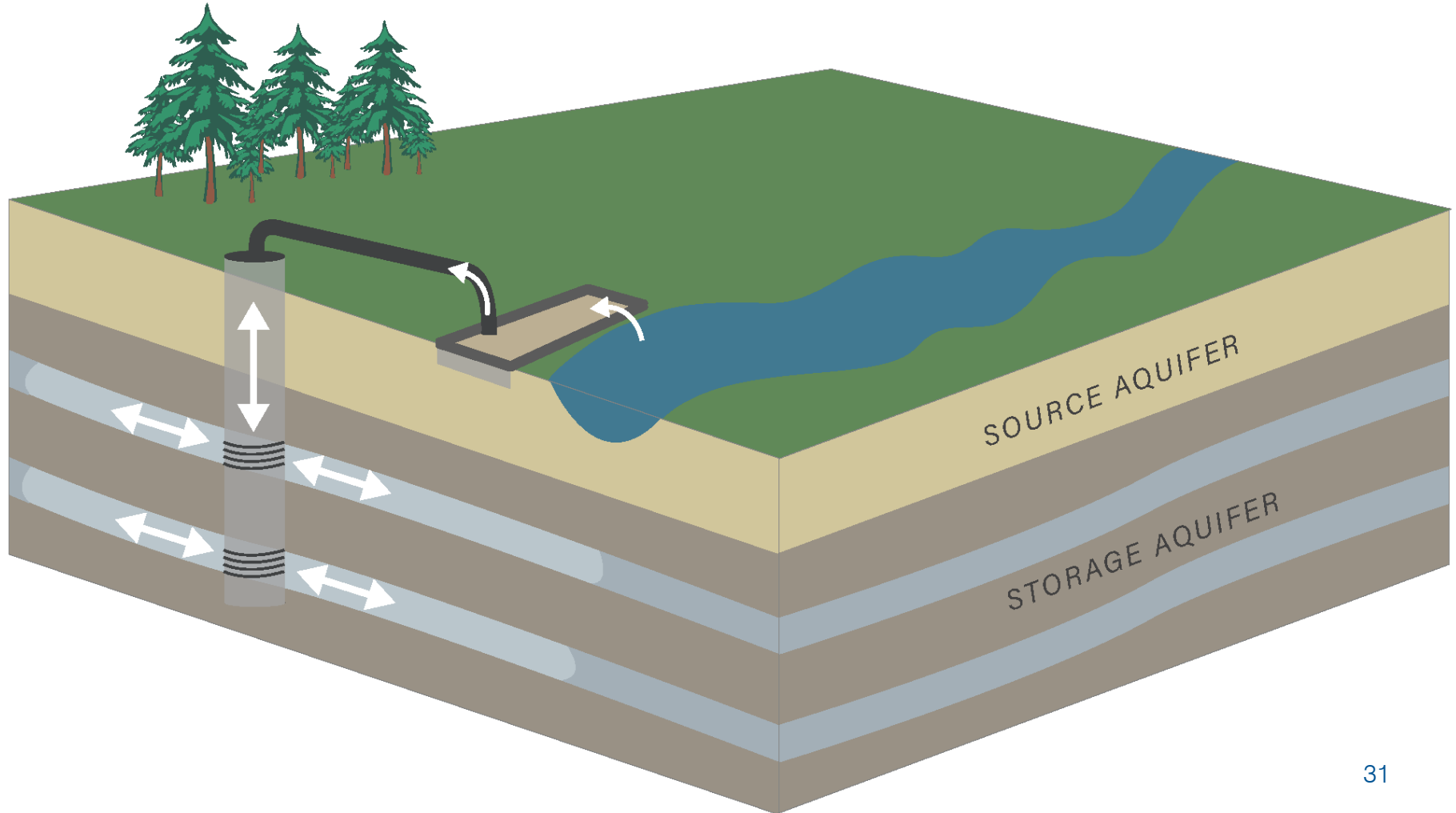


Source Water “Diversión”

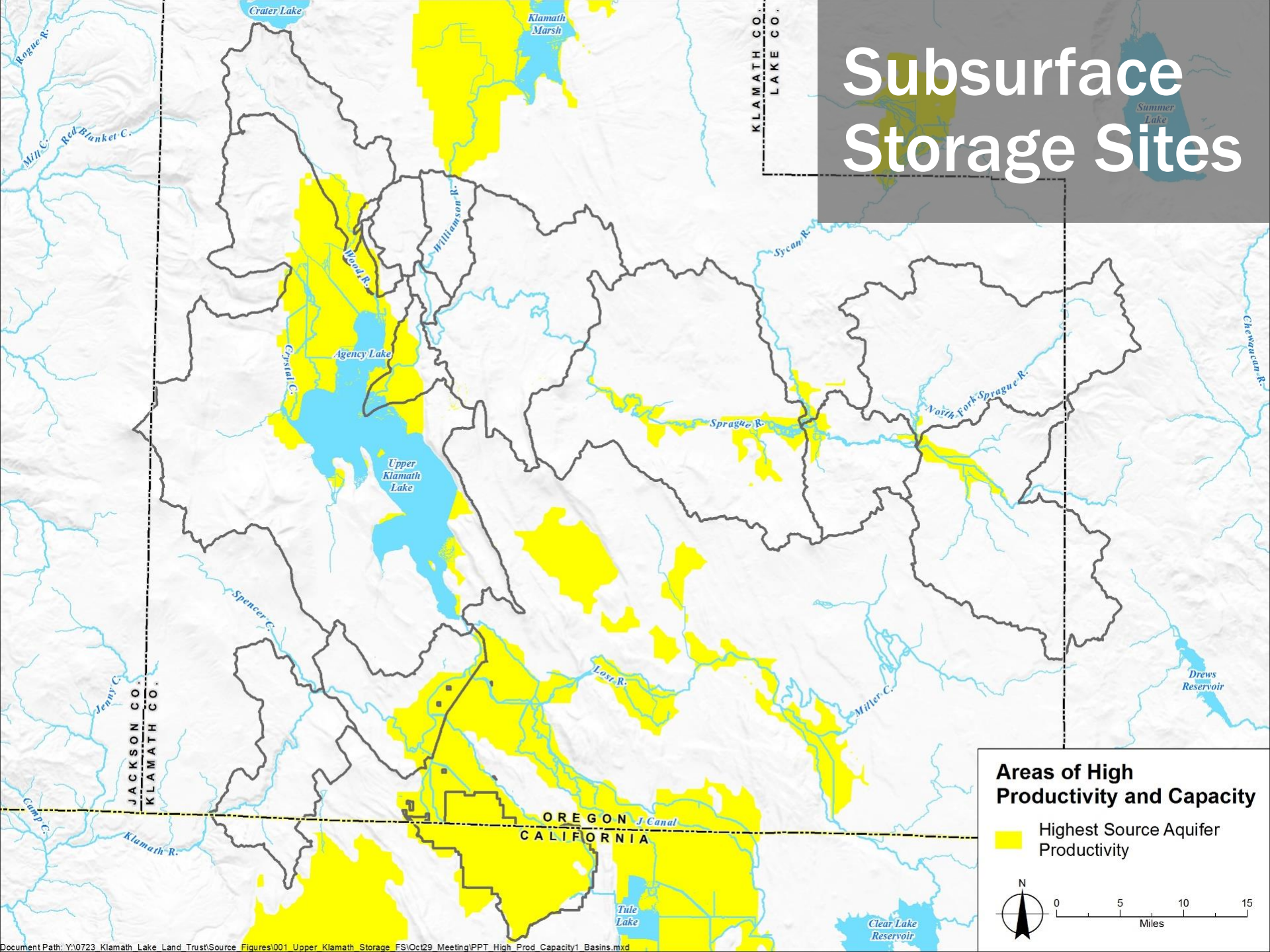
Vertical Groundwater Wells




Source Water “Diversión” Engineered Filtration System

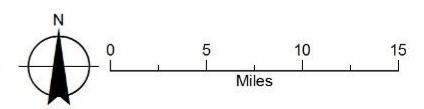


Subsurface Storage Sites

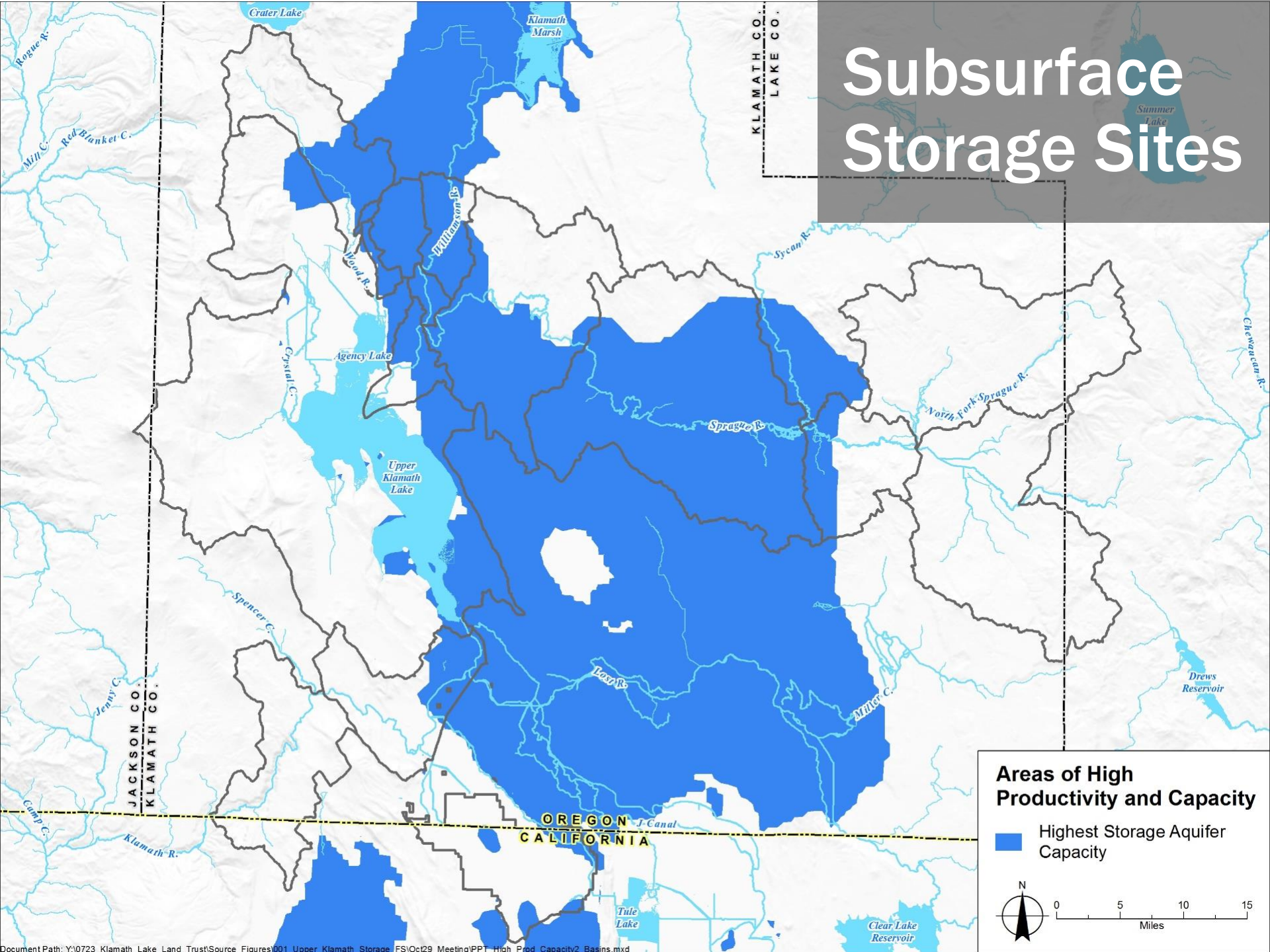


Areas of High Productivity and Capacity

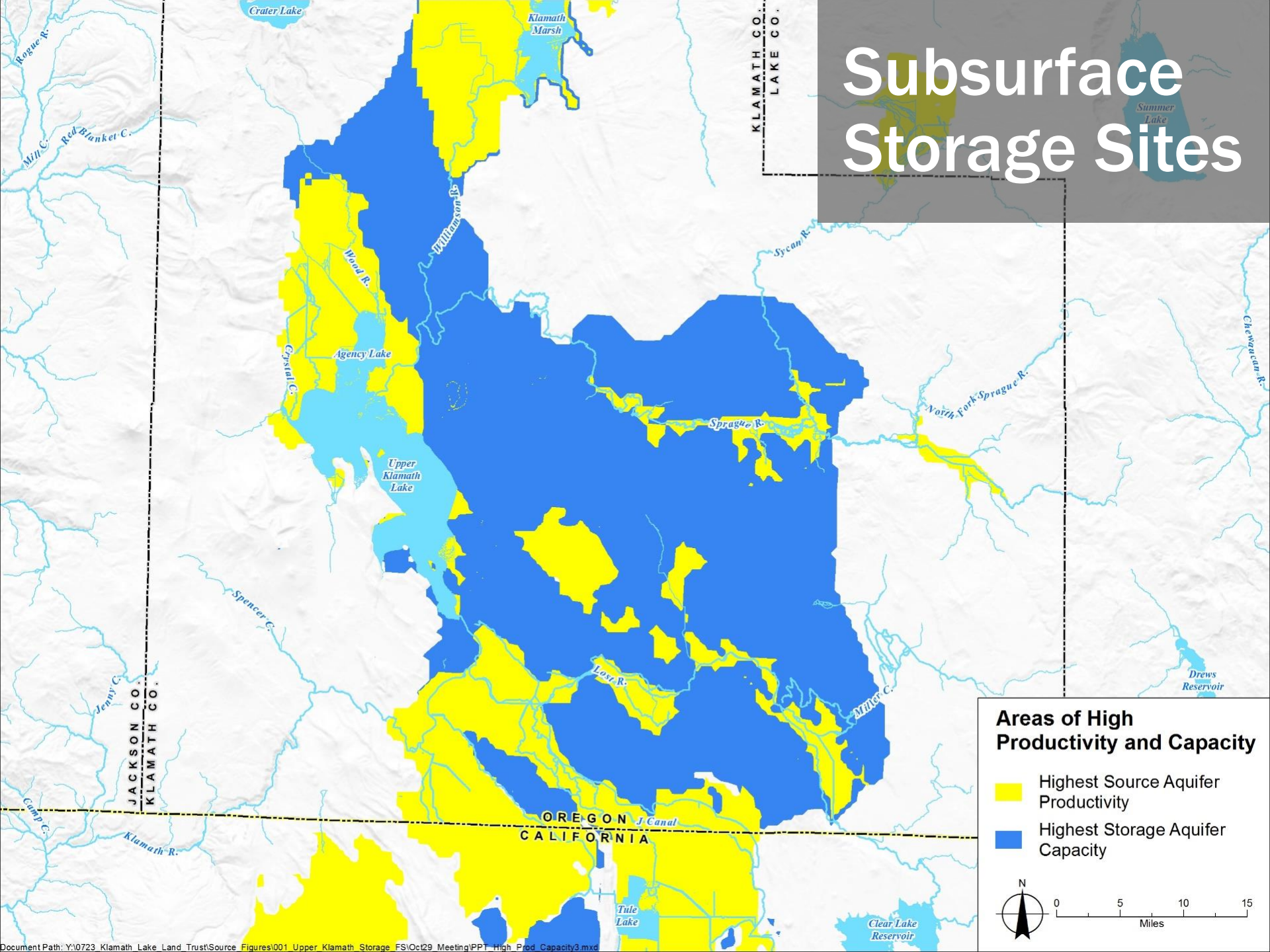
 Highest Source Aquifer Productivity



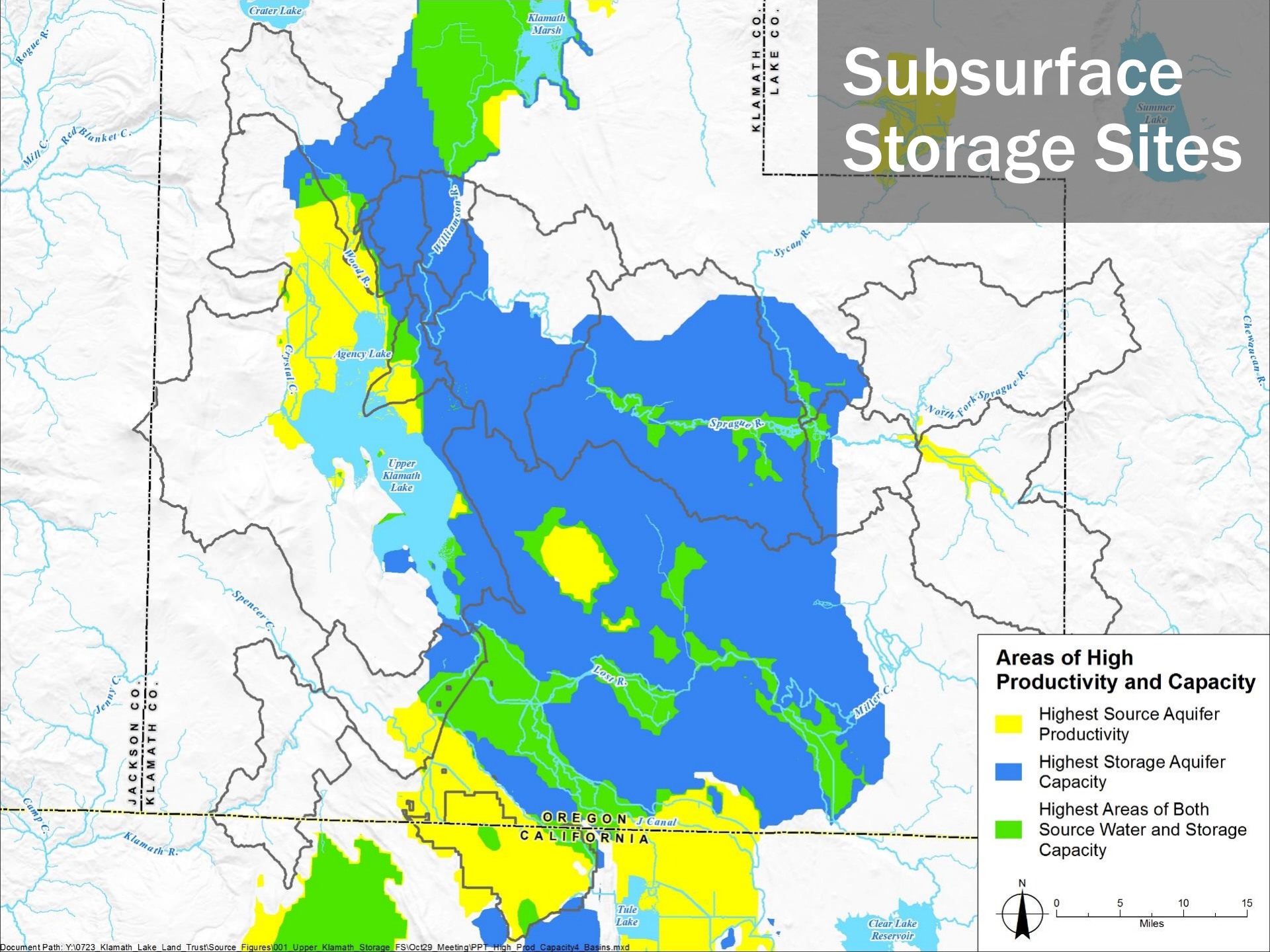
Subsurface Storage Sites




Subsurface Storage Sites

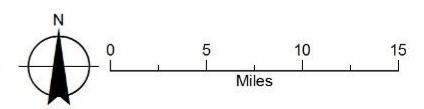


Subsurface Storage Sites

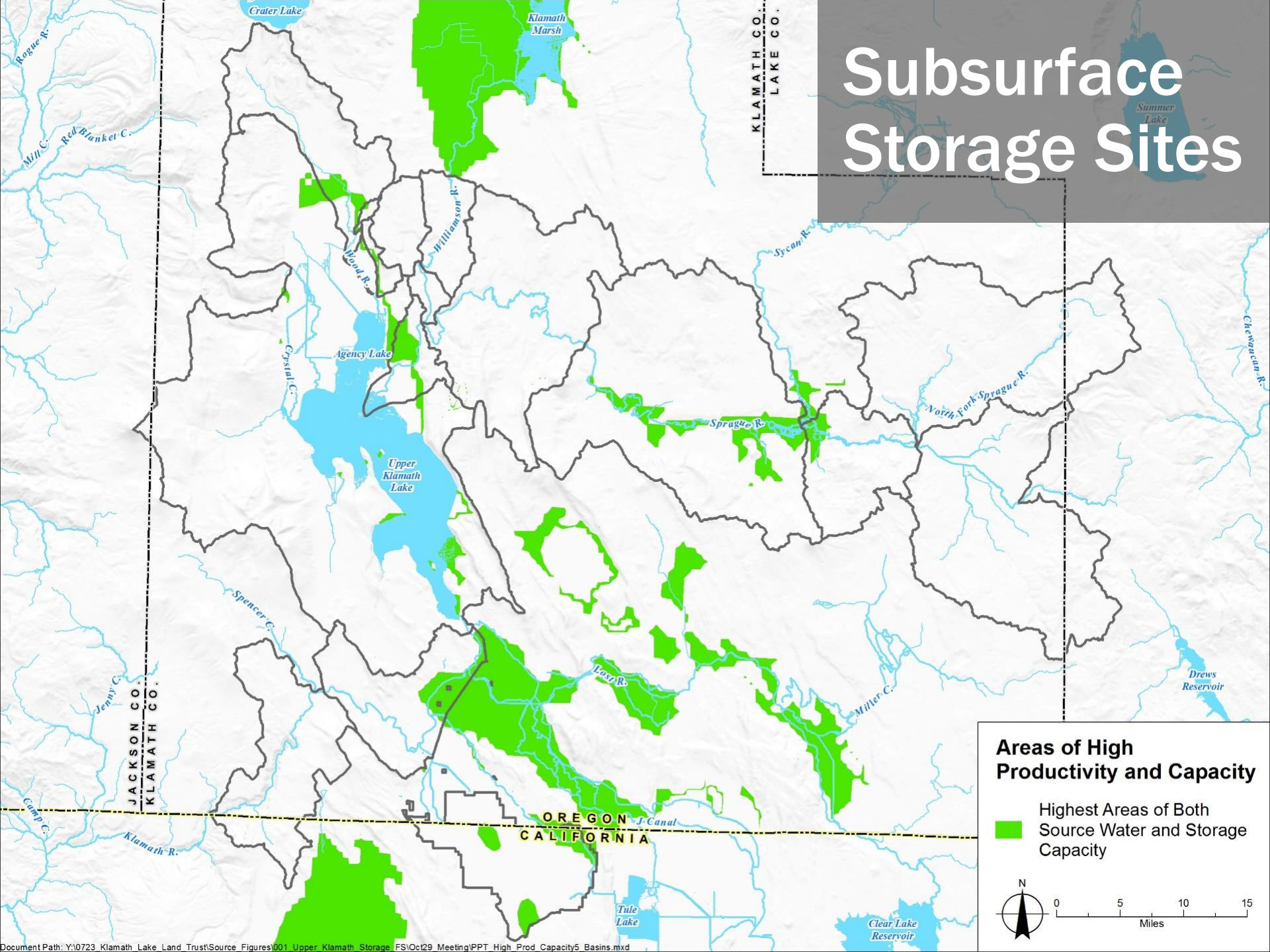


Areas of High Productivity and Capacity

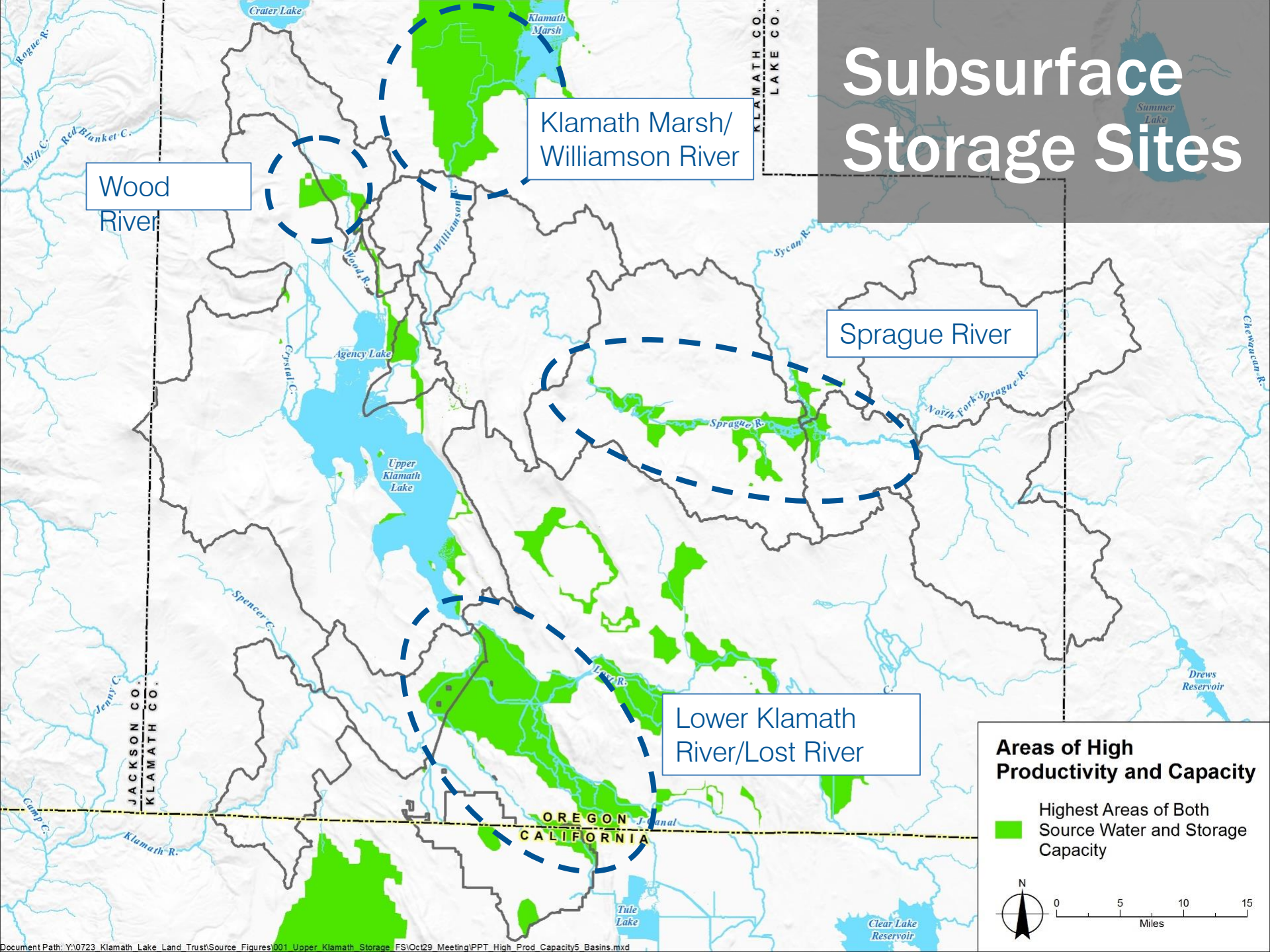
-  Highest Source Aquifer Productivity
-  Highest Storage Aquifer Capacity
-  Highest Areas of Both Source Water and Storage Capacity



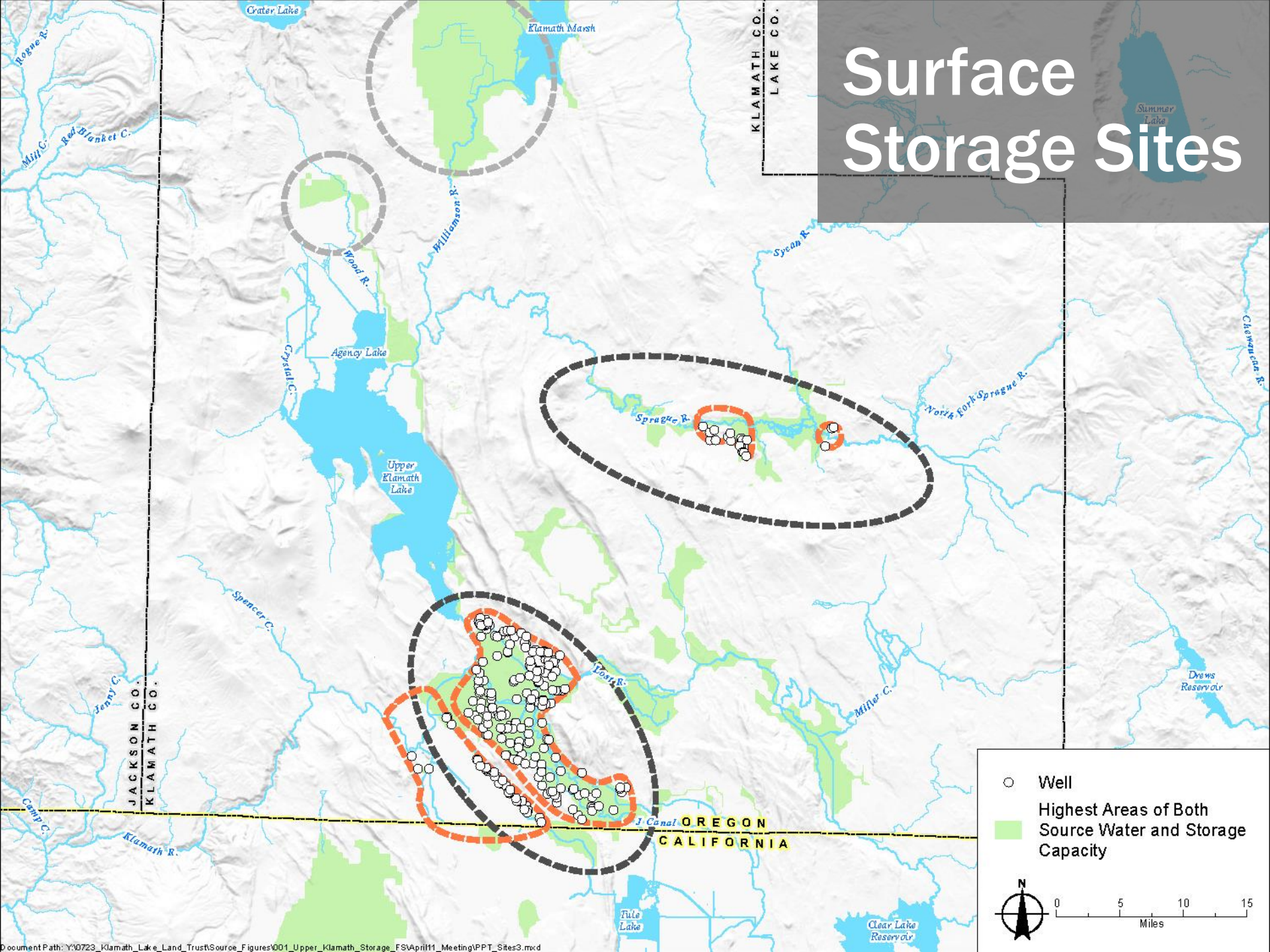
Subsurface Storage Sites



Subsurface Storage Sites



Surface Storage Sites

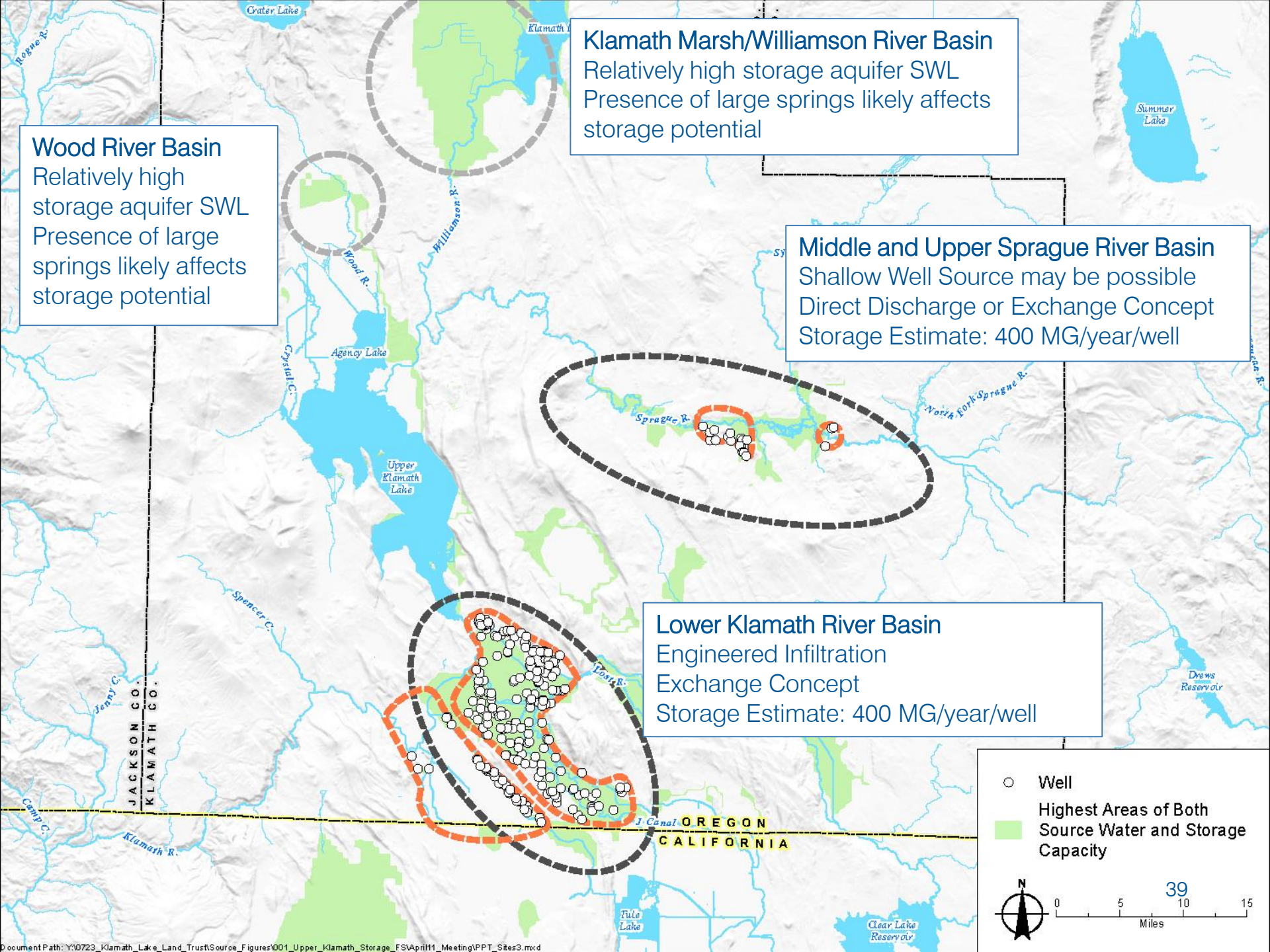


○ Well

■ Highest Areas of Both Source Water and Storage Capacity

N

0 5 10 15 Miles



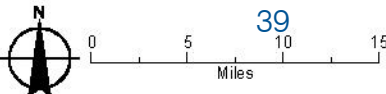
Wood River Basin
 Relatively high storage aquifer SWL
 Presence of large springs likely affects storage potential

Klamath Marsh/Williamson River Basin
 Relatively high storage aquifer SWL
 Presence of large springs likely affects storage potential

Middle and Upper Sprague River Basin
 Shallow Well Source may be possible
 Direct Discharge or Exchange Concept
 Storage Estimate: 400 MG/year/well

Lower Klamath River Basin
 Engineered Infiltration
 Exchange Concept
 Storage Estimate: 400 MG/year/well

○ Well
 Highest Areas of Both Source Water and Storage Capacity



Storage Opportunities

Surface and subsurface storage opportunities exist in the Upper Klamath Basin...

Storage Opportunities

Surface and subsurface storage opportunities exist in the Upper Klamath Basin...

...a focus on smaller, dispersed storage can allow added flexibility and incremental implementation.

Summary

- Surplus water appears available but *depends on agreements* on application of tribal claims, scenic waterway flows, and future Bi-Op modifications
- Storage site selection depends in part on how stakeholders *prioritize relative needs/benefits*
- Sites provide *dispersed storage* options that provide flexibility in managing flow benefits
- Subsurface storage provides potential for *incremental implementation of significant storage volumes*

Next Steps

- Seek continued funding and partnerships
- Confirm legal and regulatory requirements
- Complete pilot studies
- Pursue incremental implementation



Thank you.

Extra slides

Storage Operations and Benefits

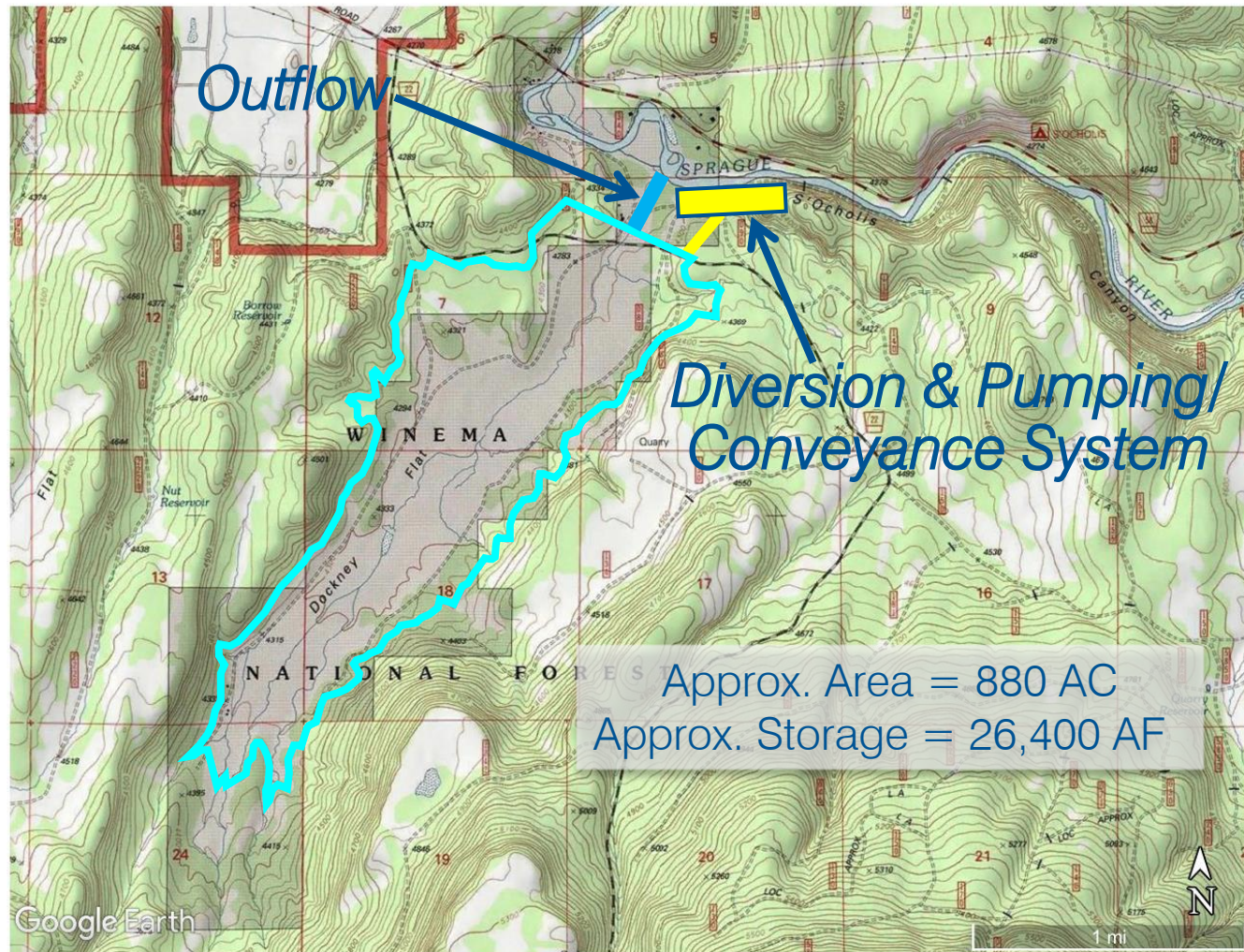
ID	Source	Storage			Recovered Water To*	"Exchanged Flow" To	Prioritization of Benefits				Comments
		Surface	Subsurface	Refuge			IRR	LKR	UKL	NWR	
L1	Lower Klamath R.		●		IRR	LKR	●	●	○	○	No flow diverted into NWR.
L2	Lower Klamath R.		●		IRR	NWR	●	◐	○	●	ET losses and water temp. increase from NWR prior to returning to LKR.
U1	Sprague R.	●	●		IRR	SPR, UKL, LKR	●	◐	●	○	ET losses and water temp. increase from UKL; no flow diverted into NWR.
U2	Sprague R.	●	●		IRR	SPR, UKL, NWR, LKR	●	◐	●	◐	ET losses and water temp. increase from UKL and from NWR prior to returning to LKR.
R1	Lower Klamath R.			●	NWR	LKR (return)	○	◐	◐	●	Higher flow returns from NWR in spring can offset need to release from UKL.

* Recovered water could be returned directly to stream rather than utilizing for irrigation under an "exchange" operation.

Thermal conditions of groundwater is a factor in deciding whether the recovered water is returned directly to stream.

Surface Storage Sites

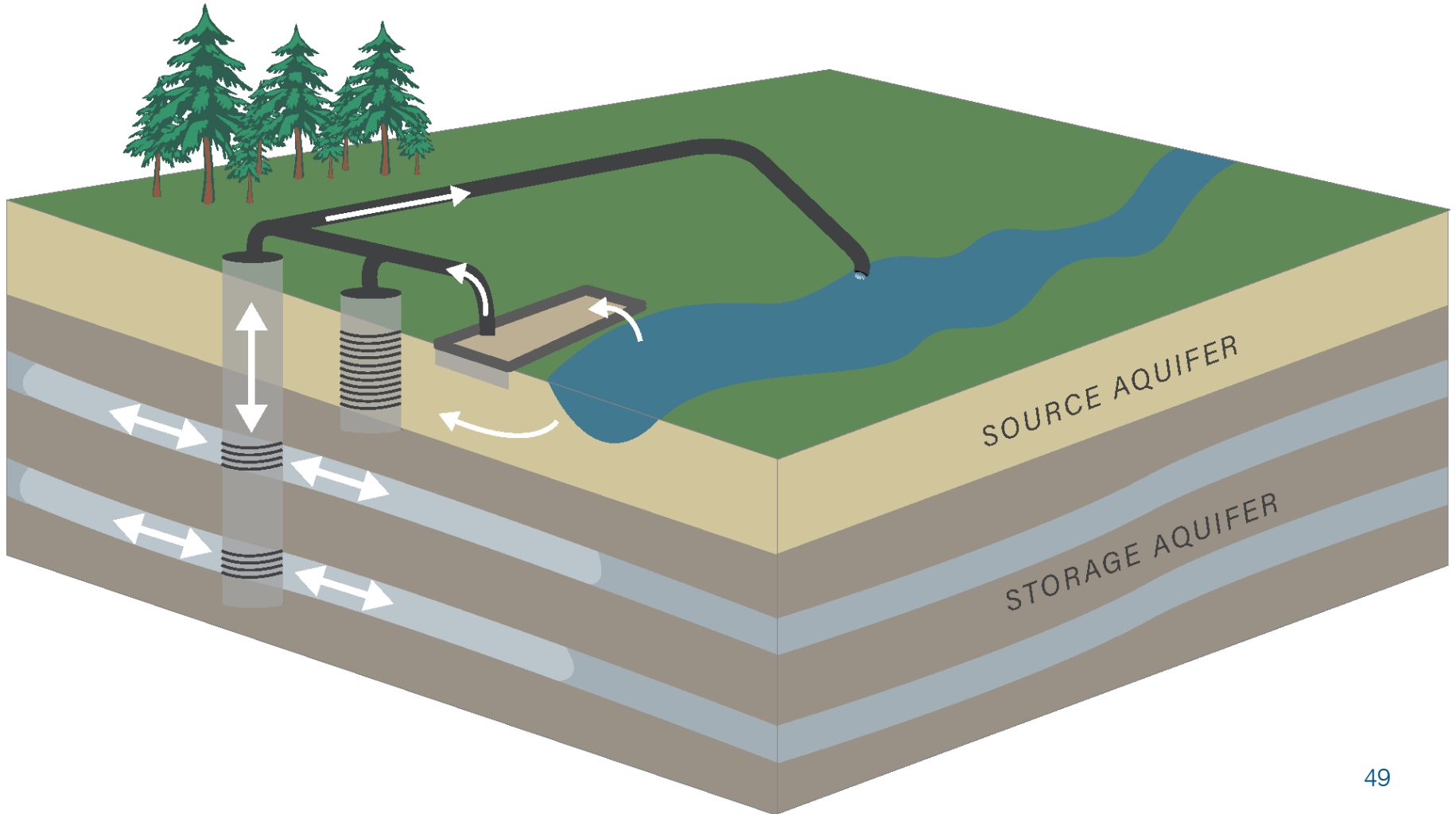
Category A
Example – #21
Dockney Flat



Subsurface Storage Sites

- Middle and Upper Sprague River
 - Source Aquifer – Alluvial and localized volcanics
 - 100 gpm to 500 gpm
 - Vertical wells may be possible
 - Storage Aquifer – Basaltic volcanics
 - Up to 4,000 gpm
 - Static water levels in decline in some locations
 - Estimated storage: up to *400 MG (1,200 AF) per year per well
 - Lower Klamath River
 - Source Aquifer – Alluvial and localized volcanics
 - 10 gpm to 50 gpm
 - Vertical wells unlikely, engineered infiltration/treatment possible
 - Storage Aquifer – Basaltic volcanics
 - Up to 10,000 gpm
 - Static water levels in decline in some locations
 - Estimated storage: up to *400 MG (1,200 AF) per year per well
 - Geothermal (up to 120 degrees F)
- *based on 50 day water availability for storage period

Direct Discharge of Stored Water



Exchange of Stored Water

