DRBC Storage Study Update

Advisory Committee on Climate Change: October 12, 2022

Chad Pindar, P.E.

Manager, Water Resource Planning Section

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

DRBC Storage Study Update

Advisory Committee on Climate Change: October 12, 2022

* Mott MacDonald contract executed on April 9, 2021 ($649,000, ends June 30, 2022)

* In early June 2022 – DRBC & MM extended the contract to December 31, 2022

* DRBC webpage for the project:

https://www.nj.gov/drbc/programs/flow/reservoir-storage-study.html

* Initial Screening Workshop – July 21, 2021
* Second Screening Workshop – November 18, 2021
* First draft of final report transmitted to DRBC – August 15, 2022

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

DRBC Storage Study Update

Advisory Committee on Climate Change: October 12, 2022

Goal: to explore the feasibility of additional freshwater storage to meet future water availability, climate adaptation, drought management and flow management needs in the Delaware River Basin.

Objectives: Identify, inventory and evaluate the feasibility of options that could provide the following additional usable storage:

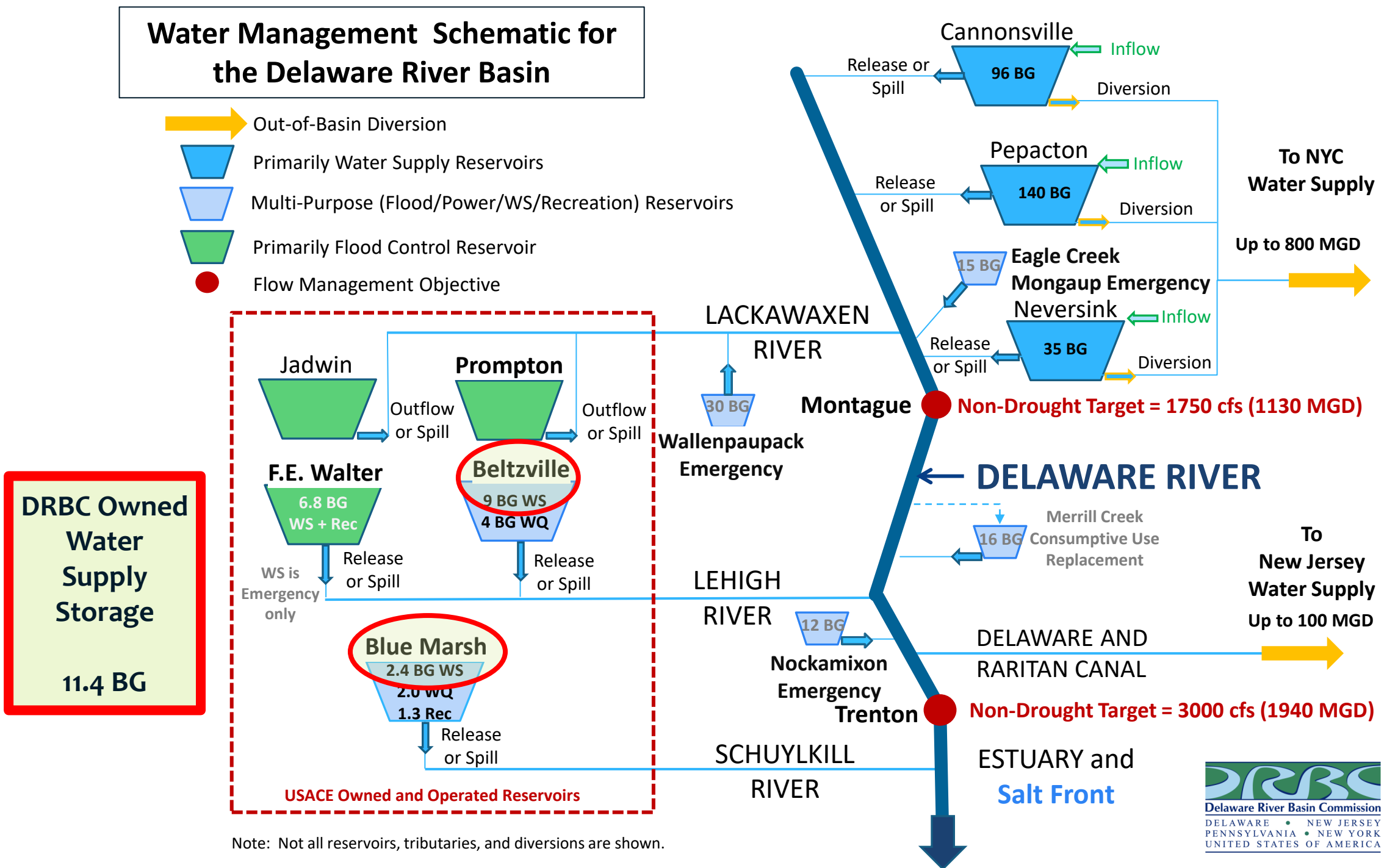
- A minimum of 1 billion gallons (BG),
- A minimum of 5 BG,
- A minimum of 10 BG
- A minimum of 20 BG

(The storage volumes can be met by a combination of projects/sources.)

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

The DRBC has not made a determination of the need for additional storage within the basin. The study is a planning level inventory of potential options that would be available if the DRBC determines that additional storage is needed in the future.

Water Management Schematic for the Delaware River Basin



Note: Not all reservoirs, tributaries, and diversions are shown.

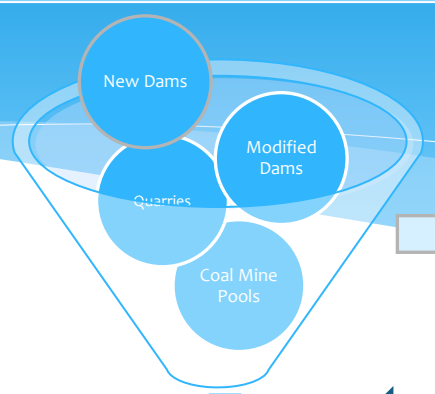
Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

DRBC Storage Study Update

Advisory Committee on Climate Change: October 12, 2022

Supplemental Screening

GATE 1A:
MANDATORY CRITERIA
Culling by Size
Screening with Limited Data



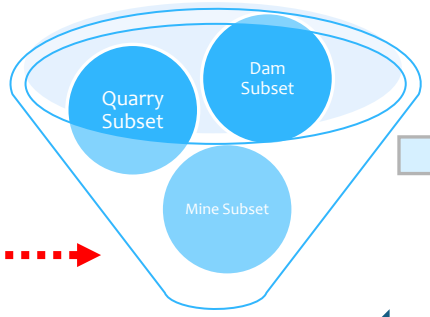
Site not Viable

OPTIONS DISCARDED BASED ON CULLING AND TECHNICAL ISSUES

Additional Staff Input on Workshop #1 Details (Additional Screening)

GATE 1B:
SUPPLEMENTARY CRITERIA
SEMI-QUANTITATIVE ASSESSMENT

Storage Opportunity Research
- Specific storage details
- Owner/Operator Interface
- Further details from cross referenced databases
- Early concept development



Site not Viable

OPTIONS DISCARDED BASED ON SEMI-QUANTITATIVE SCREEN AND TECHNICAL ISSUES

Additional Staff Input

REDUCED DATASET FOR DETAILED EVALUATION

CONCEPT STORAGE OPPORTUNITIES

PRIORITIZED PROJECTS

~ 40 projects

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

DRBC Storage Study Update

Advisory Committee on Climate Change: October 12, 2022

1. New dams

- 21 Previously Studied Dams + Various Team identified
- 5 high potential new dams
- 2 “New” identified sites

2. Modification to existing dams:

- 24 Candidate Sites
- 16 high potential sites

3. Quarries:

- 1,300 Quarries in 3 states
- 33 potential sites

4. Deep Mines:

- 31 Mine Pools in DRB
- 5 high potential sites

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

DRBC Storage Study Update

Advisory Committee on Climate Change: October 12, 2022

New Dams

PREVIOUSLY IDENTIFIED SITES FOR NEW DAMS

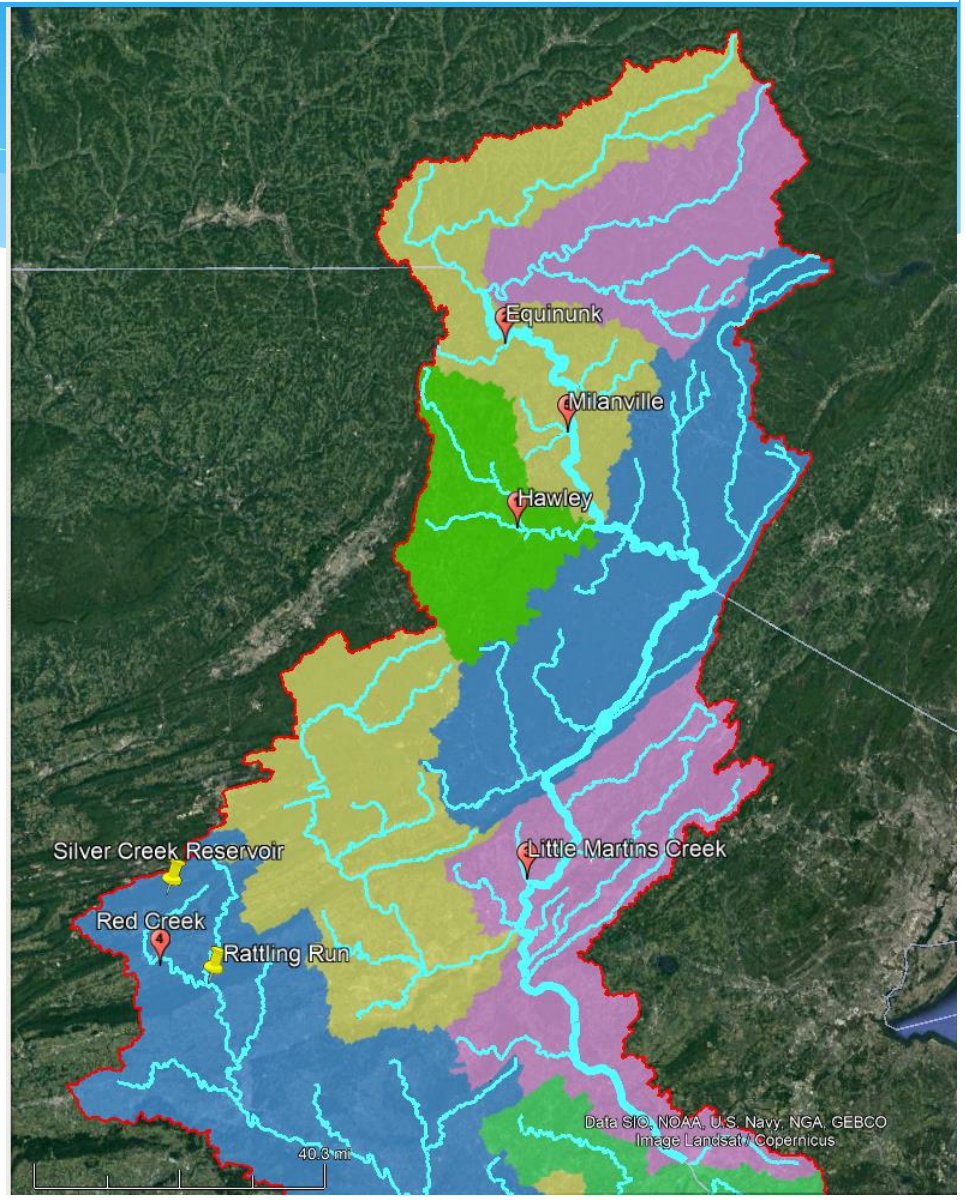
Map key	Project Name	County	Subwatershed	New Capacity, BG	Flooded Area, ac
1	Hawley	Wayne	Lackawaxen	?	394
2a	Equinunk (small)	Wayne	Upper DR	10	485
2b	Equinunk (large)	Wayne	Upper DR	43	1358
3	Little Martins Creek	Northampton	Middle DR	29	1122
4	Red Creek	Schuylkill	Schuylkill	26	1282
5	Milanville	Wayne	Lackawaxen	43	1979

NEW SITES FOR NEW DAMS

6 - Silver Creek

7 - Rattling Run

Carried 7 concepts forward.



Delaware River Basin Commission

DELAWARE • NEW JERSEY

PENNSYLVANIA • NEW YORK

UNITED STATES OF AMERICA

DRBC Storage Study Update

Advisory Committee on Climate Change: October 12, 2022

Existing Dams

Existing Dams are being evaluated for both "Dam Raising" and "Purchase/Lease" of existing storage.

	NAME	STATE	COUNTY	CURRENT MAX STORAGE, BG	OWNER	OWNER TYPE
	MERRILL CREEK	NJ	WARREN	15	MERRILL CRK GROUP	POWER COS
	MONGAUP SYSTEM	NY	SULLIVAN	5	EAGLE CREEK	POWER CO
	CANNONSVILLE	NY	DELAWARE	141	NYCDEP	PUBLIC WATER
	PENN FOREST	PA	CARBON	9	BETHLEHEM	PUBLIC WATER
	WILD CREEK	PA	CARBON	6	BETHLEHEM	PUBLIC WATER
	LAKE ONTELAUNEE	PA	BERKS	7	READING	PUBLIC WATER
	STILL CREEK	PA	SCHUYLKILL	4	TAMAQUA WATER	PUBLIC WATER
	GREEN LANE RES	PA	MONTGOMERY	8	AQUA PA	PRIVATE WATER
	PROMPTON	PA	WAYNE	24	USACE	FEDERAL
	BLUE MARSH	PA	BERKS	42	USACE	FEDERAL

Carried ~10 concepts forward.

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

DRBC Storage Study Update

Advisory Committee on Climate Change: October 12, 2022

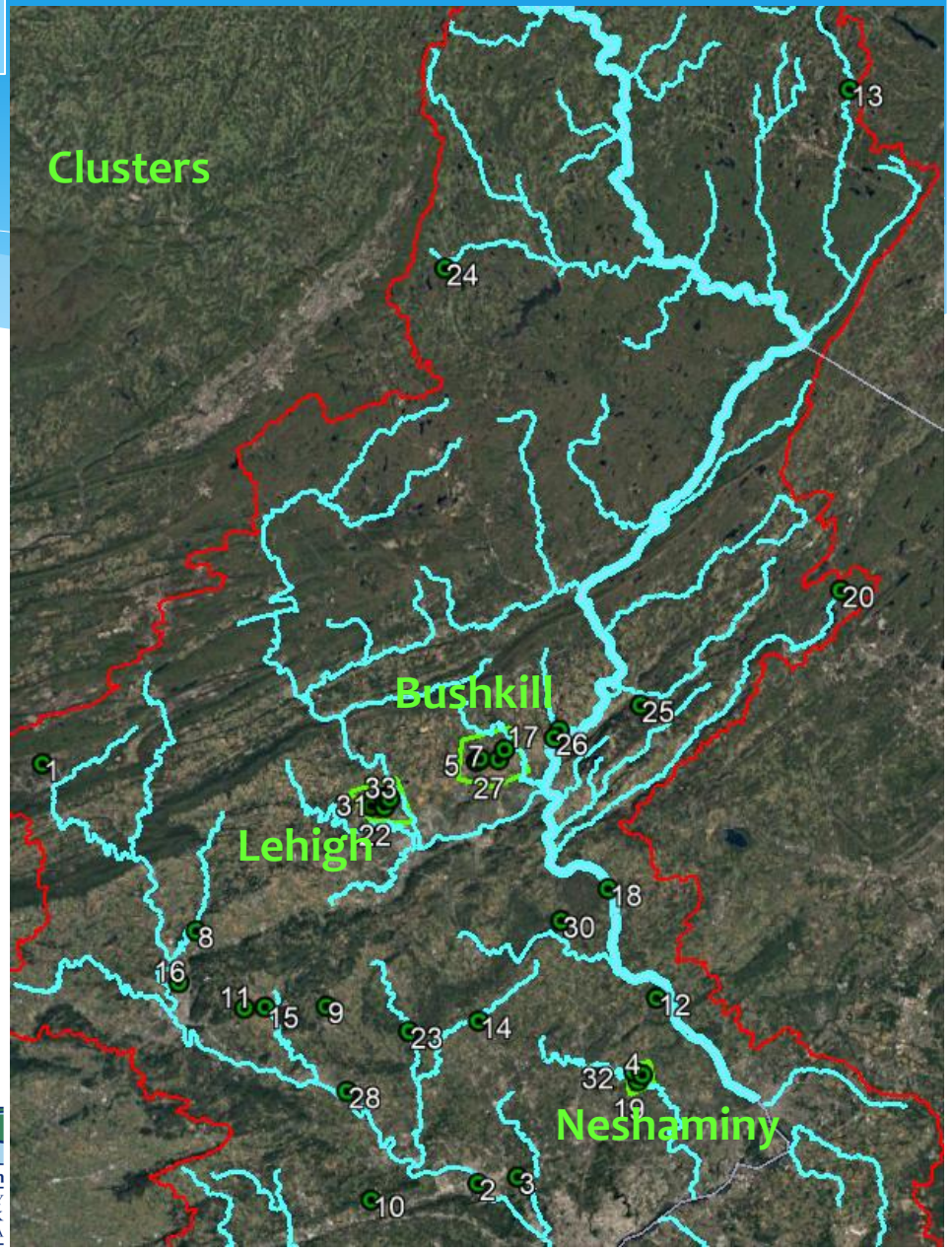
Quarries

Started with >1,300 sites

Screened down to ~ 33 based largely on volume

three "clusters" have emerged

Carried ~19 concepts forward.



Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

DRBC Storage Study Update

Advisory Committee on Climate Change: October 12, 2022

Mines

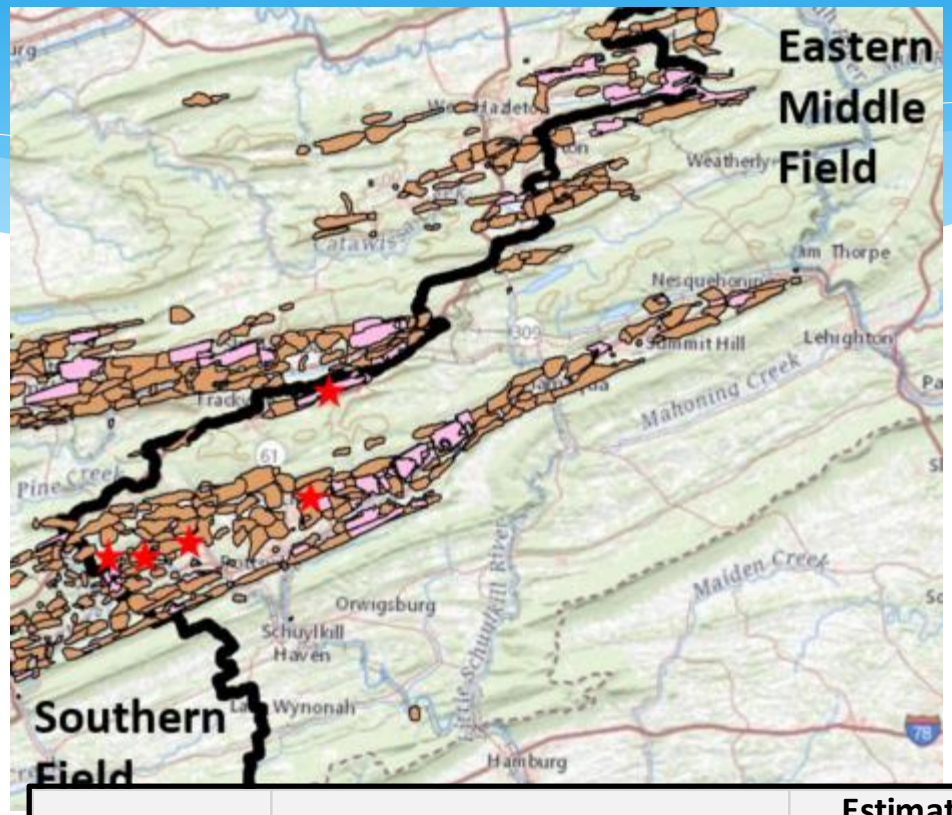
Reviewed existing information from PADEP, USBM, EPCAMR, Schuylkill Headwaters Association, SRBC

Begin to develop project concepts.

Carried 5 concepts forward.

South Anthracite Field						Eastern Middle Anthracite Field					
Key	Pool	Vol. (gal)				Key	Pool	Vol. (gal)			
1	Tamaqua Lands (S)	800,000,000				24	Audenreid	241,844,000			
2	Tamaqua Lands (N)	312,000,000				25	Spring Brook	5,880,000			
3	Mary D	400,000,000				26	Tresckow	17,280,000			
4	Kaska	600,000,000				27	Tresckow #21	84,240,000			
5	Silver Creek	1,774,000,000	X			29	Coleraine	67,860,000			
6	Eagle Hill	727,000,000				29	Evans	20,160,000			
7	Palmer Vein	400,000,000				31	Silver Brook	683,000,000			
8	Bear Ridge	40,000,000					**Total**	**1,120,264,000**			
9	Pine Fores	419,000,000									
10	Wadesville	3,582,000,000	X								
11	Pottsville East	125,000,000				**Western Middle Anthracite Field**					
12	Pine Knot #1	600,000,000				**Key**	**Pool**	**Vol. (gal)**			
13	Thomaston	784,000,000				#Morea		2,679,000,000	#	X	
14	Richardson	625,000,000				NA	**Total**	**2,679,000,000#**			
15	Glendower	403,000,000									
16	Buck Run (old)	477,000,000									
17	Buck Run (dam basin)	53,000,000									
18	Lytle	795,000,000									
19	Phoenix Park	2,054,000,000	X								
20	Otto	2,265,000,000	X								
21	Middle Creek	700,000,000									
	Total	**17,935,000,000**									

Note: Volumes taken from USBM TP #727-1949; # denotes value from USGS SIR 2010-5261.



Name	Region	Estimated Volume (BG)
Silver Creek	South Anthracite Field	1.8
Wadesville	South Anthracite Field	3.6
Phoenix Park	South Anthracite Field	2.1
Otto	South Anthracite Field	2.3
Morea	Western Middle Anthracite Field	2.7
	Total	12.5

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

DRBC Storage Study Update

Advisory Committee on Climate Change: October 12, 2022

What does carried forward mean?

The 38 projects which made it to the final round of screening are then further developed conceptually. The project concept is captured in a multi-page Storage Project Summary (SPS).

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

DRBC Storage Study Update

Advisory Committee on Climate Change: October 12, 2022

38 Storage Project Summaries (SPS)

1. Project Overview
2. Water Quantity & Quality
3. Infrastructure Design, Construction & Operation
4. Environmental Impacts
5. Social & Economic Impacts
6. Project Cost & Schedule
7. Potential Ancillary Benefits
8. Storage Project Score

This enables comparisons of projects.

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

DRBC
Feasibility Evaluation of Additional Storage Options

STORAGE PROJECT SCORING

STORAGE PROJECT: M19
NAME: Phoenix Park Deep Mine

SIX PRIMARY CRITERIA	Quantitative Evaluation Metric (when appropriate) (enter values only)	Score (5=best, 1=worst)	special two-factor scoring for habitat impacts: replaceability (5=easy; 1=difficult)	special two-factor scoring for habitat impacts: quantity impacted (5=large, 1=small)	Weight	Weighted Score	Project Specific Comments
1. Water Quantity and Quality		**2.83**			30%	**0.85**	
a Volume of storage provided (BG)	2.05	1					
a Hydrological reliability of supply (months to fill)	7	4					Recharge of the mine is unclear, others have recharged quickly
a Release rate (cfs)	25	2					May need to further reduce release rate or change discharge
a Promptness of delivery to mainstem (day)	2.6	3					
a Geographic Benefit		3					
a Quality of stored water		4					Assumes treatment
2. Infrastructure Design, Construction and Operation		**2.90**			10%	**0.29**	
a Site/Civil, land & Easements		3					Longer pipeline may create land issues
a Subsurface conditions		2					Mines create complexity
a Infrastructure Complexity		4					No complex design
a Construction complexity		3.5					Pipeline construction can be difficult
a Operational complexity		2					Treatment makes for more complex operations
3. Environmental Impacts		**4.21**			15%	**0.63**	
a Protected species		4					None known, but likely
a Water quality degradation		5					Quality may be improved by treatment
a Obstruction to passage of aquatic animals		5					Not likely
a Hydromodification		1					Change to low flow stream; mine dewatering will have likely impact
Habitat Type		Combined average					
a Wetlands inundated or filled (ac)		5	5	5			
a Stream length inundated (mi)		5	5	5			
a Uplands inundated or developed (ac)		4.5	5	4			Pipeline could minimally impact
4. Social and Economic Impacts		**5.00**			10%	**0.50**	
a Disruption/displacement		5					
a Safety and health		5					
a Social equity		5					
a Recreational loss		5					
a Cultural/historical resources		5					
a Aesthetic		5					May prompt further area reclamation
a Loss of tax revenue		5					
a Loss of production from farmland, timberland, quarries		5					
a Emissions of greenhouse gasses		3					
5. Project Costs & Schedule		**2.00**			30%	**0.60**	
a Land acquisition cost ($)	$0.150M						
a Construction Cost ($)	$23M						
a Operating Cost ($/yr)	$1.35M						
a Overall Cost ($)	$49M	2					
a Cost effectiveness ($/BG)	24	1					
a Schedule (Time to make Operational, years)	13	3					
6. Ancillary Benefits		**2.40**			5%	**0.12**	
a Flood control		1					
a Recreation/tourism		1					
a Habitat/Fishery enhancement		1					
a water quality improvement/environmental remediation (i.e. acid mine discharge, quarry reclamation)		4					Could be flow related stream impacts
a Ability to leverage funding from other programs		5					
OVERALL		**3.22**				**2.99**	

DRBC Storage Study Update

Advisory Committee on Climate Change: October 12, 2022

Storage Project Scoring Sheets

Primary Criteria	Weight
Water Quantity & Quality	30%
Infrastructure Design, Construction and Operation	10%
Environmental Impacts	15%
Social & Economic Impacts	10%
Project Costs & Schedule	30%
Ancillary Benefits	5%

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

DRBC Storage Study Update

Advisory Committee on Climate Change: October 12, 2022

Table 7-1 All projects sorted by weighted score

ID	Project Name	Location	Project type	Vol. (BG)	Total Cost (M$)	Cost effective-ness (M$/BG)	Pump in or Gravity	OVERALL WEIGHTED SCORE	1. Water quantity & quality	2. Infra. design, const. & Ops.	3. Environ. impacts	4. Social & Economic Impacts	5. Project Costs & Schedule	6. Ancil. Benefits
T2	Rio	Sullivan, NY	Transfer	2.0	27	14	NA	4.16	4.17	4.60	5.00	5.00	3.83	1.00
Q19	Eureka Rush Valley	Bucks	Quarry	1.7	24	14		4.07	3.75	3.60	4.79	4.88	4.00	3.60
Q02	Dyer Glasgow	Montgomery	Quarry	6.2	30	5		4.06	3.50	3.10	4.61	4.75	4.50	3.60
E4	Prompton	Wayne	Dam mod	2.0	2	1	G	4.04	4.17	3.80	3.25	4.78	4.50	1.80
Q04	Hanson Penns Peak	Bucks	Quarry	3.3	31	10		4.04	3.58	3.60	4.57	4.88	4.17	3.60
Q12	Solebury	Bucks	Quarry	2.3	38	16		4.03	3.75	3.20	4.57	5.00	4.00	4.00
Q25	Tilcon Oxford	Warren, NJ	Quarry	1.2	28	23		4.02	4.00	3.60	4.57	4.88	3.83	2.80
T4	Lake Ontelaunee	Berks	Transfer	1.0	27	27	NA	4.01	3.33	4.60	5.00	5.00	4.17	1.00
Q07	Glasgow (Delaware)	Northampton	Quarry	4.6	26	6		4.01	4.08	3.70	4.93	4.25	3.67	3.00
E2	Cannonsville	Delaware, NY	Dam mod	13.0	77	6	G	3.99	4.67	3.60	3.21	4.89	4.00	1.20
Q22	NESL Whitehall	Lehigh	Quarry	1.2	34	28		3.96	3.83	3.00	4.86	4.69	3.67	4.20
Q21	NESL Ormrod	Lehigh	Quarry	1.3	45	35		3.92	3.83	3.10	4.93	4.63	3.50	4.20
T1	Merrill Creek	Warren, NJ	Transfer	2.0	110	55	NA	3.91	4.50	4.60	5.00	5.00	2.67	1.00
Q23	Lehigh Perkiomenville	Montgomery	Quarry	1.0	26	26		3.91	3.58	3.80	4.79	4.88	3.67	3.00
Q01	Pottsville	Schuylkill	Quarry	6.9	39	5		3.91	3.42	3.40	4.21	4.63	4.17	4.00
Q08	Holcim Evansville	Berks	Quarry	3.1	44	14		3.91	3.75	3.20	4.79	4.00	3.83	3.90
T3	Penn Forest/Wild Creek	Carbon/ Monroe	Transfer	3.0	162	54	NA	3.87	3.83	4.60	5.00	5.00	3.17	1.20
Q27	NESL Nazareth	Northampton	Quarry	1.0	25	25		3.86	3.67	3.40	4.21	5.00	3.83	2.80
Q03	Plymouth Meeting	Montgomery	Quarry	3.5	39	11		3.76	3.50	3.10	3.89	4.75	3.83	3.80
M32	Morea Basin	Schuylkill	Mine Pool	2.7	65	24	P	3.58	3.08	3.20	4.43	5.00	3.50	2.40
M20	Otto	Schuylkill	Mine Pool	2.3	65	28	P	3.53	3.17	3.00	4.43	5.00	3.33	2.40
Q14	M&M Telford	Bucks	Quarry	1.0	25	25		3.50	3.17	2.90	4.07	4.75	3.67	1.40
Q07	Glasgow (Bushkill)	Northampton	Quarry	4.6	26	6		3.47	3.42	2.50	3.43	4.50	3.67	2.60
Q16	Berks Temple	Berks	Quarry	1.0	30	30		3.42	3.25	2.20	4.64	3.25	3.67	2.00
Q05	Glasgow Nazareth	Northampton	Quarry	4.2	48	12		3.37	3.25	2.30	3.00	4.38	3.83	2.60
Q06	Lehigh Imperial	Northampton	Quarry	3.8	51	13		3.34	3.25	2.30	3.14	4.38	3.67	2.60
E1	Wild Creek	Carbon/ Monroe	Dam mod	1.0	135	135	G	3.29	4.00	2.80	3.50	4.89	2.50	1.00
E3	Blue Marsh	Berks	Dam mod	5.0	65	13	G	3.19	3.83	2.20	3.43	4.11	2.67	1.80
M5	Silver Creek	Schuylkill	Mine Pool	1.7	65	38	P	3.12	3.00	3.20	4.50	5.00	2.00	2.40
N4	Rattling Run	Berks	New dam	1.3	293	225	G	3.05	3.83	3.40	3.36	4.22	1.83	1.60
N5	Equinunk	Wayne	New dam	42.0	1150	27	G	3.03	4.50	2.60	2.00	3.00	2.33	2.40
M19	Phoenix Park	Schuylkill	Mine Pool	2.1	65	31	P	2.99	2.83	2.90	4.21	5.00	2.00	2.40
N2	Milanville	Wayne	New dam	42.0	950	23	G	2.95	4.17	2.60	2.16	3.00	2.33	2.40
N1	Red Creek	Schuylkill	New dam	13.3	366	28	P	2.90	3.67	2.20	2.93	3.22	2.33	2.40
N6	Hawley	Wayne	New dam	1.3	182	140	G	2.87	4.17	2.80	2.18	3.33	2.00	1.60
N3	Little Martins Creek	Northampton	New dam	7.1	353	50	P	2.87	4.17	2.20	1.96	3.44	2.17	2.20
N7	Silver/Big Creek	Schuylkill	New dam	11.3	921	81	P	2.77	3.50	1.80	2.68	4.33	1.83	3.00
M10	Wadesville	Schuylkill	Mine Pool	3.6	65	18	P	0.00	NA	NA	NA	NA	NA	NA

Top 38 Projects

- Storage Projects Summaries (SPS) developed for each
  - 7 New Dams
  - 4 Dam Modifications
  - 4 Transfers
  - 18 Quarries
  - 5 Mine Pools
- 2 groupings of projects

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

DRBC Storage Study Update

Advisory Committee on Climate Change: October 12, 2022

Table 7.3-1 Most Feasible Projects, Sorted by Overall Score

Site Name	Site ID	County/ State	Overall Weighted Score	Volume, BG	Cost, M$	Cost Effectiveness, M$/BG
Eureka Rush Valley	Q19	Bucks, PA	4.07	1.7	24	14.1
Dyer	Q02	Montgomery, PA	4.06	6.2	30	4.9
Prompton	E4	Wayne, PA	4.04	2.0	2	1.0
Penns Peak	Q04	Bucks, PA	4.04	3.3	31	9.5
Solebury Twp	Q12	Bucks, PA	4.03	2.3	38	16.3
Tilcon Oxford	Q25	Warren, NJ	4.02	1.2	28	23.3
Glasgow (Del River)	Q07	Northampton, PA	4.01	4.6	26	5.7
Cannonsville	E2	Delaware , NY	3.99	13.0	77	5.9
Whitehall	Q22	Lehigh, PA	3.96	1.2	34	28.0
Ormrod	Q21	Lehigh, PA	3.92	1.3	45	34.6
Wadesville	Q01	Schuylkill, PA	3.91	6.9	39	4.8
Holcim Evansville	Q08	Berks, PA	3.91	3.1	44	14.3
Perkiomenville	Q23	Montgomery, PA	3.91	1.0	26	26.0
NESL Nazareth	Q27	Northampton, PA	3.86	1.0	25	25.0

Most Feasible Projects

- Doesn't include transfers
- Shouldn't be thought of a ranking, but rather a grouping
- 14 projects; 12 quarries, 2 expansions at existing reservoirs
- Most are in PA
- No new dams
- No mine pools
- Quarries are constrained by fill & discharge rates (pump sizes, pipelines, etc.)

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

DRBC Storage Study Update

Advisory Committee on Climate Change: October 12, 2022

Transferrable Storage – "excess existing storage"

* Project team was unable to get a good sense of costs and volume available without additional detailed, serious discussions with owners.
* However, feel confident that water is available.
* Transfers were not included in the most feasible for this reason.
* Captured in Appendix B of the report.

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

DRBC Storage Study Update

Advisory Committee on Climate Change: October 12, 2022

Special Notes on Quarries

1. Most owners probably do not know anything about DRBC.
2. Most owners do not know that they are included in this study.
3. DRBC/MM has not yet contacted / interacted with most owners.
4. Information to develop project concepts came from public sources.

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

DRBC Storage Study Update

Advisory Committee on Climate Change: October 12, 2022

August 15: Draft report to DRBC

September 9: Comments back to MM

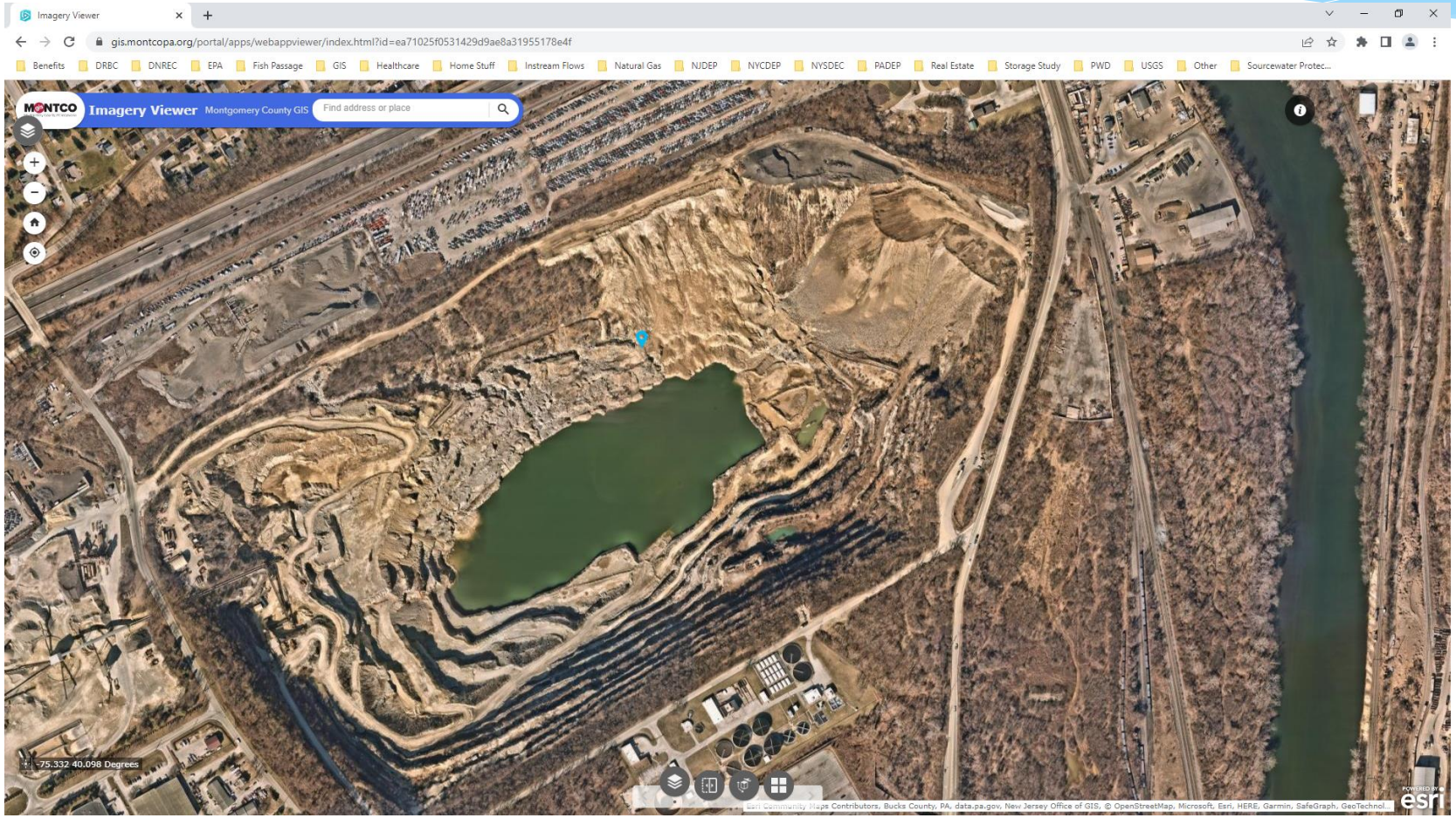
Next Steps

* Revised draft report from MM
* Draft report to signatory member reviewers
* Final Report

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

DRBC Storage Study Update

Advisory Committee on Climate Change: October 12, 2022



Discussion / Questions ?

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA