Winter 2020 Update to “Debt Repayment Obligations Created by the Proposed Bear River Development Project”*

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Abstract. This updates the 2019 report “Debt Repayment Obligations Created by the Proposed Bear River Development Project” to take into account the State’s October 2019 report on this project.

*I received helpful comments from the audience at the February 14, 2020 Colloquium for the Advancement of Economics at the University of Utah’s Economics Department.

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In October 2019 the Utah Division of Water Resources issued an update[1] to the 2014 report on which the 2019 study "Debt Repayment Obligations Created by the Proposed Bear River Development Project" ("DRO19")[2], was largely based. In this document I describe how I have conducted a revised analysis in light of the new study.

One of the new study's improvements was incorporation of environmental mitigation costs, at $100,000/acre. This was the same value chosen in DRO19's environmental mitigation cost modeling. Since the State now models environmental mitigation, we will drop this part of DRO19's model.

The most important change for our purposes is the increased emphasis on siting a reservoir in Whites Valley. This introduces something DRO19 lacks, flexible reservoir sizes: ten for Whites Valley (and two for Fielding). Hence there are *many* more than DRO19's seven reservoir combinations to consider ($(2+1)*(10+1)-1 = 29$ just considering Whites Valley and Fielding). In addition, different reservoir sizes require different pipeline and pump sizes. A third complication is extensive pumping of water uphill, and resulting assumptions on the cost of electricity to run the pumps.

Step 1 of this update entailed fixing errors in the State Report. On pages 98–110 of its Vol. II, the cost of building "Fielding 40k" is consistently given as being *higher* than the cost of building "Fielding 70k." This makes no sense, and Vol. I p. 117 Table 10-1 has a small note at its bottom giving the correct costs.

Next, on pages 109–110 of Vol. II, the Pipeline Fielding/Cutler is listed among the needed costs, but it is missing from the accompanying diagram, where it ought to be included.

Step 2 of this update entailed fixing an inconsistency in the State Report. On pages 17–18 of its Vol. I, the State assumed a 4% interest rate and 50-year repayment period. However, on pages 860 and 864 of Vol. III, when calculating the "power cost" line of the State's scenarios, the State used 3% and only considered 20 years' worth of costs. This amounts to inconsistently "cherry-picking" whichever financing assumptions will make the project look cheaper. To fix this, we unwind the capitalization of the power costs, extend the power costs to 30 years, then recapitalize them using the same interest rate (4%) and term (30 years) used in the rest of the model.

[1]Bear River Development Report, Utah Division of Water Resources, 2019. Prepared by Bowen Collins & Associates in association with HDR. Three volumes.

[2]Available at `http://content.csbs.utah.edu/~lozada/Research/USMag_Report-MostRecent.pdf`. Slide presentations and other material related to that document are available at `http://content.csbs.utah.edu/~lozada/Research/index.htm#BRD`. URL's in electronic versions of this document are clickable hyperlinks.

```
ReservoirsAndPumpsPipes =
  Map[
   If[Cache == True && BoxElder == False && Weber == False &&
      Jordan == False &&
      (#[[CubRPosition, AFPosition]] > 0 ||
        #[[AboveCutlerPosition, AFPosition]] > 0 ||
        #[[TempleForkPosition, AFPosition]] > 0)
     (*then Fielding Pump is unneeded*),
     #, (* else Fielding Pump is needed *)
     If[(#[[CubRPosition, AFPosition]] > 0 ||
          #[[AboveCutlerPosition, AFPosition]] > 0 ||
          #[[TempleForkPosition, AFPosition]] > 0) &&
       #[[WhitesVPosition, AFPosition]] == 0 &&
       #[[FieldingPosition, AFPosition]] > 0,
      AddToCost[FieldingPump - FieldingPumpAdjustment, #],
      (*else*)
      AddToCost[FieldingPump, #]
     ]] &, Reservoirs];
```

Figure 1. Calculating whether the Fielding Pump (cost $187,554,000) is needed, and if so, whether to subtract the Fielding Pump Adjustment ($114,196,000) from that cost.

Step 3 was to build a set of rules reflecting the State's scenarios A–M. Once this rules database is constructed, all feasible combinations of infrastructure can be modeled.

Sub-step (3a) concerns the Fielding Pump. Figure 1 shows the *Mathematica* code used to calculate the cost of the Fielding Pump in all possible situations. In this computer language, "&&" means "and" and "||" means "or." The entire computer code is available at `http://content.csbs.utah.edu/~lozada/Research/NewBearElectric.nb` in *Mathematica* notebook form and `http://content.csbs.utah.edu/~lozada/Research/NewBearElectric.pdf` in PDF form, where the data structure "`ReservoirsAndPumpsPipes`" and functions such as "`AddToCost[additional cost, #]`" are defined (the "#" there stands for the previous contents of the data structure). Code such as "`CubRPosition, AFPosition`" denotes the amount of acre-feet for the Cub River reservoir in the situation (which may be zero). The rules are inferred from an extremely close study of the State's scenarios A–M.

Sub-step (3b) concerns the Fielding/Cutler Pipeline. Figure 2 shows the *Mathematica* code used to calculate its cost in all possible situations.

```
ReservoirsAndPumpsPipes = Map[
     If[Cache == False ||
        (#[[CubRPosition, AFPosition]] > 0 &&
          #[[AboveCutlerPosition, AFPosition]] > 0 &&
          #[[TempleForkPosition, AFPosition]] > 0), #,
       (* else Pipeline Fielding/Cutler is needed *)
       If[#[[FieldingPosition, AFPosition]] == 40 000,
        AddToCost[PipeFieldingCutlerShort, #],
        AddToCost[PipeFieldingCutlerLong, #]]
      ] &,
     ReservoirsAndPumpsPipes];
```

Figure 2. Calculating whether the Fielding/Cutler Pipeline is needed, and if so, whether its appropriate length is short (cost $37,175,000) or long (cost $50,195,000).

Sub-step (3c) concerns the Fielding-West Haven Pipeline and the Bear River Diversion. Figure 3 shows the *Mathematica* code used to calculate its cost in all possible situations.

Sub-step (3d) was to verify that the *Mathematica* program actually can duplicate every one of the State's thirteen Scenarios A–M. If so, the rule base was constructed correctly. The procedure here is to remove the corrections for State inconsistencies and errors; generate all the possible reservoir combinations for our Scenario 1, the only participation scenario the State considers; then check whether present among the 528 possible reservoir combinations generated in the previous parts of Step 3 are the thirteen State scenarios, with exactly the same calculated aggregate cost and acre-feet of capacity which the State had for them. There are[3], except for the State's Scenario I, which is absent from the *Mathematica* possibilities because it violates the constraint that storage has to be greater than or equal to 400,000 AF when all the Districts participate. (Scenario I only has 244,000 AF of storage.)

The final results of Step 3 are given in Table 1.

The last steps of the analysis are:

4. Feed the *Mathematica* results back into the spreadsheet `http://content.csbs.utah.edu/~lozada/Research/NewBearElectric.xlsx`.

[3]See `http://content.csbs.utah.edu/~lozada/Research/NewBear.xlsx`, especially the sheet named "AWHSimpler."

```
ReservoirsAndPumpsPipes =
   Map[If[Weber == True || Jordan == True,
      AddToCost[PipeFieldingWHaven, #], #] &,
    ReservoirsAndPumpsPipes];
  Export["OutputNewBear3.dat", ReservoirsAndPumpsPipes];
ReservoirsAndPumpsPipes =
   Map[If[#[[FieldingPosition, AFPosition]] == 0 &&
        (BoxElder || Weber || Jordan ||
          (Cache && (#[[CubRPosition, AFPosition]] == 0 &&
              #[[AboveCutlerPosition, AFPosition]] == 0 &&
              #[[TempleForkPosition, AFPosition]] == 0)))
      ,
      AddToCost[BearRDiversion, #], #] &,
    ReservoirsAndPumpsPipes];
```

Figure 3. First five lines: Calculating whether the Fielding-West Haven Pipeline is needed. Remaining lines: calculating whether the Bear River Diversion is needed.

Scenario	reservoirs
1	Whites Valley 400k
2	Whites Valley 305k
3	Whites Valley 305k
4	Whites Valley 319k
5	Whites Valley 319k
6	Whites Valley 305k
7	Whites Valley 305k
8	Whites Valley 305k
9	Whites Valley 305k
10	Whites Valley 305k
11	Whites Valley 305k
12	Fielding 70k, Temple Fork
13	Fielding 70k, Temple Fork
14	Fielding 70k, Temple Fork
15	Fielding 70k, Temple Fork

Table 1. Least-Cost Reservoir Combinations

	Cache WD	Bear River WCD	Weber Basin WCD	Jordan Valley WCD
Scenario 1	**239_{323}**	**552_{748}**	**61_{76}**	**64_{78}**
Scenario 2		679_{866}	71_{85}	73_{85}
Scenario 3	306_{414}		73_{92}	75_{91}
Scenario 4	291_{392}	673_{906}		85_{101}
Scenario 5	291_{392}	673_{906}	84_{103}	
Scenario 6			**101_{113}**	**99_{110}**
Scenario 7		988_{1139}		106_{116}
Scenario 8		988_{1139}	108_{120}	
Scenario 9	445_{550}			108_{125}
Scenario 10	445_{550}		111_{130}	
Scenario 11	276_{469}	639_{1085}		
Scenario 12				**141_{124}**
Scenario 13			**147_{129}**	
Scenario 14		660_{886}		
Scenario 15	255_{206}			

Table 2. Per capita annual debt, in dollars (previous results as subscripts; lower numbers mean the project is more affordable).

5. For each scenario the spreadsheet then adds contingency costs, engineering/legal/administrative overhead, inflation from 8/17 to 3/19, and capitalized O&M, then

6. allocates them to the participating districts. This completes analysis of the northern infrastructure.

7. The spreadsheet calculates southern infrastructure costs and allocations with new numbers but with the same procedure as before,

8. then combines the northern and southern analyses to get overall conclusions, again using the same procedure as before.

The new conclusions are in Tables 2, 3, 4, and 5, and Figures 4, 5, 6, 7, and 8. In Scenarios 1 and 6, costs are somewhat lower than in our earlier report, but in Scenarios 12 and 13 costs are somewhat higher.

	Bear River WCD	Weber Basin WCD	Jordan Valley WCD
Scenario 1	**0.01**	$\mathbf{0.24_{0.19}}$	$\mathbf{0.28_{0.23}}$
Scenario 2	0.01	$0.21_{0.17}$	$0.25_{0.21}$
Scenario 3		$0.20_{0.16}$	$0.24_{0.20}$
Scenario 4	0.01		$0.21_{0.18}$
Scenario 5	0.01	$0.17_{0.14}$	
Scenario 6		$\mathbf{0.15_{0.13}}$	$\mathbf{0.18_{0.17}}$
Scenario 7	0.01		$0.17_{0.16}$
Scenario 8	0.01	$0.14_{0.12}$	
Scenario 9			$0.17_{0.15}$
Scenario 10		$0.13_{0.11}$	
Scenario 11	0.01		
Scenario 12			$\mathbf{0.13_{0.15}}$
Scenario 13		$\mathbf{0.10_{0.11}}$	
Scenario 14	0.01		
Scenario 15			

Table 3. Debt Service Coverage Ratios (previous results as subscripts; higher numbers mean the project is more affordable). The DSCR for Cache is approximately zero.

	2018 Net Revenues	Annual Debt Payments Needed to Pay for Bear River Development	Deficit in Millions
Jordan Valley WCD	\$12,763,020	\$45,141,535	\$32.4
Weber Basin WCD	\$9,151,195	\$38,005,757	\$28.9
Bear River WCD	\$420,689	\$30,350,450	\$29.9
Cache County	\$0	\$30,350,450	\$30.4
Total	\$22,334,904	\$143,848,193	\$121.5

Table 4. Water District Annual Revenues, Debt, and Deficit.

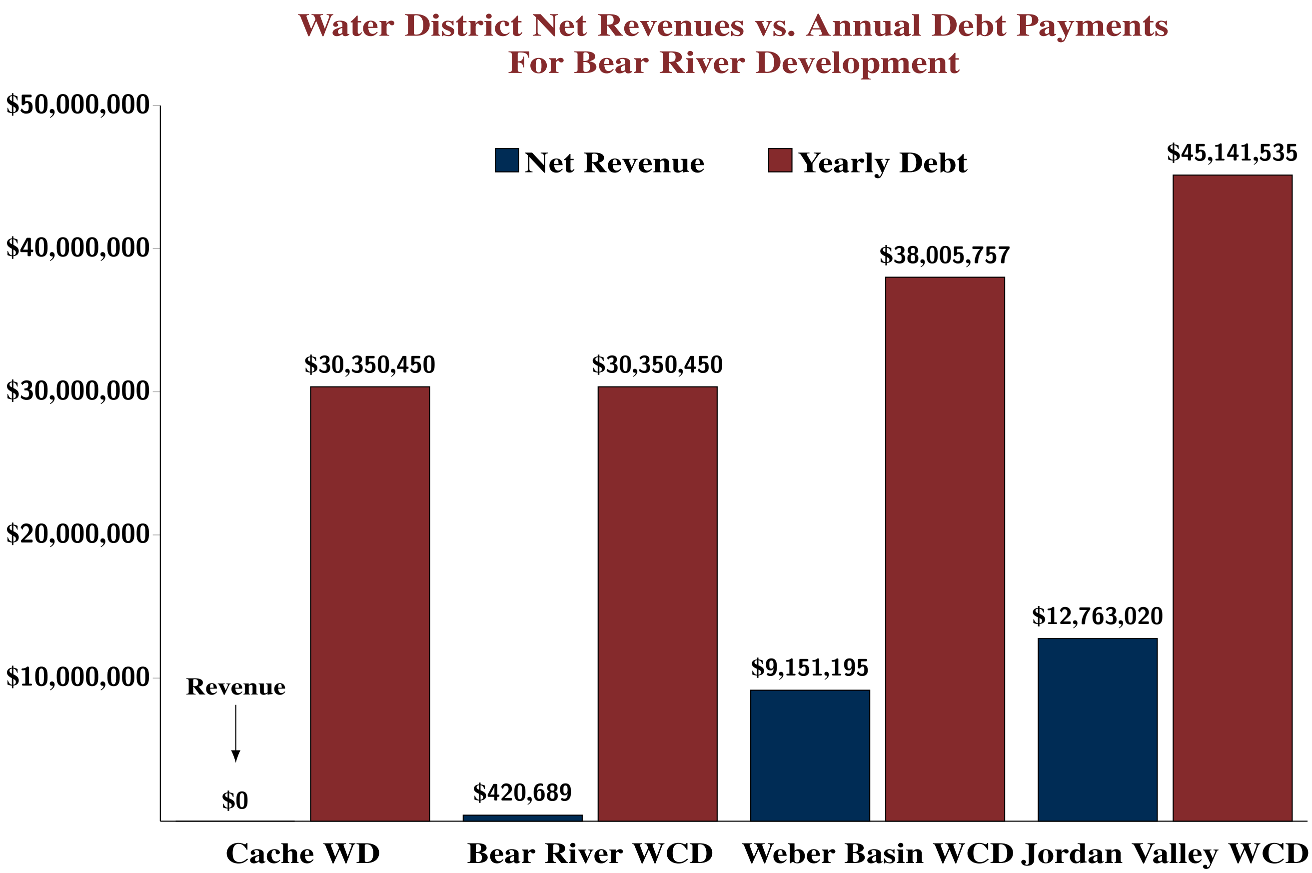
Water District Net Revenues vs. Annual Debt Payments
For Bear River Development
$50,000,000
$40,000,000
$30,000,000
$20,000,000
$10,000,000
Net Revenue
Yearly Debt
Revenue
$0
$30,350,450
$420,689
$30,350,450
$9,151,195
$38,005,757
$12,763,020
$45,141,535
Cache WD
Bear River WCD
Weber Basin WCD
Jordan Valley WCD

Figure 4

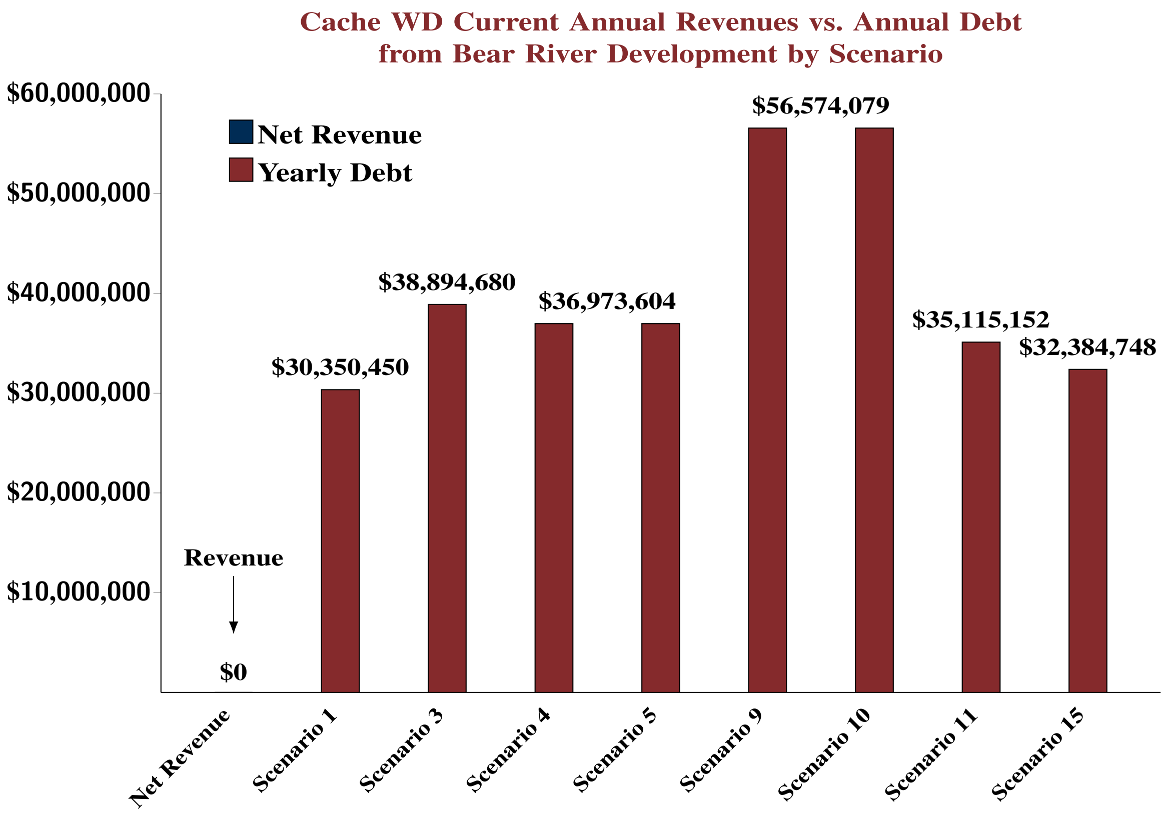
Cache WD Current Annual Revenues vs. Annual Debt
from Bear River Development by Scenario
Net Revenue
Yearly Debt
$60,000,000
$50,000,000
$40,000,000
$30,000,000
$20,000,000
$10,000,000
Revenue
$0
$30,350,450
$38,894,680
$36,973,604
$56,574,079
$35,115,152
$32,384,748
Net Revenue
Scenario 1
Scenario 3
Scenario 4
Scenario 5
Scenario 9
Scenario 10
Scenario 11
Scenario 15

Figure 5

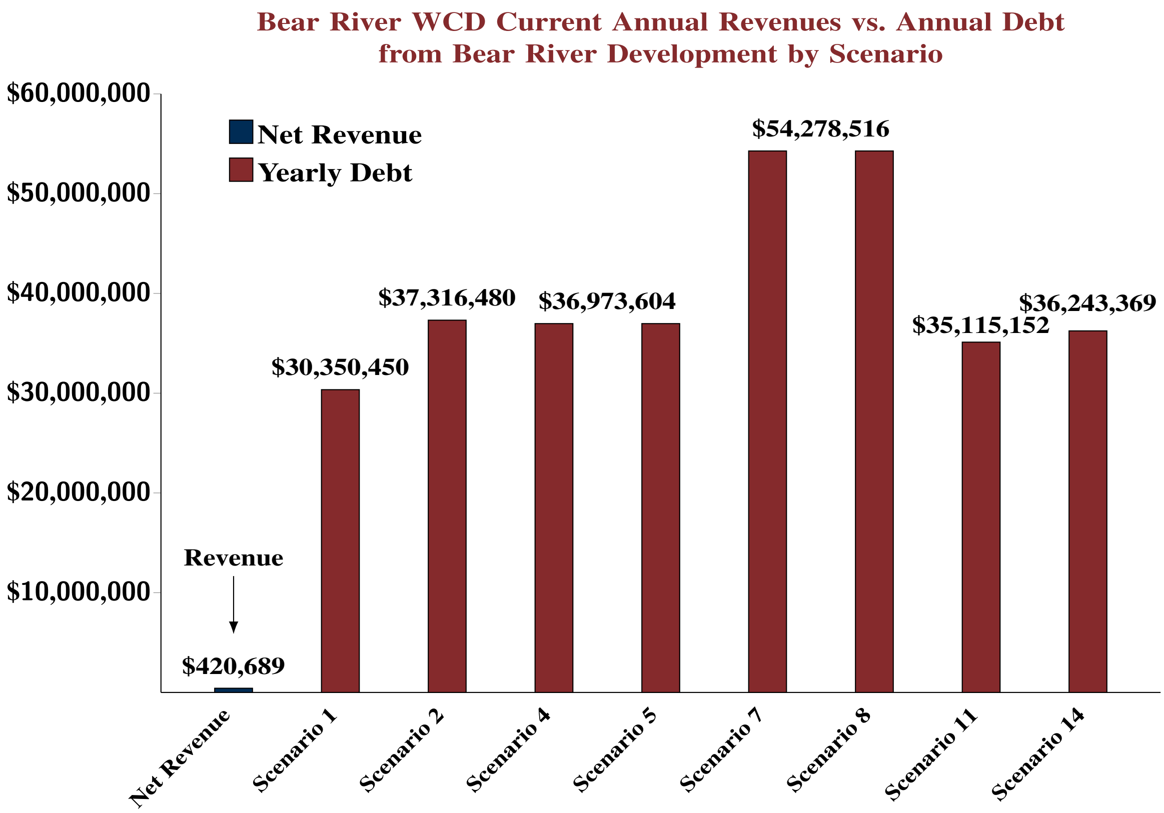
Bear River WCD Current Annual Revenues vs. Annual Debt
from Bear River Development by Scenario
$60,000,000
$50,000,000
$40,000,000
$30,000,000
$20,000,000
$10,000,000
Net Revenue
Yearly Debt
Revenue
$420,689
$30,350,450
$37,316,480
$36,973,604
$54,278,516
$35,115,152
$36,243,369
Net Revenue
Scenario 1
Scenario 2
Scenario 4
Scenario 5
Scenario 7
Scenario 8
Scenario 11
Scenario 14

Figure 6

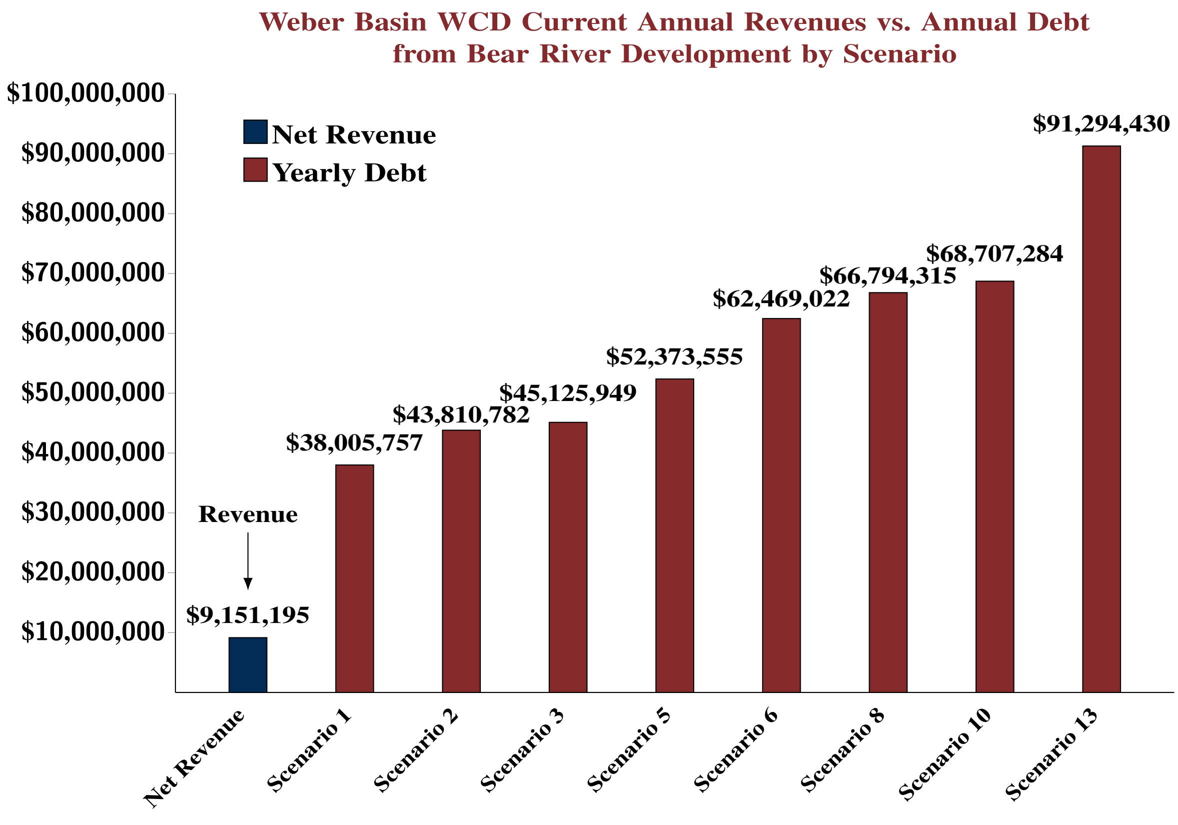
Weber Basin WCD Current Annual Revenues vs. Annual Debt
from Bear River Development by Scenario
$100,000,000
$90,000,000
$80,000,000
$70,000,000
$60,000,000
$50,000,000
$40,000,000
$30,000,000
$20,000,000
$10,000,000
Net Revenue
Yearly Debt
Revenue
$9,151,195
$38,005,757
$43,810,782
$45,125,949
$52,373,555
$62,469,022
$66,794,315
$68,707,284
$91,294,430
Net Revenue
Scenario 1
Scenario 2
Scenario 3
Scenario 5
Scenario 6
Scenario 8
Scenario 10
Scenario 13

Figure 7

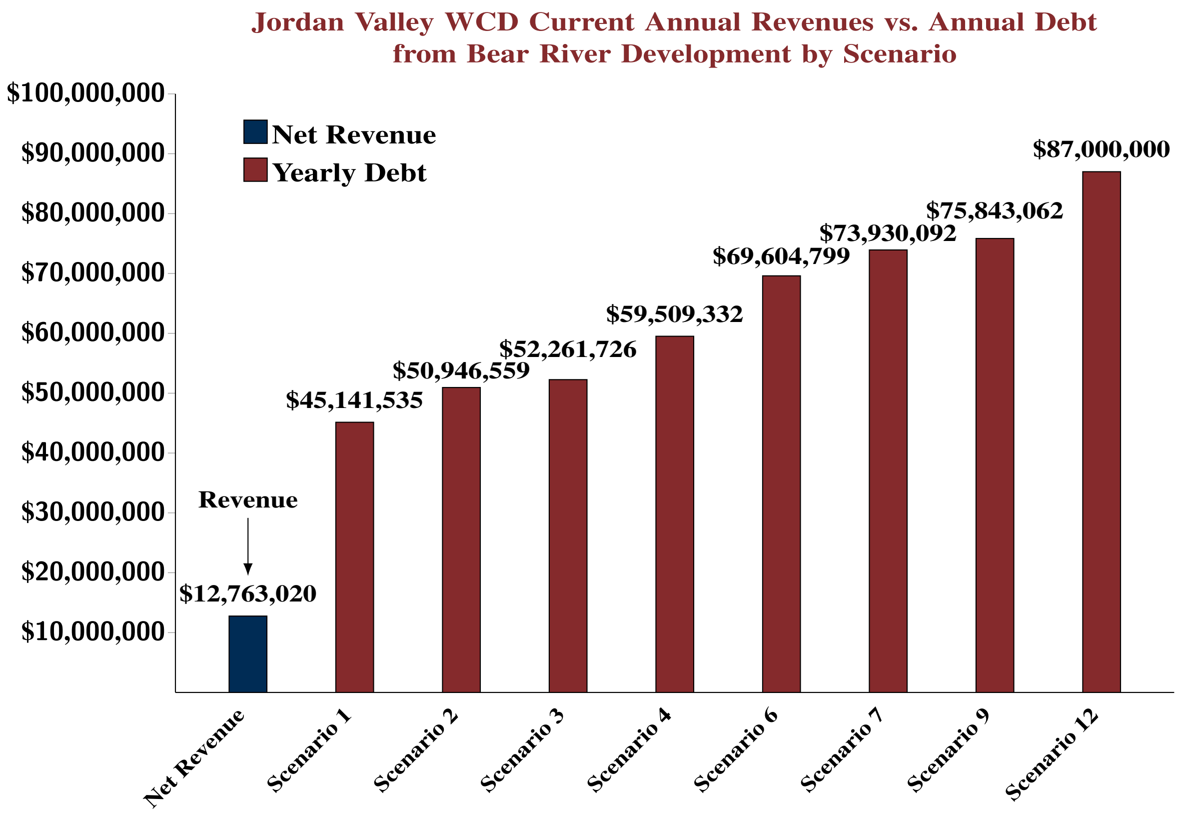
Jordan Valley WCD Current Annual Revenues vs. Annual Debt
from Bear River Development by Scenario
$100,000,000
$90,000,000
$80,000,000
$70,000,000
$60,000,000
$50,000,000
$40,000,000
$30,000,000
$20,000,000
$10,000,000
Net Revenue
Yearly Debt
Revenue
$12,763,020
$45,141,535
$50,946,559
$52,261,726
$59,509,332
$69,604,799
$73,930,092
$75,843,062
$87,000,000
Net Revenue
Scenario 1
Scenario 2
Scenario 3
Scenario 4
Scenario 6
Scenario 7
Scenario 9
Scenario 12

Figure 8

Water System	Annual Payments for Bear River Development	Total Debt from Bear River Development
Bluffdale	$5,710,000	$98,700,000
Draper City	$2,940,000	$50,800,000
Draper Irr.Co.	$4,860,000	$84,000,000
Granger-Hunter	$9,390,000	$162,400,000
Herriman	$6,830,000	$118,100,000
Kearns	$17,510,000	$302,800,000
Magna	$7,230,000	$125,000,000
Midvale	$1,610,000	$27,800,000
Riverton	$7,620,000	$131,800,000
S Jordan	$14,080,000	$243,500,000
S Salt Lake	$1,370,000	$23,700,000
Tylrsv-Benn	$4,220,000	$73,000,000
W Jordan	$13,110,000	$226,700,000
Total	$96,480,000	$1,668,300,000

Table 5. Jordan Valley WCD Debt from Bear River Development, Scenario 12.