UPPER BEAR RIVER DRAINAGE
WATER RESOURCE INVESTIGATION

Level II Feasibility Study

EXECUTIVE SUMMARY

REPORT

for the
Wyoming Water Development Commission
January 1984

by

FORSgren-PERKINS ENGINEERING, P.A.
Evanston, Wyoming

and

ROLLINS, BROWN AND GUNNELL, INC.
Provo, Utah
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INTRODUCTION
EXECUTIVE SUMMARY REPORT

INTRODUCTION

This comprehensive Level II Feasibility Study shows how critical existing Upper Bear River Drainage Basin water shortages can be practically and economically resolved (See Figure 1 in Appendix). The Level II proposed plan will provide supplemental water for both the City of Evanston and 17,250 acres of grass land owned by the Upper Bear River Water Users (See Figures 2 and 3 in Appendix).

All available Bear River compact water from spring run-off must be stored at two separate reservoir sites and then released later in the year to meet the peak water usage demands. The development of these two water storage reservoirs (Sulphur Creek Reservoir Enlargement and West Fork of the Bear River Reservoir) with associated water delivery systems now constitutes the Upper Bear River Project (see Figures 1 through 5 in the Appendix).

The City of Evanston has recently more than doubled its water rates and is now prepared and committed to proceed with the development of the Sulphur Creek Reservoir Enlargement, which will supply their critical existing and future water needs. The Upper Bear River Irrigators (17,250 acres) will develop the West Fork of the Bear River Reservoir to meet their water shortage needs. Further detailed discussion will now be separated, therefore, into these two projects.

BENEFIT-COST RATIO

On a very conservative basis, the entire Upper Bear River Project has a positive benefit/cost ratio of 1.003, a 17 year pay back period, and a design life of 50 years for all piping and over 100 years for the two dam structures.

By all these standards, this project is above breakeven. In light of the fact that this project pay back period is 17 years compared to a dam structure life of over 100 years, the project will definitely be a benefit and an asset to the State of Wyoming and area residents for many years to come. It is very difficult to apply a benefit value to indirect benefits, such as recreation, property value changes, conservation of water rights, diversification of the local economy and the effects of construction, drought relief, continued city growth, etc., all of which will definitely increase the project benefit to the State of Wyoming and the area.
1.0 UPPER BEAR RIVER PROJ.  
CITY OF EVANSTON  
MUNICIPAL SUPPLY
1.0 CITY OF EVANSTON - MUNICIPAL SUPPLY
SULPHUR CREEK RESERVOIR ENLARGEMENT

1.1 Project Description

The Level II recommended water supply system for the City of Evanston or the Sulphur Creek Enlargement Project is detailed below and highlighted by Figures 2 and 3 in the Appendix.

1. Sulphur Creek Reservoir Enlargement: The existing 5,700 Ac. Ft. reservoir will be increased to a capacity of 18,200 Ac. Ft., which will annually yield the needed 4,200 Ac. Ft. of culinary water for the City of Evanston (See Figures 4 and 5 in the Appendix).

2. Bear Canal Enlargement and Lining: Available Bear River water will be diverted to the Sulphur Creek Reservoir through the existing Bear Canal which will be lined and enlarged to handle the required diversion flows (See Figure 3 in the Appendix).

3. Raw Water Supply Line: Stored spring run-off water in the Sulphur Creek Reservoir will be delivered to the Evanston water treatment plant through 2.8 miles of 24-inch pipe line and 7.2 miles of 27-inch pipe line (See Figure 2 in Appendix).

4. Hydroelectric Power Facilities: During winter months, when water usage is low, the excess capacity in the raw water supply line will operate a 250 KW generator which will be installed on the supply line at Evanston for maximum power production.

1.2 Existing Municipal Water Shortage

Fueled by the area oil and gas development, the City of Evanston has grown from 4,500 people in 1977 to an estimated 10,600 today. This 136 percent increase in population has totally exhausted the City's available water resources. The following critical conditions now exist in the City:

1. As early as 1979 and 1980 water shortages were predicted by the City, therefore, water meter installations were programmed in order to reduce water consumption by 30 percent. In 1983 most water meter installations were completed, thus reducing the present water shortage from over 1,500,000 gallons per day to several hundred thousand gallons per day.

2. During hot summer periods the City cannot meet present water demands even by purchasing additional water from private well sources. Water usage restrictions and rationing measures have been imposed. The City's future growth and, thus, the area economy, is now limited by water supply.
3. The water demand, even if the population stays the same, is expected to increase next summer because new lawns still have to be planted at occupied homes.

4. The full utilization of all of the City's existing surface water diversion rights are limited by the capacity of the City's old existing 20-inch raw water supply line and water treatment plant.

5. The City is also presently utilizing its full permitted capacity for all six City water supply wells during the summer.

6. Existing Bear River flow rates are so low in the late summer and fall that storage of spring run-off water is the only secure means available for acquiring the additional needed municipal water. This storage need is now very critical.

1.3 Future Municipal Water Shortage

Population projections for the City range from a high of 40,000 people to a low of 15,000 people ultimately and from 14,000 to 20,000 people within the next 10 years.

Regardless of the population projection used, the City of Evanston must double its present water supply within the next 10 years and provide additional water when the City grows beyond 20,000 people.

The Level II study, therefore, recommends developing the Sulphur Creek Reservoir enlargement to yield 4,200 Ac. Ft. per year or adequate water supply for 40,000 people and the raw water pipe line for 11.0 MGD or a population of 25,000 people. Excess storage water will be released annually by the City for irrigation use by the Sulphur Creek Water Users until all stored water is needed for City culinary use.

1.4 Municipal Water Development Plan

1.4.1 Bear River Water Availability

The 1980 Bear River Compact Amendment between Wyoming, Idaho and Utah allocated Wyoming an additional 35,000 ac. ft. of storage and 13,000 ac. ft. of annual depletion. The State Engineer has allocated the City of Evanston 9,370 ac. ft. of storage and 1,670 ac. ft. of annual depletion, which will allow for the projected municipal water needs to be stored at the Sulphur Creek Reservoir during spring run-off.

1.4.2 Best Practical Water Plan

After extensive geotechnical drilling and investigation and alternative and economic analysis, it was determined that this critical short supply water could be best provided by constructing the Sulphur Creek Enlargement Project described in Section 1.1 of this report. The specific project costs and elements are as follows:
UPPER BEAR RIVER PROJECT - EVANSTON MUNICIPAL SUPPLY

Sulphur Creek Reservoir Enlargement $5,239,000
Bear Canal Enlargement & Lining 1,050,000
Raw Water Supply Line 2,750,000
Hydroelectric Power Facilities 405,000

Total Municipal Water Supply Cost $9,444,000

The City of Evanston will also need to provide additional water system improvements in order to bring their present water system up to standard and meet future short range needs as follows:

EVANSTON ADDITIONAL WATER SYSTEM IMPROVEMENTS

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Treatment Plant Updates - Now</td>
<td>$1,030,000</td>
</tr>
<tr>
<td>Water Treatment Plant Expansion - 1995</td>
<td>3,300,000</td>
</tr>
<tr>
<td>Peaking Storage and Distribution</td>
<td>2,700,000</td>
</tr>
</tbody>
</table>

Total Additional Water System Costs $7,030,000

Total Evanston Water System Costs $16,474,000

1.5 State Participation and Evanston Ability-To-Pay

1.5.1 Evanston Water User Rates

The City's Water System Enterprise Fund has operated at a deficit since the 1977 oil impact began, therefore, new water use sensitive rates have now been implemented which have raised the monthly user rates from $9.00 to $20.45 per household.

This politically difficult action, although placing the Evanston user charges ($20.45) higher than the Casper rate of $17.64 and equivalent to the Cheyenne rate of $21.16, is still not expected to remove the water system deficit spending. Continued annual water user rate increases are mandatory in order to remove deficit spending and allow for the construction of just the additional $7,030,000 water system improvements without the Upper Bear River-Evanston Municipal Supply project.

1.5.2 State Participation in Evanston Municipal Supply Project

In light of the present budget situation, and need for $7,030,000 of additional water treatment and distribution system improvements, this critical need for additional water supply (Upper Bear River Project) comes at a very difficult time for the City. In our best judgement, the absolute upper limit of the City's ability-to-pay for its portion of the Upper Bear River project is 25 percent of the total cost at a four (4) percent interest rate or approximately $215,000.00 per year. Any additional funding burden could force the City into annual water user rate increases in excess of four to seven percent per year, which is politically impossible and an excessive burden.
The City of Evanston is, therefore, requesting the following State participation:

STATE PARTICIPATION SUMMARY

<table>
<thead>
<tr>
<th>Grant Funds</th>
<th>$7,083,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loan @ 4% Int. for 15 Yrs.</td>
<td>2,361,000</td>
</tr>
<tr>
<td><strong>Total State Participation</strong></td>
<td><strong>$9,444,000</strong></td>
</tr>
</tbody>
</table>

1.6 Project Impacts - Evanston Municipal Supply

1. Correct present Sulphur Creek dam deficiencies. Existing dam is on State's list of deficient dams.

2. Provide much needed water supply for the City of Evanston, thus providing adequate water now and also allowing for the continued growth of the area and State economy.

3. Provide positive flood control for the Bear River in the Evanston area.

4. The selected plan will also produce electric power for the area rather than require imported power at significant cost.

5. Additional irrigation water will be provided for the Sulphur Creek and other water users, as long as the City of Evanston's population stays less than 40,000 people.

6. Approximately 400 acres of irrigated pasture land will be displaced by the expanded reservoir.

7. The Evanston Boat Club and one old log house will have to be relocated.

8. Approximately 1.6 miles of county road will also have to be relocated.

9. The Sulphur Creek Water Users will no longer be the sole owners and operators of the Sulphur Creek Reservoir. The Upper Bear River Irrigators will also no longer be the sole owners and operators of the Westside and Bear Canals.

10. An increased reservoir pool will be provided, thus making the Sulphur Creek Reservoir an effective fishery.

11. Approximately one mile of the Sulphur Creek will be inundated, thus reducing the creek fishery by that amount during high storage periods.

12. Additional recreation on the enlarged lake will be provided.
13. All downstream irrigators will benefit from additional late season return waters.

14. Area economic diversification will be supported through an adequate supply of culinary quality of water.
2.0 UPPER BEAR RIVER PROJ.
WATER USERS
IRRIGATION SUPPLY
2.0 WATER USERS' IRRIGATION SUPPLY
WEST FORK OF THE BEAR RIVER RESERVOIR

2.1 Project Description

The Level II recommended water supply system for the Upper Bear River Water Users or the West Fork Reservoir Project is detailed below and highlighted by Figures 3, 6 and 7 in the Appendix.

1. West Fork Reservoir: Construct a new earth-filled dam on the West Fork of the Bear River which will create a storage capacity of 17,500 acre-feet as shown in Figures 3, 6 and 7 of the Appendix. This reservoir will then yield 10,000 acre-feet of irrigation water seven out of every 10 years, thus meeting the major portion of the annual Upper Bear River irrigation needs of 13,800 acre-feet per year.

2. Canal Improvements: In order to remove areas of high conveyance losses due to seepage, the point of diversion of the East Fork Canal will be changed, thus eliminating several miles of existing canals, and also 0.5 miles of the Bear Canal will be lined. One new transfer structure will also be needed at Mill Creek.

3. Additional Dam Abutment Investigations: It is recommended that additional investigation be performed on the right abutment before beginning final design of the dam structure. From the Level II work performed, we have been able to verify the feasibility and stability of the dam. Because of the complexity of the glacial moraine forming the right abutment and right side of the reservoir, we were not able to perform a seepage analysis. Additional work needs to be done to more completely define the characteristics of the moraine, including the depth, thickness, lateral extent, permeability characteristics, and amount of cover soil.

4. Water Conservation Measures Needed: Three conservation practices have been proposed to help make up the unmet water need: 1) The first is a change from continuous flooding to intermittent flooding while irrigating, with an accompanying change in crop type from hydrophilic species to grasses and legumes; 2) The second is a change of diversion point for the Hilliard East Fork Canal. By moving the point of diversion downstream about nine miles, approximately 30 percent of the flow of the canal, now lost to seepage, can be saved; 3) The third is lining of a short section of the Bear Canal where a large amount of seepage occurs. The lining is intended to eliminate most of this seepage.
2.2 Existing Upper Bear River Irrigation Shortage

The ranchers in the Upper Bear River drainage area have historically suffered from a lack of late season irrigation water. Usually by early July, sometimes much sooner, diversions from the Bear River into irrigation canals are closed to provide water to higher priority downstream users. This lack of water has put severe limitations on the agricultural productivity of the area. An additional 13,800 acre-feet of water is needed annually to satisfy the irrigation needs for the 17,250 irrigated acres in the area.

Not only is there a lack of late season water historically, but on dry or drought years ranchers can not irrigate their pasture even in June. This drought condition thus forces the ranchers to sell much of the breeding stock that otherwise would be carried over and rebuilt annually. This causes a herd depletion which often takes years to replace. The drought avoidance provided by the West Fork Reservoir will, therefore, significantly improve the long term productivity of the ranch operations in the area.

2.3 Irrigation Water Development Plan

2.3.1 Bear River Water Availability

The Upper Bear River and Mill Creek Water User's Association received, in 1983, an annual storage allocation of 10,335 acre-feet and an annual depletion allocation of 4,125 acre-feet of Bear River compact water. This new allocation will supply about 75 percent of the unmet water needs. The other 25 percent must be made up by conservation practices by the irrigators.

2.3.2 Best Practical Water Plan

It is proposed that a reservoir be constructed on the West Fork of the Bear River to store the new allocation of water. The water is to be stored during spring run-off for later irrigation use. A stochastic method was used to size the reservoir to insure a 10,000 acre-feet annual yield with 70 percent reliability. A reservoir of 17,500 acre-feet meets this requirement.

A geologic investigation, foundation investigation, borrow investigation and preliminary design for the proposed West Fork Dam were completed. The geologic and foundation investigation revealed that the west abutment and central section of the proposed structure will be founded upon clay and sandy clay deposits formed in an ancient proglacial lake. These deposits are firm, well consolidated and very impermeable. They will provide a very good foundation for the structure and a relatively water tight reservoir basin.

The east abutment is composed of glacial morrainal material deposited along the margin of a glacier occupying the Bear River Channel.
These deposits are discontinuous and unpredictable. Some areas within the moraine are very porous and permeable, while others are relatively impermeable. A three to seven feet thick soil layer covers much of the moraine.

The borrow investigation showed that enough satisfactory material is available in the immediate vicinity from which to construct the dam.

Three alternate alignments for the dam were studied. Details of the most cost effective project are shown in Figures 6 and 7 and cost estimated below:

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<tr>
<th>UPPER BEAR RIVER PROJECT - WATER USERS' IRRIGATION SUPPLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Fork Reservoir                                 $5,848,000</td>
</tr>
<tr>
<td>Canal Improvements                                 232,000</td>
</tr>
</tbody>
</table>

Total Irrigation Supply Costs                                $6,080,000

2.4 Irrigators' Ability-To-Pay

An economic analysis was performed to determine the ability of the ranch operators to pay for these improvements. Estimates were made based upon several methods, including changes in income, the value of alternative feed, and land sales. The outcome of these estimates is dependent upon the required rate of return on investment. If no return on investment is required, the estimates range from $2.50 per acre to $9.50 per acre. If a return of five percent on investment is required, the estimates of ability to pay reduce to a range of $.32 to $1.82 per acre.

Perhaps the best estimate of ability to pay comes from the ranchers themselves. They have indicated that the maximum they can pay for supplemental water is $2.50 per acre, which sum includes an existing payment of $.86 per acre for the construction of Whitney Dam. The Whitney Dam will be paid for in 1991. After 1991 the $2.50 per acre applied over the 17,250 irrigated acres would amount to an annual payment of $43,125.

2.5 State Participation

The Upper Bear River Water Users are requesting additional funding for further geotechnical investigation and seepage analysis of the West Fork Dam right abutment at this time in order to refine the anticipated dam construction costs. Next year the irrigators will be requesting Level III and IV funding for their project based on their ability-to-pay.

2.6 Project Impacts - Water Users' Irrigation Supply

1. Provide much needed late season irrigation water supply for 17,250 acres of grass land annually.
2. Provide some water on dry years, thus avoiding the herd depletion effects of drought.

3. Provide positive flood control for the Bear River in the Evanston Area.

4. Approximately 360 acres of non-irrigated privately owned land will be displaced by this reservoir project.

5. Approximately 1.2 miles of the West Fork of the Bear River will be inundated, thus reducing the river fishery by that amount.

6. Additional recreation on the new lake will be provided.

7. An additional reservoir fishery will be provided since a minimum reservoir pool of 500 acre-feet will be provided.

8. All downstream irrigators will benefit from additional late season return waters.

9. Area economic diversification will be encouraged because of additional water supply availability.
FIGURE 3 LIES DIRECTLY SOUTH OF FIGURE 2

CITY OF EVANSTON PROPOSED WATER SUPPLY SYSTEM

EVANSTON WATER TREATMENT PLANT

POSSIBLE HYDROPOWER SITE

NEW EVANSTON WATER SUPPLY LINE

EXISTING 20" EVANSTON SUPPLY LINE

EXISTING EVANSTON INTAKE

SULPHUR CREEK RESERVOIR ENLARGEMENT

FORSGREN - PERKINS ENGINEERING
ROLLINS, BROWN & GUNNELL, Inc.

UPPER BEAR RIVER PROJECT
CITY OF EVANSTON WATER SUPPLY SYSTEM
EXISTING GROUND EL. 7166

ZONE I

FILTER DRAIN

RIPRAP BEDDING

RIPRAP

APPROXIMATE MATERIAL DESCRIPTION

BORROW SOURCE

APPROXIMATE QUANTITY CUBIC YARDS

ZONE 1

SILTS & CLAY WITH A MINIMUM OF 50% PASSING A NO. 200 SIEVE, AND A MINIMUM PLASTICITY INDEX OF 4.

500 - 325

865,000

FILTER DRAIN

PROCESSED GRANULAR MATERIAL MEETING THE GRADATION REQUIREMENTS SPECIFIED

330 - 346

56,500

RIPRAP MOUNDING

WELL-GRaded SANDY GRAVEL, WITH A MAX SIZE OF 4", A MINIMUM OF 50% RETAINED ON A NO. 4 SIEVE, A MINIMUM OF 6% PASSING A NO. 200 SIEVE.

330 - 346

8,000

RIPRAP

WELL-GRaded ROCK FRAGMENTS AND COAL, HAVING A MAXIMUM SIZE OF 8", AN AVERAGE SIZE OF 4", AND A MINIMUM SIZE OF 2", OR COMMERCIAL

330 - 346

14,000

NOTE:

ACCEPTABLE MATERIALS EXCAVATED FROM THE CUT-OFF TRENCH, OUTLETS, OR OTHER AREAS SHALL BE USED IN THE CONSTRUCTION. ORGANIC MATERIALS SHALL BE WASTED.

NOTE:

1. CUT-OFF TRENCH SHALL EXTEND TO FORM DECOMPOSED SHALE OR CLAY, OR TO COMPETENT BEDROCK WHERE SHALE OR CLAY ARE NOT ENCOUNTERED, AS DETERMINED BY THE CONSTRUCTION ENGINEER.

2. THE FILTER DRAIN SHALL BE PLACED BETWEEN STA 6+00 AND STA 46+80.

3. FOUNDATION GROUTING SHALL BE DONE BETWEEN STA 0+00 AND STA 20+00.

HILLIARD FORMATION (SHALE)

Maximum Cross Section

Sta. 42+00

ZONE 1

Silty Clay and Sand

HILLIARD FORMATION (SANDSTONE)

Cross Section Sta. 9+00
EXISTING GROUND EL 8258

ZONE MATERIAL DESCRIPTION

ZONE I CLAY, SANOY CLAYS, GRAVELLY CLAYS, CLASSIFYING AS DM, SG, or CL-1; OR DM, SG, or CL-1; OR QM OR QG WITH A MINIMUM PLASTICITY INDEX OF 4% AND A MAXIMUM PARTICLE SIZE OF 4".

ZONE II SANDY CLAYS, GRAVELLY CLAYS, CLASSIFYING AS CM, SG, or CU-1 WITH A MAXIMUM PARTICLE SIZE OF 4".

FILTER DRAIN PROCESSED GRANULAR MATERIAL MEETING THE GRADATION REQUIREMENTS SPECIFIED.

RIPRAP WELL-GRADED ROCK FRAGMENTS AND COBBLES HAVING A MAXIMUM SIZE OF 28", AN AVERAGE SIZE OF 4", AND A MINIMUM PASSING A NO. 400 SIEVE. WITH A MINIMUM OF 50% PASSING A NO. 200 SIEVE.

RIPRAP WELL-GRADED ROCK FRAGMENTS AND COBBLES HAVING A MAXIMUM SIZE OF 28", AN AVERAGE SIZE OF 4", AND A MINIMUM PASSING A NO. 400 SIEVE.

IMPERMEABLE BLANKET CLAY, SANOY CLAYS, GRAVELLY CLAYS, CLASSIFYING AS DM, SG, or CL-1; OR DM, SG, or CL-1; OR QM OR QG WITH A MINIMUM PLASTICITY INDEX OF 4% AND A MAXIMUM PARTICLE SIZE OF 4".

Typical Section Sta. 0+00 - Sta. 2+00

Maximum Cross-Section Sta. 12+00

Typical Section Sta. 20+00 - Sta. 26+85

Notes:
1. CUTOFF TRENCH SHALL EXTEND TO FIRM CLAY AS DETERMINED BY THE ENGINEER.
2. FILTER DRAIN SHALL BE PLACED FROM STA. 3+00 TO STA. 20+00.
3. DRAINAGE WELLS SHALL BE PLACED AT 30' CENTERS FROM STA. 13+50 TO STA. 16+00.
4. IMPERMEABLE BLANKET SHALL BE PLACED FOR A DISTANCE OF 300 FEET FROM THE UPSTREAM TOE IN ALL AREAS WHERE THE WATER DEPTH WILL EXCEED 10 FEET FROM STATION 13+50 TO STATION 26+85.

Notes:
1. ACCEPTABLE MATERIALS EXCAVATED FROM THE CUTOFF TRENCH, OUTLETS, OR OTHER AREAS SHALL BE USED IN THE CONSTRUCTION. ORGANIC MATERIALS SHALL BE WASTED.

ZONE | MATERIAL DESCRIPTION | APPROXIMATE QUANTITY CU YDS
---|---|---
ZONE I | CLAY, SANDY CLAYS, GRAVELLY CLAYS, CLASSIFYING AS DM, SG, or CL-1; OR DM, SG, or CL-1; OR QM OR QG WITH A MINIMUM PLASTICITY INDEX OF 4% AND A MAXIMUM PARTICLE SIZE OF 4". | 848,000
ZONE II | SANDY CLAYS, GRAVELLY CLAYS, CLASSIFYING AS CM, SG, or CU-1 WITH A MAXIMUM PARTICLE SIZE OF 4". | 435,000
FILTER DRAIN | PROCESSED GRANULAR MATERIAL MEETING THE GRADATION REQUIREMENTS SPECIFIED. | 43,000
RIPRAP | WELL-GRADED ROCK FRAGMENTS AND COBBLES HAVING A MAXIMUM SIZE OF 28", AN AVERAGE SIZE OF 4", AND A MINIMUM PASSING A NO. 400 SIEVE. WITH A MINIMUM OF 50% PASSING A NO. 200 SIEVE. | 15,000
RIPRAP | WELL-GRADED ROCK FRAGMENTS AND COBBLES HAVING A MAXIMUM SIZE OF 28", AN AVERAGE SIZE OF 4", AND A MINIMUM PASSING A NO. 400 SIEVE. | 29,800
IMPERMEABLE BLANKET | CLAY, SANDY CLAYS, GRAVELLY CLAYS, CLASSIFYING AS DM, SG, or CL-1; OR DM, SG, or CL-1; OR QM OR QG WITH A MINIMUM PLASTICITY INDEX OF 4% AND A MAXIMUM PARTICLE SIZE OF 4". | 120,000

ACCEP TABLE MATERIALS EXCAVATED FROM THE CUTOFF TRENCH, OUTLETS, OR OTHER AREAS SHALL BE USED IN THE CONSTRUCTION. ORGANIC MATERIALS SHALL BE WASTED.

Wyoming Water Development Commission
West Fork Dam Cross Sections Figure 7