

**REPORT ON THE
RECOVERY OF ABERDEEN-SPRINGFIELD PROJECT WATER
BY WELLS**

**Prepared for:
Aberdeen-Springfield Canal Company**

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REPORT ON THE RECOVERY OF ABERDEEN-SPRINGFIELD PROJECT WATER BY WELLS

EXECUTIVE SUMMARY

The Aberdeen-Springfield Canal Company (ASCC) and its predecessor has been delivering water from the Snake River to its shareholders since 1907. A large component of the water diverted from the river seeps into the local ground water system. Water leaks from the ASCC's canals and laterals and non-consumed irrigation water percolates through the soils to the ground water body. Over time the water level in the underlying ground water system has risen so that in some areas the surface of the ground water body is at or near the land surface. *When for how long?*

which wells? Many wells were constructed to lower the undesirable high water table. With time, wells were *which wells* ~~those~~ *on* constructed by the company and its shareholders to recover the surface water that had *the* *35* *40s* seeped into the ground water system and reapply the recovered project water to lands served by the ASCC. Today there are about 270 wells producing water that supplements the surface water supply to irrigated lands within the ASCC's service area.

There is a productive aquifer, the Aberdeen Aquifer, underlying the ASCC service area. The geology is much more complex than that found in most of the Eastern Snake Plain Aquifer which is west of this subject area. The area, in the past, was not only covered by lava flows but was also, at times, covered by lakes that deposited lacustrine sediments. These fine-grained materials, in places, separate productive aquifer materials, basalts, deposited from various flows and, hence, sub-aquifers are created, sometimes under artesian pressure.

Recharge from ASCC to the ground water body can be divided into two categories; namely, 1) recharge via seepage from conveyance canals and laterals, and 2) recharge via seepage from irrigated fields. The combined impact of these two methods then accounts for the total recharge to the ground water body beneath the ASCC's system. On an average, about 320,000 acre-feet (af) is diverted each year into the Aberdeen-Springfield Canal and about 55%, or about 177,100 af, is lost from the system by seepage before delivery to the fields.

This seepage recharges the ground water body beneath the canal system.

$\uparrow$ 1 share/acre = 58,942 acres.

There are approximately 59,000 ASCC acres irrigated within the system. On an average, the company delivers to the fields about 107,800 af per year. The ASCC also assesses approximately ^{58,942} ~~59,000~~ shares. Some of these lands use ground water obtained from recovery wells as a supplemental water supply. Ground water districts have recently been formed in the Aberdeen-Springfield area and data are being tabulated to better determine the amount of ground water pumpage in the area. It is believed that only a fraction of the recharged water from the project is pumped and recovered each year. Until such data are available, for purposes of this report it has been estimated that approximately 34,000 af are pumped each year as a supplemental water supply. This combined with the deliveries from the canal system yields a total average water supply to the fields of 141,800 af. Of this amount, approximately 118,000 af is consumed by the crops leaving approximately 23,800 acre-feet as additional recharge or for a total of 200,900 af annually.

However, as noted above, ground water is used as a portion of the total supply to the ASCC's assessed acreage. Hence the net ground water recharge to the Aberdeen Aquifer, after subtracted out the estimated ground water pumpage, is 166,900 af annually. The table which follows shows a tabulation of the amount of water that, on an average, is diverted and in part is recharge water to the aquifer system.

RECOVERY OF ASCC PROJECT WATER BY WELLS

Calculation of ASCC's Annual Ground Water Recharge		
Activity	Volume * (acre-feet)	Percent of Diversion (%)
Diversion from the Snake River	320,000	100%
Measured spills back to Snake River or American Falls Reservoir	32,000	10%
Measured spills to Hilton Basin	1,120	0%
Estimated evaporation from canals and laterals	2,230	1%
Delivery to fields from surface water	107,800	34%
Calculated ground water recharge from canals and lateral seepage	177,100	55%
Calculated ground water recharge from irrigated fields	23,800	NA
Total ground water recharge by ASCC system	200,900	NA
Estimated ground water pumpage as an ASCC supplemental supply	34,000	NA
Net ground water recharge by ASCC system	160,900	52%

* These values are all rounded values taken from the text of the report.

Over more than nine decades, millions of acre-feet of water have seeped from the company's delivery system into the underlying ground water body and a very sizable amount of water is in residence directly under the ASCC's system as a result of this recharge. A ground water mound is now under the ASCC delivery system. Each year ground water levels rise in summer months within the ASCC service area as a result of the recharge, despite the fact that ground water is being pumped by the wells. During the non-irrigation season, ground water

levels decline as this water from this summertime build-up disperses to adjacent areas. Over the decades since irrigation began, the millions of acre-feet of water seeping into the ground water system from the ASCC deliveries have created a general rise in water levels in the area of several tens of feet.

TABLE OF CONTENTS

Executive Summary	i
Table of Contents	v
List of Figures	vi
1.0 Overview	1
1.1 Purpose and Scope of Investigation	1
1.2 Location of the Service Area	2
1.3 History of Water Diversion by ASCC	4
2.0 ASCC Delivery System	7
2.1 Delivery from the River	7
2.2 Wells	11
3.0 Ground Water Hydrology	16
4.0 Irrigation of Crops	24
5.0 Ground Water Recharge Through Canal Losses and Seepage from Irrigated Fields	27
5.1 Water Diversions, Deliveries and Canal Losses	27
5.2 Consumptive Use of Crops and Surface and Ground Water Seepage from Cropped Areas	30
5.3 Water Budget of Imported Water	32
6.0 Impact of ASCC Ground Water Recharge to the Aberdeen Aquifer	34
6.1 Water Level Change	34
6.2 Age of Ground Water	42
7.0 Conclusions	44
References Cited	45

LIST OF FIGURES

Fig. 1	Aberdeen-Springfield Canal Company, Map showing location, delivery system and assessed acres	3
Fig. 2	Check dam and the ASCC feeder canal with flow to right returning to Snake River and ASCC Main Canal flowing to the left above the check dam	8
Fig. 3	A section of the main canal where significant seepage occurs	8
Fig. 4	Looking down the High Line Canal in the Big Fill area. Photo is just below the split from the Main Canal and the Big Fill Reservoir can be seen to the right	10
Fig. 5	Looking down the raceway where water is split from the Main Canal into the Low Line Canal	10
Fig. 6	Ground water recovery well in the foreground with a center pivot in the distance that is supplied water from the well	12
Fig. 7	Production wells located in the ASCC service area as reported to IDWR by the Aberdeen-American Falls and the Bingham Ground Water Districts	13
Fig. 8	Cumulative totals of wells, by type, drilled in the Aberdeen-Springfield area	15
Fig. 9	Stearns geologic map	18
Fig. 10	Character and Water-Bearing Properties of Geologic Units in the American Falls Reservoir Area	21
Fig. 11	Selected well logs from the Aberdeen-Springfield area	23
Fig. 12	Aberdeen-Springfield Canal, Canal Diversion, Deliveries, Losses and Calculated Ground Water Recharge	28
Fig. 13	Graph of Canal Delivery, Loss and Recharge	31
Fig. 14	Reproduction of Stearns 1938 water level map	36
Fig. 15	Profile of ground water levels in Aberdeen Aquifer after Stearns (1938)	37
Fig. 16	Composite hydrograph of water level measurements made by the ASCC of Aberdeen Aquifer	41

REPORT ON THE RECOVERY OF ABERDEEN-SPRINGFIELD PROJECT WATER BY WELLS

1.0 OVERVIEW

1.1 Purpose and Scope of Investigation

The Aberdeen-Springfield Canal Company (ASCC) retained Barnett Intermountain Water Consulting (BIWC), through its attorney, Roger D. Ling, to investigate the ground water resources that underlie the ASCC service area. The focus of the investigation was to determine how wells in the ASCC service area are recovering ground water which is the result of seepage from the ASCC delivery system and from the irrigation of land with water delivered by ASCC within the company's service area (see Idaho Code 42-228). For a significant period of time, large volumes of water diverted by ASCC to be delivered to its users have been lost by seepage to the ground water resource of the area and a portion of this water has been recovered by wells and reused on ASCC serviced lands.

The purpose of the investigation and this report is to quantify and describe this movement of imported surface water into the underlying ground water body, to describe the nature of the ground water body and to describe and quantify the recovery of the surface water recharged to the ground water body by wells operated by ASCC and its shareholders. The investigation only considered the impact of this artificial recharge to the ground water system that exists below the ASCC service area and the impact to the larger Eastern Snake Plain Aquifer (ESPA) if observations in that regard assisted in the understanding of the water resources within the service area. Field work

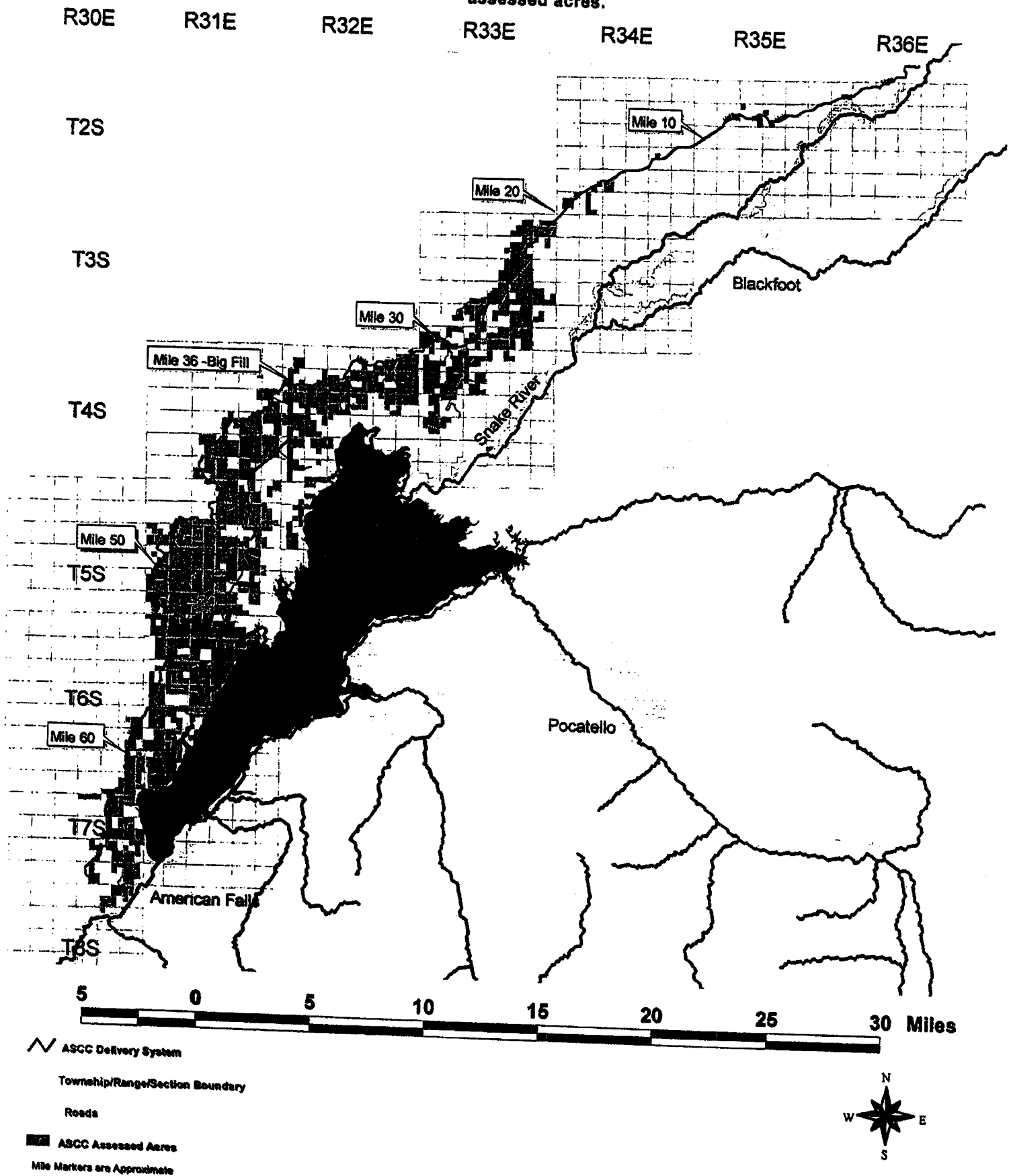
was accomplished by BIWC in 2000 only to acquaint the investigators with the area and the operation of ASCC. No new data was collected. BIWC relied on information gained by interviews with ASCC officials and state officials and by information in print and in the public record.

1.2 Location of the Service Area

The service area of the ASCC is the area covered by this report. In this report, the service area is defined as starting in the northeast extent of the study area at a point where the diversion dam of the Aberdeen-Springfield Canal diverts water from the Snake River north of Blackfoot near the community of Firth. The canal then extends southwesterly, approximately 53 miles (67.5 canal miles), to a point where the main canal terminates and the last water deliveries by ASCC are made. The location of the service area is shown on Figure 1. The Snake River and the American Falls Reservoir parallel the area on the southeast and the shoreline of the reservoir makes up the southeastern boundary of a portion of the area. The lower extent of the service area is approximately three miles below (southwest) the American Falls Dam. The northwest extent of the service area is approximately the location of the ASCC main canal, with some lands being served by the company just west of the canal.

The area is in Bingham and Power Counties and can be accessed from the south by leaving I-86 at the community of American Falls and traveling north on State Highway 39. The larger communities in the study area are on State Highway 39 and are Aberdeen and Springfield. The service area is considered in this investigation to be lands under and adjacent to the ASCC canal and laterals which are the approximately

**Figure 1. Aberdeen-Springfield Canal Company
Map showing location, delivery system, and
assessed acres.**



Prepared by: S.T. Howser, 9/11/2000

59,000 acres of agricultural lands within the ASCC delivery system that are assessed each year by the company.

1.3 History of Water Diversion by ASCC

The Carey Act was a federal law that encouraged land reclamation in the West. The Act was very important in Idaho. In all, there were 65 projects in the state (Williams, 1970). The Idaho Department of Water Resources (IDWR) has researched the history of the Carey Act in Idaho and published a report. Most of the material offered here was abstracted from that report. The area now served by the ASCC was initially identified as the American Falls Project under the Carey Act. The project, as proposed, was one of the first Carey Act proposals in Idaho and was given the Carey Act. The Carey Act allowed for companies to be formed that, with some initial up-front financial backing, proposed to develop water delivery companies and sell water to new settlers on lands that were allowed to be segregated from the federal domain by, in the case of Idaho, the Idaho State Land Board.

The original proposal for the American Falls Project was received by the State Land Board on December 14, 1895 from the American Falls Canal and Power Company (AFCPC), which was to be the original construction company. Two requests for the segregation of the federal land were denied but in 1899 the construction company was granted its segregation request which approved the development of the water facilities to irrigate the segregated desert lands. The ASCC holds a February 6, 1895 natural flow right to divert 1172.1 cfs from the Snake River. The final contract was agreed to in 1901 and construction commenced. The company's original proposal called for an all-gravity system to divert water from the Snake River. The point of diversion of the waters from

the Snake River was in Bingham County and the project, it was intended, would irrigate lands in both Bingham and Power Counties.

As with many of the Carey Act proposals, the initial economics were flawed. It was estimated that the project would cost about \$250,000 and that the company could manage a viable project by selling a perpetual water right to the settlers for about \$10 per acre. As the project progressed, it became apparent that the costs had been grossly underestimated and with still some work remaining to be accomplished, expenditures had reached about \$886,000. The AFCPC was deep in debt and was allowed to fall into receivership. The interests of the company were purchased by a new company, the American Falls Canal Security Company (AFCSC). In 1914, the original construction company was declared to be in voluntary bankruptcy. There was a pattern in Idaho with many of the original construction companies falling into bankruptcy as was the case with the American Falls Project. The AFCSC increased the price of water to \$40 per acre to put the project on an improved financial basis.

It was soon determined that in the course of some of the irrigation seasons there was shortage of water on the Snake River to serve the project and so the AFCSC entered into a contract with the U.S. Bureau of Reclamation to purchase storage water from the Jackson Reservoir on the Snake River in Wyoming. As the project progressed, it was determined that some lands could be served by pumping water to a higher elevation and a second company was created to manage the pump systems. That second company was named the Rockford Canal Company (RCC). The RCC has become inactive and all of the water users who were served by the RCC now pump water from wells and recover water lost by leakage from the ASCC system.

In 1910, the contract between the State of Idaho and the AFCSC was judged to be complete and an operating company was created; the Aberdeen-Springfield Canal Company, which has continued to operate the project for the last ninety years. The ASCC's policy is to allow one share per acre. The ASCC has 58,942 shares.

2.0 ASCC DELIVERY SYSTEM

2.1 Delivery from the River

Figure 1 is, in part, a map of the ASCC delivery system as provided by the ASCC. The diversion of water from the Snake River occurs near Firth, Idaho in Section 34 in T1S, R36E. Water initially is diverted into a feeder canal and runs south in the feeder canal for a distance of approximately three miles. The feeder canal provides a control with respect to the volume of water conveyed through the ASCC system as a check dam across the feeder canal allows for spills back to the river system and a measured flow into the Aberdeen-Springfield Canal. Figure 2 is a photograph of the check dam with the flow of water observed to the right returning to the Snake River. The feeder canal can be observed looking upstream in the center part of the photograph and to the left, not observed in the photograph and above the check dam, water flows into the Aberdeen-Springfield Main Canal. Figure 1 illustrates the route of the canals and laterals in blue. The areas in green on the figure indicate lands served by the ASCC. Laterals off the canal are illustrated on the map with the first two laterals diverting from the canal more than 20 miles downstream in Section 14 of T3S, R33E. In total, there are forty-four laterals and they are illustrated on the map. Figure 3 is a photo looking upstream along the main canal in Section 9, T4S, R32E. The canal is often operated near capacity. This photo is looking into an area where significant seepage occurs but the water in the full canal conceals the nature of the canal bottom.

At a point in Section 7, T4S, R32E the canal is split into a High Line Canal and a Low Line Canal. At this split, water is also diverted into the Big Fill Reservoir which serves as a re-regulating reservoir as water from this storage can pass under the High Line Canal and feed the Low Line Canal. The photograph on the cover of the report is

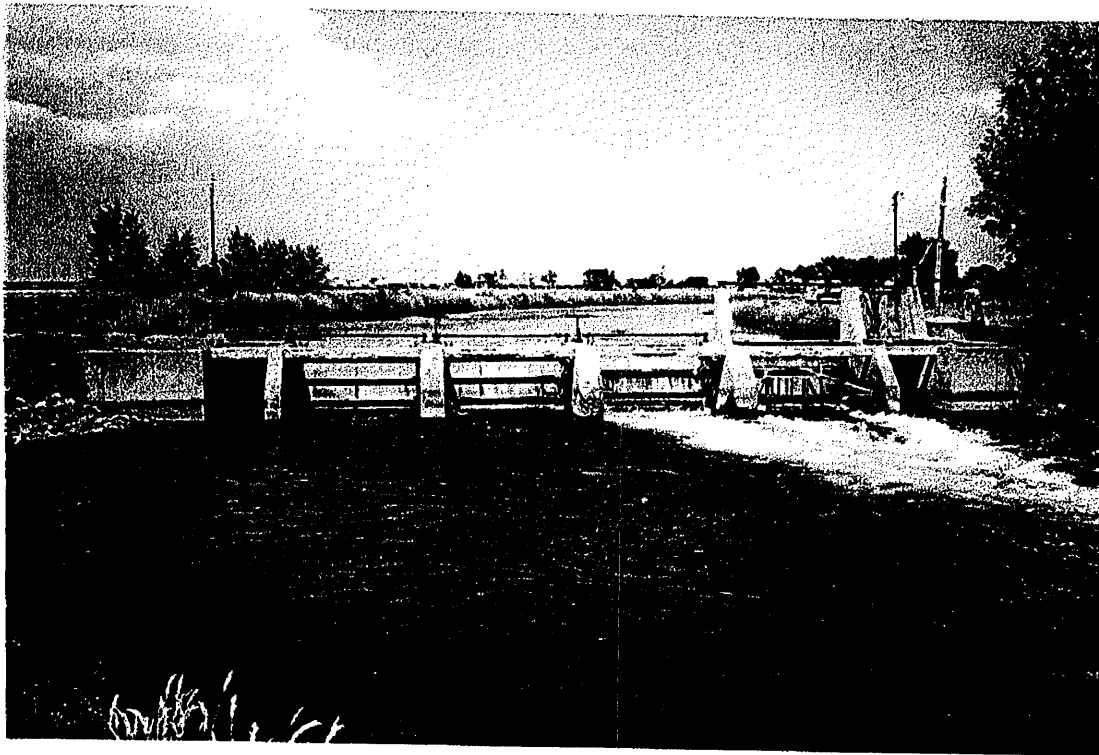


Figure 2. Check dam and the ASCC feeder canal with flow to right returning to Snake River and ASCC Main Canal flowing to the left above the check dam.

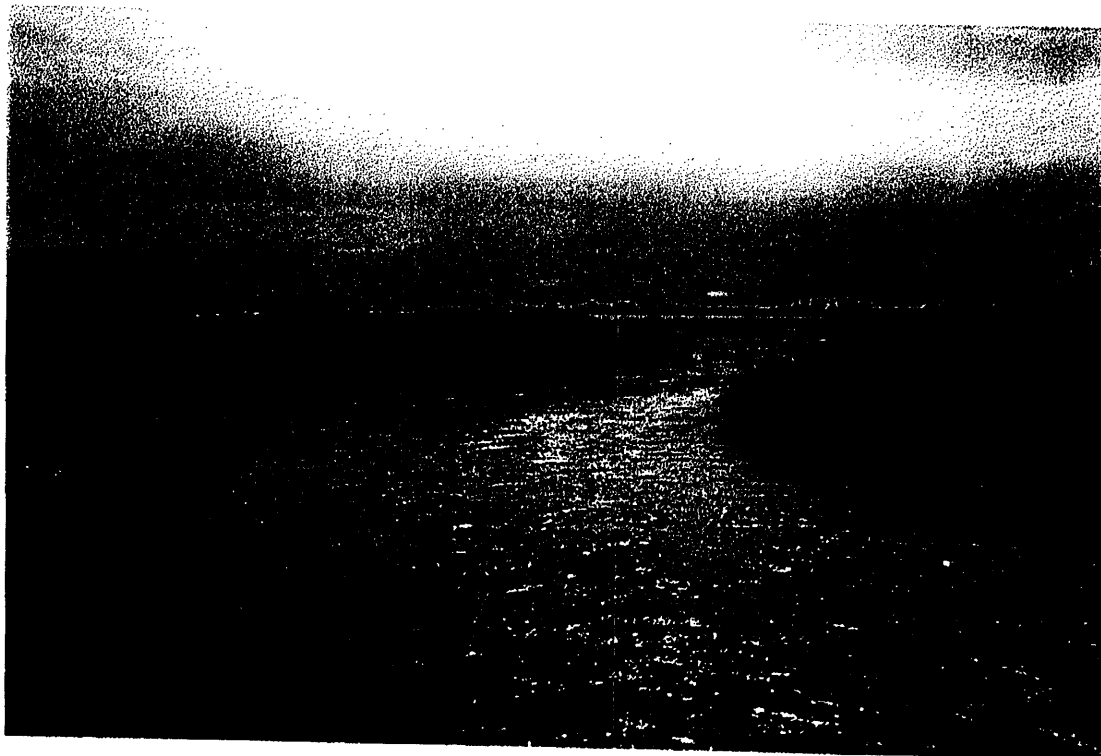


Figure 3. A section of the main canal where significant seepage occurs.

looking upstream from where the canal is split and on the left a gage house can be seen where water is diverted to the Big Fill Reservoir. Figure 4 is a photograph taken at the point where the canal is split. The photo is looking downstream along the High Line Canal, with the Big Fill Reservoir in the distance to the right. Figure 5 is a photo looking down a raceway just below where the main canal is split off. The raceway discharges water to the Low Line Canal.

In total, there are 84 miles of delivery canals and 286 miles of laterals. The total surface area covered by the canals and laterals is estimated by the ASCC to be 733 acres. This entire, very lengthy delivery system is composed of unlined conveyances that, in some areas, cross over lava flows where water can be observed, at times, to be sinking into the ground water as whirlpools will develop. When the canal system is not full, openings or fractures in the canal bed can be observed that would allow water to flow directly into the underlying ground water aquifer.

To better control the flow of water through this long system, the ASCC maintains fifteen discharge points back to the river or to the American Falls Reservoir where these return flows are measured. In addition, there is an area adjacent to the canal that is a closed basin with basalt exposed at the land surface. This basin is referred to as the Hilton Basin and it is located in Section 31, T3S, R33E. Water can be diverted into this basin when demands downstream in the delivery system are reduced. The spilled water rapidly infiltrates into basalts and the underlying aquifer system.



Figure 4. Looking down the High Line Canal in the Big Fill area. Photo is just below the split from the Main Canal and the Big Fill Reservoir can be seen to the right.

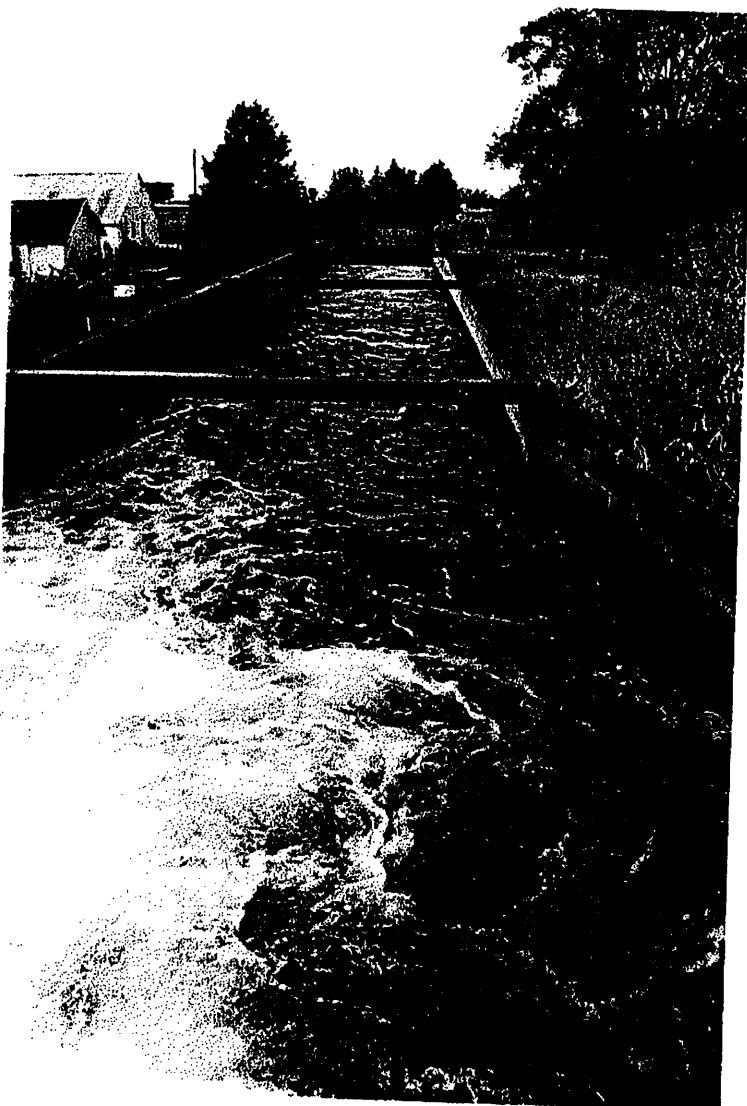


Figure 5. Looking down the raceway where water is split from the Main Canal into the Low Line Canal.

2.2 Wells

Over the decades since the deliveries of water from the Snake River have taken place, hundreds of wells have been drilled in the ASCC service area. Some were drilled initially as drainage wells. With time, some of the drainage wells were converted to production wells and, in later years, wells were drilled to ^{divert} produce water from the recharged underlying aquifer for flood irrigation. Much of the flood irrigation has now been converted to sprinklers and there is economy and convenience in providing pumped water from the ground directly into pressurized sprinkler systems. Figure 6 is a photograph of a well with a sprinkler system in the distance. Figure 7 is a map which shows the location of producing wells within the ASCC service area reported to the IDWR by the two newly created ground water districts; the Aberdeen-American Falls Ground Water District and the Bingham Ground Water District. The map was provided by the IDWR. The IDWR reports there has been identified 270 producing wells, but some in this total will be dropped from the forthcoming reports if they are irrigating less than 5 acres.

The many irrigation wells in the area that are operated by ASCC shareholders have become an extension of the ASCC delivery system and allow for the recovery of project water from the recharged ground water system for use on project lands. Many of these irrigation wells were drilled after 1952. Castelin (1974) investigated the drilling of wells and stated the following:

Figure 5, showing cumulative totals of wells by type drilled in the area from 1949 to 1970, gives an indication of degree and type of development occurring. Additional wells are in use, but many of those drilled prior to

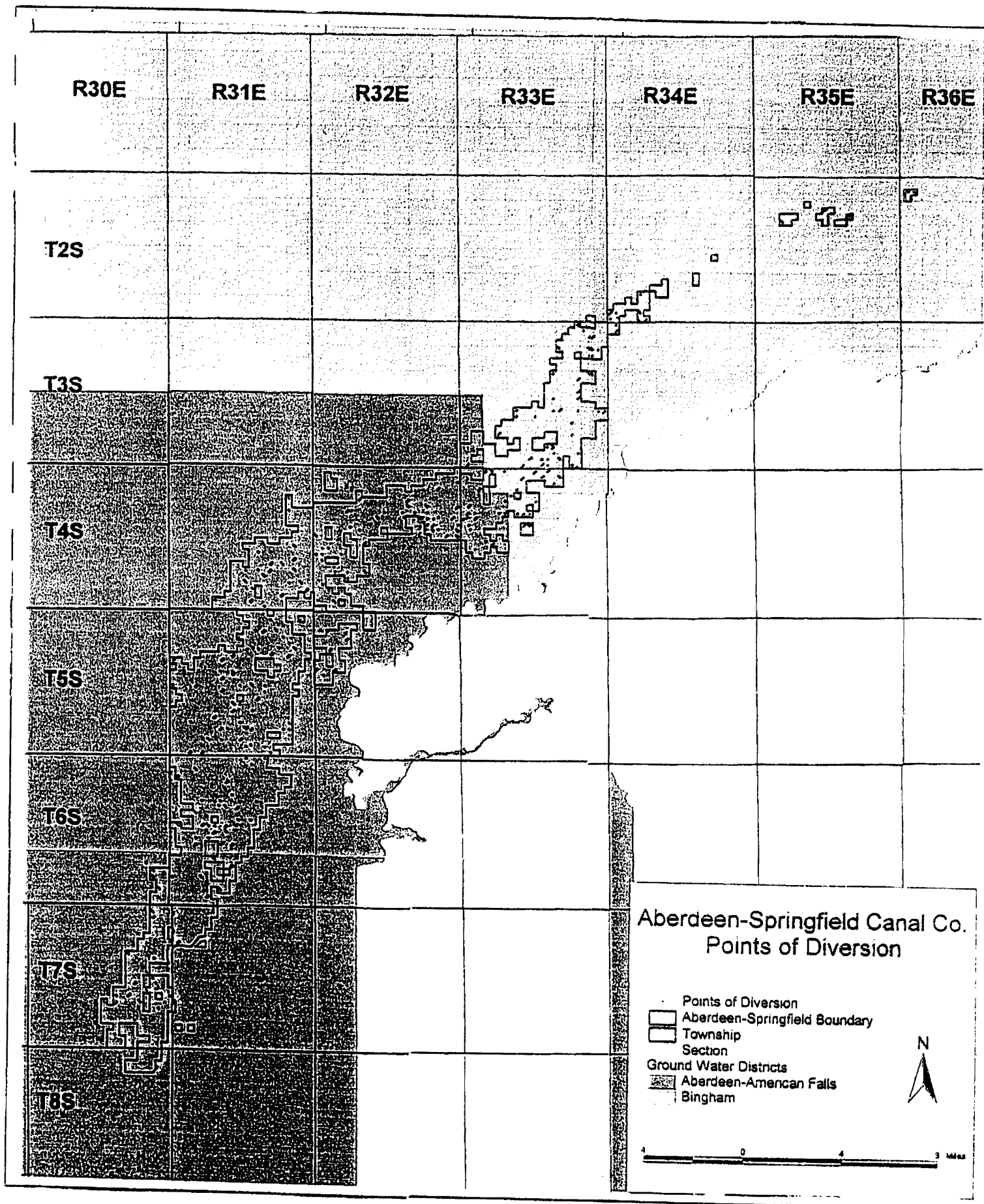


Figure 7. Production wells located in the ASCC service area as reported to IDWR by the Aberdeen-American Falls and the Bingham Ground-Water Districts.

July 1, 1953, are not included in well driller reports submitted to the Department of Water Administration from whose files figure 5 was derived. On the basis of the 391 reports examined, 134 wells (34%) were 16 inches in diameter, 72 (18%) were 18 inches in diameter, and 62 (15%) were 6 inches in diameter. Irrigation wells range in depth from as shallow as 60 feet to as deep as 495 feet, with most being between 200-300 feet deep.

It should be noted that although Castelin was studying the "Aberdeen-Springfield Area," his area of study covered a much larger area than the service area of the ASCC. Many of the wells reported may have been drilled on "new" lands being developed adjacent to the ASCC system and other canal systems. These wells for new lands were taking advantage of the recharged aquifers in the area that had received water for decades from the canal systems. Castelin's observations do document the significant well drilling and ground water development occurring from 1952 to 1970. Almost certainly Castelin does not report many additional wells drilled as water well drilling and the required reporting of wells drilled to IDWR was only starting to be regulated by the State by the end of Castelin's reporting period.

*so, will
-Roger's
Claim
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this
continued
use?*

Figure 8 has been copied directly from the Castelin report. The figure illustrates that over a period of about 17 years, mostly large diameter irrigation wells were being reported as being drilled in the area studied by Castelin at the rate of about 16 per year. Cumulatively, this represents a very significant development of the recharged ground water resource.

3.0 GROUND WATER HYDROLOGY

The ASCC service area is on the eastern edge of the Eastern Snake Plain Aquifer (ESPA). The ESPA is a remarkable aquifer. The aquifer has been significantly recharged by irrigation activities since early in the Twentieth Century and the aquifer is heavily used to produce ground water for irrigation. Springs which discharge from the aquifer are very significant and help maintain the flow of the Snake River. Some visualize the ESPA as one large contiguous block of basalt that is extremely permeable because of the pore spaces created during the deposition and cooling of basalt flows. Lava flowed across the plain and with many flows over an extended period the plain was built. In the resulting basalts, there are large openings, such as voids, fractures and joints and even caverns left as molten lava exited the cooling flows. Although this generalization of the lithology of the aquifer might be helpful in understanding the ESPA, it is not totally accurate. The ESPA, in general, should be thought of being composed of hundreds of individual lava flows, sub-aquifers. Typically, the bottom of an individual lava flow is more dense and less permeable and the top of the flow tends to be more porous and provide more opportunity for ground water movement. This stratification provides for transmissivities that vary with depth and directs, at times, downward moving ground water to moving laterally when less permeable material is encountered.

It is with the above understanding that ground water models have been created to simulate ground water flows in the ESPA. This above description of the lithology of the aquifer does not very accurately describe the hydrogeology on the fringe of the ESPA in the ASCC service area. Detailed information in the ASCC service area is lacking. IDWR investigators who have studied the area indicate that much additional

investigative work needs to be done in this area to fully understand the ground water resources. Further, the investigators indicate that the ESPA model is far too coarse to be used in predicting and analyzing ground water flow in the ASCC service area (Hal Anderson, oral commun. 2000). Perhaps the most comprehensive investigative work on the ground water geology in the area was done by Harold Stearns and others more than 60 years ago. Subsequent investigators such as Woodward (1960) and Castlin (1978) chose not to do additional, original geologic investigations but rather chose to quote extensively from Stearns (1938). Figure 9 is a copy of a portion of the Stearns geologic map of the area (1938, plate 4). Our knowledge of the hydrogeology of the area has been gained, in part, by our general understanding of the hydrogeology of the area, by field investigations, by review of well logs, but we also, as with previous investigators, rely, to a large degree, upon the work of Stearns.

Stearns describes an ancestral Snake River, flowing northwest of the ASCC area and the current Snake River. The river was pushed southwest and later dammed on numerous occasions by lava flows coming mostly from the west and then the southwest. The latter damming of the river created lakes in the general Aberdeen-Springfield area and there was deposited in those lake sediments that are now consolidated or partly consolidated silt, clay and sand with a few local pebble lenses. At various times during the deposition of these lacustrine materials, the dam would be breached and the lakes would be drained. Also during this time of lacustrine deposition, lava flows would extend into the area primarily from the north and, hence, in Stearns' words there are layers of "intercalated basalt." These interbeds of basalt form what might be termed the major sub-aquifers in the area and from these basalt aquifers many wells now extract water and numerous large springs discharge. Stearns notes that these springs issue at a higher elevation than the American Falls Reservoir

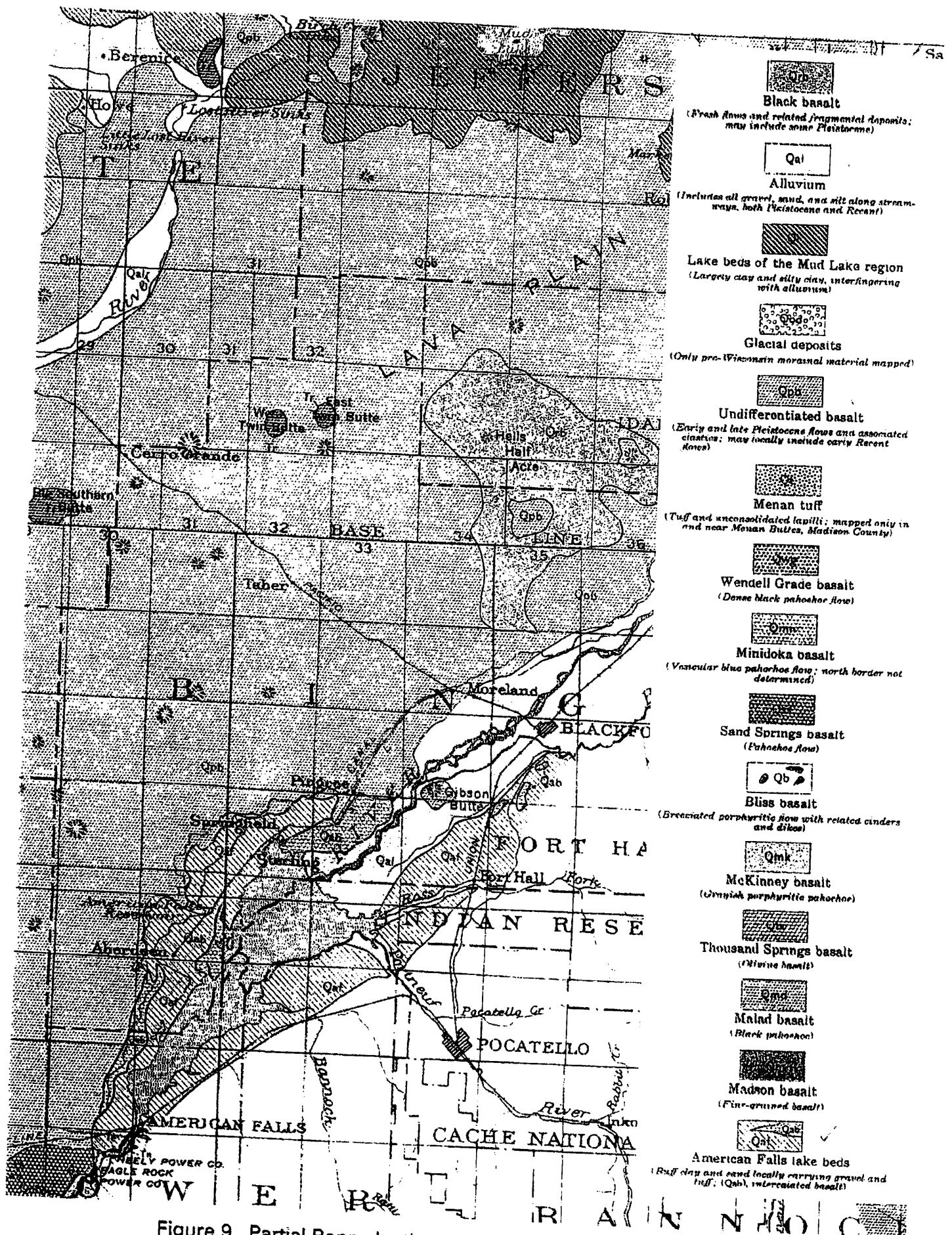


Figure 9. Partial Reproduction of Geologic Map (Stearns, 1938)

and that under "present conditions the seeped areas on the project have resulted from irrigation and not from the construction of the American Falls Reservoir," (see Stearns, 1938, p. 118)

More recent basalt flows capped some of the lake beds and much of the area is now covered by wind-blown loess that provides the base materials for the productive soils in the area. The aquifer in the area, hence, varies significantly from the adjacent ESPA and is composed of many sub-aquifers. To distinguish the aquifer recharged by the leakage from the ASCC delivery system from the ESPA, in this report this local aquifer will be referred to as the Aberdeen Aquifer.

Working from Stearns' report, Castelin (1974, p. 8) describes the geology as follows:

The portion of geologic history pertinent to the study area ranged from late Pliocene time to the present. It was during this period of time that events occurred which determined the characteristics of surface- and ground-water occurrence, movement and quality in the area.

During late Pliocene time, over one million years ago, a lava dam in the vicinity of Raft River created a broad shallow lake which was filled intermittently by streams. When much of the basin had been filled with predominantly fine sand, silt, and gravel, the dam was overtopped and the lake drained. These sediments, termed the Raft Formation, underlie most of the American Falls Reservoir.

It is postulated that the Snake River, which had been flowing near the center of its plain, was forced to flow around the southern limits of a series of basalt flows extruded from vents to the north. At time the Snake River was dammed completely by these flows. A lava dam a few miles downstream from the present American Falls Dam formed a lake in which more than 80 feet of sediments, consisting primarily of clay, silt, and sand, were deposited. This series of basalt flows and associated sediments, overlain by the lake bed sediments were named the Snake River Group and the American Falls Lake Beds, respectively. These events occurred up until the late Pleistocene, less than one million years ago. Since that time the Snake River has been eroding its channel in the basalt and reworking the lake bed sediments until they have assumed the appearance we recognize today.

It is important to realize that this positioning of intercalated or interbedded basalts in the Aberdeen Aquifer creates significantly varying permeability as water moves downward and recharges the aquifer. The lake beds act as aquacludes, or less permeable zones, and when water reaches an interbedded basalt, the water has a tendency to move laterally rather than down through the underlying lake bed. It is also important to visualize some of these interbedded basalt, sub-aquifers, as being confined in some areas with lake beds above and below being much less permeable. Lake beds and basalt flows also terminate laterally. When a basalt flow reaches its terminus and is surrounded not only above but also below by the much less permeable lake beds, ground water flow is also terminated to a degree. In some locations, this confinement has resulted in artesian conditions, with wells penetrating this type of sub-aquifer, sometimes flow at land surface. Figure 10, reproduced from Castelin (1974, p. 10) is a

**CHARACTER AND WATER BEARING PROPERTIES OF GEOLOGIC UNITS IN THE
AMERICAN FALLS RESERVOIR AREA**
(Geologic units after Carr and Trimble 1963)

SYSTEM	SERIES	STRATIGRAPHIC UNIT AND SYMBOL	THICKNESS (feet)	CHARACTER AND DISTRIBUTION	WATER SUPPLY
Quaternary	Recent and Upper Pleistocene	Dune sand, alluvium terraces deposits, and thin loessial deposits Qal	0-50	Unconsolidated windblown sand and silt, and fluvialite clay, silt, sand, and gravel discontinuously overlying older formations around the reservoir.	Upstream from the reservoir the coarse deposits yield moderate to large supplies to wells where they occur below the water table. Along the west and southeast sides of the reservoir the deposits are above the water table
	Upper Pleistocene	Unconformity			
		American Falls Lake Beds Qal	0-80	Partly consolidated medium to thin-bedded clay silt, and fine sand with a persistent but discontinuous thin layer of gravel at the base. Crops out on both sides of the reservoir for many miles above American Falls	Yields small supplies to domestic and stock wells. Discharges a significant amount of water to reservoir from gravel at base of formation
		Unconformity			
Quaternary	Upper or Middle Pleistocene	Basalt of the Snake River Group Qpb	1 000+	Medium to dark-gray, fine to medium-grained, commonly vesicular basalt flows, locally separated by basaltic pyroclastic rocks. Lake, playa and stream deposits interbedded with the flows at some places. Intertongue with and overlies the Raft Formation on the west side of the reservoir.	Basalt flows and pyroclastic rocks (Snake Plain aquifer) yield large quantities of water to wells. The principal source of ground water for irrigation west north and northeast of the reservoir
		Unconformity			
		Raft Formation	75 200+	Light-colored poorly bedded silt and fine sand with a few clay beds, a few local beds of basaltic and rhyolitic tuffs, and some gravel in the lower part. Underlies most of the American Falls Reservoir and extends an undetermined distance west and southwest of the reservoir.	Sandy and gravelly beds yield small amounts of water to wells. Not a principal aquifer in the American Falls area
Quaternary(?)	Pleistocene (?)	Unconformity			
		Little Creek Formation	15 100	Medium to dark gray, dense to fine grained, somewhat vesicular basalt, and white buff red, and brown basaltic and rhyolitic tuff with some conglomerate lenses. Underlies the southwestern part of the area.	Appears to be moderately permeable. Probably a major source of irrigation water west of American Falls
Tertiary	Middle Pliocene	Unconformity			
		Walcott Tuff	15-50	White bedded rhyolitic tuff, black obsidian welded tuff, and red welded tuff. Central part perititic and spherulitic. Exposed in the canyon of the river below American Falls and south of American Falls	Yields moderate amounts of water to wells
Tertiary	Middle Pliocene	Nasely Formation	30 150	Tan to brown, fine to coarse-grained rhyolitic tuff with lenses of gravel and a few beds of white marl. Exposed in the canyon of the river but subsurface extent not known	Sandy and gravelly beds probably yield some water to wells

Figure 10. Character and Water-Bearing Properties of Geologic Units in the American Falls Reservoir Area. (Carr and Trimble, 1963)

table which describes the various stratigraphic units found in the area and their water-bearing properties. This table is based on work done by Carr and Trimble (1963).

Well logs are filed in the offices of the IDWR. Also, the ASCC has records of many wells in its offices. Figure 11 is a summary of the well log information from the ASCC files for four wells drilled into the Aberdeen Aquifer. These four wells were selected as the information on file concerning the earth material encountered during drilling of the wells illustrates the sedimentary and volcanic interbedded nature of the Aberdeen Aquifer.

Figure 11. Selected Well Logs from the Aberdeen-Springfield Area
(illustrating interlayered nature of the Aberdeen Aquifer)

Aberdeen Low Line Spill Well		Hedge Drain Flowing Well	
NW¼NW¼, Section 18, T5S, R30E, B.M. (just below spillway structure on west side of drain) drilled: 1970		SE¼SW¼, Section 9, T6S, R31E, B.M.	
0 - 20'	top soil, clay, sub water	0 - 5'	soil
20 - 28'	broken lava	5 - 12'	sand
28 - 105'	hard gray lava	12 - 40'	basalt, creviced
105 - 115'	brown clay	40 - 60'	clay, yellow
115 - 150'	black lava	60 - 70'	clay, gray, hard
150' - 175'	black broken lava	70'	sand
175'	black sand		(filled with sand, not flowing)
		Pradhome Well No. 2	
Well No. 3 — O. Anderson Well		SE¼SW¼, Section 2, T5S, R31E, B.M. (at the toe of Low Line Canal) drilled: 1957	
1320' west, 500' north of SE Corner, Section 16, T6S, R31E, B.M.		0 - 6'	dirt
0 - 16'	sandy soil	6 - 26'	rock
16 - 20'	coarse gravel, some water	26 - 34'	mud
20 - 40'	sandy soil	34 - 100'	broken rock
40 - 62'	solid lava	(good flow of water at 75')	
62 - 65'	blue shale	100'	cinders
65 - 100'	sand and water		(maximum artesian flow — 4 cfs)
100 - 120'	shale		
120 - 140'	sandstone and water course (later abandoned)		

4.0 IRRIGATION OF CROPS

There is not in place a system to exactly track how much of the ASCC assessed acreage is irrigated each year, nor is there a tracking of the irrigation methods nor sources used. Hence, for this report, BIWC turned to the management of the company for an estimate of this type of information. The company indicates that there are just less than 59,000 acres that receive water each year (ASCC has 58,942 outstanding shares and the company policy allows one share per acre). Not all of the acres are irrigated each year as some miscellaneous land may be fallow, hence, the amount of land irrigated may vary slightly each year. Factors that influence the irrigated acreage include current agricultural economics, including crop prices, cropping patterns, land fallowing and the availability of contracts for the sale of crops raised.

A majority of the land is irrigated exclusively with surface water delivered by ASCC. Of the slightly less than 59,000 acres irrigated each year by ASCC shareholders, it is estimated that perhaps 40,000 acres received water exclusively from the surface system. Some lands receive pumped ground water as a supplemental source to the surface water supply. Additional lands, irrigated by ASCC shareholders, receive only recovered ground water. For this report, we estimate that 19,000 acres are irrigated by ground water.

quantity of water to these lands?

recovered gws

At this time, the amount of ground water pumped for irrigation in 1999 in the ASCC service area has not yet been tallied but data has been collected as newly required by the IDWR. For the purpose of this report, it is estimated that 2.4 af per acre is applied on all of the irrigated lands each year. This allows for a calculation that 96,000 af of water applied to the estimated 40,000 acres exclusively irrigated from the surface

sprinklers (Steve Howser, oral commun., 2000). Pressure for the sprinkler systems is provided by on-farm pumps.

Crops raised and harvested in the ASCC service area, in order of acreage, are grain, alfalfa, potatoes and sugar beets (Steve Howser, oral commun., 2000). These four crops are planted on a rotation basis. Most of the land is cropped each year from this rotation but perhaps 7,000 acres is in permanent irrigated pasture.

5.0 GROUND WATER RECHARGE THROUGH CANAL LOSSES AND SEEPAGE FROM IRRIGATED FIELDS

For purposes of this report, the ground waters recharge from diversion and irrigation in the Aberdeen-Springfield area will be discussed in two categories; namely, 1) recharge via seepage from conveyance canals and laterals, and 2) recharge via seepage from irrigated fields. The combined impact of these two methods then accounts for the total recharge to the ground water body beneath the ASCC's system.

5.1 Water Diversions, Deliveries and Canal Losses

On an average, the ASCC has been diverting from the Snake River about 320,000 af per year. Deliveries have been made since 1907. Figure 12 lists the diversions over the last ten years (1990-1999). Over this ten-year period, the least water diverted was in 1993 when 278,156 af were diverted in that dry year. The largest amount of water diverted was in 1999 when 354,588 af were diverted. The ten-year average diversion is 319,153 af. The data found in Figure 12 were provided by the ASCC and are based on readings at the weir at the point where water is diverted into the Main Canal.

A significant amount of water seeps from the Aberdeen-Springfield Canal as it traverses through varying soil and rock materials. Losses are particularly thought to be significant in areas where the canal has been cut through lava flows. The water delivery to the shareholders in the ASCC is measured by employees of the ASCC. Forty-four separate diversions are made from the canal for the lateral system. The average deliveries over the ten-year period reported in Figure 12 is 107,795 af. The lowest year of deliveries in the ten-year period was 1993 when 89,025 af were delivered. The

greatest delivery made to the forty-four diversions during the same period was in 1990 when 130,465 af of water was delivered.

Figure 12
Aberdeen-Springfield Canal
Canal Diversion, Deliveries, Losses and Calculated Ground Water Recharge

1. Year	2. Diversions from Snake River	3. Canal Spill Back to River and Reservoir	4. Hilton Basin Spills	5. Canal and Lateral Evaporation	6. Water Delivered to Fields	7. Canal Loss* Ground Water Recharge (Calculated)
1990	338,103	20,597	0	2,230	130,465	184,811
1991	312,563	21,959	0	2,230	108,669	179,705
1992	283,182	11,782	50	2,230	96,629	172,541
1993	278,156	27,237	428	2,230	89,025	159,664
1994	347,454	22,140	0	2,230	108,798	214,286
1995	286,017	37,410	4,546	2,230	89,451	156,926
1996	343,954	36,529	428	2,230	123,627	181,568
1997	311,961	40,241	1,304	2,230	107,163	162,327
1998	335,555	45,475	978	2,230	113,977	173,873
1999	354,588	56,567	3,419	2,230	110,142	185,649
Average	319,153	31,994	1,115	2,230	107,795	177,135
Total	3,191,533	319,937	11,153	22,300	1,077,946	1,771,350

* Column 2 minus columns 3, 5 and 6. The calculated recharge includes water that seeps to the ground water from the Hilton Basin.

Each year there are operational spills of diverted water from the canals back to the Snake River or directly to the American Falls Reservoir. These spills are measured at seven locations. Over the ten-year period, the amount of the spills has averaged 31,994

af per year. The largest spill amount was in 1999 when 56,567 af were spilled. The smallest spill was in 1992 when 11,782 af were spilled.

Starting in 1992, the ASCC also began reporting operational spills, for regulation purposes, from their delivery system to a closed basin referred to as the Hilton Basin. Water spilled to the Hilton Basin rapidly percolates to the ground water system. Between 1992 and 1999, these Hilton Basin spills have been reported in all but one of the years. Over the ten years the average spill has been 1115 af. The largest Hilton spill was reported in 1995 when 4546 af was diverted. No water was reported spilled in 1990, 1991 and 1994 (see Figure 12).

Some water, although small when compared to the amount diverted from the river, is lost each year by evaporation directly from the canal and lateral water surfaces. It is estimated that the water surface area in the ASCC delivery system is 733 acres (ASCC oral commun., 2000). Records for observed evaporation rates have been kept for the Aberdeen area for a number of years. The ASCC system is operated from mid-April through mid-October. By using land based pan evaporation rates for the Aberdeen station collected by the University of Idaho over the past ten-year period and by assuming that April evaporation is similar to the reported October data and that the canal operates for two-thirds of April and two-thirds of October, and by applying the factor of 0.72 (Bill Ondrechen, oral commun., 2000) to convert the land-based evaporation data to free water surface evaporation, the potential evaporative rate of 36.4 inches was calculated. When applied to the estimated 733 acres of free water surface in the ASCC's delivery system, a potential evaporation of approximately 2,230 acre-feet is calculated.

The seepage to the ground water from the canals and laterals can be calculated by subtracting from the total diversion each year the amount of water spilled back to the Snake River and American Falls Reservoir, the calculated evaporation, and the deliveries to the fields. These calculations are shown as the bottom entry on Figure 12. The calculated seepage to the ground water body over the ten-year period averaged approximately 177,100 af., or 55% of the amount of water that was diverted from the Snake River into the ASCC canal system. The greatest loss occurred in 1994 when approximately 214,300 af were lost and the smallest loss was recorded in 1993 when approximately 159,700 af were lost from the canals and laterals. These losses of project water recharge the underlying Aberdeen Aquifer. Since the ASCC began operations in 1907, from the above numbers it can be estimated that over 16 million af have been contributed to the ground water system underlying the ASCC service area. The amount of system spills, deliveries, transmission loss and diversions for the ten years cited above and the relationship between these four factors can be observed on the graph identified as Figure 13. The relationship of the diversions, deliveries, evaporation, spills and canal loss recharge is shown on Figure 13.

5.2 Consumptive Use of Crops and Surface and Ground Water Seepage From Cropped Areas

The amount of water consumed varies from crop to crop; each of the five crops listed as being raised in the Aberdeen Springfield area in Section 3 consume their own specific amount of water. Irrigated pasture also has a different consumptive rate. IDWR concluded that the average crop consumption in the ESPA area is 2 af per year (IDWR, 1999). For the purposes of this report, a crop consumption of 2 af per acre per year for

Aberdeen-Springfield Canal

Canal Delivery, Loss and Recharge

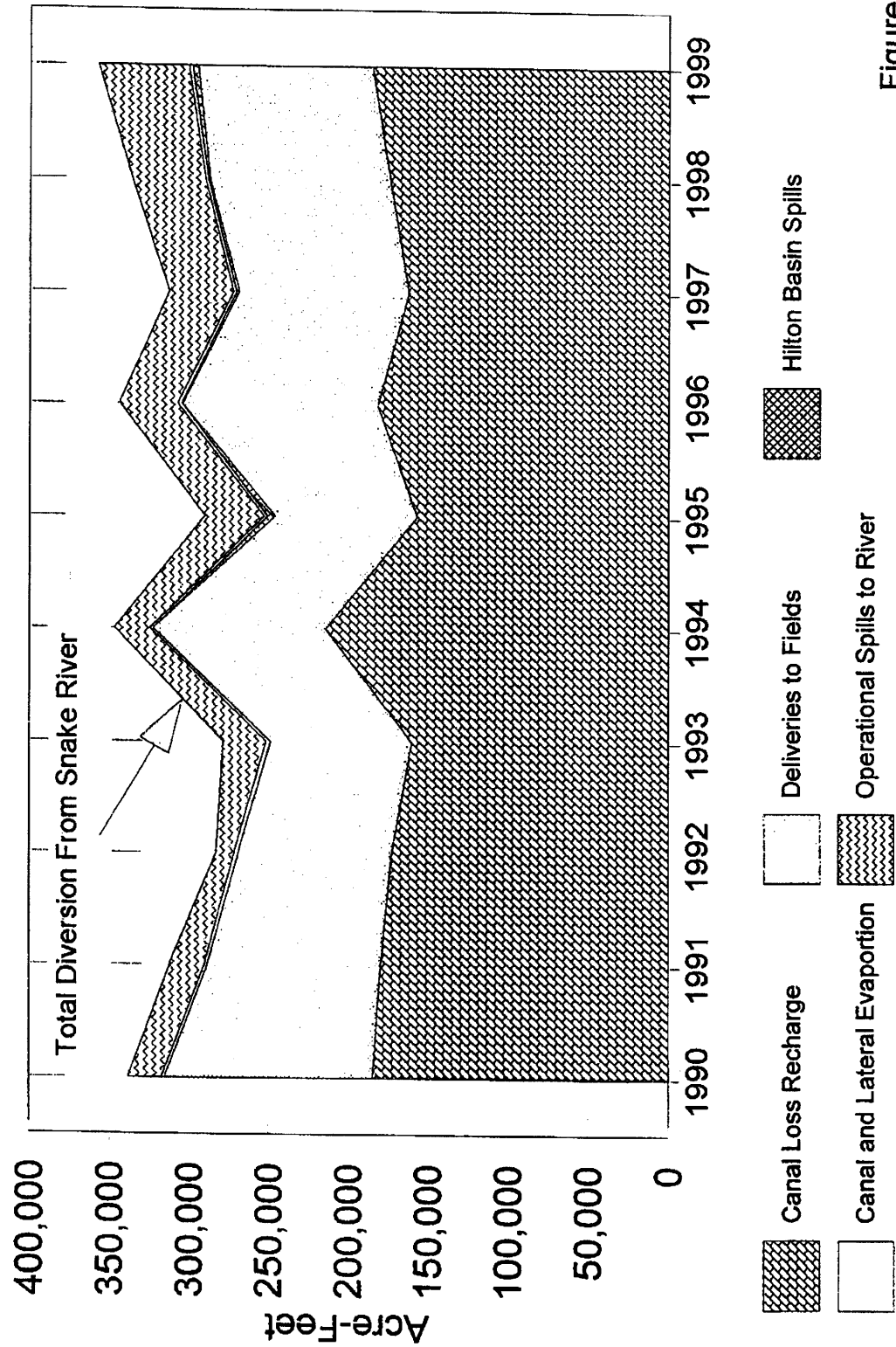


Figure 13

the ASCC service area will be used. For the ten-year period of 1990 to 1999, the ASCC indicated deliveries were made to holders of approximately 59,000 shares. With one share per acre, this could represent an average delivery to 59,000 acres. Some land is not irrigated each year but for this report we will analyze the maximum amount that could be consumed and so we have used the consumption from the irrigation of 59,000 acres. Hence, 118,000 af could have been consumed, on average, each year over the ten-year period.

Water applied to the irrigated areas that is not consumed by the crops seeps into the aquifer. The ASCC reports that on average, over the past ten years, approximately 107,800 af is delivered to the irrigated lands from the canal system and in Section 3 of this report we estimated that an additional 34,000 af was pumped from the ground water by ASCC shareholders in the service area each year to provide the needed supplemental supply of water. Hence, an estimated 141,800 af is applied to lands in the area each year. By subtraction, it is estimated that 23,800 af could recharge the ground water beneath the system each year due to seepage from ASCC shareholder fields.

*I can't include
pumped SW as
recharge
to SW*

5.3 Water Budget of Imported Water

Over the last decade, there has averaged a diversion of approximately 320,000 af per year into the Aberdeen-Springfield system from the Snake River as measured at the diversion of the ASCC at the diversion dam. Of that amount, an average over the last decade of approximately 32,000 af have been allowed to spill back to the river system and approximately 107,800 af have been delivered to the farms. It is estimated that 2,230 af per year is evaporated from the canals and laterals. Figure 12 provides the basic data in tabular form. By subtraction, it can be determined that 177,100 af, on an

average, is lost to the underlying Aberdeen Aquifer each year from the canals and laterals. The Hilton Basin spills were not subtracted from the diversions when the recharge from the canals and laterals were calculated because these spills quickly seep into the Aberdeen Aquifer.

On an average, an estimated 141,800 af is delivered to the fields from surface and ground water. This report has estimated that on the farms 118,000 af on an average each year, is consumed by the crops, which allows for the additional ground water recharge from the irrigated fields of 23,800 af. When combined with the calculated recharge via seepage from canals and laterals, a total average annual recharge to the Aberdeen Aquifer of 200,900 af is calculated.

To determine the net recharge to the Aberdeen Aquifer, one needs to subtract from the total recharge the estimated amount of ground water pumpage as a supplemental supply to ASCC assessed acres. This was estimated previously as 34,000 af annually. Hence, the net impact of ASCC's operations, including water delivery through surface canals as well as ground water pumpage is an annual recharge to the Aberdeen Aquifer of 166,900 af. $(200,900 - 34,000)$

6.0 IMPACT OF ASCC PROJECT WATER RECHARGE TO THE ABERDEEN AQUIFER

6.1 Water Level Change

There is no record of the ground water conditions in the ASCC service area prior to the delivery of surface water and the commencement of the ground water recharge by the activities of the ASCC starting in 1907. There were no well logs. There are no recorded water levels. There are no historic reports that describe the water resources and the ground water resources that date back prior to the beginning of the introduction of surface water by the ASCC and its predecessors.

We do know that the recharge of on an average of over 166,900 af per year to the immediate area has had a significant impact on the ground water resources of the area and that there is now much more water in storage in the area. The water levels are much higher and a ground water mound has been built by this recharge that has reached out many miles in all directions. These increased water levels have resulted in increased spring flows back to the Snake River system at locations near to and also far removed from the ASCC service area. Since the beginning of the surface water irrigation project, perhaps more than 16 million af has been recharged into the aquifer system.

The ESPA model that was used to predict the impact of ground water recharge on the ESPA system can be helpful in understanding the impact of ground water recharge on the Aberdeen Aquifer and surrounding areas. The ESPA model has only a few nodes in the ASCC area as the model was prepared to describe a very large area. Modelers have stated that there is a general lack of knowledge of the unique nature of the hydrogeology in the ASCC service area and, hence, the model cannot be used to reflect

the details of the impacts of the recharge in the Aberdeen Aquifer. It is also believed that it would be impractical now, because of the lack of detailed information and the cost of modeling work to create a model specifically for the ASCC service area so as to recreate prior to irrigation hydrologic conditions in the ground water aquifers and then to use the model to predict future impacts if recharge and discharge were to be altered.

*But early years
didn't pump
either.*

It is known that water levels increased as irrigation waters were imported. This is evidenced by high water tables in some of the irrigated areas that were not originally impaired by high ground water levels when irrigation began. In 1960 Woodward (Woodward, 1960) detailed issues associated with these increased water levels in the Sterling area. Sterling is a sub-area within the ASCC service area.

There is evidence in the record as to the impact of this recharge on the Aberdeen Aquifer prior to 1930 as Stearns and others reported on this area and prepared a map showing contours of the water table through much of the ESPA. After about 20 years of ASCC deliveries, it appears that a significant ground water mound can be observed from a map in the Stearns report. The small portion of the water level map from the Stearns report (1938, Plate 19) that covers the Aberdeen Aquifer and immediately adjacent areas has been photocopied and enlarged and made a part of this report as Figure 14. We have constructed a cross-section of the water levels, as reported by Stearns on an east-west line that we have added to and shown on Figure 14 as line A-A. The cross-section, Figure 15, clearly shows the increased water levels, the ground water mound with its apex under the ASCC High Line Canal and lands irrigated from the canal. To the east, the water level drops off rapidly and terminates at the American Falls Reservoir where it intersects the water surface in the reservoir. To the west of the apex, the water level also drops off steeply. These steep ground water gradients will result in

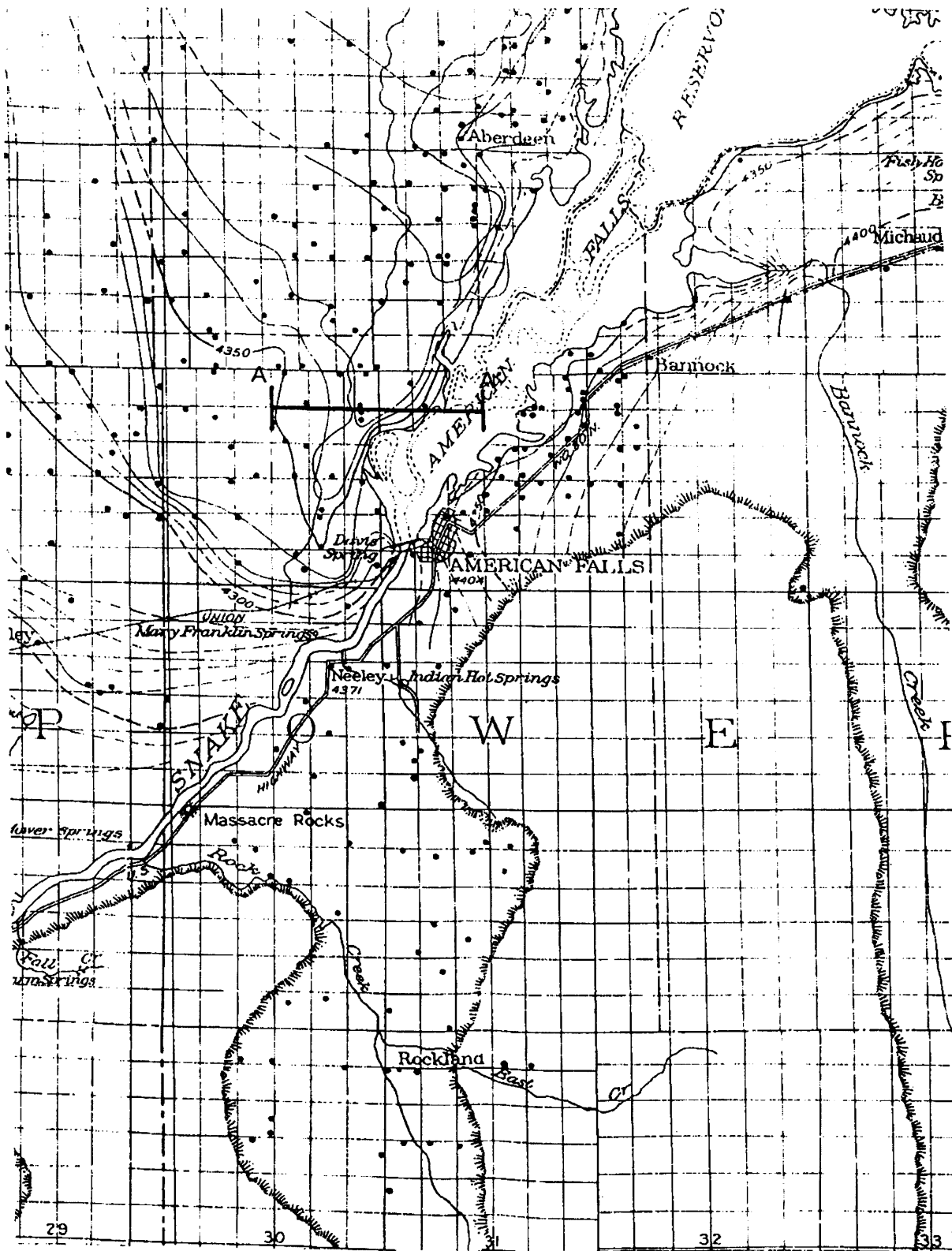
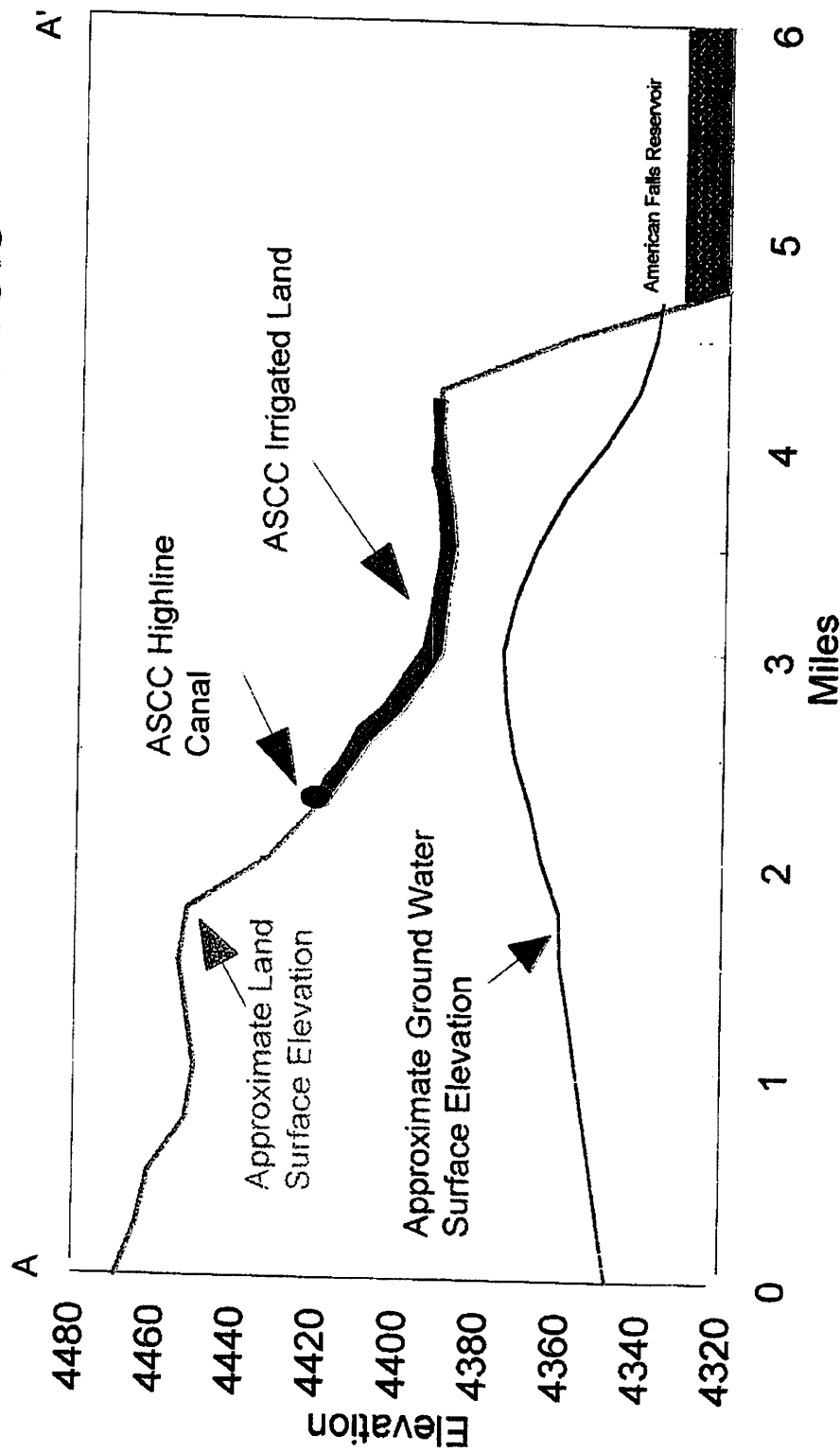


Figure 14. Reproduction of Stearns' 1938 Water Level Contour Map

Aberdeen Aquifer

Profile of Ground-Water Levels



Ground water levels approximated from Stearns (1938). Figure 15

a rapid flow of ground water away from the apex of the mound. Stearns' observations were made in 1928-30 shortly after the American Falls Reservoir was first filled. The Reservoir started to fill in October of 1927 (U.S. Bureau of Reclamation, oral commun., 2000).

Castelin also noted mounding of ground water brought about by the leakage of project water into the Aberdeen Aquifer from the canals. Excerpts from his report follow.

Shortly after irrigation water is applied to land in the area in May some noticeable changes begin to occur. A ground water "mound" or ridge begins to form approximately along the axis of the Aberdeen-Springfield canal and becomes very pronounced later in the season. Leakage from the canal recharges the ground water system to such an extent that water levels in wells in close proximity to the canal are held artificially high.....

..... Based on previously published hydrographs, by spring of the following year water levels recover to the level of the prior year, which indicates that recharge to the aquifers equals or exceeds the rate of withdrawal and natural discharge.

Castelin, like Stearns forty years before him, prepared water surface elevation contour maps. These maps also show the ground water mound and cross-sections like Figure 15 could be prepared to illustrate the mound.

Castelin also tried in 1974 to determine if there were water level changes in the area between the Stearns study and Castelin's effort. He measured water surface elevations

in the same wells or in nearby wells at the same time of the year that the Stearns measurements were made. Castelin concluded that "it is readily apparent that water levels throughout much of the area have risen, in some areas as much as 12 feet."

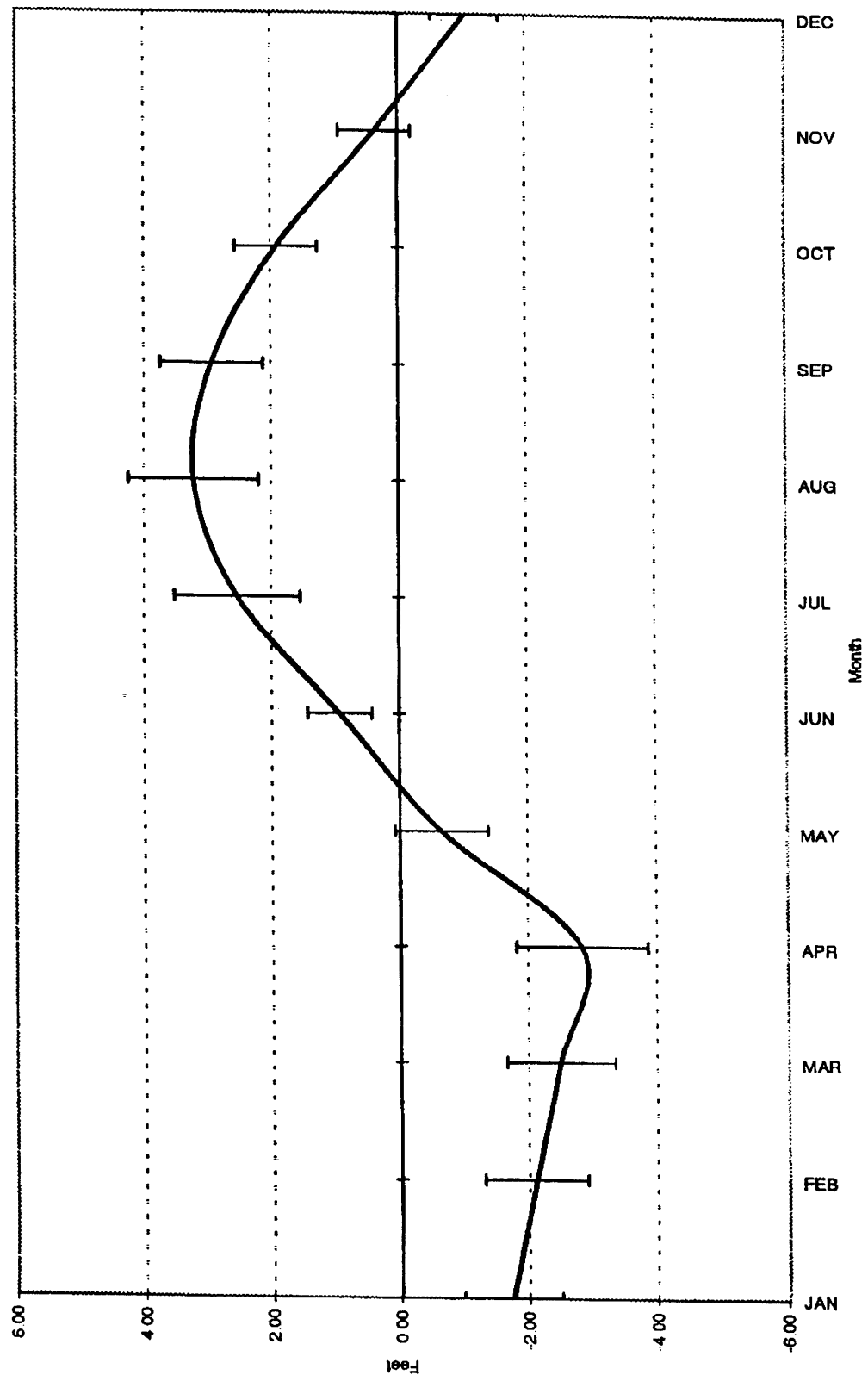
The IDWR predicts, through its model, the impact of managed large-scale recharge on the ESPA in a recently published report (IDWR, 1999). That report identifies that water levels in some areas of the ESPA rose as much as 60' to 70' between 1907 and 1959. The same report examines the opportunity for additional artificial ground water recharge within the service area of the ASCC and notes ten locations along the canal that are candidate for additional artificial recharge opportunities. At one particular site, the Hilton Basin, the report indicates that the ASCC believes this one site alone could receive a continuous flow of 150 cfs.

The impacts reported in the Sterling sub-area were also common to many other areas within the ASCC service area. Areas in fields would become "wet" and would need to be drained to be cultivated and cropped. Wells were drilled as drain wells, many of them by the ASCC. Some of these wells encountered artesian pressure and in some of the wells the pressure was great enough for the wells to flow water. Some wells were equipped with pumps. Project water recovered from the recharged ground water system was used for irrigation. With time, additional wells were drilled as irrigation wells to take advantage of the high ground water levels and water from these irrigation wells was used to supplement the surface water deliveries. In the service area of the Rockford Canal, water users who once received surface water supplies from the ASCC system found it more advantageous to pump their full water supply from the recharged Aberdeen Aquifer than to maintain the surface system and, hence, some users converted to the ground water source as their sole supply to irrigate water.

The U.S. Geological Survey, for many years, made water level measurements in several wells in the ASCC service area and reported them in published reports. There was a series of reports of which the Sisco and Griffiths (1968) reference is an example. The manager of the ASCC also for many years made water level measurements in approximately 60 wells. From this large database, water level changes during a calendar year can be observed. Figure 16 is a composite of the water level changes that were recorded by the ASCC manager over 50 years. The manager's records document that the ground water mound increases each year during the irrigation season. Figure 16 illustrates how, on an average, the water levels in the observed wells are low during the non-irrigation season and, on an average, increase about six feet during the irrigation season. This is counter to what one might expect in areas where there is a significant amount of ground water pumped from the aquifer. It is common in ground water pumped areas for the water levels to decline during the summer pumping season and recover during the non-pumping season. The reverse is true in the Aberdeen Aquifer. The water level increase observed in Figure 16 only reflects a portion of the effect of the recharge occurring during the irrigation season. The increase is the residual remaining after the impact of summer ground water pumping has been offset by the recharge.

It can be concluded that because of the recharge caused by the imported Snake River water by the ASCC over the last nine decades that ground water levels have risen significantly underneath the ASCC service area. Higher, once dry, aquifer areas have been saturated with water imported from the Snake River by the ASCC. There are hundreds of thousands, if not millions, of acre-feet in residence in a ground water mound underneath the ASCC service area as a result of this imported water. Water levels are perhaps several tens of feet higher than they were prior to 1907.

Figure 16. Composite hydrograph of water level measurements made by the ASCC management of the Aberdeen Aquifer



This ground water mound continues to be recharged, on an average, at a rate of 166,900 acre-feet per year. This water, not reclaimed by the wells in the ASCC service area, adds to the ground water mound which eventually dissipates to adjacent aquifer areas increasing the water levels for scores of miles and resulting in increased discharge of springs along the Snake River. TFC

6.2 Age of Ground Water

The age of irrigation water in the ground water in the ESPA at various locations west of the ASCC service area has been determined by analyzing stable isotopic data in waters collected from the aquifer. The study, "Age of Irrigation Water in Ground Water from the Eastern Snake River Plain Aquifer, South-Central Idaho," Plummer (2000), did not extend into the ASCC service area but did report the age of ground waters almost adjacent to the area to the west. The investigation determined that in the Eastern Snake Plain Aquifer, in general, most of the ground waters were surface source irrigation waters or a mixture of irrigation water and regional background water. The period of time the irrigation water had been in the ground was from zero to eight years and is referred to as the age of the water.

Although an investigation of this nature has not been performed in the ASCC service area, it is believed that the majority of the waters in the Aberdeen Aquifer in the first few hundred feet of saturated aquifer materials that is intercepted by recovery wells is like the area studied to the west, very young. Often produced ground water from major aquifers can be determined to have been in the ground for scores of years, centuries or thousands of years but the range of zero to eight years found by the above cited investigation is a reasonable number to contemplate with respect to the age of much of

the ground water in the ground water mound underneath the ASCC service area which is very young.

7.0 CONCLUSIONS

- Over the last nine decades, a very significant amount of water has been diverted into the ASCC service area and more than half the diverted project water has seeped into the underlying Aberdeen Aquifer.
- A very significant ground water mound that is ten's of feet high has developed over the years and it rises each year along the ASCC system during the irrigation season and falls a few feet each winter when the recharge from the imported ASCC water terminates.
- Project water is recovered each year from this groundwater mound by wells operated by shareholders in the ASCC. The use of these wells has, in effect, extended the delivery facilities of the ASCC system.
- After crops have consumed the water needed for their growth, as provided by surface water deliveries from the ASCC canals and as provided by the recovery wells, there is still more than half of the diverted water left in the Aberdeen Aquifer and that net recharge moves laterally to recharge areas outside the ASCC service area.

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