Pipeline to the Future

Construction, Operations, and Maintenance Cost Comparison Of Alignments

January 23, 2004

Executive Summary

During 2001 and 2002, WESTCAPS embarked on a study for the West Maricopa Combine Water Company. The study was completed in 2002 and was conducted to determine which route was the most economical and feasible from approximately Interstate 10 and Sun Valley Parkway to the area around Sarival Road and the interstate. The study concluded that the "best" alignment for a water supply line was along the north side of the interstate which transitioned to Yuma Road, terminating at Sarival Road. This became known within WESTCAPS as the Yuma Road alignment.

Since 2002, housing development has been constructed along some of this preferred alignment. This sudden development has increased the cost of constructing a pipeline along Yuma Road, and West Maricopa Combine has a desire to use an alignment that does not involve the demolition and repair of new construction. In 2003, West Maricopa Combine identified another route along the Roosevelt Irrigation District (RID) canal. Further discussions with RID personnel led West Maricopa Combine to believe that RID's right-of-way might be available for the construction of the main water line. Although the RID Canal alignment was longer in length than the recommended option, it could be less expensive to construct. In order to fully understand the differences, an estimate was needed in order to compare the two alignments in terms of construction costs, operations costs, and maintenance costs. WESTCAPS decided during the first half of 2003 to embark on a study to compare the costs of this new alignment along the RID canal with the Yuma Road alignment.

In late 2002, West Maricopa Combine received guidance from the Arizona Department of Water Resources that they would be allowed to withdraw their Central Arizona Project water credits directly from the Hassayampa River. This was followed by an earlier decision that West Maricopa Combine would be allowed to pump an amount equivalent to their CAP recharge of 25,000 acre-feet per year. These decisions helped to clear the way for new planning. Part of the new planning included the development of a new well field rather than use the well field which was planned during the 2002 report.

A new well field along the Hassayampa River would meet future water demands and is designed to be four miles long and ½-mile wide, and straddles Interstate 10 (see the Yuma Road or RID Canal Alignment Maps on pages 10 and 11 for details on the well field, and for details on the water alignment routes in general). The cost to develop a well field, which includes 16 wells for the delivery of 25,000 acre-feet per year, is approximately $7,200,000 which excludes pump and motor purchases, but includes funds for well site permitting, power to the site, and a hydro-geologic study.

The pipeline system is designed to meet a demand of 37,500 acre-feet per year. This is the yearly demand multiplied by 1.5 to meet the instantaneous peak delivery.

As more emphasis was given to the route along the RID canal, the simplest route was the following. From the southern edge of the well field at Yuma Road, the trunk line would parallel the Yuma Road alignment east to Johnson Road where it would transition south along Johnson Road until intersecting the northern right-of-way of the RID canal. The trunk line would parallel the northern right-of-way of the canal until intersecting Yuma Road just east of Tuthill Road. From this intersection the water trunk line would parallel Yuma Road until terminating at Sarival Road.

The Yuma Road well field manifold is split to deliver water to the main trunk line just south of the midpoint of the well field, while the RID manifold is modeled to deliver the peak demand to the southern tip of the well field. Because the Yuma Road well field uses two sections of manifold pipe that are smaller than one larger pipe, the Yuma Road well field is less expensive to construct than the RID Canal well field. However, because the RID Canal alignment delivers water along the manifold entirely downhill, operations costs are less expensive using the RID Canal well field. The cost breakdown for the well field construction and operations/maintenance costs are shown in Table ES-1.

Table ES-1. Comparison in Cost of Constructing and Operating/Maintaining the Pipe Manifold for the Well Field for the Yuma Road and RID Canal Options.

	Yuma Road		RID Canal	
Section	Cost to Construct	Operations/ Maintenance Costs[1]	Cost to Construct	Operations/ Maintenance Costs[1]
1st ½-mile	$114,000	$34,800	$114,000	$34,800
2nd ½ mile	199,000	35,800	199,000	35,800
3rd ½ mile	307,000	37,200	307,000	37,200
4th ½ mile	406,000	49,600	406,000	38,300
5th ½ mile	686,000	53,200	576,000	40,700
6th ½ mile	113,000	34,700	1,731,000	55,500
7th ½ mile	205,000	47,000	630,000	41,400
8th ½ mile	1,073,000	80,300	687,000	53,200
TOTAL	$3,103,000	$372,600	$4,650,000	$336,900

[1] Yearly costs.

Although not apparent, each ½-mile segment is slightly larger than the previous segment to accommodate for increasing flows being pumped from the well field. The 6th, 7th, and 8th ½-mile segments of the Yuma Road construction are less expensive because these segments begin south of the interstate, are smaller, and feed water into the main trunk line as the first through fifth segments do for the north portion of the interstate. For more detail on the well field, see the beginning section of Chapter 3 of the report.

Although the RID Canal alignment is two miles longer than the Yuma Road alignment, the cost of the Yuma Road trunk line was slightly more expensive to construct. The Yuma Road alignment was more expensive when taking into account the cost of having to cross the interstate and the interstate dike twice – once at the well field and again when transitioning from the interstate dike to Yuma Road near Miller Road. In addition, it was estimated that the Yuma Road alignment would encounter many small conduit type utilities amounting to about $1 million more in construction costs when compared to the RID Canal alignment.

The RID Canal alignment trunk line is more expensive to operate due to a longer length of pipe and when overcoming higher elevations when compared to the Yuma Road alignment. The following table highlights construction and operations costs for both alignments. For details on individual construction items, see Chapter 3, or refer to Table 5-1 in Chapter 5.

Table ES-2. Comparison of Construction and Operations Costs for the Yuma Road and RID Canal 42-inch Main Trunk Line.[1]

Activity	Yuma Road Alignment	RID Canal Alignment
Construction Cost	$33,512,000	$32,961,000
Operations Costs[2]	$410,000	$427,000

[1] The estimate is for a concrete pipeline. The main trunk line for the Yuma Road alignment parallels the Interstate 10 dike and transitions to Yuma Road terminating at Sarival Road. The RID Canal alignment follows the RID canal and transitions on to Yuma Road until its terminus at Sarival Road.

[2] Yearly operations costs. Does not include maintenance costs.

When comparing construction and operations costs for the laterals, all were similar with the exception of the Miller Road lateral. The Miller Road lateral for the Yuma Road alignment is 30-inches, and is one length of pipe. Because the RID canal crosses at the mid-point of water deliveries for Miller Road, one section of 16-inch pipe delivers water north from the intersection of the RID canal and Miller Road, and another length of 28-inch pipe parallels Miller Road south of the intersection of the RID canal and Miller Road. In addition, the two sections of pipeline for the RID Canal alignment are shorter in length than if the lateral were constructed for the Yuma Road alignment (see alignment maps on page 10 and 11 to see this detail).

The most noticeable difference in cost however is the difference in operations costs between the Miller Road lateral for the Yuma Road alignment, and for the RID Canal alignment. No power costs are necessary for the Miller Road lateral for the Yuma Road alignment. This is due to the booster pump which is located approximately 1-mile up-pipe from the Miller Road lateral along the main trunk line, and the drop in elevation along the Miller Road lateral which provides additional gain in pressure head which substitutes the need for a booster pump.

Due to the lack of a booster pump in the vicinity of the Miller Road lateral along the RID canal route, booster pumping is necessary for the southern section of the Miller Road lateral. The northern section of the Miller Road lateral requires two booster pumps in order to overcome elevation increases.

A small difference exists between the Tuthill Road laterals for the Yuma Road and RID Canal alignments due only to their difference in lengths. Differences in costs were not apparent for the Cotton Lane lateral when applying the two alignments.

The following table highlights the construction and operations costs for each lateral.

Table ES-3. Comparison of Construction and Operations Costs for Three Laterals Associated with the Yuma Road versus RID Canal Trunk Line.

	Yuma Road			RID Canal		
Lateral	**Pipe Size[1]**	**Construction Costs**	**Operations Costs**	**Pipe Size[1]**	**Construction Costs**	**Operations Costs**
Miller Road[2]	30	$3,615,000	$0	16, 28	$3,306,000	$130,800
Tuthill Road	12	$288,200	$5,000	12	$278,000	$5,000
Cotton Lane	32	$1,713,800	$107,600	32	$1,714,000	$107,600
TOTAL		$5,617,000	$112,600		$5,298,000	$243,400

[1] Pipe sizes are for inside diameter in inches. The three laterals were modeled using HDPE pipe. HDPE pipe is less expensive below 42-inches in size. Concrete pipe is less expensive in sizes above 42-inches in size.

[2] The northern portion of the Miller Road lateral for the RID Canal alignment is 16-inches, the southern portion is 28-inches.

The remaining costs for the construction of the system are water storage reservoirs, located in accordance with the demand needed at various points along the trunk line. The locations chosen for the reservoirs were at the intersections of the well field and the trunk line, and the intersections of the trunk line and the laterals. The reservoirs were sized according to demands anticipated for each area. In the 2002 report, a 33-million gallon reservoir was calculated as the size of reservoir needed to fulfill 36-hours of delivery without receiving deliveries from the well field due to lack of power. This study concluded that four reservoirs were desired, totaling a capacity equal to 33-million gallons.

Pipeline material appurtenances (air chambers, pressure reducing valves, gate valves, etc.) are needed, and their costs are accounted for. Other expenses associated with the construction of the system are also accounted for, such as contingencies, the engineering design, construction administration, a chlorination system, land easement fees, and an administration and facilities staff building. These costs are lumped into a category called General Expenses. The above mentioned costs are shown in Table ES-4.

Table ES-4. Pipeline Appurtenance Costs and General Expenses for the Yuma Road and RID Canal Alignment.

Activity	Yuma Road Alignment	RID Canal Alignment
Water Storage Reservoirs	$9,726,000	$9,726,000
Pipeline Appurtenances	$2,800,000	$2,928,000
General Expenses	$23,446,000	$23,568,000
TOTAL	$35,972,000	$36,222,000

Additional details on the above costs are available in Chapter 4, and in Table 5-1.

The total capital costs and yearly operations costs for the entire system are tallied below in Table ES-5.

Table ES-5. All Costs Associated with the Construction of the Yuma Road Alignment and the RID Canal Alignment, Including O & M Costs.

	Yuma Road Alignment	RID Canal Alignment
Total Capital Costs	$82,740,000	$83,530,000
Yearly Operations Costs[1]	$1,610,000	$1,709,000

[1] This cost includes operations and maintenance costs.

When comparing each system for apparent cost differences, the following are worth mentioning. The construction of the manifold pipeline for the RID Canal alignment is noticeably more expensive. An ever increasing manifold size is needed for the RID Canal alignment for the well field versus two smaller manifold size pipes for the Yuma Road alignment well field.

The Yuma Road trunk line is more expensive than the RID Canal trunk line even though it is shorter in length by 2 miles. The Yuma Road trunk line is more expensive because of the substantial expense in crossing the Interstate 10 dike and the interstate, twice. The RID alignment crosses the interstate and the dike once.

The Miller Road lateral for the Yuma Road alignment is more expensive than the Miller Road lateral for the RID Canal alignment. This however is offset by the fact that the Miller Road lateral for the RID system is substantially more expensive to operate.

Although the construction and operating cost estimate is higher for the RID Canal, the differences are not so great that other variables couldn't be taken into account. One system could not be recommended over the other with respect to the costs which were studied in this report alone. In order to recommend one system over the other, further study might be warranted in terms of the cost to replace the system in the future, differences in soil conditions which might make larger differences in the cost of excavation, more exact designs in the amount of earth cover needed along each system, and potentially changing the locations of laterals could affect construction and operations costs in favor of a less expensive water delivery system.

The report which follows provides more detail on each aspect of the system, including back-up material and data provided in the appendix.

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ACRONYMS

'	feet
ac.	Acre
AC	asphaltic concrete
AVG.	average
CAP	Central Arizona Project
cfs	cubic feet per second
Cls	class (pipe)
cy, cu yd	cubic yards
d	designation for stations south of the main trunk line for Miller Rd.
ea.	each
Elev.	elevation
ft.	feet
HDPE	High Density Polyethylene (pipe material)
hr.	hour
hp	horse-power
H-W	Hazen-Williams (friction factor)
in.	inch, inches
gal.	gallon
Kw	Kilowatt
L.F.	linear feet
M	million
mi	miles
O&M	Operations and Maintenance
PMP	Pipeline Modeling Program
psi	pounds per square inch
RID	Roosevelt Irrigation District
S.C.A.D.A.	Supervisory Control and Data Acquisition
sec.	seconds
Sta.	station
u	designation for stations north of the main trunk line for Miller Rd.
ua	urban areas
Vel.	velocity
WESTCAPS	West Salt River Valley Central Arizona Project Subcontractors
WMC	West Maricopa Combine
WPA	Water Provider Area
yr.	year
x	times
x-ing	crossing

CHAPTER I

INTRODUCTION

The previous West Maricopa Combine Pipeline Study, completed in August 2002 (2002 report), examined various alignments to deliver potable water to Buckeye and to Sarival Road. The report concluded that overall, the preferred pipeline alignment was the alignment beginning from Sun Valley Parkway and Van Buren and traversing along the Interstate 10 dike and then along Yuma Road, ultimately terminating at the intersection of Yuma Road and Sarival Road. In the 2002 report, this alignment was described as Alignment 3. Later, this alignment became commonly referred to as the Yuma Road alignment.

Since 2002, the West Maricopa Combine Water Company has been approved to withdraw their CAP allocation from the Hassayampa River. This represents a change when compared to the 2002 report which sited the well field at Sun Valley Parkway and Van Buren. The new well field is approximately 4 miles long and 1/2-mile wide along the Hassayampa River, straddling both sides of Interstate 10.

This report does not explain much of the water demand projections calculated in the 2002 report. However, this report does pick-up where the 2002 report left off in terms of population projection, and water demands. The conclusions reached in this report are difficult to compare to the 2002 report with respect to cost. For example, the peak flow demand of 37,500 acre-feet per year is used to size the water delivery system and determine operation costs, but this volume is not explained in detail here as it was in the 2002 report. Also, the delivery system from the Hassayampa River along the Interstate 10 Dike is approximately 3 ½ miles longer than the pipeline modeled for the 2002 report. In addition, the backward flow regimes published in the 2002 report were not re-modeled. The various flow regimes have been derived in the 2002 report and are not re-examined. The goal is to compare the Yuma Road alignment to an alignment paralleling the right-of-way for the Roosevelt Irrigation District (RID) canal in terms of construction and operation costs.

The laterals are sized based on the demand results for water provider areas from 2000 to 2025 from the 2002 report. The demand values are 16,896 acre-feet per year, 915 acre-feet per year, and 19,689 acre-feet per year for Miller Road, Tuthill Road, and Cotton Lane respectively.

In general, construction costs are higher for the Yuma Road alignment versus the 2002 report time frame due to inflation and housing development that has occurred along Yuma Road in only 18-months time. In particular, a new community in Buckeye, Arizona, called Sundance, is nearly constructed. When completed, Sundance will be approximately 2-miles long. This two mile stretch includes new asphalt roads, curbs, landscaping, and meandering sidewalks which make any construction additions along this stretch of Yuma Road difficult.

A map showing the Yuma Road alternative from the 2002 report is provided for reference purposes in Figure 1. The Yuma Road trunk line studied in this report is similar except that the trunk line is extended from the Hassayampa River to Sun Valley Parkway.

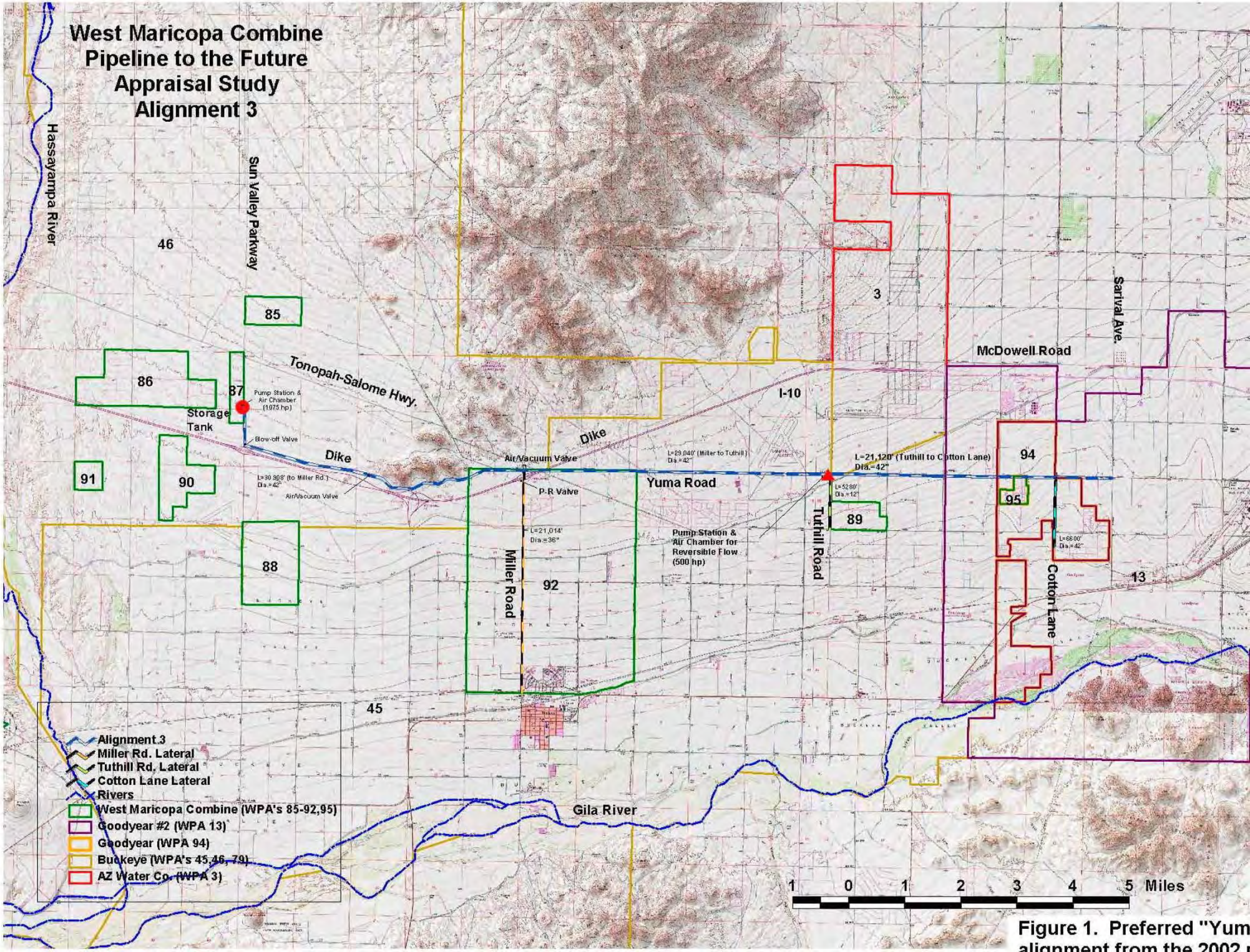


Figure 1. Preferred "Yum
alignment from the 2002 r

CHAPTER II

DESCRIPTION OF ALIGNMENTS

The following are the descriptions of the alignments for each pipeline. For graphical representation of each alignment, refer to Figures 2 and 3 on pages 10 and 11. The following are summary descriptions for each alignment.

Yuma Rd Summary Description
The well field manifold is 4 miles long with one section north of Interstate 10, and the second section south of the interstate. The manifold for the well field is located along the eastern edge of the Hassayampa River. Approximately 2/3 of the distance south from the northern tip of the well field, the main trunk line intersects the well field manifold and traverses 9.1 miles southeast, paralleling the north side of the Intestate 10 dike, intersecting Yuma road. The main trunk line then parallels Yuma road for 14.9 miles, terminating at Sarival Road.

RID Summary Description
The well field manifold and the main trunk line intersect at the southern tip of the well field and traverses east along Yuma road for 2 miles, then south along Johnson road for just under 2 miles, intersecting the north side of the RID canal right-of-way. From the intersection of Johnson road and the canal right-of-way, the alignment parallels the RID for 13.6 miles, intersecting Yuma road. From the intersection of Yuma road and the canal, the pipeline traverses eastward along Yuma road for 4.8 miles, terminating at Sarival road.

Yuma Rd Detailed Description
The Hassayampa River well field stretches approximately 4 miles in length along the eastern edge of the river and straddles Interstate 10. Approximately 1 1/3 miles of the well field is located south of the interstate, and approximately 2 2/3 miles of the well field is located north of the interstate. Roads in this area are not common, but the well field does cross over two infrequently used roads in the vicinity of the well field. About 1 ¾ miles north of Interstate 10, the Tonopah Salome Highway crosses over the proposed well field. The southern tip of the well field is bordered by Yuma Road. The Tonopah Salome Highway appears to be located within the county. The south side of Yuma Road in the vicinity of the well field has been incorporated by the town of Buckeye, while the north side of Yuma Rd is considered county land.

The well field manifold crosses the interstate, and the interstate dike. One method for

crossing existing infrastructure without posing interruption to service is to jack and bore an underpass beneath the structure. The interstate would require a jack and bore operation, but an analysis was not done to determine whether it would be more or less expensive to jack and bore across the dike, or also to what extent Maricopa County Flood Control district would allow with respect to crossing this area. The construction estimate provided includes the cost for jacking and boring across the dike.

Approximately 2 ½ miles south of the northern most point of the well field, the main trunk line connects the well field manifold, and traverses mostly east and south along the north side of the Interstate 10 dike. The surrounding area is mostly undeveloped except that improved roads in the area are the first steps to developable lands. Most notable is Sun Valley Parkway, which aims to provide potentially thousands of future residents in north Buckeye access to the interstate in the south. From the intersection of the manifold, the main trunk line traverses 9.1 miles to the intersection of Yuma Road, west of the interstate. This intersection occurs about 8/10 of a mile west of the interstate along the Yuma Road alignment. At the point where the pipeline begins to traverse along the Yuma Road alignment, a road does not exist. Yuma Road and the Yuma Road alignment do not intersect until approximately a hundred feet east of the interstate.

Due east from the well field area, the interstate traverses along topography which increases slightly in elevation as it approaches the White Tank Mountains. The distance between the mountains and the dike narrows to an average of 130-feet. The pipeline crosses the dike at Highway 85 – Oglesby Road to avoid the narrow canyon alignment, then roughly parallels the south side of the dike northeastward to the Yuma Road alignment.

From Yuma road, the pipeline parallels the south shoulder of Yuma Road, terminating at Sarival Road. The Sundance home development is a new edition to Yuma Road. Sundance begins 3/10 of a mile west of Watson Road, and ends 1/3 of a mile east of Rainbow Road/North Sundance Parkway, representing a 2.7 mile stretch of development along Yuma Road. In the 2002 report, a new development is mentioned as beginning ¾ of a mile west of Cotton Lane on Yuma Road and ending at the intersection of Cotton Lane and Yuma Road. This new development was constructed by Beazer Homes.

The following are the perceived advantages and disadvantages of the Yuma Road alignment.

Yuma Road Advantages:

- The alignment is shorter by 3 miles when compared to the RID alignment, and therefore is less expensive with respect to material costs. The cost to replace the infrastructure would be advantageous when compared to the RID trunk line.

- Deliveries into north Buckeye could be made more easily from an alignment already partially located north of Interstate 10. Pump energy costs for deliveries to the north are minimized using this alignment versus the RID alignment. This scenario is not apparent in this study since the laterals are all sited south of the Yuma Road trunk line.
- The trunk line paralleling the interstate dike would be relatively easy to install and is straight for 5 miles. The Yuma Road portion would require constructing through paved roads and development, but it also is a straight stretch for approximately 15 miles.

Yuma Road Disadvantages:

- The main trunk line would encounter new development along Yuma Road between Interstate 10 and Sarival Road. In addition to the expense of ripping out new construction, residents in the area might view the construction negatively and wonder why a water line couldn't have been installed prior to their arrival. In addition to crossing through this new development, the construction of the pipeline would also have to make special construction provisions for crossing Interstate 10 and the interstate dike twice. The dike and interstate would need to be crossed once at the well field (the well field manifold), and again where the main trunk line transitions away from the interstate dike toward Yuma Road just east of Miller Road.
- Although the interstate dike alignment is relatively free of utilities, the transition on to Yuma Road is not. Particularly the first three miles of the Yuma Road alignment where numerous utilities are known to cross the road. Fiber optic cable traverses along the north side of Yuma Road from the interstate east to Jackrabbit Road, and then along the south side of Yuma Road east to an unknown point. A gas pipeline is located on the north side of Yuma Road from Jackrabbit to Perryville Road.
- Pipeline and related infrastructure replacement costs would likely increase due to planned development along Yuma Road.

RID Detailed Description

The southern-most tip of the well field manifold ends at Yuma Road, and from this point, the main trunk line heads east along Yuma Road for 2 miles to Johnson Road. The main trunk line parallels Johnson Road south for approximately 1 ¾ miles until it intersects the northern right-of-way of the RID canal. The north section of Yuma Road along the alignment is county land, the south side of the road is incorporated by the town of

Buckeye. Except for a 1,200-foot strip of length on the east side of Johnson Road which is incorporated by Buckeye, the east side of Johnson Road is county land. The west side of Johnson Road is incorporated by the town of Buckeye. Though unsure of any existing utilities which could influence what side of Yuma and Johnson Roads to traverse, it would be more beneficial to connect to the end of the manifold and construct the pipeline on the north side of Yuma Road and the east side of Johnson road in order to minimize road crossings when intersecting the northern edge of the RID canal.

From the intersection of Johnson Road and the RID canal, the main trunk line parallels the north side of the RID canal for 13.6 miles until it intersects Yuma Road, with few obstructions other than crossing major roads. Some of these roads are Palo Verde, Oglesby, Miller, Watson, Rainbow and Dean Roads.

The trunk line intersects Yuma Road 3/10 of a mile east of Tuthill Road and would traverse along the southern shoulder of Yuma Road for 4.8 miles. The reach from approximately Tuthill Road to Sarival Road, is less developed, but RID lateral canals cross this stretch of Yuma Road.

The following are the perceived advantages and disadvantages of the RID Canal alignment.

RID Canal Advantages:

- The new Sundance development located on Yuma Road beginning just east of the interstate is avoided. The expense of ripping out paved roads, utilities, and replacing the removed infrastructure is avoided.
- A negative public relations with the Sundance community is avoided.
- By using the RID right-of-way, construction across the interstate and interstate dike occurs only once.
- Easement fees appear to be less expensive using the RID canal right-of-way versus county or city right-of-way.
- The construction avoids very much traffic control by constructing less of the pipeline along Yuma Road.
- Future activities to replace pipeline and infrastructure costs less since less of the pipeline is constructed along a high traffic roadway.

RID Canal Disadvantages:

- The main trunk line is three miles longer than the main trunk line for the Yuma Road alignment. A longer alignment reflects a higher materials cost.
- The canal right-of-way could represent a narrower strip of land when constructing the pipeline, which could cause logistical construction challenges.

The following are the explanations of the alignments for each lateral planned along Miller and Tuthill Roads, and Cotton Lane for each main trunk line alignment.

Miller Road Lateral for the Yuma Road Alignment
A tee would be constructed from the main trunk line at Miller Road north of the interstate. The lateral would be constructed along the west shoulder of Miller Road and be constructed through the interstate underpass and continue for just under four miles terminating at Baseline Road north of the Southern Pacific railroad line. The main challenge associated with Miller Road is the RID canal, and the subsequent pipeline turnout which also parallels Miller Road on the west shoulder of the road (evidence of this pipeline is obvious since manholes are observable above ground level on the west shoulder). Nevertheless, the west shoulder, also explained in the 2002 report, still appears to be the best location for the lateral. A new development is occurring south of the RID canal along Miller Road on the east side of the shoulder.

Miller Road Lateral for the RID Canal Alignment
Two tees would be constructed at the intersection of the RID canal and Miller Road. Because the RID canal is located south of the Yuma Road alignment, a north and south lateral extension is needed from the RID canal alignment. The lateral is shorter in length than the Yuma Road alignment for the Miller Road lateral. Although the south extension terminates at Baseline Road, the north extension terminates at the interstate, and not at Yuma Road, making the Miller Road lateral about 300-feet shorter than the Miller Road lateral for the Yuma Road alignment.

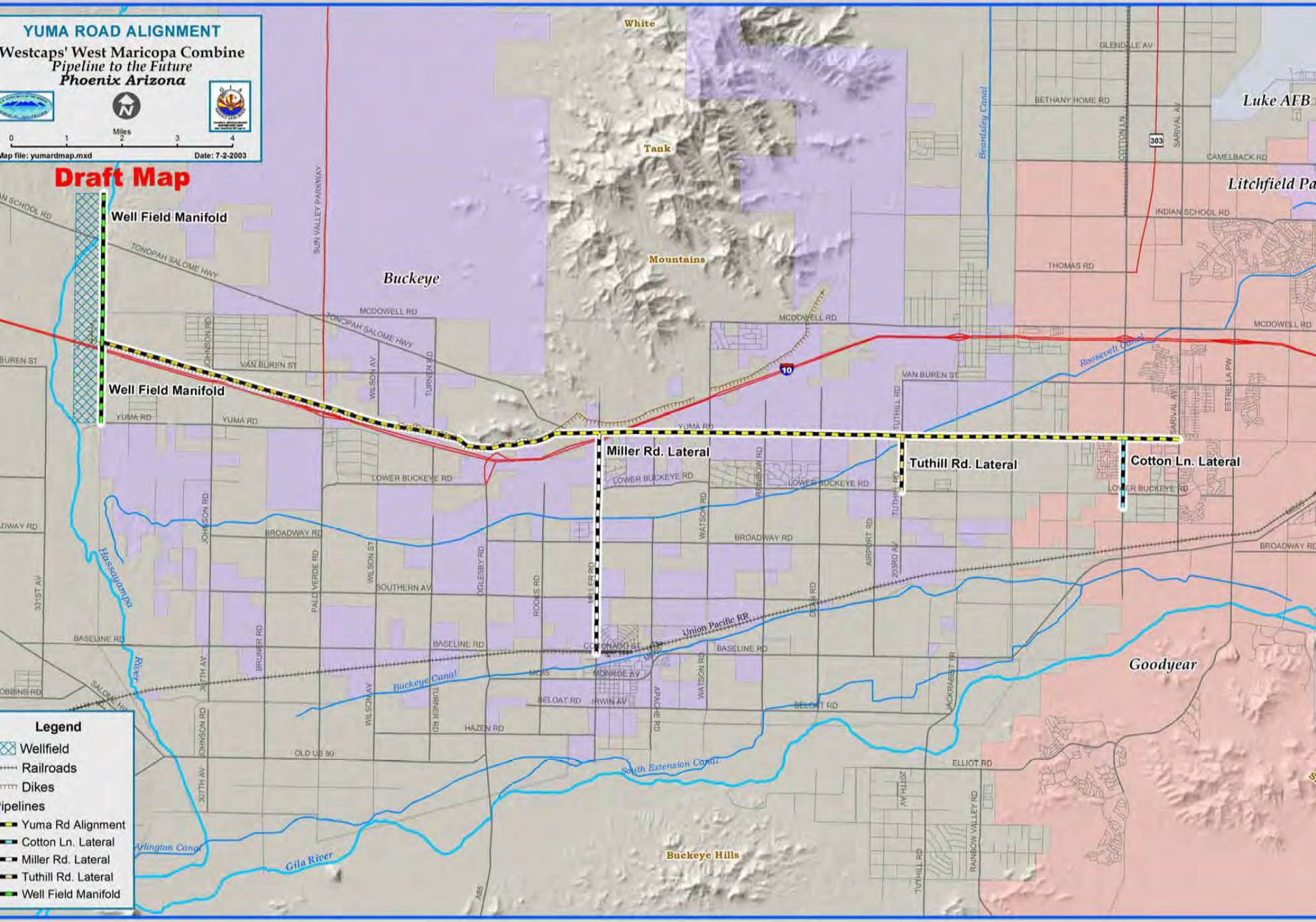
Tuthill Road Lateral for the Yuma Road Alignment
At Tuthill Road and Yuma Road, a lateral would be constructed along the west shoulder of Tuthill Road. This lateral would extend 1 mile south to Lower Buckeye Road. About 800-feet south of the main trunk line connection, the lateral crosses the RID canal in order to continue to Lower Buckeye.

Tuthill Road Lateral for the RID Canal Alignment
A tee would be constructed from the north bank of the RID main trunk line, would cross the canal, and continue south to Lower Buckeye Road. The north extension, from the trunk line to Yuma Road, is not planned, and would thus make the RID Canal alignment for the Tuthill Road lateral less expensive to construct since approximately 800-feet of pipeline is not needed. Currently a manufactured home development exists in the area between Yuma Road and the RID canal on Tuthill Road.

Cotton Lane Lateral for the Yuma Road Alignment
At Yuma Road and Cotton Lane, a tee would be constructed to bring water south along the west shoulder of Cotton Lane. The lateral extends approximately 1 ¼ miles south past Lower Buckeye Road. The lateral would encounter an 18-inch drainage channel located 400-feet south of the intersection of Yuma Road and Cotton Lane. An irrigation canal also crosses Cotton Lane approximately ½ a mile south of the intersection of Yuma Road and Cotton Lane.

Cotton Lane Lateral for the RID Canal Alignment

The Cotton Lane lateral for the RID canal would traverse the same alignment, and would be identical in length as the Cotton Lane lateral for the Yuma Road alignment.


YUMA ROAD ALIGNMENT
Westcaps' West Maricopa Combine
Pipeline to the Future
Phoenix Arizona
Miles
0 1 2 3 4
Map file: yumardmap.mxd
Date: 7-2-2003
Draft Map
Well Field Manifold
Well Field Manifold
Miller Rd. Lateral
Tuthill Rd. Lateral
Cotton Ln. Lateral
Buckeye
White Tank Mountains
Buckeye Hills
Goodyear
Luke AFB
Litchfield Pa
Beardsley Canal
Roosevelt Canal
Buckeye Canal
South Extension Canal
Arlington Canal
Gila River
Hassayampa River
Union Pacific RR
SUN VALLEY PARKWAY
TONOPAH SALOME HWY
INDIAN SCHOOL RD
MCDOWELL RD
VAN BUREN ST
YUMA RD
LOWER BUCKEYE RD
BROADWAY RD
SOUTHERN AV
BASELINE RD
HAZEN RD
OLD US 80
MONROE AV
BELOAT RD
IRWIN AV
COLONADO ST
ELLIOT RD
THOMAS RD
BETHANY HOME RD
GLENDALE AV
CAMELBACK RD
JOHNSON RD
WILSON AV
TURNER RD
PALO VERDE RD
WILSON ST
OGLESBY RD
ROOKS RD
MILLER RD
WATSON RD
RAINBOW RD
TUTHILL RD
AIRPORT RD
203RD AV
207TH AV
SARIVAL AV
ESTRELLA PW
COTTON LN
RAINBOW VALLEY RD
JACKRABBIT TR
DEAN RD
PEORIA AV
BRUNER RD
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Legend
Wellfield
Railroads
Dikes
Pipelines
Yuma Rd Alignment
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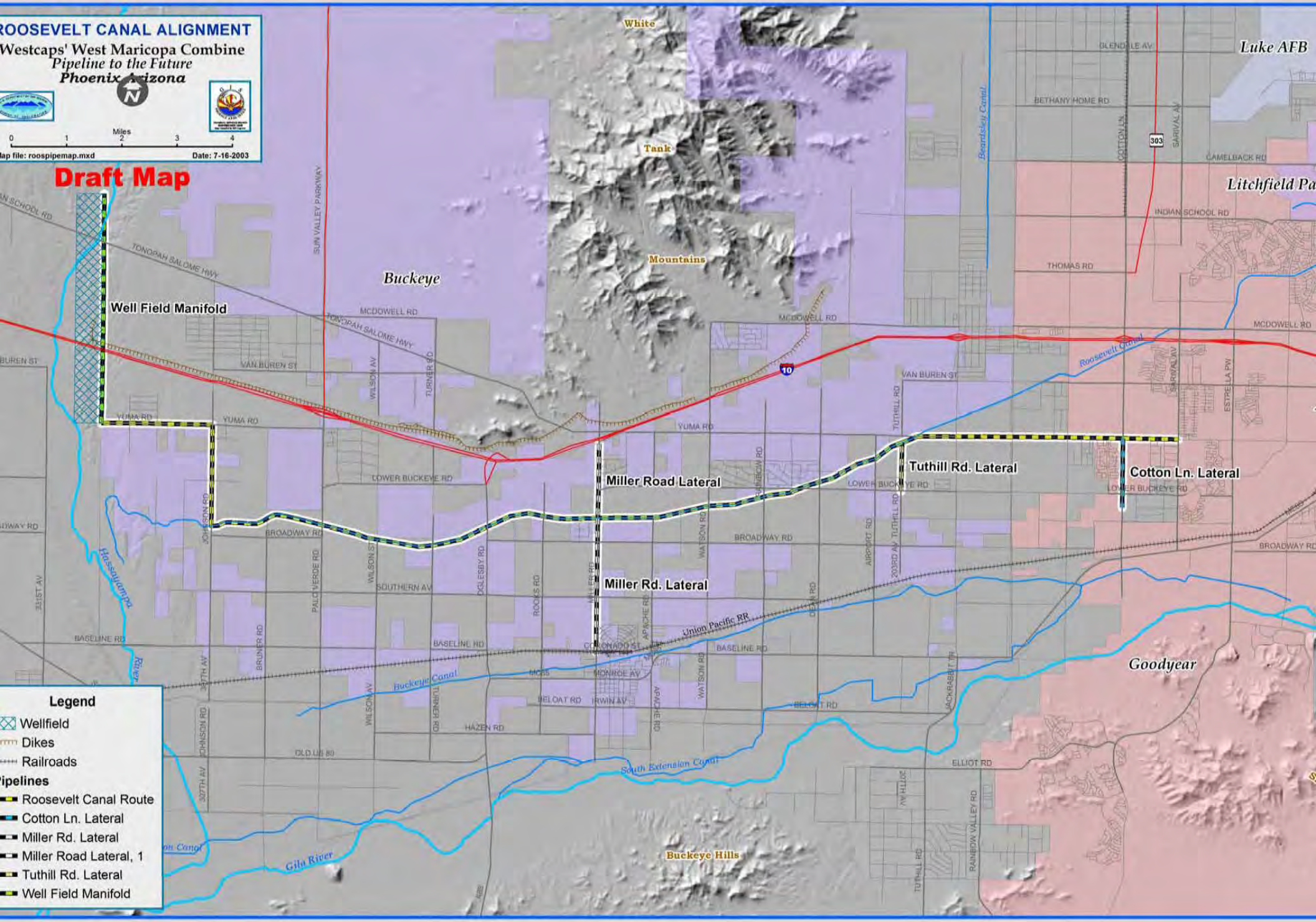
Miller Rd. Lateral
Tuthill Rd. Lateral
Well Field Manifold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Westcaps' West Maricopa Combine
Pipeline to the Future
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Draft Map
Well Field Manifold
Miller Road Lateral
Miller Rd. Lateral
Tuthill Rd. Lateral
Cotton Ln. Lateral
Buckeye
Goodyear
Luke AFB
White Tank Mountains
Buckeye Hills
Roosevelt Canal
Buckeye Canal
South Extension Canal
Gila River
Hassayampa River
Union Pacific RR
Beardsley Canal
Litchfield Pa
Legend
Wellfield
Dikes
Railroads
Pipelines
Roosevelt Canal Route
Cotton Ln. Lateral
Miller Rd. Lateral
Miller Road Lateral, 1
Tuthill Rd. Lateral
Well Field Manifold

CHAPTER III

HYDRAULIC ANALYSIS AND CONSTRUCTION COST ESTIMATIONS

Background

The goal of this study is to determine which alignment, the Yuma Road or RID Canal, is most favorable to use. Ultimately, the determining factor is cost. Initially this study began strictly as an exercise to determine the difference in the cost of constructing the Yuma Road alignment versus the RID canal alignment. With time, other variables were thought to have some importance that was not related to the cost of construction.

Public Relations

With respect to public relations, it would be desirable to avoid the new Sundance community along Yuma Road. Another less thought of public relations issue is the disruption to traffic along Miller Road during the construction of the Miller Road lateral. The traffic along Miller Road appears to be greater than the traffic along other planned roads for the construction of a pipeline. The commuters along Miller Road would be inconvenienced by traffic control, or could find other alternate routes from the town of Buckeye toward the north. At this time it appears that little development has occurred along Miller Road, and that Miller Road is being used mostly by commuters living in the Town of Buckeye to commute between their residence and the interstate.

Replacement cost

Bonding rates for municipal water systems are traditionally calculated using a 20-year time horizon. This report likewise calculates the cost of building, operating, and maintaining the system over 20 years in a present worth dollar figure, and in terms of dollars per acre-foot, and dollars per thousand gallons. However, it is important to consider the replacement cost of the system, and not just in terms of the materials, but the cost to access the pipeline and related infrastructure. This study does not calculate the replacement cost. However, although replacement of the RID Canal alignment would be considered more expensive, the actual replacing of materials may be more expensive along Yuma Road when more development has been constructed.

Design Parameters

The following parameters, common to either system, were the basis for calculating the pipeline infrastructure needed.

- The system is modeled to determine the cost of operations at 25,000 acre-feet per year. However, the design is meant to meet a peak demand of 1 ½ times the yearly water delivery, or 37,500 acre-feet per year on a yearly adjusted basis. The modeling effort determines the infrastructure needed based on delivering 37,500 acre-feet per year.
- Flow velocities in pipes are modeled to stay within 5 feet per second. Up to a 10% increase in flow above 5 feet per second is allowed for 42-inches in diameter or larger sized pipe. This reduces pipe friction cost which helps to keep energy costs down, and lengthens the life of the pipe by reducing internal scouring due to high velocities.
- The Hazen-Williams (H-W) Friction Factor of 130 is used. Both HDPE and concrete pipe are modeled for use in this study since HDPE pipe has been priced as a less expensive alternative for pipe sizes under 42-inches. For pipe sizes of 42-inches or larger, concrete is the less expensive material. According to the 2002 report, an H-W friction factor of 135 is used for concrete pipe. This study applies the H-W value of 130 for all pipe, for ease of use in all of the calculations. This is not only due to the fact that a similar value was used in the 2002 report, but according to the Civil Engineering Reference Manual, Michael R. Lindburg, P.E., the range for the H-W value for plastic is 120 to 150, and for concrete it is 85 to 152.
- Five feet of earth cover is assumed for all buried pipe. According to WESTCAPS advisors, this is a Maricopa County construction requirement. The trenching dimensions are the width of the pipe plus 19-inches, and the width of the pipe plus five feet of earth cover.
- Pipe pressures were not allowed to fall below zero during the modeling run for the well field manifold or the main trunk line. Pipe pressures were not allowed to fall below 37 psi, nor rise above 75 psi for any of the laterals in areas where water deliveries were expected to occur (the exception is the first 2/3 of a mile of the Miller Road lateral under the Yuma Road pumping scenario) in order to maintain sufficient, but not excessive, water pressure for domestic delivery.
- The 2002 report describes that the water need not be treated, and that the cost to provide the equipment and chemicals for water treatment is not considered. Approximately one year ago, the Rose Valley Water Company is alleged to have delivered water which contained amoebic meningitis caused by the Naegleria fowleri amoeba. Any bacteria and viruses in the water can be safely controlled by applying either chlorine, or ozonating the product water, and the West Maricopa CombineWater Company has stated that they will provide chlorine treatment. This study includes the cost of equipment, the cost of operations of the equipment, and maintenance costs for chlorinating the product water.

- Contingencies for the system are calculated in the following way. The general contingency, applied to the value of construction, is calculated as 20% of the cost of constructing the pipeline, reservoirs, and pipeline appurtenances. The engineering and administration expense is calculated as 20% of the cost of the constructing the pipeline, the reservoirs, and unlisted items. See Table 5-1, Cost Comparison Sheet for the Yuma Road and RID canal alignment for these specific costs.
- The value used for amortizing the annual interest rate and duration are 5.5 percent and 20 years.
- Overall motor and pump efficiency is assumed as 68 percent.
- The electrical power cost is 90 mills ($0.09) per kilowatt-hour.
- Land easement fees in various areas are often calculated by the taxing district for that area, and are based on an unwieldy calculation which makes engineering principles seem like basic mathematics. For ease of calculations, land easement fees are roughly calculated as $1,000 per acre for the RID canal right-of-way, $1,500 per acre along Yuma and Johnson Roads between the well field and the RID canal, $2,000 per acre for the well field area, $2,500 per acre along the Interstate 10 dike, $3,500 per acre along Miller Road, Tuthill Road, and Cotton Lane, and $4,000 per acre along Yuma Road.
- Earthwork is calculated as $5.80 per cubic yard for trenching, $1.90 per cubic yard to backfill, $2.86 per cubic yard to compact backfill, and $6.95 per cubic yard to remove spoil assuming the haul distance is 2 miles or less.
- Urban areas are considered more expensive to build through than undeveloped areas. The additional costs to consider besides the earthwork activities needed through undeveloped areas include the reconstruction of asphaltic concrete pavement, pipe bedding for pipe support due to traffic in urban areas, traffic control, and the replacement of any utilities. The areas considered for this additional cost were along Yuma Road (main trunk line for the 42-inch pipe), and the southern end of the Miller Road lateral (30-inch pipe) where the lateral must be placed within Buckeye town limits. The cost of asphaltic concrete is $5.60 per square yard, and the cost to bypass or replace utilities is a rough calculation of 75% of the total cost of jacking and boring under other utilities since smaller utilities are known to exist, but are unknown in terms of magnitude. The cost of pipe bedding for 42-inch pipe is $21.91 per linear foot, and $9.13 per linear foot for 30-inch pipe. The cost for traffic control is $21 per linear foot for 42-inch pipe, and $16.15 per linear foot for 30-inch pipe.

Hydraulic Analysis

The hydraulic analysis was conducted by using a pipeline modeling program (PMP) developed by several engineers in the early 1990's at the Phoenix Area Office of the Bureau of Reclamation. In 1995 the modeling program underwent improvement refinements. Unlike many programs which cannot be improved or refined by the user,

this program allows the user, if familiar with hydraulic and fluid mechanics engineering principles, to make improvements and adjustments. The improvements made for this study included adding an estimate for the cost of spoil removal based on the trenching material minus the backfill replacement. An additional column was added to calculate the amount of land needed with respect to the cost of land easements. The pressure transferred to a lateral (tee) from the trunk line was additionally added to the PMP. And if pipe sizes changed along a line, the PMP was adjusted to read the upstream line pressure and elevation.

The PMP updates the hydraulic profile of the pipeline for a set distance selected by the user. The hydraulic profile includes the elevation, friction losses for a set distance, the pumping head added (if any), the head out of one section in feet and psi, and the head back into the next section in feet and psi, and the velocity in feet per second. The user selects the distance, and in essence, how often the hydraulic profiling should occur. The shorter the distance, the more accurate the analysis, but the more tedious it is to profile such short distances, particularly if the pipe length is miles long. The longer the distance selected between points, the less accurate a picture the designer has in correctly determining the class of pipe needed based on hydraulics due to error.

For this study, a distance of 500-feet was selected to model the pipeline. At point "zero feet" the only hydraulics occurring are the addition of pressure added by the pump and the volume of water being pushed by the pump which the PMP associates with a pressure value at the inlet of the pipe in terms of feet and psi. At point "5.0", 500-feet later, the PMP calculates the new pressure in the pipe based on friction losses, elevation differences, if a booster pump added any more pressure, or if a pressure reducing valve dropped the pressure. The next section is then adjusted accordingly, and so on. At the conclusion of modeling the length of the Yuma Road main trunk line, the length in the PMP was incorrectly valuing the length to be longer than the main trunk line actually was. An adjustment was needed and a new column was created in the PMP to provide a correction factor in order to correctly value alignment lengths. The first column in the PMP is labeled "Sta." and is the actual station length for each notch shown on the hydraulic modeling map. The next column is labeled "Map Sta." which is the station value shown on the map. For example, in Table 1 for either the Yuma Road or RID canal, the second row shows 4.8 as the station value, and 5.0 as the map station value. The map is labeled as station 5.0 (500-feet), but the actual value of that length is 484-feet. The results of the modeling are available in the appendix.

As an added safety factor, the average pressure in any one section of pipe is increased by 40% to account for incidences of water hammer. Based on the pressures calculated in any one section of 484-feet of pipe the PMP reads a second lotus sheet to determine what

class of pipe is appropriate, and the cost per foot for that class pipe is subsequently shown. The earthwork needed is additionally calculated in subsequent columns based on the size of pipe selected by the user, and the length of pipe needed, and earth cover required. The equations in the PMP used to calculate earthwork are a function of the user's equation to calculate the size of trench needed based on the size of pipe selected.

Results of the Modeling Run

The results of the modeling run using the PMP for the peak delivery of 37,500 acre-feet per year for both the Yuma Road and RID alignment are summarized on the subsequent pages. The results include the hydraulic analysis of the well field along the Hassayampa River, the main trunk line from the well field to Sarival Road, and of the Miller Road, Tuthill Road, and Cotton Lane laterals which are modeled to deliver 16,896 acre-feet per year, 915 acre-feet per year, and 19,689 acre-feet per year respectively.

Pipeline Requirements for the Well Field Using the Yuma Road Alignment

The well field manifold collects and routes water along a north-south alignment along the eastern section of the well field. The manifold converges to a point just north of the Interstate 10 dike. North of the interstate, the water is directed southward, and thus each section of pipe must be larger to handle larger volumes of water. Likewise, the southern section directs water northward.

The well field is divided into ½-mile sections. Each section has two wells deliver water to the manifold for a total of 16 wells. Each well delivers 3.25 cubic feet per second, or 1,450 gallons per minute for 2/3 of a day to meet 25,000 acre-feet per year.

The Yuma Road alignment is positioned such that five ½-mile sections are located above the interstate, and three are located below the interstate. Each section is outlined in the table below, and additionally can be referenced between Tables 1 and 8 in the appendix in the PMP Modeling Section. Tables 1 through 5 are the ½-mile sections of pipe above the interstate, and Tables 6 through 8 are the sections below the interstate. Table 1 is the most northern ½-mile section, and Table 6 is the most southern ½-mile section.

Table 3-1. Pipe Sizes, Velocities, and Descriptions for Well Field Manifold Sections Using the Yuma Road Alignment.

Section	Pipe Size (in.)	Velocity (ft/sec)	Description	Table in Appendix.
1st ½-mile	16	4.6	First fifth section north of I-10	Yuma-Table 1
2nd ½ mile	22	4.9	2nd section north of I-10	Yuma-Table 2
3rd ½ mile	28	4.5	3rd section north of I-10	Yuma-Table 3
4th ½ mile	32	4.6	4th north of interstate	Yuma-Table 4
5th ½ mile	36	4.6	Last fifth before trunk line	Yuma-Table 5
1st ½ mile	16	4.6	First third south of I-10	Yuma-Table 6
2nd ½ mile	22	4.9	2nd third south of interstate	Yuma-Table 7
3rd ½ mile	28	4.5	Last third before trunk line	Yuma-Table 8

The following table provides the hydraulic results for the well field using the Yuma Road alignment.

Table 3-2. Pipe Sizes, Pressure Ranges, Schedules, and Unit Costs for Manifold Pipe Using the Yuma Road Alignment.

Section	Pipe Size (in.)	Press. Range* (psi)	Pipe Class (Schedules)	Pipe Unit Cost Range ($/ft)
1st ½-mile	16	23 - 28	35, 50	$31.15
2nd ½ mile	22	19 - 36	35, 50	58.93
3rd ½ mile	28	12 - 19	20, 35	95.50
4th ½ mile	32	25 – 32	35, 50	124.71
5th ½ mile	36	35 – 40	50, 65	157.82 – 195.71
1st ½ mile	16	17 - 26	35	31.15
2nd ½ mile	22	13 -25	20, 35	58.93
3rd ½ mile	28	25 - 32	50	95.50

* Representative of pressure range for ½ mile section, not design pressures which adds an additional 40% for safety purposes.

Pipeline Requirements for the Well Field Using the RID Canal Alignment

The well field for the RID canal alignment is located similarly to the well field for the Yuma Road alignment. However, the RID canal must be reached from the well field, so the well field manifold transitions into the trunk line at the southern tip of the well field. All of the water in the manifold is directed southward whereas some of the water was

directed northward using the Yuma Road alignment. Since all of the water is directed southward, each section of manifold pipe is larger to handle larger volumes of water, as shown in the following table.

Table 3-3. Pipe Sizes, Velocities, and Descriptions for Well Field Manifold Sections Using the RID Canal Alignment.

Section	Pipe Size (in.)	Velocity (ft/sec)	Description	Table in Appendix.
1st ½-mile	16	4.6	First section north of I-10	RID-Table 1
2nd ½ mile	22	4.9	2nd section north of I-10	RID-Table 2
3rd ½ mile	28	4.5	3rd section north of I-10	RID-Table 3
4th ½ mile	32	4.6	4th section north of I-10	RID-Table 4
5th ½ mile	36	4.6	Last section north of I-10	RID-Table 5
6th ½ mile	42	4.0	First section below I-10	RID-Table 6
7th ½ mile	42	4.7	2nd section south of interstate	RID-Table 7
8th ½ mile	42	5.4	Last eighth before trunk line	RID-Table 8

The following table provides the hydraulic results for the well field using the RID Canal alignment.

Table 3-4. Pipe Sizes, Pressure Ranges, Schedules, and Unit Costs for Manifold Pipe Using the RID Canal Alignment.

Section	Pipe Size (in.)	Press. Range* (psi)	Pipe Class (Schedules)	Pipe Unit Cost Range ($/ft)
1st ½-mile	16	23 - 28	35, 50	$31.15
2nd ½ mile	22	21 - 26	35	58.93
3rd ½ mile	28	12 - 21	20, 35	95.50
4th ½ mile	32	14 – 27	20, 35, 50	124.71
5th ½ mile	36	12 – 26	20, 35, 50	157.82
6th ½ mile	42	14 - 18	20, 35	202.44
7th ½ mile	42	22 -29	35, 50	202.44
8th ½ mile	42	30 - 36	50	202.44

* Representative of pressure range for ½ mile section, not design pressures which adds an additional 40% for safety purposes.

The cost to operate the system to deliver water is provided below. The cost to maintain the system is also taken into account. Several factors determine the cost of water delivery. These are the volume of water, the density of the material (in this case water), the internal friction to overcome when pumping, and the elevation difference in pumping. The following table compares the cost of construction and operations/maintenance costs between the Yuma Road and RID Canal alternatives.

Table 3-5. Comparison in Cost of Constructing and Operating/Maintaining the Pipe Manifold for the Well Field for the Yuma Road and RID Canal Options

	Yuma Road		RID Canal	
Section	Cost to Construct	Operations/ Maintenance Costs[1]	Cost to Construct	Operations/ Maintenance Costs[1]
1st ½-mile	$114,000	$34,800	$114,000	$34,800
2nd ½ mile	199,000	35,800	199,000	35,800
3rd ½ mile	307,000	37,200	307,000	37,200
4th ½ mile	406,000	49,600	406,000	38,300
5th ½ mile	686,000	53,200	576,000	40,700
6th ½ mile	113,000	34,700	1,731,000	55,500
7th ½ mile	205,000	47,000	630,000	41,400
8th ½ mile	1,073,000	80,300	687,000	53,200
TOTAL	$3,103,000	$372,600	$4,650,000	$336,900

[1] Yearly costs. Maintenance costs are calculated as 1.28% of construction costs.

Differences in costs for what appear to be similar sections are apparent. For the 4th and 5th half-mile sections, the Yuma Road alignment is more expensive in terms of operations and maintenance costs. This is due to the split manifold which requires higher pressures in the last segments of the north section in order to attain equivalent pressures with respect to the southern portion of the manifold in order for both sections to feed into the main trunk line. The high cost is also apparent in sections 7 and 8 for the Yuma Road alignment versus the RID Canal alignment, even though the RID has larger flows through its pipeline. Section 8 is the last half-mile section of pipe prior to discharging flows into the trunk line. Section 7 is the next to the last section of pipe, and section 6 precedes 7. These last three sections of pipe for the Yuma Road alignment are pumping water in the manifold uphill in order to reach the main trunk line, whereas the RID alignment for the well field all flow downhill to feed flows into the trunk line.

Some of the construction costs for one alignment are wildly different compared to their counterpart for what appear to be similar sections. In particular, section 6 of the RID

Canal alignment is about $1.6 million more than the counterpart section for Yuma Road. This is because the sixth half-mile section of the RID Canal manifold is not only larger (42-inch diameter versus 16-inch diameter), but the RID Canal portion must also be constructed to bypass the Interstate 10 dike and the interstate itself, at an estimated cost of $1,109,000 for the bypass alone.

The eighth section of Yuma Road pipe is noticeably more expensive than the RID alignment counterpart. This section of Yuma Road manifold is the last section prior to connecting to the main trunk line, and must also bypass the interstate and interstate dike infrastructure. The additional cost for bypassing this infrastructure with 28-inch diameter pipeline is estimated to be $740,000.

The following are the advantages and disadvantages of using the Yuma Road alignment versus the RID Canal alignment for the well field manifold.

- The Yuma Road option is less of a cost to construct versus the RID Canal alignment by $1,547,000. Both alignments are similar lengths, but the RID Canal alignment requires three sections of 42-inch pipe for the last three half-mile lengths, while the Yuma Road three ½-mile lengths below the interstate are 16, 22, and 28-inches in diameter.
- Although more volume of water is flowing through the last three sections of 42-inch pipe for the RID Canal, the elevation drop from north to south assists in reducing energy costs and thus the RID Canal saves in operations/maintenance costs versus the Yuma Road alignment by approximately $36,000 per year. Without adjusting for inflation, the operations/maintenance savings by using the RID pays for the additional construction costs in 43 years.
- Replacement costs are not calculated, but would favor the Yuma Road alignment due to the smaller, less expensive pipe required.

Pipeline Requirements for the Trunk Line

The optimum size for the trunk line is 42-inches in inside diameter. At this size with peak flow the velocity is 5.4 feet per second. This velocity should not be exceeded by installing a smaller sized trunk line. The pipe class required ranges from schedule 20 to schedule 50, and is all priced at $202.44 per foot. The average water pressure along the main trunk line ranges from 4 psi to 35 psi from the well field to Sarival Road, regardless of whether the Yuma Road or RID alignment was modeled. Low pressures in the main trunk line were desired in order to use smaller schedule pipe and thus keep pipe costs low. Higher pressures in the laterals were needed for residential distribution which required booster pumping in most cases and subsequently higher class pipes. At 42-inches in diameter, our cost estimate was no different whether schedule 50 or schedule 20 was used.

Requirements for the Yuma Road Trunk Line

The Yuma Road trunk line begins at the eastern edge of the well field and is placed on the north side of the Interstate 10 dike. In order for the separated well field manifolds to successfully deliver water into the trunk line, both north and south well field manifolds must deliver water to the trunk line at equal pressures. Note that "Head Out" pressures for Yuma Road alignment Table 5 (last manifold segment north of the interstate) and Yuma Road alignment Table 8 (last manifold segment south of the interstate) equal 30.05 psi.

From the well field in the direction of flow toward Phoenix, the topography generally increases in elevation as the pipeline approaches the White Tank Mountains. The foothills of the White Tank Mountains are approximately 38-feet higher than the beginning of the trunk line. The elevation difference which must be overcome, combined with friction losses amount to about 1-foot of pressure loss per 484-feet of pipe length, which require that a booster pump be located approximately 500-feet east of Sun Valley Parkway, or about 4 miles east of the transition from the well field manifold to the trunk line. Another booster pump is required at the White Tank Mountains for the trunk line about 7.9 miles east of the transition from the well field manifold to the trunk line, or about 1 ¼ miles along the trunk line west of Miller Road. From the White Tanks to Sarival Road along Yuma Road, the topography generally decreases by approximately 66 feet in elevation. Although the peak flow is being delivered at a friction loss of about 1-foot per 484 feet of pipeline length from the White Tank Mountains to Sarival Road, booster pumping is not needed due to the assistance from gravity with the 66-foot elevation drop.

The details of the trunk line for the Yuma Road alignment are shown in the following table.

Table 3-6. Pipe Size, Velocity, Pressure Range, Pipe Class, Unit Costs, and Overall Length for the Construction of a Concrete Pipe for the Yuma Road Trunk Line Alignment from the Well Field to Sarival Road.

Pipe Size (in.)	Velocity (ft/sec)	Pressure Range* (psi)	Pipe Class (Schedules)	Unit Costs ($/ft)	Length of Trunk Line (miles)
42	5.4	3 – 70	20, 35, 50	$202.44	19.7

* Representative of actual pressure across the 20-mile range of pipe, not design pressures which adds an additional 40% for design purposes.

The details of providing booster pumps, the cost of providing booster pumps, and the yearly operations costs associated with booster pumping are shown below.

Table 3-7. Location, Cost of a Booster Pump, Horsepower Output, and Total Yearly Power Requirement Based on Two Booster Pumps for the Yuma Road Alignment Main Trunk Line.

Location (General and Map Station)	Booster Pumping Head (ft)	Required Power Output (hp)	Purchase Cost ($)	Yrly. Operations Cost[1] (for both pumps)
500' east of Sun Valley Pkwy, Sta. 35+70	60	350	$48,000	
1 ¼ miles west of Miller Rd., Sta. 56+70	60	350	$48,000	$409,850

[1] Annual power requirement, based on Kw-hr/yr, in order to deliver 25,000 acre-feet per year.

Requirements for the RID Canal Trunk Line

The RID Canal trunk line begins at the southern end of the well field, at the intersection of the eastern edge of the Hassayampa River and Yuma Road. The trunk line traverses eastward and parallels Yuma Road. At Johnson Road the trunk line veers southward until it intersects the north edge of the RID canal.

From the beginning of the trunk line to the RID canal, the topography increases and decreases in elevation, but generally decreases in elevation from one end to the other by approximately 30-feet. As water flows toward Phoenix paralleling the RID canal, the topography increases gradually by approximately 18 feet from the intersection of Johnson Road and the RID canal, to the intersection of the RID canal and Yuma Road.

Hydraulic pressure losses due to friction are approximately 1-foot per 484-feet of length which is not assisted sufficiently by gravity along the trunk line in order to avoid a booster pump. Because of some decreases in elevation, a booster pump is not needed until about 3/10 of a mile west of Ogelsby Road/Highway 85, or about 8 ½ miles from the beginning of the trunk line. Further increases in elevation require that another booster pump be placed about 3/5 of a mile east of Watson Road, or about 13 ½ miles from the start of the trunk line. From the second booster pump, the drop in pressure along the main trunk line continues until it reaches a final pressure of 4.4 psi at the Sarival Road terminus.

Details of the trunk line for the RID Canal alignment are shown in the following table.

Table 3-8. Pipe Size, Velocity, Pressure Range, Pipe Class, Unit Costs, and Overall Length for the Construction of a Concrete Pipe for the RID Canal Trunk Line Alignment from the Well Field to Sarival Road.

Pipe Size (in.)	Velocity (ft/sec)	Pressure Range* (psi)	Pipe Class (Schedules)	Unit Costs ($/ft)	Length of Trunk Line (miles)
42	5.4	3 - 35	20, 35, 50	$202.44	21.7

* Representative of actual pressure across the 22-mile range of pipe, not design pressures which adds an additional 40% for pipeline design purposes.

The details associated with booster pumps, the cost of providing booster pumps, and the yearly operations costs associated with booster pumping are shown below.

Table 3-9. Location, Cost of Booster Pumps, Horsepower Output, and Total Yearly Power Requirement Based on Two Booster Pumps for the RID Canal Alignment Main Trunk Line.

Location (General and Map Station)	Booster Pumping Head (ft)	Required Power Output (hp)	Purchase Cost ($)	Yrly. Operations Cost[2] (for both pumps)
3/10 mile west of Hwy. 85, Sta. 68+33	60	350	$48,000	
2.6 miles east of Miller Rd., Sta. 95+33	65	380	$50,000	$426,900

[2] Annual power requirement based on Kw-hr/yr, in order to deliver 25,000 acre-feet per year.

Overall construction costs for the Yuma Road and RID Canal trunk line are the following.

Table 3-10. Itemization of Costs for Construction Activities Associated with the Construction of the Yuma Road Alignment and RID Canal Main Trunk Line.

Activity	Yuma Road Cost ($)	RID Canal Cost ($)
Pipe Costs (including installation, but not appurtenances)	$20,936,000	$23,190,000
Pipeline Appurtenances	2,660,000	2,787,000
Booster Pumps	96,000	98,000
Pumping Facilities (Housing and Operations)	2,433,000	2,433,000
Pipeline Trenching and General Excavating	960,000	1,063,000
Backfilling Operation	215,000	225,000
Compacting Backfill	294,000	326,000
Removing Spoil (less than 2 mile haul)	366,000	449,000
Urban Area Costs (AC pavement, bedding, traffic control)	2,466,000	1,149,000
Jack and Bore (mobilizing, dike x-ing, I-10 x-ing, RID, etc.)	1,866,000	919,000
Combination of Replacing or Bypassing Smaller Utilities	1,220,000	322,000
Total of Activities	$33,512,000	$32,961,000

Pipeline costs, pipe appurtenances, trenching, backfilling, compacting, and removing soil are expected to be higher for the RID Canal alignment than the Yuma Road alignment simply due to the longer length of the RID Canal alignment. The additional cost to the RID Canal alignment for these items is about $2.5 million more than the Yuma Road alignment.

The additional cost to construct through urban areas is approximately $1.3 million more if the Yuma Road alignment is used. This is a function of constructing more of the pipeline along Yuma Road which necessitates having to grapple with existing development. The RID avoids some of the development along Yuma Road by paralleling the RID canal, but does not avoid development altogether which is the reason the RID canal urban development cost is approximately $1.1 million.

The cost of crossing the interstate dike, the interstate, the RID canal, and some of the RID canal laterals is more expensive to undertake using the Yuma Road alignment by almost $1 million. The Yuma Road alignment must cross the interstate and the interstate dike twice – once at the well field, and the other at Miller Road in order to transition from the interstate dike alignment to Yuma Road. By traversing along the RID canal right-of-way, the RID Canal alignment avoids having to cross the interstate dike and interstate a second time by transitioning on to Yuma Road about a third of a mile east of Tuthill Road.

The last item in Table 3-10., replacing or bypassing smaller utilities, is more expensive for the Yuma Road alignment due to the existing development along Yuma Road. This item, along with the additional cost of constructing through urban development, is expected to increase in price as more development is expected to occur along Yuma Road in this area.

The following are the advantages and disadvantages of using the Yuma Road alignment versus the RID Canal alignment for the main trunk line.

- The materials, installation, pipeline appurtenances, trenching, backfilling, compacting, and removing spoil associated with building the pipeline along the RID Canal route is approximately 10% more expensive than the Yuma Road alignment. The Yuma Road alignment is more expensive when considering constructing a pipeline through an urban setting. In addition, the Yuma Road alignment must cross Interstate 10 and the interstate dike twice, versus one crossing using the RID Canal alignment.
- The RID Canal alignment is more expensive to operate. The yearly operations costs necessary to deliver 25,000 acre-feet are approximately $17,000 more for the RID Canal alignment using a cost of $0.09 per Kw-hr.
- The future right-of-way along the RID canal is unlikely to change with time if the Roosevelt Irrigation District does not undergo any corporate changes. The future of the Yuma Road alignment is especially likely to change as development continues, and would thus make replacement costs more expensive as access to underground pipe becomes more difficult and more expensive, and as replacement of more infrastructure above the pipe is likely to be required.
- Construction along the RID canal would be less disruptive to the new Sundance community being constructed between Interstate 10 and Rainbow Road along Yuma Road.

Pipeline Requirements for the Laterals

The distribution of peak flows across laterals is made according to the 2002 report, where peak flows among the laterals equals 37,500 acre-feet per year. With respect to the North-South pipeline along Sarival Road, in the reverse flow schematic, the North-South pipeline supplies this peak flow for the laterals from the east instead of the Hassayampa well field. The 2002 report illustrates that peak flows for any one scenario is 51.8 cubic feet per second (37,500 acre-feet per year).

Requirements at the Miller Road Lateral for the Yuma Road Alignment

In order to meet build-out demand, a total of 11,264 acre-feet per year of water is needed from the main trunk line into the approximate center of the town of Buckeye along Miller Road. When accounting for instant demand, a peak flow of 16,896 acre-feet per year is used for the design flow, which is equivalent to an instantaneous flow of 23.3 cubic feet per second.

At this peak rate, the optimum size pipe is 30-inches in inside diameter. At this size and peak flow, the velocity is 4.8 feet per second. The pipe class required ranges from schedule 35 to 80 and ranges in price from $109.56 per foot to $166.67 per foot for HDPE type material pipe. The average water pressure along the Miller Road lateral ranges from 20 to 57 psi. The first 3,870 feet of the 21,000 foot lateral are not an adequate pressure for domestic delivery (20 to 39 psi) and would require booster pumping should future development in this area require water. The remaining 17,000 feet of the lateral is pressurized between 40 and 58 psi which is adequate for domestic delivery. The pressure at the beginning of the lateral is a function of the velocity, friction losses, and pipe sizes where the lateral intersects at the main trunk line (for this size lateral, the pressure is equal to the main trunk line).

The elevation along Miller Road decreases from Yuma Road to the terminus of the line in Buckeye by 202-feet over 21,000 feet of pipeline. Friction losses are 1.1 feet of pressure per 484-feet of pipeline, but the gain in pressure due to the drop in elevation averages 4.6 feet per 484-feet of pipeline. The gains in pressure due to elevation drops are greater than friction losses, and thus two pressure reducing valves are necessary along the lateral to control the rise in pressure which would dictate the use of higher class pipe which adds expense. The first valve is required 1.7 miles from the beginning of the lateral, and the second valve is placed 3 miles from the beginning of the lateral.

Another major construction cost associated with this lateral is the cost of crossing the RID canal and three smaller canals. Smaller utilities are also expected to be encountered, particularly and around the town of Buckeye. The combined cost of crossing the four canals, of having to deal with smaller utilities, and the cost of mobilizing this equipment is estimated to cost $486,000.

The details of the Miller Road lateral for the Yuma Road alignment are shown in the following table.

Table 3-11. Pipe Size, Velocity, Pressure Range, Pipe Class, Unit Costs, and Overall Length for the Construction of HDPE Pipe for the Miller Road Lateral Associated with the Yuma Road Trunk Line Alignment.

Pipe Size (in.)	Velocity (ft/sec)	Pressure Range* (psi)	Pipe Class (Schedules)	Unit Costs ($/ft)	Length of Lateral (miles)
30	4.8	20 – 48	35, 50, 65, 80	$109.56 - $166.67	4.0

* Representative of actual pressure across the 4-mile range of pipe, not design pressures which adds an additional 40% for design purposes.

Requirements at the Miller Road Lateral for the RID Canal Alignment

The delivery of water along Miller Road from the main RID Canal trunk line requires that one pipeline deliver water north toward the interstate, and that the other pipeline deliver water south toward the town of Buckeye. In contrast to the Miller Road lateral for the Yuma Road alignment, which delivers water from one point to another, the RID Canal alignment lateral delivers an equivalent volume of water to two different points using two pipelines. A construction cost savings is realized since two pipes of smaller size are used rather than one larger one.

Overall, the lateral is shorter than the one needed for the Yuma Road alignment. The northern portion of the pipeline lateral extends to the interstate, and not to the Yuma Road alignment which is north of the interstate.

Since most of the demand is near the town of Buckeye, the greater proportion of the water is assigned to that area. The northern portion of the area above the RID canal was determined to require about 25% of the demand or a peak flow of 4,225 acre-feet per year. This demand requires a pipeline of 16-inches in size in order to make adequate deliveries.

To deliver water north to the interstate from the RID canal requires overcoming 81 feet of elevation. Overcoming this elevation, combined with approximately 1.9 feet of hydraulic friction losses per 484-feet of pipeline length requires two booster pumping stations in order to deliver water to the area along the interstate. The first booster pumping station is needed at the main trunk line which feeds into the lateral. The second booster pump is needed a third of a mile north of the intersection of the main trunk line and the lateral.

Similar to the Miller Road lateral for the Yuma Road alignment, a major construction

cost associated with this lateral is the cost of crossing the RID canal and three smaller canals. Similarly, smaller utilities are also expected to be encountered, particularly in the area of the town of Buckeye. The combined cost of crossing the four canals, of having to deal with smaller utilities, and the cost of mobilizing this equipment is estimated at $486,000.

The details for the northern portion of the Miller Road lateral for the RID Canal alignment are shown in the following table.

Table 3-12. Pipe Size, Velocity, Pressure Range, Pipe Class, Unit Costs, and Overall Length for the Construction of HDPE Pipe for the Northern Segment of the Miller Road Lateral Associated with the RID Canal Trunk Line Alignment.

Pipe Size (in.)	Velocity (ft/sec)	Pressure Range* (psi)	Pipe Class (Schedules)	Unit Costs ($/ft)	Length of Lateral (miles)
16	4.2	40 – 73	65, 80, 95, 110	$38.63 - $63.06	1.3

* Representative of actual pressure across the 1-mile range of pipe, not design pressures which adds an additional 40% for design purposes.

The details of providing for booster pumps, the cost of providing booster pumps, and the yearly operations costs associated with booster pumping are shown below.

Table 3-13. Location, Cost of Booster Pumps, Horsepower Output, and Total Yearly Power Requirement Based on Two Booster Pumps for the Northern Portion of the Miller Road Lateral Associated with the RID Canal Alignment Main Trunk Line.

Location (General and Map Station)	Booster Pumping Head (ft)	Required Power Output (hp)	Purchase Cost ($)	Yearly Operations Cost[1] (for both pumps)
@ RID canal trunk line, Sta. 0+00u	80	50	$10,750	
0.367 miles north of RID canal trunk line, Sta. 2+00u	80	50	$10,750	$61,600

[1] Annual power requirement based on Kw-hr/yr, in order to deliver 2,800 acre-feet per year.

The southern portion of the lateral was modeled to deliver a peak flow of 12,669 acre-feet per year or 17.5 cfs. At this flow, an adequately sized pipe is 28-inches. Friction losses are approximately 1-foot per 484-feet of pipe length. An elevation drop of 105 feet from the start of the lateral to its terminus in Buckeye 2 ½ miles later overcomes any hydraulic pressure losses due to friction. However, the gains in pressure due to the elevation loss require higher class pipe. Instead, four pressure reducing valves were installed along the length of pipe at an estimated cost of an additional $16,000. However, this cost outweighed the cost of installing higher class pipe which would have cost an additional $670,000. Therefore, pressures along the southern portion of the lateral were maintained closer to 40 psi, and in some instances are slightly less in order to avoid the higher class pipe.

The details of the southern portion of the Miller Road lateral for the RID Canal alignment are shown in the following table.

Table 3-14. Pipe Size, Velocity, Pressure Range, Pipe Class, Unit Costs, and Overall Length for the Construction of HDPE Pipe for the Southern Segment of the Miller Road Lateral Associated with the RID Canal Trunk Line Alignment

Pipe Size (in.)	Velocity (ft/sec)	Pressure Range* (psi)	Pipe Class (Schedules)	Unit Costs ($/ft)	Length of Lateral (miles)
28	4.1	38 – 48	65	$118.37	2.5

* Representative of actual pressures across the 2 ½ -mile range of pipe, not design pressures which adds an additional 40% for design purposes.

Due to the low pressure in the main RID canal trunk line, one booster pump is needed to immediately bring the pressure up in the lateral in order to meet basic domestic service. The details of the booster pump, the cost of providing a booster pump, and the yearly operations costs associated with booster pumping are shown below.

Table 3-15. Location, Cost of Booster Pumps, Horsepower Output, and Total Yearly Power Requirement Based on Two Booster Pumps for the Southern Portion of the Miller Road Lateral Associated with the RID Canal Alignment Main Trunk Line.

Location (General and Map Station)	Booster Pumping Head (ft)	Required Power Output (hp)	Purchase Cost ($)	Yrly. Operations Cost[1]
@ RID canal trunk line, Sta. 0+00d	60	120	$19,000	$69,200

[1] Annual power requirement based on Kw-hr/yr in order to deliver 8,445 acre-feet per year.

Overall construction costs for the Miller Road lateral are described below for the Yuma Road and RID Canal alignment.

Table 3-16. Itemization of Costs for Construction Activities Associated with the Construction of the Miller Road Lateral for the Yuma Road Alignment and RID Canal Alignment.

Activity	Miller Road for Yuma ($)	Miller Road for the RID ($)
Pipe Costs (including installation, but not appurtenances)	$2,774,100	$1,886,300
Pipeline Appurtenances	87,700	88,500
Booster Pumps	0	40,500
Pumping Facilities (Housing and Operations)	0	604,300
Pipeline Trenching and General Excavating	138,600	107,900
Backfilling Operation	31,400	25,400
Compacting Backfill	46,000	37,000
Removing Spoil (less than 2 mile haul)	51,400	36,500
Urban Area Costs (AC pavement, bedding, traffic control)	87,600	79,900
Jack and Bore (mobilizing, dike x-ing, I-10 x-ing, RID, etc.)	277,600	277,600
Combination of Replacing or Bypassing Smaller Utilities	208,200	208,200
Total of Activities	$3,702,600	$3,392,100

Except for a couple of items, small differences exist in most of the estimated construction costs above. The items with noticeable differences are pipe costs and pumping facilities costs. The differences in pipe costs is related to the use of two smaller sized pipe if using the RID alignment, versus one larger sized pipe if using the Yuma Road alignment.

A pumping facility was not necessary for the Miller lateral under the Yuma Road scenario. However, three booster pumps are needed for the Miller Road lateral under the RID Canal scenario. The difference in cost is $604,300 if the RID Canal alignment is chosen.

Requirements at the Tuthill Road Lateral for the Yuma Road Alignment

Eventual build out along Tuthill Road would demand 610 acre-feet of water per year. The peak demand for design purposes is 915 acre-feet per year, or 1 ¼ cubic feet per second.

At this peak flow, the optimum sized pipe is 7-inches in inside diameter. However, because the pipeline only extends 1-mile south from the trunk line, future extensions of this line are highly probable. Future extensions of the Tuthill Road lateral would equate to more demand. Ultimately it is felt that the true demand for water beyond 1-mile is not known, and so the pipeline is arbitrarily modeled to a size of 12-inches to accommodate for an unknown future demand. The particulars for the pipeline are then modeled with the known peak demand of 915 acre-feet per year using a 12-inch pipe. For HDPE pipe in the 65 to 80 class range, the per unit cost is $11.24 and $13.78 respectively.

A booster pump is needed at the transition of the trunk line and the lateral in order to deliver at an adequate domestic pressure. Further increases in elevation pressure head occur as the elevation drops 40-feet over the course of a mile.

The major cost of constructing this pipeline is not in materials or installation expense, but in crossing the RID canal and one smaller lateral. Other smaller utilities are expected, and the combined expense of crossing canals and bypassing utilities is estimated to cost nearly 2 ½ times the cost of purchasing and installing pipe. In fact, the cost of crossing utilities is a greater expense than all of the activities associated with constructing the pipeline which includes the earthwork.

The details of the Tuthill Road lateral for the Yuma Road alignment are shown in the following table.

Table 3-17. Pipe Size, Velocity, Pressure Range, Pipe Class, Unit Costs, and Overall Length for the Construction of HDPE Pipe for the Tuthill Road Lateral Associated with the Yuma Road Trunk Line Alignment.

Pipe Size (in.)	Velocity (ft/sec)	Pressure Range* (psi)	Pipe Class (Schedules)	Unit Costs ($/ft)	Length of Lateral (miles)
12	1.6	41 – 56	65, 80	$11.24 - $13.78	1.0

* Representative of actual pressures across the 1 -mile range of pipe, not design pressures which adds an additional 40% for design purposes.

The details of providing for a booster pump, the cost of providing the pump, and the yearly operations costs associated with booster pumping are shown below.

Table 3-18. Location, Cost of a Booster Pump, Horsepower Output, and Total Yearly Power Requirement Based on a Booster Pump for the Tuthill Road Lateral Associated with the Yuma Road Alignment.

Location (General and Map Station)	Booster Pumping Head (ft)	Required Power Output (hp)	Purchase Cost ($)	Yrly. Operations Cost[1]
@ Yuma Road trunk line, Sta. 0+00	60	10	$4,600	$5,000

[1] Annual power requirement based on Kw-hr/yr, in order to deliver 610 acre-feet per year.

Requirements at the Tuthill Road Lateral for the RID Canal Alignment

The Tuthill Road lateral for the RID Canal alignment is shorter in length than the Tuthill Road lateral for the Yuma Road alignment. This is because the RID canal crosses Tuthill Road just south of the intersection of Yuma Road and Tuthill Road. From the canal, the lateral is transitioned south only for 0.86 miles and it is not necessary to make up the 707 foot difference in length.

The details of the Miller Road lateral for the RID Canal alignment are described in the table below.

Table 3-19. Pipe Size, Velocity, Pressure Range, Pipe Class, Unit Costs, and Overall Length for the Construction of HDPE Pipe for the Tuthill Road Lateral Associated with the RID Canal Trunk Line Alignment.

Pipe Size (in.)	Velocity (ft/sec)	Pressure Range* (psi)	Pipe Class (Schedules)	Unit Costs ($/ft)	Length of Lateral (miles)
12	1.6	46 – 58	65, 80	$11.24 - $13.78	0.86

* Representative of actual pressures across the 1-mile range of pipe, not design pressures which adds an additional 40% for design purposes.

The details of providing for a booster pump, the cost of providing the pump, and the yearly operations costs associated with booster pumping are shown below.

Table 3-20. Location, Cost of a Booster Pump, Horsepower Output, and Total Yearly Power Requirement Based on a Booster Pump for the Tuthill Road Lateral Associated with the RID Canal Alignment.

Location (General and Map Station)	Booster Pumping Head (ft)	Required Power Output (hp)	Purchase Cost ($)	Yrly. Operations Cost[1]
@ RID Canal trunk line, Sta. 0+00	60	10	$4,600	$5,000

[1] Annual power requirement based on Kw-hr/yr, in order to deliver 610 acre-feet per year.

Overall construction costs for the Tuthill Road lateral are shown below for the Yuma Road and RID Canal alignment.

Table 3-21. Itemization of Costs for Construction Activities Associated with the Construction of the Tuthill Road Lateral for the Yuma Road Alignment and RID Canal Alignment.

Activity	Tuthill Road for Yuma ($)	Tuthill Road for the RID ($)
Pipe Costs (including installation, but not appurtenances)	$66,000	$60,000
Pipeline Appurtenances	6,000	6,000
Booster Pumps	4,600	4,600
Pumping Facilities (Housing and Operations)	24,400	24,400
Pipeline Trenching and General Excavating	17,500	15,100
Backfilling Operation	4,300	3,800
Compacting Backfill	6,500	5,700
Removing Spoil (less than 2 mile haul)	5,000	4,400
Urban Area Costs (AC pavement, bedding, traffic control)	0	0
Jack and Bore (mobilizing, dike x-ing, I-10 x-ing, RID, etc.)	133,200	133,200
Combination of Replacing or Bypassing Smaller Utilities	26,600	26,600
Total of Activities	$294,100	$283,800

The difference in cost between the laterals is specifically associated with the length of the pipeline. The Tuthill Road lateral for the Yuma Road alignment is one-mile in length which begins at Yuma Road and ends at Lower Buckeye Road. The Tuthill Road lateral associated with the RID Canal alignment is shorter than one mile in length since it begins at the north portion of the intersection of the RID canal and Tuthill Road, and terminates at Lower Buckeye Road.

Requirements at the Cotton Lane Lateral for the Yuma Road Alignment

Build out demand south of Yuma Road around the Cotton Lane area is expected to reach 13,125 acre-feet per year. In order to meet a future peak load along the Cotton Lane lateral, the lateral is designed to accommodate for a flow of 19,689 acre-feet per year, or about 27.2 cfs.

At this peak rate, the optimum size pipe is 32-inches in inside diameter. At this size and peak flow, the velocity is 4.9 feet per second. The pipe class required is schedule 65, and for a 32-inch pipe the cost is $154.62 per foot for HDPE pipe, which includes installation. The average water pressure along the Cotton Lane lateral ranges from 38 to 46 psi.

A booster pump is needed at the intersection of the main trunk line and the lateral in order to bring the pressure in the line up to domestic delivery standards from about 12 psi. The elevation drop along Cotton Lane, 33-feet in 1 ¼ miles, is not as dramatic as the elevation drop associated with either Miller or Tuthill Roads. The gain in pressure head due to the drop in elevation is 2.4 feet per 484-feet of pipe length. This compares to 4.6 feet per 484-feet, and 3.7 feet per 484-feet of pipe length for the Miller and Tuthill Roads respectively. The friction loss along the 32-inch line at peak flow is about 1.1 feet per 484 feet of pipe length. Overall, the effect of the elevation drop and friction losses amounts to a gain in pressure head along the length of the lateral. However, the pressure gains are slight, and across the 1 ¼ mile length of the lateral the same pipe schedule can be used without requiring pressuring reducing valves.

Unlike the Miller and Tuthill Road laterals, the Cotton Lane lateral can be constructed without having to cross a major obstacle like the RID canal or a smaller canal lateral. The RID canal crosses Cotton Lane approximately 1 ¾ miles north of the intersection of Yuma Road and Cotton Lane. Overall this lateral is fairly easy to build with relatively few pipeline appurtenances, the shoulder is wide and the road itself can be avoided, and major obstacles and other utilities are not present. Constructing this lateral is hundreds of thousands of dollars less in cost compared to the other laterals simply due to not having to cross a major canal waterway. An 18-inch drainage culvert crosses Cotton Lane south of the intersection of Yuma Road and Cotton Lane. Because relatively few utilities are expected to be dealt with along Cotton Lane, the cost of crossing this drainage culvert is included in the line item cost associated with crossing utilities.

The details of the Cotton Lane lateral for the Yuma Road alignment are shown in the following table.

Table 3-22. Pipe Size, Velocity, Pressure Range, Pipe Class, Unit Costs, and Overall Length for the Construction of HDPE Pipe Associated with the Delivery of a Peak Flow of 19,689 acre-feet per year for the Cotton Lane Lateral with Respect to the Yuma Road Alignment.

Pipe Size (in.)	Velocity (ft/sec)	Pressure Range* (psi)	Pipe Class (Schedules)	Unit Costs ($/ft)	Length of Lateral (miles)
32	4.9	38 – 46	65	$154.62	1.28

* Representative of actual pressures across the 1-mile range of pipe, not design pressures which adds an additional 40% for design purposes.

The details for providing for a booster pump, and the yearly operations costs associated with booster pumping are shown below.

Table 3-23. Location, Cost of a Booster Pump, Horsepower Output, and Total Yearly Power Requirement Based on a Booster Pump for the Cotton Lane Lateral Associated with the Yuma Road Alignment.

Location (General and Map Station)	Booster Pumping Head (ft)	Required Power Output (hp)	Purchase Cost ($)	Yrly. Operations Cost[1]
@ Yuma Road trunk line, Sta. 0+00	60	185	$27,750	$107,600

[1] Annual power requirement based on Kw-hr/yr, in order to deliver 13,125 acre-feet per year.

Requirements at the Cotton Lane Lateral for the RID Canal Alignment

The details of delivering water along Cotton Lane with the RID Canal system are similar to the details of using the Yuma Road alignment. Both systems have similar alignments in this area. The main trunk line for either system parallels Yuma Road east of the RID canal. Therefore, the lateral along Cotton Lane is the same length regardless of which alignment is used. Water pressures at the main trunk line are within a couple of psi using the PMP model. Although no difference in the estimated cost to construct or operate the Cotton Lane lateral for either the Yuma Road or RID Canal alignment are apparent, the following tables are still provided showing the details of this lateral.

Table 3-24. Pipe Size, Velocity, Pressure Range, Pipe Class, Unit Costs, and Overall Length for the Construction of HDPE Pipe Associated with the Delivery of a Peak Flow of 19,689 acre-feet per year for the Cotton Lane Lateral with Respect to the RID Canal Alignment.

Pipe Size (in.)	Velocity (ft/sec)	Pressure Range* (psi)	Pipe Class (Schedules)	Unit Costs ($/ft)	Length of Lateral (miles)
32	4.9	38 – 46	65	$154.62	1.28

* Representative of actual pressures across the 1-mile range of pipe, not design pressures which adds an additional 40% for design purposes.

The details for providing for a booster pump, and the yearly operations costs associated with booster pumping are shown below.

Table 3-25. Location, Cost of a Booster Pump, Horsepower Output, and Total Yearly Power Requirement Based on a Booster Pump for the Cotton Lane Lateral Associated with the RID Canal Alignment.

Location (General and Map Station)	Booster Pumping Head (ft)	Required Power Output (hp)	Purchase Cost ($)	Yrly. Operations Cost[1]
@ Yuma Road trunk line, Sta. 0+00	60	185	$27,750	$107,600

[1] Annual power requirement based on Kw-hr/yr, in order to deliver 13,125 acre-feet per year.

Table 3-26. Itemization of Costs for Construction Activities Associated with the Construction of the Cotton Lane Lateral for the Yuma Road Alignment and RID Canal Alignment.

Activity	Cotton Lane for Yuma ($)	Cotton Lane for the RID ($)
Pipe Costs (including installation, but not appurtenances)	$1,048,500	$1,048,500
Pipeline Appurtenances	$46,000	$46,000
Booster Pumps	27,800	27,750
Pumping Facilities (Housing and Operations)	500,000	500,000
Pipeline Trenching and General Excavating	47,500	47,500
Backfilling Operation	10,300	10,300
Compacting Backfill	15,500	15,500
Removing Spoil (less than 2 mile haul)	19,200	19,200
Urban Area Costs (AC pavement, bedding, traffic control)	0	0
Jack and Bore (mobilizing, dike x-ing, I-10 x-ing, RID, etc.)	0	0
Combination of Replacing or Bypassing Smaller Utilities	45,000	45,000
Total of Activities	$1,759,800	$1,759,800

No cost difference exists between the two options. Any owner/operator's desire is that the bulk of the construction expense be tied up in the installation and purchase of pipe material, and the Cotton Lane lateral will live up to this billing should construction begin prior to any future development along this area, or any widening of the existing road.

Cost Summary

The results of the costs for constructing the well field, the main trunk line, and the three laterals are summarized below. The costs are for the construction of the pipeline, including pumps and pumping facilities, and pipeline appurtenances.

Table 3-27. Costs Associated with the Construction of the West Maricopa Combine Pipeline to the Future with Respect to the Pipeline for the Well Field; Main Trunk Line; and Miller Road, Tuthill Road and Cotton Lane Laterals.

Segment	Yuma Road Alignment	RID Canal Alignment
Well Field	$3,103,000	$4,650,000
Main Trunk Line	33,512,000	32,961,000
Miller Road Lateral	3,702,600	3,392,100
Tuthill Road Lateral	294,100	283,800
Cotton Lane Lateral	1,759,800	1,759,800
TOTAL	$42,371,500	$43,046,700

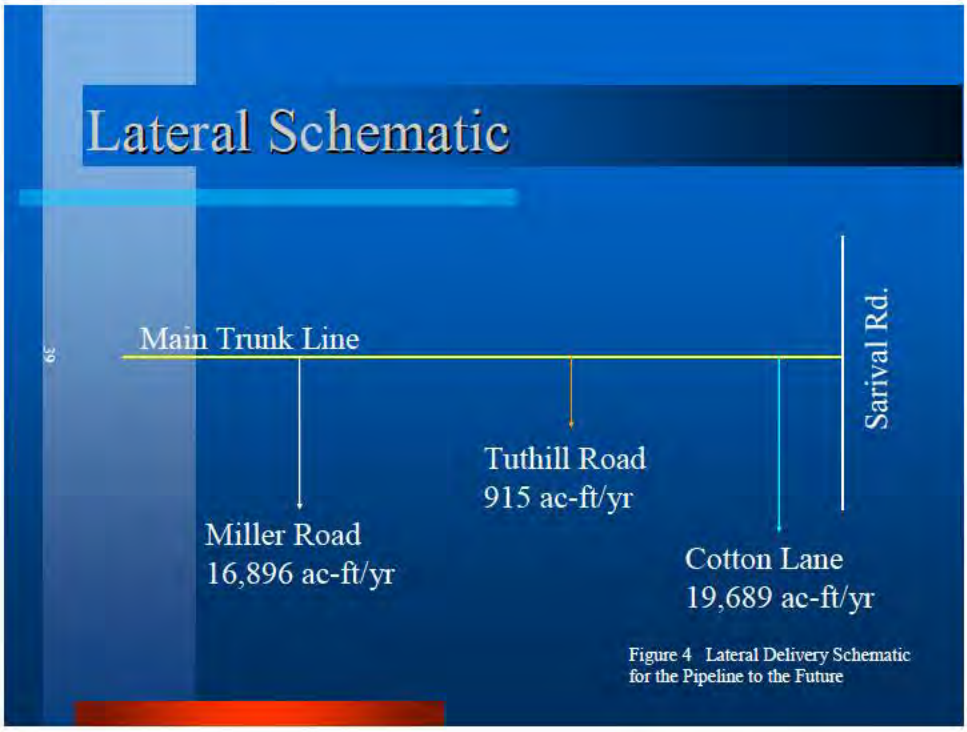

Figure 4 Lateral Delivery Schematic for the Pipeline to the Future

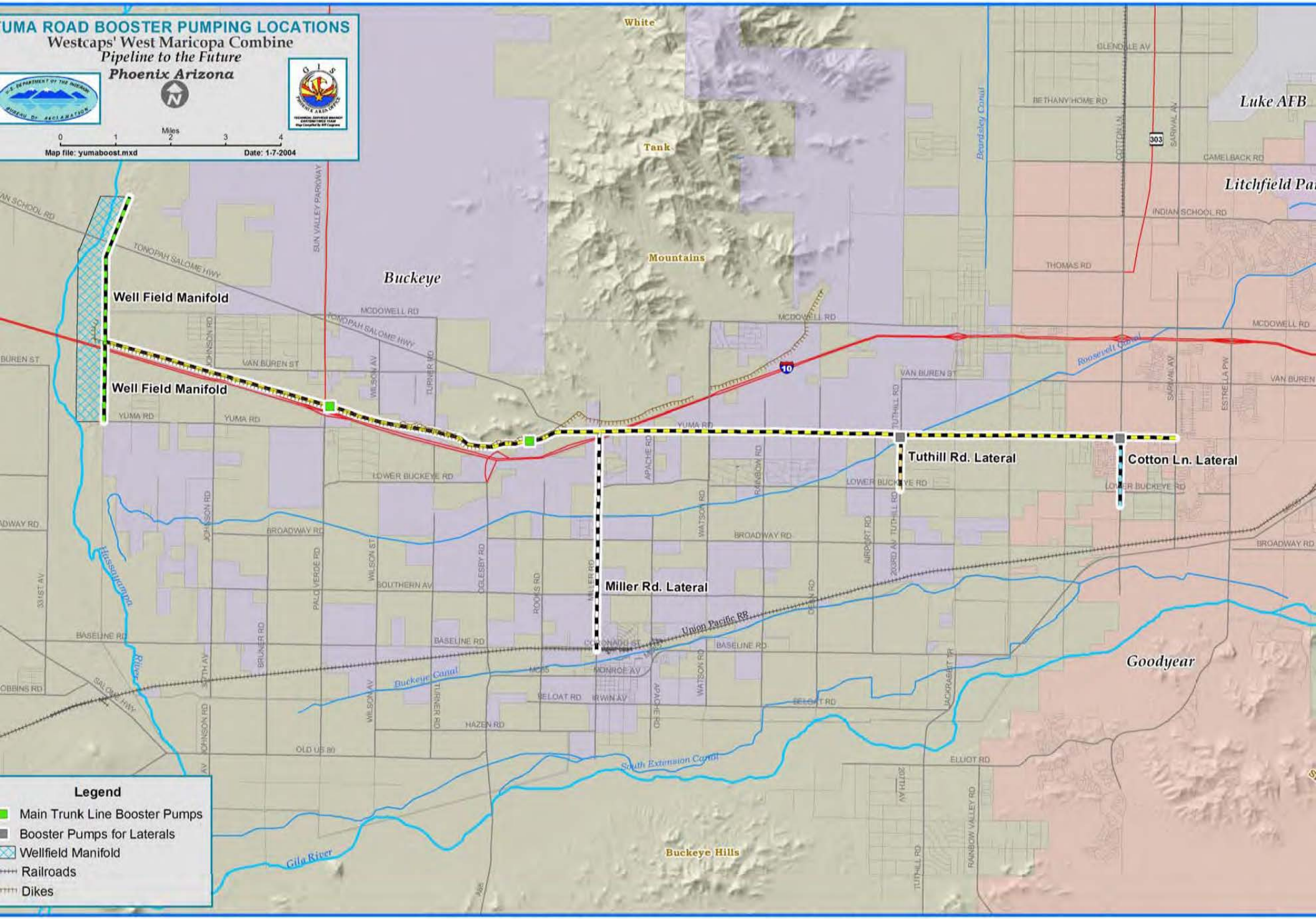

Figure 5. Locations of Booster Pumps along the Yuma Road Alignment

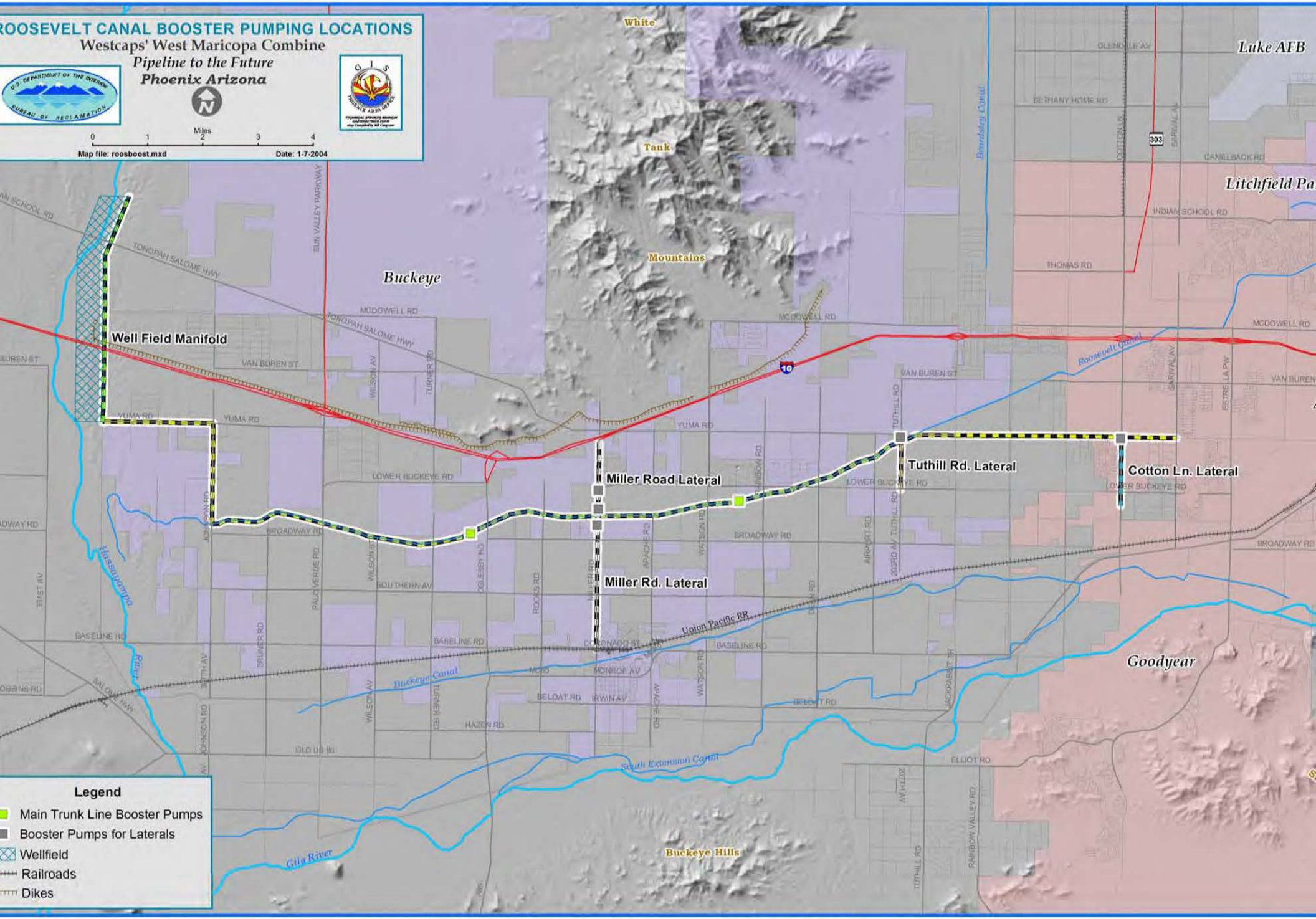

Figure 6. Locations of Booster Pumps along the RID Canal Alignment

CHAPTER IV

WELL FIELD CONSTRUCTION, RESERVOIR PLANNING, LAND VALUATION, and GENERAL EXPENSES

Background

Documented in this chapter are other parts of the water delivery system, but in general their construction does not vary in cost from one alignment to another. In some cases the costs are identical for either alignment. For example, similar costs are estimated for the construction of the well field, the cost of including water reservoirs, an administration building, and a chlorination system. Other costs such as the engineering and administration of the overall construction, construction contingencies, the cost of land easement, etc. are not dissimilar mostly because both alignments are similar in costs, and these costs are estimated based on a percentage of the overall cost of the water distribution system. The following areas highlight the design of, and the cost to construct the particular portion of the water delivery system.

Development of the Well Field

West Maricopa Combine has sought a special use permit that allows the recharge of CAP water downstream of the CAP canal in the Hassayampa River, and to withdraw their allocation along the banks of the Hassayampa River in the vicinity of Interstate 10. This system is sized based on a withdrawal of 25,000 acre-feet per year. To limit the impacts of groundwater drawdown due to tight well spacing, a pumping limit of 15,000 acre-feet per square mile per year was necessary.

Although it is desired to have as much of the system away from construction development (due to the higher cost of construction), the desire is also to have access to the system during construction and once it was built. Interstate 10 provides an area where fast access to the system is available by road, and the various roads which cross the interstate can provide access to the system during and after construction. In order to maintain 15,000 acre-feet of withdrawal per square mile per year, the well field was designed to be ½-mile wide. Ultimately, the pumping of 25,000 acre-feet per year across 2 square miles results in 12,500 acre-feet per year per square mile of groundwater pumping.

Some wells in the vicinity of the Hassayampa River have been documented at 3,000 gallons per minute of yield. Other wells in the region of the river are known to yield 2,000 gallons per minute. This system was conservatively designed to operate well under 2,000 gallons per minute per well, and to operate for less than a 24-hour period. A total

of 16 wells delivering 1,450 gallons per minute, operating at two-thirds of a day can deliver 25,000 acre-feet per year. Each ½-mile section was designed for two wells to feed one line (in series) into the manifold pipe aligned in the north-south direction along the eastern edge of the well field.

A detailed estimate of the cost of constructing a well was provided during the development of the 2002 report. Estimates were provided by a local well driller for 16-in and 20-inch wells and well casings. The larger of the two well sizes was considered for the water volumes predicted in the event flows exceed 1,500 gallons per minute per well. The cost of the 2002 estimate was $410,890 per 20-inch well. An additional $35,000 is added per well site for permitting, power to the site, and a hydro study. Therefore, the estimate per well is $450,000, and the estimate for 16 wells is $7,200,000 (see Cost Comparison Sheet, Chapter 5). The final tally excludes the pump, motor, and pipeline costs which are included in the "Pipeline Requirements for the Well Field" section in Chapter 3.

Development of Reservoirs

In order to reduce the dependence on the operations of well field and booster pumps, and reduce the dependence of constant power availability for those pumps, reservoirs are planned by West Maricopa Combine at various strategic locations. Land required by the reservoir was arbitrarily multiplied by a factor of four to arrive at the total amount of land needed for a reservoir. The cost of constructing a reservoir was estimated using the City of Phoenix Water System Master Plan – Reservoir Cost Assumptions based on Engineering News Record Magazine (#4769). Reservoir appurtenances were $350,000 per reservoir, regardless of size. The value of land for each reservoir ranged from $25,000 to $30,000 per acre.

Strategically, the most ideal location for a reservoir is at the junction of two separate pipelines. Therefore, a reservoir is located at the junction of the well field manifold with the trunk line, and the trunk line with each lateral.

The size of the reservoir for each lateral was governed by the amount of water that was expected at build out. The smallest reservoir was planned at the well field and the trunk line. It is desired to have some extra capacity at the well field, but ultimately the extra capacity was desired closer to the point of delivery. For more detail and the total estimated cost for each reservoir, see the cost comparison sheet in the summary chapter, Chapter 5.

Estimate of Land Needed and Land Values

The PMP calculates the right-of-way needed based on the size of the pipe, and the anticipated right-of-way needed to construct the pipe which includes future access to the pipeline. Right-of-way was assigned not on the size of the pipe, but the amount of space thought necessary in order to adequately construct the line, or to access in the future. For all pipe sizes 36-inches or smaller, 25-feet was provided for a right-of-way. For the 42-inch trunk line, 50-feet was allocated to the right-of-way and the calculations toward the land easement fee.

Projected land values in order to calculate land easements were estimated in the following way. In the vicinity of the Hassayampa River, the estimated value of land is assigned $2,000 per acre. Along the interstate, north of the interstate dike, the value of land is assigned $2,500 per acre. Along Yuma Road between the interstate and Sarival Road, the land is valued at $4,000 per acre. For the land in the vicinity of Yuma Road and Johnson Road just east of the Hassayampa River, the land is valued at $1,500 per acre. Along Miller Road, Tuthill Road, and Cotton Lane, the value of land is generally valued at $3,500 per acre with respect to a land easement fee.

General Expenses

This section includes items which are calculated based on the overall size of the project, or overall estimated cost of the project. This includes items such as contingencies, design and administration of the construction, a building necessary to house staff who will work on the project, a S.C.A.D.A. system, and a chlorination system.

As part of general expenses, contingencies are built into a project. Contingencies are factored to account for an uncertain occurrence, or something that can happen, but cannot be foreseen. The contingency line item is valued at 20% of construction costs which include pipeline construction costs, reservoir costs, and pipeline appurtenances.

The engineering and administration function of the construction is a value calculated as a percentage of the project cost. This value is calculated at 20% of the construction costs plus unlisted items which include pipeline, reservoir costs and the value estimated for contingencies.

The cost of a facilities building, a S.C.A.D.A. system, and a chlorination system were estimated based on the cost of similar infrastructure for other projects. These costs are shown in the cost comparison sheet in the concluding chapter which follows.

CHAPTER V

CONCLUSIONS AND OBSERVATIONS

The study conducted for WESTCAPS and the West Maricopa Combine Water Company concluded that a substantial difference between the Yuma Road and the RID Canal alignments in terms of construction costs was not evident. On an estimated $80 million project, less than $1 million is the difference in cost between the alignments.

The difference in operations and maintenance costs between the two systems is also somewhat small. Less than $100,000 is the difference in yearly O&M costs between the two systems on a total O&M budget that should include about $2 million per year. The difference in O&M cost is smaller still if water deliveries north of the RID canal along the Miller Road lateral are not needed immediately, or at all. All of the water deliveries along the trunk line or laterals are either along relatively flat ground, or are downhill, except for the water delivery north of the RID canal along Miller Road which must overcome substantial elevation differences. The difference in annual O&M costs between the two systems falls to less than $10,000 per year in the event that water deliveries are not necessary north of the RID canal along Miller Road.

It is worth noting that the RID Canal alignment was the more expensive alternative for construction, operations, and maintenance costs. However, this study only estimated these particular costs, and none of the costs which were estimated favored one alignment over the other overwhelmingly. Other costs which may have been a more deciding factor were not embarked upon, but are worth noting nonetheless.

One cost that could be studied is the future replacement cost of infrastructure. This cost could be a more significant indicator in terms of selecting one alignment over the other. The drawback is that cost differences would remain an estimate due to guesswork in terms of overcoming future infrastructure obstacles along the trunk line and laterals. Although the RID Canal alignment is longer and would naturally cost more to replace in terms of materials, the Yuma Road alignment could be much more difficult to access in years to come if the region becomes fully developed versus the RID canal right-of-way which would likely remain unchanged and would provide easy access not only for replacement, but for minor or other repairs should any be necessary.

Another cost not easily quantifiable is the public relations cost of building through the new Buckeye Sundance community now that new streets and associated infrastructure has been constructed. Naturally the comment among residents will be akin to why this construction wasn't accomplished prior to the construction for our community. If there is a potential for press releases occurring, West Maricopa Combine would further desire to avoid this situation - either locally or regionally - with respect to their construction disrupting a newly built community.

The following table, Table 5-1, illustrates the differences in constructing and operating specific parts of each water pipeline system.

Another cost that was estimated equally among both systems was the cost of providing pipeline earth cover. Any portion constructed along Yuma Road requires 5-feet of earth cover per county code. Both alignments have portions which are planned along Yuma Road. However, due to less traffic, smaller loads, and slower velocities driven along the RID canal right-of-way, something less than 5-feet of cover may be adequate for the RID canal trunk line within the canal right-of-way. A cost savings may be realized for the trunk line along the RID canal which was not reflected.

Based only on the items presented in Table 5-1, and without further conclusions on other variables, a strong recommendation cannot be given for either system based on the factors studied and presented in this report. Based on the information studied, an example is given on the amortized, present-value cost, of both systems based on dollars per acre-feet, and dollars per thousand gallons.

Table 5-2. Amortized Capital Costs – 20 Years with a Municipal Capital Recovery Factor Equal to 0.0837 (Based on 5.5% Bonding Rate and 20 Year Financing) for the Yuma Road and RID Canal Alignments.

Alignment	Annualized Capital[1]	O&M[2]	Total Annual Cost*	Cost/ac-ft**	Cost/1,000 gallons
Yuma Road	$6,925,432	$1,609,987	$8,535,419	$341	$1.05
RID Canal	$6,991,490	$1,709,260	$8,700,749	$348	$1.07

* - Total Annual Cost is the annualized capital plus the O&M Cost

** - The cost is based on the overall delivery of 25,000 acre-feet per year.

1 Annualized Capital is the Total Capital Costs from Table 5-1 multiplied by the capital recovery factor.

2 The O&M value is derived from Table 5-1 as the yearly operations costs.

Other features and costs that were not part of the study are mentioned in the following table. These are costs such as the recharge facility use fee, the cost of recovery storage reservoir, the cost of CAP water, the option for including reverse flow, and a 10% profit and 33% income tax inclusion. By presenting these costs, a more accurate reflection is given of the true cost the system owners need to plan on charging for delivering water in order to account for all costs and in order to make a profit. Although the items are accounted for, they were not researched in detail for cost accuracy as were the materials items for the construction and operations of the system.

Table 5-3. The Cost of Delivering Water With Respect to All Fees Including Income Tax in Order to Earn a 10% Profit.

SUMMARY OF TOTAL PER UNIT COSTS				
	Yuma Road Alignment		**RID Canal Alignment**	
Description of Cost	$/Acre-Foot	$/1,000 gallons	$/Acre-Foot	$/1,000 gallons
Amortized Capital Cost - Pipeline	$341	$1.05	348	1.07
Recharge Facility Use Fee[1]	13	0.04	13	0.04
Cost of Recovery to Storage Reservoir[2]	169	0.52	169	0.52
SUBTOTAL	523	1.61	530	1.63
10% Profit and 33% Income Tax[3]	90	0.28	91	0.28
SUBTOTAL	613	1.89	621	1.91
CAP Water Cost[4]	150	0.46	150	0.46
TOTAL COST FOR FORWARD FLOW	**763**	**2.35**	**771**	**2.37**
Additional Facilities for Reverse Flow[5]	34	0.10	n/a	n/a
10% Profit and 33% Income Tax[3]	6	0.02	n/a	n/a
SUBTOTAL	40	0.12	n/a	n/a
TOTAL COST FOR FORWARD AND REVERSE FLOW	**803**	**2.47**	n/a	n/a

[1] Cost of recharge is from West Maricopa Combine data provided to WESTCAPS during the 2002 report process.

[2] Recovery costs were calculated on 6/11/02. The original work did not include verifying the cost of recharge or recovery for the 2002 report.

[3] Allowable for private utilities.

[4] Cost of CAP Water was an amount determined as part of the 9/15 plan.

[5] Cost was not calculated for this study for the RID Canal alignment. The cost provided was calculated during the 2002 report process and re-published for this report to give a true cost of water for at least one alignment for the forward and reverse flow options.

Table 5-1. Cost Comparison of the Yuma Road and RID Canal Alignments for the West Maricopa Combine Pipeline to the Future.

			YUMA ROAD				RID CANAL		
			Construc.	Operations			Construc.	Operations	
ITEMS	**Unit**	**Size**	Costs	Costs	**Unit**	**Size**	Costs	Costs	**Description (if any)**
Well Construction									Excludes pump and motor, which is included in the Manifold Section below
Well Field wells:	16 ea	20-in	$7,200,000	$92,160	16 ea	20-in	$7,200,000	$92,160	Includes $35,000 per well site for permitting, power to the site, and hydro study
Subtotal			**$7,200,000**	**$92,160**			**$7,200,000**	**$92,160**	
Manifold									
1st of 8:		16-in	$113,554	$34,753		16-in	$113,554	$34,753	Opera ions costs are energy costs plus maintenance costs calculated at 1.28%
2nd of 8:		22-in	$198,732	$35,844		22-in	$198,732	$35,844	of construction costs. The text in the report separates opera ions costs from
3rd of 8:		28-in	$306,661	$37,225		28-in	$306,661	$37,225	maintenance costs.
4th of 8:		32-in	$405,760	$49,594		32-in	$394,135	$38,345	
5th of 8:		36-in	$686,219	$53,184		36-in	$575,748	$40,670	
6th of 8:		16-in	$112,554	$34,741		42-in	$1,731,116	$55,458	
7th of 8:		22-in	$204,932	$47,023		42-in	$630,253	$41,367	
8th of 8:		28-in	$1,072,624	$80,331		42-in	$686,772	$53,191	
main line:		42-in	$30,851,275	$804,747		42-in	$30,174,380	$813,143	
Miller Rd(1st lateral):		30-in	$3,614,804	$46,269		16, 28-in	$3,306,486	$173,122	
Tuthill (2nd lateral):		12-in	$288,200	$8,689		12-in	$277,664	$8,554	
Cotton Ln (3rd lat.):		32-in	$1,713,785	$129,526		32-in	$1,713,785	$129,526	
Subtotal			**$39,569,100**	**$1,361,926**			**$40,109,286**	**$1,461,199**	
Construct Reservoirs (1)									
@ Well Field:	2	M/gal	$930,000	$11,904	2	M/gal	$930,000	$11,904	1.2 acres needed at $25,000/ac } 4x the area calculated for maint. & expansion
@ Miller Road:	13	M/gal	$3,590,000	$45,952	13	M/gal	$3,590,000	$45,952	8 acres needed at $30,000/ac } 4x the area calculated for maint. & expansion
@ Tuthill Road:	3	M/gal	$1,230,000	$15,744	3	M/gal	$1,230,000	$15,744	2 acres needed at $30,000/ac } 4x the area calculated for maint. & expansion
@ Cotton Lane:	15	M/gal	$3,976,000	$50,893	15	M/gal	$3,976,000	$50,893	9.2 acres needed at $30,000/ac } 4x the area calculated for maint. & expansion
Subtotal	**33**	**M/gal**	**$9,726,000**	**$124,493**	**33**	**M/gal**	**$9,726,000**	**$124,493**	
Appurtenances									
Air Chamber(2):	12	ea	$154,500		15	ea	$225,500		located after each pump
Air/Vacuum valve(3):	16	ea	$8,200		17	ea	$8,700		at high points in the line
Press. reducing(4):	5	ea	$19,250		5	ea	$18,500		valve limits the continued high pressure in the line so that less expensive pipe can be installed
Gate valves(5):	73	ea	$1,070,000		77	ea	$1,110,750		located every 1/2 mile
S.C.A.D.A.:			$1,500,000				$1,500,000		lump sum
Elbows:			$48,000				$64,000		avg. price of $8,000/elbow including slurry
Subtotal			**$2,799,950**				**$2,927,450**		
General Expenses									
Contingencies:			$10,419,010				$10,552,547		20% of construction cost (including pipeline and reservoir costs, and appurtenances)
Eng. & Admin.:			$11,942,822				$12,077,567		20% of construction costs plus unlisted items line (includes pipeline, reservoir costs,
Land (Easement):			$474,240				$327,493		and unlisted items, but excludes appurtenances)
Building:			$500,000	$25,000			$500,000	$25,000	Building maintenance, janitorial services, taxes, etc.
Chlorination System:			$110,000	$6,408			$110,000	$6,408	
Subtotal			**$23,446,072**	**$31,408**			**$23,567,607**	**$31,408**	
Total Capital Costs			**$82,741,122**				**$83,530,343**		
Yearly Operations Costs			**$1,609,987**				**$1,709,260**		

(1) - Reservoir cost includes construction plus land acquisition costs plus $350,000 per site for appurtenances. Reservoir costs are based on City of Phoenix Reservoir Cost Assumptions, ENR 4769, Figure A7.6.
(2) - $2,000 for a 12" line, $3,500 for a 16" line, $7,500 for a 22" line, $14,500 for a 28" line, $16,000 for a 32" line, $19,500 for a 36" line, and $25,000 for a 42" line.
(3) - $200 for 1/2", $300 for 1", and $600 for 3", {Yuma Rd is 2 ea. of the 1/2", 2 ea. of the 1", 12 ea - 3"}, {RID alignment is 3 ea - 1/2", 1 ea - 1", 13 ea - 3"}.
(4) - $2,300 for 22", $3,500 for 28", $3,900 for 30", $4,500 for 32", $5,250 for 36".
(5) - 60 gate valves are required for the trunk line for Yuma Rd, and 64 for the RID trunk line at a cost of $16,000/each. 8 gate valves are needed at Miller Road (Yuma Rd.; 30-in, $9,500), 8 valves are needed at Miller Rd. (RID; 16-in, $3,000; 28-in, $8,750), 2 valves needed at Tuthill (Yuma; 12-in, $2,000), 2 needed at Tuthill (RID; 12-in, $2,000), 3 needed at Cotton Lane (Yuma; 32-in, $10,000), 3 needed at Cotton (RID; 32-in, $10,000).

CHAPTER VI

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PHOTOGRAPHS


STOP


Love's


35

APPENDIX

PMP Modeling Results for the Yuma Road Alignment

Table 1. Hydraulic Parameters and Associated Construction Costs for Water Delivery Using HDPE Pipe along the Hassayampa River for the First Fifth of the Well Field Above Interstate 10 (1/8 of of the Total Volume Being Planned for Delivery).

Project Description:
West Maricopa Combine Pipeline
Yuma Rd. alignment using HDPE pipe.

C= 130 (H-W friction factor)
Q= 6.475 cfs
= 4,688 acre-feet per year

Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)	Avg. Head (psi)
0.0	0.0	0	---	---	60	0	0	60	25.97	---	---	---
4.8	5.0	-10	16	2.27	0	67.73	29.32	67.73	29.32	484	4.6	27.65
9.7	10.0	-10	16	2.27	0	65.46	28.34	65.46	28.34	484	4.6	28.83
14.5	15.0	-10	16	2.27	0	63.20	27.36	63.20	27.36	484	4.6	27.85
19.4	20.0	-10	16	2.27	0	60.93	26.38	60.93	26.38	484	4.6	26.87
25.6	26.4	0	16	2.90	0	48.02	20.79	48.02	20.79	620	4.6	23.58
					---					---		
	total pumping power =				60	ft				2,558	ft	
				=	44.1	hp			(	0.48	) miles	
total pumping power + 30% =					57.3	hp						

* - Includes the cost of furnishing and installing pipe

5 ******
6.2 ******
9.3 ******
4.2 ******
15.2 ******
26 ******
16.8 ******
14.8 ******
11.5 ******
13 ******
19 ******
1.4 672
14.5 ******
14.6 ******

					Earthwork				
Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Trench Excav. (cu yd)	Am't. of Backfill (cu yd)	Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)	addt'l exc., bckfll & re-construct cost thru ua
---	---	---	---	$8,650	---	---	---		
38.7	50	$31.15	$15,089	$0	331	245	245	0%	$0
40.4	50	$31.15	$15,089	$0	331	245	245	0%	$0
39.0	50	$31.15	$15,089	$0	331	245	245	0%	$0
37.6	50	$31.15	$15,089	$0	331	245	245	0%	$0
33.0	35	$31.15	$19,314	$0	424	314	314	0%	$0
			$79,670	$8,650	1,750	1,294	1,294		$0
					x $5.80/cy	x $1.9/cy	x $2.86/cy		
					$10,149	$2,459	$3,701		

Remove Spoil (cu yd)
456
x $6.95/cy
$3,168

		CONSTRUCTION COST SUMMARY	
		Project Description:	
		West Maricopa Combine Pipeline	
Land		Yuma Rd. alignment using HDPE	
(acres)		pipe.	

0.3		Pipe costs	$79,670
0.3		Earthwork	$19,476
0.3		Pump costs	$8,650
0.3		Pump Facility	$4,758
0.4			----------
----------		1st Subtotal	$112,554
1.5	ac	Land (Easement fee)	$2,936
x $2,000/ac			----------
------		Total	$115,490
$2,936			

ANNUAL ESTIMATED PUMPING COSTS

68%	= Est. Total Pump Efficiency
$0.090	per kW hr = Electric power cost
$33,300	(annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)

Table 2. Hydraulic Parameters and Associated Construction Costs for Water Delivery Using HDPE Pipe along the Hassayampa River for the Second Fifth of the Well Field Above Interstate 10 (1/4 of of the Total Volume Being Planned for Delivery).

Project Description:
West Maricopa Combine Pipeline
Yuma Rd. alignment using HDPE pipe.

C= 130 (H-W friction factor)
Q= 12.95 cfs
= 9,375 acre-feet per year

	Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)	Avg. Head (psi)
	25.6	26.4	0	---	---	60	48.02	20.79	108.02	46.76	---	---	---
*****	30.4	31.4	-10	22	1.74	0	58.14	25.17	58.14	25.17	484	4.9	35.97
	35.3	36.4	0	22	1.74	0	46.41	20.09	46.41	20.09	484	4.9	22.63
	40.1	41.4	0	22	1.74	0	44.67	19.34	44.67	19.34	484	4.9	19.71
	45.0	46.4	-10	22	1.74	0	52.93	22.91	52.93	22.91	484	4.9	21.13
	51.2	52.8	-10	22	2.22	0	50.71	21.95	50.71	21.95	620	4.9	22.43
						---					---		
		total pumping power =				60	ft				2,558	ft	
					=	44.1	hp			(	0.48	) miles	
	total pumping power + 30% =					57.3	hp						

* - Includes the cost of furnishing and installing pipe
***** - Pressure reducing valve necessary at this location in order to keep the cost of higher press
more expensive, pipe down.

5	******
6.2	******
9.3	******
4.2	******
15.2	******
26	******
16.8	******
14.8	******
11.5	******
13	******
19	******
1.4	672
14.5	******
14.6	******

Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Earthwork: Trench Excav. (cu yd)	Earthwork: Am't. of Backfill (cu yd)	Earthwork: Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)	addt'l exc., bckfll & re-construct cost thru ua
---	---	---	---	$15,000	---	---	---		
50.4	50	$58.93	$28,546	$0	419	297	297	0%	$0
31.7	35	$58.93	$28,546	$0	419	297	297	0%	$0
27.6	35	$58.93	$28,546	$0	419	297	297	0%	$0
29.6	35	$58.93	$28,546	$0	419	297	297	0%	$0
31.4	35	$58.93	$36,538	$0	536	380	380	0%	$0
			$150,721	$15,000	2,212	1,569	1,569		$0
					x $5.80/cy	x $1.9/cy	x $2.86/cy		
					$12,827	$2,982	$4,488		

Remove Spoil (cu yd)
642
x $6.95/cy
$4,464

sure,

CONSTRUCTION COST SUMMARY
West Maricopa Combine Pipeline
Yuma Rd. alignment using HDPE pipe.

Land (acres)			
0.3			
0.3	Pipe costs	$150,721	$0
0.3	Earthwork	$24,761	
0.3	Pump costs	$15,000	
0.4	Pump Facility	$8,250	
1	1st Subtotal	$198,732	
x $2,000/ac	Land (Easement fee)	$2,936	
$2,936	TOTAL	$201,668	

ANNUAL ESTIMATED PUMPING COSTS

68% = Est. Total Pump Efficiency
$0.090 per kW hr = Electric power cost

$33,300 (annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)

Table 3. Hydraulic Parameters and Associated Construction Costs for Water Delivery Using HDPE Pipe along the Hassayampa River for the Middle Fifth of the Well Field Above Interstate 10 (3/8 of of the Total Volume Being Planned for Delivery).

Project Description:
West Maricopa Combine Pipeline
Yuma Rd. alignment using HDPE pipe.

C= 130 (H-W friction factor)
Q= 19.425 cfs
= 14,063 acre-feet per year

Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)	Avg. Head (psi)
51.2	52.8	-10	---	---	60	50.71	21.952	55.355	23.96	---	---	---
56.0	57.8	10	28	1.14	0	34.22	14.81	34.22	14.81	484	4.5	19.39
60.8	62.8	20	28	1.14	0	23.08	9.99	23.08	9.99	484	4.5	12.40
65.7	67.8	10	28	1.14	0	31.94	13.83	31.94	13.83	484	4.5	11.91
70.5	72.8	10	28	1.14	0	30.81	13.34	30.81	13.34	484	4.5	13.58
76.7	79.2	10	28	1.46	0	29.35	12.71	29.35	12.71	620	4.5	13.02
					---					---		
total pumping power =					60	ft				2,558	ft	
				=	44.1	hp			(	0.48	) miles	
total pumping power + 30% =					57.3	hp						

* - Includes the cost of furnishing and installing pipe

5	******
6.2	******
9.3	******
4.2	******
15.2	******
26	******
16.8	******
14.8	******
11.5	******
13	******
19	******
1.4	672
14.5	******
14.6	******

Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Earthwork: Trench Excav. (cu yd)	Earthwork: Am't. of Backfill (cu yd)	Earthwork: Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)	addt'l exc., bckfll & re-construct cost thru ua
---	---	---	---	$20,500	---	---	---		
27.1	35	$95.50	$46,260	$0	515	351	351	0%	$0
17.4	20	$95.50	$46,260	$0	515	351	351	0%	$0
16.7	20	$95.50	$46,260	$0	515	351	351	0%	$0
19.0	20	$95.50	$46,260	$0	515	351	351	0%	$0
18.2	20	$95.50	$59,213	$0	660	449	449	0%	$0
			$244,254	$20,500	2,721	1,853	1,853		$0
					x $5.80/cy	x $1.9/cy	x $2.86/cy		
					$15,780	$3,520	$5,298		

Remove Spoil (cu yd): 868

x $6.95/cy

$6,034

	CONSTRUCTION COST SUMMARY			
	Project Description:			
	West Maricopa Combine Pipeline			
Land	Yuma Rd. alignment using HDPE			
(acres)	pipe.			

0.3	Pipe costs	$244,254		
0.3	Earthwork	$30,632		$0
0.3	Pump costs	$20,500		
0.3	Pump Facility	$11,275		
0.4		---		
---	1st Subtotal	$306,661		
1	Land (Easement fee)	$2,936		
x $2000/ac		---		
---	TOTAL	$309,597		
$2,936				

ANNUAL ESTIMATED PUMPING COSTS

68% = Est. Total Pump Efficiency
$0.090 per kW hr = Electric power cost

$33,300 (annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)

Table 4. Hydraulic Parameters and Associated Construction Costs for Water Delivery Using HDPE Pipe along the Hassayampa River for the Fourth of Five Segments from the Top of the Well Field Above Interstate 10 (1/2 of the Total Volume Being Planned for Delivery).

Project Description:
West Maricopa Combine Pipeline
Yuma Rd. alignment using HDPE pipe.

C= 130 (H-W friction factor)
Q= 25.9 cfs
= 18,751 acre-feet per year

Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)	Avg. Head (psi)
76.7	79.2	10	---	---	80	29.35	12.706	54.675	23.67	---	---	---
81.6	84.2	2	32	1.01	0	61.66	26.69	61.66	26.69	484	4.6	25.18
86.4	89.2	-8	32	1.01	0	70.65	30.59	70.65	30.59	484	4.6	28.64
91.3	94.2	-10	32	1.01	0	71.64	31.01	71.64	31.01	484	4.6	30.80
96.1	99.2	-10	32	1.01	0	70.63	30.58	70.63	30.58	484	4.6	30.79
102.3	105.6	-17	32	1.29	0	76.34	33.05	76.34	33.05	620	4.6	31.81
					---					---		
	total pumping power =				80	ft				2,558	ft	
				=	58.8	hp			(	0.48	) miles	
total pumping power + 30% =					76.4	hp						

* - Includes the cost of furnishing and installing pipe

5 ******
6.2 ******
9.3 ******
4.2 ******
15.2 ******
26 ******
16.8 ******
14.8 ******
11.5 ******
13 ******
19 ******
1.4 672
14.5 ******
14.6 ******

Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Earthwork: Trench Excav. (cu yd)	Earthwork: Am't. of Backfill (cu yd)	Earthwork: Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)	addt'l exc., bckfll & re-construct cost thru ua
---	---	---	---	$33,500	---	---	---		
35.3	35	$124.71	$60,410	$0	585	387	387	0%	$0
40.1	50	$124.71	$60,410	$0	585	387	387	0%	$0
43.1	50	$124.71	$60,410	$0	585	387	387	0%	$0
43.1	50	$124.71	$60,410	$0	585	387	387	0%	$0
44.5	50	$124.71	$77,324	$0	748	496	496	0%	$0
			$318,962	$33,500	3,087	2,046	2,046		$0
					x $5.80/cy	x $1.9/cy	x $2.86/cy		
					$17,902	$3,887	$5,851		

Remove Spoil (cu yd)
1041
x $6.95/cy
$7,232

Land
(acres)

0.3
0.3
0.3
0.3
0.4

1
x $2,000/ac

$2,936

CONSTRUCTION COST SUMMARY

Project Description:
West Maricopa Combine Pipeline
Yuma Rd. alignment using HDPE pipe.

Pipe costs	$318,962
Earthwork	$34,872
Pump costs	$33,500
Pump Facility	$18,425

1st Subtotal	$405,760
Land (Easement fee)	$2,936

TOTAL	$408,695

ANNUAL ESTIMATED PUMPING COSTS

68% = Est. Total Pump Efficiency
$0.090 per kW hr = Electric power cost

$44,400 (annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)

Table 5. Hydraulic Parameters and Associated Construction Costs for Water Delivery Using HDPE Pipe along the Hassayampa River for the Fifth of Five Segments from the Top of the Well Field Above Interstate 10 (5/8 of the Total Volume Being Planned for Delivery).

Project Description:
West Maricopa Combine Pipeline
Yuma Rd. alignment using HDPE pipe.

C= 130 (H-W friction factor)
Q= 32.375 cfs
= 23,438 acre-feet per year

	Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)	Avg. Head (psi)
	102.3	105.6	-17	---	---	80	76.34	33.05	78.17	33.84	---	---	---
	107.1	110.6	-30	36	0.86	0	90.31	39.09	90.31	39.09	484	4.6	36.47
	112.0	115.6	-30	36	0.86	0	89.45	38.72	89.45	38.72	484	4.6	38.91
	116.8	120.6	-30	36	0.86	0	88.59	38.35	88.59	38.35	484	4.6	38.54
	121.7	125.6	-30	36	0.86	0	87.72	37.98	87.72	37.98	484	4.6	38.16
	127.9	132.0	-40	36	1.10	0	96.62	41.83	96.62	41.83	620	4.6	39.90
*****	132.7	137.0	-50	36	0.86	0	69.42	30.05	69.42	30.05	484	4.6	35.94
						---------					----------		
		total pumping power =				80	ft				3,042	ft	
					=	58.8	hp			(	0.58	) miles	
	total pumping power + 30% =					76.4	hp						

* - Includes the cost of furnishing and installing pipe
***** - Pressure reducing valve necessary so that bottom portion of manifold can pump into the main trunk line.

5 ******
6.2 ******
9.3 ******
4.2 ******
15.2 ******
26 ******
16.8 ******
14.8 ******
11.5 ******
13 ******
19 ******
1.4 672
14.5 ******
14.6 ******

					Earthwork				
Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Trench Excav. (cu yd)	Am't. of Backfill (cu yd)	Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)	addt'l exc., bckfll & re-construct cost thru ua
---	---	---	---	$40,250	---	---	---		
51.1	65	$195.71	$94,802	$0	658	425	425	0%	$0
54.5	65	$195.71	$94,802	$0	658	425	425	0%	$0
53.9	65	$195.71	$94,802	$0	658	425	425	0%	$0
53.4	65	$195.71	$94,802	$0	658	425	425	0%	$0
55.9	65	$195.71	$121,346	$0	842	544	544	0%	$0
50.3	50	$157.82	$76,448	$0	658	425	425	0%	$0
			$577,002	$40,250	4,131	2,668	2,668		$0
					x $5.80/cy	x $1.9/cy	x $2.86/cy		
					$23,961	$5,069	$7,630		

Remove Spoil (cu yd)
1,463
x $6.95/cy
$10,170

Land
(acres)

0.3
0.3
0.3
0.3
0.4
0.3

2
x $2,000/ac

$3,492

CONSTRUCTION COST SUMMARY

Project Description:
West Maricopa Combine Pipeline
Yuma Rd. alignment using HDPE pipe.

Pipe costs	$577,002
Earthwork	$46,829
Pump costs	$40,250
Pump Facility	$22,138
----------	----------
1st Subtotal	$686,219
Land (Easement fee)	$3,492
----------	----------
TOTAL	$689,711

ANNUAL ESTIMATED PUMPING COSTS

68% = Est. Total Pump Efficiency
$0.090 per kW hr = Electric power cost

$44,400 (annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)

Table 6. Hydraulic Parameters and Associated Construction Costs for Water Delivery Using HDPE Pipe along the Hassayampa River for the Southern Most Third of the Well Field Below Interstate 10 (this segment represents 1/8 of of the Total Volume Being Planned for Delivery).

Project Description:
West Maricopa Combine Pipeline
Yuma Rd. Alignment using HDPE pipe.

C= 130 (H-W friction factor)
Q= 6.475 cfs
= 4,688 acre-feet per year

Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)	Avg. Head (psi)
0.0	0.0	-80	---	---	60	0.00	0	60	25.97	---	---	---
4.8	5.0	-80	16	2.27	0	57.73	24.99	57.73	24.99	484	4.6	25.48
9.7	10.0	-80	16	2.27	0	55.46	24.01	55.46	24.01	484	4.6	24.50
14.5	15.0	-75	16	2.27	0	48.20	20.86	48.20	20.86	484	4.6	22.44
19.4	20.0	-70	16	2.27	0	40.93	17.72	40.93	17.72	484	4.6	19.29
25.6	26.4	-70	16	2.90	0	38.02	16.46	38.02	16.46	620	4.6	17.09
					---					---		
	total pumping power =				60	ft				2,558	ft	
				=	44.1	hp			(	0.48	) miles	
total pumping power + 30% =					57.3	hp						

* - Includes the cost of furnishing and installing pipe

5 ******
6.2 ******
9.3 ******
4.2 ******
15.2 ******
26 ******
16.8 ******
14.8 ******
11.5 ******
13 ******
19 ******
1.4 672
14.5 ******
14.6 ******

					Earthwork				
Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Trench Excav. (cu yd)	Am't. of Backfill (cu yd)	Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)	addt'l exc., bckfll & re-construct cost thru ua
---	---	---	---	$8,650	---	---	---		
35.7	35	$31.15	$15,089	$0	331	245	245	0%	$0
34.3	35	$31.15	$15,089	$0	331	245	245	0%	$0
31.4	35	$31.15	$15,089	$0	331	245	245	0%	$0
27.0	35	$31.15	$15,089	$0	331	245	245	0%	$0
23.9	35	$31.15	$19,314	$0	424	314	314	0%	$0
			$79,670	$8,650	1,750	1,294	1,294		$0
					x $5.80/cy	x $1.9/cy	x $2.86/cy		
					$10,149	$2,459	$3,701		

Remove Spoil (cu yd)
456
x $6.95/cy
$3,168

|

CONSTRUCTION COST SUMMARY

Project Description:
West Maricopa Combine Pipeline
Yuma Rd. Alignment using HDPE pipe.

Land (acres)
0.3
0.3
0.3
0.3
0.4

1
x $2000/ac

$2,936

Pipe costs	$79,670
Earthwork	$19,476
Pump costs	$8,650
Pump Facility	$4,758

1st Subtotal	$112,554
Land (Easement fee)	$2,936

TOTAL	$115,490

ANNUAL ESTIMATED PUMPING COSTS

68% = Est. Total Pump Efficiency
$0.090 per kW hr = Electric power cost

$33,300 (annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)

Table 7. Hydraulic Parameters and Associated Construction Costs for Water Delivery Using HDPE Pipe along the Hassayampa River for the Middle Third of the Well Field Below Interstate 10 (this segment represents 1/4 of Total Volume Being Planned for Delivery).

Project Description:
West Maricopa Combine Pipeline
Yuma Rd. Alignment using HDPE pipe.

C= 130 (H-W friction factc
Q= 12.95 cfs
= 9,375 acre-feet per year

Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)
25.6	26.4	-70	---	---	80	38.02	16.459	59.01	25.55	---	---
30.4	31.4	-66	22	1.74	0	53.27	23.06	53.27	23.06	484	4.9
35.3	36.4	-64	22	1.74	0	49.54	21.44	49.54	21.44	484	4.9
40.1	41.4	-58	22	1.74	0	41.80	18.10	41.80	18.10	484	4.9
45.0	46.4	-53	22	1.74	0	35.06	15.18	35.06	15.18	484	4.9
51.2	52.8	-49	22	2.22	0	28.84	12.49	28.84	12.49	620	4.9
					---					---	
	total pumping power =				80	ft				2,558	ft
				=	58.8	hp			(	0.48	) miles
total pumping power + 30% =					76.4	hp					

* - Includes the cost of furnishing and installing pipe

5 ******
6.2 ******
9.3 ******
4.2 ******
15.2 ******
26 ******
16.8 ******
14.8 ******
11.5 ******
13 ******
19 ******
1.4 672
14.5 ******
14.6 ******

of the

or)

r

Avg. Head (psi)	Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Earthwork: Trench Excav. (cu yd)	Earthwork: Am't. of Backfill (cu yd)	Earthwork: Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)
---	---	---	---	---	$19,000	---	---	---	
24.30	34.0	35	$58.93	$28,546	$0	419	297	297	0%
22.25	31.2	35	$58.93	$28,546	$0	419	297	297	0%
19.77	27.7	35	$58.93	$28,546	$0	419	297	297	0%
16.64	23.3	35	$58.93	$28,546	$0	419	297	297	0%
13.83	19.4	20	$58.93	$36,538	$0	536	380	380	0%
				$150,721	$19,000	2,212	1,569	1,569	
						x $5.80/cy	x $1.9/cy	x $2.86/cy	
						$12,827	$2,982	$4,488	

Remove Spoil (cu yd)
642
x $6.95/cy
$4,464

addt'l exc., bckfll & re-construct cost thru ua	Land (acres)
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.4
$0	1
	x $2000/ac
	$2,936

CONSTRUCTION COST SUMMARY

Project Description:
West Maricopa Combine Pipeline
Yuma Rd. Alignment using HDPE pipe.

Pipe costs	$150,721
Earthwork	$24,761
Pump costs	$19,000
Pump Facility	$10,450
1st Subtotal	$204,932
Land (Easement fee)	$2,936
TOTAL	$207,868

ANNUAL ESTIMATED PUMPING COSTS

68% = Est. Total Pump Efficiency
$0.090 per kW hr = Electric power cost

$44,400 (annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)

Table 8. Hydraulic Parameters and Associated Construction Costs for Water Delivery Using HDPE Pipe along the Hassayampa River for the Top Most Third of the Well Field Below Interstate 10 (this segment represents 3/8 of of the Total Volume Being Planned for Delivery).

Project Description:
West Maricopa Combine Pipeline
Yuma Rd. Alignment using HDPE pipe.

C= 130 (H-W friction factor)
Q= 19.425 cfs
= 14,063 acre-feet per year

Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)	Avg. Head (psi)
51.2	52.8	-49	---	---	120	28.84	12.485	74.42	32.22	---	---	---
56.0	57.8	-45	28	1.14	0	69.28	29.99	69.28	29.99	484	4.5	31.10
60.8	62.8	-41	28	1.14	0	64.15	27.77	64.15	27.77	484	4.5	28.88
65.7	67.8	-39	28	1.14	0	61.01	26.41	61.01	26.41	484	4.5	27.09
70.5	72.8	-38	28	1.14	0	58.87	25.49	58.87	25.49	484	4.5	25.95
76.7	79.2	-50	28	1.46	0	69.42	30.05	69.42	30.05	620	4.5	27.77
					---------					----------		
	total pumping power =				120	ft				2,558	ft	
				=	88.2	hp			(	0.48	) miles	
total pumping power + 30% =					114.7	hp						

* - Includes the cost of furnishing and installing pipe

** - 28"/42" pipe

5 ******
6.2 ******
9.3 ******
4.2 ******
15.2 ******
26 ******
16.8 ******
14.8 ******
11.5 ******
13 ******
19 ******
1.4 672
14.5 ******
14.6 ******

Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Earthwork: Trench Excav. (cu yd)	Earthwork: Am't. of Backfill (cu yd)	Earthwork: Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)	addt'l exc., bckfll & re-construct cost thru ua
---	---	---	---	$37,250	---	---	---		
43.5	50	$95.50	$46,260	$0	515	351	351	0%	$0
40.4	50	$95.50	$46,260	$0	515	351	351	0%	$0
37.9	50	$95.50	$46,260	$0	515	351	351	0%	$0
36.3	50	$95.50	$46,260	$0	515	351	351	0%	$0
38.9	50	$95.50	$59,213	$0	660	449	449	0%	$0
			$244,254	$37,250	2,721	1,853	1,853		$0
					x $5.80/cy	x $1.9/cy	x $2.86/cy		
					$15,780	$3,520	$5,298		

Remove Spoil (cu yd)	mobilizing:	$160,000
868	I-10 Dike crossing:**	$320,000
x $6.95/cy	manifold I-10 x-ing:**	$260,000
$6,034	TOTAL EARTHWORK	$740,000

costs $280,000 per 290-ft of length to jack and bore (+ 100' on either side of structure which requires exca

|

Land
(acres)

0.3
0.3
0.3
0.3
0.4

1
x $2,000/ac

$2,936

CONSTRUCTION COST SUMMARY
Project Description:
West Maricopa Combine Pipeline
Yuma Rd. Alignment using HDPE
pipe.

Pipe costs	$244,254
Earthwork	$770,632
Pump costs	$37,250
Pump Facility	$20,488
1st Subtotal	$1,072,624
Land (Easement fee)	$2,936
TOTAL	$1,075,560

ANNUAL ESTIMATED PUMPING COSTS

ɑvation)

68% = Est. Total Pump Efficiency
$0.090 per kW hr = Electric power cost

$66,601 (annual power requirement, based on Kw hr / yr ,
and assuming the pump runs two-thirds of a day)

Table 9. Hydraulic Parameters and Associated Construction Costs for Water Delivery Using Concrete Pipe Along the I-10 Flood Control Dike and Yuma Road frc the Pipe Interchange to Sarival Road.

Project Description:
West Maricopa Combine Pipeline. Concrete Pipe Placed Parallel to the Interstate 10 Dike and Yuma Rd.

C= 130 (H-W fr
Q= 51.80 cfs
= 37,501 acre-fe

Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)
132.7	137.0	-50	---	---	0	69.42	30.05	69.42	30.05	---	---
137.6	142.0	-39	42	0.97	0	57.45	24.87	57.45	24.87	484	5.4
142.4	147.0	-30	42	0.97	0	47.48	20.55	47.48	20.55	484	5.4
147.3	152.0	-25	42	0.97	0	41.51	17.97	41.51	17.97	484	5.4
152.1	157.0	-20	42	0.97	0	35.54	15.38	35.54	15.38	484	5.4
156.9	162.0	-22	42	0.97	0	36.57	15.83	36.57	15.83	484	5.4
161.8	167.0	-25	42	0.97	0	38.60	16.71	38.60	16.71	484	5.4
166.6	172.0	-28	42	0.97	0	40.62	17.59	40.62	17.59	484	5.4
171.5	177.0	-30	42	0.97	0	41.65	18.03	41.65	18.03	484	5.4
176.3	182.0	-40	42	0.97	0	50.68	21.94	50.68	21.94	484	5.4
181.2	187.0	-29	42	0.97	0	38.71	16.76	38.71	16.76	484	5.4
186.0	192.0	-30	42	0.97	0	38.74	16.77	38.74	16.77	484	5.4
190.9	197.0	-40	42	0.97	0	47.77	20.68	47.77	20.68	484	5.4
195.7	202.0	-41	42	0.97	0	47.80	20.69	47.80	20.69	484	5.4
200.5	207.0	-41	42	0.97	0	46.83	20.27	46.83	20.27	484	5.4
205.4	212.0	-39	42	0.97	0	43.86	18.99	43.86	18.99	484	5.4
210.2	217.0	-35	42	0.97	0	38.89	16.83	38.89	16.83	484	5.4
215.1	222.0	-35	42	0.97	0	37.92	16.41	37.92	16.41	484	5.4
219.9	227.0	-36	42	0.97	0	37.95	16.43	37.95	16.43	484	5.4
224.8	232.0	-38	42	0.97	0	38.98	16.87	38.98	16.87	484	5.4
229.6	237.0	-37	42	0.97	0	37.00	16.02	37.00	16.02	484	5.4
234.4	242.0	-40	42	0.97	0	39.03	16.90	39.03	16.90	484	5.4
239.3	247.0	-36	42	0.97	0	34.06	14.75	34.06	14.75	484	5.4
244.1	252.0	-38	42	0.97	0	35.09	15.19	35.09	15.19	484	5.4
249.0	257.0	-37	42	0.97	0	33.12	14.34	33.12	14.34	484	5.4
253.8	262.0	-39	42	0.97	0	34.15	14.78	34.15	14.78	484	5.4
258.7	267.0	-38	42	0.97	0	32.18	13.93	32.18	13.93	484	5.4
263.5	272.0	-36	42	0.97	0	29.21	12.64	29.21	12.64	484	5.4
268.4	277.0	-35	42	0.97	0	27.24	11.79	27.24	11.79	484	5.4
273.2	282.0	-35	42	0.97	0	26.27	11.37	26.27	11.37	484	5.4
278.0	287.0	-35	42	0.97	0	25.30	10.95	25.30	10.95	484	5.4
282.9	292.0	-35	42	0.97	0	24.33	10.53	24.33	10.53	484	5.4
287.7	297.0	-35	42	0.97	0	23.35	10.11	23.35	10.11	484	5.4
292.6	302.0	-35	42	0.97	0	22.38	9.69	22.38	9.69	484	5.4
297.4	307.0	-35	42	0.97	0	21.41	9.27	21.41	9.27	484	5.4
302.3	312.0	-34	42	0.97	0	19.44	8.42	19.44	8.42	484	5.4
307.1	317.0	-34	42	0.97	0	18.47	8.00	18.47	8.00	484	5.4
312.0	322.0	-34	42	0.97	0	17.50	7.58	17.50	7.58	484	5.4
316.8	327.0	-33	42	0.97	0	15.53	6.72	15.53	6.72	484	5.4

321.6	332.0	-33	42	0.97	0	14.56	6.30	14.56	6.30	484	5.4
326.5	337.0	-33	42	0.97	0	13.59	5.88	13.59	5.88	484	5.4
331.3	342.0	-32	42	0.97	0	11.62	5.03	11.62	5.03	484	5.4
336.2	347.0	-34	42	0.97	0	12.65	5.47	12.65	5.47	484	5.4
341.0	352.0	-34	42	0.97	0	11.68	5.05	11.68	5.05	484	5.4
345.9	357.0	-33	42	0.97	60	9.71	4.20	69.71	30.18	484	5.4
350.7	362.0	-32	42	0.97	0	67.73	29.32	67.73	29.32	484	5.4
355.5	367.0	-31	42	0.97	0	65.76	28.47	65.76	28.47	484	5.4
360.4	372.0	-31	42	0.97	0	64.79	28.05	64.79	28.05	484	5.4
365.2	377.0	-30	42	0.97	0	62.82	27.20	62.82	27.20	484	5.4
370.1	382.0	-28	42	0.97	0	59.85	25.91	59.85	25.91	484	5.4
374.9	387.0	-27	42	0.97	0	57.88	25.06	57.88	25.06	484	5.4
379.8	392.0	-27	42	0.97	0	56.91	24.64	56.91	24.64	484	5.4
384.6	397.0	-28	42	0.97	0	56.94	24.65	56.94	24.65	484	5.4
389.5	402.0	-29	42	0.97	0	56.97	24.66	56.97	24.66	484	5.4
394.3	407.0	-27	42	0.97	0	54.00	23.38	54.00	23.38	484	5.4
399.1	412.0	-25	42	0.97	0	51.03	22.09	51.03	22.09	484	5.4
404.0	417.0	-24	42	0.97	0	49.06	21.24	49.06	21.24	484	5.4
408.8	422.0	-24	42	0.97	0	48.09	20.82	48.09	20.82	484	5.4
413.7	427.0	-24	42	0.97	0	47.11	20.40	47.11	20.40	484	5.4
418.5	432.0	-24	42	0.97	0	46.14	19.98	46.14	19.98	484	5.4
423.4	437.0	-23	42	0.97	0	44.17	19.12	44.17	19.12	484	5.4
428.2	442.0	-21	42	0.97	0	41.20	17.84	41.20	17.84	484	5.4
433.1	447.0	-21	42	0.97	0	40.23	17.42	40.23	17.42	484	5.4
437.9	452.0	-21	42	0.97	0	39.26	17.00	39.26	17.00	484	5.4
442.7	457.0	-19	42	0.97	0	36.29	15.71	36.29	15.71	484	5.4
447.6	462.0	-17	42	0.97	0	33.32	14.42	33.32	14.42	484	5.4
452.4	467.0	-15	42	0.97	0	30.35	13.14	30.35	13.14	484	5.4
457.3	472.0	-13	42	0.97	0	27.38	11.85	27.38	11.85	484	5.4
462.1	477.0	-11	42	0.97	0	24.41	10.57	24.41	10.57	484	5.4
467.0	482.0	-11	42	0.97	0	23.44	10.15	23.44	10.15	484	5.4
471.8	487.0	-12	42	0.97	0	23.47	10.16	23.47	10.16	484	5.4
476.6	492.0	-11	42	0.97	0	21.49	9.30	21.49	9.30	484	5.4
481.5	497.0	-15	42	0.97	0	24.52	10.62	24.52	10.62	484	5.4
486.3	502.0	-16	42	0.97	0	24.55	10.63	24.55	10.63	484	5.4
491.2	507.0	-15	42	0.97	0	22.58	9.78	22.58	9.78	484	5.4
496.0	512.0	-16	42	0.97	0	22.61	9.79	22.61	9.79	484	5.4
500.9	517.0	-10	42	0.97	0	15.64	6.77	15.64	6.77	484	5.4
505.7	522.0	-5	42	0.97	0	9.67	4.19	9.67	4.19	484	5.4
510.6	527.0	-11	42	0.97	0	14.70	6.36	14.70	6.36	484	5.4
515.4	532.0	-15	42	0.97	0	17.73	7.67	17.73	7.67	484	5.4
520.2	537.0	-17	42	0.97	0	18.76	8.12	18.76	8.12	484	5.4
525.1	542.0	-20	42	0.97	0	20.79	9.00	20.79	9.00	484	5.4
529.9	547.0	-18	42	0.97	0	17.82	7.71	17.82	7.71	484	5.4
534.8	552.0	-14	42	0.97	0	12.85	5.56	12.85	5.56	484	5.4
539.6	557.0	-15	42	0.97	0	12.87	5.57	12.87	5.57	484	5.4
544.5	562.0	-15	42	0.97	0	11.90	5.15	11.90	5.15	484	5.4
549.3	567.0	-12	42	0.97	60	7.93	3.43	67.93	29.41	484	5.4
554.2	572.0	-11	42	0.97	0	65.96	28.55	65.96	28.55	484	5.4
559.0	577.0	-11	42	0.97	0	64.99	28.13	64.99	28.13	484	5.4
563.8	582.0	-10	42	0.97	0	63.02	27.28	63.02	27.28	484	5.4
568.7	587.0	-10	42	0.97	0	62.05	26.86	62.05	26.86	484	5.4
573.5	592.0	-10	42	0.97	0	61.08	26.44	61.08	26.44	484	5.4
578.4	597.0	-10	42	0.97	0	60.11	26.02	60.11	26.02	484	5.4

583.2	602.0	-9	42	0.97	0	58.14	25.17	58.14	25.17	484	5.4
588.1	607.0	-7	42	0.97	0	55.17	23.88	55.17	23.88	484	5.4
592.9	612.0	-7	42	0.97	0	54.20	23.46	54.20	23.46	484	5.4
597.7	617.0	-7	42	0.97	0	53.22	23.04	53.22	23.04	484	5.4
602.6	622.0	-6	42	0.97	0	51.25	22.19	51.25	22.19	484	5.4
607.4	627.0	-5	42	0.97	0	49.28	21.33	49.28	21.33	484	5.4
612.3	632.0	-4	42	0.97	0	47.31	20.48	47.31	20.48	484	5.4
617.1	637.0	-3	42	0.97	0	45.34	19.63	45.34	19.63	484	5.4
622.0	642.0	-3	42	0.97	0	44.37	19.21	44.37	19.21	484	5.4
626.8	647.0	-4	42	0.97	0	44.40	19.22	44.40	19.22	484	5.4
631.7	652.0	-5	42	0.97	0	44.43	19.23	44.43	19.23	484	5.4
636.5	657.0	-6	42	0.97	0	44.46	19.25	44.46	19.25	484	5.4
641.3	662.0	-6	42	0.97	0	43.49	18.83	43.49	18.83	484	5.4
646.2	667.0	-7	42	0.97	0	43.52	18.84	43.52	18.84	484	5.4
651.0	672.0	-8	42	0.97	0	43.55	18.85	43.55	18.85	484	5.4
655.9	677.0	-9	42	0.97	0	43.58	18.86	43.58	18.86	484	5.4
660.7	682.0	-11	42	0.97	0	44.60	19.31	44.60	19.31	484	5.4
665.6	687.0	-10	42	0.97	0	42.63	18.46	42.63	18.46	484	5.4
670.4	692.0	-11	42	0.97	0	42.66	18.47	42.66	18.47	484	5.4
675.3	697.0	-12	42	0.97	0	42.69	18.48	42.69	18.48	484	5.4
680.1	702.0	-13	42	0.97	0	42.72	18.49	42.72	18.49	484	5.4
684.9	707.0	-14	42	0.97	0	42.75	18.51	42.75	18.51	484	5.4
689.8	712.0	-15	42	0.97	0	42.78	18.52	42.78	18.52	484	5.4
694.6	717.0	-17	42	0.97	0	43.81	18.97	43.81	18.97	484	5.4
699.5	722.0	-16	42	0.97	0	41.84	18.11	41.84	18.11	484	5.4
704.3	727.0	-17	42	0.97	0	41.87	18.12	41.87	18.12	484	5.4
709.2	732.0	-17	42	0.97	0	40.90	17.70	40.90	17.70	484	5.4
714.0	737.0	-16	42	0.97	0	38.93	16.85	38.93	16.85	484	5.4
718.8	742.0	-17	42	0.97	0	38.96	16.86	38.96	16.86	484	5.4
723.7	747.0	-16	42	0.97	0	36.98	16.01	36.98	16.01	484	5.4
728.5	752.0	-18	42	0.97	0	38.01	16.46	38.01	16.46	484	5.4
733.4	757.0	-16	42	0.97	0	35.04	15.17	35.04	15.17	484	5.4
738.2	762.0	-18	42	0.97	0	36.07	15.62	36.07	15.62	484	5.4
743.1	767.0	-18	42	0.97	0	35.10	15.20	35.10	15.20	484	5.4
747.9	772.0	-19	42	0.97	0	35.13	15.21	35.13	15.21	484	5.4
752.8	777.0	-18	42	0.97	0	33.16	14.35	33.16	14.35	484	5.4
757.6	782.0	-18	42	0.97	0	32.19	13.93	32.19	13.93	484	5.4
762.4	787.0	-18	42	0.97	0	31.22	13.51	31.22	13.51	484	5.4
767.3	792.0	-19	42	0.97	0	31.25	13.53	31.25	13.53	484	5.4
772.1	797.0	-18	42	0.97	0	29.28	12.67	29.28	12.67	484	5.4
777.0	802.0	-19	42	0.97	0	29.31	12.69	29.31	12.69	484	5.4
781.8	807.0	-19	42	0.97	0	28.34	12.27	28.34	12.27	484	5.4
786.7	812.0	-20	42	0.97	0	28.36	12.28	28.36	12.28	484	5.4
791.5	817.0	-21	42	0.97	0	28.39	12.29	28.39	12.29	484	5.4
796.4	822.0	-22	42	0.97	0	28.42	12.30	28.42	12.30	484	5.4
801.2	827.0	-21	42	0.97	0	26.45	11.45	26.45	11.45	484	5.4
806.0	832.0	-23	42	0.97	0	27.48	11.90	27.48	11.90	484	5.4
810.9	837.0	-24	42	0.97	0	27.51	11.91	27.51	11.91	484	5.4
815.7	842.0	-26	42	0.97	0	28.54	12.35	28.54	12.35	484	5.4
820.6	847.0	-28	42	0.97	0	29.57	12.80	29.57	12.80	484	5.4
825.4	852.0	-30	42	0.97	0	30.60	13.25	30.60	13.25	484	5.4
830.3	857.0	-30	42	0.97	0	29.63	12.83	29.63	12.83	484	5.4
835.1	862.0	-32	42	0.97	0	30.66	13.27	30.66	13.27	484	5.4
839.9	867.0	-33	42	0.97	0	30.69	13.28	30.69	13.28	484	5.4

844.8	872.0	-35	42	0.97	0	31.72	13.73	31.72	13.73	484	5.4
849.6	877.0	-36	42	0.97	0	31.74	13.74	31.74	13.74	484	5.4
854.5	882.0	-37	42	0.97	0	31.77	13.75	31.77	13.75	484	5.4
859.3	887.0	-38	42	0.97	0	31.80	13.77	31.80	13.77	484	5.4
864.2	892.0	-39	42	0.97	0	31.83	13.78	31.83	13.78	484	5.4
869.0	897.0	-40	42	0.97	0	31.86	13.79	31.86	13.79	484	5.4
873.9	902.0	-41	42	0.97	0	31.89	13.81	31.89	13.81	484	5.4
878.7	907.0	-43	42	0.97	0	32.92	14.25	32.92	14.25	484	5.4
883.5	912.0	-44	42	0.97	0	32.95	14.26	32.95	14.26	484	5.4
888.4	917.0	-45	42	0.97	0	32.98	14.28	32.98	14.28	484	5.4
893.2	922.0	-45	42	0.97	0	32.01	13.86	32.01	13.86	484	5.4
898.1	927.0	-46	42	0.97	0	32.04	13.87	32.04	13.87	484	5.4
902.9	932.0	-47	42	0.97	0	32.07	13.88	32.07	13.88	484	5.4
907.8	937.0	-47	42	0.97	0	31.09	13.46	31.09	13.46	484	5.4
912.6	942.0	-48	42	0.97	0	31.12	13.47	31.12	13.47	484	5.4
917.5	947.0	-49	42	0.97	0	31.15	13.49	31.15	13.49	484	5.4
922.3	952.0	-50	42	0.97	0	31.18	13.50	31.18	13.50	484	5.4
927.1	957.0	-52	42	0.97	0	32.21	13.94	32.21	13.94	484	5.4
932.0	962.0	-53	42	0.97	0	32.24	13.96	32.24	13.96	484	5.4
936.8	967.0	-54	42	0.97	0	32.27	13.97	32.27	13.97	484	5.4
941.7	972.0	-55	42	0.97	0	32.30	13.98	32.30	13.98	484	5.4
946.5	977.0	-57	42	0.97	0	33.33	14.43	33.33	14.43	484	5.4
951.4	982.0	-60	42	0.97	0	35.36	15.31	35.36	15.31	484	5.4
956.2	987.0	-62	42	0.97	0	36.39	15.75	36.39	15.75	484	5.4
961.0	992.0	-62	42	0.97	0	35.42	15.33	35.42	15.33	484	5.4
965.9	997.0	-63	42	0.97	0	35.45	15.34	35.45	15.34	484	5.4
970.7	1002.0	-64	42	0.97	0	35.47	15.36	35.47	15.36	484	5.4
975.6	1007.0	-65	42	0.97	0	35.50	15.37	35.50	15.37	484	5.4
980.4	1012.0	-66	42	0.97	0	35.53	15.38	35.53	15.38	484	5.4
985.3	1017.0	-67	42	0.97	0	35.56	15.39	35.56	15.39	484	5.4
990.1	1022.0	-68	42	0.97	0	35.59	15.41	35.59	15.41	484	5.4
995.0	1027.0	-69	42	0.97	0	35.62	15.42	35.62	15.42	484	5.4
999.8	1032.0	-70	42	0.97	0	35.65	15.43	35.65	15.43	484	5.4
1004.6	1037.0	-72	42	0.97	0	36.68	15.88	36.68	15.88	484	5.4
1009.5	1042.0	-72	42	0.97	0	35.71	15.46	35.71	15.46	484	5.4
1014.3	1047.0	-73	42	0.97	0	35.74	15.47	35.74	15.47	484	5.4
1019.2	1052.0	-74	42	0.97	0	35.77	15.48	35.77	15.48	484	5.4
1024.0	1057.0	-76	42	0.97	0	36.80	15.93	36.80	15.93	484	5.4
1028.9	1062.0	-77	42	0.97	0	36.83	15.94	36.83	15.94	484	5.4
1033.7	1067.0	-79	42	0.97	0	37.85	16.39	37.85	16.39	484	5.4
1038.6	1072.0	-80	42	0.97	0	37.88	16.40	37.88	16.40	484	5.4
1043.4	1077.0	-80	42	0.97	0	36.91	15.98	36.91	15.98	484	5.4
1048.2	1082.0	-78	42	0.97	0	33.94	14.69	33.94	14.69	484	5.4
1053.1	1087.0	-74	42	0.97	0	28.97	12.54	28.97	12.54	484	5.4
1057.9	1092.0	-75	42	0.97	0	29.00	12.55	29.00	12.55	484	5.4
1062.8	1097.0	-76	42	0.97	0	29.03	12.57	29.03	12.57	484	5.4
1067.6	1102.0	-76	42	0.97	0	28.06	12.15	28.06	12.15	484	5.4
1072.5	1107.0	-76	42	0.97	0	27.09	11.73	27.09	11.73	484	5.4
1077.3	1112.0	-76	42	0.97	0	26.12	11.31	26.12	11.31	484	5.4
1082.1	1117.0	-76	42	0.97	0	25.15	10.89	25.15	10.89	484	5.4
1087.0	1122.0	-77	42	0.97	0	25.18	10.90	25.18	10.90	484	5.4
1091.8	1127.0	-78	42	0.97	0	25.21	10.91	25.21	10.91	484	5.4
1096.7	1132.0	-79	42	0.97	0	25.23	10.92	25.23	10.92	484	5.4
1101.5	1137.0	-82	42	0.97	0	27.26	11.80	27.26	11.80	484	5.4

1106.4	1142.0	-83	42	0.97	0	27.29	11.82	27.29	11.82	484	5.4
1111.2	1147.0	-85	42	0.97	0	28.32	12.26	28.32	12.26	484	5.4
1116.1	1152.0	-86	42	0.97	0	28.35	12.27	28.35	12.27	484	5.4
1120.9	1157.0	-87	42	0.97	0	28.38	12.29	28.38	12.29	484	5.4
1125.7	1162.0	-87	42	0.97	0	27.41	11.87	27.41	11.87	484	5.4
1130.6	1167.0	-87	42	0.97	0	26.44	11.45	26.44	11.45	484	5.4
1135.4	1172.0	-87	42	0.97	0	25.47	11.03	25.47	11.03	484	5.4
1140.3	1177.0	-87	42	0.97	0	24.50	10.60	24.50	10.60	484	5.4
1145.1	1182.0	-85	42	0.97	0	21.53	9.32	21.53	9.32	484	5.4
1150.0	1187.0	-80	42	0.97	0	15.56	6.73	15.56	6.73	484	5.4
1154.8	1192.0	-79	42	0.97	0	13.59	5.88	13.59	5.88	484	5.4
1159.7	1197.0	-78	42	0.97	0	11.61	5.03	11.61	5.03	484	5.4
1164.5	1202.0	-78	42	0.97	0	10.64	4.61	10.64	4.61	484	5.4
1166.9	1204.5	-78	42	0.49	0	10.16	4.40	10.16	4.40	242	5.4
					---------					----------	
	total pumping power =				120	ft				103,419	ft
					= 705.6	hp				(19.59	) miles

* - Includes the cost of furnishing and installing pipe

om

riction factor)

et per year

|---------- Earthwork

Avg. Head (psi)	Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Trench Excav. (cu yd)	Am't. of Backfill (cu yd)	Compact Backfill/ Remove Spoil (cu yd)
---	---	---	---	---	$0	---	---	---
27.46	38.4	50	$202.44	$98,062	$0	775	482	482
22.71	31.8	35	$202.44	$98,062	$0	775	482	482
19.26	27.0	35	$202.44	$98,062	$0	775	482	482
16.68	23.3	35	$202.44	$98,062	$0	775	482	482
15.61	21.8	35	$202.44	$98,062	$0	775	482	482
16.27	22.8	35	$202.44	$98,062	$0	775	482	482
17.15	24.0	35	$202.44	$98,062	$0	775	482	482
17.81	24.9	35	$202.44	$98,062	$0	775	482	482
19.99	28.0	35	$202.44	$98,062	$0	775	482	482
19.35	27.1	35	$202.44	$98,062	$0	775	482	482
16.76	23.5	35	$202.44	$98,062	$0	775	482	482
18.73	26.2	35	$202.44	$98,062	$0	775	482	482
20.69	29.0	35	$202.44	$98,062	$0	775	482	482
20.48	28.7	35	$202.44	$98,062	$0	775	482	482
19.63	27.5	35	$202.44	$98,062	$0	775	482	482
17.91	25.1	35	$202.44	$98,062	$0	775	482	482
16.62	23.3	35	$202.44	$98,062	$0	775	482	482
16.42	23.0	35	$202.44	$98,062	$0	775	482	482
16.65	23.3	35	$202.44	$98,062	$0	775	482	482
16.45	23.0	35	$202.44	$98,062	$0	775	482	482
16.46	23.0	35	$202.44	$98,062	$0	775	482	482
15.82	22.2	35	$202.44	$98,062	$0	775	482	482
14.97	21.0	20	$202.44	$98,062	$0	775	482	482
14.76	20.7	20	$202.44	$98,062	$0	775	482	482
14.56	20.4	20	$202.44	$98,062	$0	775	482	482
14.36	20.1	20	$202.44	$98,062	$0	775	482	482
13.29	18.6	20	$202.44	$98,062	$0	775	482	482
12.22	17.1	20	$202.44	$98,062	$0	775	482	482
11.58	16.2	20	$202.44	$98,062	$0	775	482	482
11.16	15.6	20	$202.44	$98,062	$0	775	482	482
10.74	15.0	20	$202.44	$98,062	$0	775	482	482
10.32	14.4	20	$202.44	$98,062	$0	775	482	482
9.90	13.9	20	$202.44	$98,062	$0	775	482	482
9.48	13.3	20	$202.44	$98,062	$0	775	482	482
8.84	12.4	20	$202.44	$98,062	$0	775	482	482
8.21	11.5	20	$202.44	$98,062	$0	775	482	482
7.79	10.9	20	$202.44	$98,062	$0	775	482	482
7.15	10.0	20	$202.44	$98,062	$0	775	482	482

6.51	9.1	20	$202.44	$98,062	$0	775	482	482
6.09	8.5	20	$202.44	$98,062	$0	775	482	482
5.46	7.6	20	$202.44	$98,062	$0	775	482	482
5.25	7.4	20	$202.44	$98,062	$0	775	482	482
5.26	7.4	20	$202.44	$98,062	$0	775	482	482
4.63	6.5	20	$202.44	$98,062	$48,000	775	482	482
29.75	41.6	50	$202.44	$98,062	$0	775	482	482
28.90	40.5	50	$202.44	$98,062	$0	775	482	482
28.26	39.6	50	$202.44	$98,062	$0	775	482	482
27.62	38.7	50	$202.44	$98,062	$0	775	482	482
26.55	37.2	50	$202.44	$98,062	$0	775	482	482
25.48	35.7	35	$202.44	$98,062	$0	775	482	482
24.85	34.8	35	$202.44	$98,062	$0	775	482	482
24.64	34.5	35	$202.44	$98,062	$0	775	482	482
24.66	34.5	35	$202.44	$98,062	$0	775	482	482
24.02	33.6	35	$202.44	$98,062	$0	775	482	482
22.73	31.8	35	$202.44	$98,062	$0	775	482	482
21.66	30.3	35	$202.44	$98,062	$0	775	482	482
21.03	29.4	35	$202.44	$98,062	$0	775	482	482
20.61	28.8	35	$202.44	$98,062	$0	775	482	482
20.19	28.3	35	$202.44	$98,062	$0	775	482	482
19.55	27.4	35	$202.44	$98,062	$0	775	482	482
18.48	25.9	35	$202.44	$98,062	$0	775	482	482
17.63	24.7	35	$202.44	$98,062	$0	775	482	482
17.21	24.1	35	$202.44	$98,062	$0	775	482	482
16.35	22.9	35	$202.44	$98,062	$0	775	482	482
15.07	21.1	35	$202.44	$98,062	$0	775	482	482
13.78	19.3	20	$202.44	$98,062	$0	775	482	482
12.49	17.5	20	$202.44	$98,062	$0	775	482	482
11.21	15.7	20	$202.44	$98,062	$0	775	482	482
10.36	14.5	20	$202.44	$98,062	$0	775	482	482
10.15	14.2	20	$202.44	$98,062	$0	775	482	482
9.73	13.6	20	$202.44	$98,062	$0	775	482	482
9.96	13.9	20	$202.44	$98,062	$0	775	482	482
10.62	14.9	20	$202.44	$98,062	$0	775	482	482
10.20	14.3	20	$202.44	$98,062	$0	775	482	482
9.78	13.7	20	$202.44	$98,062	$0	775	482	482
8.28	11.6	20	$202.44	$98,062	$0	775	482	482
5.48	7.7	20	$202.44	$98,062	$0	775	482	482
5.27	7.4	20	$202.44	$98,062	$0	775	482	482
7.02	9.8	20	$202.44	$98,062	$0	775	482	482
7.90	11.1	20	$202.44	$98,062	$0	775	482	482
8.56	12.0	20	$202.44	$98,062	$0	775	482	482
8.36	11.7	20	$202.44	$98,062	$0	775	482	482
6.64	9.3	20	$202.44	$98,062	$0	775	482	482
5.57	7.8	20	$202.44	$98,062	$0	775	482	482
5.36	7.5	20	$202.44	$98,062	$0	775	482	482
4.29	6.0	20	$202.44	$98,062	$48,000	775	482	482
28.98	40.6	50	$202.44	$98,062	$0	775	482	482
28.34	39.7	50	$202.44	$98,062	$0	775	482	482
27.71	38.8	50	$202.44	$98,062	$0	775	482	482
27.07	37.9	50	$202.44	$98,062	$0	775	482	482
26.65	37.3	50	$202.44	$98,062	$0	775	482	482
26.23	36.7	50	$202.44	$98,062	$0	775	482	482

25.59	35.8	35	$202.44	$98,062	$0	775	482	482
24.52	34.3	35	$202.44	$98,062	$0	775	482	482
23.67	33.1	35	$202.44	$98,062	$0	775	482	482
23.25	32.6	35	$202.44	$98,062	$0	775	482	482
22.61	31.7	35	$202.44	$98,062	$0	775	482	482
21.76	30.5	35	$202.44	$98,062	$0	775	482	482
20.91	29.3	35	$202.44	$98,062	$0	775	482	482
20.06	28.1	35	$202.44	$98,062	$0	775	482	482
19.42	27.2	35	$202.44	$98,062	$0	775	482	482
19.21	26.9	35	$202.44	$98,062	$0	775	482	482
19.23	26.9	35	$202.44	$98,062	$0	775	482	482
19.24	26.9	35	$202.44	$98,062	$0	775	572	482
19.04	26.7	35	$202.44	$98,062	$0	775	572	482
18.83	26.4	35	$202.44	$98,062	$0	775	572	482
18.84	26.4	35	$202.44	$98,062	$0	775	572	482
18.86	26.4	35	$202.44	$98,062	$0	775	572	482
19.09	26.7	35	$202.44	$98,062	$0	775	572	482
18.88	26.4	35	$202.44	$98,062	$0	775	572	482
18.46	25.8	35	$202.44	$98,062	$0	775	572	482
18.48	25.9	35	$202.44	$98,062	$0	775	572	482
18.49	25.9	35	$202.44	$98,062	$0	775	572	482
18.50	25.9	35	$202.44	$98,062	$0	775	572	482
18.51	25.9	35	$202.44	$98,062	$0	775	572	482
18.74	26.2	35	$202.44	$98,062	$0	775	572	482
18.54	26.0	35	$202.44	$98,062	$0	775	572	482
18.12	25.4	35	$202.44	$98,062	$0	775	572	482
17.91	25.1	35	$202.44	$98,062	$0	775	572	482
17.28	24.2	35	$202.44	$98,062	$0	775	572	482
16.86	23.6	35	$202.44	$98,062	$0	775	572	482
16.44	23.0	35	$202.44	$98,062	$0	775	572	482
16.23	22.7	35	$202.44	$98,062	$0	775	572	482
15.81	22.1	35	$202.44	$98,062	$0	775	572	482
15.39	21.6	35	$202.44	$98,062	$0	775	572	482
15.41	21.6	35	$202.44	$98,062	$0	775	572	482
15.20	21.3	35	$202.44	$98,062	$0	775	572	482
14.78	20.7	20	$202.44	$98,062	$0	775	572	482
14.14	19.8	20	$202.44	$98,062	$0	775	572	482
13.72	19.2	20	$202.44	$98,062	$0	775	572	482
13.52	18.9	20	$202.44	$98,062	$0	775	572	482
13.10	18.3	20	$202.44	$98,062	$0	775	572	482
12.68	17.8	20	$202.44	$98,062	$0	775	572	482
12.48	17.5	20	$202.44	$98,062	$0	775	572	482
12.27	17.2	20	$202.44	$98,062	$0	775	572	482
12.29	17.2	20	$202.44	$98,062	$0	775	572	482
12.30	17.2	20	$202.44	$98,062	$0	775	572	482
11.88	16.6	20	$202.44	$98,062	$0	775	572	482
11.67	16.3	20	$202.44	$98,062	$0	775	572	482
11.90	16.7	20	$202.44	$98,062	$0	775	572	482
12.13	17.0	20	$202.44	$98,062	$0	775	572	482
12.58	17.6	20	$202.44	$98,062	$0	775	572	482
13.02	18.2	20	$202.44	$98,062	$0	775	572	482
13.04	18.3	20	$202.44	$98,062	$0	775	572	482
13.05	18.3	20	$202.44	$98,062	$0	775	572	482
13.28	18.6	20	$202.44	$98,062	$0	775	572	482

13.51	18.9	20	$202.44	$98,062	$0	775	572	482
13.74	19.2	20	$202.44	$98,062	$0	775	572	482
13.75	19.2	20	$202.44	$98,062	$0	775	572	482
13.76	19.3	20	$202.44	$98,062	$0	775	572	482
13.77	19.3	20	$202.44	$98,062	$0	775	572	482
13.79	19.3	20	$202.44	$98,062	$0	775	572	482
13.80	19.3	20	$202.44	$98,062	$0	775	572	482
14.03	19.6	20	$202.44	$98,062	$0	775	572	482
14.26	20.0	20	$202.44	$98,062	$0	775	572	482
14.27	20.0	20	$202.44	$98,062	$0	775	572	482
14.07	19.7	20	$202.44	$98,062	$0	775	572	482
13.86	19.4	20	$202.44	$98,062	$0	775	572	482
13.87	19.4	20	$202.44	$98,062	$0	775	572	482
13.67	19.1	20	$202.44	$98,062	$0	775	572	482
13.47	18.9	20	$202.44	$98,062	$0	775	572	482
13.48	18.9	20	$202.44	$98,062	$0	775	572	482
13.49	18.9	20	$202.44	$98,062	$0	775	572	482
13.72	19.2	20	$202.44	$98,062	$0	775	572	482
13.95	19.5	20	$202.44	$98,062	$0	775	572	482
13.96	19.5	20	$202.44	$98,062	$0	775	572	482
13.98	19.6	20	$202.44	$98,062	$0	775	572	482
14.21	19.9	20	$202.44	$98,062	$0	775	572	482
14.87	20.8	20	$202.44	$98,062	$0	775	572	482
15.53	21.7	35	$202.44	$98,062	$0	775	572	482
15.54	21.8	35	$202.44	$98,062	$0	775	572	482
15.34	21.5	35	$202.44	$98,062	$0	775	572	482
15.35	21.5	35	$202.44	$98,062	$0	775	572	482
15.36	21.5	35	$202.44	$98,062	$0	775	572	482
15.38	21.5	35	$202.44	$98,062	$0	775	572	482
15.39	21.5	35	$202.44	$98,062	$0	775	572	482
15.40	21.6	35	$202.44	$98,062	$0	775	572	482
15.41	21.6	35	$202.44	$98,062	$0	775	572	482
15.43	21.6	35	$202.44	$98,062	$0	775	572	482
15.66	21.9	35	$202.44	$98,062	$0	775	572	482
15.67	21.9	35	$202.44	$98,062	$0	775	572	482
15.46	21.7	35	$202.44	$98,062	$0	775	572	482
15.48	21.7	35	$202.44	$98,062	$0	775	572	482
15.71	22.0	35	$202.44	$98,062	$0	775	572	482
15.94	22.3	35	$202.44	$98,062	$0	775	572	482
16.16	22.6	35	$202.44	$98,062	$0	775	572	482
16.39	23.0	35	$202.44	$98,062	$0	775	572	482
16.19	22.7	35	$202.44	$98,062	$0	775	572	482
15.34	21.5	35	$202.44	$98,062	$0	775	572	482
13.62	19.1	20	$202.44	$98,062	$0	775	572	482
12.55	17.6	20	$202.44	$98,062	$0	775	572	482
12.56	17.6	20	$202.44	$98,062	$0	775	572	482
12.36	17.3	20	$202.44	$98,062	$0	775	572	482
11.94	16.7	20	$202.44	$98,062	$0	775	572	482
11.52	16.1	20	$202.44	$98,062	$0	775	572	482
11.10	15.5	20	$202.44	$98,062	$0	775	572	482
10.89	15.2	20	$202.44	$98,062	$0	775	572	482
10.91	15.3	20	$202.44	$98,062	$0	775	572	482
10.92	15.3	20	$202.44	$98,062	$0	775	572	482
11.36	15.9	20	$202.44	$98,062	$0	775	572	482

11.81	16.5	20	$202.44	$98,062	$0	775	572	482
12.04	16.9	20	$202.44	$98,062	$0	775	572	482
12.27	17.2	20	$202.44	$98,062	$0	775	572	482
12.28	17.2	20	$202.44	$98,062	$0	775	572	482
12.08	16.9	20	$202.44	$98,062	$0	775	572	482
11.66	16.3	20	$202.44	$98,062	$0	775	572	482
11.24	15.7	20	$202.44	$98,062	$0	775	572	482
10.82	15.1	20	$202.44	$98,062	$0	775	572	482
9.96	13.9	20	$202.44	$98,062	$0	775	572	482
8.03	11.2	20	$202.44	$98,062	$0	775	572	482
6.31	8.8	20	$202.44	$98,062	$0	775	572	482
5.45	7.6	20	$202.44	$98,062	$0	775	572	482
4.82	6.7	20	$202.44	$98,062	$0	775	572	482
4.50	6.3	20	$202.44	$49,031	$0	388	286	241
				---	---	---	---	---
				$20,936,223	$96,000	165,502	112,907	102,920
						x $5.80/cy	x $1.9/cy	x $2.86/cy
						---	---	---
						$959,911	$214,524	$294,350

Remove Spoil (cu yd)	I-10 Dike & main-line
52,595	
x $6.95/cy	
---	combined ot
$365,532	TOTAL

* - additional excavation, backfill & reconstruct thru urban areas includes additional required beddir
the ABC backfill is assumed as the same price as medium weight soil (therefore, no additional cos
** - 42" pipe costs $280,000 per 290-ft of length to jack and bore (+ 100' on either side of structure
*** - estimate of 42" pipe costs $140,000 per 290-ft length to bore for smaller canals (+50' on either

----------------- ----------------- |

estimate % of exc./bkfll thru urban areas (ua)	addt'l exc., bckfll & re-construct cost thru ua*	Land (acres)

0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
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0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6

CONSTRUCTION COST SUMMARY

Project Description:
West Maricopa Combine Pipeline. Concrete Pipe Placed Parallel to the Interstate 10 Dike

Pipe costs	$20,936,223
Earthwork	$7,386,452
Pump costs	$96,000
Pump Facility	$2,432,600

1st Subtotal	$30,851,275
Land (Easement fee)	$388,098

TOTAL	$31,239,373

ANNUAL ESTIMATED PUMPING COSTS

68%	= Est. Total Pump Efficiency
$0.090	per kW hr = Electric power cost
$409,851	(annual power requirement, based on Kw h and assuming the pump runs two-thirds of a

0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
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0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
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0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
0%	$0	0.6
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100%	$22,318	0.6		
100%	$22,318	0.6		
100%	$11,159	0.3		
	---	---		
	$2,466,110	119	ac	
		57.8	ac; I-10 Dike alignment	
		60.9	ac; Yuma rd alignment	
		$144,564	$2,500/ac - I-10 Dike	
		$243,534	$4,000/ac - Yuma	
mobilizing:	$240,000	$388,098	Total Easement Cost	
crossing:**	$386,000			
I-10 x-ing:**	$561,000			
RID x-ing:**	$223,000			
6 canals:***	$456,300			
ther util's:	$1,219,725			
UTILITIES:	$3,086,025			

ng, ABC backfill, AC pavement replacement, and traffic control
st), AC pavement = $5.60/S.Y., pipe bedding is $21.91/L.F., and traffic control is $21/L.F.
which requires excavation)
r side of structure which requires excavation)

ır / yr ,
a day)

Table 10. Hydraulic Parameters and Associated Construction Costs for Water Delivery Using HDPE pipe along Miller Road from the Main Trunk Line in Order to Deliver a Maximum of 16,896 acre-feet per year.

Project Description:
West Maricopa Combine Pipeline
HDPE Pipeline lateral for Yuma Rd. Alignment.

C= 130 (H-W friction factor)
Q= 23.338 cfs
= 16,896 acre-feet per year

	Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)	Avg. Head (psi)
	0.0	0.0	1090	---	---	0	47.31	20.481	47.31	20.48	---	---	---
	4.8	5.0	1085	30	1.14	0	51.17	22.15	51.17	22.15	484	4.8	21.32
	9.7	10.0	1078	30	1.14	0	57.03	24.69	57.03	24.69	484	4.8	23.42
	14.5	15.0	1070	30	1.14	0	63.89	27.66	63.89	27.66	484	4.8	26.17
	19.4	20.0	1062	30	1.14	0	70.74	30.62	70.74	30.62	484	4.8	29.14
	24.2	25.0	1059	30	1.14	0	72.60	31.43	72.60	31.43	484	4.8	31.03
	29.1	30.0	1053	30	1.14	0	77.46	33.53	77.46	33.53	484	4.8	32.48
	33.9	35.0	1048	30	1.14	0	81.32	35.20	81.32	35.20	484	4.8	34.37
	38.8	40.0	1040	30	1.14	0	88.18	38.17	88.18	38.17	484	4.8	36.69
	43.6	45.0	1034	30	1.14	0	93.04	40.28	93.04	40.28	484	4.8	39.22
	48.4	50.0	1028	30	1.14	0	97.89	42.38	97.89	42.38	484	4.8	41.33
	53.3	55.0	1020	30	1.14	0	104.75	45.35	104.75	45.35	484	4.8	43.86
	58.1	60.0	1017	30	1.14	0	106.61	46.15	106.61	46.15	484	4.8	45.75
	63.0	65.0	1013	30	1.14	0	109.47	47.39	109.47	47.39	484	4.8	46.77
*****	67.8	70.0	1008	30	1.14	0	88.40	38.27	88.40	38.27	484	4.8	42.83
	72.7	75.0	1003	30	1.14	0	92.25	39.94	92.25	39.94	484	4.8	39.10
	77.5	80.0	998	30	1.14	0	96.11	41.61	96.11	41.61	484	4.8	40.77
	82.3	85.0	994	30	1.14	0	98.97	42.84	98.97	42.84	484	4.8	42.23
	87.2	90.0	989	30	1.14	0	102.83	44.51	102.83	44.51	484	4.8	43.68
	92.0	95.0	983	30	1.14	0	107.69	46.62	107.69	46.62	484	4.8	45.57
*****	96.9	100.0	979	30	1.14	0	88.44	38.28	88.44	38.28	484	4.8	42.45
	101.7	105.0	975	30	1.14	0	91.30	39.52	91.30	39.52	484	4.8	38.90
	106.6	110.0	971	30	1.14	0	94.15	40.76	94.15	40.76	484	4.8	40.14
	111.4	115.0	966	30	1.14	0	98.01	42.43	98.01	42.43	484	4.8	41.59
	116.3	120.0	961	30	1.14	0	101.87	44.10	101.87	44.10	484	4.8	43.26
	121.1	125.0	956	30	1.14	0	105.73	45.77	105.73	45.77	484	4.8	44.93
	125.9	130.0	952	30	1.14	0	86.87	37.61	86.87	37.61	484	4.8	41.69
	130.8	135.0	947	30	1.14	0	90.73	39.28	90.73	39.28	484	4.8	38.44
	135.6	140.0	944	30	1.14	0	92.59	40.08	92.59	40.08	484	4.8	39.68
	140.5	145.0	940	30	1.14	0	95.44	41.32	95.44	41.32	484	4.8	40.70
	145.3	150.0	935	30	1.14	0	99.30	42.99	99.30	42.99	484	4.8	42.15
	150.2	155.0	932	30	1.14	0	101.16	43.79	101.16	43.79	484	4.8	43.39
	155.0	160.0	928	30	1.14	0	104.02	45.03	104.02	45.03	484	4.8	44.41
	159.9	165.0	924	30	1.14	0	106.88	46.27	106.88	46.27	484	4.8	45.65
*****	164.7	170.0	920	30	1.14	0	87.79	38.00	87.79	38.00	484	4.8	42.14
	169.5	175.0	916	30	1.14	0	90.65	39.24	90.65	39.24	484	4.8	38.62
	174.4	180.0	913	30	1.14	0	92.51	40.05	92.51	40.05	484	4.8	39.64
	179.2	185.0	909	30	1.14	0	95.36	41.28	95.36	41.28	484	4.8	40.66
	184.1	190.0	906	30	1.14	0	97.22	42.09	97.22	42.09	484	4.8	41.69

188.9	195.0	902	30	1.14	0	100.08	43.33	100.08	43.33	484	4.8	42.71
193.8	200.0	898	30	1.14	0	102.94	44.56	102.94	44.56	484	4.8	43.94
198.6	205.0	896	30	1.14	0	103.80	44.93	103.80	44.93	484	4.8	44.75
203.4	210.0	893	30	1.14	0	105.66	45.74	105.66	45.74	484	4.8	45.34
208.3	215.0	889	30	1.14	0	108.52	46.98	108.52	46.98	484	4.8	46.36
210.7	217.5	888	30	0.57	0	108.94	47.16	108.94	47.16	242	4.8	47.07
					---					---		
	total pumping power =				0	ft				21,071	ft	
				=	0.0	hp				(3.99	) miles	

* - Includes the cost of furnishing and installing pipe

***** - Pressure reducing valve necessary at this location to keep the cost of higher pressure, more expensive pipe down.

						Earthwork	
Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Trench Excav. (cu yd)	Am't. of Backfill (cu yd)	Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)
---	---	---	---	$0	---	---	---	
29.8	35	$109.56	$53,071	$0	549	369	369	0%
32.8	35	$109.56	$53,071	$0	549	369	369	0%
36.6	50	$109.56	$53,071	$0	549	369	369	0%
40.8	50	$109.56	$53,071	$0	549	369	369	0%
43.4	50	$109.56	$53,071	$0	549	369	369	0%
45.5	50	$109.56	$53,071	$0	549	369	369	0%
48.1	50	$109.56	$53,071	$0	549	369	369	0%
51.4	65	$135.89	$65,825	$0	549	369	369	0%
54.9	65	$135.89	$65,825	$0	549	369	369	0%
57.9	65	$135.89	$65,825	$0	549	369	369	0%
61.4	65	$135.89	$65,825	$0	549	369	369	0%
64.0	65	$135.89	$65,825	$0	549	369	369	0%
65.5	65	$135.89	$65,825	$0	549	369	369	0%
60.0	65	$135.89	$65,825	$0	549	369	369	0%
54.7	65	$135.89	$65,825	$0	549	369	369	0%
57.1	65	$135.89	$65,825	$0	549	369	369	0%
59.1	65	$135.89	$65,825	$0	549	369	369	0%
61.2	65	$135.89	$65,825	$0	549	369	369	0%
63.8	65	$135.89	$65,825	$0	549	369	369	0%
59.4	65	$135.89	$65,825	$0	549	369	369	0%
54.5	65	$135.89	$65,825	$0	549	369	369	0%
56.2	65	$135.89	$65,825	$0	549	369	369	0%
58.2	65	$135.89	$65,825	$0	549	369	369	0%
60.6	65	$135.89	$65,825	$0	549	369	369	0%
62.9	65	$135.89	$65,825	$0	549	369	369	0%
58.4	65	$135.89	$65,825	$0	549	369	369	0%
53.8	65	$135.89	$65,825	$0	549	369	369	0%
55.5	65	$135.89	$65,825	$0	549	369	369	0%
57.0	65	$135.89	$65,825	$0	549	369	369	0%
59.0	65	$135.89	$65,825	$0	549	369	369	0%
60.7	65	$135.89	$65,825	$0	549	369	369	0%
62.2	65	$135.89	$65,825	$0	549	369	369	0%
63.9	65	$135.89	$65,825	$0	549	369	369	0%
59.0	65	$135.89	$65,825	$0	549	369	369	0%
54.1	65	$135.89	$65,825	$0	549	369	369	0%
55.5	65	$135.89	$65,825	$0	549	369	369	0%
56.9	65	$135.89	$65,825	$0	549	369	369	0%
58.4	65	$135.89	$65,825	$0	549	438	369	100%

59.8	65	$135.89	$65,825	$0	549	438	369	100%
61.5	65	$135.89	$65,825	$0	549	438	369	100%
62.6	65	$135.89	$65,825	$0	549	438	369	100%
63.5	65	$135.89	$65,825	$0	549	438	369	100%
64.9	65	$135.89	$65,825	$0	549	438	369	100%
65.9	65	$135.89	$32,913	$0	275	219	185	100%
			$2,774,113	$0	23,900	16,505	16,055	
					x $5.80/cy	x $1.9/cy	x $2.86/cy	
					$138,621	$31,360	$45,919	

Remove Spoil (cu yd)	
7,395	mobilizing:
x $6.95/cy	RID x-ing:*
	3 canals:**
	combined other util's:
$51,395	TOTAL UTILITIES:

* - 30"/42" [42" pipe costs $280,000 per 290-ft of length to jack and bore (+ 100' on eithe
** - 30"/42" [estimate of 42" pipe costs $140,000 per 290-ft length to bore (+50' on either

------------------ |	
addt'l exc., bckfll & re-construct cost thru ua	Land (acres)

$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
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$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$13,476	0.3

CONSTRUCTION COST SUMMARY

Project Description:
West Maricopa Combine Pipeline
HDPE Pipeline lateral for Yuma Rd.
Alignment.

Pipe costs	$2,774,113
Earthwork	$840,691
Pump costs	$0
Pump Facility	$0

1st Subtotal	$3,614,804
Land (Easement fee)	$37,948

TOTAL	$3,652,752

ANNUAL ESTIMATED PUMPING COSTS

68%	= Est. Total Pump Efficiency
$0.090	per kW hr = Electric power cost
$0	(annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)

$13,476	0.3	
$13,476	0.3	
$13,476	0.3	
$13,476	0.3	
$13,476	0.3	
$6,738	0.1	
$87,596	10.8	ac
	x $3,500/ac	
	$37,948	

$40,000
$85,500
$152,100
$208,200
$485,800

er side of structure which requires excavation)]
r side of structure which requires excavation)]

Table 11. Hydraulic Parameters and Associated Construction Costs for Water Delivery Using HDPE Pipe along Tuthill Road from the Main Trunk Line in Order to Deliver a Maximum of 915 acre-feet per year.

Project Description:
West Maricopa Combine Pipeline
HDPE Pipeline lateral for Yuma Rd. Alignment.

C= 130 (H-W friction factor)
Q= 1.264 cfs
= 915 acre-feet per year

Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)	Avg. Head (psi)
0.0	0.0	1007	---	---	60	32.26	13.965	92.26	39.94	---	---	---
4.8	5.0	1003	12	0.45	0	95.81	41.48	95.81	41.48	484	1.6	40.71
9.7	10.0	998	12	0.45	0	100.36	43.45	100.36	43.45	484	1.6	42.46
14.5	15.0	994	12	0.45	0	103.92	44.99	103.92	44.99	484	1.6	44.22
19.4	20.0	991	12	0.45	0	106.47	46.09	106.47	46.09	484	1.6	45.54
24.2	25.0	987	12	0.45	0	110.02	47.63	110.02	47.63	484	1.6	46.86
29.1	30.0	984	12	0.45	0	112.57	48.73	112.57	48.73	484	1.6	48.18
33.9	35.0	980	12	0.45	0	116.13	50.27	116.13	50.27	484	1.6	49.50
38.8	40.0	975	12	0.45	0	120.68	52.24	120.68	52.24	484	1.6	51.26
43.6	45.0	973	12	0.45	0	122.23	52.91	122.23	52.91	484	1.6	52.58
48.4	50.0	970	12	0.45	0	124.78	54.02	124.78	54.02	484	1.6	53.47
52.4	54.1	967	12	0.37	0	127.42	55.16	127.42	55.16	397	1.6	54.59

total pumping power = 60 ft 5,241 ft
= 8.6 hp (0.99) miles

* - Includes the cost of furnishing and installing pipe

Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Earthwork: Trench Excav. (cu yd)	Earthwork: Am't. of Backfill (cu yd)	Earthwork: Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)
---	---	---	---	$4,600	---	---	---	
57.0	65	$11.24	$5,445	$0	278	211	211	0%
59.4	65	$11.24	$5,445	$0	278	211	211	0%
61.9	65	$11.24	$5,445	$0	278	211	211	0%
63.8	65	$11.24	$5,445	$0	278	211	211	0%
65.6	65	$11.24	$5,445	$0	278	211	211	0%
67.5	80	$13.78	$6,675	$0	278	211	211	0%
69.3	80	$13.78	$6,675	$0	278	211	211	0%
71.8	80	$13.78	$6,675	$0	278	211	211	0%
73.6	80	$13.78	$6,675	$0	278	211	211	0%
74.9	80	$13.78	$6,675	$0	278	211	211	0%
76.4	80	$13.78	$5,474	$0	228	173	173	0%
			---	---	---	---	---	---
			$66,072	$4,600	3,009	2,285	2,285	0%
					x $5.80/cy	x $1.9/cy	x $2.86/cy	
					---	---	---	
					$17,451	$4,342	$6,535	

Remove Spoil (cu yd): 724
x $6.95/cy

$5,030

mobilizing:
RID x-ing:*
1 canal:**
combined other util's:
TOTAL UTILITIES:

* - 12"/42" [42" pipe costs $280,000 per 290-ft of le
** - 12"/42" [estimate of 42" pipe costs $140,000 pe

addt'l exc., bckfll & re-construct cost thru ua	Land (acres)
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.2
$0	3.0 ac
	x $3,500/ac
	$10,528
$20,000	
$62,500	
$50,700	
$26,640	
$159,840	

CONSTRUCTION COST SUMMARY
Project Description:
West Maricopa Combine Pipeline
HDPE Pipeline lateral for Yuma Rd.
Alignment.

Pipe costs	$66,072
Earthwork	$193,198
Pump costs	$4,600
Pump Facility	$24,350
1st Subtotal	$288,220
+ 20% unlisted items	$57,644
2nd Subtotal	$345,864
Land (Easement fee)	$10,528
TOTAL	$356,392

ANNUAL ESTIMATED PUMPING COSTS

68%	= Est. Total Pump Efficiency
$0.090	per kW hr = Electric power cost
$5,000	(annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)

ength to jack and bore (+ 100' on either side of structure which requires excavation)]
er 290-ft length to bore (+50' on either side of structure which requires excavation)]

Table 12. Hydraulic Parameters and Associated Construction Costs for Water Delivery Using HDPE Pipe along Cotton Lane from the Main Trunk Line in Order to Deliver a Maximum of 19,689 acre-feet per year.

Project Description:
West Maricopa Combine Pipeline
HDPE Pipeline lateral for Yuma Rd. Alignment.

C= 130 (H-W friction factor)
Q= 27.196 cfs
= 19,689 acre-feet per year

Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)	Avg. Head (psi)
0.0	0.0	964	---	---	60	27.47	11.892	87.47	37.87	---	---	---
4.8	5.0	963	32	1.11	0	87.36	37.82	87.36	37.82	484	4.9	37.84
9.7	10.0	961	32	1.11	0	88.26	38.21	88.26	38.21	484	4.9	38.01
14.5	15.0	958	32	1.11	0	90.15	39.03	90.15	39.03	484	4.9	38.62
19.4	20.0	956	32	1.11	0	91.04	39.41	91.04	39.41	484	4.9	39.22
24.2	25.0	953	32	1.11	0	92.94	40.23	92.94	40.23	484	4.9	39.82
29.1	30.0	951	32	1.11	0	93.83	40.62	93.83	40.62	484	4.9	40.43
33.9	35.0	948	32	1.11	0	95.72	41.44	95.72	41.44	484	4.9	41.03
38.8	40.0	946	32	1.11	0	96.62	41.83	96.62	41.83	484	4.9	41.63
43.6	45.0	944	32	1.11	0	97.51	42.21	97.51	42.21	484	4.9	42.02
48.4	50.0	940	32	1.11	0	100.40	43.46	100.40	43.46	484	4.9	42.84
53.3	55.0	937	32	1.11	0	102.30	44.28	102.30	44.28	484	4.9	43.87
58.1	60.0	934	32	1.11	0	104.19	45.10	104.19	45.10	484	4.9	44.69
63.0	65.0	933	32	1.11	0	104.08	45.06	104.08	45.06	484	4.9	45.08
67.8	70.0	931	32	1.11	0	104.98	45.44	104.98	45.44	484	4.9	45.25

total pumping power = 60 ft = 185.2 hp

6,782 ft (1.28) miles

* - Includes the cost of furnishing and installing pipe

Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Trench Excav. (cu yd)	Am't. of Backfill (cu yd)	Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)
---	---	---	---	$27,750	---	---	---	
53.0	65	$154.62	$74,898	$0	585	387	387	0%
53.2	65	$154.62	$74,898	$0	585	387	387	0%
54.1	65	$154.62	$74,898	$0	585	387	387	0%
54.9	65	$154.62	$74,898	$0	585	387	387	0%
55.8	65	$154.62	$74,898	$0	585	387	387	0%
56.6	65	$154.62	$74,898	$0	585	387	387	0%
57.4	65	$154.62	$74,898	$0	585	387	387	0%
58.3	65	$154.62	$74,898	$0	585	387	387	0%
58.8	65	$154.62	$74,898	$0	585	387	387	0%
60.0	65	$154.62	$74,898	$0	585	387	387	0%
61.4	65	$154.62	$74,898	$0	585	387	387	0%
62.6	65	$154.62	$74,898	$0	585	387	387	0%
63.1	65	$154.62	$74,898	$0	585	387	387	0%
63.4	65	$154.62	$74,898	$0	585	387	387	0%
			---	---	---	---	---	
			$1,048,571	$27,750	$8,184	$5,425	$5,425	
					x $5.80/cy	x $1.9/cy	x $2.86/cy	
					---	---	---	
					$47,467	$10,307	$15,515	

Remove Spoil (cu yd)	
2,759	
x $6.95/cy	

$19,175	

Combined other util's:
TOTAL UTILITIES:

addt'l exc., bckfll & re-construct cost thru ua	Land (acres)
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	3.9 ac
	x $3,500/ac
	$13,622
$45,000	
$45,000	

CONSTRUCTION COST SUMMARY

Project Description:
West Maricopa Combine Pipeline
HDPE Pipeline lateral for Yuma Rd.
Alignment.

Pipe costs	$1,048,571
Earthwork	$137,464
Pump costs	$27,750
Pump Facility	$500,000
1st Subtotal	$1,713,785
Land (Easement fee)	$13,622
TOTAL	$1,727,408

ANNUAL ESTIMATED PUMPING COSTS

68%	= Est. Total Pump Efficiency
$0.090	per kW hr = Electric power cost
$107,590	(annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)

PMP Modeling Results for the RID Canal Alignment

Table 1. Hydraulic Parameters and Associated Construction Costs for Water Delivery Using HDPE Pipe along the Hassayampa River for the First Eighth of the Well Field (first eighth is located above Interstate 10).

Project Description:
West Maricopa Combine Pipeline
RID alignment using HDPE Pipe

C= 130 (H-W friction factor)
Q= 6.475 cfs
= 4,688 acre-feet per year

Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)	Avg. Head (psi)
0.0	0.0	0	---	---	60	0	0	60	25.97	---	---	---
4.8	5.0	-10	16	2.27	0	67.73	29.32	67.73	29.32	484	4.6	27.65
9.7	10.0	-10	16	2.27	0	65.46	28.34	65.46	28.34	484	4.6	28.83
14.5	15.0	-10	16	2.27	0	63.20	27.36	63.20	27.36	484	4.6	27.85
19.4	20.0	-10	16	2.27	0	60.93	26.38	60.93	26.38	484	4.6	26.87
25.6	26.4	0	16	2.90	0	48.02	20.79	48.02	20.79	620	4.6	23.58
					---					---		
	total pumping power =				60	ft				2,558	ft	
				=	44.1	hp			(	0.48	) miles	
total pumping power + 30% =					57.3	hp						

* - Includes the cost of furnishing and installing pipe

5 ******
6.2 ******
9.3 ******
4.2 ******
15.2 ******
26 ******
16.8 ******
14.8 ******
11.5 ******
13 ******
19 ******
1.4 672
14.5 ******
14.6 ******

					Earthwork				
Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Trench Excav. (cu yd)	Am't. of Backfill (cu yd)	Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)	addt'l exc., bckfll & re-construct cost thru ua
---	---	---	---	$8,650	---	---	---		
38.7	50	$31.15	$15,089	$0	331	245	245	0%	$0
40.4	50	$31.15	$15,089	$0	331	245	245	0%	$0
39.0	50	$31.15	$15,089	$0	331	245	245	0%	$0
37.6	50	$31.15	$15,089	$0	331	245	245	0%	$0
33.0	35	$31.15	$19,314	$0	424	314	314	0%	$0
			$79,670	$8,650	1,750	1,294	1,294		$0
					x $5.80/cy	x $1.9/cy	x $2.86/cy		
					$10,149	$2,459	$3,701		

Remove Spoil (cu yd)
456
x $6.95/cy
$3,168

CONSTRUCTION COST SUMMARY

Project Description:
West Maricopa Combine Pipeline
RID alignment using HDPE Pipe

Land (acres)		

0.3	Pipe costs	$79,670
0.3	Earthwork	$19,476
0.3	Pump costs	$8,650
0.3	Pump Facility	$4,758
0.4		----------
----------	1st Subtotal	$112,554
1	Land (Easement fee)	$2,936
x $2,000/ac		----------
------	TOTAL	$115,490
$2,936		

ANNUAL ESTIMATED PUMPING COSTS

68% = Est. Total Pump Efficiency
$0.090 per kW hr = Electric power cost

$33,300 (annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)

Table 2. Hydraulic Parameters and Associated Construction Costs for Water Delivery Using HDPE Pipe along the Hassayampa River for the Second Eighth of the Well Field (second eighth is located above Interstate 10).

Project Description:
West Maricopa Combine Pipeline
RID alignment using HDPE Pipe

C= 130 (H-W friction factor)
Q= 12.95 cfs
= 9,375 acre-feet per year

Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)	Avg. Head (psi)
25.6	26.4	0	---	---	60	48.02	20.79	54.01	23.38	---	---	---
30.4	31.4	-10	22	1.74	0	62.27	26.96	62.27	26.96	484	4.9	25.17
35.3	36.4	0	22	1.74	0	50.54	21.88	50.54	21.88	484	4.9	24.42
40.1	41.4	0	22	1.74	0	48.80	21.13	48.80	21.13	484	4.9	21.50
45.0	46.4	-10	22	1.74	0	57.06	24.70	57.06	24.70	484	4.9	22.91
51.2	52.8	-10	22	2.22	0	54.84	23.74	54.84	23.74	620	4.9	24.22
					---					---		
total pumping power =					60	ft				2,558	ft	
				=	44.1	hp			(	0.48	) miles	
total pumping power + 30% =					57.3	hp						

* - Includes the cost of furnishing and installing pipe

5	******
6.2	******
9.3	******
4.2	******
15.2	******
26	******
16.8	******
14.8	******
11.5	******
13	******
19	******
1.4	672
14.5	******
14.6	******

Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Earthwork: Trench Excav. (cu yd)	Earthwork: Am't. of Backfill (cu yd)	Earthwork: Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)	addt'l exc., bckfll & re-construct cost thru ua
---	---	---	---	$15,000	---	---	---		
35.2	35	$58.93	$28,546	$0	419	297	297	0%	$0
34.2	35	$58.93	$28,546	$0	419	297	297	0%	$0
30.1	35	$58.93	$28,546	$0	419	297	297	0%	$0
32.1	35	$58.93	$28,546	$0	419	297	297	0%	$0
33.9	35	$58.93	$36,538	$0	536	380	380	0%	$0
			$150,721	$15,000	2,212	1,569	1,569		$0
					x $5.80/cy	x $1.9/cy	x $2.86/cy		
					$12,827	$2,982	$4,488		

Remove Spoil (cu yd)
642
x $6.95/cy
$4,464

CONSTRUCTION COST SUMMARY
West Maricopa Combine Pipeline
RID alignment using HDPE Pipe

Land (acres)				
	0			
	0			
0.3				
0.3	Pipe costs	$150,721		$0
0.3	Earthwork	$24,761		
0.3	Pump costs	$15,000		
0.4	Pump Facility	$8,250		
---		---		
1	1st Subtotal	$198,732		
x $2,000/ac	Land (Easement fee)	$2,936		
---		---		
$2,936	TOTAL	$201,668		

ANNUAL ESTIMATED PUMPING COSTS

68%	= Est. Total Pump Efficiency
$0.090	per kW hr = Electric power cost

$33,300 (annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)

Table 3. Hydraulic Parameters and Associated Construction Costs for Water Delivery Using HDPE Pipe along the Hassayampa River for the Third Eighth of the Well Field (the third of eight segments is located above Interstate 10).

Project Description:
West Maricopa Combine Pipeline
RID alignment using HDPE Pipe

C= 130 (H-W friction factor)
Q= 19.425 cfs
= 14,063 acre-feet per year

Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)	Avg. Head (psi)
51.2	52.8	-10	---	---	60	54.84	23.74	57.42	24.86	---	---	---
56.0	57.8	10	28	1.14	0	36.28	15.71	36.28	15.71	484	4.5	20.28
60.8	62.8	20	28	1.14	0	25.15	10.89	25.15	10.89	484	4.5	13.30
65.7	67.8	10	28	1.14	0	34.01	14.72	34.01	14.72	484	4.5	12.80
70.5	72.8	10	28	1.14	0	32.87	14.23	32.87	14.23	484	4.5	14.48
76.7	79.2	10	28	1.46	0	31.42	13.60	31.42	13.60	620	4.5	13.91
					---					---		
total pumping power =					60	ft				2,558	ft	
				=	44.1	hp			(	0.48	) miles	
total pumping power + 30% =					57.3	hp						

* - Includes the cost of furnishing and installing pipe

5	******
6.2	******
9.3	******
4.2	******
15.2	******
26	******
16.8	******
14.8	******
11.5	******
13	******
19	******
1.4	672
14.5	******
14.6	******

Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Earthwork: Trench Excav. (cu yd)	Earthwork: Am't. of Backfill (cu yd)	Earthwork: Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)	addt'l exc., bckfll & re-construct cost thru ua
---	---	---	---	$20,500	---	---	---		
28.4	35	$95.50	$46,260	$0	515	351	351	0%	$0
18.6	20	$95.50	$46,260	$0	515	351	351	0%	$0
17.9	20	$95.50	$46,260	$0	515	351	351	0%	$0
20.3	20	$95.50	$46,260	$0	515	351	351	0%	$0
19.5	20	$95.50	$59,213	$0	660	449	449	0%	$0
			$244,254	$20,500	2,721	1,853	1,853		$0
					x $5.80/cy	x $1.9/cy	x $2.86/cy		
					$15,780	$3,520	$5,298		

Remove Spoil (cu yd)
868
x $6.95/cy
$6,034

	CONSTRUCTION COST SUMMARY			
	Project Description:			
	West Maricopa Combine Pipeline			
Land	RID alignment using HDPE Pipe			
(acres)	0			

0.3	Pipe costs	$244,254		
0.3	Earthwork	$30,632		$0
0.3	Pump costs	$20,500		
0.3	Pump Facility	$11,275		
0.4		---		
---	1st Subtotal	$306,661		
1	Land (Easement fee)	$2,936		
x $2000/ac		---		
---	TOTAL	$309,597		
$2,936				

ANNUAL ESTIMATED PUMPING COSTS

68% = Est. Total Pump Efficiency
$0.090 per kW hr = Electric power cost

$33,300 (annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)

Table 4. Hydraulic Parameters and Associated Construction Costs for Water Delivery Using HDPE Pipe along the Hassayampa River for the Fourth of Eight Segments from the Top of the Well Field Above Interstate 10 (1/2 of the Total Volume Being Planned for Delivery).

Project Description:
West Maricopa Combine Pipeline
RID alignment using HDPE Pipe

C= 130 (H-W friction factor)
Q= 25.9 cfs
= 18,751 acre-feet per year

	Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)	Avg. Head (psi)
	76.7	79.2	10	---	---	60	31.42	13.602	45.71	19.79	---	---	---
	81.6	84.2	2	32	1.01	0	52.70	22.81	52.70	22.81	484	4.6	21.30
	86.4	89.2	-8	32	1.01	0	61.69	26.70	61.69	26.70	484	4.6	24.76
	91.3	94.2	-10	32	1.01	0	62.68	27.13	62.68	27.13	484	4.6	26.92
*****	96.1	99.2	-10	32	1.01	0	30.83	13.35	30.83	13.35	484	4.6	20.24
	102.3	105.6	-17	32	1.29	0	36.54	15.82	36.54	15.82	620	4.6	14.58
						---------					----------		
		total pumping power =				60	ft				2,558	ft	
					=	44.1	hp			(	0.48	) miles	
		total pumping power + 30% =				57.3	hp						

* - Includes the cost of furnishing and installing pipe
***** - Pressure reducing valve necessary to keep pipe costs low.

5 ******
6.2 ******
9.3 ******
4.2 ******
15.2 ******
26 ******
16.8 ******
14.8 ******
11.5 ******
13 ******
19 ******
1.4 672
14.5 ******
14.6 ******

					Earthwork				
Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Trench Excav. (cu yd)	Am't. of Backfill (cu yd)	Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)	addt'l exc., bckfll & re-construct cost thru ua
---	---	---	---	$26,000	---	---	---		
29.8	35	$124.71	$60,410	$0	585	387	387	0%	$0
34.7	35	$124.71	$60,410	$0	585	387	387	0%	$0
37.7	50	$124.71	$60,410	$0	585	387	387	0%	$0
28.3	35	$124.71	$60,410	$0	585	387	387	0%	$0
20.4	20	$124.71	$77,324	$0	748	496	496	0%	$0
			---	---	---	---	---		---
			$318,962	$26,000	3,087	2,046	2,046		$0
					x $5.80/cy	x $1.9/cy	x $2.86/cy		
					---	---	---		
					$17,902	$3,887	$5,851		

Remove Spoil (cu yd)
1041
x $6.95/cy

$7,232

	CONSTRUCTION COST SUMMARY
	Project Description:
	West Maricopa Combine Pipeline
Land	RID alignment using HDPE Pipe
(acres)	0

0.3	Pipe costs $318,962
0.3	Earthwork $34,872
0.3	Pump costs $26,000
0.3	Pump Facility $14,300
0.4	----------
----------	1st Subtotal $394,135
1	Land (Easement fee) $2,936
x $2,000/ac	----------
------	TOTAL $397,070
$2,936	

ANNUAL ESTIMATED PUMPING COSTS

68% = Est. Total Pump Efficiency
$0.090 per kW hr = Electric power cost

$33,300 (annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)

Table 5. Hydraulic Parameters and Associated Construction Costs for Water Delivery Using HDPE Pipe along the Hassayampa River for the Fifth of Eight Segments from the Top of the Well Field Above Interstate 10 (5/8 of the Total Volume Being Planned for Delivery).

Project Description:
West Maricopa Combine Pipeline
RID alignment using HDPE Pipe

C= 130 (H-W friction factor)
Q= 32.375 cfs
= 23,438 acre-feet per year

	Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)	Avg. Head (psi)
	102.3	105.6	-17	---	---	60	36.54	15.82	48.27	20.90	---	---	---
	107.1	110.6	-30	36	0.86	0	60.41	26.15	60.41	26.15	484	4.6	23.52
	112.0	115.6	-30	36	0.86	0	59.55	25.78	59.55	25.78	484	4.6	25.96
	116.8	120.6	-30	36	0.86	0	58.69	25.41	58.69	25.41	484	4.6	25.59
	121.7	125.6	-30	36	0.86	0	57.82	25.03	57.82	25.03	484	4.6	25.22
*****	127.9	132.0	-40	36	1.10	0	23.35	10.11	23.35	10.11	620	4.6	17.57
	132.7	137.0	-50	36	0.86	0	32.49	14.07	32.49	14.07	484	4.6	12.09
						---------					----------		
		total pumping power =				60	ft				3,042	ft	
					=	44.1	hp			(	0.58	) miles	
		total pumping power + 30% =				57.3	hp						

* - Includes the cost of furnishing and installing pipe

5 ******
6.2 ******
9.3 ******
4.2 ******
15.2 ******
26 ******
16.8 ******
14.8 ******
11.5 ******
13 ******
19 ******
1.4 672
14.5 ******
14.6 ******

					Earthwork				
Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Trench Excav. (cu yd)	Am't. of Backfill (cu yd)	Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)	addt'l exc., bckfll & re-construct cost thru ua
---	---	---	---	$31,500	---	---	---		
32.9	35	$157.82	$76,448	$0	658	425	425	0%	$0
36.4	50	$157.82	$76,448	$0	658	425	425	0%	$0
35.8	35	$157.82	$76,448	$0	658	425	425	0%	$0
35.3	35	$157.82	$76,448	$0	658	425	425	0%	$0
24.6	35	$157.82	$97,853	$0	842	544	544	0%	$0
16.9	20	$157.82	$76,448	$0	658	425	425	0%	$0
			---	---	---	---	---		---
			$480,093	$31,500	4,131	2,668	2,668		$0
					x $5.80/cy	x $1.9/cy	x $2.86/cy		
					---	---	---		
					$23,961	$5,069	$7,630		

Remove Spoil (cu yd)
1,463
x $6.95/cy

$10,170

CONSTRUCTION COST SUMMARY

Project Description:
West Maricopa Combine Pipeline
RID alignment using HDPE Pipe

Land (acres)		
		0
0.3	Pipe costs	$480,093
0.3	Earthwork	$46,829
0.3	Pump costs	$31,500
0.3	Pump Facility	$17,325
0.4		
0.3	1st Subtotal	$575,748
	Land (Easement fee)	$3,492
2		
x $2,000/ac	TOTAL	$579,240
$3,492		

ANNUAL ESTIMATED PUMPING COSTS

68% = Est. Total Pump Efficiency
$0.090 per kW hr = Electric power cost

$33,300 (annual power requirement, based on Kw hr / yr , and assuming the pump runs half a day)

Table 6. Hydraulic Parameters and Associated Construction Costs for Water Delivery Using Concrete Pipe along the Hassayampa River for the Sixth of Eight Segments Located Below Interstate 10.

Project Description:
West Maricopa Combine Pipeline
RID alignment using Concrete Pipe

C= 130 (H-W friction factor)
Q= 38.85 cfs
= 28,126 acre-feet per year

Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)	Avg. Head (psi)
132.7	137.0	-50	---	---	60	32.49	14.065	46.245	20.02	---	---	---
137.6	142.0	-38	42	0.57	0	33.67	14.58	33.67	14.58	484	4.0	17.30
142.4	147.0	-39	42	0.57	0	34.10	14.76	34.10	14.76	484	4.0	14.67
147.3	152.0	-41	42	0.57	0	35.53	15.38	35.53	15.38	484	4.0	15.07
152.1	157.0	-45	42	0.57	0	38.96	16.87	38.96	16.87	484	4.0	16.13
158.3	163.4	-49	42	0.73	0	42.23	18.28	42.23	18.28	620	4.0	17.58
					---					---		
	total pumping power =				60	ft				2,558	ft	
				=	44.1	hp			(	0.48	) miles	
total pumping power + 30% =					57.3	hp						

* - Includes the cost of furnishing and installing pipe

** - 42" pipe cost

5 ******
6.2 ******
9.3 ******
4.2 ******
15.2 ******
26 ******
16.8 ******
14.8 ******
11.5 ******
13 ******
19 ******
1.4 672
14.5 ******
14.6 ******

Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Earthwork: Trench Excav. (cu yd)	Earthwork: Am't. of Backfill (cu yd)	Earthwork: Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)	addt'l exc., bckfll & re-construct cost thru ua
---	---	---	---	$37,250	---	---	---		
24.2	35	$202.44	$98,062	$0	775	482	482	0%	$0
20.5	20	$202.44	$98,062	$0	775	482	482	0%	$0
21.1	35	$202.44	$98,062	$0	775	482	482	0%	$0
22.6	35	$202.44	$98,062	$0	775	482	482	0%	$0
24.6	35	$202.44	$125,519	$0	992	617	617	0%	$0
			$517,767	$37,250	4,093	2,545	2,545		$0
					x $5.80/cy	x $1.9/cy	x $2.86/cy		
					$23,739	$4,836	$7,279		

Remove Spoil (cu yd)			
1548		mobilizing:	$240,000
x $6.95/cy	I-10 Dike	crossing:**	$483,000
$10,757	manifold	I-10 x-ing:**	$386,000
	TOTAL EARTHWORI		$1,109,000

sts $280,000 per 290-ft of length to jack and bore (+ 100' on either side of structure which requires excavati

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CONSTRUCTION COST SUMMARY
Project Description:
West Maricopa Combine Pipeline
RID alignment using Concrete Pipe

Land (acres)		
0.6	Pipe costs	$517,767
0.6	Earthwork	$1,155,611
0.6	Pump costs	$37,250
0.6	Pump Facility	$20,488
0.7		
	1st Subtotal	$1,731,116
3	Land (Easement fee)	$5,872
x $2,000/ac		
$5,872	TOTAL	$1,736,987

ANNUAL ESTIMATED PUMPING COSTS

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68% = Est. Total Pump Efficiency
$0.090 per kW hr = Electric power cost

$33,300 (annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)

Table 7. Hydraulic Parameters and Associated Construction Costs for Water Delivery Using Concrete Pipe along the Hassayampa River for the Seventh of Eight Segments Which is Located Below Interstate 10.

Project Description:
West Maricopa Combine Pipeline
RID alignment using Concrete Pipe

C= 130 (H-W friction factc
Q= 45.324 cfs
= 32,813 acre-feet per year

Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)
158.3	163.4	-49	---	---	60	42.23	18.281	51.115	22.13	---	---
163.1	168.4	-53	42	0.76	0	54.36	23.53	54.36	23.53	484	4.7
168.0	173.4	-58	42	0.76	0	58.60	25.37	58.60	25.37	484	4.7
172.8	178.4	-64	42	0.76	0	63.84	27.64	63.84	27.64	484	4.7
177.7	183.4	-66	42	0.76	0	65.08	28.17	65.08	28.17	484	4.7
183.9	189.8	-70	42	0.97	0	68.11	29.49	68.11	29.49	620	4.7
					---					---	
	total pumping power =				60	ft				2,558	ft
				=	44.1	hp			(	0.48	) miles
total pumping power + 30% =					57.3	hp					

* - Includes the cost of furnishing and installing pipe

5 ******
6.2 ******
9.3 ******
4.2 ******
15.2 ******
26 ******
16.8 ******
14.8 ******
11.5 ******
13 ******
19 ******
1.4 672
14.5 ******
14.6 ******

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Avg. Head (psi)	Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Earthwork: Trench Excav. (cu yd)	Earthwork: Am't. of Backfill (cu yd)	Earthwork: Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)
---	---	---	---	---	$42,500	---	---	---	
22.83	32.0	35	$202.44	$98,062	$0	775	482	482	0%
24.45	34.2	35	$202.44	$98,062	$0	775	482	482	0%
26.50	37.1	50	$202.44	$98,062	$0	775	482	482	0%
27.91	39.1	50	$202.44	$98,062	$0	775	482	482	0%
28.83	40.4	50	$202.44	$125,519	$0	992	617	617	0%
				---	---	---	---	---	
				$517,767	$42,500	4,093	2,545	2,545	
						x $5.80/cy	x $1.9/cy	x $2.86/cy	
						---	---	---	
						$23,739	$4,836	$7,279	

Remove Spoil (cu yd)
1548
x $6.95/cy

$10,757

addt'l exc., bckfll & re-construct cost thru ua	Land (acres)
$0	0.6
$0	0.6
$0	0.6
$0	0.6
$0	0.7
$0	3
	x $2000/ac
	$5,872

CONSTRUCTION COST SUMMARY

Project Description:
West Maricopa Combine Pipeline
RID alignment using Concrete Pipe
0

Pipe costs	$517,767
Earthwork	$46,611
Pump costs	$42,500
Pump Facility	$23,375
1st Subtotal	$630,253
Land (Easement fee)	$5,872
TOTAL	$636,125

ANNUAL ESTIMATED PUMPING COSTS

68% = Est. Total Pump Efficiency
$0.090 per kW hr = Electric power cost

$33,300 (annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)

Table 8. Hydraulic Parameters and Associated Construction Costs for Water Delivery
Using Concrete Pipe along the Hassayampa River for the Eighth of Eight S
Which is Located Below Interstate 10.

Project Description:
West Maricopa Combine Pipeline
RID alignment using Concrete Pipe

C= 130 (H-W friction factc
Q= 51.798 cfs
= 37,500 acre-feet per year

Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)
183.9	189.8	-70	---	---	80	63.84	27.636	71.92	31.13	---	---
188.7	194.8	-70	42	0.97	0	70.95	30.71	70.95	30.71	484	5.4
193.6	199.8	-75	42	0.97	0	74.98	32.46	74.98	32.46	484	5.4
198.4	204.8	-80	42	0.97	0	79.01	34.20	79.01	34.20	484	5.4
203.3	209.8	-80	42	0.97	0	78.04	33.78	78.04	33.78	484	5.4
208.1	214.8	-85	42	0.97	0	82.07	35.53	82.07	35.53	484	5.4
211.5	218.3	-87	42	0.68	0	83.39	36.10	83.39	36.10	339	5.4
					---					---	
	total pumping power =				80	ft				2,761	ft
					= 58.8	hp				(0.52	) miles
	total pumping power + 30% =				76.4	hp					

* - Includes the cost of furnishing and installing pipe

5 ******
6.2 ******
9.3 ******
4.2 ******
15.2 ******
26 ******
16.8 ******
14.8 ******
11.5 ******
13 ******
19 ******
1.4 672
14.5 ******
14.6 ******

Segments

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Avg. Head (psi)	Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Earthwork: Trench Excav. (cu yd)	Earthwork: Am't. of Backfill (cu yd)	Earthwork: Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)
---	---	---	---	---	$50,000	---	---	---	
30.92	43.3	50	$202.44	$98,062	$0	775	482	482	0%
31.59	44.2	50	$202.44	$98,062	$0	775	482	482	0%
33.33	46.7	50	$202.44	$98,062	$0	775	482	482	0%
33.99	47.6	50	$202.44	$98,062	$0	775	482	482	0%
34.65	48.5	50	$202.44	$98,062	$0	775	482	482	0%
35.81	50.1	50	$202.44	$68,643	$0	543	337	337	0%
				---	---	---	---	---	
				$558,953	$50,000	4,419	2,748	2,748	
						x $5.80/cy	x $1.9/cy	x $2.86/cy	
						---	---	---	
						$25,628	$5,221	$7,859	

Remove Spoil (cu yd)
1671
x $6.95/cy

$11,612

addt'l exc., bckfll & re-construct cost thru ua	Land (acres)
$0	0.6
$0	0.6
$0	0.6
$0	0.6
$0	0.6
$0	0.4
$0	3
	x $2000/ac
	$6,339

CONSTRUCTION COST SUMMARY
Project Description:
West Maricopa Combine Pipeline
RID alignment using Concrete Pipe

Pipe costs	$558,953
Earthwork	$50,319
Pump costs	$50,000
Pump Facility	$27,500
1st Subtotal	$686,772
Land (Easement fee)	$6,339
TOTAL	$693,111

ANNUAL ESTIMATED PUMPING COSTS

68% = Est. Total Pump Efficiency
$0.090 per kW hr = Electric power cost

$44,400 (annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)

Table 9. Hydraulic Parameters and Associated Construction Costs for the Main Trunk Lin
Using Concrete Pipe Along the RID Canal and Yuma Road.

Project Description:
West Maricopa Combine Main Trunk
Line Using Concrete Along the RID
Canal and Yuma Rd.

C= 130 (H-W friction facto
Q= 51.798 cfs
= 37,500 acre-feet per year

Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)
211.5	218.3	-87	---	---	0	78.04	33.784	78.04	33.78	---	---
216.3	223.3	-90	42	0.97	0	80.07	34.66	80.07	34.66	484	5.4
221.2	228.3	-86	42	0.97	0	75.10	32.51	75.10	32.51	484	5.4
226.0	233.3	-85	42	0.97	0	73.13	31.66	73.13	31.66	484	5.4
230.9	238.3	-75	42	0.97	0	62.16	26.91	62.16	26.91	484	5.4
235.7	243.3	-70	42	0.97	0	56.19	24.32	56.19	24.32	484	5.4
240.6	248.3	-60	42	0.97	0	45.22	19.57	45.22	19.57	484	5.4
245.4	253.3	-60	42	0.97	0	44.25	19.15	44.25	19.15	484	5.4
250.2	258.3	-70	42	0.97	0	53.27	23.06	53.27	23.06	484	5.4
255.1	263.3	-69	42	0.97	0	51.30	22.21	51.30	22.21	484	5.4
259.9	268.3	-67	42	0.97	0	48.33	20.92	48.33	20.92	484	5.4
264.8	273.3	-70	42	0.97	0	50.36	21.80	50.36	21.80	484	5.4
269.6	278.3	-70	42	0.97	0	49.39	21.38	49.39	21.38	484	5.4
274.5	283.3	-68	42	0.97	0	46.42	20.10	46.42	20.10	484	5.4
279.3	288.3	-68	42	0.97	0	45.45	19.68	45.45	19.68	484	5.4
284.1	293.3	-69	42	0.97	0	45.48	19.69	45.48	19.69	484	5.4
289.0	298.3	-70	42	0.97	0	45.51	19.70	45.51	19.70	484	5.4
293.8	303.3	-71	42	0.97	0	45.54	19.71	45.54	19.71	484	5.4
298.7	308.3	-69	42	0.97	0	42.57	18.43	42.57	18.43	484	5.4
303.5	313.3	-64	42	0.97	0	36.60	15.84	36.60	15.84	484	5.4
308.4	318.3	-63	42	0.97	0	34.63	14.99	34.63	14.99	484	5.4
313.2	323.3	-63	42	0.97	0	33.66	14.57	33.66	14.57	484	5.4
318.1	328.3	-65	42	0.97	0	34.68	15.01	34.68	15.01	484	5.4
322.9	333.3	-67	42	0.97	0	35.71	15.46	35.71	15.46	484	5.4
327.7	338.3	-69	42	0.97	0	36.74	15.91	36.74	15.91	484	5.4
332.6	343.3	-72	42	0.97	0	38.77	16.78	38.77	16.78	484	5.4
337.4	348.3	-75	42	0.97	0	40.80	17.66	40.80	17.66	484	5.4
342.3	353.3	-79	42	0.97	0	43.83	18.97	43.83	18.97	484	5.4
347.1	358.3	-82	42	0.97	0	45.86	19.85	45.86	19.85	484	5.4
352.0	363.3	-88	42	0.97	0	50.89	22.03	50.89	22.03	484	5.4
356.8	368.3	-91	42	0.97	0	52.92	22.91	52.92	22.91	484	5.4
361.7	373.3	-93	42	0.97	0	53.95	23.35	53.95	23.35	484	5.4
366.5	378.3	-96	42	0.97	0	55.98	24.23	55.98	24.23	484	5.4
371.3	383.3	-99	42	0.97	0	58.01	25.11	58.01	25.11	484	5.4
376.2	388.3	-100	42	0.97	0	58.04	25.12	58.04	25.12	484	5.4
381.0	393.3	-101	42	0.97	0	58.07	25.14	58.07	25.14	484	5.4
385.9	398.3	-107	42	0.97	0	63.09	27.31	63.09	27.31	484	5.4
390.7	403.3	-110	42	0.97	0	65.12	28.19	65.12	28.19	484	5.4
395.6	408.3	-112	42	0.97	0	66.15	28.64	66.15	28.64	484	5.4

400.4	413.3	-114	42	0.97	0	67.18	29.08	67.18	29.08	484	5.4
405.2	418.3	-116	42	0.97	0	68.21	29.53	68.21	29.53	484	5.4
410.1	423.3	-118	42	0.97	0	69.24	29.97	69.24	29.97	484	5.4
414.9	428.3	-120	42	0.97	0	70.27	30.42	70.27	30.42	484	5.4
419.8	433.3	-120	42	0.97	0	69.30	30.00	69.30	30.00	484	5.4
424.6	438.3	-121	42	0.97	0	69.33	30.01	69.33	30.01	484	5.4
429.5	443.3	-120	42	0.97	0	67.36	29.16	67.36	29.16	484	5.4
434.3	448.3	-121	42	0.97	0	67.39	29.17	67.39	29.17	484	5.4
439.2	453.3	-121	42	0.97	0	66.42	28.75	66.42	28.75	484	5.4
444.0	458.3	-120	42	0.97	0	64.45	27.90	64.45	27.90	484	5.4
448.8	463.3	-120	42	0.97	0	63.48	27.48	63.48	27.48	484	5.4
453.7	468.3	-120	42	0.97	0	62.50	27.06	62.50	27.06	484	5.4
458.5	473.3	-119	42	0.97	0	60.53	26.21	60.53	26.21	484	5.4
463.4	478.3	-119	42	0.97	0	59.56	25.78	59.56	25.78	484	5.4
468.2	483.3	-119	42	0.97	0	58.59	25.36	58.59	25.36	484	5.4
473.1	488.3	-119	42	0.97	0	57.62	24.94	57.62	24.94	484	5.4
477.9	493.3	-117	42	0.97	0	54.65	23.66	54.65	23.66	484	5.4
482.8	498.3	-117	42	0.97	0	53.68	23.24	53.68	23.24	484	5.4
487.6	503.3	-118	42	0.97	0	53.71	23.25	53.71	23.25	484	5.4
492.4	508.3	-118	42	0.97	0	52.74	22.83	52.74	22.83	484	5.4
497.3	513.3	-118	42	0.97	0	51.77	22.41	51.77	22.41	484	5.4
502.1	518.3	-118	42	0.97	0	50.80	21.99	50.80	21.99	484	5.4
507.0	523.3	-118	42	0.97	0	49.83	21.57	49.83	21.57	484	5.4
511.8	528.3	-118	42	0.97	0	48.86	21.15	48.86	21.15	484	5.4
516.7	533.3	-118	42	0.97	0	47.89	20.73	47.89	20.73	484	5.4
521.5	538.3	-118	42	0.97	0	46.91	20.31	46.91	20.31	484	5.4
526.3	543.3	-117	42	0.97	0	44.94	19.46	44.94	19.46	484	5.4
531.2	548.3	-117	42	0.97	0	43.97	19.04	43.97	19.04	484	5.4
536.0	553.3	-117	42	0.97	0	43.00	18.62	43.00	18.62	484	5.4
540.9	558.3	-116	42	0.97	0	41.03	17.76	41.03	17.76	484	5.4
545.7	563.3	-116	42	0.97	0	40.06	17.34	40.06	17.34	484	5.4
550.6	568.3	-116	42	0.97	0	39.09	16.92	39.09	16.92	484	5.4
555.4	573.3	-116	42	0.97	0	38.12	16.50	38.12	16.50	484	5.4
560.3	578.3	-116	42	0.97	0	37.15	16.08	37.15	16.08	484	5.4
565.1	583.3	-116	42	0.97	0	36.18	15.66	36.18	15.66	484	5.4
569.9	588.3	-115	42	0.97	0	34.21	14.81	34.21	14.81	484	5.4
574.8	593.3	-114	42	0.97	0	32.24	13.96	32.24	13.96	484	5.4
579.6	598.3	-113	42	0.97	0	30.27	13.10	30.27	13.10	484	5.4
584.5	603.3	-113	42	0.97	0	29.30	12.68	29.30	12.68	484	5.4
589.3	608.3	-113	42	0.97	0	28.32	12.26	28.32	12.26	484	5.4
594.2	613.3	-113	42	0.97	0	27.35	11.84	27.35	11.84	484	5.4
599.0	618.3	-113	42	0.97	0	26.38	11.42	26.38	11.42	484	5.4
603.9	623.3	-113	42	0.97	0	25.41	11.00	25.41	11.00	484	5.4
608.7	628.3	-113	42	0.97	0	24.44	10.58	24.44	10.58	484	5.4
613.5	633.3	-113	42	0.97	0	23.47	10.16	23.47	10.16	484	5.4
618.4	638.3	-112	42	0.97	0	21.50	9.31	21.50	9.31	484	5.4
623.2	643.3	-111	42	0.97	0	19.53	8.45	19.53	8.45	484	5.4
628.1	648.3	-111	42	0.97	0	18.56	8.03	18.56	8.03	484	5.4
632.9	653.3	-111	42	0.97	0	17.59	7.61	17.59	7.61	484	5.4
637.8	658.3	-111	42	0.97	0	16.62	7.19	16.62	7.19	484	5.4
642.6	663.3	-111	42	0.97	0	15.65	6.77	15.65	6.77	484	5.4
647.4	668.3	-111	42	0.97	0	14.68	6.35	14.68	6.35	484	5.4
652.3	673.3	-111	42	0.97	0	13.71	5.93	13.71	5.93	484	5.4
657.1	678.3	-110	42	0.97	0	11.73	5.08	11.73	5.08	484	5.4

662.0	683.3	-109	42	0.97	60	9.76	4.23	69.76	30.20	484	5.4
666.8	688.3	-109	42	0.97	0	68.79	29.78	68.79	29.78	484	5.4
671.7	693.3	-109	42	0.97	0	67.82	29.36	67.82	29.36	484	5.4
676.5	698.3	-109	42	0.97	0	66.85	28.94	66.85	28.94	484	5.4
681.4	703.3	-109	42	0.97	0	65.88	28.52	65.88	28.52	484	5.4
686.2	708.3	-109	42	0.97	0	64.91	28.10	64.91	28.10	484	5.4
691.0	713.3	-109	42	0.97	0	63.94	27.68	63.94	27.68	484	5.4
695.9	718.3	-109	42	0.97	0	62.97	27.26	62.97	27.26	484	5.4
700.7	723.3	-109	42	0.97	0	62.00	26.84	62.00	26.84	484	5.4
705.6	728.3	-109	42	0.97	0	61.03	26.42	61.03	26.42	484	5.4
710.4	733.3	-109	42	0.97	0	60.06	26.00	60.06	26.00	484	5.4
715.3	738.3	-109	42	0.97	0	59.09	25.58	59.09	25.58	484	5.4
720.1	743.3	-109	42	0.97	0	58.12	25.16	58.12	25.16	484	5.4
725.0	748.3	-109	42	0.97	0	57.14	24.74	57.14	24.74	484	5.4
729.8	753.3	-109	42	0.97	0	56.17	24.32	56.17	24.32	484	5.4
734.6	758.3	-109	42	0.97	0	55.20	23.90	55.20	23.90	484	5.4
739.5	763.3	-109	42	0.97	0	54.23	23.48	54.23	23.48	484	5.4
744.3	768.3	-109	42	0.97	0	53.26	23.06	53.26	23.06	484	5.4
749.2	773.3	-109	42	0.97	0	52.29	22.64	52.29	22.64	484	5.4
754.0	778.3	-109	42	0.97	0	51.32	22.22	51.32	22.22	484	5.4
758.9	783.3	-109	42	0.97	0	50.35	21.80	50.35	21.80	484	5.4
763.7	788.3	-108	42	0.97	0	48.38	20.94	48.38	20.94	484	5.4
768.5	793.3	-107	42	0.97	0	46.41	20.09	46.41	20.09	484	5.4
773.4	798.3	-106	42	0.97	0	44.44	19.24	44.44	19.24	484	5.4
778.2	803.3	-106	42	0.97	0	43.47	18.82	43.47	18.82	484	5.4
783.1	808.3	-106	42	0.97	0	42.50	18.40	42.50	18.40	484	5.4
787.9	813.3	-106	42	0.97	0	41.53	17.98	41.53	17.98	484	5.4
792.8	818.3	-106	42	0.97	0	40.55	17.56	40.55	17.56	484	5.4
797.6	823.3	-106	42	0.97	0	39.58	17.14	39.58	17.14	484	5.4
802.5	828.3	-106	42	0.97	0	38.61	16.72	38.61	16.72	484	5.4
807.3	833.3	-106	42	0.97	0	37.64	16.30	37.64	16.30	484	5.4
812.1	838.3	-106	42	0.97	0	36.67	15.88	36.67	15.88	484	5.4
817.0	843.3	-106	42	0.97	0	35.70	15.45	35.70	15.45	484	5.4
821.8	848.3	-105	42	0.97	0	33.73	14.60	33.73	14.60	484	5.4
826.7	853.3	-105	42	0.97	0	32.76	14.18	32.76	14.18	484	5.4
831.5	858.3	-105	42	0.97	0	31.79	13.76	31.79	13.76	484	5.4
836.4	863.3	-105	42	0.97	0	30.82	13.34	30.82	13.34	484	5.4
841.2	868.3	-105	42	0.97	0	29.85	12.92	29.85	12.92	484	5.4
846.1	873.3	-105	42	0.97	0	28.88	12.50	28.88	12.50	484	5.4
850.9	878.3	-105	42	0.97	0	27.91	12.08	27.91	12.08	484	5.4
855.7	883.3	-105	42	0.97	0	26.94	11.66	26.94	11.66	484	5.4
860.6	888.3	-105	42	0.97	0	25.96	11.24	25.96	11.24	484	5.4
865.4	893.3	-105	42	0.97	0	24.99	10.82	24.99	10.82	484	5.4
870.3	898.3	-105	42	0.97	0	24.02	10.40	24.02	10.40	484	5.4
875.1	903.3	-104	42	0.97	0	22.05	9.55	22.05	9.55	484	5.4
880.0	908.3	-104	42	0.97	0	21.08	9.13	21.08	9.13	484	5.4
884.8	913.3	-104	42	0.97	0	20.11	8.71	20.11	8.71	484	5.4
889.6	918.3	-104	42	0.97	0	19.14	8.29	19.14	8.29	484	5.4
894.5	923.3	-104	42	0.97	0	18.17	7.87	18.17	7.87	484	5.4
899.3	928.3	-104	42	0.97	0	17.20	7.45	17.20	7.45	484	5.4
904.2	933.3	-101	42	0.97	0	13.23	5.73	13.23	5.73	484	5.4
909.0	938.3	-103	42	0.97	0	14.26	6.17	14.26	6.17	484	5.4
913.9	943.3	-103	42	0.97	0	13.29	5.75	13.29	5.75	484	5.4
918.7	948.3	-103	42	0.97	0	12.32	5.33	12.32	5.33	484	5.4

923.6	953.3	-100	42	0.97	65	8.35	3.61	73.35	31.75	484	5.4
928.4	958.3	-100	42	0.97	0	72.37	31.33	72.37	31.33	484	5.4
933.2	963.3	-102	42	0.97	0	73.40	31.78	73.40	31.78	484	5.4
938.1	968.3	-101	42	0.97	0	71.43	30.92	71.43	30.92	484	5.4
942.9	973.3	-101	42	0.97	0	70.46	30.50	70.46	30.50	484	5.4
947.8	978.3	-101	42	0.97	0	69.49	30.08	69.49	30.08	484	5.4
952.6	983.3	-101	42	0.97	0	68.52	29.66	68.52	29.66	484	5.4
957.5	988.3	-101	42	0.97	0	67.55	29.24	67.55	29.24	484	5.4
962.3	993.3	-101	42	0.97	0	66.58	28.82	66.58	28.82	484	5.4
967.2	998.3	-101	42	0.97	0	65.61	28.40	65.61	28.40	484	5.4
972.0	1003.3	-100	42	0.97	0	63.64	27.55	63.64	27.55	484	5.4
976.8	1008.3	-101	42	0.97	0	63.67	27.56	63.67	27.56	484	5.4
981.7	1013.3	-102	42	0.97	0	63.70	27.57	63.70	27.57	484	5.4
986.5	1018.3	-103	42	0.97	0	63.73	27.59	63.73	27.59	484	5.4
991.4	1023.3	-103	42	0.97	0	62.76	27.17	62.76	27.17	484	5.4
996.2	1028.3	-104	42	0.97	0	62.78	27.18	62.78	27.18	484	5.4
1001.1	1033.3	-104	42	0.97	0	61.81	26.76	61.81	26.76	484	5.4
1005.9	1038.3	-103	42	0.97	0	59.84	25.91	59.84	25.91	484	5.4
1010.7	1043.3	-100	42	0.97	0	55.87	24.19	55.87	24.19	484	5.4
1015.6	1048.3	-103	42	0.97	0	57.90	25.07	57.90	25.07	484	5.4
1020.4	1053.3	-104	42	0.97	0	57.93	25.08	57.93	25.08	484	5.4
1025.3	1058.3	-104	42	0.97	0	56.96	24.66	56.96	24.66	484	5.4
1030.1	1063.3	-104	42	0.97	0	55.99	24.24	55.99	24.24	484	5.4
1035.0	1068.3	-103	42	0.97	0	54.02	23.38	54.02	23.38	484	5.4
1039.8	1073.3	-103	42	0.97	0	53.05	22.96	53.05	22.96	484	5.4
1044.7	1078.3	-103	42	0.97	0	52.08	22.54	52.08	22.54	484	5.4
1049.5	1083.3	-103	42	0.97	0	51.11	22.12	51.11	22.12	484	5.4
1054.3	1088.3	-103	42	0.97	0	50.14	21.70	50.14	21.70	484	5.4
1059.2	1093.3	-101	42	0.97	0	47.17	20.42	47.17	20.42	484	5.4
1064.0	1098.3	-103	42	0.97	0	48.19	20.86	48.19	20.86	484	5.4
1068.9	1103.3	-101	42	0.97	0	45.22	19.58	45.22	19.58	484	5.4
1073.7	1108.3	-100	42	0.97	0	43.25	18.72	43.25	18.72	484	5.4
1078.6	1113.3	-99	42	0.97	0	41.28	17.87	41.28	17.87	484	5.4
1083.4	1118.3	-98	42	0.97	0	39.31	17.02	39.31	17.02	484	5.4
1088.3	1123.3	-98	42	0.97	0	38.34	16.60	38.34	16.60	484	5.4
1093.1	1128.3	-98	42	0.97	0	37.37	16.18	37.37	16.18	484	5.4
1097.9	1133.3	-98	42	0.97	0	36.40	15.76	36.40	15.76	484	5.4
1102.8	1138.3	-98	42	0.97	0	35.43	15.34	35.43	15.34	484	5.4
1107.6	1143.3	-99	42	0.97	0	35.46	15.35	35.46	15.35	484	5.4
1112.5	1148.3	-101	42	0.97	0	36.49	15.80	36.49	15.80	484	5.4
1117.3	1153.3	-102	42	0.97	0	36.52	15.81	36.52	15.81	484	5.4
1122.2	1158.3	-103	42	0.97	0	36.55	15.82	36.55	15.82	484	5.4
1127.0	1163.3	-104	42	0.97	0	36.58	15.83	36.58	15.83	484	5.4
1131.8	1168.3	-105	42	0.97	0	36.60	15.85	36.60	15.85	484	5.4
1136.7	1173.3	-107	42	0.97	0	37.63	16.29	37.63	16.29	484	5.4
1141.5	1178.3	-110	42	0.97	0	39.66	17.17	39.66	17.17	484	5.4
1146.4	1183.3	-111	42	0.97	0	39.69	17.18	39.69	17.18	484	5.4
1151.2	1188.3	-112	42	0.97	0	39.72	17.20	39.72	17.20	484	5.4
1156.1	1193.3	-113	42	0.97	0	39.75	17.21	39.75	17.21	484	5.4
1160.9	1198.3	-114	42	0.97	0	39.78	17.22	39.78	17.22	484	5.4
1165.8	1203.3	-115	42	0.97	0	39.81	17.23	39.81	17.23	484	5.4
1170.6	1208.3	-116	42	0.97	0	39.84	17.25	39.84	17.25	484	5.4
1175.4	1213.3	-117	42	0.97	0	39.87	17.26	39.87	17.26	484	5.4
1180.3	1218.3	-118	42	0.97	0	39.90	17.27	39.90	17.27	484	5.4

1185.1	1223.3	-119	42	0.97	0	39.93	17.28	39.93	17.28	484	5.4
1190.0	1228.3	-120	42	0.97	0	39.96	17.30	39.96	17.30	484	5.4
1194.8	1233.3	-121	42	0.97	0	39.99	17.31	39.99	17.31	484	5.4
1199.7	1238.3	-122	42	0.97	0	40.01	17.32	40.01	17.32	484	5.4
1204.5	1243.3	-123	42	0.97	0	40.04	17.34	40.04	17.34	484	5.4
1209.4	1248.3	-124	42	0.97	0	40.07	17.35	40.07	17.35	484	5.4
1214.2	1253.3	-125	42	0.97	0	40.10	17.36	40.10	17.36	484	5.4
1219.0	1258.3	-127	42	0.97	0	41.13	17.81	41.13	17.81	484	5.4
1223.9	1263.3	-128	42	0.97	0	41.16	17.82	41.16	17.82	484	5.4
1228.7	1268.3	-130	42	0.97	0	42.19	18.26	42.19	18.26	484	5.4
1233.6	1273.3	-130	42	0.97	0	41.22	17.84	41.22	17.84	484	5.4
1238.4	1278.3	-127	42	0.97	0	37.25	16.13	37.25	16.13	484	5.4
1243.3	1283.3	-124	42	0.97	0	33.28	14.41	33.28	14.41	484	5.4
1248.1	1288.3	-125	42	0.97	0	33.31	14.42	33.31	14.42	484	5.4
1252.9	1293.3	-126	42	0.97	0	33.34	14.43	33.34	14.43	484	5.4
1257.8	1298.3	-125	42	0.97	0	31.37	13.58	31.37	13.58	484	5.4
1262.6	1303.3	-125	42	0.97	0	30.40	13.16	30.40	13.16	484	5.4
1267.5	1308.3	-125	42	0.97	0	29.42	12.74	29.42	12.74	484	5.4
1272.3	1313.3	-126	42	0.97	0	29.45	12.75	29.45	12.75	484	5.4
1277.2	1318.3	-127	42	0.97	0	29.48	12.76	29.48	12.76	484	5.4
1282.0	1323.3	-128	42	0.97	0	29.51	12.78	29.51	12.78	484	5.4
1286.9	1328.3	-129	42	0.97	0	29.54	12.79	29.54	12.79	484	5.4
1291.7	1333.3	-132	42	0.97	0	31.57	13.67	31.57	13.67	484	5.4
1296.5	1338.3	-134	42	0.97	0	32.60	14.11	32.60	14.11	484	5.4
1301.4	1343.3	-135	42	0.97	0	32.63	14.13	32.63	14.13	484	5.4
1306.2	1348.3	-136	42	0.97	0	32.66	14.14	32.66	14.14	484	5.4
1311.1	1353.3	-136	42	0.97	0	31.69	13.72	31.69	13.72	484	5.4
1315.9	1358.3	-137	42	0.97	0	31.72	13.73	31.72	13.73	484	5.4
1320.8	1363.3	-137	42	0.97	0	30.75	13.31	30.75	13.31	484	5.4
1325.6	1368.3	-137	42	0.97	0	29.78	12.89	29.78	12.89	484	5.4
1330.5	1373.3	-137	42	0.97	0	28.81	12.47	28.81	12.47	484	5.4
1335.3	1378.3	-135	42	0.97	0	25.83	11.18	25.83	11.18	484	5.4
1340.1	1383.3	-130	42	0.97	0	19.86	8.60	19.86	8.60	484	5.4
1345.0	1388.3	-128	42	0.97	0	16.89	7.31	16.89	7.31	484	5.4
1349.8	1393.3	-127	42	0.97	0	14.92	6.46	14.92	6.46	484	5.4
1354.7	1398.3	-128	42	0.97	0	14.95	6.47	14.95	6.47	484	5.4
1357.0	1400.7	-128	42	0.47	0	14.49	6.27	14.49	6.27	233	5.4

total pumping power = 125 ft 114,551 ft

= 734.9 hp (21.70) miles

* - Includes the cost of furnishing and installing pipe

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Avg. Head (psi)	Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Earthwork: Trench Excav. (cu yd)	Earthwork: Am't. of Backfill (cu yd)	Earthwork: Compact Backfill (cu yd)	Earthwork: estimate % of exc./bkfll thru urban areas (ua)
---	---	---	---	---	$0	---	---	---	
34.22	47.9	50	$202.44	$98,062	$0	775	482	482	0%
33.59	47.0	50	$202.44	$98,062	$0	775	482	482	0%
32.08	44.9	50	$202.44	$98,062	$0	775	482	482	0%
29.28	41.0	50	$202.44	$98,062	$0	775	482	482	0%
25.62	35.9	35	$202.44	$98,062	$0	775	482	482	0%
21.95	30.7	35	$202.44	$98,062	$0	775	482	482	0%
19.36	27.1	35	$202.44	$98,062	$0	775	482	482	0%
21.11	29.6	35	$202.44	$98,062	$0	775	482	482	0%
22.64	31.7	35	$202.44	$98,062	$0	775	482	482	0%
21.57	30.2	35	$202.44	$98,062	$0	775	482	482	0%
21.36	29.9	35	$202.44	$98,062	$0	775	482	482	0%
21.59	30.2	35	$202.44	$98,062	$0	775	482	482	0%
20.74	29.0	35	$202.44	$98,062	$0	775	482	482	0%
19.89	27.8	35	$202.44	$98,062	$0	775	482	482	0%
19.68	27.6	35	$202.44	$98,062	$0	775	482	482	0%
19.69	27.6	35	$202.44	$98,062	$0	775	482	482	0%
19.71	27.6	35	$202.44	$98,062	$0	775	482	482	0%
19.07	26.7	35	$202.44	$98,062	$0	775	482	482	0%
17.13	24.0	35	$202.44	$98,062	$0	775	482	482	0%
15.42	21.6	35	$202.44	$98,062	$0	775	482	482	0%
14.78	20.7	20	$202.44	$98,062	$0	775	482	482	0%
14.79	20.7	20	$202.44	$98,062	$0	775	482	482	0%
15.24	21.3	35	$202.44	$98,062	$0	775	482	482	0%
15.68	22.0	35	$202.44	$98,062	$0	775	482	482	0%
16.35	22.9	35	$202.44	$98,062	$0	775	482	482	0%
17.22	24.1	35	$202.44	$98,062	$0	775	482	482	0%
18.32	25.6	35	$202.44	$98,062	$0	775	482	482	0%
19.41	27.2	35	$202.44	$98,062	$0	775	482	482	0%
20.94	29.3	35	$202.44	$98,062	$0	775	482	482	0%
22.47	31.5	35	$202.44	$98,062	$0	775	482	482	0%
23.13	32.4	35	$202.44	$98,062	$0	775	482	482	0%
23.79	33.3	35	$202.44	$98,062	$0	775	482	482	0%
24.67	34.5	35	$202.44	$98,062	$0	775	482	482	0%
25.12	35.2	35	$202.44	$98,062	$0	775	482	482	0%
25.13	35.2	35	$202.44	$98,062	$0	775	482	482	0%
26.22	36.7	50	$202.44	$98,062	$0	775	482	482	0%
27.75	38.9	50	$202.44	$98,062	$0	775	482	482	0%
28.41	39.8	50	$202.44	$98,062	$0	775	482	482	0%

28.86	40.4	50	$202.44	$98,062	$0	775	482	482	0%
29.31	41.0	50	$202.44	$98,062	$0	775	482	482	0%
29.75	41.7	50	$202.44	$98,062	$0	775	482	482	0%
30.20	42.3	50	$202.44	$98,062	$0	775	482	482	0%
30.21	42.3	50	$202.44	$98,062	$0	775	482	482	0%
30.01	42.0	50	$202.44	$98,062	$0	775	482	482	0%
29.59	41.4	50	$202.44	$98,062	$0	775	482	482	0%
29.17	40.8	50	$202.44	$98,062	$0	775	482	482	0%
28.96	40.5	50	$202.44	$98,062	$0	775	482	482	0%
28.33	39.7	50	$202.44	$98,062	$0	775	482	482	0%
27.69	38.8	50	$202.44	$98,062	$0	775	482	482	0%
27.27	38.2	50	$202.44	$98,062	$0	775	482	482	0%
26.63	37.3	50	$202.44	$98,062	$0	775	482	482	0%
25.99	36.4	50	$202.44	$98,062	$0	775	482	482	0%
25.57	35.8	35	$202.44	$98,062	$0	775	482	482	0%
25.15	35.2	35	$202.44	$98,062	$0	775	482	482	0%
24.30	34.0	35	$202.44	$98,062	$0	775	482	482	0%
23.45	32.8	35	$202.44	$98,062	$0	775	482	482	0%
23.24	32.5	35	$202.44	$98,062	$0	775	482	482	0%
23.04	32.3	35	$202.44	$98,062	$0	775	482	482	0%
22.62	31.7	35	$202.44	$98,062	$0	775	482	482	0%
22.20	31.1	35	$202.44	$98,062	$0	775	482	482	0%
21.78	30.5	35	$202.44	$98,062	$0	775	482	482	0%
21.36	29.9	35	$202.44	$98,062	$0	775	482	482	0%
20.94	29.3	35	$202.44	$98,062	$0	775	482	482	0%
20.52	28.7	35	$202.44	$98,062	$0	775	482	482	0%
19.88	27.8	35	$202.44	$98,062	$0	775	482	482	0%
19.25	26.9	35	$202.44	$98,062	$0	775	482	482	0%
18.83	26.4	35	$202.44	$98,062	$0	775	482	482	0%
18.19	25.5	35	$202.44	$98,062	$0	775	482	482	0%
17.55	24.6	35	$202.44	$98,062	$0	775	482	482	0%
17.13	24.0	35	$202.44	$98,062	$0	775	482	482	0%
16.71	23.4	35	$202.44	$98,062	$0	775	482	482	0%
16.29	22.8	35	$202.44	$98,062	$0	775	482	482	0%
15.87	22.2	35	$202.44	$98,062	$0	775	482	482	0%
15.23	21.3	35	$202.44	$98,062	$0	775	482	482	0%
14.38	20.1	20	$202.44	$98,062	$0	775	482	482	0%
13.53	18.9	20	$202.44	$98,062	$0	775	482	482	0%
12.89	18.0	20	$202.44	$98,062	$0	775	482	482	0%
12.47	17.5	20	$202.44	$98,062	$0	775	482	482	0%
12.05	16.9	20	$202.44	$98,062	$0	775	482	482	0%
11.63	16.3	20	$202.44	$98,062	$0	775	482	482	0%
11.21	15.7	20	$202.44	$98,062	$0	775	482	482	0%
10.79	15.1	20	$202.44	$98,062	$0	775	482	482	0%
10.37	14.5	20	$202.44	$98,062	$0	775	482	482	0%
9.73	13.6	20	$202.44	$98,062	$0	775	482	482	0%
8.88	12.4	20	$202.44	$98,062	$0	775	482	482	0%
8.24	11.5	20	$202.44	$98,062	$0	775	482	482	0%
7.82	11.0	20	$202.44	$98,062	$0	775	482	482	0%
7.40	10.4	20	$202.44	$98,062	$0	775	482	482	0%
6.98	9.8	20	$202.44	$98,062	$0	775	482	482	0%
6.56	9.2	20	$202.44	$98,062	$0	775	482	482	0%
6.14	8.6	20	$202.44	$98,062	$0	775	482	482	0%
5.51	7.7	20	$202.44	$98,062	$0	775	482	482	0%

4.65	6.5	20	$202.44	$98,062	$48,000	775	482	482	0%
29.99	42.0	50	$202.44	$98,062	$0	775	482	482	0%
29.57	41.4	50	$202.44	$98,062	$0	775	482	482	0%
29.15	40.8	50	$202.44	$98,062	$0	775	482	482	0%
28.73	40.2	50	$202.44	$98,062	$0	775	482	482	0%
28.31	39.6	50	$202.44	$98,062	$0	775	482	482	0%
27.89	39.0	50	$202.44	$98,062	$0	775	482	482	0%
27.47	38.5	50	$202.44	$98,062	$0	775	482	482	0%
27.05	37.9	50	$202.44	$98,062	$0	775	482	482	0%
26.63	37.3	50	$202.44	$98,062	$0	775	482	482	0%
26.21	36.7	50	$202.44	$98,062	$0	775	482	482	0%
25.79	36.1	50	$202.44	$98,062	$0	775	482	482	0%
25.37	35.5	35	$202.44	$98,062	$0	775	482	482	0%
24.95	34.9	35	$202.44	$98,062	$0	775	482	482	0%
24.53	34.3	35	$202.44	$98,062	$0	775	482	482	0%
24.11	33.8	35	$202.44	$98,062	$0	775	482	482	0%
23.69	33.2	35	$202.44	$98,062	$0	775	482	482	0%
23.27	32.6	35	$202.44	$98,062	$0	775	482	482	0%
22.85	32.0	35	$202.44	$98,062	$0	775	482	482	0%
22.43	31.4	35	$202.44	$98,062	$0	775	482	482	0%
22.01	30.8	35	$202.44	$98,062	$0	775	482	482	0%
21.37	29.9	35	$202.44	$98,062	$0	775	482	482	0%
20.52	28.7	35	$202.44	$98,062	$0	775	482	482	0%
19.66	27.5	35	$202.44	$98,062	$0	775	482	482	0%
19.03	26.6	35	$202.44	$98,062	$0	775	482	482	0%
18.61	26.0	35	$202.44	$98,062	$0	775	482	482	0%
18.19	25.5	35	$202.44	$98,062	$0	775	482	482	0%
17.77	24.9	35	$202.44	$98,062	$0	775	482	482	0%
17.35	24.3	35	$202.44	$98,062	$0	775	482	482	0%
16.93	23.7	35	$202.44	$98,062	$0	775	482	482	0%
16.51	23.1	35	$202.44	$98,062	$0	775	482	482	0%
16.09	22.5	35	$202.44	$98,062	$0	775	482	482	0%
15.67	21.9	35	$202.44	$98,062	$0	775	482	482	0%
15.03	21.0	35	$202.44	$98,062	$0	775	482	482	0%
14.39	20.1	20	$202.44	$98,062	$0	775	482	482	0%
13.97	19.6	20	$202.44	$98,062	$0	775	482	482	0%
13.55	19.0	20	$202.44	$98,062	$0	775	482	482	0%
13.13	18.4	20	$202.44	$98,062	$0	775	482	482	0%
12.71	17.8	20	$202.44	$98,062	$0	775	482	482	0%
12.29	17.2	20	$202.44	$98,062	$0	775	482	482	0%
11.87	16.6	20	$202.44	$98,062	$0	775	482	482	0%
11.45	16.0	20	$202.44	$98,062	$0	775	482	482	0%
11.03	15.4	20	$202.44	$98,062	$0	775	482	482	0%
10.61	14.9	20	$202.44	$98,062	$0	775	482	482	0%
9.97	14.0	20	$202.44	$98,062	$0	775	482	482	0%
9.34	13.1	20	$202.44	$98,062	$0	775	482	482	0%
8.92	12.5	20	$202.44	$98,062	$0	775	482	482	0%
8.50	11.9	20	$202.44	$98,062	$0	775	482	482	0%
8.08	11.3	20	$202.44	$98,062	$0	775	482	482	0%
7.66	10.7	20	$202.44	$98,062	$0	775	482	482	0%
6.59	9.2	20	$202.44	$98,062	$0	775	482	482	0%
5.95	8.3	20	$202.44	$98,062	$0	775	482	482	0%
5.96	8.3	20	$202.44	$98,062	$0	775	482	482	0%
5.54	7.8	20	$202.44	$98,062	$0	775	482	482	0%

4.47	6.3	20	$202.44	$98,062	$50,000	775	482	482	0%
31.54	44.2	50	$202.44	$98,062	$0	775	482	482	0%
31.55	44.2	50	$202.44	$98,062	$0	775	482	482	0%
31.35	43.9	50	$202.44	$98,062	$0	775	482	482	0%
30.71	43.0	50	$202.44	$98,062	$0	775	482	482	0%
30.29	42.4	50	$202.44	$98,062	$0	775	482	482	0%
29.87	41.8	50	$202.44	$98,062	$0	775	482	482	0%
29.45	41.2	50	$202.44	$98,062	$0	775	482	482	0%
29.03	40.6	50	$202.44	$98,062	$0	775	482	482	0%
28.61	40.1	50	$202.44	$98,062	$0	775	482	482	0%
27.98	39.2	50	$202.44	$98,062	$0	775	482	482	0%
27.56	38.6	50	$202.44	$98,062	$0	775	482	482	0%
27.57	38.6	50	$202.44	$98,062	$0	775	482	482	0%
27.58	38.6	50	$202.44	$98,062	$0	775	482	482	0%
27.38	38.3	50	$202.44	$98,062	$0	775	482	482	0%
27.17	38.0	50	$202.44	$98,062	$0	775	482	482	0%
26.97	37.8	50	$202.44	$98,062	$0	775	482	482	0%
26.33	36.9	50	$202.44	$98,062	$0	775	482	482	0%
25.05	35.1	35	$202.44	$98,062	$0	775	482	482	0%
24.63	34.5	35	$202.44	$98,062	$0	775	482	482	0%
25.07	35.1	35	$202.44	$98,062	$0	775	482	482	0%
24.87	34.8	35	$202.44	$98,062	$0	775	482	482	0%
24.45	34.2	35	$202.44	$98,062	$0	775	482	482	0%
23.81	33.3	35	$202.44	$98,062	$0	775	482	482	0%
23.17	32.4	35	$202.44	$98,062	$0	775	482	482	0%
22.75	31.9	35	$202.44	$98,062	$0	775	482	482	0%
22.33	31.3	35	$202.44	$98,062	$0	775	482	482	0%
21.91	30.7	35	$202.44	$98,062	$0	775	482	482	0%
21.06	29.5	35	$202.44	$98,062	$0	775	482	482	0%
20.64	28.9	35	$202.44	$98,062	$0	775	482	482	0%
20.22	28.3	35	$202.44	$98,062	$0	775	482	482	0%
19.15	26.8	35	$202.44	$98,062	$0	775	482	482	0%
18.30	25.6	35	$202.44	$98,062	$0	775	482	482	0%
17.44	24.4	35	$202.44	$98,062	$0	775	482	482	0%
16.81	23.5	35	$202.44	$98,062	$0	775	482	482	0%
16.39	22.9	35	$202.44	$98,062	$0	775	482	482	0%
15.97	22.4	35	$202.44	$98,062	$0	775	482	482	0%
15.55	21.8	35	$202.44	$98,062	$0	775	482	482	0%
15.34	21.5	35	$202.44	$98,062	$0	775	482	482	0%
15.57	21.8	35	$202.44	$98,062	$0	775	572	482	100%
15.80	22.1	35	$202.44	$98,062	$0	775	572	482	100%
15.81	22.1	35	$202.44	$98,062	$0	775	572	482	100%
15.83	22.2	35	$202.44	$98,062	$0	775	572	482	100%
15.84	22.2	35	$202.44	$98,062	$0	775	572	482	100%
16.07	22.5	35	$202.44	$98,062	$0	775	572	482	100%
16.73	23.4	35	$202.44	$98,062	$0	775	572	482	100%
17.18	24.0	35	$202.44	$98,062	$0	775	572	482	100%
17.19	24.1	35	$202.44	$98,062	$0	775	572	482	100%
17.20	24.1	35	$202.44	$98,062	$0	775	572	482	100%
17.21	24.1	35	$202.44	$98,062	$0	775	572	482	100%
17.23	24.1	35	$202.44	$98,062	$0	775	572	482	100%
17.24	24.1	35	$202.44	$98,062	$0	775	572	482	100%
17.25	24.2	35	$202.44	$98,062	$0	775	572	482	100%
17.27	24.2	35	$202.44	$98,062	$0	775	572	482	100%

17.28	24.2	35	$202.44	$98,062	$0	775	572	482	100%
17.29	24.2	35	$202.44	$98,062	$0	775	572	482	100%
17.30	24.2	35	$202.44	$98,062	$0	775	572	482	100%
17.32	24.2	35	$202.44	$98,062	$0	775	572	482	100%
17.33	24.3	35	$202.44	$98,062	$0	775	572	482	100%
17.34	24.3	35	$202.44	$98,062	$0	775	572	482	100%
17.35	24.3	35	$202.44	$98,062	$0	775	572	482	100%
17.58	24.6	35	$202.44	$98,062	$0	775	572	482	100%
17.81	24.9	35	$202.44	$98,062	$0	775	572	482	100%
18.04	25.3	35	$202.44	$98,062	$0	775	572	482	100%
18.05	25.3	35	$202.44	$98,062	$0	775	572	482	100%
16.98	23.8	35	$202.44	$98,062	$0	775	572	482	100%
15.27	21.4	35	$202.44	$98,062	$0	775	572	482	100%
14.41	20.2	20	$202.44	$98,062	$0	775	572	482	100%
14.43	20.2	20	$202.44	$98,062	$0	775	572	482	100%
14.00	19.6	20	$202.44	$98,062	$0	775	572	482	100%
13.37	18.7	20	$202.44	$98,062	$0	775	572	482	100%
12.95	18.1	20	$202.44	$98,062	$0	775	572	482	100%
12.74	17.8	20	$202.44	$98,062	$0	775	572	482	100%
12.76	17.9	20	$202.44	$98,062	$0	775	572	482	100%
12.77	17.9	20	$202.44	$98,062	$0	775	572	482	100%
12.78	17.9	20	$202.44	$98,062	$0	775	572	482	100%
13.23	18.5	20	$202.44	$98,062	$0	775	572	482	100%
13.89	19.4	20	$202.44	$98,062	$0	775	572	482	100%
14.12	19.8	20	$202.44	$98,062	$0	775	572	482	100%
14.13	19.8	20	$202.44	$98,062	$0	775	572	482	100%
13.93	19.5	20	$202.44	$98,062	$0	775	572	482	100%
13.72	19.2	20	$202.44	$98,062	$0	775	572	482	100%
13.52	18.9	20	$202.44	$98,062	$0	775	572	482	100%
13.10	18.3	20	$202.44	$98,062	$0	775	572	482	100%
12.68	17.8	20	$202.44	$98,062	$0	775	572	482	100%
11.83	16.6	20	$202.44	$98,062	$0	775	572	482	100%
9.89	13.8	20	$202.44	$98,062	$0	775	572	482	100%
7.96	11.1	20	$202.44	$98,062	$0	775	572	482	100%
6.89	9.6	20	$202.44	$98,062	$0	775	572	482	100%
6.47	9.1	20	$202.44	$98,062	$0	775	572	482	100%
6.37	8.9	20	$202.44	$47,070	$0	372	275	231	100%
				$23,189,687	$98,000	183,316	118,650	113,997	
						x $5.80/cy	x $1.9/cy	x $2.86/cy	
						$1,063,231	$225,436	$326,033	

Remove Spoil (cu yd)	
64,665	mobilizing:
x $6.95/cy	RID x-ing:*
$449,423	6 canals:**
	combined other util's:
	TOTAL UTILITIES:

* - 42" pipe costs $280,000 per 290-ft
** - estimate of 42" pipe costs $140,0

addt'l exc., bckfll & re-construct cost thru ua	Land (acres)

$0	0.6
$0	0.6
$0	0.6
$0	0.6
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CONSTRUCTION COST SUMMARY

Project Description:
West Maricopa Combine Main Trunk Line Using Concrete Along the RID

Pipe costs	$23,189,687
Earthwork	$4,454,094
Pump costs	$98,000
Pump Facility	$2,432,600

1st Subtotal	$30,174,380
Land (Easement fee)	$231,258

TOTAL	$30,405,638

ANNUAL ESTIMATED PUMPING COSTS

68%	= Est. Total Pump Efficiency
$0.090	per kW hr = Electric power cost
$426,911	(annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)

$0	0.6
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$22,318	0.6	
$22,318	0.6	
$22,318	0.6	
$10,713	0.3	
------------	----------------	
$1,148,917	131	acres
	23.4	ac; Hassayampa area
	79.5	ac; RID alignment
	29.2	ac; along Yuma rd.
	$35,029	$1,500/ac - Hassayampa area
	$79,510	$1,000/ac - RID
	$116,719	$4,000/ac - along Yuma
$240,000	$231,258	Total Easement Cost
$223,000		
$456,300		
$321,755		
$1,241,055		

t of length to jack and bore

00 per 290-ft length to bore for smaller canals

Table 10. Hydraulic Parameters and Associated Construction Costs for Water Delivery North of the RID Canal to Interstate 10 Using HDPE pipe along Miller Road from the Main Trunk Line in Order to Deliver a Maximum of 4,225 acre-feet per y

Project Description:
West Maricopa Combine Pipeline RID
Alignment Using HDPE Pipe for the
Miller Road Lateral (North Segment)

C= 130 (H-W friction factor)
Q= 5.836 cfs
= 4,225 acre-feet per year

Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)	Avg. Head (psi)
0.0	0.0	994	---	---	80	41.52	17.974	121.52	52.61	---	---	---
4.8	5.0	998	16	1.87	0	115.65	50.06	115.65	50.06	484	4.2	51.34
9.7	10.0	1003	16	1.87	0	108.78	47.09	108.78	47.09	484	4.2	48.58
14.5	15.0	1008	16	1.87	0	101.91	44.11	101.91	44.11	484	4.2	45.60
19.4	20.0	1013	16	1.87	80	95.03	41.14	175.03	75.77	484	4.2	42.63
24.2	25.0	1018	16	1.87	0	168.16	72.80	168.16	72.80	484	4.2	74.28
29.1	30.0	1022	16	1.87	0	162.29	70.26	162.29	70.26	484	4.2	71.53
33.9	35.0	1029	16	1.87	0	153.42	66.42	153.42	66.42	484	4.2	68.34
38.8	40.0	1034	16	1.87	0	146.55	63.44	146.55	63.44	484	4.2	64.93
43.6	45.0	1040	16	1.87	0	138.68	60.03	138.68	60.03	484	4.2	61.74
48.4	50.0	1046	16	1.87	0	130.80	56.63	130.80	56.63	484	4.2	58.33
53.3	55.0	1053	16	1.87	0	121.93	52.78	121.93	52.78	484	4.2	54.71
58.1	60.0	1059	16	1.87	0	114.06	49.38	114.06	49.38	484	4.2	51.08
63.0	65.0	1063	16	1.87	0	108.19	46.84	108.19	46.84	484	4.2	48.11
67.8	70.0	1070	16	1.87	0	99.32	43.00	99.32	43.00	484	4.2	44.92
70.7	73.0	1075	16	1.12	0	93.20	40.34	93.20	40.34	291	4.2	41.67
					---					---		
total pumping power =					160	ft				7,072	ft	
					= 106.0	hp				(1.34	) miles	

* - Includes the cost of furnishing and installing pipe

15.2	7296
26	********
16.8	8064
14.8	7104
11.5	5520
13	6240
19	9120
1.4	672
14.5	6960
14.6	7008

/ear.

Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Earthwork: Trench Excav. (cu yd)	Earthwork: Am't. of Backfill (cu yd)	Earthwork: Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)
---	---	---	---	$10,750	---	---	---	
71.9	80	$47.40	$22,961	$0	331	245	245	0%
68.0	80	$47.40	$22,961	$0	331	245	245	0%
63.8	65	$38.63	$18,712	$0	331	245	245	0%
59.7	65	$38.63	$18,712	$10,750	331	245	245	0%
104.0	110	$63.06	$30,546	$0	331	245	245	0%
100.1	110	$63.06	$30,546	$0	331	245	245	0%
95.7	95	$57.85	$28,023	$0	331	245	245	0%
90.9	95	$57.85	$28,023	$0	331	245	245	0%
86.4	95	$57.85	$28,023	$0	331	245	245	0%
81.7	95	$57.85	$28,023	$0	331	245	245	0%
76.6	80	$47.40	$22,961	$0	331	245	245	0%
71.5	80	$47.40	$22,961	$0	331	245	245	0%
67.3	80	$47.40	$22,961	$0	331	245	245	0%
62.9	65	$38.63	$18,712	$0	331	245	245	0%
58.3	65	$38.63	$11,227	$0	199	147	147	0%
			---	---	---	---	---	
			$355,350	$21,500	4,838	3,578	3,578	
					x $5.80/cy	x $1.9/cy	x $2.86/cy	
					---	---	---	
					$28,063	$6,799	$10,234	

Remove Spoil (cu yd): 1,260
x $6.95/cy

$8,759

combined other util's:
TOTAL UTILITIES:

* - 30"/42" [42" pipe costs $280,000 per 290-ft of length to jack and bore (+ 100' on eithe
** - 30"/42" [estimate of 42" pipe costs $140,000 per 290-ft length to bore (+50' on either

addt'l exc., bckfll & re-construct cost thru ua	Land (acres)
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.2
$0	4.1 ac
	x $3,500/ac
	$14,206

CONSTRUCTION COST SUMMARY

Project Description:
West Maricopa Combine Pipeline RID Alignment Using HDPE Pipe for the Miller Road Lateral (North Segment)

Pipe costs	$355,350
Earthwork	$56,854
Pump costs	$21,500
Pump Facility	$225,000
1st Subtotal	$658,704
Land (Easement fee)	$14,206
TOTAL	$672,910

ANNUAL ESTIMATED PUMPING COSTS

68% = Est. Total Pump Efficiency
$0.090 per kW hr = Electric power cost

$61,567 (annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)

$3,000
$3,000

er side of structure which requires excavation)]
r side of structure which requires excavation)]

Table 11. Hydraulic Parameters and Associated Construction Costs for Water Delivery South of the RID Canal Toward Buckeye Using HDPE pipe along Miller Road from the Main Trunk Line in Order to Deliver a Maximum of 12,670 acre-feet per

Project Description:
West Maricopa Combine Pipeline RID
Alignment Using HDPE Pipe for the
Miller Road Lateral South of the RID Canal

C= 130 (H-W friction factor)
Q= 17.5 cfs
= 12,669 acre-feet per year

	Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)	Avg. Head (psi)
	0.0	0.0	993	---	---	60	41.52	17.974	101.52	43.95	---	---	---
	4.8	5.0	990	28	0.94	0	103.58	44.84	103.58	44.84	484	4.1	44.39
	9.7	10.0	984	28	0.94	0	108.64	47.03	108.64	47.03	484	4.1	45.94
*****	14.5	15.0	980	28	0.94	0	89.37	38.69	89.37	38.69	484	4.1	42.86
	19.4	20.0	976	28	0.94	0	92.43	40.01	92.43	40.01	484	4.1	39.35
	24.2	25.0	971	28	0.94	0	96.49	41.77	96.49	41.77	484	4.1	40.89
	29.1	30.0	967	28	0.94	0	99.55	43.10	99.55	43.10	484	4.1	42.43
	33.9	35.0	963	28	0.94	0	102.62	44.42	102.62	44.42	484	4.1	43.76
	38.8	40.0	958	28	0.94	0	106.68	46.18	106.68	46.18	484	4.1	45.30
	43.6	45.0	954	28	0.94	0	109.74	47.51	109.74	47.51	484	4.1	46.84
*****	48.4	50.0	948	28	0.94	0	91.84	39.76	91.84	39.76	484	4.1	43.63
	53.3	55.0	944	28	0.94	0	94.90	41.08	94.90	41.08	484	4.1	40.42
	58.1	60.0	940	28	0.94	0	97.97	42.41	97.97	42.41	484	4.1	41.75
	63.0	65.0	937	28	0.94	0	100.03	43.30	100.03	43.30	484	4.1	42.86
	67.8	70.0	933	28	0.94	0	103.09	44.63	103.09	44.63	484	4.1	43.97
	72.7	75.0	929	28	0.94	0	106.15	45.95	106.15	45.95	484	4.1	45.29
	77.5	80.0	925	28	0.94	0	109.22	47.28	109.22	47.28	484	4.1	46.62
*****	82.3	85.0	922	28	0.94	0	89.02	38.54	89.02	38.54	484	4.1	42.91
	87.2	90.0	917	28	0.94	0	93.09	40.30	93.09	40.30	484	4.1	39.42
	92.0	95.0	914	28	0.94	0	95.15	41.19	95.15	41.19	484	4.1	40.74
	96.9	100.0	910	28	0.94	0	98.21	42.52	98.21	42.52	484	4.1	41.85
	101.7	105.0	906	28	0.94	0	101.27	43.84	101.27	43.84	484	4.1	43.18
	106.6	110.0	902	28	0.94	0	104.34	45.17	104.34	45.17	484	4.1	44.50
	111.4	115.0	899	28	0.94	0	106.40	46.06	106.40	46.06	484	4.1	45.61
*****	116.3	120.0	895	28	0.94	0	87.57	37.91	87.57	37.91	484	4.1	41.98
	121.1	125.0	893	28	0.94	0	88.63	38.37	88.63	38.37	484	4.1	38.14
	125.9	130.0	890	28	0.94	0	90.69	39.26	90.69	39.26	484	4.1	38.81
	129.3	133.5	888	28	0.66	0	92.04	39.84	92.04	39.84	339	4.1	39.55
						---					---		
	total pumping power =					60	ft				12,933	ft	
						= 119.2	hp				(2.45	) miles	

* - Includes the cost of furnishing and installing pipe
***** - Pressure relief valves used to maintain under 65 psi peak pressure to keep from using

higher pressure-class pipe.

14.5 6960
14.6 7008

year.

					Earthwork			
Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Trench Excav. (cu yd)	Am't. of Backfill (cu yd)	Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)
---	---	---	---	$19,000	---	---	---	
62.2	65	$118.37	$57,338	$0	515	351	351	0%
64.3	65	$118.37	$57,338	$0	515	351	351	0%
60.0	65	$118.37	$57,338	$0	515	351	351	0%
55.1	65	$118.37	$57,338	$0	515	351	351	0%
57.2	65	$118.37	$57,338	$0	515	351	351	0%
59.4	65	$118.37	$57,338	$0	515	351	351	0%
61.3	65	$118.37	$57,338	$0	515	351	351	0%
63.4	65	$118.37	$57,338	$0	515	351	351	0%
65.6	65	$118.37	$57,338	$0	515	351	351	0%
61.1	65	$118.37	$57,338	$0	515	351	351	0%
56.6	65	$118.37	$57,338	$0	515	351	351	0%
58.4	65	$118.37	$57,338	$0	515	351	351	0%
60.0	65	$118.37	$57,338	$0	515	351	351	0%
61.6	65	$118.37	$57,338	$0	515	351	351	0%
63.4	65	$118.37	$57,338	$0	515	351	351	0%
65.3	65	$118.37	$57,338	$0	515	351	351	0%
60.1	65	$118.37	$57,338	$0	515	351	351	0%
55.2	65	$118.37	$57,338	$0	515	351	351	0%
57.0	65	$118.37	$57,338	$0	515	351	351	0%
58.6	65	$118.37	$57,338	$0	515	351	351	0%
60.4	65	$118.37	$57,338	$0	515	375	351	25%
62.3	65	$118.37	$57,338	$0	515	417	351	100%
63.9	65	$118.37	$57,338	$0	515	417	351	100%
58.8	65	$118.37	$57,338	$0	515	417	351	100%
53.4	65	$118.37	$57,338	$0	515	417	351	100%
54.3	65	$118.37	$57,338	$0	515	417	351	100%
55.4	65	$118.37	$40,137	$0	361	292	246	100%
			---	---	---	---	---	
			$1,530,936	$19,000	13,758	9,767	9,368	
					x $5.80/cy	x $1.9/cy	x $2.86/cy	
					---	---	---	
					$79,798	$18,558	$26,793	
						Remove Spoil (cu yd)		mobilizing:
						3,991		RID x-ing:*
						x $6.95/cy		3 canals:**

---------- combined other util's:
$27,739 TOTAL UTILITIES:

* - 28"/42" [42" pipe costs $280,000 per 290-ft of length to jack and bore (does not include
** - 28"/42" [estimate of 42" pipe costs $140,000 per 290-ft length to bore (does not includ

addt'l exc., bckfll & re-construct cost thru ua	Land (acres)
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$3,330	0.3
$13,426	0.3
$13,426	0.3
$13,426	0.3
$13,426	0.3
$13,426	0.3
$9,398	0.2
$79,859	7.4
	x $3,500/ac
	$25,980 ac

$40,000
$85,500
$152,100

CONSTRUCTION COST SUMMARY
Project Description:
West Maricopa Combine Pipeline RID Alignment Using HDPE Pipe for the Miller Road Lateral South of the RID Canal

Pipe costs	$1,530,936
Earthwork	$718,546
Pump costs	$19,000
Pump Facility	$379,300
1st Subtotal	$2,647,782
Land (Easement fee)	$25,980
TOTAL	$2,673,762

ANNUAL ESTIMATED PUMPING COSTS

68%	= Est. Total Pump Efficiency
$0.090	per kW hr = Electric power cost
$69,232	(annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)

$208,200
$485,800

e the + 100' on either side of structure which requires excavation)]
de the +50' on either side of structure which requires excavation)]

Table 12. Hydraulic Parameters and Associated Construction Costs for Water Delivery Using HDPE Pipe Along Tuthill Road South from the RID Alignment Main Trunk Line in Order to Deliver a Maximum of 915 acre-feet per year.

Project Description:
West Maricopa Combine Pipeline RID
Alignment Using HDPE Pipe for the
Tuthill Road Lateral

C= 130 (H-W friction factor)
Q= 1.264 cfs
= 915 acre-feet per year

Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)	Avg. Head (psi)
0.0	0.0	1004	---	---	60	37.59	16.273	97.59	42.25	---	---	---
4.8	5.0	996	12	0.45	0	105.14	45.52	105.14	45.52	484	1.6	43.88
9.7	10.0	993	12	0.45	0	107.69	46.62	107.69	46.62	484	1.6	46.07
14.5	15.0	989	12	0.45	0	111.25	48.16	111.25	48.16	484	1.6	47.39
19.4	20.0	986	12	0.45	0	113.80	49.26	113.80	49.26	484	1.6	48.71
24.2	25.0	982	12	0.45	0	117.35	50.80	117.35	50.80	484	1.6	50.03
29.1	30.0	977	12	0.45	0	121.90	52.77	121.90	52.77	484	1.6	51.79
33.9	35.0	974	12	0.45	0	124.46	53.88	124.46	53.88	484	1.6	53.32
38.8	40.0	971	12	0.45	0	127.01	54.98	127.01	54.98	484	1.6	54.43
43.6	45.0	966	12	0.45	0	131.56	56.95	131.56	56.95	484	1.6	55.97
45.3	46.8	964	12	0.16	0	133.40	57.75	133.40	57.75	174	1.6	57.35
					---						---	
	total pumping	power =			60	ft				4,534	ft	
				=	8.6	hp			(	0.86	) miles	

* - Includes the cost of furnishing and installing pipe

15.2 ******
26 ******
16.8 ******
14.8 ******
11.5 ******
13 ******
19 ******
1.4 672

14.5 ******
14.6 ******

Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Trench Excav. (cu yd)	Am't. of Backfill (cu yd)	Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)
					|----------		Earthwork	----------
---	---	---	---	$4,600	---	---	---	
61.4	65	$11.24	$5,445	$0	278	211	211	0%
64.5	65	$11.24	$5,445	$0	278	211	211	0%
66.3	80	$13.78	$6,675	$0	278	211	211	0%
68.2	80	$13.78	$6,675	$0	278	211	211	0%
70.0	80	$13.78	$6,675	$0	278	211	211	0%
72.5	80	$13.78	$6,675	$0	278	211	211	0%
74.7	80	$13.78	$6,675	$0	278	211	211	0%
76.2	80	$13.78	$6,675	$0	278	211	211	0%
78.4	80	$13.78	$6,675	$0	278	211	211	0%
80.3	80	$13.78	$2,403	$0	100	76	76	0%
			----------	----------	----------	----------	----------	----------
			$60,018	$4,600	2,603	1,977	1,977	0
					x $5.80/cy	x $1.9/cy	x $2.86/cy	
					----------	----------	----------	
					$15,096	$3,756	$5,653	

Remove Spoil (cu yd)	
626	combined other util's:
x $6.95/cy	TOTAL UTILITIES:

$4,351	

mobilizing:
RID x-ing:*
1 canal:**

* - 12"/42" [42" pipe costs $280,000 per 290-ft of le
** - 12"/42" [estimate of 42" pipe costs $140,000 pe

addt'l exc., bckfll & re-construct cost thru ua	Land (acres)	
$0	0.3	
$0	0.3	
$0	0.3	
$0	0.3	
$0	0.3	
$0	0.3	
$0	0.3	
$0	0.3	
$0	0.3	
$0	0.1	
$0	3	ac
	x $3,500/ac	
	$9,108	

$20,000	
$62,500	
$50,700	
$26,640	
$159,840	

CONSTRUCTION COST SUMMARY

Project Description:
West Maricopa Combine Pipeline RID Alignment Using HDPE Pipe for the Tuthill Road Lateral

Pipe costs	$60,018
Earthwork	$188,697
Pump costs	$4,600
Pump Facility	$24,350
1st Subtotal	$277,664
Land (Easement fee)	$9,108
TOTAL	$286,772

ANNUAL ESTIMATED PUMPING COSTS

68%	= Est. Total Pump Efficiency
$0.090	per kW hr = Electric power cost
$5,000	(annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)

ength to jack and bore (+ 100' on either side of structure which requires excavation)]
er 290-ft length to bore (+50' on either side of structure which requires excavation)]

Table 13. Hydraulic Parameters and Associated Construction Costs for Water Delivery Using HDPE Pipe along Cotton Lane from the Main Trunk Line Using the RID Alignment in Order to Deliver a Maximum of 19,689 acre-feet per year.

Project Description:
West Maricopa Combine Pipeline RID
Alignment Using HDPE Pipe for the
Cotton Lane Lateral

C= 130 (H-W friction factor)
Q= 27.196 cfs
= 19,689 acre-feet per year

Sta.	Map Sta.	Elev	Pipe dia (in.)	Fric. loss (ft.)	Pump head (ft.)	Head out (ft.)	Head out (psi)	Head in (ft.)	Head in (psi)	Reach Length (ft.)	Vel. (ft/s)	Avg. Head (psi)
0.0	0.0	964	---	---	60	31.68	13.714	91.68	39.69	---	---	---
4.8	5.0	963	32	1.11	0	91.57	39.64	91.57	39.64	484	4.9	39.67
9.7	10.0	961	32	1.11	0	92.47	40.03	92.47	40.03	484	4.9	39.84
14.5	15.0	958	32	1.11	0	94.36	40.85	94.36	40.85	484	4.9	40.44
19.4	20.0	956	32	1.11	0	95.25	41.24	95.25	41.24	484	4.9	41.04
24.2	25.0	953	32	1.11	0	97.15	42.05	97.15	42.05	484	4.9	41.64
29.1	30.0	951	32	1.11	0	98.04	42.44	98.04	42.44	484	4.9	42.25
33.9	35.0	948	32	1.11	0	99.93	43.26	99.93	43.26	484	4.9	42.85
38.8	40.0	946	32	1.11	0	100.83	43.65	100.83	43.65	484	4.9	43.45
43.6	45.0	944	32	1.11	0	101.72	44.03	101.72	44.03	484	4.9	43.84
48.4	50.0	940	32	1.11	0	104.61	45.29	104.61	45.29	484	4.9	44.66
53.3	55.0	937	32	1.11	0	106.51	46.11	106.51	46.11	484	4.9	45.70
58.1	60.0	934	32	1.11	0	108.40	46.93	108.40	46.93	484	4.9	46.52
63.0	65.0	933	32	1.11	0	108.29	46.88	108.29	46.88	484	4.9	46.90
67.8	70.0	931	32	1.11	0	109.19	47.27	109.19	47.27	484	4.9	47.07

total pumping power = 60 ft 6,782 ft
= 185.2 hp (1.28) miles

* - Includes the cost of furnishing and installing pipe

Avg. Head + 40% (psi)	Pipe Cls	Pipe Unit Cost* ($/ft)	Reach Pipe Cost ($)	Pump Cost ($)	Trench Excav. (cu yd)	Am't. of Backfill (cu yd)	Compact Backfill (cu yd)	estimate % of exc./bkfll thru urban areas (ua)
---	---	---	---	$27,750	---	---	---	
55.5	65	$154.62	$74,898	$0	585	387	387	0%
55.8	65	$154.62	$74,898	$0	585	387	387	0%
56.6	65	$154.62	$74,898	$0	585	387	387	0%
57.5	65	$154.62	$74,898	$0	585	387	387	0%
58.3	65	$154.62	$74,898	$0	585	387	387	0%
59.1	65	$154.62	$74,898	$0	585	387	387	0%
60.0	65	$154.62	$74,898	$0	585	387	387	0%
60.8	65	$154.62	$74,898	$0	585	387	387	0%
61.4	65	$154.62	$74,898	$0	585	387	387	0%
62.5	65	$154.62	$74,898	$0	585	387	387	0%
64.0	65	$154.62	$74,898	$0	585	387	387	0%
65.1	65	$154.62	$74,898	$0	585	387	387	0%
65.7	65	$154.62	$74,898	$0	585	387	387	0%
65.9	65	$154.62	$74,898	$0	585	387	387	0%
			---	---	---	---	---	
			$1,048,571	$27,750	$8,184	$5,425	$5,425	
					x $5.80/cy	x $1.9/cy	x $2.86/cy	
					---	---	---	
					$47,467	$10,307	$15,515	

Remove Spoil (cu yd)	
2,759	
x $6.95/cy	

$19,175	

Combined other util's:
TOTAL UTILITIES:

addt'l exc., bckfll & re-construct cost thru ua	Land (acres)
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	0.3
$0	3.9 ac
	x $3,500/ac
	$13,622
$45,000	
$45,000	

CONSTRUCTION COST SUMMARY

Project Description:
West Maricopa Combine Pipeline RID Alignment Using HDPE Pipe for the Cotton Lane Lateral

Pipe costs	$1,048,571
Earthwork	$137,464
Pump costs	$27,750
Pump Facility	$500,000
1st Subtotal	$1,713,785
Land (Easement fee)	$13,622
TOTAL	$1,727,408

ANNUAL ESTIMATED PUMPING COSTS

68%	= Est. Total Pump Efficiency
$0.090	per kW hr = Electric power cost
$107,590	(annual power requirement, based on Kw hr / yr , and assuming the pump runs two-thirds of a day)