Taylor's Ferry Pump Station
Benefit-Cost Analysis

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August, 2008

Background

This business case provides a different approach to assessing a CIP project. The Taylor's Ferry Pump Station (TFPS) is driven by the fire flow requirements of Jackson Middle School and as a backup supply to the Arnold cascade service areas. We will use a risk cost approach to determine whether the benefits to rehabilitating TFPS (alternative recommended in the BDR), which is the reduction in risk cost of a fire at Jackson Middle School (JMS) and Markham Elementary School (MES) and a reduction in risk of having a supply outage, is greater than the life-cycle costs. If the net present value (NPV) is positive then it will reinforce the decision to rehabilitate TFPS, if the NPV is negative then the alternative is to abandon TFPS and rely on Capitol Highway Pump Station (CHPS) to supply the Arnold cascade service area.

The PCR notes that the load scenario tables "results determined that using the TFPS combined with available storage was sufficient to meet the special fire considerations for 2005 and 2030 demands. This meets the load scenario criteria for reduced fire flow for one supply out of service. The key finding is that both the Capitol Highway and Taylors Ferry Pump Stations need to be in service to provide standard fire flows in the Arnold service area."

The required fire flow at Jackson Middle School (JMS) is 6000 gpm based on square footage of buildings and construction materials. Without TFPS the amount of fire flow available would be roughly 3000 gpm until Alto Park tank emptied and then the flow would decrease to roughly 2300 gpm but also cause decreases in pressure in parts of Arnold service area.

A reduction in required fire flow of up to 75% is allowed when the building has full coverage from an approved sprinkler system, and a reduction in required fire flow of 25% is allowed when the building is provided with an approved automatic and manual fire alarm system. JMS does not have full coverage of either sprinkler or alarm system.

TFPS also provides a level of service as a backup supply to the Arnold cascade service areas. Arnold cascade is a large service area but the CHPS can supply the PDD plus a fire flow of roughly 3,300 gpm (or roughly 2,500 if we include wholesale supply from Arnold which is not needed by our customer in case of emergency). TFPS fills the need of emergency backup and the additional fire flow required at higher levels for these schools. The emergency back-up connection from Lake Oswego would not likely be available during peak months, and therefore not included in supply analysis.

Water Supply

Is TFPS needed to supply water to the Arnold cascade service areas? Without TFPS backup supply to the Arnold cascade, which includes Stephenson and Stephenson Pump service areas as well as wholesale to Lake Grove Water District, is less flexible. The Arnold Cascade is considered a large service area with 2,931 services (excluding wholesale) and demand is anticipated to grow slightly to 2030.

Additional benefits of a backup supply would only accrue if the TFPS were truly needed in order to avoid interruption of supply. Currently, one of the Taylor's Ferry pumps is set as the second pump so whenever capacity exceeds the primary pump at CHPS then one of the TFPS pumps kick in. The calculations below show that CHPS can supply the non-fire demands of the service areas without TFPS.

The full pumping capacity of CHPS is 4,600 gpm and firm pumping capacity, which assumes that the largest unit at the pump station does not operate because it is reserved as a standby unit, provides 2,500 gpm. PDD for Arnold Cascade (including the three retail service areas and Lake Grove wholesale) is 1,989 or 80% of firm pumping capacity and 43% of full pumping capacity at CHPS.

Arnold has storage capacity of 3.2 ADD and even if all tanks were at the low setting there is still more than 2.1 ADD storage available. Stephenson has 2.8 ADD of storage and at low setting has 1.5 days of ADD.

As a backup, the CHPS also has a pumper truck with a capacity of 1,500 gpm and takes about 1 hour to set up. If TFPS was abandoned and then an emergency took CHPS temporarily out of service then the PDD of 1,289 (during an emergency Lake Grove could take water from its other supply sources and is therefore excluded from demand calculations) can be fully met from the pump truck (or a trailer mounted pump which we consider later in this report). Storage is also still available during an emergency.

Currently, there are no connections for a portable pump at TFPS but if the pump station was taken offline then these connections could be added at a low cost. This connection is important because it can pump directly to distribution, and JMS, as well as to the tanks.

The above assumes that without TFPS the PWB would have pumper trucks available indefinitely in the future. This would require a high level of preparedness and coordination within the bureau in case of emergency plus the installment of connections for the pump at TFPS site, albeit at a relatively low cost. The TFPS connection is only significant if a greater alarm fire would require more than 3,000 gpm or if the mains from the tank to distribution are broken (although main repair would happen in less than 24 hours as per service level policy).

In case of power outage there is a generator at the CHPS station. The generator can run the two small pumps simultaneously but not the big pump. This is the same as the firm pumping capacity of 2,500 gpm which is enough to supply the Arnold cascade during

PDD. This is enough to supply a fire demand of more than 1,200 gpm plus PDD. This emergency setup would not be able to supply a large fire of at least 3rd alarm or greater.

If TFPS were taken offline then it would be beneficial to have an automatic switch on the generator at CHPS in case of a power outage. Also, having electricity switch over to the generator when the larger pump is run during some PDD days or to exercise the larger pump is being explored by Operations as a possibility for reducing the larger service fees from PGE associated with that pump. The automatic switch to the generator would cost roughly $50,000.

We analyzed SCADA data for the last 8 years to see when the CHPS has been out. Outages of short duration (less than one day) occur almost yearly. However, it is difficult to tell whether these outages where significant emergency or just small events or routine maintenance. The OEs remember only one significant incident back in August 2003, when CHPS was offline because of a failure of the RTU. This was an intermittent problem and in order to troubleshoot the problem the ITs had CHPS shut down several times for durations of a few hours to a few days. During this time pumping came from TFPS, however, the CHPS could have been operated locally since the RTU only shut down communications with the Control Center, i.e. TFPS was not needed as a backup in this case. The ITs believe that, from their perspective, there is no scenario in which an IT failure would cause a shut down since the pump station could always be controlled manually on location by the OEs.

We conclude that the CHPS is sufficient to supply Arnold cascade with water during PDD with firm pump capacity. TFPS would then need to be justified based on the need to provide full fire flow during an emergency or to avoid supply interruptions. The following sections outline and quantify those risk costs beginning with the risk cost of fire. Risk costs associated with supply interruptions if TFPS is abandoned are considered in subsequent sections.

Probability Analysis for a Large Fire at Jackson Middle School

There are 477 facilities at schools[1] listed under PF&R data. Only a limited number of schools would have multiple facilities so the number of schools may be slightly lower; if we 25% had multiple facilities then 477/1.25 = 382 schools. There were 2 school fires of ≥ 3rd alarm in the past ten years, or 0.2 fires per year of this size[1] (see \\wb-pdx\vol1\ENG\Asset Management\Business Cases\Taylors Ferry PS\FireData&RiskEstimation.xls sheet “PF&Rdata” for data taken from PF&R, sheet

[1] PF&R’s list of educational facilities is 1,250 including business schools, day care facilities, etc. but we count only the 477 elementary, middle and high schools because PF&R believe that schools exhibit similar characteristics in the probability of fire but are different than other educational facilities in this respect. Most of the schools have one facility and PF&R says that the actual # schools would only be slightly lower. By comparison GIS shows 226 schools in the Multnomah county portion of Portland and does not include some private schools. School fires in Portland represent 3.6% of all structural fires while nationally the rate is only 1.6%.

“NationalFireData” for USFA data, sheet “EdFacilities” for information on schools, and sheet “ProbabilityEst” for how we calculated likelihood of 3rd alarm fires at school). Of these fires one was at Lents school (arson) and the other at Binnsmead school (roof caught fire when a contractor was replacing the roof). We assume that a one or two alarm fire would not require more than the 2300 to 3000 gpm available without TFPS (this was confirmed by PF&R as a good assumption).

Probability of 3rd, 4th or 5th alarm fire at Jackson Middle School =
Number of 3+ alarm fires at schools / Number of schools

= 0.2 school fires (3+ alarm) per year / 382 schools
= 0.052% (once in 1,910 year event)

Different methodologies to calculate fire probability were used including looking at the percent of all fires at schools or educational facilities and multiplying that by the percent of fires that are 3 alarm or greater. Different methodologies yielded similar results.

Not all 3 alarm or greater fires would require the fire flow above 3000 gpm. If the fire was combated offensively, meaning the crew was in the building and putting water directly on the seat of the fire then less fire flow is required. If it became defensive, i.e. the fire crews could not get into the building and spraying water from the side and above to keep the fire from spreading, then higher fire flow would be needed to have effective defensive combating of a larger fire.

Consequence of Fire at Jackson Middle School

The value of improvements (mostly building) at Jackson Middle School is $34 million. If we estimate the value of all the equipment and furniture inside the school at $3 million[2] then the total property value is $37 million. Insurance would cover most of this.

There are 720 children enrolled at Jackson Middle School. If the school had to use temporary structures or bus the children to other schools for one year, the inconvenience factor, or a decrease in the quality of education, is given a value of $1,000 per student per year for the purposes of this analysis (UO/OSU education costs approximately $6,000 per year as a comparative educational value and as the students would still be receiving their education albeit in temporary structures or schools farther away the inconvenience is only a percent of the total education value). The decrease in the total value of education (social cost) would be approximately $0.7 million. If PPS purchased or leased temporarily facilities for the students at $1300 per student per year (roughly half the PPS

[2] PPS Statement of Net Assets lists buildings and capital improvements at $186 million and vehicles and equipment at $16 million, or 8.4% of buildings and capital improvements. This rate equates to roughly $3 million for equipment and furniture at Jackson Middle School.

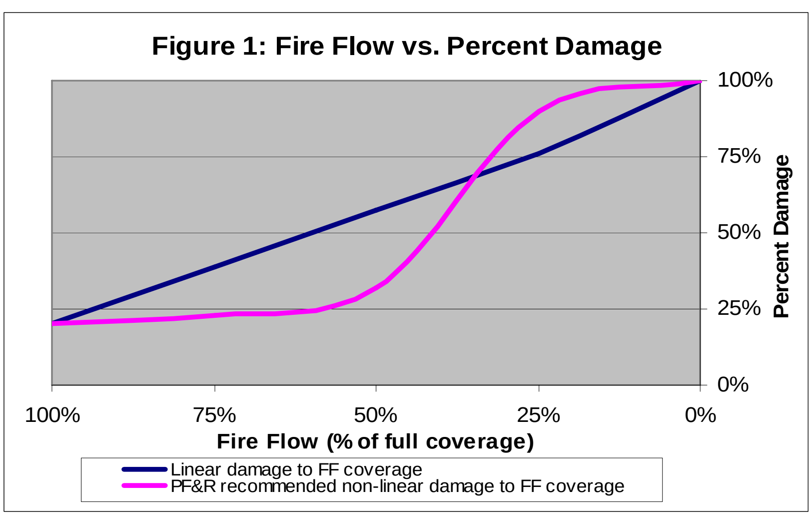
per student budget for building and classroom support) this comes to just under $1 million.

Total possible consequence is the financial value of assets ($37 million) plus the social cost ($0.7 million) plus the temporary educational cost to PPS ($1 million). The risk exposure is calculated as:

Risk exposure = consequence x likelihood
Risk exposure = $38.7 million x 0.052%
Risk exposure = $20,262 per year

The above is total risk exposure. However, fire fighting, even at lower flow of 3000 gpm (the amount available w/o TFPS) would presumably prevent full destruction of building and equipment. As a comparison the 3rd alarm fire at Lent Elementary School in 2003 caused approximately $1 million in damage and the 4th alarm fire at Binnsmead Middle School also in 2003 caused approximately $2.8 million in damage. The market values of school improvements (buildings) are $6.6 million and $11.5 million which equal 15% and 24% of the market value of the buildings.

Given the above, with full fire flow we estimate property and other damage would start at 20% with full fire flow. As fire flow decreases, damage increases. A simple model would say that damage increases linearly with a decrease in fire flow. Since the first response is offensive (getting water directly onto the seat of the fire) which uses less water than a defensive combat (applying water from multiple locations on the outside roof and walls of a structure to stop its spread), PF&R suggests that the percent damage would be flat until 50% coverage and at levels below that the percent damage would increase rapidly (see PF&R suggested fire flow priorities below). These curves are demonstrated in Figure 1 below:



Assumptions are that with full fire flow, as with the Lents and Binnsmead schools above-mentioned, the damages from a 3 alarm or greater fire would be limited to 20% of the consequence and that providing less fire flow results in a non-linear increase in destruction as recommended by PF&R. If we assume that the increase in damage up to 50% (or 3000 gpm available with only CHPS) is relatively flat with an increase of 12% damage to the value of the fire damage. Net risk exposure from providing the current minimum fire flow of 3000 and the net present value (NPV) are:

Net risk exposure = (\$20,262 x 0.321) – (\$20,262 x 0.2)
Net risk exposure = \$2,431 per year

$NPV_{Jackson\ Middle\ School}$ *(80 years, 3%) = \$75,633*

The Markham elementary school (MES) requires 5000 gpm and is another risk cost to consider. While PF&R would consider this low risk due to the 3000 gpm provided, if the curve from figure 1 is used we can estimate the damage would be 66% of the damage applied to JMS. Markham elementary school value is \$7.294 million or 20% of the value of JMS. Therefore, we can add 13.2% (66% x 20%) onto the risk cost of the JMS. This gives us the following:

$\boldsymbol{NPV}_{total\ for\ both\ schools}$ *(80 years, 3%) = \$85,617*

Another risk to consider is fatalities in school fires. U.S. Fire Administration and PF&R state that fatalities from school fires are rare. USFA reported 0.0 fatalities per 1,000 fires at schools in a 3-year average (2003 – 2005). Most fatalities were related to issues on exit systems and poor exiting systems at schools have been addressed in Portland by the PF&R and schools. Injury rates are roughly the same for school and non-school fires, 13.1 per 1,000 fires. Since the higher fire flow would be used for defensive purposes if 6,000 gpm was needed, but not available, it would be missed later in the fighting and to avoid escalation of the fire so at that point the school would likely have been evacuated and additional injuries would be unlikely. PF&R concurs in these assumptions. Therefore, safety risk cost was not included in the estimate.

Other Considerations on Fire Flow – PF&R has suggested the following priority for fire flow:

High: Areas that deliver fire flow of less than 750 gpm and Single Family Residential - 500 gpm from one hydrant

Medium: Areas that deliver less than 50% of required fire flow or deliver at least 3000 gpm regardless of fire flow.

Low: Areas that deliver more than 50% of required fire flow.

Without TFPS the service area can provide 3,000 gpm of fire flow for 4 hours before Alto Park tank runs dry (from low setting). The duration of the required fire flow is 4 hours. Without TFPS, PF&R rates the available fire flow to JMS as a priority rating on the cusp between medium and a low priority for MES.

Discussion Issues with Fire Flow in Arnold:

(1) The high fire flow for the JMS is in part driven by the fact that the school does not have full sprinkler or alarm coverage. OR fire code says that fire flows can be reduced by up to 75%, as approved, if the building is provided with an approved automatic sprinkler system. With a sprinkler system, current fire flow would likely be sufficient to the JMS. Providing fire flow is an important part of the service the PWB to its customers. However, should significant resources at a cost to all customers be invested to achieve higher fire flows in service areas where customers do not install sprinkler systems is an issue the PWB needs to address, particularly in cases such as this where the current fire flow is on the border of medium to low priority for PF&R.

(2) Without TFPS and if connections were provided then PWB's pumper truck could add 1,500 gpm at Taylor's Ferry which would provide additional flow directly to distribution at JMS (alternatively, and included in the analysis, a trailer mounted pump could provide similar fire flow and at a cost of roughly $50,000 be significantly cheaper than a pump station with, arguably, only a minimal decrease in level of service). Since the defensive fire fighting would not take place until later in the combat the portable pump would provide the additional flow at the later stages of the fire when its most needed. Issues concerning a portable pump and connections at Taylors Ferry include portable pumps not being tied to a certain service area and in case of a larger or multiple emergency would be sent to the area of greatest need, relying on outside vendors for repair, maintenance and increasing emergency preparedness and coordination with PF&R. While adding connections at Taylors Ferry might be considered *if* the TFPS were abandoned, it must be recognized that a portable pump stationed at a different site does not provide nearly the same level of service as a permanent pump station.

Supply Redundancy at Arnold Cascade – Scenarios and Benefits

Emergencies other than fire need also be considered in risk analysis. A list of possible emergencies, their estimated return period and possible consequences are considered as well as back up and responses in case of emergency are considered below:

Catastrophic event (500 year) – In most cases such as a large earthquake it is not likely that it would take out only CHPS and leave operational the TFPS, the pump mains and the tanks. Catastrophic event would likely damage multiple distribution assets, if not supply, and cause service disruption to the area. In this case, TFPS would not likely be of use.

Power outage (20 year) – If CHPS were out of service due to a power outage then there is a generator and a pump truck at the pump station. Arnold service area has more than a 3 ADD supply of storage and Stephenson (part of the Cascade) has a 2.8 ADD storage supply. If, in the rare instance the tanks ran out then the backup generator and pump truck would be able to continue supplies to distribution and storage. Without TFPS the generator should be configured to automatically turn on in case of a power outage (approximate cost would be roughly $50,000).

Pump main break (100 year) – The pump main from CHPS is 20" DI installed in 1997 and has cathodic protection. The pump main could be replaced within 24 hours and there is sufficient storage to cover such a short-term emergency. A large break in the pump main could drain the tanks but since most main breaks are much less than 100 gpm (because they are buried, as is the pump main here) and because SCADA would automatically shut valves down then the loss to the tanks would be minimal or not at all since the pumps would just increase their output until shut down.

Other large main break (20 – 50 years) – During a large break in the main the tanks in the cascade system would drain. All mains in the Arnold service area are buried and in most scenarios large main breaks would be less than 100 gpm. An extreme main break for Arnold service area which would drain at multiples faster than 100 gpm would be much more infrequent than the 20 – 50 year scenario. Since breaks would not be of a magnitude anywhere near fire flow rates and are repaired in less than 24 hours (PWB policy and practice) it is extremely unlikely to drain any of the tanks in the service area and cause a service outage beyond the shutoff zone for the emergency repair.

Equipment failure (20 year) – There are three pumps at CHPS so if one pump goes out of service the other two are active and sufficient to supply PDD. In case all three pumps went out then, as recommended, the pump truck would be available as backup supply. In the load scenario table even with the largest pump out of service the firm capacity is more than enough to supply the PDD for the entire Arnold cascade including Lake Grove Water District. In case of emergency, Lake Grove could source its water from one of its other suppliers and the pump truck at CHPS can supply more than PDD. In addition, the storage facilities have a three-day ADD available capacity.

Maintenance outages (5 years) – Available storage and pump capacity from the pumper truck can provide more than three days ADD to the service area. Maintenance outages that would put the entire pump station out of service for periods longer than the available storage would be extremely unlikely, greater than a 500 year event.

Shutoffs at CHPS for other bureau construction – Operations raised concerns that if PDOT or BES was doing work and required a shutoff at the CHPS that without TFPS this would limit flexibility of shutdowns in the service area. This type of work is quite rare in this service area (more common has been in the mall projects and with the new max lines). Actions from other bureaus that affect water distribution are discussed well in advance with other bureaus and back up systems could be installed in place prior to any work that may require a shutdown at the CHPS and its pump mains. Additionally, there is sufficient storage in the area so the combined emergency pump truck and storage should be sufficient for any such shutdown to the CHPS.

Risk-Cost Analysis on non-Fire Emergency

As shown above, most emergencies also have back up supply (assuming, again, that the generator is put on automatic shut on in case of power outage and that the bureau maintains a pumper truck at CHPS for non-fire emergencies). However, human and equipment error as well as the possibility that some emergencies still might run the tanks dry and cause interruptions in supply.

Consider that some of the above listed events might lead to water outages some of the time, but not every time. We will use a sensitivity analysis to get high and low ranges of frequency of outages and risk cost. We shall use a 5 year and 50 year event as the more and less frequent probabilities to give us a range in risk costs to supply outages w/o TFPS.

Utilizing information from willingness to pay (WTP) studies in rural Colorado, Seattle, and England (see \\wb-pdx\vol1\ENG\Asset Management\Business Cases\Taylors Ferry PS\FireData&RiskEstimation.xls and open the sheet "WTP" for estimation detail) we performed a sensitivity analysis. At the more frequent outage of every 2-5 years we estimate customers in Arnold cascade (2,931) were WTP $1.00 per month to avoid these outages. At the low frequency level we estimate that Arnold cascade customers were WTP $0.10 per month to avoid outages once every 25-50 years. In the medium range we estimate that Arnold cascade customers are WTP $0.25 per month to avoid outages once every 10-15 years. The net present values (NPV) of these outages are given below:

Low Frequency (25-50 year event), Low WTP (80 years, 3%) = $109,733
Medium Frequency (10-15 year event), Medium WTP (80 years, 3%) = $274,348
High Frequency (< 5 year event), High WTP (80 years, 3%) = $1,097,393

The value chosen to avoid possible outages in the Arnold cascade would depend on the *additional* frequency of outages that the engineers or decision maker believe would be likely from not having TFPS. From the analysis on outages above we can see that outages in Arnold cascade without TFPS would still be very infrequent. However, given that no system is perfect and there may be human error, or improper functions with SCADA or just that a main break might be a very large one, we would offer that the NPV would be somewhere close to the medium frequency range or slightly more towards the low end depending on circumstance but not likely to be at the high frequency extreme.

Life-Cycle Costs

The life cycle cost estimate for TFPS (refer to \\wb-pdx\vol1\ENG\Asset Management\Business Cases\Taylors Ferry PS\NPV_Calculation.xls for benefit and life-cycle cost estimates and NPV) is $1,547,883. This includes the safety and electrical pump station building rehabilitation in the current year plus replacing the pumps, motors, vault and piping in 5 years (currently in the 5-year CIP).

***Scenario 1*:** Our analysis compares the cost of having TFPS to taking the pump station out of service. The costs involved with removing TFPS include $100,000 to decommission the pump station plus $50,000 to install a switch on the CHPS generator so that it will turn on automatically in case of a power outage. The life-cycle cost of TFPS net of the costs of not having it are $1,397,883.

***Scenario 2*:** Operations is concerned with not having a backup supply to a large service area. In this scenario we estimate additional staff would be needed to provide emergency support to areas where redundancy is reduced so that a quicker response is given in case of emergency. We estimated 5% of an additional OE salary/benefit/fleet would be allocated to this specific situation and that a trailer mounted pump would be placed at CHPS with emergency connections at the (former) Taylors Ferry site. The life-cycle cost of these additional operations emergency preparedness would be $239,192, significantly cheaper than operating TFPS but at a level of service slightly lower than having a permanent pump station. The TFPS life-cycle cost net of these additional operational costs is $1,158,692.

Results Analysis – The Value of Having Taylor's Ferry Pump Station

This business case evaluates one question: Is the NPV of having TFPS positive: i.e. is the life cycle cost of the recommended alternative less than or greater than the benefits over the same period of time.

The main benefits of having TFPS are reducing the risk cost of a fire at the two schools and having a redundant supply of water to decrease the likelihood of supply outages. Our sensitivity analysis provides low and high estimates of the values for the two benefits of reduced risk costs by having TFPS. The assumptions are given below with results presented in Table 1.

The ***low value*** is based on the low estimate for supply outages and the willingness to pay by customers to avoid *additional* but infrequent outages (25-50 years) if TFPS was not available. It is also based on the risk cost of fire when the damage curve (see figure 1) is relatively flat up to 50% of fire flow as per PF&R recommendation. It assumes a very conservative estimate on the number of schools but that all schools have a probability of reaching a 3rd alarm or greater fire. Although these are considered the "low" value estimates they are the values that are supported by the data and have assumptions recommended by PF&R as the most reasonable.

The ***medium value*** is the based on an estimate of what PWB customers are willing to pay to avoid *additional* outages due to not having TFPS with a mid-point estimate on their frequency (10-15 years). The midpoint average also assumes a non-linear damage curve (see figure 1) but that the curve is not so flat as the one recommended by PF&R but not quite linear either.

The ***high value*** is based on an high estimate for supply outages of the value that customers would have in willingness to pay to avoid *additional* frequent outages (< 5 years) due to not having TFPS. The high value for fire risk cost assumes that the frequency of 3rd alarm or greater fires at schools is much higher (and Portland is already 2.5 times the national average) and that the damage curve is linear as in figure 1 (linear curve, which presumes greater fire damage than predicted by PF&R).

Table 1: NPV of the benefits derived from TFPS

Benefit	Low Value	Medium Value	High Value
Reduced fire risk cost	$85,865	$205,301	$352,132
Reduced supply outages	$109,733	$274,348	$1,097,393
TOTAL BENEFITS	***$195,598***	***$479,649***	***$1,449,525***

Net present values (NPV) and benefit-cost (B/C) ratios are calculated for low, medium and high benefits for the two scenarios in Table 2 below.

Table 2: Sensitivity analysis using NPV and B/C ratios for low, medium and high benefits of TFPS project for the two scenarios.

	Scenario 1		**Scenario 2**	
Benefit level	**NPV**	**B/C ratio**	**NPV**	**B/C ratio**
Low benefits	- $1,202,286	0.14	- $963,094	0.17
Medium benefits	- $918,234	0.34	- $679,042	0.41
High benefits	$51,642	1.04	$290,833	1.25

Summary

The fire risk cost is relatively low and PF&R puts the priority for the additional fire flow from TFPS to the JMS on the cusp between low and medium priority with the additional fire flow from TFPS to MES to be low priority. Asset Management would assign a benefit of low to medium for risk cost reduction for fires ($85,865 – $205,301).

Willingness to pay is derived from published studies in other locales. The low end of the WTP to avoid outages is the choice experiment done by SPU (Seattle) although they type and frequency of the outages presented here were different from the published studies we feel the estimates were reasonable and even on the high end for the more frequent outage scenario. This is a new methodology first being introduced to the PWB and the figures used need a more rigorous analysis and discussion, but we believe the figures and methodology used here is a reasonable starting point. We caution decision makers to review this methodology carefully and make a judgment based on their own aversion to risk and what the value of an interruption in supply would be to our customers. Asset Management would put the WTP to avoid outages in the medium to high risk cost ($274,348 - $1,097,373) with higher risk costs to be chosen if the decision maker believes outages would be more frequent (2-5 years) and our customers WTP would be high to avoid these.

The final value is driven more by the supply outage risk cost and whether or not the PWB would be will to risk additional outages in order to reduce costs of operation and CIP. If one takes a more conservative approach with greater risk aversion or one that believes risk outages might be more frequent (2 – 5 years even with backup emergency trailer mounted pump) and therefore PWB customers WTP a higher amount to have TFPS, then the result would have a positive NPV and a B/C ratio greater than one. Those who are less risk averse or believe that supply outages without TFPS would not be as frequent (10 – 15 years or more) and PWB customers WTP for these less frequent outages would be lower, then the NPV would be negative and B/C ratio less than one.