Product Design using Value Engineering
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Lecture - 18
VE: Success Stories - I

Namaskar Friends! Welcome to session 18 of our course on Product Design using Value Engineering. So, currently we are in the 4th week of our discussion, and we are left with three more sessions to complete the course; as you may have realized by now that this is a very exhaustive course and very practical course.

So, practical I mean to say that concepts that we learn are directly applicable to what we see around us, the products that we see around us, there is always a scope for improvement and if we follow the concepts of value engineering, we can easily modify the product in terms of their design, in terms of their functional requirements, in terms of the materials that we used to create those products, in terms of the manufacturing processes that we use to make those products.

So, basically, there is a scope for improvement in each and every product that we see around us, sometimes the manufacturing process can be made more effective, more efficient, easier as well as fast quick cost effective. So, from manufacturing point of view there are lot of opportunities, where we can improve our product.

Similarly, from materials point of we can make a lot of changes in the materials that are being used and make the product functionally satisfying as well as at the same time cost effective. So, we can see that from materials point of view, manufacturing point of view there is a scope where we can change the product, similarly from design point of view also, we can come up with alternate designs, we can try to combine few assembly operations. Suppose, the product has to be assembled, we can see that how many assembly operations are being done, can we combine few parts, can we modularize some of the parts, so that the assembly operation number of assembly operations can be reduced.

So, basically we can say that our target is to make our product functionally satisfying and at the same time it must be cost effective. So, it is a very practical oriented course and today, we are going to take a case study and try to understand that how the value engineering concepts that we have learnt can be applied. So, the approach is known to all of you are aware that how to solve any value engineering case or how to solve any problem using the concepts principles rules guidelines of value engineering.

Today, we will see a practical application a case study where successfully value engineering has been applied and lot of financial benefits, lot of cost benefits have been achieved. So, this case study that we are going to take today has been taken from a very, you can say, practical oriented book on Value Engineering, A Practical Approach for Owners, Designers and Contractors, the book has been written by Larry W. Zimmerman and Glen D Hart.

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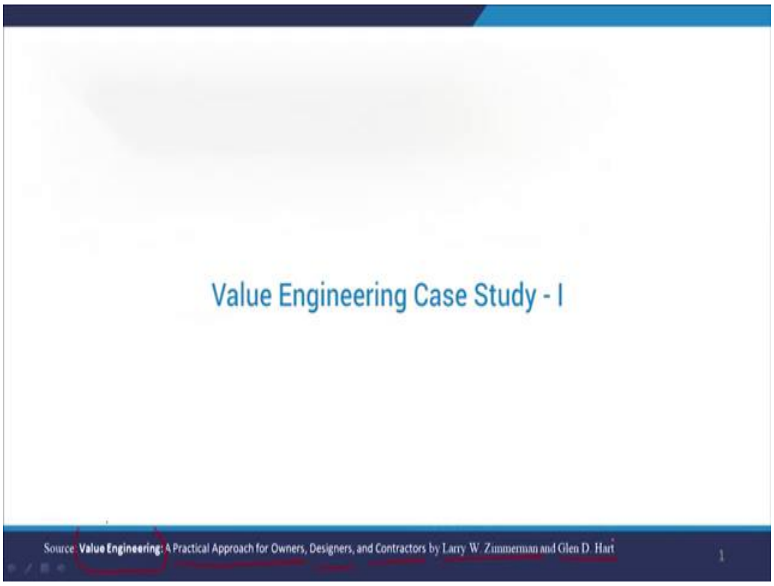

This is good book, so you can see it is a practical approach. So, basically we can apply the principles that we are learning to solve our product design problems. So, let us see what is this case study? This case studies related to the design modifications in the wastewater treatment facility. So, let us, as the saying goes that first and foremost, we must try to achieve or attain or collect all possible information related to the problem at hand or the design that we are going to modify or the product which we are going to analyze. So, let us see, what is the information given in the book related to this waste wastewater treatment facility.

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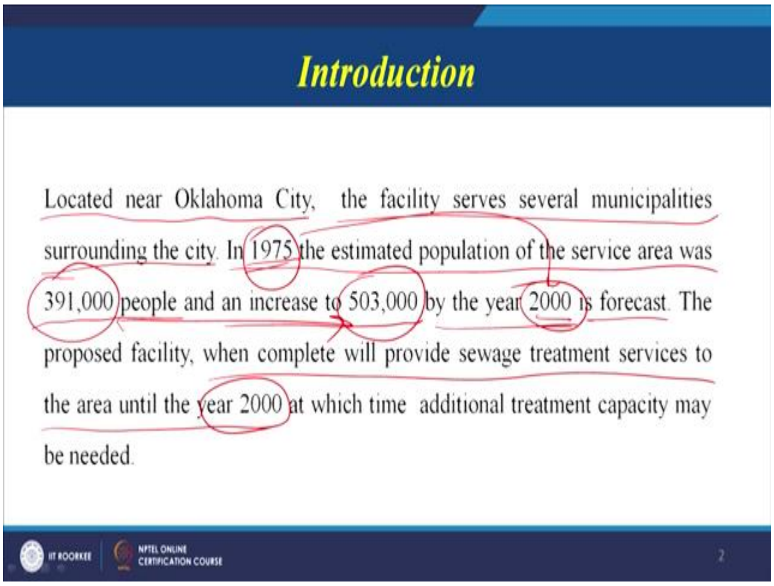

So, this wastewater treatment facility is located in the Oklahoma City, so this is the facility several municipalities surrounding the city. So, there is Oklahoma City and around the city, there are number of municipalities, and this central facility wastewater treatment facility is serving all these municipalities.

So, in 1975 the estimated population of the service area was 391000 people and in that increase 503000 by the year 2000 is the forecast. So, the current population is given and it may increase to this population by the year 2000 and the facility we are talking of time domain is from 1975 to 2000. So, the facility has to be revamped, the facility must be upgraded, the facility must be expanded, so that number of people who are residing in those areas is going to increase. Therefore, the load on this wastewater treatment facility is also going to increase.

The proposed facility when complete will provide sewage treatment services to the area until the year 2000. So, till 2000 it is expected that the facility which is being created this waste water facility will serve the society till 2000, then later on may be it may be further upgraded and revamped or may be modified as per the requirement. So, at which time after 2000 additional treatment facility may be needed, after 2000 there maybe requirement for a additional treatment facility.

Which means that while we are designing this facility, while we are analyzing this facility we must take into account that the population is further going to increase, and there may be a requirement for up gradation for expansion of the existing facility.

So, with those we can say constraints, the designers achieved or attacked this problem. So, what are the requirements now? First thing is the information what is the facility, what is the load on this facility in terms of the population, what is the time domain for which the facility is expected to serve the community, the number of municipalities that are being served by the community, by this facility sorry, so all this information is already now available with us. Now, we can see what are the project requirements?

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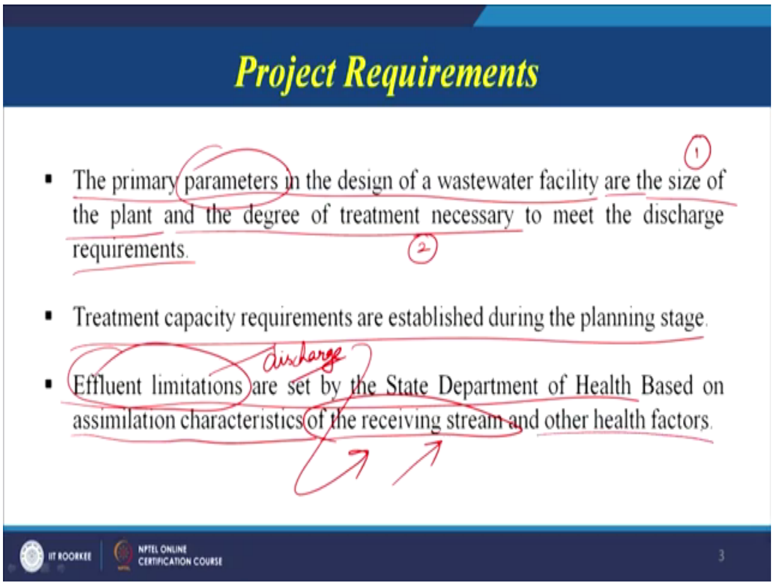

The primary parameters in the design of the waste water facility are, so, these are the parameters for design the size of the plant that is maybe, the first parameter and the degree of treatment necessary to meet the discharge requirements. Now whatever waste water is suppose coming it has to be treated, and then it has to be discharged may be into a river.

So, what are the degree of treatment or what are the discharge requirements? Because each and every country will have certain discharge requirement in terms of the type of effluents that or the type of, we can say bacteria or the type of other pollutants that are there in the water, how to treat them, and at what level, they can be discharged into or what type of treatment and what level of treatment or what degree of treatment is necessary to ensure that the water is not treated to be discharged into the flowing river.

So, two things are very important the size of the plant and the degree of treatment necessary. The treatment capacity requirements are established during the planning stage, so that has to be taken into account what is the type of treatment and the degree of treatment that is necessary in order to follow the government guidelines. So, the effluent limitations are set by the State Department of Health.

So, what type of effluents, we can discharge into the stream, these limitations are set by the department of health based on the simulation characteristics of the receiving stream. So, receiving stream where we are discharging our treated wastewater, and other health factors.

So, depending upon that what are the state guidelines for ensuring the dumping or the discharge of the treated water into the flowing stream. We have to see that how our treatment facility must operate, what are the process parameters for operating a wastewater treatment facility. So that the discharge that we are putting into the stream is acceptable as per the government norms,so this is the project requirements.

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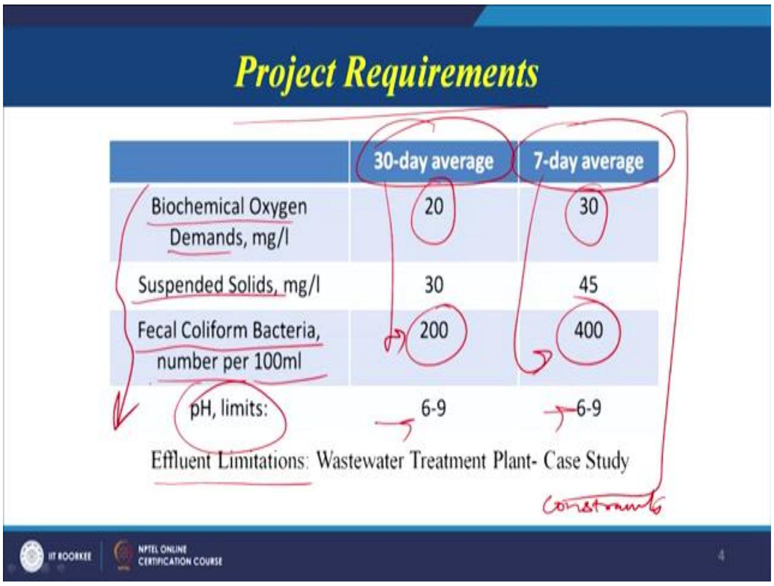

Now, we can see this is the level of accepted limitations as set by the government. So, biochemical oxygen demand this is 30 day average value is given 7 day, average similarly we can see fecal coliform bacteria number per 100 ml this number has to be satisfied 30 day average has to be this and 7 day average has to be this, so pH limits is also important 6 to 9. So, 30 day average values are given, 7 day average values are given, so these are the constraints which have to be taken care of while we are designing our facility.

So, based on the suspended solids also you see there can be other criteria also which are the effluent limitations. So, this is you can say requirement which the plant has to meet. So, if the plant is not able to get to this level of you can say limitations or this level of criteria the treatment will be ineffective and the government may not allow the effluents to be discharged into the stream, so this criteria has to be met.

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Now, this is a description of the project, the unit operations required for the treatment are, so what are the requirements we can see here, there is a liquid stream, and there is a sludge handling stream. So, this is star for ultimate capacity of the plant and double star is for the average flow that is required.

So, we can see, the liquid stream what are the important units there influent pumping, screening, grit removal, primary clarification, activated sludge unit, recycle pumping, final clarification and chlorination. Similarly in sludge handling primary sludge pumping, activated sludge pumping, so, all these are the units, so, as we have seen in value engineering that whenever we attack a problem, we use the technique of now since you know all the techniques blast create and refine.

So, what is our target? We try to blast the complete product or the complete facility or the complete service into it is individual components or parts or sub-assemblies and then we try to see, each and every subassembly that what is the basic function, and the secondary function of the subassembly and then we try to create, we try to generate, we try to brainstorm, and we try to find out a large number of alternatives which can solve the similar function, but at a reasonable cost or at a even at a higher cost, but at a lower overall life cycle cost based on that we try to select the best alternative, so that the functional requirements are met.

So, in that line only this complete, we can say, classification is into the individual units, like chemical conditioning incineration which is another synonym for burning. So, we have different types of units which make up this wastewater treatment facilities. Now, we can focus on each of these units independently, individually and then try to find out that what are the basics and the secondary functions for these units.

So, I will suggest that some of the terms here may not be that relevant to all the learners, so the important point to understand here is that what is the step by step procedure that we can follow to solve any actual problem. So, the actual problem here is that we have to find out a cost effective design so that our overall cost is minimized.

So, let us now, try to see the next stage that is who is going to the value engineering? Now, the project, we have a project at hand, we know this is the project that has to be solved, these are the project requirements, this is the level of effluent treatment, that is necessary, then what is the degree of effluent treatment necessary, then, what are the units that are there in a standard effluent treatment plant for wastewater treatment plant.

Now, based on these units the teams have to be made, as we have seen in the techniques of value engineering, use the expertise knowledge of the specialists that is one technique use the specialist knowledge of the vendors. So, when you are brainstorming or creative idea generation is going on we must take into account the expertise of the people, who can help us to solve this problem.

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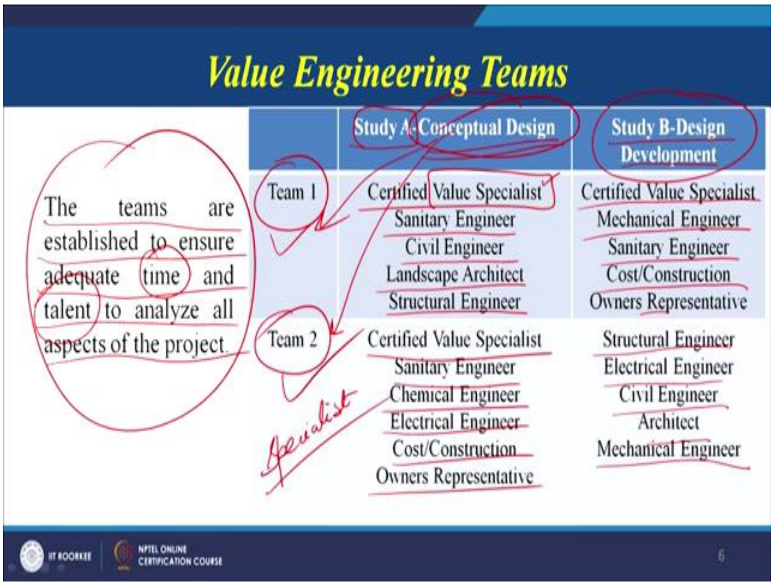

So, the teams are established, what is the purpose of the teams? The teams are established to ensure adequate time and talent to analyze all aspects of the project. So, in timely manner the project has to be completed and the talent has to be harnessed or used. So, we can see, team 1 is made up of a certified value specialists.

So, very special companies have this guts to have a value specialist. So, the companies which want to be successful normally like to have a value specialist, so, we have A in this case study there is a certified value specialist which is available with the company or they can hired as consultants also.

Then, there is a sanitary engineer, civil engineer, landscape architect and engineer this is team 1, so this study A is the conceptual design of the plant or of the facility. Similarly there is a team 2 again, there are certified value and the specialist, sanitary engineer, chemical engineer, electrical engineer, cost and construction, owners representative, so there are you can see team 1 and team 2 which is selected to solve this problem.

Then study B is the design, so first is a conceptual design. So, conceptual design is done by team 1 and team 2 and then the design and development that is study B that is done by certified value analyst again mechanical engineer, sanitary engineer, cost construction owners representative. Similarly, structural engineer, electrical engineer, civil engineer architect and mechanical engineer that is team 2. So, this is, the constitution of the teams that has been made to solve or to design this plant facility.

We can see that there are specialist drawn from different areas of expertise. So, there are mechanical engineers, electrical engineer, chemical engineer, sanitary engineers, value specialist representative from the construction company. So, there is a diverse group of individuals will sit brainstorm and find out creative solutions to solve to save a lot of money for the institute or for the government or for the organization which is going to develop this facility.

Now, we have a team, we have a problem at hand, we have the limitation and the constraints that we have to follow; now finally, we do the functional analysis.

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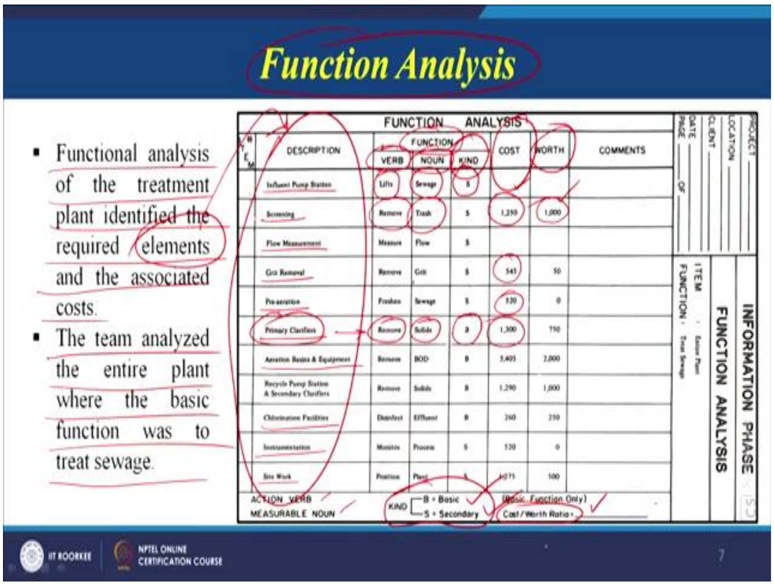

Now, what are the various units that we have already seen in the wastewater treatment facility? So, there is a influent pump station, screening is done, flow measurement, grit removal, pre aeration, primary clarifier aeration basins and equipment, chlorination instrumentation site work. So, there are lot of you can say, steps or elements that make up this wastewater treatment facility.

Now, we know, we do the functional analysis, we try to define the function, using the verb and a noun. So, this verb and noun technique is used, so, in verb and a noun what is the influent pump station, what is the function? Lifts sewage. Similarly suppose we say primary clarifiers what is the function? Remove solids.

Now, again the kind of function it is given here, the kind of function can be either basic or it can be secondary. So, the kind of function is also mentioned, influent pump station lift sewage that is the secondary function for this.

Similarly, primary clarifiers remove solid, this is the basic function for this facility and wherever possible the cost is also written. So, we have a cost component also similarly we can see action verb and measurable noun are put here. So, we can also, calculate the cost to worth ratio, this is a worth also is something which is mentioned. So, worth and cost sometimes it may be so possible that we are spending some money, but not adding any value to the facility or not creating any value for the facility so in that case, the worth may be less.

So, here also screening you see the remove trash cost is given, similarly, worth is also given that currently we are spending 1250 units of money, but it can be done in 1000 also. So, we can calculate cost by worth ratio. So, this is the basic functional analysis for the different units which we are going to use for our wastewater treatment facility.

So, functional analysis of the treatment plant identified the required elements. So, these are all the elements which are given in this column, and the associated cost. So, the costs are also given. The team analyze, the entire plant where the basic function was to treat the sewage. Now the basic purpose is known to all of us, it is a sewage treatment facility.

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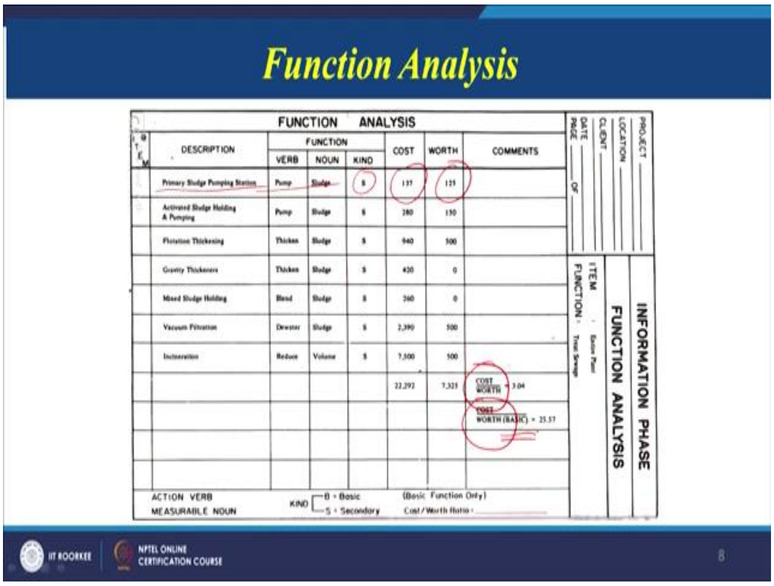

ITEM	DESCRIPTION	VERB	NOUN	KIND	COST	WORTH	COMMENTS
	Primary Sludge Pumping Station	Pump	Sludge	S	137	125	
	Activated Sludge Holding & Pumping	Pump	Sludge	S	280	150	
	Flotation Thickening	Thicken	Sludge	S	940	500	
	Gravity Thickeners	Thicken	Sludge	S	420	0	
	Mixed Sludge Holding	Blend	Sludge	S	260	0	
	Vacuum Filtration	Dewater	Sludge	S	2,390	500	
	Incineration	Reduce	Volume	S	7,500	500	
					22,292	7,325	COST / WORTH = 3.04
							COST / WORTH (BASIC) = 25.57

Now, we can see here again, this is primary sludge pumping station it is I think in continuation. So, we have verb and noun pump sludge it is a secondary function, the cost is this much, work is this much. So, very easily, we can calculate the total cost to worth ratio and cost to worth for the basic functions that have to be achieved. So, here we have seen that there are opportunities where we can make the modification, because the cost is on the higher side, the work is on the lower side.

So, therefore, we can see that if we put efforts in these particular subsections or sub elements of the overall sludge or the waste treatment facility, we can very easily reduce the gap between the cost and the worth.

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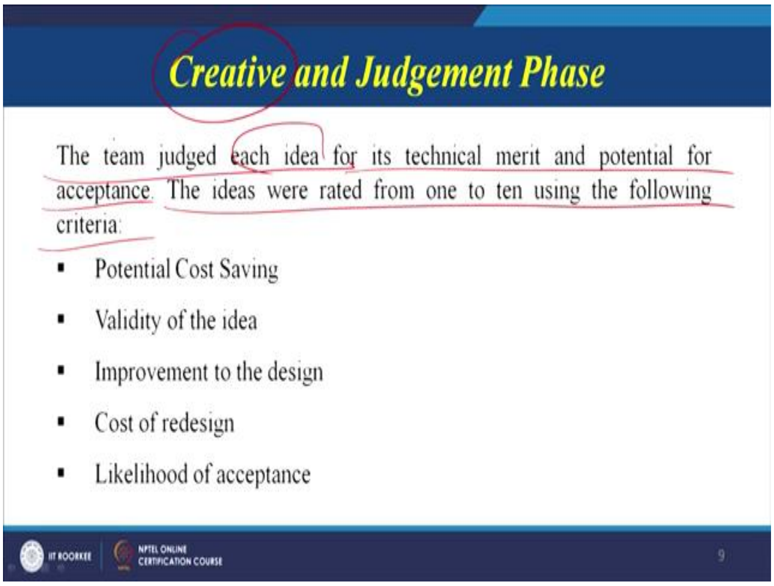

Now, the next stage as we know that this is the overall facility, these are the individual elements or the parts or the subsystems which create or which are responsible for our basic function of treating the sludge of the waste. So, we have now created a functional analysis matrix or functional analysis table, in which we know what is the role or what in engineering terms, what is the function of each and every facility.

What is the cost of that facility? Facility here I mean to say is the element or the part that is the part maybe this pump, this is for the basic function, this is the cost. So, after that now we can see that there are opportunities, where there is a difference between cost and the worth. So, why not to attack those problems or there are many units, many elements in the overall system which are only serving the secondary function are not contributing anything towards the basic function of treatment of sewage.

So, now, we have found out that yes, there exist a large number of opportunities which can be tapped, which can be exploited for better cost justification of the project, so, the team, there is a team already we know, there is a conceptual design team and there is actual equipment design team. So, the team judged each idea for it is technical merit and potential for acceptance, the ideas were rated from 1 to 10 following the criteria. So, the now creative and judgment phase number of ideas were created.

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PROJECT ______
LOCATION ______
CLIENT ______
DATE ______
PAGE ____ OF ____

NO (1)	CREATIVE IDEA (2)	ADVANTAGES (3)	DISADVANTAGES (4)	IDEA (5) RATING
1	Reduce air volume in space above pumps	Reduce Energy		7
2	Use screw pumps for return sludge pumps	Lower Energy Cost	Less Flexibility	3
3	Combine influent pump station with Existing station	Less Cost Easier Operation	Work while plant in operation	6
4	Install only 20MGD capacity	Save initial cost		6
5	Check hydraulic head losses	Minimize Head	None	7
6	Relocate grit tanks adjacent to Phase I, Plant	Less intercystor Combine operations	None	10
7	Reduce freeboard - Lower Roof of Grit Building	Initial Costs	None	7
8	Reduce size of Preaeration Tanks	Energy savings	None	10
9	Use Common Wall Construction with Grit Tank	Cost Savings	Minor Savings	7
10	Relocate meters	Save money	Eases Operation	10
11	Use Rectangular Clarifiers	Cost	Redesign	9
12	Reduce Yard Piping - Use Channels		More cost	6

LIST ALL CREATIVE IDEAS BEFORE PROCEEDING TO JUDGEMENT PHASE | 10 MOST DESIRABLE | 1 LEAST DESIRABLE

So, if we go to the next slide, we can see, there are large number of creative ideas which were generated and they are listed here one by one, and advantage of each idea and disadvantage of each idea is also given, and the rating to each and every idea is given.

So, we can see, the scale is from 1 to 10 for the ideas, 10 means most desirable, and 1 means least desirable. So, we can see that there are number of ideas which were generated like one of the ideas, I will read for you, use the screw pumps for return sludge pumps. So, we can this is one idea, that for return sludge pump. So, we must use, we can use screw pumps also then, there is another idea maybe I will read for reduce the size of the pre aeration tanks. So, it will lead to energy savings that is advantage, but there is no disadvantage for this idea.

Similarly, we can say reduce freeboard, lower roof of the grit building. So, advantage is initial cost will be less. So, we can see, their large number of ideas which were created. So, if we go back, and see the team judged each idea for it is technical merit and potential for acceptance.

The ideas were rated from 1 to 10 as we have seen 1 to 10 using the following criteria what is the criteria? What is the potential of the idea towards cost saving? What is the validity of the idea? Sometime, some of the ideas that we create may not be technically feasible or commercially viable, third is whether it is leading to improvement of the design then what will be the cost of redesign?

Sometimes it happens that it is very brilliant idea, but it challenges the very basic aspect of design and there is a lot of cost involved for redesigning. So, that also is a criteria to decide which idea is going to be feasible for us and the other criteria is likelihood of acceptance.

Because sometimes there may be a cultural mind block also, and sometimes a societal implications also, technically 5 ideas may be feasible, but maybe because of our cultural thought process or because of our societal way, the way we think or we the way we think as a community, the idea may be selected so, that the likelihood of acceptance also based on all the constraints as well as the criteria.

Now, based on all these criteria's these ideas was scrutinized, and ranking was given from one to ten and finally the best ideas were selected for further implementation. So, the development once we have seen that, there are number of idea; so this is a glimpse of the idea.

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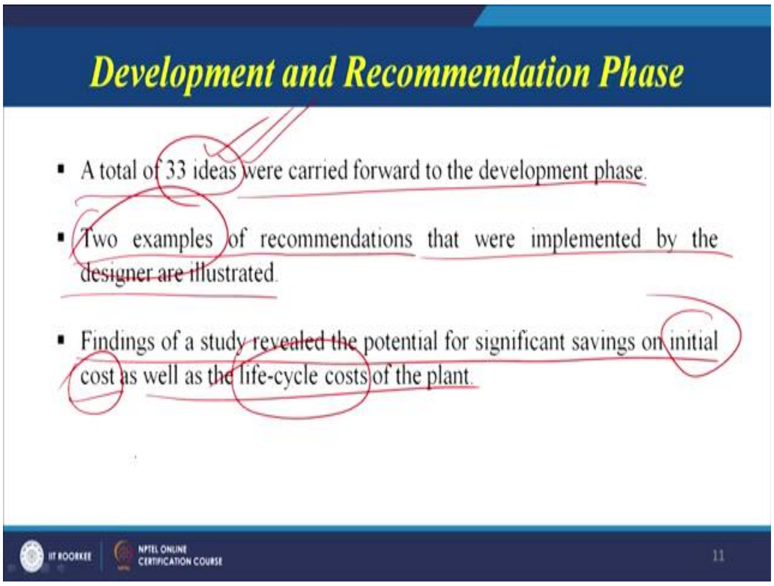

So, we can see that a total of 33 ideas were carried forward to the development phase, so, 33 ideas. Now, today, we are trying to take two examples of recommendations that were implemented by the designer. Today, we are going to talk about two examples only but there were 33 ideas which were generated by the conceptual design team.

Findings of a study revealed that potential for significant savings on initial cost as well as life cycle cost of the plant. So, whatever ideas were generated, they had the potential of savings not only on the initial cost, but also on the life cycle cost of the plant. So, we are quickly going to see that 2 ideas.

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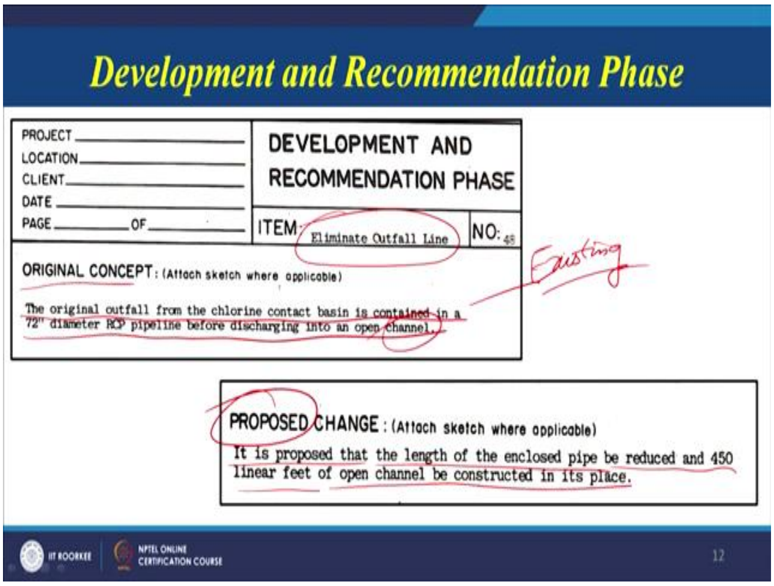

So, this is the development and the recommendation phase. So, we are showing the template also how the normally templates look like when we are going to report or document any value engineering case study.

So, we have seen that right from the identification of the problem, then collecting all the information related to the problem, then, forming a team which is going to solve the problem establishing the constraints and the design requirements, finally doing the functional analysis for each and every component of the design.

Then, the functional cost, analysis cost and worth ratio can be calculated, then we have to create a large number of ideas to focus on the functional requirements of the project or the plant or the product and finally, we select some best ideas based on criteria as we have seen in this study. Once the ideas are generated and they have been scrutinized based on certain criteria, we go to the next stage of development and recommendation.

So, here we are quickly going to take 2 ideas. So, this is idea number 1 that we are going to discuss today. So, the item is eliminate the outfall line original concept, what was the original concept? The original can outfall from the chlorine contact basin is contained in a 72 inch diameter RCP pipeline before discharging it into the open channel. This is our existing system, what is our proposed system? The proposed change is we will see in the diagram also, it is proposed that, the length of the enclosed pipe be reduced and 450 linear feet of open channel be constructed in it is place.

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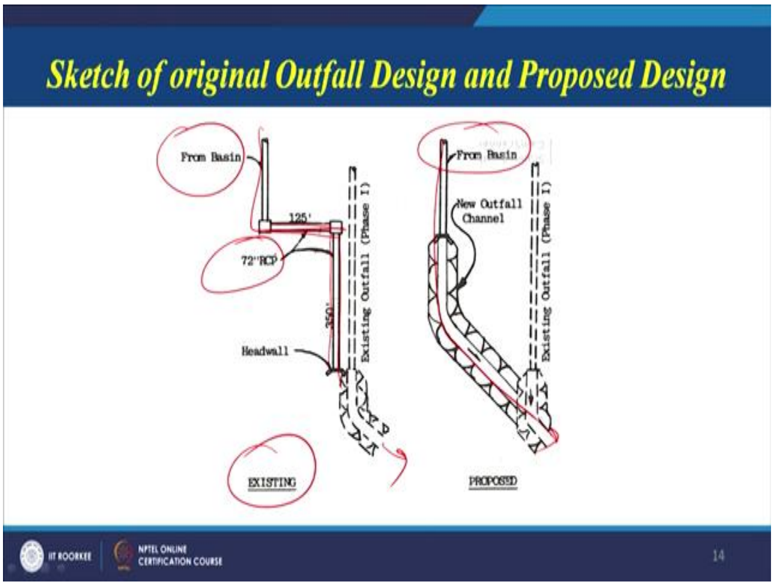

So, let us now, try to see the diagram, this is the diagram this is a 72 inch RCP, this one RCP pipe and the discharge is taking place here this is the existing design. But once we propose the change so this is from basin. So, this type of design is now modified to a straight design and here, it is being discharged. So, this RCP 72 inch RCP is not required now.

So, we can see here, the proposed change is, it is proposed on the length of the enclosed pipe, what is there? The original out fall from the chlorine contact basin is contained in a 72 diameter RCP pipeline. So, they say that it is proposed the length of the enclosed pipe be reduced and 450 linear feet of open channel be constructed in it is place. So, there is a change in the design which is helping us to achieve a cost benefit.

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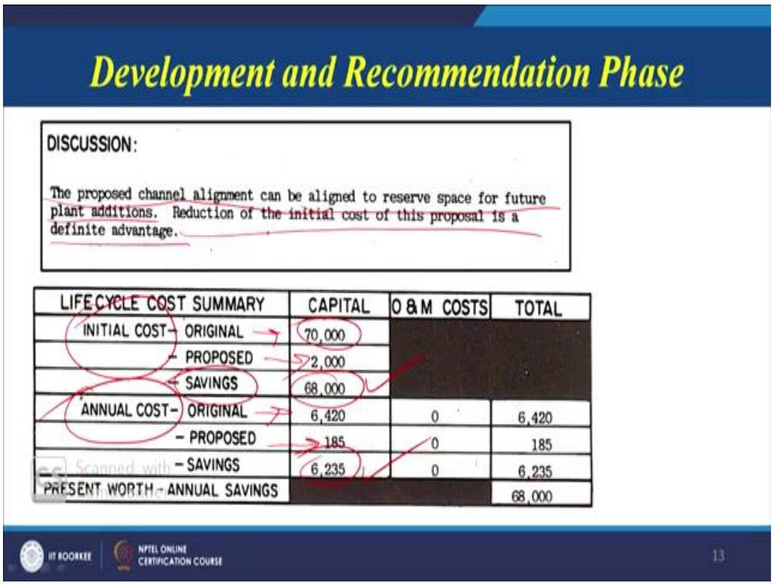

Now, what is a cost benefit that we can see the proposed channel alignment can be aligned to reserve space for future plant additions also, reduction of the initial cost of this proposal is a definite advantage. So, these are the advantages initial cost you see original design where RCP is used 70,000, and the proposed is only 2000 savings you can say 68000 only in single unit of the overall sewage treatment plant. So, the annual cost that is life cycle cost also original is 6420 and proposed is only 185 savings, you can see 6235. So, you can yourself see the savings, the savings are substantial.

Therefore, a slight modification in the design without affecting the functional requirement of the flow is able to save us a lot of money. Similarly, we can take the other concept also.

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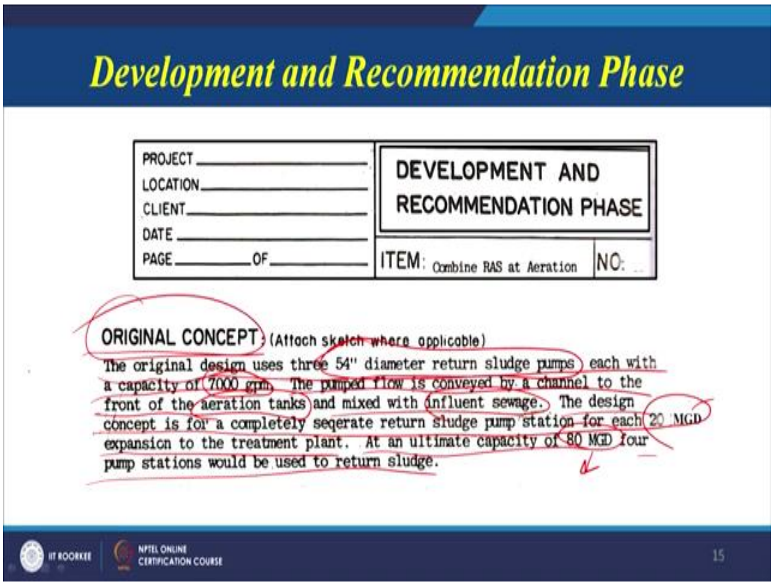

So, here, we can see what is the original concept? The original concept is the original design uses 3, 54 inch diameter return sludge pump each with the capacity of 7000 gallons per month. So, the original design 54 inch diameter return sludge pumps. So, these are the units which are being used and this is the capacity.

The pumped flow is conveyed by a channel to the front of the aeration tanks, and mixed with the influent sewage, the design concept is for a completely separate return sludge pump station for 20 MGD that is another capacity unit expansion to the treatment plant. So, this is another expansion that is possible at an ultimate capacity of 80 MGD, 4 pump stations would be used to return the sludge, so 80 MGD is million gallons per day.

So, this is you can say capacity, now this is the original concept. So, I think little bit detailed by as I told you in the very beginning that you may not be able to understand each and every terms of this case study, but the approach is important that how to approach a problem.

Now, here, in this case study this is sewage treatment case study. So, there will be use of lot of pumps, lot of channels through which the sewage will flow. So, we have to focus on these basic elements of pumps and the flow channels, and we have to optimize redesign them, so that we can save some money.

One of the case study already you have seen related to the chlorination tank and the discharge and change in the design has saved a lot of money. Similarly here also with proposed concept we can save lot of money. So, what is the proposed change?

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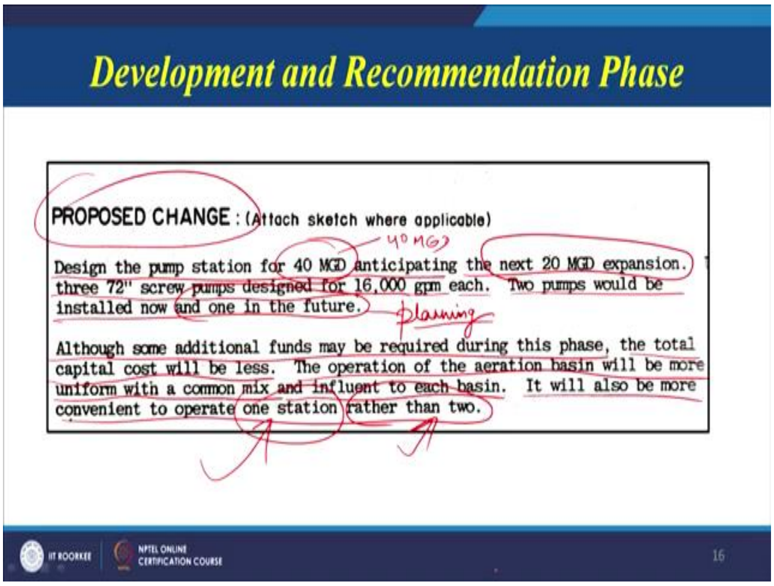

As, we have seen, there can be some modification in the capacity that we are handling some modification in the expansion capacity that we can handle at a later stage. So, some planning can help us save a lot of money. So, now, what is a proposed change, they say, design the pump station for a 40 MGD anticipating the next 20 MGD expansion. So, right now we can say it is 80 focuses on 80, but it is suggested that you go for a 40 MGD anticipating the next 20 MGD expansion.

372 inch screw pumps designed for 16000 gallons per month each. Two pumps would be installed now, and one in the future; one in the future means we are focusing on our planning aspect also we are planning for the future, and here also instead of original concept, we are modifying this figure as 40 MGD. Although some additional funds may be required during this phase, the total capital cost will be less. The operation of the aeration basin will be more uniform within a common mix and influent to each basin it will also be more convenient to operate one station rather than the two. So, instead of in place of two stations, we are now focusing on one station only.

So, I think, I may not have been able to clear the concept, you can say clearly, but the point is very clear that is how to solve any problem this is related to civil engineering or mechanical engineering design of a sewage treatment plant, before the discharge is put into the flowing stream. So, here, we can see, there is a large number of units which are combining to form a system, which is acting as a sewage treatment plant.

So, here, the reference is given in the very first slide, I suggest all the learners if possible, if the book is available in the library for all of you can focus on the detailed study because within a half an hour duration we will not be able to complete the studies. The idea is to give you a reference that such type of successful applications of value engineering are possible has been documented, and learners can take advantage of these documented case studies, and try to frame a thought process that if they apply the concepts principles, rules, guidelines, tools, techniques of value engineering a lot of money can be saved for the organization.

So, here, we have seen two such cases, in first case, there was a design modification in second case there was a management application of doing something now, planning something for the future, and then trying to save money for the organization by better planning of our facility. So, with this we conclude the today session, in next session we will also take another successful implementation of value engineering which will be discussed in the form of a case study.

Thank you.