IMPLEMENTATION OF GREEN BUILDING CONCEPT IN RESIDENTAL BUILDING

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Abstract
A safe and sufficient supply of water is required for human development. The gap between available water supply and water demand is growing by the day. Proper sanitation, particularly a decentralized approach, can solve the problem of water supply and wastewater management, which can be accomplished through the reuse of grey water. Grey water (GW) flow is typically around 65% of total wastewater flow from a household. Light grey water accounts for approximately 50% of total GW. As a result, GW has a high potential for recycling and reuse. To increase reuse practices at the grass roots level, technologies for GW treatment at the household level must be developed. Furthermore, different flow diagrams must be developed. Furthermore, there is a need for the developments of flow diagrams with various technologies that target the type of reuse flushing, gardening, agriculture, and so on. We reviewed grey water characteristics and various treatment technologies in this study with the goal of developing a schematic of a grey water recycling system designed specifically for domestic use. Grey water characteristics vary greatly; grey water amounts range from 50% to 80% of the wastewater volume produced by households.
Keywords: Grey water, household, recycling system, reuse, GW treatment, sanitation, green building

Introduction
Decentralized waste water treatment or treating waste water at source is gaining importance as the country is facing water shortage for meeting various water uses. Grey water includes any household water that is free from fecal matter. Hence water from kitchen sinks, bathroom, wash basins and washing machines can collectively be called as grey water. On the contrary water from toilets containing urine and fecal matter is known as black water. Grey water constitutes about 55-75 % of total household waste water. In this context grey water has good reuse potential as it is free from fecal coli forms and hence can be collected and treated separately in individual households. The degree of treatment decides its use for various non potables uses such as irrigation, toilet flushing or ground water recharge. The Ministry of Environment and Forests norms for environment clearance to construction projects is 100% treatment of grey water by collecting grey and black water in separate pipelines and reusing it for irrigation or flushing. But there are no recommendations for separating household grey water in India. The knowledge of the state of the art technologies adopted in grey waste water management in households in other countries can help in utilizing the reuse potential of it. Sometimes kitchen water and laundry water are not included in grey water due to the presence of oil and greases in kitchen water and surfactants in laundry water which may decrease the efficiency of the various physical and biological treatment techniques. Grey water is defined as wastewater without any contributions from toilet water. It is considered high volume, low strength wastewater with high potential for reuse and application. The composition of grey water is varied and depends on the lifestyle, fixtures and climatic conditions. Reuse of grey water has been an old practice, and it is still being done in areas that are water stressed. This practice if given the needed attention can help reduce the over-reliance on freshwater resources and reduce the pollution caused by discharge of untreated grey water into freshwater resources.

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Grey Water Characteristics

The water requirement per capita for an average Indian household with a sewerage system is 135 lpcd, of which approximately 70 - 90 l will be generated as grey wastewater. The characteristics of grey waste water differ greatly between households, depending on food habits and standard of living. TSS, oil, grease, and BOD are abundant in kitchen waste water, but COD, phosphorus (primarily inorganic in the form of phosphates), and xenobiotic compounds are abundant in bathing and laundry water.

Reduced Water Use

With the use of grey water management system the amount of water that was previously being used can be brought down to half. Water is known to be an essential asset for us. It is a resource that need to be conserved for generations to come and in order to do just that recycling grey water is the best option.

Saves Cash

On the off chance that you are being billed heavily in regard to the usage of water, by incorporating grey water recycling system your water bill will be cut down to half.

Heat Recuperation

Heated water incorporates thermal energy and this thermal energy goes down the drain each time we use water bathing, washing or utilize hot water for various other things. A grey water recycling system uses the thermal energy to warm new approaching cold water. This implies that its use reduces the measure of energy used up to 60%.

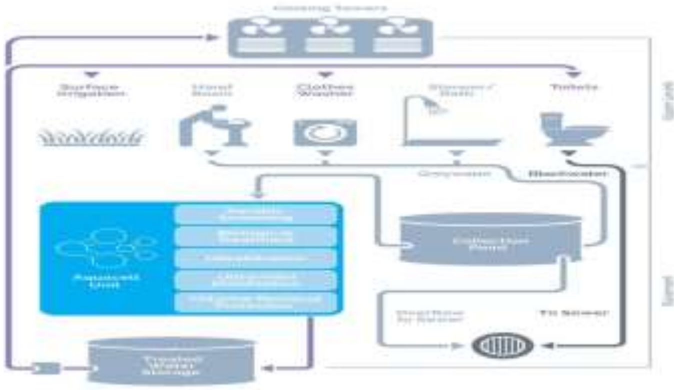

Fig 1: A grey water recycling system

Literature Review

Shaikh, Sk Sameer and Sk Younus, "Grey Water Reuse: A Sustainable Solution of Water Crisis in Pusad City in Maharashtra, India", International Journal on Recent and Innovation Trends in Computing and Communication, Vol 3:2, February 2015,pp. 167-170. [2] Manual on water supply and treatment, Ministry of Urban Development, New Delhi, 1999.Comparative test on household detergent powders, Consumer Voice, 2015

Fangyue Li, Knut Wichmann and Ralf Otterpohl, "Review of the technological approaches for grey water treatment and reuses", Science of the total environment,Vol 407, February 2009, pp. 3439–3449.

S Simon Jaboring, "Overview and feasibility of advanced grey water treatment systems for single households", Urban water Journal, 11:5, May2013. o Guide lines for safe use of waste water, excreta and grey water – Excreta and grey water use in agriculture, World Health Organistaion, 2006. Water reuse guidance manual factsheet, USEPA, 2012. [8] Waste Water Engineering: Treatment and Reuse, Metcalf and Eddy, Fourth Edition.

Materials and Methodology

Grey Water Treatment Techniques

The degree of treatment can be determined based on the desired treatment quality. Reusing domestic waste water for potable purposes necessitates a higher level of treatment, including tertiary

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treatment. Water quality for non-potable uses such as landscape irrigation, agriculture, toilet flushing, and ground water recharge, on the other hand, can be achieved more easily by employing traditional and cost-effective treatment techniques such as coagulation, filtration, and biological treatment systems.

Preliminary treatment

Removal of a fraction of suspended particles as well as oil and grease will help the efficient functioning of the main treatment scheme. Fine screens (size < 6mm) can be used to remove the suspended particles like dust, hair and food.

Physico- Chemical treatment

Achieving non potable water usage standards for grey water demands considerable removal of turbidity and SS which can be achieved by physicochemical techniques like filtration and coagulation. These are conventional and cost effective techniques used in community water supply schemes. As the organic loading in grey water is less, properly.

Biological treatment

Studies have reported biological treatment techniques like Membrane Bio Reactor, Rotating Biological Contactor and Sequential Batch Reactor to be effective for comparatively low organically loaded grey waste water.

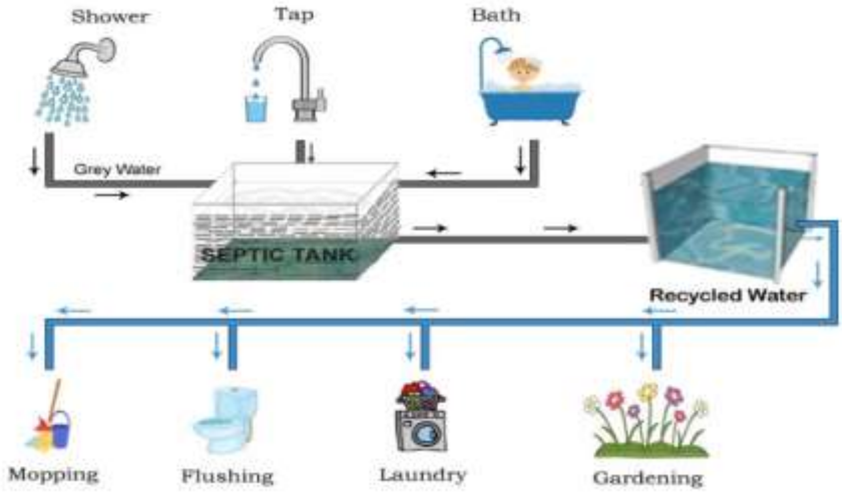

Fig 2: Categories of Water

Clean Water

A safe water supply is the foundation of a healthy economy, but it is woefully underfunded globally. Waterborne diseases are estimated to cost India approximately USD 600 million per year in economic costs. This is especially true in drought and flood-prone areas, which have affected one-third of the country in recent years.

In India, less than half of the population has access to safe drinking water. Water is contaminated with chemicals, primarily fluoride and arsenic, in 1.96 million homes.

Grey Water

Grey water (also spelled grey water in the United States) is domestic wastewater generated in households or office buildings from streams free of faces, i.e. all streams except toilet wastewater. Sinks, showers, baths, washing machines, and dishwashers are all sources of grey water. Grey water is generally safer to handle and easier to treat and reuse onsite for toilet flushing, landscape or crop irrigation, and other non-potable uses because it contains fewer pathogens than domestic wastewater. Grey water may still contain pathogens from soiled clothing or cleaning the anal area in the shower or bath.

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Fig 3: Grey water Sample

Process Involved In Water Treatment

Chemical flocculants provide an extremely effective treatment in coagulation processes. As the name implies, they are chemically synthesised from various monomers derived from electrolytes, cationic, anionic, and nonionic polymers. However, many studies have found that these chemical flocculants are toxic.

They generate sludge containing high concentrations of metal hydroxides, which are toxic to living organisms if released into bodies of water. Organic flocculants used to treat water include alum, aluminium chlorohydrate, and aluminium sulphate.

Test on Treated Grey Water

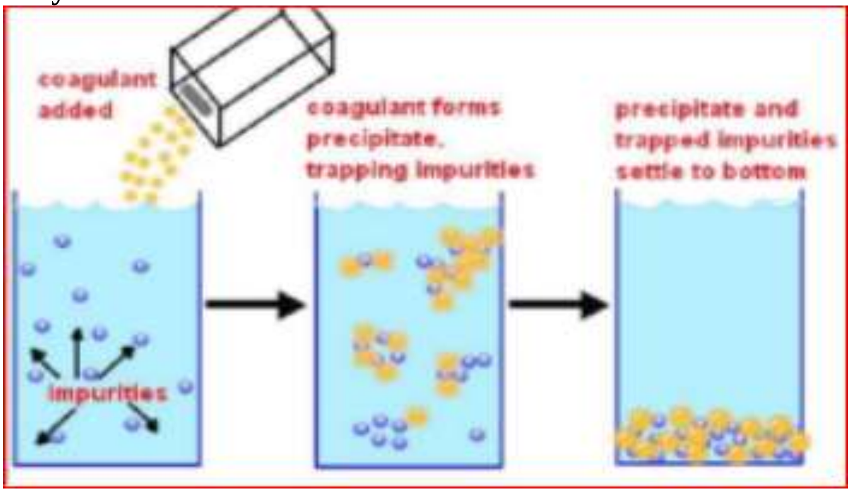

Fig 4(a): pH Test

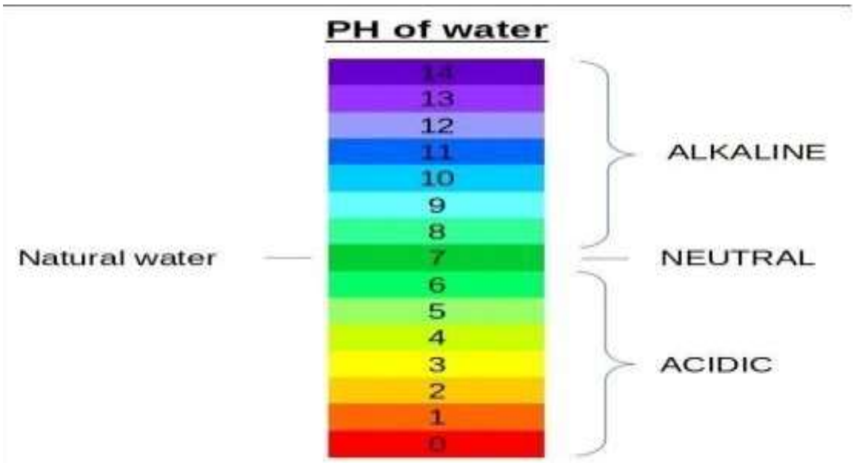

Fig 4(b): pH Test

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Jar Test

The laboratory jar test is used to choose and quantify a treatment programme for removing suspended solids or oil from raw water, a dilute process, or a waste stream. Jar tests are carried out on a four- or six-gang stirrer, which can simulate mixing and settling conditions in a clarifier. Jars (beakers) containing different treatment programmes or the same product at different dosages are run side by side, and the results are compared to an untreated jar or one containing the current programme.

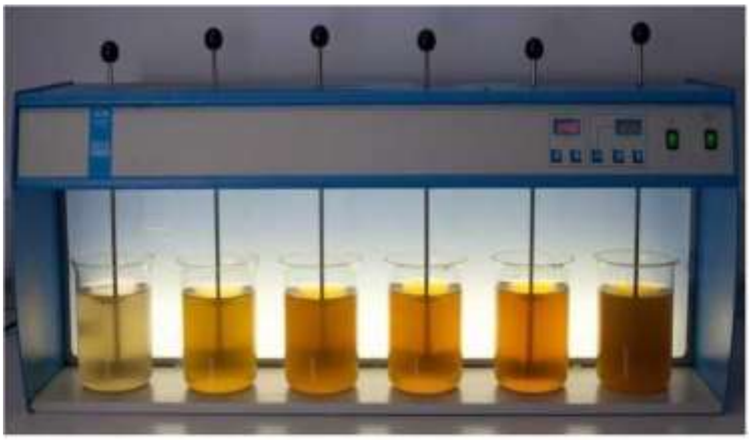

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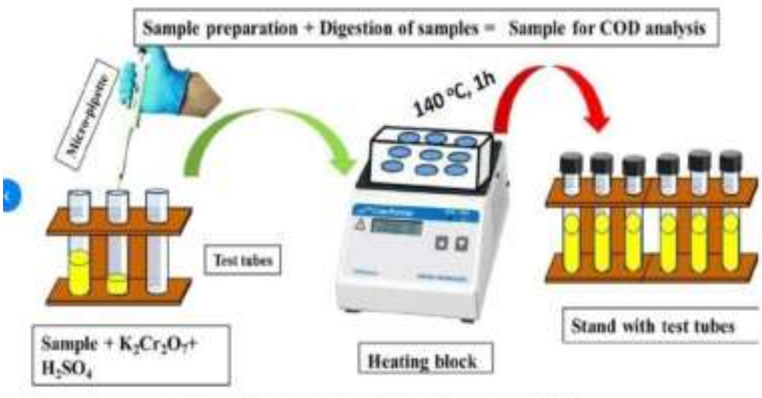
Fig 5: Jar Test

Chemical Oxygen Demand Test

Prior to completing the COD test, a series of known standards are prepared using KHP (potassium hydrogen phthalate). Most wastewater samples will fall in the high range, so standards of 100, 250, 500 and 1000 mg/L are typically prepared. COD standards can also be purchased.



Schematic experimental diagram for determination of chemical oxygen demand (COD).

Fig 6: Chemical Oxygen Demand Test

BIO Chemical Oxygen Demand

Standard Potassium Dichromate Reagent - Digestion Solution Weigh accurately 4.913gof potassium dichromate previously dried at 103 ºC for 2 - 4 hours and transfers it to a beaker. Weigh exactly 33.3g of mercuric sulphate and add to the same beaker. Measure accurately 167 ml of concentrated sulphuric acid using clean dry measuring cylinder and transfer it to the beaker. Dissolve the contents and cool to room temperature.

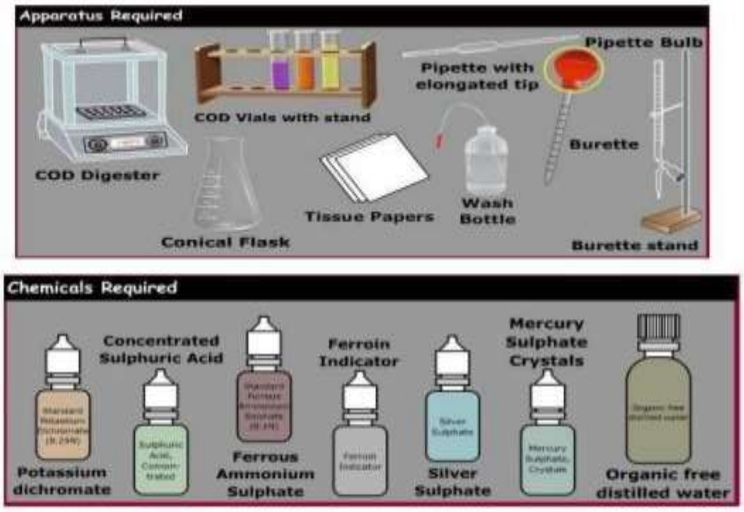


Fig 7: BIO Chemical Oxygen Demand

To determine the conductivity of the given sample

Fig 8: Conductivity of the given sample

Table 1: BOD level

BOD LEVEL	Water Quaity
1-2	Very Good There will not be much organic waste present in the water Supply
3-5	Fair : Moderately Clean
6-9	Poor : Somewhat polluted
100 or greater	Very Poor : Very Polluted Contains orgains

Alkalinity

Alkalinity is a measure of the ability of the water to resist changes in pH, this is also known as buffering. For the majority of applications, it is important to maintain a stable pH.

Alkalinity is made up of calcium and magnesium carbonates, bicarbonates, chlorides and sulfates, however it is conventionally always quoted as mg/L $CaCO_3$.

Acidity

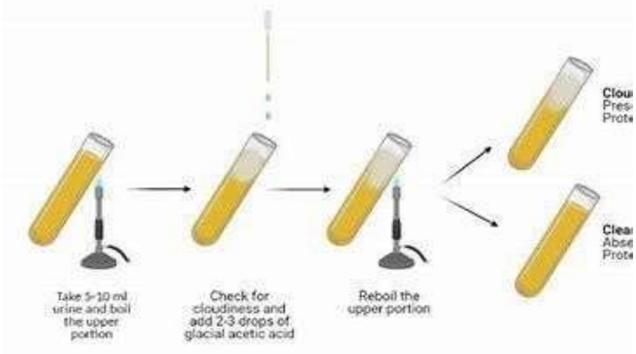


Fig 9: Acidity test

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Table 2: Amount of minerals present in the water

S.NO	PARAMETERS	LIMITS
1	pH	6.5-8.5
2	Electric conductivity	1500 µ/cm
3	Nitrate	45 mg/l
4	Chloride	250 mg/l
5	Fluoride	1 mg/l
6	Sulphates	200 mg/l
7	Iron	0.3 mg/l
8	Sodium	0 mg/l
9	Potassium	3.5 mg/l

Results and Discussion

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Water Analysis Report

Report No. CB02243 DT09-04-2022 Rev Dt:05-04-2022, 1.08 pm

Place of Sample & Description of Source as in WCR + Clarifications: Research students in SNR Boys Hostel Kompally, Hyderabad. Borewell details in the hostel not known. Borewell water is used in washing machine. The waste water from washing machine delivery pipe is collected into empty 1 liter Bisleri packaged water bottle (2 Nos). This is in the interest of an academic project.

Other sample(s) from same client Nil

Sample Collection Data (as in WCR) Date: 05-04-2022, 12.15 pm By: Mr. Shravan Reddy, Mr. Nitish Kumar, Mr. Satish Patil, students of CMR College of Engineering and Technology

Desired Testing Ser. & Code: Groundwater Potability Tests (GPT)

Client concerns: After proper treatment, it is to determine the suitablility of water for agriclutuure, floor cleaning, car cleaning and toilet flush

Test Request by: (as in TRL/Receipt) Mr. P. Shravan Reddy, CMR College of Engineering and Technology,Hyderabad, Mobile: 8220853851 Email: shravann82@gmail.com

Test Dates:

Group	Start	End	Interpretation & Reporting
Physical	05-04-2022	05-04-2022	The time between end of analysis and report dates is utilised for clarifications & interpretation of results.
Chemical	05-04-2022	06-04-2022	
Microbial	05-04-2022	08-04-2022	

A. Physical & Sensory Characteristics:

Sl	Parameter & Estimation Methods		Observed Value (OV)	Units	IS:10500 Ref. Values Acceptable	IS:10500 Ref. Values Permissible
1	Colour (Filtered by WM42 Paper / 0.45µ Membrane)	:	0 Colourless	PCU (Hazen) Naked Eye Observation	5	15
2	Odour	:	Surf/detergent smell	Odor Rating	Agreeable	Agreeable
3	Turbidity	:	30.0	NTU	1	5
4	pH At 25°C	:	8.0	pH value	6.5 to 8.5	No relaxation
5	Electrical Conductivity (EC)	:	1822	µ Siemens / cm		2000 (CPCB)
	TDS Range Est. (TDSE) from EC	:	911 - 1,366.5	mg/ltr (ppm)	500	2,000
6	Total dissolved solids (TDSG)	:	1094	mg/ltr (ppm)	500	2,000

1.Color is based on IS3025 Part-4 platinum cobalt visual comparison; Colorless= 0 Hazen Unit (PCU).
2..Odor rating by lab personnel: Odour rating by an expanded, 5members smell panel, (4)Detergent smell (1) surf smell.

The Institute of Health Systems, Kukatpally, Hyderabad, TS 500072, India. Page 1 of 3

B. Chemical Characteristics:

Sl	Parameter & Estimation Methods		Observed Value (OV)	Units	IS:10500 Ref. Values Acceptable	Permissible
1	Alkalinity (Alk)					
a	Phenolpthalene Alk (P)	:	0	As $CaCO_3$ mg/l		
b	Total Alkalinity (T)	:	299.2	As $CaCO_3$ mg/l	200	600
c	Carbonate (CO_3)	:	0	As $CaCO_3$ mg/L		
d	Bicarbonate (HCO_3)	:	299.2	As $CaCO_3$ mg/L		
e	Hydroxides (OH)	:	0	As $CaCO_3$ mg/L		
2 a	Total Hardness	:	430	As $CaCO_3$ mg/l	200	600
b	Calcium	:	88.1	As Ca^{++} mg/L	75	200
c	Magnesium	:	51	As Mg^{++} mg/L	30	100
d	Carbonate hardness	:	299.2	As $CaCO_3$ mg/l		
e	Non-CO_3 hardness	:	130.8	As $CaCO_3$ mg/l		
3	Nitrogen					
a	Ammonia (NH_3)	:	0.00	$NH_{3/4}$-N mg/L	0.5	No relaxation
b	Nitrite (NO_2)	:	0.0190	As NO_2-N mg/L	WHO: 0.9 mg/l as N	
c	Nitrate (NO_3)	:	23.10	As NO_3 mg/L	45	No relaxation
	As Nitorgen	:	5.22	As NO3-N mg/L	10	No relaxation
4	Chloride	:	155.2	As Cl^- mg/L	250	1,000
	Chloride meq/l	:	4.37	meq/L		
5	Flouride	:	0.95	As F^- mg/L	1	1.5
6	Sulphates	:	231.8	As SO_4 mg/L	200	400
7	Total Iron	:	0	As Fe mg/L	0.3	1
8	Manganese	:	0	As Mn mg/L	0.1	0.3

C. Bacteriological Analysis:

Sl	Parameter & Estimation Methods		Observed Value (OV)	Units	IS:10500 Ref. Values Acceptable	Permissible
1	Total Coliforms	:	1600(600,5300)	MPN/100ml,(95%CI)		
2	Thermotolerant Coliforms	:	Present	Absent / Present	Absent	Absent
3	*E.coli*	:	Present	Absent / Present	Absent	Absent

1.Most probable number (MPN) & 95% Confidence Interval (CI), is estimated by results of 48h incubation of 5 MacConkey broth culture tubes for each of 3 (10, 1 & 0.1 ml) dilutions, using IS1622-1981 App-B, Table-3/4.
2.Positive culture of total coliforms, from one of the tubes with minimum dilution, is cultured in HiMedia brilliant green lactose broth (BGLB) in water bath at 44°C for 24 hours and examined for gas formation to identify thermo-tolerant coliforms.
3.Positive culture of total coliforms, from one of the tubes with minimum dilution, is cultured in HiMedia tryptone water in water bath at 44°C for 24 hours, and examined, after adding Kovac's reagent for pink ring to identify presence of E.coli.

Chemical materials	Cost of material
Potassium Alum – **KAl $(SO_4)_2 \cdot 12H_2O$ (7gms for1000ml)**	320 RS
Hydrochloric acid and potassiumchloride (buffer solution)50 g for 80L of water	250 RS per liter
UV filter	2000 RS
Active carbon filter	500 RS
Chlorine filter	800 RS

Physical materials	Cost of material
Water tank Capacity(500*4) =2000Liter's	**2*7000=14000 RS**
Pipes 3 meter (2 inchdiameter)	**140 RS**
Pump motor (1.5 hp)	**3000 RS**

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D. Notes and Recommendations:

1. The results may be interpreted as per the clients' research project design.
2. The following references may be of interest for the study:
   i. Seth KN; Patel Mittal, and Desai Mrunali D. A Study on Characterization & Treatment of Laundry Effluent. International Journal for Innovative Research in Science & Technology (IJIRST). 2017 Jun; 4(1):47-49. https://ijirst.org/Article.php?manuscript=IJIRSTV4I1017
   ii. Rodrigues Karen Campos; Morais Lucas Salomao Rael de, and Paula Heber Martins de. Green/sustainable treatment of washing machine greywater for reuse in the built environment. Cleaner Engineering and Technology. 2022; 6(100410). https://www.sciencedirect.com/science/article/pii/S2666790822000155

End of the Report

Director

Test results are given only in relation to sample(s) tested for desired test service, & based on sampling information provided by the client. The test report shall not be reproduced except in full, without prior written approval of the laboratory.

References:

IS10500. Indian Standard Drinking Water Specification. Second Revision. New Delhi: Bureau of Indian Standard (BIS); 2012 May; https://law.resource.org/pub/in/bis/S06/is.10500.2012.pdf.
WHO. Guidelines for drinking-water quality. Fourth Edition. Geneva: WHO, 2011. Http://www.who.int/water_sanitation_health/publications/2011/dwq_guidelines/en/

Parameters	Observed Value	Acceptable
1 Alkalinity		
Phenolpthalene	o	ok
Total Alkalinity	299.2	Yes
Carbonate	0	
Bicarbonate	299.2	
Hydroxide	O	Yes
2 total hardness	430	Yes
Calcium	88.1	Yes
Magnesium51	51	Yes
Carbonate Hardness	299.2	
Non CO3 hardness	130.8	
3 Nitrogen		
Ammonia	O	No
Nitrite	0.0190	Yes
Nitrate	23.10	No
4 Chloride	155.2	No
5 Flouride	0.95	Yes
6 Sulphates	231.8	Yes
7 Total Iron	0	Maybe
8 Magnese	0	Maybe

Wastewater type	Total waste water Total (%)	Total waste water (L/day)
Toilet	32	186
Hand basin	5	28
Bath/shower	33	193
kitchen	7	44
laundry	23	135

Conclusion

Grey water reuse is an important option for lowering potable water consumption in various building occupancies. The review reveals significant variations in the quality and quantity of grey water over time and across sources, and that variability is largely due to the treatment system chosen. The review also reveals that when recycled grey waters are properly treated, heavy metals and organic micro-contaminants pose no threat to human health. The results revealed that the strategy's environmental benefit is the use of water-efficient systems. This saves a lot of water and reduces waste. Because of the lower energy consumption throughout the life cycle, the environmental impact is minimal.

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Reference

1.Greywater.com. (2004). Greywater - what it is, how to treat it, how to use it (www.greywater.com). Greywatersafer.com. (2004). Greywater safer (www.greywatersafer.com).

2.Ledin, A., Eriksson, E., and Henze, M. (2001a). Aspects of groundwater recharge using grey wastewater. In Decentralised Sanitation and Reuse, G. Lettinga, ed (London), pp. 650.

3.Ledin, A., Eriksson, E., and Henze, M. (2001b). Aspects of groundwater recharge using grey wastewater. In Decentralised Sanitation and Reuse, P. Lens, G. Zeemann, and G. Lettinga, eds (London), pp. 650. · Little, L. Gray water Guidelines, T.w.c.a.o.s. Arizona, ed (The water conservation alliance of southern Arizona), pp. 25.

4.Marshall, G. (1996). Greywater Re-Use: Hardware, Health, Environment And The Law. In Sixth International Permaculture Conference & Convergence, P. Austin, ed (Perth & Bridgetown, Western Australia). · Morel, A. (2002). DEWATS - Decentralized wastewater treatment systems.

5.Morel, A., and Koottatep. (2003). Decentralized wastewater management. · Nolde, E. (1999). Greywater reuse systems for toilet flushing in multistory buildings - over ten years experience in Berlin. In Urban Water, pp. 275- 284.

6.Agency-UK, E., 2011. Greywater for domestic users: an information guide. Published by environmental agency. Available at: www.enviroment-agency.gov.uk.

7.Al-Hamaiedeh, H., Bino, M., 2010. Effect of treated grey water reuse in irrigation on soil and plants. Desalination 256, 115-119.

8.Al-Jayyousi, O.R., 2003. Greywater reuse: towards sustainable water management. Desalination 156, 181-192.